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Fig 4
Fig 5.
Fig 6
Fig 3
Receiver
STEAM
EXHAUST
250 Hub
7000
1260
1020
720
1300
2600

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Midland Railway Carriage and Wagon Co Limited .. .. Abbey Works, Shrewsbury

Castings (Iron).

Bodley Brothers & Co. .. .. Exeter
Bowling Iron Co., Limited .. Bradford
Carrick & Wardale .. .. Gateshead
Clay Cross Co .. .. .. Clay Cross, near Chester
Clayton, Howlett & Venables .. Harrow Road, London, W
Cookshott & Jowett .. .. Thornton Road, Bradfor
Forsyth, Miller & Co. .. .. Mile End, Glasgow
Goodwin, J., & Co. .. .. Motherwell, N.B.
Harper & Co. .. .. .. Aberdeen
Hind, H., & Son .. .. .. Nottingham
Hunter & English .. .. .. Bow, E.
Jackson, P. R., & Co. .. .. Salford Rolling Mills, Mi
Macfarlane, Walter, & Co .. Possil Park, Glasgow
McCulloch, T., & Sons .. .. Kilmarnock
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbu
Neill, W., & Son .. .. .. St. Helen's Junction, Lan
Savile Street Foundry and Engineering Co., Limited.. .. Sheffield
Tinsley, Eliza .. .. .. Greatbridge, Staffordshi

Castings (Malleable Iron).

Palmer, W. R., Limited .. .. Bagot St. Foundry, Birmi
Tangyes Limited .. .. .. Cornwall Works, Birmin

Castings (Steel).

Askham Bros. & Wilson, Ltd .. Sheffield
Bessemer, Henry, & Co., Limited Sheffield
Bowling Iron Co., Limited .. Bradford
Brown, Bayley, Dixon & Co. .. Sheffield
Darlington Steel & Iron Co., Ltd. Darlington
Forsyth, Miller & Co. .. .. Mile End, Glasgow
Hadfield Steel Foundry Co. .. Sheffield
Jackson, P. R., & Co. .. .. Salford Rolling Mills, Master
Jessop, Wm., & Sons .. .. Sheffield
Landore-Siemens Steel Co. .. Landore, South Wales
Osborn, S., & Co. .. .. .. Sheffield
Reichwald, A. .. .. .. Newcastle-on-Tyne
Savile Street Foundry and Engineering Co., Limited.. .. Sheffield
Spencer, John, & Sons .. .. Newburn Steelworks, castle-on-Tyne
Stanners Close's Steel Co .. Wolsingham, via Darling
Steel Co of Scotland, Ltd., The Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmin

Cement.

Burham Brick, Lime and Cement Co., Limited .. .. Nicholas Lane, E.C.
Francis & Co .. .. .. Vauxhall, S.W.
Francis, C., Son & Co .. .. 17, Gracechurch Street, I
Greaves, Bull & Lakin .. .. Warwick
Rugby Portland Cement Co .. Rugby, Warwickshire
Wouldham Cement Co .. .. 30, Lime Street, E.C

Chains and Cables.

Hodgkinson & Co., Limited .. Manchester
Pickering, John .. .. .. Stockton-on-Tees
Whitehouse & Co .. .. .. Tipton, Staffordshire
Wright, Jos & Co .. .. .. Tipton, Staffordshire

Chemical Works (Plant for).

Carrick & Wardale .. .. Gateshead
Daglish, R., & Co .. .. .. St. Helen's, Lancashire
Grange Iron Co., Limited .. Durham
Piggott, Thos., & Co. .. .. Birmingham

Clutches (Friction).

Bagshaw, J., & Sons .. .. Batley
Mather & Platt .. .. .. Salford Ironworks, Manc

Coal Cutting Machines.

Grange Iron Co., Limited .. Durham

Coal Merchants.

Clay Cross Co. .. .. .. Clay Cross, near Chesterf

Coke Ovens.

Jameson Patent Coking Co. .. St. Nicholas Chambers, castle

Colliery Plant.

Clay Cross Co. .. .. .. Clay Cross, near Chesterf
Daglish, R., & Co. .. .. St. Helen's, Lancashire
Davy Brothers, Limited .. Sheffield
Goodwin, James, & Co. .. Ardrossan, N.B.
Grange Iron Co., Limited .. Durham
Hathorn, Davey & Co .. .. Leeds
Lowca Engineering Co., Ltd., The Whitehaven
Walker Brothers .. .. .. Pagefield Ironworks, Wig
Woods, H., & Co. .. .. .. Salford, Manchester

Compasses.
Negretti & Zambra .. .. Holborn Viaduct, E.C.

Condensers (Fresh Water).
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Normandy, A. .. .. .. Custom House Station, Victoria Docks, E.
Suffield & Brown .. .. .. James St., Commercial Rd. E.

Coppersmiths.
Birmingham Battery & Metal Co. Birmingham
Storey, I., & Sons .. .. .. Knott Mill, Manchester

Cotton Presses.
Pigott, Thos., & Co. .. .. Birmingham
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Couplings (Railway).
Roger, Robert, & Co. .. .. Stockton-on Tees
Turton, Geo. .. .. .. 4, Westminster Chambers, S.W.

Cranes, Travellers, Winches, &c.
Appleby Brothers .. .. .. East Greenwich, S E.
Ashbury Railway Carriage & Iron Co., Limited .. .. Openshaw, Manchester
Balmforth, Wm., Executors of (Loco Steam) .. .. .. Rodley, near Leeds
Bowser, W., & Son .. .. Great Wellington St , Glasgow
Butters Brothers .. .. .. 63, Hope Street, Glasgow
Carrick & Ritchie .. .. .. Edinburgh
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Cochrane, Jno. .. .. .. Barrhead
Coles, H. J. .. .. .. 89, Summer Street, S E.
Cowans, Sheldon & Co., Limited St. Nicholas Works, Carlisle
East Ferry Road Engineering Works Co., Limited .. .. Millwall, E.
Fielding & Platt .. .. .. Gloucester
Gibbins, R C., & Co .. .. Berkley Street, Birmingham
Grange Iron Co , Limited .. .. Durham
Hanna, Donald & Wilson .. .. Paisley, N.B.
Hanson, Wm .. .. .. Quebec Works, Bradford
Ianson, C., Son & Co .. .. Darlington
Ince Foundry & Engineering Co Newport, Monmouthshire
Jessop, J., & Son .. .. .. Leicester
Melville, W. M. .. .. .. Kirkcaldy
Ormerod, Grierson & Co .. .. Hulme, Manchester
Paul, M., & Co .. .. .. Lowestoft Works, Dumbarton
Pickering, Jthn. .. .. .. Stockton-on Tees
Priestman Brothers .. .. .. Hull
Ransomes & Rapier .. .. .. 5, Westminster Chambers, S W
Roger, R., & Co. .. .. .. Iron Foundry, Stockton-on-Tees
Rose, Downs & Thompson .. .. Hull
Russell, Geo., & Co .. .. .. Motherwell, near Glasgow
Saville Street Foundry and Engineering Co , Limited .. .. Sheffield
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Shanks, Alexander, & Son .. .. Deus Ironworks, Arbroath
Shirlaw, A., & Co.. .. .. Berkley Street, Birmingham
Smith, Thos .. .. .. Rodley, near Leeds
Stothert & Pitt, Limited .. .. Bath
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Thomas, T., & Sons .. .. .. Acme Works, Cardiff
Tweddell, R H .. .. .. 14, Delahay Street, S.W.
Walker, T., & Co. .. .. .. Leeds
Wilson, J. H., & Co .. .. .. Sandhills, Liverpool

Crankshafts.
Beardmore, I & W .. .. .. Glasgow
Bessemer, Henry, & Co , Limited sheffield
Clarke's Crank Co , Limited .. Lincoln
Mersey Forge, Limited, The .. Liverpool

Crucibles.
Doulton & Co .. .. .. Lambeth, S E.

Die Makers.
Patent (Metal) Die Co. Ltd., The 29, Addington Street, S.E

Disincrustants.
Bell, J. .. .. Asbestos Works, Southwark, S.E.
Hannay's Marine Appliances Co , Limited .. .. .. 67, Great Clyde Street, Glasgow
The Disincrustant Marseillais Co Cheetham, Manchester

Disinfectors.
Manlove, Alliott, Fryer & Co . Nottingham

Disintegrators.
Askham Bros. & Wilson, Ltd .. Sheffield
Evans, J., & Co. .. .. Trumpet St , Guthorne, Manchester
Farmer, Jas , & Sons .. .. Salford, Manchester
Hartley & Arnoux Brothers .. Stoke-on Trent
Jordan, T. W., Son & Commans 52, Gracechurch Street, E.C.
Marsden, Francis . .. . Sheffield
Triggs, P. (Carr's) .. .. .. 39, Broad Street, Bristol

Distillery Plant.—*(See Brewery and Distillery Plant).*

Distilling (Water) Apparatus.
Chaplin, Alex., & Co. .. . Glasgow
Normandy, A .. .. . Custom House Station, Victoria Docks, E.
Rosa & Duncan .. .. Glasgow

Diving Apparatus.
Barnett & Foster .. .. . 252, Eagle Wharf Road, N

Drawings, Tracings, &c.
Kell, J , & Son .. .. . 40, King Street, Covent Garden
Messer & Thorpe .. .. .. 8, Quality Court, E C

Dredging Machines.
Bruce & Batho .. 9, Victoria Chambers, S W.
Clark, Bunnett & Co., Limited .. Bathbone Place, W
Edwards & Symes .. .. .. Wharf Road, Cubitt Town, E.
Fleming & Ferguson .. .. Paisley, N B.
Hanna, Donald & Wilson .. Paisley, N B.
Hunter & English .. .. .. Bow, London, E
Priestman Brothers .. .. Hull
Rose, Downs & Thompson .. Old Foundry, Hull
Stothert & Pitt, Limited .. .. Bath

Drying Machines for Textile Materials.
Smith & Johnston .. .. .. Paisley Road, Glasgow

Ebonite.
Winter, F .. .. 138, London Wall, E.C.

Economisers (Fuel).
Gosling, Robert, & Co. .. .. Hatton Court, Ipswich
Green, E., & Son .. .. .. St Ann's Square, Manchester
Lowcock, A.... .. .. Colebam Foundry, Shrewsbury
Pollock, Macnab, & Highgate . Shettleston, Glasgow

Electric Lighting Plant.
Crompton, R. E., & Co .. . Arc Works, Chelmsford
Edison & Swan United Electric Light Co., Limited, The .. 57, Holborn Viaduct, E.C.
Glover, W. T., & Co. .. .. 25, Booth Street, Manchester
Lane, Howard, & Co. .. .. 110 & 116, Palmerston Buildings, London, E.C.
Woodhouse & Rawson .. .. 11, Queen Victoria Street, E.C.

Electrical Engineers.
Chamberlain & Hookham, Ltd.. Birmingham
Crompton, R. E., & Co. .. .. Mansion House Buildings, E.C.
Hartnell, W. .. .. .. Park Row, Leeds
James, Jabez, & Co., Limited .. 40, Princes St., Stamford St., S.E.
Johnson & Phillips .. .. 14, Union Ct., Old Broad St., E.C.
Woodhouse & Rawson .. .. 11, Queen Victoria Street, E.C.

Elevators, Grain, Conl, &c.
Priestman Brothers .. .. Hull
Rose, Downs & Thompson Old Foundry, Hull

Emery and Emery Cloth.
Acton & Borman .. .. .. 72, Shoe Lane, E C
Goldsworthy, T., & Sons.. .. Hulme, Manchester
Oakey, John, & Sons .. .. Wellington Mills, London, S.E.

Emery Wheels.
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria St., E.C
Black's Emery Wheel & Machine Co., Limited .. .. .. Ardwick, Manchester
Sterne, L., & Co., Limited .. Glasgow & London

Engine and Boiler Fittings.
Beck & Co , Limited .. .. 130, Great Suffolk Street, S E.
Cran, Jno., & Co. .. .. Albert Engine Works, Leith
Dewrance, John, & Co .. .. 168, Great Dover Street, S.E.
Galloway, W & J , & Sons .. Manchester
M'Neil, C., Jr .. .. .. Kinning Park Ironworks, Glasgow
Picking, Hopkins & Co. .. .. Bow, London, E.
Tangyes Limited .. .. .. Cornwall Works, Birminghatu
Weir, G. & J. .. .. .. 40, Jamaica Street, Glasgow
Winn, Charles, & Co .. .. Granville Street, Birmingham

Engines (Air).
Tyler, H , & Co . . .. 84, Whitecross Street, E.C

Engines (Blowing).
Adamson, D , & Co .. .. Dukinfield, Manchester
Carrick & Wardale .. .. Gateshead
Daglish, R , & Co. .. .. St. Helen's, Lancashire
Davy Brothers, Limited .. Sheffield
Galloway, W & J , & Sons .. Manchester
Goodfellow & Matthews .. .. Hyde, near Manchester
Nell, W., & Son .. .. .. St Helen's Junction, Lanc.
Ormerod, Grierson & Co .. .. Hulme, Manchester
Saville Street Foundry and Engineering Co , Limited.. .. Sheffield
Walker Brothers .. .. .. Wigan

Engines (Fire).
Merryweather & Sons .. .. Greenwich, S E
Rose, W., & Co. .. .. .. Deansgate, Manchester

Engines (Gas).
Andrew, J E H , & Co .. .. Stockport
Barker, T. B., & Co. .. .. Scholefield St., Birmingham
British Gas Engine & Engineering Co .. .. .. 11, Queen Victoria Street, E C
Crossley Bros , Limited .. .. Manchester
Muller, H L .. .. .. Birmingham
Okes, J C R .. .. .. 39, Queen Victoria Street, E.C.
Sterne, L., & Co , Limited .. Crown Ironworks, Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Victor Gas Engine Co . .. 72, Whitechapel, Liverpool

Engines (Locomotive).
Appleby Brothers .. .. .. East Greenwich, S.E.
Bagnall, W. G. .. .. .. Stafford
Baldwin Locomotive Works .. Philadelphia, U S.A.
Balmforth Wm. (Executors of) Rodley, near Leeds
Black, Hawthorn & Co .. .. Gateshead-on Tyne
Chaplin, A , & Co. .. . Glasgow
Decauville, Aîné .. .. .. Petit Bourg, (Seine et Oise), France
Falcon Engine & Car Works, Ltd. Loughborough
Grange Iron Co., Limited .. Durham
Hawthorn, R & W .. .. Newcastle-on Tyne
Hudswell, Clarke & Co . .. Leeds
Hunslet Engine Co . .. Leeds
Jessop, J., & Son .. .. .. Leicester
Kerr, Stuart & Co .. .. .. 20, Bucklersbury, E C.
Lowca Engineering Co , Ltd , The Whitehaven
Manning, Wardle & Co .. .. Boyne Engine Works, Leeds
McCulloch, T , & Sons .. .. Kilmarnock
Merryweather & Sons .. .. Greenwich Road, S.E.
Peckett, Thomas .. .. .. Atlas Engine Works, Bilston
Rogers Loco & Machine Works.. Paterson, N.J , U S A
Walker Brothers .. .. .. Pagefield Ironworks, Wigan

Engines (Marine).
Appleby Brothers .. .. .. East Greenwich, S.E.
Burrell, C , & Sons .. . Thetford
Cran, John, & Co .. .. Albert Engine Works, Leith
Hanna Donald & Wilson .. Paisley, N B
Hawthorn, R & W .. .. Newcastle-on-Tyne
Hayes, Ed .. .. .. Stony Stratford
Hunter & English .. .. .. Bow, E
Lobnitz, R., & Co. .. .. Leven Ironworks, Dumbarton
Plenty & Son .. .. .. Eagle Ironworks, Newbury, Berks
Rankin & Blackmore .. .. Greenock
Roger, R , & Co .. .. .. Stockton on Tees
Rose, Downs & Thompson .. Hull
Ross & Duncan .. .. .. Whitefield Works, Glasgow
Thornycroft J. I., & Co. .. Chiswick, W.
Vosper & Co .. .. .. Broad Street, Portsmouth
Wilson, Alex & Co. .. .. Vauxhall Ironworks, Wandsworth Road, S W.
Wilson, H M. .. .. .. Blyth, Northumberland
Wood Brothers .. .. .. Valley Ironworks, Sowerby Bridge, Yorkshire
Yarrow & Co .. .. .. Isle of Dogs, London, E.

Engines (Portable).
Appleby Brothers .. .. .. East Greenwich, S.E.
Barrows & Stewart .. .. Banbury
Belleville, J. & Co. .. .. 4 St Denis, Seine
Clayton & Shuttleworth .. .. Lincoln
Davey, Paxman & Co. .. .. Colchester
Farmer, Robey, Brown & Co. .. Gainsborough
Foster, W., & Co., Limited .. Lincoln
Garrett, R., & Sons .. .. Leiston Works, Suffolk
Hindley, E S .. .. .. Bourton, Dorset
Hornsby, R., & Sons, Limited .. Grantham
Marshall, Sons & Co., Limited .. Gainsborough
Mather, G R .. .. .. Wellingborough
Ransomes, Head & Jefferies .. Ipswich
Reading Ironworks Co. Ltd, .. Reading
Robey & Co .. .. .. Lincoln
Ruston, Proctor & Co. .. .. Sheaf Ironworks, Lincoln
Smedley Brothers .. .. Belper
Turner, E R & F. .. .. St Peter's, Ipswich

Engines (Rotary).
Heenan & Froude . .. .. Manchester

Engines (Stationary).
Adamson, D , & Co .. .. Dukinfield, Manchester
Appleby Brothers . .. .. East Greenwich, S.E.
Aitken, McNeil & Co. .. .. Helen Street, Govan, Glasgow
Allen & Macilan . .. .. Sentinel Works, Glasgow
Barrows & Stewart .. .. Banbury
Brotherhood, P. .. .. .. Belvedere Road, Westminster Bridge, S.E
Buckley and Taylor .. .. Castle Ironworks, Oldham
Carrick & Wardale .. .. Gateshead
Chaplin, Alex , & Co. .. .. Cranston Hill Engine Works, Glasgow
Clayton & Shuttleworth .. .. Lincoln
Coalbrookdale Co , Limited .. Coalbrookdale, Shropshire
Cochrane, J. .. .. .. Barrhead
Coles, H. J. .. .. .. Summer Street, S.E
Copeland, J , & Co. .. .. Dobbie's Loan, Glasgow
Daglish, R., & Co... .. .. St. Helen's, Lancashire
Davey, Paxman & Co. .. .. Colchester
Davy brothers, Limited .. Sheffield
Donkin, B., & Co... .. .. Bermondsey, S.E
Douglas & Grant .. .. .. Dunnikier Foundry, Kirkcaldy, N.B

Engines (Stationary).—*Continued.*
Farmer, Jas., & Sons .. .. Salford, Manchester
Farmer, Robey, Brown & Co. .. Trent Foundry, Gainsborough
Fawcett, Thomas, C. .. .. Manor Road, Leeds
Foster, W., & Co., Limited .. Lincoln
Galloway, W. & J., & Sons .. Manchester
Garrett, R., & Sons .. .. Leiston Works, Suffolk
Goodfellow & Matthews .. .. Hyde, near Manchester
Grange Iron Co., Limited .. Durham
Hathorn, Davey & Co. .. . Leeds
Hasson, Wm. .. .. .. Quebec Works, Bradford
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Heenan & Froude .. .. .. Manchester
Hick, Hargreaves & Co .. .. Soho Ironworks, Bolton
Hindley, E. S. .. .. .. Bourton, Dorset
Holborow & Co. .. .. .. Dudbridge Ironworks, Stroud
Hornsby, R., & Sons, Limited .. Grantham
Hunter & English .. .. .. Bow, E.
Ince Foundry & Engineering Co. Newport, Monmouthshire
Jessop, J., & Son .. .. .. Leicester
Lane & Reynolds .. .. .. Cranbrook St., Old Ford Rd., E.
Lowca Engineering Co., Ltd., The Whitehaven
Machinery & Hardware Co., Ltd. 147, Queen Victoria Street, E.C.
Manlove, Alliott, Fryer & Co. .. Nottingham
Marshall, Sons & Co., Limited.. Gainsborough
McCulloch, T., & Sons .. .. Kilmarnock
Musgrave, J., & Sons .. .. Bolton
Neill, Wm., & Son.. .. .. St. Helen's Junction, Lancashire
New, D., & Co .. .. .. 16, Devonshire Chambers, E.C.
Norman, J, & Co. .. .. .. Keppoch hill Engine Works, Glasgow
Ormerod, Grierson & Co .. .. Hulme, Manchester
Paul, M., & Co. .. .. .. Dumbarton
Peckett, Thomas .. .. .. Atlas Engine Works, Bristol
Pigott, T., & Co .. .. .. Bow, E.
Ransomes, Head & Jefferies .. Ipswich
Robey & Co .. .. Lincoln
Roger, R., & Co. .. .. .. Stockton-on-Tees
Rose, Downs & Thompson .. Old Foundry, Hull
Russell, Geo., & Co. .. .. Motherwell, near Glasgow
Ruston, Proctor & Co. .. .. Sheaf Ironworks, Lincoln
Saville Street Foundry and Engineering Co., Limited .. Sheffield
Shanks, Alexander, & Son .. Deus Ironworks, Arbroath
Smedley Brothers .. .. .. Eagle Ironworks, Belper
Smith & Johnston .. .. .. Paisley Road, Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Taylor & Challen .. .. .. Birmingham
Tyler, H., & Co. .. .. .. 84 & 85, Upper Whitecross Street, E.C.
Walker Brothers .. .. .. Pagefield Ironworks, Wigan
Walker, T., & Co. .. .. .. Leeds
Welford Bros. .. .. .. Sunderland
Wilson, Alex., & Co. .. .. Vauxhall Ironworks, Wandsworth Road, S.W.
Woods, H. & Co. .. .. .. Manchester

Engines (Traction).
Aveling & Porter .. .. .. Rochester
Burrell, C., & Son .. .. Thetford
Clayton & Shuttleworth . .. Lincoln
Foster, Wm , & Co., Limited .. Lincoln
Fowler, John, & Co. .. .. Leeds
Marshall, Sons & Co .. .. Gainsborough
Reading Ironworks Co., Ltd .. Reading

Engravers, Mechanical, &c.
Cattell, A S , & Co .. .. 17, Bear Alley, Farringdon Street, E C
Hare & Co .. .. 31, Essex Street, Strand
Rimbault, J H .. .. .. 30, Malden Lane, W.C.

Excavators.
Bruce & Batho .. .. .. 9, Victoria Chambers, Westminster, S.W.
Chaplin, Alex., & Co. .. .. Glasgow
Fleming & Ferguson .. .. Paisley, N B
Priestman Brothers .. .. 5a, Queen Victoria Street, E.C.
Rose, Downs & Thompson .. Hull
Ruston, Proctor & Co .. .. Sheaf Ironworks, Lincoln

Fans and Blowers.
Allday, Wm., Sons, & Co. .. Birmingham
Capell, R A .. ..
Donald, J., & Sons .. .. 42, Oxbogan Street, Glasgow
Donkin, B., & Co.... .. .. Bermondsey, S.E.
Grange Iron Co , Limited .. Durham
McCulloch, T , & Sons .. .. Kilmarnock
Saville Street Foundry and Engineering Co., Limited .. Sheffield
Schiele, C., & Co .. .. .. 2, Clarence Buildings, Manchester
Selig, Sonnenthal & Co .. .. 85, Queen Victoria Street, E C.
Thwaites Brothers. .. .. Vulcan Ironworks, Bradford
Union Engineering Co. .. .. Booth Street, Manchester
Walker Brothers .. .. .. Wigan

Feed-Water Heaters.
British Gas Engine & Engineering Co . .. . 11, Queen Victoria Street, E.C.
Saville Street Foundry and Engineering Co., Limited.. .. Sheffield
Stevin, L., & Co , Limited .. Crown Ironworks, Glasgow
Suffield & Brown .. .. .. James Street, Commercial Road, East, E.
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Taylor & Challen .. .. .. Derwent Foundry, Birmingham
Wood, Hamilton & Co. .. .. Salford, Manchester
Wright, Jos., & Co. .. .. Tipton, Staffordshire

Files and File Sharpening Apparatus.
Bedford, J., & Sons .. .. .. Lion Works, Sheffield
Jowitt, T , & Sons .. .. .. Sheffield
Tilghman Patent Sand Blast Co., Limited . .. . Sheffield

Filtering Apparatus.
Halliday, J., & Co... .. .. Water Street, Newtown, Manchester
Pulsometer Engineering Co. .. Nine Elms, S W.

Firebars.
Patent Diagonal Rocking Fire-Bar Co. .. .. 250, Gresham House, E.C.

Fire Clay Goods.
Farnley Iron Co. .. .. .. Farnley, near Leeds
Glenboig Union Fire Clay Co , The Glasgow
Kershaw & Pole .. .. .. 1, Cullum Street, E.C.

Floor Cloth Machinery.
Farmer, Jas., & Sons .. .. Salford, Manchester
Landale, James .. .. .. Kirkcaldy, N.B.
Summers, T & W. .. .. .. Gloucester

Forgings (Iron and Steel).
Askham Bros & Wilson, Ltd. .. Sheffield
Beardmore, I & W. .. .. Glasgow
Bessemer, Henry, & Co., Limited Sheffield
Brown, Bailey, Dixon & Co. .. Sheffield
Clarke's Crank Co . .. .. Lincoln
Glasgow Hydraulic Forge Co. .. Sentinel Works, Polmadie, Glasgow
Goodfellow & Matthews .. .. Hyde, near Manchester
Hill & Smith .. .. Brierley Hill Ironworks, near Dudley
Ibbotson Brothers & Co., Ltd... Sheffield
Jessop, Wm., & Sons .. .. Sheffield
Kirkstall Forge Co .. .. Near Leeds
Landore Siemens Steel Co. .. Landore, South Wales
Leeds Forge Co. .. .. .. Leeds
Mersey Forge, Limited, The .. Liverpool
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury
Osborne, S., & Co. .. .. .. Sheffield
Reichwald, A. .. .. .. Newcastle-on-Tyne
Saville Street Foundry and Engineering Co , Limited.. .. Sheffield
Spencer, J , & Son. .. .. .. Newcastle-on-Tyne
Staffordshire Wheel & Axle Co., Limited .. .. Springhill, Birmingham
Stannars Close's Steel Co. .. Wolstinghan, vid Darlington
Steel Co. of Scotland, The .. Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Furnace Fittings.
Galloway, W. & J., & Sons .. Manchester
Martin, W. A. & Co. .. .. Pocock Street, S.E.
Walker, Robert .. .. .. 7, Union Court, Old Broad Street, E.C.

Galvanised Iron.
Hill & Smith .. .. .. Tipton, Staffordshire
Lysaght, John, Limited .. .. Bristol
Morewood & Co. .. .. .. Soho, Birmingham

Gas Exhausters.
Donkin, B., & Co... .. .. Bermondsey, S.E.
Körting Brothers .. .. .. 17, Lancaster Avenue, Manchester
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Saville Street Foundry and Engineering Co., Limited.. .. Sheffield

Gas Works (Plant for).
Dowson Economic Gas Co., Ltd., 3, Great Queen Street, Westminster, S.W.
Grange Iron Co., Limited .. Durham
Hanna, Donald & Wilson .. Paisley, N.B.
Horton, J. & W. .. .. .. Etna Works, Smethwick, Birmingham
Ianson, C., Son, & Co. .. .. Darlington
Müller, H. L. .. .. .. Birmingham
Piggott, Thos., & Co. .. .. Springhill, Birmingham

Gauge Glasses.
Martin, Guilbert .. .. .. 1 & 2, Falcon Street, E.C.
Tomey & Sons .. .. .. Tay Glass Works, Perth, N.
Tomey, Jos., & Sons .. .. Manor Glass Works, Aston, Birmingham

Gauges (Pressure).
Dewrance & Co .. .. .. 168, Great Dover Street, S E.
Salter, Geo , & Co.... .. .. West Bromwich
Schaffer & Budenberg .. .. 1, Southgate, Manchester

Gearing.—*(See Wheels, Geared.)*

Girders.
Ashbury Railway Carriage & Iron Co , Limited .. .. .. Openshaw, Manchester
Davies Bros. & Co.... .. .. Crown Ironworks, Wolverhampton
De Bergue & Co., Limited .. Manchester
Goodwin, James, & Co. .. .. Motherwell, N.B.
Ianson, C., Son & Co. .. .. Darlington
Ince Foundry & Engineering Co. Newport, Monmouthshire
Lindsay, W. H., & Co. .. .. 14, South Wharf, Paddington W
Lowca Engineering Co., Ltd., The Whitehaven
Lysaght, John, Limited .. .. Bristol
McCulloch, T., & Sons .. .. Kilmarnock
Measures, Bros. & Co. .. .. Southwark St., S.E.

Glass Machinery (Plate)
Daglish, R., & Co.... .. .. St. Helen's, Lancashire
Musgrave, J., & Sons .. .. Bolton

Glazing.
Braby & Son .. .. .. 356, Euston Road, London
Grover & Co., Limited .. .. Britannia Works, Wharf Rd., N

Governors (Engine).
Blair, George .. .. .. 32, Queen Street, Glasgow
Duncan Bros (Taite's Electric).. 32, Queen Victoria Street, E.C
McCulloch, T., & Sons .. .. Kilmarnock
Murdoch, Wm., & Co .. .. 30, Hope Street, Glasgow
Schaffer & Budenberg .. .. Manchester
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Whitley Partners .. .. .. Hunslet Road, Leeds

Grindstones.
Robson, Robert .. .. .. 21, Grainger Street, West, Newcastle-on-Tyne

Gunpowder Machinery.
Hall, J & E. .. .. .. Dartford, Kent
Hastie, J., & Co .. .. .. Kilbiam Engine Works, Greenock
Saville Street Foundry and Engineering Co., Limited.. .. Sheffield
Taylor & Challen .. .. .. Birmingham

Hammers (Hydraulic).
Fielding & Platt .. .. .. Gloucester
Tweddell, R H. .. .. .. 14, Delahay Street, S.W.

Hammers (Power).
Player, W. & J. .. .. .. Lionel Street, Birmingham

Hammers (Steam).—*(See Steam Hammers.)*

Heating Apparatus.
Gibbs, R. R. .. .. .. St James' Heating Works, Mill Street, Liverpool
Korting Brothers .. .. .. 17, Lancaster Avenue, Manchester
Thames Bank Iron Co., The .. Upper Ground Street, S.E.

Hematite Pig Iron.
West Cumberland Iron & Steel Co. .. .. Workington, Cumberland

Hoisting Machinery.
Appleby Brothers .. .. .. East Greenwich, S E.
Balmforth Wm. (Executors of).. Rodley, near Leeds
Bowser & Son .. .. .. Great Wellington St., Glasgow
Carrick & Ritchie .. .. .. Edinburgh
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works Glasgow
Coles, H. J. .. .. .. Summer Street, S.E.
Cowans, Sheldon & Co , Limited St. Nicholas Works, Carlisle
Crowley, John, & Co. .. .. Sheffield
Gibbins, R C., & Co. .. .. Berkley Street, Birmingham
Glover, Walter T., & Co. .. 25, Booth Street, Manchester
Hunter & English .. .. .. Bow, E.
Jessop, J., & Son .. .. .. Leicester
Melville, W. M. .. .. .. Kirkcaldy
Pickering, Jthn. .. .. .. Stockton-on-Tees
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Shanks, Alexander, & Son .. Deus Ironworks, Arbroath
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Thomas, T., & Sons .. .. .. Cardiff
Waygood, R., & Co. .. .. .. Newington Works, Falmouth Street, S.E.

Hoops for Boiler Flues.
Bolton Iron & Steel Co. .. .. Bolton
Bowling Iron Co., Limited .. Bradford

Hose Pipe (Flax).
Richards & Co. .. .. .. Aberdeen

Hydraulic Machinery.
Adamson, D., & Co. .. .. Dukinfield, Manchester
Anderson & Gallwey .. .. 8, Buckingham Street, W.C.
Beck & Co., Limited .. .. 130, Great Suffolk Street, Southwark, S.E.
Berry, Henry .. .. .. Croydon Works, Hunslet, Leeds
Coles, H. J. .. .. .. 89, Summer Street, S.E.
Cowans, Sheldon & Co., Limited St. Nicholas Works, Carlisle
Dudgeon, Richard .. .. .. 114, Fenchurch Street, E.C.
Fielding & Platt .. .. .. Gloucester
Hathorn, Davey & Co. .. .. Leeds
Middleton, Robert .. .. .. Sheepscar Foundry, Leeds
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Ramsbottom, J. .. .. .. Hunslet, Leeds
Rose, Downs & Thompson .. Old Foundry, Hull
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W.
Williams, W. L. .. .. .. 2, Westminster Chambers, S.W.

Hydraulic Presses.

...ssemer, Henry, & Co., Limited	Sheffield
...rrick & Wardale	Gateshead-on-Tyne
...se, H. J.	69, Sumner St., Southwark, S.E.
...reland, J., & Co.	Dubbs's Loan, Glasgow
...dding & Platt	Gloucester
...Midleton, Robert	Sheepscar Foundry, Leeds.
...Norman, John, & Co. ..	Keppochill Engine Works, Glasgow
...Rose, Downs & Thompson ..	Old Foundry, Hull
...Rothert & Pitt, Limited..	Bath
...Tangyes Limited	Cornwall Works, Birmingham
...Tweddell, R. H.	14, Delahay Street, S.W.
...Tyler, H., & Co.	84, Upper Whitecross St., E.C.
...Woods, H., & Co.	Salford, Manchester

Hydrokineter.

Weir, G. & J.	40, Jamaica Street, Glasgow

Ice Making Machines.

Piggott, T., & Co.	Springhill, Birmingham

India Rubber Goods.

Angus, Geo., & Co.	Newcastle-on-Tyne
Barbury India Rubber Comb Co.	138, London Wall, E.C.
India Rubber, Gutta Percha & Telegraph Works Co., Limited	Silvertown, Essex
MacLellan, George, & Co. ..	GlasgowRubberWorks,Glasgow
North British Rubber Co., Ltd.	Edinburgh
Star Rubber Co., The	131, West Regent St., Glasgow

Indicators (Steam Engine).

Hannan & Buchanan	75, Robertson Street, Glasgow
White & Carlton (Stroudley's Speed)	65, Queen Victoria Street, E.C.

Injectors.

Donald, J., & Son	42, Cadogan Street, Glasgow
Fairburn & Hall	63, Royal Exchange, Manchester
Gresham & Craven	Manchester
Hancock Inspirator Co	108, Upper Thames St., E.C.
Holden & Brooke	St. Simon Works, Salford
Körting Brothers	17, Lancaster Avenue, Manchester
Malan, C. S.	21, Mansfield Chambers, St. Anne's Square, Manchester
Manlove, Alliott, Fryer & Co. ..	Nottingham
Patent Exhaust Steam Injector Co., Limited	4, St. Ann's Square, Manchester
Schaffer & Budenburg	St. Mary Street, Manchester

Insurance Companies.

Employers' Liability Assurance Corporation, Limited	84 & 85, King William Street, E.C.
London Mutual Boiler Insurance Co., Limited	17, Queen Victoria Street, E.C.

Iron Buildings.

Clark, Bunnett & Co., Limited..	Rathbone Place, W.
Davies Brothers & Co.	Crown Iron Works, Wolverhampton
Davies, M. H.	Grange Rd., Bermondsey, S.E.
Dixon, I.	Windsor Ironworks, Liverpool
Lysaght, John, Limited	Bristol
Macfarlane, Walter, & Co. ..	Possil Park, Glasgow
Morewood & Co.	Soho, Birmingham
Morton, F., & Co., Limited ..	Naylor St. Ironworks, Liverpool

Iron and Steel Works (Plant for).

Adamson, D., & Co.	Dukinfield, Manchester
Davey, Bros., Limited	Sheffield
Galloway, W. & J., & Sons ..	Manchester
Goodwin, James, & Co.	Ardrossan, N.B.
McCulloch, T. & Sons	Kilmarnock
Thwaites Bros.	Bradford
Walker Bros.	Wigan
Walker, T., & Co.	Leeds
Whitwell, W. (Stoves)	Stockton-on-Tees
Woods, H., & Co.	Salford, Manchester

Jacks (Lifting).

Dudgeon, Richard	114, Fenchurch Street, E.C.
Gibbins, R. C., & Co.	Berkley St., Birmingham
Pickering, John	Stockton-on-Tees
Selig, Sonnenthal & Co.	85, Queen Victoria Street, E.C.
Shirlaw, A., & Co.	Berkley Street, Birmingham
Tangyes Limited	Cornwall Works, Birmingham

Keys and Pins.

Mills, Jas (Executors of) ..	Dredbury, near Stockport
Smith, H. Ford	Seddon St., Salford, Manchester

Lamps.

Barnett & Foster	23a, Eagle Wharf Road, N.

Launches and Yachts.

Burnet, L., & Co.	Govan, Glasgow
Chaplin, Alex., & Co.	Cranston Hill Engine Works, Glasgow
Cochran & Co.	Birkenhead
Crun, J., & Co	Albert Engine Works, Leith
Des Vignes, G. F. G.	Chertsey
Edwards & Souns	Wharf Rd., Cubitt Town, E.
Forrett & Son	Limehouse, E
Lanus, Donald & Wilson	Paisley, N.B
Hayes, Rd.	Stony Stratford
Kerr, Stuart & Co	20, Bucklersbury, E.C.
Miller & Tapp	Middle Mall, Hammersmith
Paul, M., & Co	Arrowford Works, Dumbarton
Rees & Duncan	Whitefield Works, Glasgow
Thornycroft, J. I., & Co. ..	Chiswick, W.
Vosper & Co.	Broad Street, Portsmouth
Yarrow & Co.	Poplar, E.

Laundry Machines.

Manlove, Alliott, Fryer & Co. ..	Nottingham

Lead Refiners and Merchants.

Rohman, Rogers, Michel & Co. ..	St. Helen's, Lancashire

Leather Machinery.

Rothert & Pitt, Limited ..	Bath

Lifts.

Coles, H. J.	89, Sumner Street, S.E.
Gibbins, R. C., & Co.	Berkley St., Birmingham
Hanson, W.	Bradford
Hunter & English	Bow, E
Pickering, John	Stockton-on-Tees
Thomas, T., & Sons	Cardiff
Waygood, R., & Co.	Falmouth Road, S.E.

Linoleum Machinery.—*(See Floor Cloth Machinery.)*

Lithographers.

Hall, Thos., & Son..	40, King Street, Covent Garden, W.C.

Locomotive Details.

Lorey, I., & Sons	Knott Mill, Manchester

Locomotive Engines.—*(See Engines, Locomotive.)*

Lubricants and Oils.

Hall, J.	Asbestos Works, Southwark, S.E.
Hyvern's American Lubricating Cream	23, Brunswick St., Liverpool
Bradford, J., & Sons	Liverpool
Crane, P. Moir, & Co., ...	Bank Street, Manchester
Engelbert & Co.	70 & 71, Bishopsgate St., E.C.
Fleming, A. B., & Co., Limited	15, Whitefriars Street, E.C.
Gibbon's Patent Candle Co., Ltd.	Battersea, S.W.
Ingosine & Co.	7, Idol Lane, E.C.

Lubricators.

Beck & Co., Limited	130, Great Suffolk Street, E.C.
Dewrance & Co.	138, Great Dover Street, S.E.
Empire Lubricator Co. ..	Great Bridgewater Street, Manchester
Körting Brothers	17, Lancaster Avenue, Manchester
Nettlefolds, Limited	Birmingham
Prior Brothers	19, St. George St., Westminster
Whitehouse & Co.	Tipton Hall Chain Works, Staffordshire

Machine Tools.

Anderson & Gallwey	8, Buckingham Street, W.C.
Archdale, Jas., & Co.	Ledsam Street, Birmingham
Askham Bros. & Wilson, Ltd. ..	Sheffield
Asquith, W.	Highroad Well Works, Halifax
Barlow, H. B., & Co.	Cornbrook Works, Manchester
Berry, F., & Sons	Calder Ironworks, Sowerby Bridge
Berry, H.	Croydon Works, Hunslet, Leeds
Booth, Geo., & Co.	Halifax
Butterfield, F. & J., & Co. ..	Keighley, Yorkshire
Cameron, John	Oldfield Road Ironworks, Salford
Churchill, C., & Co.	Cross Street, Finsbury, E.C.
Davis & Primrose	Etna Ironworks, Bangor Road, Leith, N.B.
De Bergue & Co., Limited ..	Manchester
Dron & Lawson	Cranston Hill Tool Works, Glasgow
Earnshaw, A., & Co.	Crown Works, Booth Town, Halifax
Fielding & Platt	Gloucester
Galloway, W. & J., & Sons ..	Manchester
Harvey, Robert, & Co.	Park Grove Ironworks, Glasgow
Heap, Joshua, & Co	Ashton-under-Lyne
Kendall & Gent	Victoria Works, Manchester
Lang, J., & Sons	Johnstone, N.B.
Lee, Howl, Ward & Howl ..	Tipton, Staffordshire
Lee & Hunt	Arkwright Works, Manchester
Lewes, Ludw., & Co.	90, Worship Street, E.C.
London Bros	Bothwell Street, Glasgow
Machinery & Hardware Co., Ltd.	147, Queen Victoria Street, E.C.
McArthur, A., & Son	Johnston, N.B.
Muir, Wm., & Co.	Sherbourne Street, Manchester
New, D., & Co.	15, Devonshire Chambers, E.C.
Pitt Bros.	Yorkshire Machine Tool Works, Liversedge
Pollock, Macnab, & Highgate ..	Shettlestone, Glasgow
Rushworth & Co.	Sowerby Bridge, Yorkshire
Scott Bros	West Mount Ironworks, Halifax
Scriven & Co.	Leeds Old Foundry, Marsh Lane Leeds
Selig, Sonnenthal & Co.	85, Queen Victoria Street, E.C.
Shepherd, Hill & Co.	Leeds
Shirlaw, A., & Co....	Suffolk Works, Birmingham
Smith & Coventry	Oxford Lane, Salford, Manchester
Smith & Willshaw..	Halifax
Tangyes Machine Tool Co., Ltd.	Soho, Birmingham
Tweddell, R. H	14, Delahay Street, S.W.
Widdowson, J. H	Orchall Lane, Salford
Wilson, Charles, & Co.	Granville Street, Birmingham

Maize Dressing Machinery.

Copeland, J., & Co.	Dobbie's Loan, Glasgow
Norman, John, & Co.	Keppochill Engine Works, Glasgow

Mathematical Instruments, Makers.

Archbutt, J. & W. E.	Westminster Bridge Road, Lambeth, S.W.
Gotz, J. R	10, Buckingham Street, W.C.
Negretti & Zambra	Holborn Viaduct, E.C.
Stanley, W. F	Great Turnstile, Holborn, W.C.

Metals (Phosphor, Alloys, &c.).

Billington & Newton	Longport, Staffordshire
Cockshott & Jowett	145, Thornton Road, Bradford
Dick, Alex.	110, Cannon Street, E.C.
Evans, James, & Co.	Gaythorn, Manchester
Hartmann, G	46, Great St. Helen's, E.C.
Hughes, J. & J.	Woodcock Street, Birmingham
Manganese Bronze & Brass Co., Limited	Lombard St., Southwark, S.E.
Phosphor Bronze Co., Limited..	Sumner Street, S.E.

Meters.

Manchester Water Meter Co., Limited	Ardwick, Manchester

Mill Gearing, Shafting, &c.

Askham Bros & Wilson, Ltd. ..	Sheffield
Bessemer, Henry, & Co., Limited	Sheffield
Bodley, Bros., & Co.	Exeter
Brown, Bayley, Dixon & Co. ..	Sheffield
Buckley & Taylor	Castle Ironworks, Oldham
Forsyth, Miller & Co.	Mile End, Glasgow
Goodfellow & Matthews	Hyde, near Manchester
Hawthorn, R. & W.	Newcastle-on-Tyne
Hick, Hargreaves & Co.	Soho Ironworks, Bolton
Hind, H., & Co	Nottingham
Jackson, P. R., & Co.	Salford Rolling Mills, Salford
Kirkstall Forge Co.	Leeds
McCulloch, T., & Sons	Kilmarnock
Musgrave, John, & Sons	Bolton
Reichwald, A.	Newcastle-on-Tyne
Savile Street Foundry and Engineering Co., Limited	Sheffield
Smith, Parfrey & Hitchings ..	Buckingham Palace Rd., S.W
Staffordshire Wheel & Axle Co.	Spring Hill, Birmingham
Taylor & Challen	Derwent Foundry, Birmingham
Tinsley, Eliza	Great Bridge, Staff
Yates & Co.	Sheaf Works, Hunslet Road, Leeds

Mill Machinery (Flour, Corn, and Rice).

Carter, J. H.	82, Mark Lane, E.C.
Clayton & Shuttleworth.. ..	Lincoln
Copeland, J., & Co.	Dobbies' Loan, Glasgow
Hunter & English	Bow, E
Landale, James	Kirkcaldy N.B
Marshall, Sons & Co., Limited ..	Gainsborough
McCulloch, T., & Son	Kilmarnock
Norman, J., & Co....	Keppochill Engine Works, Glasgow
Ransomes, Head, & Jefferies ..	Ipswich
Ruston, Proctor, & Co.	Lincoln
Turner, E. R., & F.	Ipswich

Mills (Paint, Oil, Mortar, &c.).

Butters Brothers	Lambhill Street, Glasgow
Follows & Bate, Limited (Paint)	Manchester
Rose, Downs, & Thompson ..	Hull
Selig, Sonnenthal & Co.	85, Queen Victoria Street, E.C.
Spencer & Co.	Melksham, Wilts

Mining Machinery.

Askham Bros & Wilson, Ltd ..	Sheffield
Chaplin, Alex., & Co.	Cranston Hill Engine Works, Glasgow
Clay Cross Co.	Clay Cross, near Chesterfield
Daglish, R. & Co.	St. Helens, Lanc
Hathorn, Davey & Co.	Leeds
Jordan, T. B., Son & Commans..	52, Gracechurch Street, E.C.
Robey & Co....	Lincoln
Ruston, Proctor & Co.	Lincoln
Tangyes Limited	Cornwall Works, Birmingham
Walker, Bros.	Wigan

Non-Conducting Compositions.

Anderson, D., & Son, Limited ..	Lagan Felt Works, Belfast
Bell, J.	Asbestos Works, Southwark, S.E.
Hsacks, A., & Co.	21, Lime Street, E.C.
Keenan, M.	Armagh Works, Tredegar Wks., N. Bow, E.
Leroy, F., & Co.	Gray Street, Commercial Rd., E.

Nuts (Finished).

Mercer, Ed.	Hollinwood, Manchester

Oils.—*(See Lubricants.)*

Oil Cans.

Kaye, Jos., & Co.	Bank Works, Kirkstall, Leeds.

Oil Distilling Plant.

Copeland, J., & Co.	Dobbie's Loan, Glasgow
Norman, John, & Co.	Keppochill Engine Works, Glasgow

Oil Mill Machinery.

Piggott, Thos., & Co.	Birmingham
Rose, Downs & Thompson ..	Old Foundry, Hull
Tangyes Limited	Cornwall Works, Birmingham

Packing (Engine).

Beldam Packing & Rubber Co...	77, Gracechurch Street, E.C.
Bell, John	Asbestos Works, Southwark
Binney & Son	Catherine St., City Road, E.C.
Lindsay, R. B., & Co.	Plantation Quay (West) Glasgow
Mead, F. M., & Co	323b, Kennington Road, S.E.
Tuck & Co., Limited	116, Cannon Street, E.C.
United Asbestos Co., Ltd., The..	161, Queen Victoria Street, E.C.

Paints.

Ragosine & Co	7, Idol Lane, Great Tower St
United Asbestos Co., Limited ..	161, Queen Victoria Street, E.C

Paper Making Machinery.

Donkin, B., & Co....	Bermondsey, S.E.
Dowdins & Grant	Kirkcaldy, N.B.

Patent Agents.

Alexander, E. P.	30, Southampton Buildings, W.C.
Allison, Brothers	52, Chancery Lane, W.C
Brewer & Jensen	33, Chancery Lane, W.C
Brookes, Wm.	53 & 56, Chancery Lane, W.C
Craven, T. E., & Son	24, Victoria Chambers, South Parade, Leeds
Hardingham, G. G. M.	101, Fleet Street, E.C
Harris & Mills	27, Southampton Building, W.C.
Horn & Son	172, Strand, W.C.
Inventors' Patent Right Association, Limited	21, Cockspur Street, S.W
Phillips & Leigh	22, Southampton Buildings, Chancery Lane, W.C.
Reffern, G. F.	4, South Street, Finsbury, E.C
Rogers, F. M	21, Finsbury Pavement, E.C
Thompson & Boult	6, Lord Street, Liverpool
Thomson, W. H. M., & Co. ..	96, Buchanan Street, Glasgow
Vaughan & Son	57, Chancery Lane, W.C.
Wise, W. Lloyd	46, Lincoln's Inn Fields, W.C

Patterns.

Ormerod, Grierson & Co	Manchester
Walker, E	Avonside Engine Works, Bristol

Permanent Way.

Askham Bros & Wilson, Ltd. ..	Sheffield
Dick, Kerr & Co.	101, Leadenhall Street, E.C.
Hartley & Arnoux Brothers ..	Stoke-on Trent
Isca Foundry & Engineering Co.	Newport, Monmouthshire
Kerr, Stuart & Co.	20, Bucklersbury, E.C.
Railway Sleeper Supply Co., The	17, Gracechurch St., London
Thomson & Browning	3, Victoria Street, E.C.

Photographic Appliances.

Gotz, J. R	10, Buckingham Street, W.C

Pig Iron Breakers.

Evans, J., & Co.	Trumpet Street, Manchester

Pile Drivers.

Gibbins, R. C., & Co.	Berkley Street, Birmingham

Piles.

Goodwin, James, & Co	Ardrossan, N.B.
Le Grand & Sutcliff	100, Bunhill Row, E.C.

Pipe Founders.

Clay Cross Co.	Clay Cross, near Chesterfield
Isca Foundry & Engineering Co.	Newport, Monmouthshire

Pipe (Drain) Making Machinery.

Clayton, Howlett & Venables ..	Harrow Road, W.

Pipes (Sanitary).

Doulton & Co	Lambeth, S.E.
Farnley Iron Co., Limited ..	Farnley, near Leeds
Glenboig Union Fire Clay Co., The	Glasgow

Pistons and Piston Rings.

Atkins & Co	Special Tool Works, Stanley Street, Sheffield
Bates, Timothy, & Co	Sowerby Bridge
Jackson, P. R., & Co.	Salford Rolling Mills, Manchester
Lockwood & Carlisle	Eagle Foundry, Park, Sheffield

Plates (Iron and Steel).

Beardmore, J. & W	Glasgow
Brown, Bayley, Dixon & Co ..	Sheffield
Jessop, Wm., & Sons, Limited	Sheffield
Landore Siemens Steel Co., The..	Landore, South Wales
Leeds Forge Co., The	Leeds
Sheldon Bar Iron Co., Limited	Stokesom-Trent
Steel Co of Scotland, Limited ..	Glasgow
West Cumberland Iron & Steel Co., Limited	Workington

Portable Engines.—*(See Engines, Portable.)*

Portable Railways.—*(See Railways, Portable.)*

Pottery and Encaustic Tile Machinery.

Bodley Brothers & Co.	Exeter
Boulton, W.	Burslem, Staffordshire

Presses (Hydraulic).—*(See Hydraulic Presses.)*

Printing Machinery for Textile Fabrics.

Farmer, Jas., & Sons	Salford

Propellers.

Ross & Duncan	Glasgow
Savile Street Foundry and Engineering Co., Limited.. ..	Sheffield

Pulley Blocks.

Crowley, John, & Co.	Sheffield
Glover, Walter T., & Co. ..	23, Booth Street, Manchester
Grimshaw & Co.	58, Paxton Street, Accrington
Pickering, John	Stockton-on-Tees
Selig, Sonnenthal & Co.	85, Queen Victoria Street, E.C.
Tangyes Limited	Birmingham
Thomson, Wm.	Kinning Park, Glasgow

Pulleys (Cast Iron).

Bagshaw, J. & Sons	Batley, Yorkshire
Bodley Brothers & Co.	Exeter
Buckley & Taylor	Castle Iron Works, Oldham
Crossley, Geo.	Cleckheaton, Yorkshire
Fawcett, Thos. C.	Manor Road, Leeds
Goodfellow & Matthews	Hyde, near Manchester
Harper & Co	Albion Ironworks, Aberdeen
Jackson, P. R., & Co	Salford Rolling Mill, Manchester
Ormerod, Grierson & Co.... ..	Hulme, Manchester
Reading Ironworks Co.	Reading
Taylor & Challen	Derwent Foundry, Birmingham
Yates, J. & Co.	Hunslet, near Leeds

Pulleys (Wrought Iron).

Bagshaw, J., & Sons	Batley
Crossley, G....	Albion Machine Works, Cleckheaton
Hall, J. & E.	Dartford Ironworks, Kent
Hudswell, Clark & Co.	Railway Foundry, Leeds
Mackie, J. & J., & Co.	Bethe Ironworks, Reading
Okes, J. C. R.	30, Queen Victoria Street, E.C.
Pickering, John	Stockton-on-Tees
Reading Ironworks Co., Ltd. ..	Reading

Pumps and Pumping Machinery.

Allen, W. H., & Co	York Street, Lambeth, S.E.
Beck & Co., Limited	130, Great Suffolk Street, S.E.
Cameron, John	Old Field Rd. Ironworks, Salford
Carrick & Wardle	Gateshead
Chaplin, A., & Co....	Glasgow
Clay Cross Co	Clay Cross, near Chesterfield
Coalbrookdale Co., Limited ..	Coalbrookdale, Shropshire
Cochrane, Jno.	Barrhead
Coles, H. J.	Sumner Street, S.E.
Daglish, R., & Co.	St. Helen's, Lancashire
Drysdale & Co.	Bon Accord Engine Works, Glasgow
Evans, Jos., & Sons	Wolverhampton
Fairburn & Hall	63, Royal Exchange, Manchester
Fielding & Platt	Gloucester
Grange Iron Co., Limited ..	Durham
Hanna, Donald & Wilson ..	Paisley
Hanson, Wm.	Bradford
Harvey, Robert, & Co.	Park Grove Ironworks, Glasgow
Hathorn, Davey & Co.	Leeds
Hatton, J.	Coventry
Hett, C. L.	Anchshire Foundry, Brigg
Hunter & English	Bow, E
Isher, R. & Co.	88, Southwark Street, S.E.
Le Grand & Sutcliff	100, Bunhill Row, E.C.
London, Bros.	Bothwell Street, Glasgow
Lowca Engineering Co., Ltd., The	Whitehaven
Mather & Platt	Manchester
McCulloch, T., & Sons	Kilmarnock
Neill, W., & Son	91, Helena Junction, Lanarkshire
New, D., & Co	15, Devonshire Chambers, E.C.
Okes, J. C. R	30, Queen Victoria Street, E.C.
Owens, S., & Co.	Whitefriars Street, E.C.
Pearn, Frank, & Co.	Manchester
Piggott, Thos., & Co	Birmingham
Fulsometer Engineering Co., Ltd.	Nine Elms, S.W.
Ramsbottom, Jno	Saxton Road, Leeds
Ruston, Proctor, & Co	Sheaf Ironworks, Lincoln
Savile Street Foundry and Engineering Co., Limited.. ..	Sheffield
Selig, Sonnenthal & Co.	85, Queen Victoria Street, E.C.
Shanks, Alexander, & Son ..	Deus Ironworks, Arbroath
Simpson & Co.	Pimlico, London
Stanmah, J.	29, Southwark Bridge Rd., S.E.
Stothert & Pitt, Limited ..	Bath
Tangyes Limited	Cornwall Works, Birmingham
Taylor & Challen	Birmingham
Tweddell, R. H	14, Delahay Street, S.W
Tyler, H. W.	84 Upper Whitecross St., E.C.
Westinghouse Brake Co., Ltd. ..	York Road, King's Cross, N
Wilson, Alex., & Co.	Vauxhall Ironworks, Wandsworth Road, S.W
Wilson, John H., & Co.	Sandhills, Liverpool
Wood, H., & Co.	Salford, Manchester

Pumps (Centrifugal).

Allen, W. H., & Co	York St. Works, Lambeth, S.E.
Drysdale & Co.	Bon Accord Engine Works Glasgow
Evans, J., & Sons	Wolverhampton
Hathorn, Davey & Co.	Leeds
Hett, C. L.	Brigg
Lowca Engineering Co., Ltd., The	Whitehaven
New, D., & Co.	15, Devonshire Chambers,
Owens, S., & Co	Whitefriars Street, E.C.
Ruston, Proctor & Co.	Lincoln
Simpson & Co	Pimlico, London
Tangyes Limited	Cornwall Works, Birmingham

Pumps (Donkey).

Cameron, John	Oldfield Rd. Ironworks, Salford
Chaplin, Alex., & Co	Cranston Hill Engine Works, Glasgow
Coalbrookdale Co., Limited ..	Coalbrookdale, Staffordshire
Cochrane, John	Barrhead, N.B
Coles, H. J.	89 Sumner St., Southwark, S.E.
Hanson, W.	Quebec Works, Bradford
Hathorn, Davey & Co.	Leeds
Hatton, J.	Coventry
London Brothers	Bothwell Street, Glasgow
Lowca Engineering Co., Ltd., The	Whitehaven
New, D., & Co.	15, Devonshire Chambers, E.C.
Okes, J. C. R	30, Queen Victoria Street, E.C.
Owens, S., & Co.	Whitefriars Street, E.C.
Roger, R., & Co.	Stockton-on-Tees
Stanmah, J	29, Southwark Bridge Rd., S.E.
Tangyes Limited	Cornwall Works, Birmingham
Wilson, Alex., & Co.	Vauxhall Ironworks, Wandsworth Road, S.W.

Railway Agents.

Oldham Brothers	110, Cannon Street, E.C.

Railway and Contractors' Plant.

Askham Bros & Wilson, Ltd ..	Sheffield
Brown, Bayley, Dixon & Co ..	Sheffield
Chaplin, Alex., & Co.	Cranston Hill Engine Works, Glasgow
Darlington Steel & Iron Co., Ltd.	3, Victoria St., Westminster, S.W
Decauville, Aîné	Petit Bourg (Seine et Oise), France
Dick, Kerr & Co	101, Leadenhall Street, E.C.
Goodwin, Jas., & Co	Ardrossan, N.B
Hadfield's Steel Foundry Co ..	Attercliffe, Sheffield
Hartley & Arnoux Brothers ..	Stoke-on-Trent
Hudswell, Clark & Co.	Railway Foundry, nr Leeds
Hunter, C., Son & Co.	Darlington
Isca Foundry & Engineering Co	Newport, Monmouthshire
Ransomes & Rapier	5, Westminster Chambers, S.W.
Thomson & Browning	3, Victoria St., Westminster, S.W.
Wood, C.	Tees Ironworks, Middlesbro-on-Tees

Railways (Portable).

Bagnall, W. G.	Stafford
Decauville, Aîné	Petit-Bourg (Seine et Oise), France
Dick, Kerr & Co	101, Leadenhall Street, E.C.
Hartley & Arnoux Brothers ..	Stoke-on-Trent
Kerr, Stuart & Co....	20, Bucklersbury, E.C.
Wood, C.	Tees Ironworks, Middlesbro'-on-Tees

Rail Lifters.

De Bergue & Co., Limited ..	Manchester

Rails (Steel or Iron).

Askham Bros & Wilson, Ltd. ..	Sheffield
Beatson, J., & Son...	402, St. Mary's Gate, Derby
Brown, Bailey, Dixon & Co., Ltd	Sheffield
Darlington Steel & Iron Co., Ltd.,	3, Victoria St., Westminster, S.W.
Hartley & Arnoux Brothers ..	Stoke-on-Trent
Steel Co of Scotland, Limited ..	Glasgow
West Cumberland Iron & Steel Co.	Workington, Cumberland

Reducing Valves.

Hanson, Wm.	Quebec Works, Bradford

Refrigerating Machinery.

Copeland, J., & Co.	Dobbie's Loan, Glasgow
Douglas & Grant	Dunnikier Foundry, Kirkcaldy, N.B.
Hall, J. & E.	Dartford Ironworks, Kent

Rice Dressing Machinery.

Copeland, J., & Co. .. .. .. Dobbie's Loan, Glasgow
Douglas & Grant .. .. .. Kirkcaldy, N.B.
Hunter & English .. .. .. Bow, E.
Landale, James .. .. .. Kirkcaldy, N.B.
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow

Rivets.—*(See Bolts, Rivets, &c.)*

Riveting Machines.

Anderson & Gallwey .. .. 8, Buckingham Street, Adelphi, W.C.
Berry, Henry .. .. .. Croydon Works, Hunslet, Leeds
De Bergue & Co., Limited .. Manchester
Fielding & Platt .. .. .. Gloucester
Gilmer, W. P., & Co. .. .. Quayside, Newcastle-on-Tyne
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
New, D., & Co .. .. .. 15, Devonshire Chambers, E.C.
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W.

Rock Drills.

Glover & Holson .. .. .. 66, James's Road, S.E.
Hartley & Arnoux Brothers .. Stoke-on-Trent

Rolling Mills.—*(See Iron & Steel Works, Plant for.)*

Rolls (Chilled and Grain).

Tinsley, Eliza .. .. .. Great Bridge, Staffordshire

Roofs (Iron, Steel and Zinc).

Ashbury Railway Carriage & Iron Co., Limited .. .. Openshaw, Manchester
Clarke, Bunnett & Co., Limited Rathbone Place, W.
Davies, Bros., & Co. .. .. Crown Ironworks, Wolverhampton
Davies, M. H. .. .. .. Grange Road, Bermondsey, S.E.
De Bergue, & Co., Limited .. Manchester
Dixon, Isaac .. .. .. Windsor Ironworks, Liverpool
Goodwin, Jas., & Co. .. .. Motherwell, N.B.
Hanna, Donald & Wilson .. Paisley, N.B.
Hill & Smith .. .. .. Tipton, Staffordshire
Ismon, C., Son & Co. .. .. Darlington
Iron Foundry & Engineering Co. Newport, Monmouthshire
Lowca Engineering Co., Ltd., The Whitehaven
Lysaght, J., Limited .. .. St. Vincent Works, Bristol
Morewood & Co .. .. .. Woodford Ironworks, Soho, Birmingham
Morton, Francis & Co. .. .. Naylor St. Ironworks, Liverpool
Walker Brothers .. .. .. Wigan

Rope Attachments.

Telschow, Geo. .. .. .. 63, King William Street, S.E.

Rope Driving Gear.

Goodfellow & Matthews .. .. Hyde, near Manchester

Ropes (Wire).—*(See Wire Ropes.)*

Rustless Iron.

The Bower-Barff Rustless Iron Co., Limited .. .. .. 23, Queen Victoria Street, E.C.

Sanitary Appliances.

Doulton & Co .. .. .. Lambeth, S.E.
Winn, Charles, & Co. .. .. Granville Street, Birmingham

Shafting.

Bagshaw, J., & Sons .. .. Batley, near Leeds
Bessemer, Henry, & Co., Limited Sheffield
Brown, Bayley, Dixon & Co. .. Sheffield
Goodfellow & Matthews .. .. Hyde, near Manchester
Harper & Co. .. .. .. Albion Ironworks, Aberdeen
Hick, Hargreaves & Co. .. .. Soho Ironworks, Bolton
Hind, H., & Son .. .. .. Nottingham
Kirkstall Forge Co. .. .. Leeds
New, D., & Co .. .. .. 15, Devonshire Chambers, E.C.
Taylor & Challen .. .. .. Derwent Foundry, Birmingham
Tinsley, Eliza .. .. .. Great Bridge, Yorkshire
Yates, J., & Co. .. .. .. Sheaf Works, Hunslet Rd., Leeds

Ship Builders.

Aberconn Shipbuilding Co .. Abbey Works, Paisley, N.B
Ross & Duncan .. .. .. Glasgow
Simons, W., & Co. .. .. Renfrew
Yarrow & Co. .. .. .. Isle of Dogs, E.

Soda Water Machinery.

Barnett & Foster .. .. .. 25a, Eagle Wharf Road, N.

Speed Indicators.

Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Tuite & Carlton .. .. .. 63, Queen Victoria Street, E.C.

Springs.

Ibbotson Brothers & Co., Limited Sheffield
Osborn, Samuel, & Co .. .. Sheffield
Salter, George, & Co. .. .. West Bromwich
Spencer, J., & Sons .. .. Newburn Steel Works, Newcastle-on-Tyne
Sterne, L., & Co., Limited .. Crown Ironworks, Glasgow
Turton, Thos., & Sons .. .. Sheaf Works, Sheffield

Steam Hammers.

Booth, Geo., & Co .. .. .. Halifax
Cochrane, John .. .. .. Barrhead
Davis & Primrose .. .. .. Etna Ironworks, Bangor Road, Leith, N.B
Davy Brothers, Limited .. .. Sheffield
Dudgeon, Richard .. .. 114, Fenchurch Street, E.C
Harvey, Robert, & Co .. .. Park Grove Ironworks, Glasgow
Massey, B. & S. .. .. .. Manchester
Musgrave, J., & Sons .. .. Bolton
Pollock, Macnab, & Highgate .. Shettleston, Glasgow
Rushworth & Co .. .. .. Sowerby Bridge, Yorkshire
Savile Street Foundry and Engineering Co., Limited .. .. Sheffield
Watson, J., & Co. .. .. .. Vulcan Ironworks, Bradford
Thwaites Brothers .. .. .. Pagefield Ironworks, Wigan
Walker Brothers .. .. .. Leeds
Walker, T., & Co. .. .. .. Leeds

Steam Traps.

Hanson, W. .. .. .. Quebec Works, Bradford
Lancaster & Tonge .. .. .. Pendleton, Manchester
Vaughan & Son .. .. .. West Gorton, Manchester

Steaming Machines.

Smith & Johnston .. .. .. Paisley Road, Glasgow

Steel Makers.

Askham Bros. & Wilson, Ltd. .. Sheffield
Beardmore, I. & W. .. .. Parkhead Ironworks, Glasgow
Bessemer, H., & Co., Limited .. Sheffield
Bolton Iron & Steel Co. .. Bolton
Brown, Bayley, Dixon & Co. .. Sheffield
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Steel Co. of Scotland, The .. 150, Hope Street, Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Turton, T., & Sons .. .. Sheaf Works, Sheffield
West Cumberland Iron and Steel Co. .. .. .. Workington, Cumberland

Steel and Iron Works (Plant for).—*(See Iron and Steel Works.)*

Steering Gear.

Donkin & Nichol .. .. .. Newcastle-on-Tyne
Grange Iron Co., Limited .. Durham
Lynn, John, & Co. .. .. Sunderland
Paul, M., & Co. .. .. .. Levenford Works, Dumbarton
Piggott, T., & Co. .. .. .. Springhill, Birmingham
Wilson, J. H., & Co. .. .. Sandhills, Liverpool

Stokers (Mechanical).

Knap, Conrad .. .. .. 11, Queen Victoria Street, E.C.
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Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow
Western & Co .. .. .. Chaddesden Works, Derby

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Aitken, McNeil & Co. .. .. Helen Street, Govan, Glasgow
Clayton, Howlett & Venables .. Harrow Road, W.
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Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Landale, James .. .. .. Kirkcaldy, N.B.
Manlove, Alliott, Fryer & Co. .. Nottingham
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow
Piggott, T., & Co .. .. .. Springhill, Birmingham

Surface Plates.

Okes, J. C. R .. .. .. 39, Queen Victoria Street, E.C.
Richards G., & Co. .. .. Atlantic Works, Broadheath, near Manchester

Tanks.

Bellamy, John .. .. .. Byng Street, Millwall, E.
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Davies Bros & Co. .. .. Crown Ironworks, Wolverhampton
Hanna, Donald & Wilson .. Paisley, N.B.
McCulloch, T., & Sons .. .. Kilmarnock
Morewood & Co .. .. .. Soho, Birmingham
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Hepburn & Gale, Limited .. Long Lane, Southwark, S.E.
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Webb & Son .. .. .. Stowmarket
White, John, & Sons .. .. Bingley, Yorkshire
Willcock, Mark .. .. .. Bowerby Bridge

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Marshall, Sons & Co., Limited .. Gainsborough

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Chadburn & Son .. .. .. Lord Street, Liverpool

Telegraph Wire and Cables.

Glover, W. T., & Co .. .. 25, Booth Street, Manchester

Timber Merchants.

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Tools (Hand and Small).

Bedford, J., & Sons .. .. Lion Works, Sheffield
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Jowitt, Thos., & Sons .. .. Sheffield
Lee, Howl, Wand & Howl .. Tipton
Nettlefolds, Limited .. .. Birmingham
Richards, George, & Co. .. .. 12, City Road, Manchester
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Shilraw, A., & Co .. .. .. Suffolk Works, Birmingham
Smith & Coventry .. .. .. Orchall Lane, Salford, Manchester
Widdowson, J. H. .. .. .. Orchall Lane, Manchester

Torpedo Boats.

Hanna, Donald & Wilson .. Paisley
Thornycroft, J. I., & Co. .. Chiswick, W.
Yarrow & Co. .. .. .. Isle of Dogs, E.

Tramways and Tramway Plant.

Askham Bros. & Wilson, Ltd. .. Sheffield
Carrington, W. T. H. (Wire) .. 9 & 11, Fenchurch Street, E.C.
Dick, Kerr & Co. .. .. .. 101, Leadenhall Street, E.C.
Hadfield's Steel Foundry Co. .. Attercliffe, Sheffield
Hartley & Arnoux Brothers .. Stoke-on-Trent
Kerr, Stuart & Co. .. .. 90, Bucklersbury, E.C.
Merryweather & Sons (Steam Engines) .. .. .. Greenwich, S.E.
Savile Street Foundry and Engineering Co., Limited .. .. Sheffield

Tube Cleaners.

Boaz, W. .. .. 29, West India Dock Road

Tubes (Brass).

Birmingham Battery & Metal Co. Birmingham
Muntz's Metal Co., Limited .. Trench Walls, nr. Birmingham

Tubes (Iron and Steel).

Aird, Jos. .. .. Tipton, Staffordshire
Birmingham Battery & Metal Co. Birmingham
Caledonian Tube Co. .. .. Coatbridge, near Glasgow
Credenda Cold-Drawn Seamless Steel Tube Co., The .. .. Ledsam Street, Birmingham
Donald, J., & Son .. .. .. 42, Cadogan Street, Glasgow
Eadie, J., & Sons .. .. .. Clydesdale Tube Works, Ruthergien, near Glasgow
Farmer, Jas., & Sons .. .. Salford
Galloway, W. & J., & Sons .. Manchester
Hildick & Hildick .. .. Tube Works, Walsall
Howell & Co. .. .. .. Brook Steel Works, Sheffield
Lewis, E., & Sons .. .. .. Wolverhampton
Lloyd & Lloyd .. .. .. Birmingham
Marshall, J., & Sons .. .. Glasgow
Russell, Jas., & Sons .. .. Crown Tube Works, Wednesbury
Skidmore, H. P. .. .. .. Netherton, near Dudley
Spencer, John .. .. .. Wednesbury
Spencer, J. E. & S. .. .. 3, Queen Street Place, Cannon Street, E.C.
Stewart, A. & J. .. .. .. Clyde Tube Works, Coatbridge
Sun Tube Co. .. .. .. Coatbridge, N.B.
Weldless Steel Tube Co. .. .. Icknield Port Rd., Birmingham

Tube Expanders.

Dron & Lawson .. .. .. Cranstonhill Tool Works, Glasgow
Dudgeon, Richd. .. .. .. 114, Fenchurch Street, E.C.
Gibb, James, & Co. .. .. 23, St. Mary Axe, E.C.
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria St., E.C.
Thomson, Wm. .. .. .. Kinning Park, Glasgow

Tube Making Machinery.

Farmer, Jas., & Sons .. .. Salford, Manchester

Tube Wells.

Isler, C., & Co .. .. .. 88, Southwark Street, S.E.
Le Grand & Sutcliff .. .. 100, Bunhill Row, E.C.

Turbines.

Donkin, B., & Co. .. .. Bermondsey, S.E.
Hanna, Donald & Wilson .. Paisley, N.B.
Hett, C. L. .. .. .. Ancholme Foundry, Brigg
King, H. J. H. .. .. .. Stroud, Gloucestershire
McKenzie, Thos., & Sons, Ltd. .. 16, Holborn Viaduct, E.C.
Stothert & Pitt, Limited .. .. Bath

Turnstiles.

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Le Grand & Sutcliff .. .. 100, Bunhill Row, E.C.

Tuyeres.

Newlove, R. R., & Co. (Water) .. Nottingham

Tyres (Railway).

Bessemer, H. & Co., Limited .. Sheffield
Brown, Bailey, Dixon, & Co. .. Sheffield
Landore Siemens-Steel Co., Ltd. Landore, South Wales
Leeds Forge Co .. .. .. Leeds

Valuers, Engineering.

Kirk, W., Price & Goulty .. 52, Queen Victoria Street, E.C.

Valves (Gas, Water, &c.).

Alley & Maclellan .. .. .. Glasgow
Beck & Co., Limited .. .. 130, Great Suffolk Street, Southwark, S.E.
Dennis, T. H. P., & Co .. .. Chelmsford
Dewrance, J., & Co., ... 188, Great Dover Street, S.E.
Donkin, B., & Co. .. .. .. Bermondsey, S.E.
Duncan Brothers .. .. .. 32, Queen Victoria Street, E.C.
Hanna, Donald & Wilson .. Paisley, N.B.
Hanson, Wm. .. .. .. Quebec Works, Bradford
Hartley & Sugden, Limited .. Halifax
Hunter & English .. .. .. Bow, London, E.
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Rhodes, S. .. .. 240, Bow Road, E.
Walker, Bros. .. .. .. Pagefield Ironworks, Wigan
Wood, H., & Co. .. .. .. Salford, Manchester

Valves, Safety.

Adams, Thos. (Executors of) .. West Gorton, Manchester
Turnbull, Alex., & Co. .. .. Glasgow

Ventilators.

Boyle, R., & Son .. .. .. 64, Holborn Viaduct, E.C.

Vices.

Macbrair, W. M. .. .. .. Sheaf Island Works, Sheffield

Vulcanite.

Winter, F .. .. 138, London Wall, E.C

Wagon (Railway) Builders.

Ashbury Railway Carriage & Iron Co., Limited .. .. .. Openshaw, Manchester
Bagnall, W. C. .. .. .. Stafford
Falcon Engine & Car Works, Ltd. Loughborough
Metropolitan Railway Carriage & Wagon Co., Limited .. .. Saltley Works, Birmingham
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury

Wagons (Tip).

Decauville, Aîné .. .. .. 4 Petit-Bourg (Seine et Oise) France
Dick, Kerr & Co, ... 101, Leadenhall Street, E.C.
Hartley & Arnoux Brothers .. Stoke-on-Trent
Hudson, B. .. .. Gildersome Foundry, near Leeds

Water Closets.

Winn, Charles, & Co. .. .. Granville Street, Birmingham

Water Meters.

Manchester Water Meter Co., Ltd. Tipping Street, Ardwick, Manchester

Water Purifying Apparatus.

Porter, John Henderson .. .. 1 & 2, Tudor Street, E.C.

Water Wheels.

Aitken, McNeil & Co. .. .. Helen Street, Govan, Glasgow
Bodley Brothers & Co. .. .. Exeter
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Hett, C. L. .. .. .. Brigg
King, H. J. H. .. .. .. Stroud, Gloucestershire
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow
Stothert & Pitt, Limited .. .. Bath

Weighing Machines.

East Ferry Road Engineering Works Co., Limited .. .. Millwall, E.
Hodgson & Stead .. .. .. Regent Road, Manchester
Ismon, Chas., Son & Co. .. .. Darlington
Pooley, Henry, & Son .. .. Albion Foundry, Liverpool
Salter, G., & Co. .. .. .. West Bromwich
Scott, Jas., & Son .. .. .. 10, Tibb Lane, Cross Street, Manchester

Well Engineers.

Isler, C., & Co. .. .. .. 88, Southwark St., London, S.E.
Le Grand & Sutcliff .. .. 100, Bunhill Row, E.C.

Wheels (Geared).

Bodley Brothers & Co. .. .. Exeter
Buckley & Taylor .. .. .. Castle Ironworks, Oldham
Fawcett, Thomas C. .. .. Manor Road, Leeds
Forsyth, Miller & Co. .. .. Mile End, Glasgow
Goodfellow & Matthews .. .. Hyde, near Manchester
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Harper & Co. .. .. .. Albion Ironworks, Aberdeen
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Hind, H., & Son .. .. .. Nottingham
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Staffordshire Wheel & Axle Co. Springhill, Birmingham
Tinsley, Eliza .. .. .. Great Bridge, Staffordshire

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Metropolitan Railway Carriage and Wagon Co. .. .. .. Saltley, Birmingham
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury
Staffordshire Wheel & Axle Co., Limited .. .. Springhill, Birmingham

Wheels (Road) and Axles.

Smith, Parfrey & Hitchings .. Buckingham Palace Rd., S.W.

Whistles (Signal).

Beck & Co., Limited .. .. Great Suffolk Street, S.E.
Cran, J., & Co. .. .. .. Leith

Winches, Steam.—*(See Cranes).*

Wire and Wire Rope Makers.

Birmingham Battery & Metal Co. Birmingham
Bullivant & Co. .. .. .. 72, Mark Lane, London, E.C.
Cradock, Geo., & Co. .. .. Wakefield
Glover, W. T., & Co. .. .. 25, Booth Street, Manchester
Warrington Wire Rope Co. .. 13, Gorse Piazza, Liverpool

Wire Making Machinery.

Crossley, Geo. .. .. .. Cleckheaton, Yorkshire
Farmer, Jas., & Sons .. .. Salford, Manchester

Wire Working Machinery.

Farmer, Jas., & Sons .. .. Salford, Manchester

Wire Tramways.

Carrington, W. T. H. .. .. 9 & 11, Fenchurch Avenue, E.C.

Wood Working Machine Makers.

Carrick & Ritchie .. .. .. Waverley Engineering Works, Edinburgh
Hindley, E. S. .. .. .. Bourton, Dorset
Marshall, Sons, & Co., Limited .. Gainsborough
M'Dowall, John, & Sons .. .. Johnstone, near Glasgow
Mansons, A., & Co. .. .. Stanley Works, Chelsea
Richards, G., & Co. .. .. Atlantic Works, Broadheath, near Manchester
Robinson, Thos., & Son, Limited Rochdale
Sands, H. .. .. Popham Street, Nottingham
Watson, J., & Son. .. .. Kilmarnock, N.B.
Western & Co .. .. .. Chaddesdon Works, Derby
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CONSTRUCTED BY MESSRS. BREITFELD AND DANEK, PRAGUE, FROM THE DESIGNS OF PROFESSOR RIEDLER, MÜNICH

(*For Notice, see Page* 69.)

Fig 1.

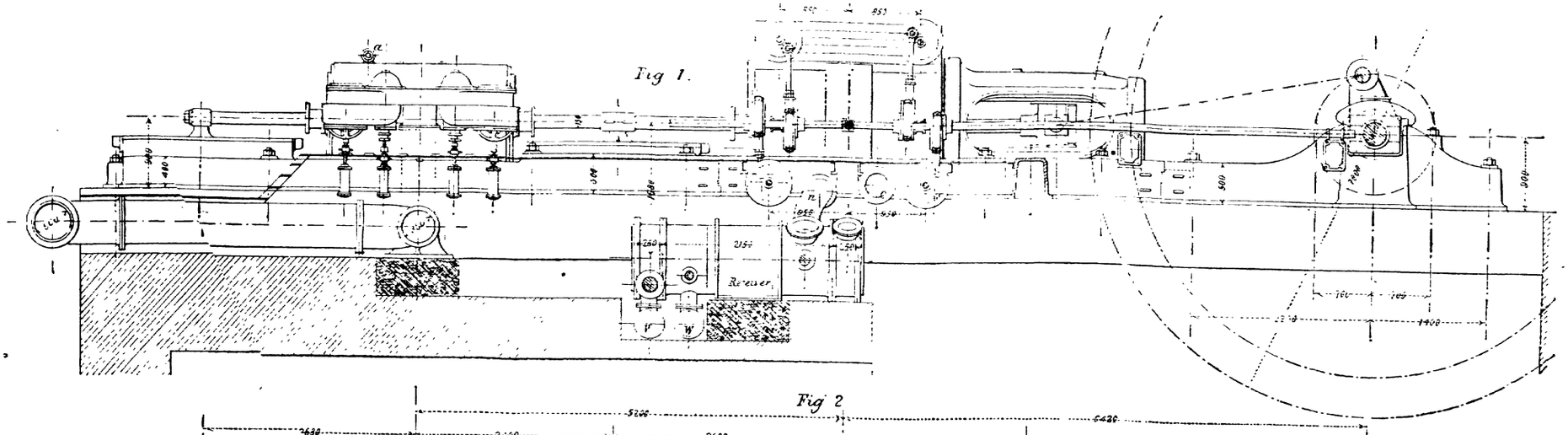
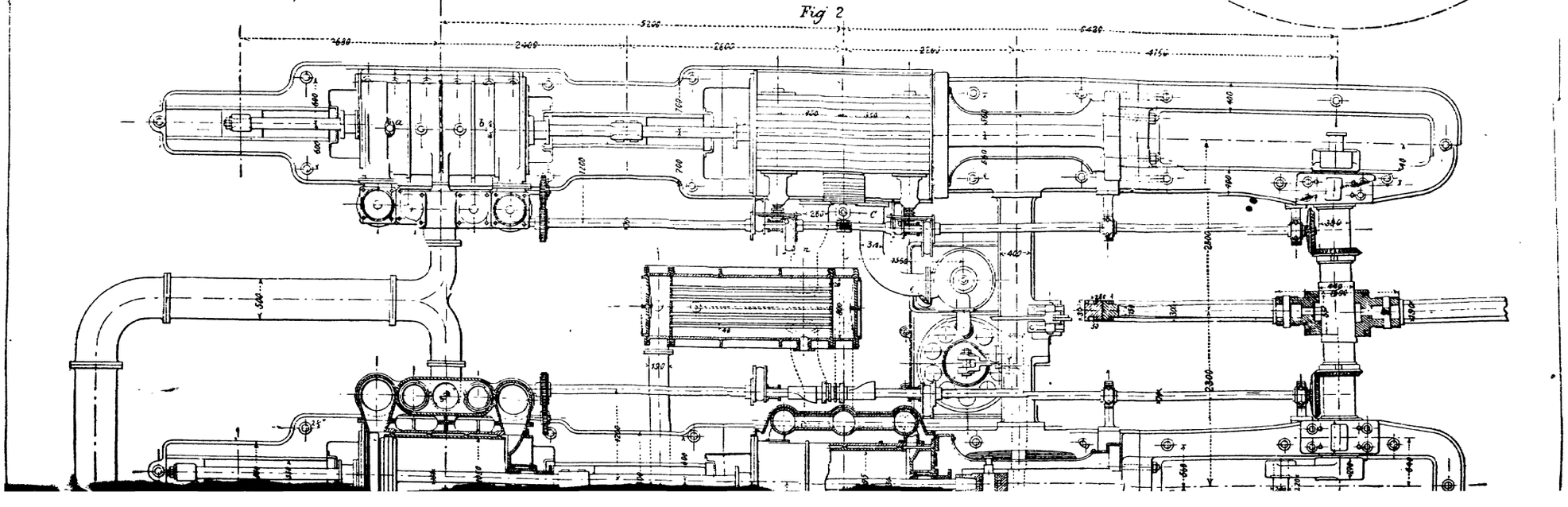


Fig 2



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MANNING, WARDLE, AND COMPANY,

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See their Illustrated Advertisement, page 42.

Locomotive Tank Engines,

TRAMWAY ENGINES AND CARS.

Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough. 5206

See Illustrated Advertisement last week, page 40.

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MANSION HOUSE BUILDINGS, E.C. 4812

See Advertisement last week, page 46.

Over 14,000 "Otto" Engines

AT WORK,

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NEWBURN STEEL WORKS,

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89, SUMNER STREET, SOUTHWARK, LONDON. 4827

Steel Hydraulic Cylinders.— HENRY BESSEMER & CO., Limited, SHEFFIELD.

See Advertisement, page 83 3627

Deck Machinery of every DESCRIPTION.

VERTICAL AND OTHER BOILERS.

SPECIAL HIGH SPEED ENGINES.

Apply, WELFORD BROTHERS, Engineers, Sunderland. (*See Advertisement last week, page 13*). 4650

Iron Roofs, Sheds, Buildings, HOUSES. Best work, reduced prices. Dixon's special CURVED IRON ROOFS are the most economical for spans up to 45 ft. Catalogues, Designs, Estimates, on application. ISAAC DIXON, Windsor Ironworks, LIVERPOOL. 4833

George Russell & Co., ENGINEERS and BOILERMAKERS, ALPHA STEAM CRANE and ENGINE WORKS, MOTHERWELL, near GLASGOW SILVER MEDAL, PARIS, 1867. 4921

SIEMENS STEEL PLATES, ANGLES, RIVETS, BARS, FORGINGS, CASTINGS, &c.

The Landore Siemens-Steel CO., LIMITED, LANDORE, R.S.O., SOUTH WALES. 4901

WIRE TRAMWAYS.

W. T. H. Carrington, 9 and 11, FENCHURCH AVENUE, E.C. Removed from 76, Cheapside, E.C. 5095

See Illustrated Advertisement last week, page 25.

A First-Class Lubricant.

"Engelbert's Lubricator."

SEE ADVERTISEMENT LAST WEEK, On Back Outside Page of Cover 4919

Hunter and English, ENGINEERS AND MILLWRIGHTS, IRON AND BRASS FOUNDERS, BOW, LONDON, E.

DREDGING MACHINERY.

HYDRAULIC MACHINERY.

"WILLIAMS'" PATENT CAPSTANS.

LAND AND MARINE STEAM ENGINES.

DISTILLERY AND BREWERY PLANT.

FLOUR AND RICE MILLS.

WATER AND GAS VALVES, CRANES, LOCK GATES, &c. PUMPING MACHINERY.

HUNTER'S PATENT FLOATING CRANE FOR DOCKS, &c.

STEAM LAUNCH MACHINERY. 4955

Boiler Tubes, Iron, Steel, and HOMOGENOUS.

EDWIN LEWIS AND SONS, Wolverhampton. 4868

Iron Boiler Tubes.— THE CALEDONIAN TUBE COMPANY, COATBRIDGE, near GLASGOW,

Having Special Stock, Shipments and Repairs executed very rapidly. 4938

Tubes. MARINE, LOCO', STEAM, BORING, COLLIERY. LARGE TUBES LAP-WELDED TO 12in. DIAM.

Joseph Aird,

TUBE WORKS,

GREAT BRIDGE, STAFFORDSHIRE.

LONDON OFFICES:

46, QUEEN VICTORIA STREET.

MANCHESTER:

QUEEN'S CHAMBERS, 5, MARKET ST.

Mr. L. SUTCLIFFE, M.E., AGENT. 5199

James Russell and Sons, LIMITED,

CROWN TUBE WORKS, WEDNESBURY.

London Warehouse: 101, Southwark Street, S.E.

Leeds Warehouse: 6, Flat Lane, Briggate

Price Lists on application. 5001

Iron and Steel Tubes.— JAMES EADIE AND SONS, CLYDESDALE TUBE WORKS, RUTHERGLEN, near GLASGOW. 51

Steam Hammers (with without guides). Hand-worked or Self-acting TOOLS for SHIPBUILDERS & BOILER MAKERS. DAVIS & PRIMROSE, LEITH, N.B.

The Patent Corliss Engi And PATENT CORLISS GEAR ENGINES, special Improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N.B. These engines are made Horizontal or Beam, Condensing, Non-condensing, and Compound. Also makers of Rice Mills and Paper Mills, and General Engineers. Machinery shipped or trucked direct from the premises. Mail

Lightfoot's Patent Self-a- TAINED DRY AIR REFRIGERATOR, For Preserving Meat, Fish, &c., on Board Ship or on Shore. 499

Steam Boilers, Ready for Deliv. W. & J. GALLOWAY & SONS, Manufacturers, always keep a large stock of "GALLOWAY" and "TWO-FLUED" Boilers ready for dispatch. 5060

Stannah's Pendulum Pups. For Prices see alternate weeks. 3238

Field's Patent Boilers and TUBES.

LEWIS OLRICK & CO., London. 5046

See Illustrated Advertisement last week, page 26.

40, KING STREET, COVENT GARDEN, W.C.

Thomas Kell and Son, Lho- graphers, &c., execute every descrip of Lithography, Chromo-lithography, Engraving and Printing, Engineering, Architectural, and Pictorial Drawing in best manner. Paper Drawing, photolithography, &c.—40, King St., Covent Garden, W 3462

Steam Cranes.

Thomas Smith,

STEAM CRANE WORKS, OLD FOUNDRY, 4345

RODLEY, NEAR LEEDS.

See Illustrated Advertisement last week, page 25.

International HEALTH EXHIBITION.

PAUL PFLEIDERER'S PATENT

Bread-Making Machinery

In Bakery Section. 4755

86, UPPER GROUND STREET, BLACKFRIARS, LONDON, S.E.

London Mutual Boiler In- SURANCE COMPANY, LIMITED. Established in 1874 for the INSURANCE and PERIODICAL INSPECTION of all kinds of Land and Marine Boilers throughout the United Kingdom.—For particulars apply to the Secretary 17, Queen Victoria Street, London, E.C. 4759

The Assured are secured against loss from claims established under the Employers' Liability Act, 1880.

The "Differential" Pumping ENGINE.—DAVEY'S PATENT for Draining Mines; Water Supply of Towns; Irrigation; Supplying Docks; Pumping Sewage; and General Pumping Purposes.

HATHORN, DAVEY, & CO., LEEDS.

H., D., & Co. have Patterns of "Differential" Engines of all sizes from 5 to 500-horse power, and have facilities for supplying very powerful Engines and Pumps at a short notice. 4750

HIGHEST AWARD, PARIS, 1878.

Goldsworthy's Emery,

Emery Cloth,

Glass Paper.

MANCHESTER. 4818

East Ferry Road Engineering WORKS CO., LIMITED, Hydraulic Engineers, Millwall, London, E. Parkes's Patent Portable Hydraulic Cranes, Lifts, and Hoists. Duckham's Patent Suspended Weighing Machines. 5124

See Illustrated Advertisement last week, page 14.

Dredgers and Excavators.— HIGHEST PRIZE AT TYNEMOUTH FOR HYDRAULIC DREDGERS.

Bruce and Batho,

9, VICTORIA CHAMBERS, 4743

WESTMINSTER, S.W.

See Illustrated Advertisement last week, page 27.

L. Sterne & Co., Limited. ENGINEERS,

Sole Makers of

Clerk's Patent

Self-Starting Gas Engine.

HIGHEST AWARD,

BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881.

GOLD MEDAL,

CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifiers,

WITH

STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels,

Emery Machines,

Spiral Springs.

The Crown Iron Works, GLASGOW.

The Crown Iron Works (Hollinwood), MANCHESTER.

10, Victoria Chambers, WESTMINSTER.

City Office and Show Rooms, 40, CANNON STREET, E.C.

10, Rue Laffitte, PARIS.

Metallurgical Department,

King's College, London, under the direction of Prof. A. K. HUNTINGTON.

In the Laboratory metals and alloys are examined mechanically with the aid of powerful testing machinery, as well as chemically. Extraction and manufacturing processes investigated and assays and analyses made.

A few free entries to the division of studies (day or evening) are obtainable through the City and Guilds' Institute. G 484

Professor Armstrong, of the

Yorkshire College, Leeds, proposes to hold a LONG VACATION CLASS in Field-work (Surveying, Levelling, &c.), at Grasmere, Westmoreland, early in August. — For particulars, address, Professor ARMSTRONG, St. Oswalds, Grasmere, R.S.O. G 463

TENDERS.

SINGAPORE TRAMWAYS.

Messrs. KER, BOLTON & Co., Glasgow, are prepared to receive

Tenders for the Supply, f.o.b.,

of the necessary RAILS, FISHPLATES, IRON or STEEL FISHBOLTS and NUTS required for the Singapore Tramways, according to Drawings and Specifications to be seen on and after 23rd inst., at the Office of JOHN STRAIN, Esq., C.E., 154, West George Street, Glasgow, from whom a Copy of the Specification and Form of Tender may be obtained on payment of One Guinea.

Tenders addressed "Singapore Tramways," to be lodged not later than 7th July.

Messrs. Ker, Bolton & Co., do not bind themselves to accept the lowest or any Tender. G 376

GREAT WESTERN RAILWAY.

The Directors of this Company are prepared to receive

Tenders for Additions to the

GOODS SHED, at the Bridgend Station, Glamorganshire.

Plans and Specification may be seen, and Forms of Tender and Bills of Quantities obtained, at the Office of the Engineer at the Newport (Mon.) Station, on and after Tuesday, the 1st proximo.

Tenders addressed to the undersigned, and marked outside "Tender for Works at Bridgend," will be received on or before Tuesday, the 15th proximo.

The Directors do not bind themselves to accept the lowest or any Tender.

FRED. G. SAUNDERS,
Paddington Station, London. Secretary.
23rd June, 1884. G 457

BELFAST HARBOUR

TO ENGINEERS AND SHIPBUILDERS.

The Belfast Harbour Commissioners are prepared to receive

Tenders for the Construction

of a Double-Ladder Self-Propelling Twin-Screw Stern-Well HOPPER DREDGER of Iron, to raise 800 tons of Spoil per hour, from a depth of 35 feet, and to carry 1,500 tons on, say 13 ft. draught of water, with a sufficient freeboard of, say 4 feet, at a speed of 10 statute miles per hour.

Or for Two smaller Dredgers, each of about one-half of the above carrying and propelling power, but with single ladders.

Or for Two Bow-well Hopper Dredgers, each to carry 800 tons, and propelled by twin screws.

Particulars of the general arrangement and construction of the Dredger required can be ascertained at the Harbour Office; but each Tenderer will have to satisfy himself as to the correctness and sufficiency of the dimensions to secure what is required, as the Commissioners do not hold themselves responsible therefor.

Tenders, endorsed "Tender for Dredger," to be lodged with the undersigned on or before the 28th day of July next.

The Commissioners do not bind themselves to accept the lowest or any Tender.

Harbour Office, W. A. CURRIE, G 464
Belfast, 24th June, 1884. Secretary.

BOMBAY MUNICIPALITY.

VEHAR WATER WORKS IMPROVEMENTS.

CAST IRON PIPES, &c

The Municipal Commissioner for the City of Bombay is prepared to receive sealed

Tenders for the Supply of

about 5,800 tons of CAST-IRON PIPES, more or less, varying in diameter from 24 in. downwards, as well as for certain other Iron Work.

Tenders must be received in Bombay on or before Twelve noon of the 6th August, 1884, addressed to "The Municipal Commissioner, Bombay," and endorsed "Tender for Pipes."

Printed Copy of the Conditions of Contract, Specification, Drawings, Bill of Quantities, general directions to Tenderers, and Form of Tender may be obtained of the undersigned, on payment of Rupees Ten, or of Messrs. E. W. and R. OLIVER, Solicitors, No. 1, Corbet Court, Gracechurch Street, London, E.C., on payment of £1 1s.

The Municipal Commissioner does not bind himself to accept the lowest or any Tender.

By order of the Municipal Commissioner
for the City of Bombay,
C. B. BRAHAM, M.I.C.E.,
Dy. Ex. Engr. in charge, Municipality, Bombay.
Dy. Ex. Engr's Office, Bombay, May 30th, 1884.
E. W. and R. OLIVER, 1, Corbet Court, Gracechurch Street, London, Solicitors. G 433

THE NEWPORT (MON.) SLIPWAY DRY DOCK AND ENGINEERING COMPANY, LIMITED.

Tenders are invited by the

above Company for the CONSTRUCTION of a DRY DOCK.

Plans and Specifications may be seen at the Offices of Mr. O. REICHENBACH, C.E., 6, Victoria Road, Westminster, London, and at the Offices of the above Company, 30, Dock Street, Newport, Mon.

Tenders may be sent in on or before Eleven o'clock a.m. on the 17th July next, addressed to the undersigned, at the Offices of the Company.

The lowest or any Tender not necessarily accepted.

By order of the Board,
WILLIAM WEST, G 419
Newport, Mon., 19th June, 1884. Secretary.

MARYPORT AND CARLISLE RAILWAY.

TO IRON-WORK CONTRACTORS.

The Directors of the above Company invite

Tenders for the Supply of

WROUGHT and CAST IRON-WORK required in the CONSTRUCTION of a BRIDGE over the Railway at MARYPORT Station.

Plans and Specification may be seen, and Form of Tender and particulars obtained, on application to Mr. JOSEPH CARTMEL, Engineer's Office, Maryport and Carlisle Railway, Maryport.

Sealed Tenders must be sent in, addressed to the Secretary of the Company, Maryport, not later than Saturday, July 19th, 1884.

The Directors do not bind themselves to accept the lowest or any Tender.

HUGH CARR, Secretary.
Maryport, 24th June, 1884. G 434

GREAT WESTERN AND LONDON AND NORTH WESTERN JOINT RAILWAYS.

The Joint Committee of the Great Western and London and North Western Railway Companies are prepared to receive

Tenders for the Construction

of the West Kirby Extension Line, which is about seven and three-quarter miles in length.

Plans can be seen, and Specification with Form of Tender and Statement of Quantities obtained, on application to Mr. ROBERT I. JOHNSTON, Engineer's Office, Woodside Station, Birkenhead, on and after Tuesday, the 15th instant.

Tenders endorsed "Tender for West Kirby Extension," to be delivered to the undersigned, not later than noon on Wednesday, the 30th instant.

The Directors do not bind themselves to accept the lowest or any Tender.

Birkenhead, J. WAIT, Secretary,
2nd July, 1884. G 477

BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive, up to noon on Thursday, the 10th July,

Tenders for the Supply of the

following STORES, viz:

CLASS A.
Steel Rails
Timber Sleepers.
Wagon Sheets.
Staffordshire Iron.
Copper Pipes, Bars, &c.
Carriage Fittings.
CASS B.
Hemp Bating, &c.
Leather Goods.
Bolts and Nuts, &c.
CASS C.
Cast Ironhairs.
Glass.
CISS D.
Brushes.
Lamps, &c
Portland Cuent.
Corrugated Iron Sheets.

Tenders must be made on Forms, copies of which, with Specifications, can be obtained on application at the Company's Offices, Finsbury Circus, E.C., on payment, for Class A. each, Class B, 10s. 6d. each; Class C, 5s. each; and Class D, 2s. 6d. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

By order,
J. PITT KENNEDY,
Offices: 45, Finsbury Circus, Officiating Secretary.
London, E.C., 27th June, 1884. G 480

DE AND ROHILKUND RAILWAY COMPANY, Limited.

The Directors are prepared to receive

Tenders for the Supply of the

following STORES:

STEEL GIRDERS for Bangunga Bridge.
STEEL FISH JOINTS.
MACHINERY AND MACHINE TOOLS.
STORES FOR LOCOMOTIVE DEPARTMENT.
PASSENGER CARRIAGES and
GOODS WAGONS.

Specifications and Drawings may be seen at the Office of Mr. W. F. BATHO, Consulting Engineer of the Company, 9, Victoria Chambers, Westminster, S.W., *from whom copies of the same may be obtained* on payment, which payment will not be returned.

Tenders, endorsed with the names of the Stores to which they refer, should be addressed to the undersigned, and delivered in sealed envelopes at the Offices of the Company as under, not later than Eleven o'clock in the morning of Wednesday, the 9th July, 1884.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
29, Min's Lane, C. C. JOHNSTON,
Cannon Street, E.C. Managing Director.
June 20th, 1884. G 481

BOARD OF PUBLIC WORKS.
NOTICE TO CONTRACTORS.

Sealed Tenders, addressed to

the undersigned, will be received up to Twelve o'clock noon on the 23rd day of July, 1884, for EXECUTING WORKS at Carrigaholt, co. Clare, viz.:

The Construction of a Pier 360 ft. long,
The Construction of a Quay 180 ft. long,
The Construction of an Inclined Approach,
The Excavation of some Rock, and
The Construction of an Approach Road,

according to Plan and Specification to be seen at this Office and at the Office of the Clerk of Petty Sessions at Carrigaholt, co. Clare.

Each Tender (which is to be on one of the Printed Forms dged with the Specification) to be for a Lump Sum, and to be accompanied by a detail (giving Quantities and Prices), and to be endorsed "Tender for Works at Carrigaholt Pier, co. Clare." The Board will not be bound to accept the lowest or any Tender.

N.B. Persons tendering who have not previously executed similar Works for the Board are requested to forward with the Tender such information and references as will satisfy the Commissioners of their ability, in every respect, to carry out the Contract, and that they have had previous experience in the construction of works of a like nature.

By order of the Board,
Office Public Works, W. B. SOADY, G 465
Dublin, 24th June, 1884. Secretary.

DUTCH STATE RAILWAY COMPANY.

The Company wants to

Sell about 6,000 tons of old

IRON RAILS, FISH-PLATES, BED-PLATES, &c., of good quality (Dutch tests), in Lots as desired by purchasers.

Conditions and information, from 20th July, 1884, at the Offices of said Company, Utrecht (Holland), and at the Offices of Resident Engineers at Groningen, Meppel, Zutfen, Nymegen, Rotterdam, Breda, and Venloo.

Copies of Conditions are sent after the 20th July, 1884, on free application to the Offices of said Company, Utrecht (Holland).

Tenders are to be delivered on or before the 5th of August, 1884, at the Offices of said Company, Utrecht (Holland). G 454

APPOINTMENTS OPEN.

The Royal India Engineering College, Coopers Hill, Staines.

APPOINTMENT OF PROFESSOR OF HYDRAULIC ENGINEERING AND MECHANISM.

This appointment becomes vacant in Sept., 1884.

The salary is £600 (first year £450 only), with bachelor quarters in the College (partly furnished), including the use of coals and gas.

The new appointment will be made by the Secretary of State for India, on the recommendation of the President of the College.

A statement of the duties may be obtained from the Secretary of the College, to whom also applications for the appointment, accompanied by testimonials, may be made before the 23rd July next. G 421

County or District Surveyorships in Ireland.

An OPEN COMPETITION for Two County or District Surveyorships in Ireland, will be held in Dublin, in August next, under the Acts 7 and 8 Vict., c. 106, and 25 and 26 Vict., c. 106.

The Examination will extend over the four days commencing with 12th August, and the six days commencing with 25th August, and will be in the following branches of knowledge.

PART I.	Maximum of Marks.
Mathematics—including Geometry, Trigonometry, Algebra, Differential and Integral Calculus, and Geometrical Optics	100
Mechanical Philosophy—including Statics and Dynamics, Hydrostatics and Hydraulics, Pneumatics, and Heat regarded as a source of Power	100
Experimental Science—including Inorganic Chemistry, Heat, Electricity, and Magnetism	100
Geology and Mineralogy	40

No Candidate will be eligible who does not show some proficiency under one at least of the heads included in Part I.

PART II.	Maximum of Marks.
Strength and other Properties of Materials, and the Circulation of Strains	100
(A.) Railway and Canal Engineering	140
(B.) Marine Engineering—including Harbour Dock, Sea, and Reclamation Works	140
(C.) Hydraulic Engineering — including Water Supply, Sewage, and Irrigation	140
(D.) County Works—including Architecture, Roads, Drainage, and River Works	140
	1000

*** Each of the groups lettered A., B., C., D., to include Designs, Estimates, Specifications, and the mechanical contrivances connected with it; and Candidates will be required to show that they have been engaged in the practice of their profession on adequate works for a sufficient time, or have had in some other way satisfactory opportunities of becoming acquainted with the practice of their profession in some one of the branches thus indicated.

Limits of age, 26 and 40.

Persons wishing to compete for those appointments, or to be reported qualified to act as Deputies to County Surveyors, must make written application to the SECRETARY, Civil Service Commission, London, S.W.

No person will be admitted to compete from whom the Secretary, Civil Service Commission, has not received, on or before the 1st August, an application on a prescribed form, which may be obtained from him at once.

Such enquiries as may be necessary will be made by the Civil Service Commissioners, with regard to the age of Candidates, and also as to their health and character.

NOTE.—All the Candidates who reach the prescribed standard, and furnish the required proof of age, health, character, and professional training, will, if they so desire it, be certified. Two of them will be appointed County Surveyors, and the others will be eligible to act temporarily as Deputies, but will have no claim to be appointed County Surveyors.

Dublin Castle, June 28th, 1884. G 472

It is intended to appoint

PROFESSORS of METALLURGY and of MECHANICAL ENGINEERING in the Technical School in connection with Firth College, Sheffield. The remuneration will depend on the qualifications of the applicants, but will in no case be less than £300 per annum, together with a portion of the respective Class and Laboratory Fees. For further particulars, apply to the REGISTRAR, to whom applications, stating experience and qualifications, must be sent, with the names of at least three referees, before 20th September, 1884.

EUSOR DRURY, G 453
Firth College, Sheffield. Registrar.

LANCASHIRE AND YORKSHIRE RAILWAY.

The Directors are desirous of receiving

Applications from thoroughly

competent persons for the APPOINTMENT of an ASSISTANT to the Engineer, to take charge under him of the maintenance of the permanent way and works. Salary £700 per annum.

Applications addressed to the Directors, and endorsed "Application for Appointment of Permanent Way Superintendent," to be forwarded not later than Monday, the 7th July prox. G 379

Hunt's Bank, Manchester, J. H. STAFFORD,
16th June, 1884. Secretary.

Draughtsman Wanted, in

GLASGOW; must have a thorough knowledge of Electric Light Apparatus. Applications giving particulars and salary expected, addressed to G 467, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 467

Opening in the Colonies for a

DRAUGHTSMAN with practical knowledge of general engineering, comprising marine, railway, and millwrights' work; if possessed of capital a partnership might result.—Address DRAUGHTSMAN, care of LEE & NIGHTINGALE, Advertising Agents, Liverpool. G 452

Travellers and Agents wanted

to push fine durable compound Machinery Oils, largely and increasingly adopted. Liberal commission.—Address J. B. TYLOR, 24, Finch Street, Whitechapel, London. G 374

Lists of Berths Vacant or

WANTED. See "ENGINEERING REVIEW," weekly 1d.; of all News Agents. G 468

SITUATIONS WANTED.

Marine Engineer wants

EMPLOYMENT at sea or ashore (extra first-class certificate); eight years' experience at sea.—Address, M. E., Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 474

A Young Engineer desires

SITUATION as ASSISTANT; would help in Office Work and Drawing. Good reference.—Address G 5000, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 478

Wanted, a Situation as Fitter;

lately out of apprenticeship. No objection to go abroad.—Address, J. P. PUE, 51, Ponsonby Street, Mulgrave Street, Liverpool. G 480

Evening Employment Wanted.

Drawings, Specifications, Estimates, Reports, &c. Well acquainted with Patent Laws. Terms moderate. Good references.—VERITAS, 1, Victoria Terrace, Home Road, Battersea, London, S.W. G 482

WANTED, &c.

Charlestown Foundry and

Iron Works Co., Limited.—WANTED to purchase a good second-hand 6-ton WEIGHING MACHINE, suitable for ordinary 4 wheeled road wagon.—State particulars and price to the SECRETARY, WALTER T. NICHOLLS, St. Austell, Cornwall. G 458

Stone Breaker Wanted, New

or Second-hand first-class, to break quartz, manganese, &c., steam power preferred. — Apply, giving price, maker's name, and where to be seen, to No. 108 W, Messrs. A. F. SHARP & Co., 14, Exchange Square, Glasgow. G 455

Wanted, an Engineering

FIRM, with a good connection amongst Gas Companies, to take up the manufacture and sale of a newly patented Gas Exhauster.—For particulars, apply to J. C. R. OKES, M.I.M.E., 39, Queen Victoria Street, London, E.C. G 456

Agents Wanted, in all indus-

trial centres, for the SALE of PROELL'S AUTOMATIC EXPANSION APPARATUS (see *Engineering*, March 21, 1884), for rendering existing slide valve engines, with throttle governors, equal to Corliss engines as regards economy in fuel and regularity of speed, the latter being guaranteed not to vary more than one per cent. per minute. Results obtained in London: sixteen per cent. extra work, besides twenty-five per cent. saving in fuel.—Apply to HERMANN KUHNE, 34, Great St. Helen's, London, E.C. G 408

Agents Wanted, to push First-

class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool. 5233

Lists of Machinery Wanted or

on SALE. See "ENGINEERING REVIEW," weekly 1d.; of all News Agents. G 469

FOR SALE.

For Sale or Hire, Locomotive

TANK ENGINE; cylinders, 12 in. diam.; 18 in. stroke; four wheels coupled; photograph on application; new locomotives in progress.—THOMAS PECKETT, Atlas Engine Works, near Bristol. G 461

For Sale, "Engineering."

Complete set of Vols., bound in Cloth to Vol. XXXVII., open to offer.—Address Mr. WALLIS, Bookseller, Brixton Road. G 460

For Sale, Steel Twin-Screw

STEAM LAUNCH (being in progress and nearly finished), 55 ft. long by 18 ft. 6 in. beam, 6 ft. 6 in. deep, draught 3 ft. 6 in.; compound non-condensing engines, 10 in. and 15 in. by 14 in. stroke; designed for light draught and high speed. Sold owing to owners requiring larger boat. — Apply, LOUDON BROTHERS, 111, Bothwell Street, Glasgow. G 420

Fly-wheel for Sale, 12 ft. dia-

meter, run 10½ in. by 9½ in., wide on face, in halves, bored to 10 in., and turned on rim, weight five tons.—Address tenders to HUNTER & ENGLISH, Engineers, 202, Bow Road, London, E. G 471

On Sale, a Pair of Horizontal

CONDENSING ENGINES, 16 in. and 22 in. cylinders, 36 in. stroke, fly spur 12 ft. diameter; about eight tons weight: pinion 4 ft. diameter; vertical air pumps; also two Boilers, each 28 ft. long, 7 ft. diameter, working pressure 50 lb., insured in the Yorkshire Boiler Insurance Company. Delivery in about three months. All in first-class condition.—Address, GEO. CRADOCK & Co., Wakefield. G 475

A No. 1 Second-hand Sissons and WHITE'S Steam PILE DRIVER for SALE.—Apply SISSONS & WHITE, Hedon Road, Hull. G 485

IN LIQUIDATION.

For Sale by Private Treaty, the old established and well-known and valuable engineering works and business, THE PHŒNIX IRON AND CRANK WORKS, at Grantham, carried on by Messrs. Hempsted & Co., for the manufacture of portable, vertical and other engines, steam cranes, boilers, patent threshing machines, wood working machinery, crank axles, castings, &c, &c. These extensive works are situate in the Dysart Road, Grantham, close to the Great Northern Railway, and are now being carried on and are in full working order. The opportunity thus offered of acquiring a valuable works and business is an exceptionally rare one.

The works can be viewed on any day, and full particulars as to terms of Sale, &c., can be obtained from Messrs. R. MACKAY & CO., 8, Lothbury, London, E.C. G 338

For Immediate Sale, at low prices for cash.

SECOND-HAND.

LANCASHIRE BOILER, 18 ft. 3 in. by 7 ft. diameter.
CORNISH BOILER, 12 ft. by 4 ft. diameter.
VERTICAL CROSS TUBE BOILER, 7 ft. 6 in. by 3 ft. 3 in. diameter.
TANK LOCOMOTIVE, 4 wheels coupled, cylinders 10 in. by 20 in.
A New 9 HP. CHAPLIN'S LOCOMOTIVE.
RAIL END PLANING MACHINE, by Craven Bros.
RAIL STRAIGHTENING MACHINE, with engine attached, by Collier.
No. 6 ROOT'S BLOWERS, by Thwaites.
Two No. 4½ PATENT BLOWERS, by Ellis.
Two SCOTT WHEEL MOULDING MACHINES.
10-ton RAILWAY WEIGHING MACHINE.
STEAM WINCHES, from 5 in. to 7 in. cylinders.

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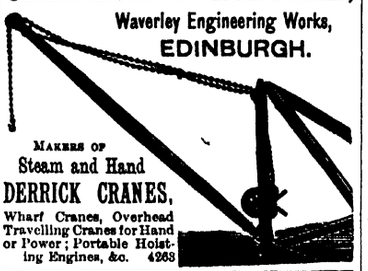
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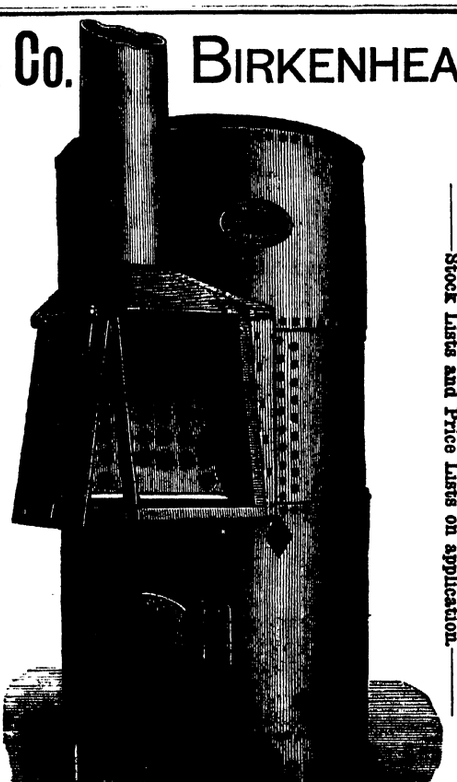
Amongst the Engines illustrated in this work are those of H.M.S. "Devastation," "Grappler," "Coquette," "Rover," "Tenedos," "Nelson," "Satellite," "Conqueror," "Boadicea," and "Bacchante;" also those of the S.S. "Parisian," "City of Richmond," "Gallia," "Richard Rush," "Mexican," "Itata," "Ulf," "Thorwaldsen," "Lord Jeffrey," "Inchrhona," "Aberdeen," "Servia," "Mercator," "Pennsylvania," "Friedrich der Grosse," "Dante," "Isa," "Moor," "Arizona," "Grecian," "Wanderer," "Novgorod," "Czar," "Assyrian Monarch," "City of San Francisco," "Anthracite," "Teucer," "Tartar," "Normandie," "Staithes," "Lady Torfrida," and "Isle of Dursey;" and the Engines of the Paddle Steamers "Hohenzollern," "Fayoume," "Mawuna," "Mount Etna," "Princes Marie," "Princes Elisabeth," "Midlothian," and "Normandy." A number of types of Torpedo Boat and Steam Launch Engines, and various arrangements of Dredging Machinery and Machinery for Submerged Rope and Chain Towage are also illustrated and fully described.

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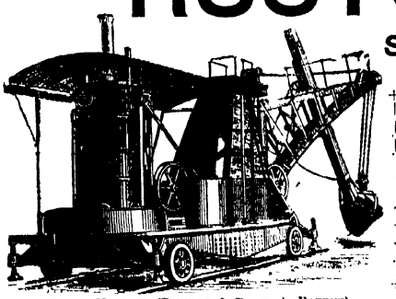
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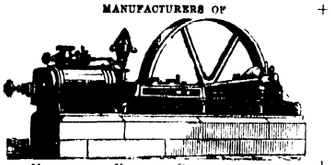
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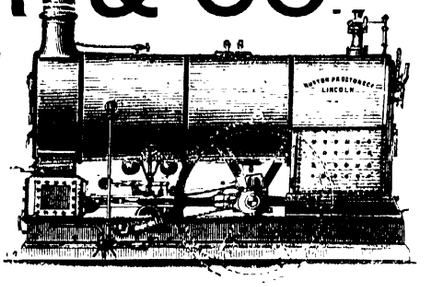
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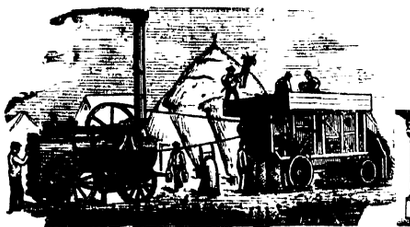
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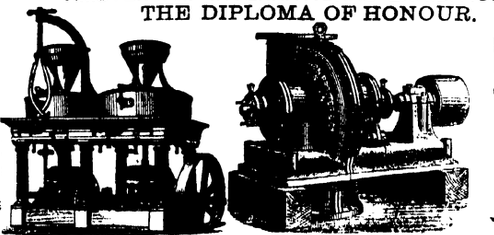
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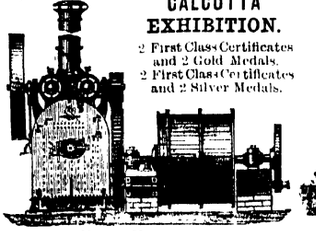
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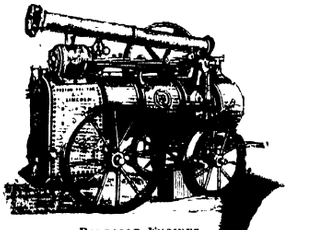
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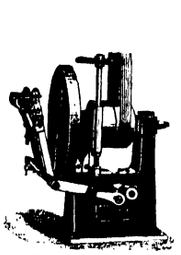


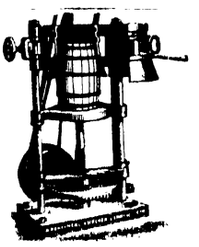
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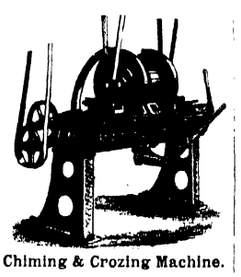
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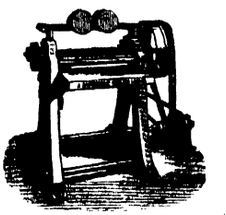
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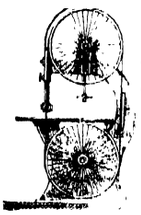

Head Rounding Machine.

FOR WHICH A GOLD MEDAL HAS JUST BEEN AWARDED AT THE FISHERIES EXHIBITION.

A. RANSOME & CO., STANLEY WORKS, CHELSEA.

CAUTION.—The notorious success of A. RANSOME & Co.'s Cask and Barrel Machines having caused them to be copied by other Engineers, Purchasers are advised to ascertain that any Cooperage Machines they may be offered do not infringe any of A. R. & Co.'s Patents. 1668

GEO. RICHARDS & CO.



Note. We have no connection with any Firm of Agents in Manchester trading under a somewhat similar name. All communications relating to Richards' Patent Wood-cutting Machines should be addressed to us,

ATLANTIC WORKS, BROADHEATH, NEAR MANCHESTER

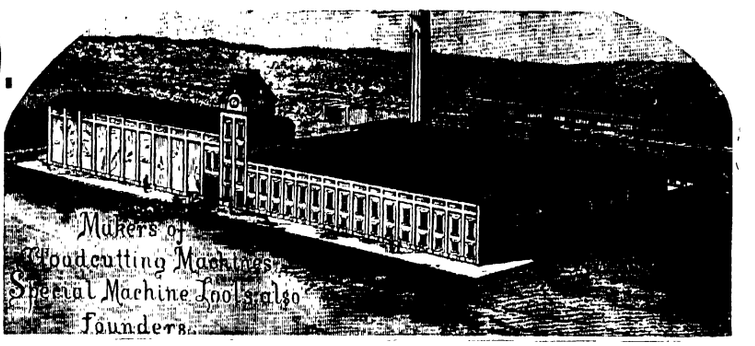
WOOD-CUTTING MACHINERY

OF HIGHEST CLASS AND OF ALL DESCRIPTIONS.

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London Show Rooms & Offices: 23 & 24, Whitecross St., E.C.

Continental Agents: SMITH & COVENTRY, 10, Rue Allibert, Paris.



WOOD-CUTTING MACHINERY OF ALL KINDS.

5148

PARTICULARS AND PRICES ON APPLICATION.

HAROLD SANDS, EAGLE WORKS, POPHAM ST., LEENSIDE, NOTTINGHAM.

JOHN FOWLER & Co., ENGINEERS, LEEDS.

CAN SUPPLY IF DESIRED THE

COMPOUND

IN ALL THEIR DIFFERENT TYPES OF ENGINES, BY WHICH IS EFFECTED IN FUEL AND WATER A

SAVING OF THIRTY PER CENT.

A most important feature in

AGRICULTURAL MACHINERY

AND ESPECIALLY IN

TRACTION ENGINES

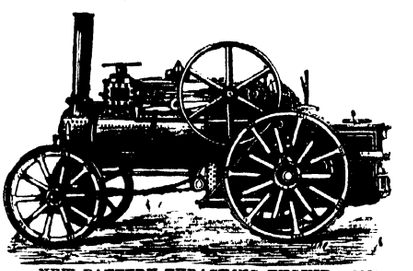
Because they have often to travel long distances where water and fuel are scarce and costly.

NOISELESSNESS.—In consequence of the steam passing from these Engines into the atmosphere at the low pressure of 8-lbs., the noise caused by the exhaust, so objectionable in ordinary Engines, is entirely overcome.

PRICES ON APPLICATION.

IPLE


STEAM PLOUGHING MACHINERY.
Adapted for the efficient Cultivation of Crops in any part of the world. Double Engine Sets of Tackle from six to twenty horse-power, and special Implements for every operation


NEW PATTERN THRASHING ENGINE. 3061

GLAZING.

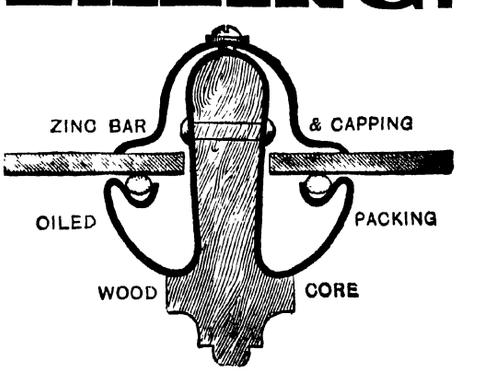
Glass set free, allowing Expansion and Contraction, and precluding Breakage.

ABSOLUTELY WATERTIGHT. PAINTING AND PUTTY SUPERSEDED.

OVER ONE MILLION FEET FIXED.

DRAWINGS AND PRICES ON APPLICATION.

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LONDON: 356 to 362, EUSTON ROAD. | **LIVERPOOL:** 6 and 8, HATTON GARDEN. | **GLASGOW:** 335, ARGYLE STREET.

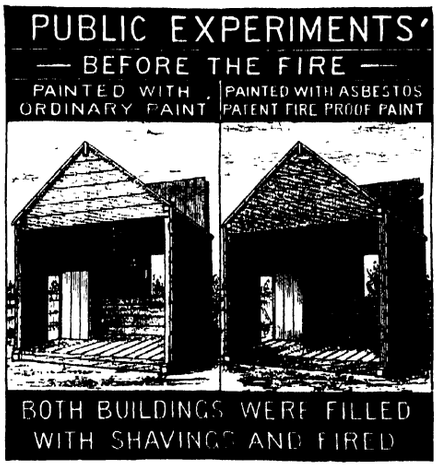
ASBESTOS FIRE-PROOF PAINT

Patents (Nos. 211 & 835)

THIS is the ONLY PAINT which has successfully stood the test of PUBLIC EXPERIMENTS.

Similar trials to demonstrate that Woodwork coated with it will offer an effectual resistance to flames were made, with results equally successful as those shown in the engravings, on the following occasions:—

LONDON (Crystal Palace)—Before the Lord Mayor and distinguished company, Jan., 1882.
LONDON (Whitehall Palace)—Before the Chairman of the Metropolitan Board of Works, Government Officials, Architects, &c., August, 1882.
LONDON (Alexandra Palace)—August, 1882.
LONDON (International Fisheries Exhibition)—By invitation of the Executive Committee of the Exhibition, three times, February and March, 1883. Witnessed by H.R.H. the Prince of Wales, the Speaker and Members of both Houses of Parliament, and over 100 Representatives of the Press.
STOCKHOLM—In the presence of the King of Sweden, Prince Karl and Suite; also Captain Halsten, Chief of Fire Brigade; Representative of the Army, Admiralty, State Railways, and Municipal Authorities, May, 1883.
AMSTERDAM—Before the Ministers of State and Municipal Authorities, August, 1883
And at various times before the Lord Provosts and Magistrates of Edinburgh and Glasgow, and the Mayors and Corporations of Manchester, Liverpool, Birmingham, Stratford-on-Avon, and other Towns.



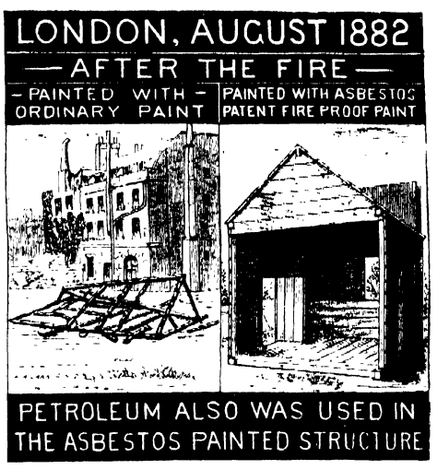
From THE TIMES, January 16th, 1882:—

"These results are highly satisfactory, and fully demonstrate the value of the Asbestos Paint as a fire-resisting medium in respect of its application to theatrical stages and effects, or in fact, to any other structures or their fittings."

THE TIMES, in referring on February 3rd, 1883, to the late Great International Fisheries Exhibition, said:—

"This is a precaution which the fear of fire renders evidently necessary, but the Exhibition buildings will, of course, be carefully watched and guarded, and *will, moreover, be thoroughly coated by the United Asbestos Company with their non-inflammable paint, a composition which, as was shown yesterday, to those who visited the ground, enables a common wooden shed to resist the efforts of flaming shavings and petroleum.*"

Hundreds of Equally Favourable Press Notices.



—IMPORTANT TESTIMONIALS.—

International Fisheries Exhibition, South Kensington, London, S.W., 19th November, 1883.

Dear Sirs,—With further reference to your letter of the 10th inst., I beg to inform you that I have duly laid the same before my Committee, and I am directed by them to express to you their entire satisfaction with the way in which your paint has stood the exposure to the weather, and the wear and tear of six months, though happily the qualities which you claim for it, and which the Committee have every reason to believe exist from the tests which they witnessed previous to the opening of the Exhibition, were not called into requisition.

I am, dear Sirs, yours faithfully,
E. CUNLIFFE OWEN, Secretary.

Messrs. the United Asbestos Company, Limited.

From H.M. INSPECTOR OF EXPLOSIVES, Home Office, May 26th, 1882:—

"I have no doubt that the Patent Fire-proof Paint will be of great value in preventing the spread of fire in wooden buildings."

From the SECRETARY OF STATE FOR INDIA, Sept. 19th, 1882:—

"I have to inform you that the samples of Paint which you have sent in have been satisfactorily tested."

Amongst the numerous buildings which have been wholly or partially protected with this Paint we may mention—

GREAT INTERNATIONAL FISHERIES EXHIBITION BUILDINGS (over 70 tons of paint were used on these buildings, and they were insured at a reduction of 50 per cent. in consequence)
HOUSES OF PARLIAMENT, Westminster. RESIDENCE OF H.R.H. PRINCE OF WALES, Sandringham.
THE BRITISH MUSEUM. THE SOUTH KENSINGTON MUSEUM.
HAMPTON COURT PALACE. ROYAL ITALIAN OPERA, Covent Garden.
CANVAS SCREENS of ROYAL AQUARIUM, Westminster.
GREAT STAGE at the CRYSTAL PALACE, Sydenham. ALHAMBRA THEATRE ROYAL.
STAGE OF SHAKESPEARE MEMORIAL THEATRE, Stratford-on-Avon.
THE BOROUGH LUNATIC ASYLUM, Birmingham. CURZON HALL STABLES, Birmingham.
WALKER'S AMMUNITION SHEDS, Birmingham; &c., &c.

SPECIALLY RECOMMENDED FOR WOODEN BUILDINGS

Of every description, especially Cotton Mills, Factories, Warehouses, and for fire-proofing the underside of floors, stairs, hoists, &c., which, as a rule, carry the flames. Timber should be dry when the Paint is applied, and outside work done, if possible, in fine weather, so that the Paint may dry and set hard, which it does very quickly. The Paint is in all cases sent out *ready for use*, with necessary instructions, and can be applied by ordinary workmen.

PRICE 38s. per cwt., f.o.b. London, Hull, Liverpool, Bristol, or Glasgow, in 5 cwt. lots. Packages cost price. Cash or London reference should accompany foreign orders.

IMPORTANT.—This Company was the first to make and introduce Asbestos Fire-proof Paints to the public. The process of manufacture was patented, but as in the case of all valuable inventions, compositions, similar in name but greatly inferior in quality and value, are being foisted on the public, and as instances have recently come to our notice where loss and disappointment have resulted therefrom, buyers who want the genuine article should, particularly when ordering through merchants, specify our brand.

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FOR IRONWORK, BRIDGES, STATIONS, AND GENERAL OUTSIDE PAINTING, ARE INVALUABLE. They have been proved to withstand the action of foul atmospheres, sulphur, gases, smoke, steam, &c., better than any paint known, and after lengthened trials in exposed positions are now specified for general outside painting by the leading Railway Companies. Being 25 per cent. lighter, these Paints are no dearer than ordinary paints.

☞ See next issue for particulars of our **ITALIAN ASBESTOS MILLBOARD** and **ITALIAN ASBESTOS** and **INDIA-RUBBER WOVEN SHEETING, TAPE** and **RINGS** for Joints of all kinds; Italian Asbestos Patent Woven H.P. Gland Packing; New Italian Asbestos Rolled Cloth Packing, with India-rubber Core (strongly recommended); and every description of Asbestos Goods.

Specify U. A. Co.'s "SALAMANDER" Brand.

"SALAMANDER." NEW ILLUSTRATED CATALOGUE ON APPLICATION. "SALAMANDER."

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4725

DEPOTS:

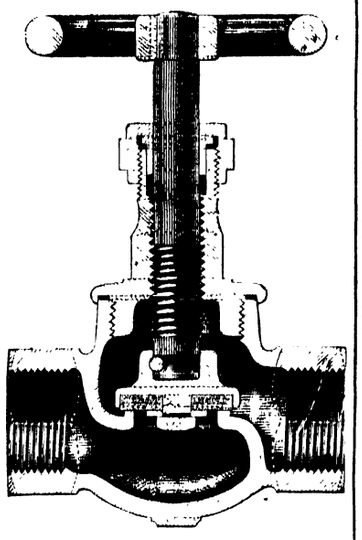
MANCHESTER: 85, CORPORATION STREET. | LIVERPOOL: 47, SOUTH JOHN STREET. | BIRMINGHAM: CLEMENT STREET. | GLASGOW: 52, ST. ENOCH SQUA

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Steam & Water Valves,

FITTED WITH SEATINGS OF

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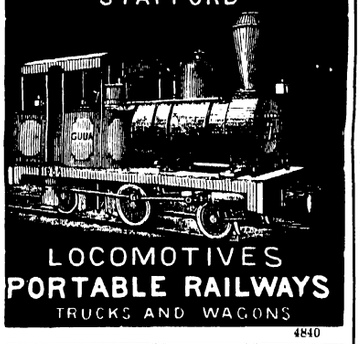
They hold perfectly tight under great pressure. The Patent Sealing can be renewed at will, without removing the body of the valve or breaking the pipe joints. While the price is only that of an ordinary gun-metal valve, they will last very much longer.

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FOR SMALL & LARGE SUPPLIES.

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FUEL ECONOMISER

FOR CORNISH, LANCASHIRE, OR ANY HORIZONTAL FLUED BOILERS

WITH OR WITHOUT GALLOWAY TUBES.

Simple—Easily Applied—No Fixing Whatever—No Alteration of Boiler—Requires no Skilled Labour to Apply it—Automatic in its Action—Improves the Draught—Utilizes the Heat in the Proper Place—Is an Excellent Smoke Burner—Cannot get out of Order—Substantial and Thoroughly Efficient.

THE GOSLING ECONOMISER GREATLY INCREASES THE POWER OF THE BOILER; STEAM USERS, THEREFORE, WHO CONTEMPLATE PUTTING IN NEW BOILERS SHOULD OBTAIN PARTICULARS OF THIS INVENTION BEFORE DOING SO.

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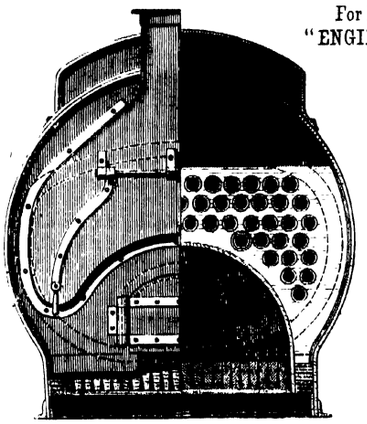
Price List post free. Engine Divider to the Trade.

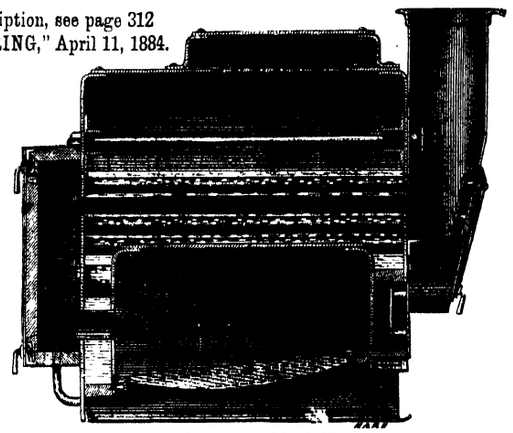
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The "RELIABLE" LAUNCH BOILER.

For Description, see page 312 "ENGINEERING," April 11, 1884.

BURRELL'S PATENT





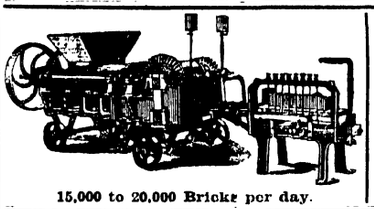
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This is the **Best Boiler yet introduced** for Launch purposes, and possesses all the advantages of both Marine return-tube and Locomotive Boilers, with the following additional advantages: Accessibility for Repairs, Consumption of Smoke, Facilities for Cleaning, &c.

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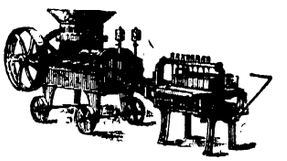
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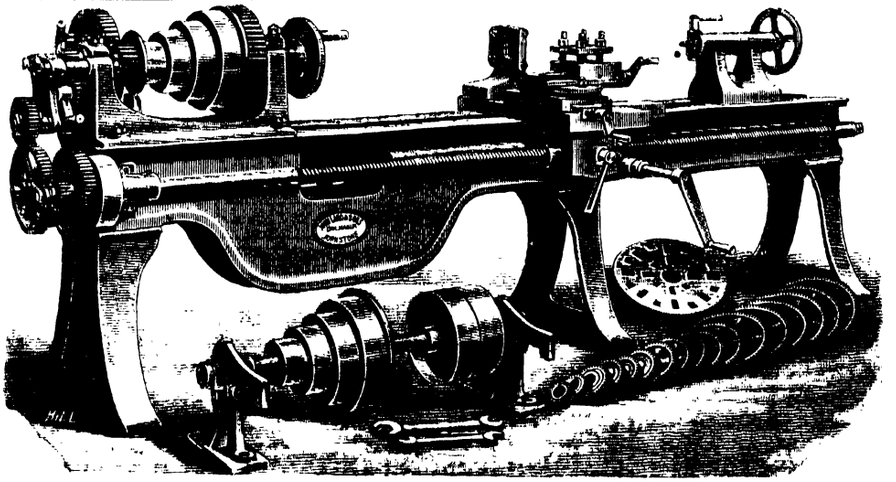
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BLYTH FOUNDRY AND ENGINE WORKS, BLYTH, NORTHUMBERLAND. 5208

SHIP REPAIRS, &c.

8¼ in. Centre Screw-Cutting Lathe, Teeth of Wheels MACHINE CUT.

PARTICULARS ON APPLICATION.

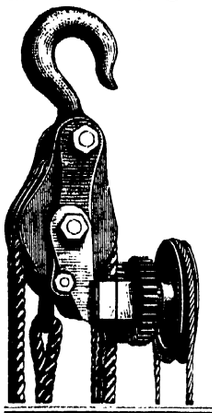


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LATHE MANUFACTURERS, JOHNSTONE, N.B.

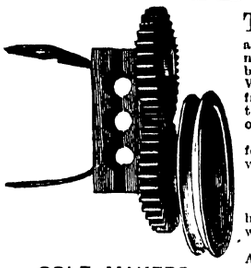
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BELL'S PATENT ROPE PULLEY FRICTION BRAKE.



Patented in Great Britain, United States, Germany, Austria, Russia, France, and Belgium.

Important to Engineers, Manufacturers, and all Users and Makers of Pulley Blocks.



THE Friction Brakes supply a want long felt, and will save their cost in half a day. They will sustain, instantaneously, any weight the blocks are capable of lifting, without the necessity of fastening the rope to any fixture. Any weight can be lowered with safety, by relieving the friction as required. When a weight is being raised, the brake may be used whilst a fresh hold is being obtained for each fresh pull. They grasp all the ropes at the same time, thereby giving frictional power without undue pressure or friction, and securing increased safety.

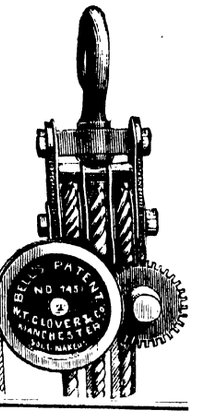
In all breakdowns and repairs of engines, &c., they will be found of the utmost assistance, and in all cases save much valuable time and labour.

They will reduce very materially the wear and tear of the ropes.

They give absolute security to life and material.

They are applicable to any existing pulley blocks, and can be attached instantly, being supported by the same bolt or pin which carries the sheaves.

In ordering, send dimensions of top block and size of rope. All sizes of blocks kept in stock, with Bell's Patent Brake attached.



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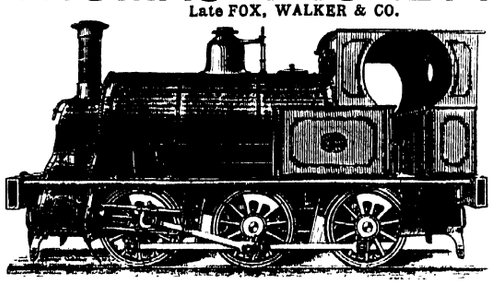
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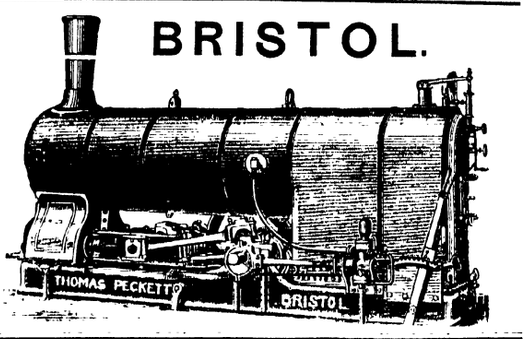
Engine & Boiler

COMBINED 4071

For Pit Sinking, Pumping, or General Work.
14 in. Cylinders, 20 in. Stroke, to Work at 120 lbs

ALWAYS IN STOCK.

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CONTRACTORS BY APPOINTMENT TO HER MAJESTY'S WAR DEPARTMENT.

ILLUSTRATED CATALOGUE, PRICE LIST AND ESTIMATES ON APPLICATION. 5230

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Numerous Official Tests show an average economy of over 10 per cent. *These Patent Bars last Years where ordinary Bars last only Months.*

Recently supplied to the order of the eminent builders of the engines and boilers of the most powerful Ironclad afloat for use in the whole of the furnaces, to work with "Forced Draught," MAKING THE THIRD Ironclad fitted. Used by the most eminent Engine and Boilermakers (Marine and Land), Railways, Home and Foreign Governments, &c. 5119

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The Best and Most Durable Metal for Bearings and Bushes of every Description; Hydraulic Pumps, Pinions, Valves, &c. &c Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c.

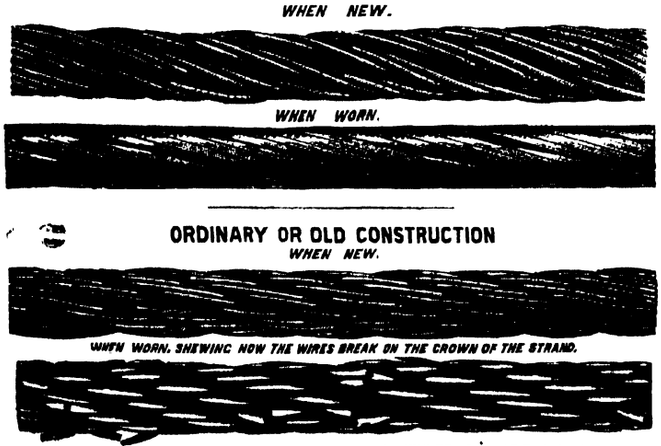
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Makers of all Descriptions of ROUND and FLAT STEEL and IRON WIRE ROPES
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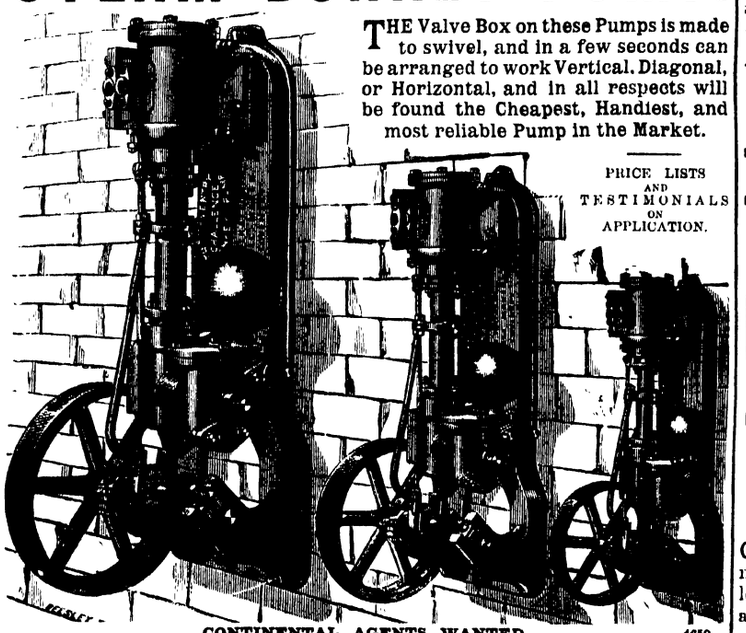
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J. HATTON, Engineer, COVENTRY.
Sole Maker of the "COVENTRY CHALLENGE"

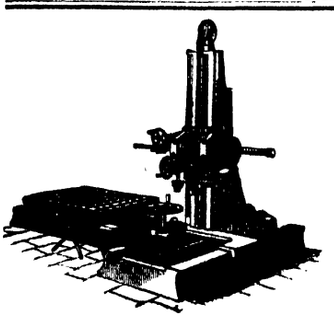
STEAM DONKEY PUMP.



THE Valve Box on these Pumps is made to swivel, and in a few seconds can be arranged to work Vertical, Diagonal, or Horizontal, and in all respects will be found the Cheapest, Handiest, and most reliable Pump in the Market.

PRICE LISTS AND TESTIMONIALS ON APPLICATION.

CONTINENTAL AGENTS WANTED. 4659



TO
MARINE ENGINEERS.

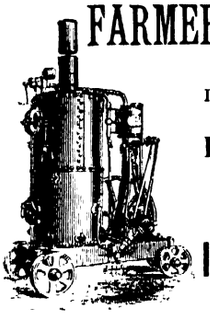
M'Arthur's Improved UNIVERSAL BORING MACHINES are the Best in the Market for Boring Marine Engine Work horizontally, and are admirably adapted for Boring, Tapping, and Stud inserting. Made in Sizes to suit requirements.

Radial Drilling Machines up to 12 ft. Radius; also, Horizontal Radial Drills, and all kinds of Engineers' and Shipbuilders' Plant.

A. M'ARTHUR & SON,
JOHNSTONE, N.B. 4466

STAND 212,
R.A.S.E. SHOW, SHREWSBURY.

Awarded the SILVER MEDAL at the Worcestershire Agricultural Society's Meeting, 1883 and CERTIFICATE OF MERIT and MEDAL at the Calcutta Exhibition, 1884.

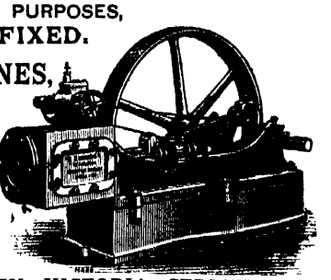


FARMER, ROBEY, BROWN & CO., LIMITED,
TRENT FOUNDRY, GAINSBOROUGH,
London Offices & Show Room: 59-63, Queen Victoria Street, E.C
MANUFACTURERS OF IMPROVED
PORTABLE AND SEMI-FIXED ENGINES
Of extra size and strength per Nominal HP., and
THRASHING MACHINES
WITH IMPROVED COMPOSITE TRUSS FRAMES.
INDEPENDENT VERTICAL ENGINES.
IMPROVED SMACK ENGINES, STEAM BOILERS, &c.
ILLUSTRATED CATALOGUES AND PRICE LISTS ON APPLICATION. 4003

E. S. HINDLEY,
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VERTICAL ENGINES & BOILERS
FOR ALL PURPOSES,
PORTABLE OR FIXED.
HORIZONTAL ENGINES,
Separate or Combined with Vertical Boilers.
SAW BENCHES,
CIRCULAR & BAND.



CATALOGUES FREE ON APPLICATION.

LONDON SHOW ROOMS: 11, QUEEN VICTORIA STREET, E.C.
Where every information may be obtained.

LIBERAL TERMS TO SHIPPERS AND THE TRADE. 4070

ROYAL SHOW, SHREWSBURY.
STAND 189.
E. R. & F. TURNER,
IPSWICH,
EXHIBIT
PORTABLE STEAM ENGINES
AND
"GIPPESWYK" VERTICAL AND HORIZONTAL STEAM ENGINES.

Above Engines are fitted with **Patent Automatic Expansion Governor**, ensuring important **fuel economy** unattainable with Engines not provided with this apparatus; uniform speed while running under varying loads is also obtained by this Governor. E. R. & F. TURNER direct special attention to these engines.

The "Gippeswyk" Vertical Engines are fixed on Boilers of highly improved construction, with Horizontal Water Tubes; ample heating and evaporating surface; priming, usual to Vertical Boilers, is avoided; Durability of the Boiler and increased facilities for cleaning and repairs are ensured in the "Gippeswyk" Boilers.

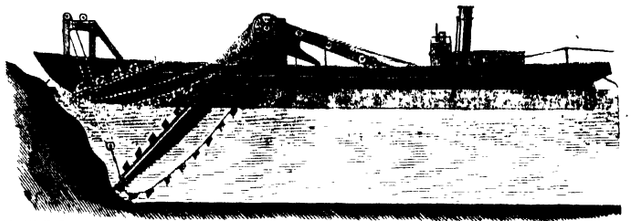
E. R. & F. TURNER also Exhibit their
CORN GRINDING MILLS
AND
CORN AND SEED CRUSHING MILLS.

Further information obtainable at the Stand above named, or from the Works, IPSWICH, on application.

DREDGING SPECIALITIES.

DREDGERS to dredge in front, in centre, or at sides.

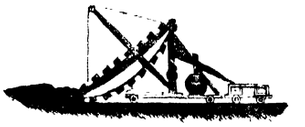
DREDGERS for abroad shipped in pieces, or made for steaming to any part of the world.



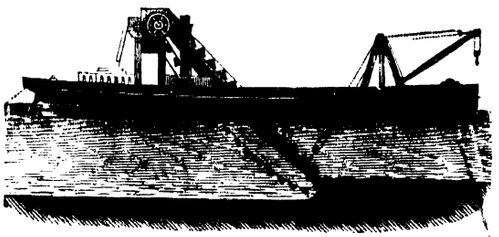
DREDGERS for River Bar, Dock, Canal or Harbour.

LAND DREDGERS or **EXCAVATORS**, for Dock, Canal, or Railway Cutting.





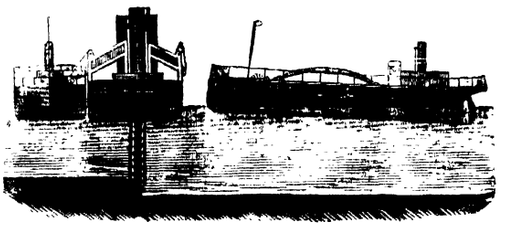
COMBINED DREDGER & HOPPER. All the Plant contained in one Hull, on the most improved principle, designed to cut its own way, and fitted for Towing, Fire Engine, or other Harbour uses.

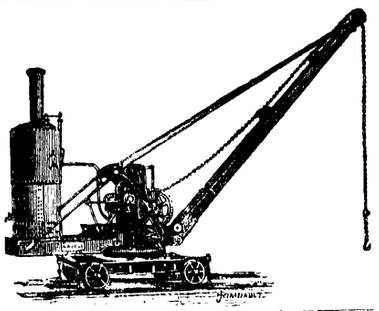


PARTICULARS ON APPLICATION TO

FLEMING & FERGUSON

PAISLEY, N.B. 5192



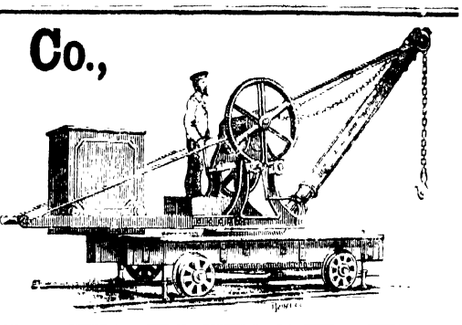


ROBERT ROGER & Co.,

Stockton Iron Foundry, Stockton-on-Tees.

STEAM AND HAND CRANES of every description.
STEAM AND HAND WINCHES.
Ships' Capstans, Pumps, Steering Gears, Water tight Doors, &c., &c.
DONKEY FEED PUMPS.
Horizontal & Vertical Steam Engines & Yacht Engines
Sole Manufacturers of 4314
MAWLAM'S PATENT RAILWAY TRUCK COUPLERS.

ILLUSTRATED CATALOGUES ON APPLICATION.



DRON & LAWSON, Cranstonhill Tool Works, GLASGOW.

PRICE LISTS ON APPLICATION.



PRICE LISTS ON APPLICATION.

MAKERS OF ALL KINDS OF MACHINE TOOLS FOR ENGINEERS, SHIPBUILDERS, &c.
Specialities: Screwing Machines, Taps, and Hand Screwing Apparatus.
Sole Makers in this Country during the currency of the Patent of DUDGEON'S TUBE EXPANDERS. 4160

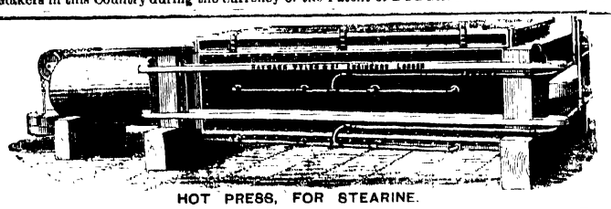
FOR LOCOMOTIVES MARINE OR OTHER ENGINES
OR MACHINERY — SPECIAL PATTERN FOR
ELECTRIC LIGHT
MACHINES

STROUDLEY'S PATENT SPEED INDICATOR

OVER 300 IN USE

TAITE & CARLTON
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4387



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HAYWARD TYLER AND CO.,

84 & 85, WHITECROSS STREET, LONDON.

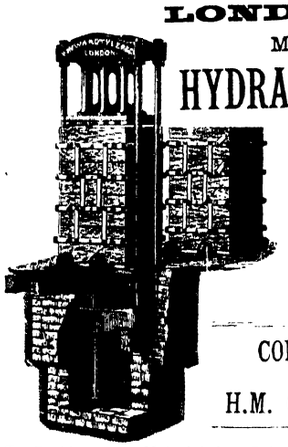
MAKERS OF

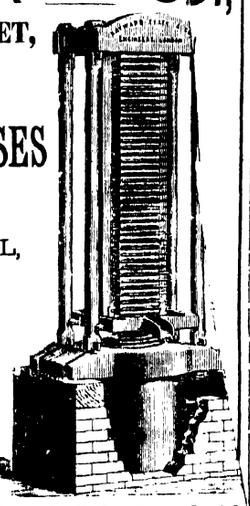
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FOR

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CONTRACTORS TO H.M. GOVERNMENT.





For Packing Loose Materials into Bales. 4930 For Extracting Oil from Castor Seed, &c.

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AT FROM ONE TO TWO-THIRDS THE COST OF WOOD ENGRAVING

ELECTRO & STEREOTYPERS

ELECTROTYPES PRODUCED IN THREE HOURS WHEN NECESSARY.

4077

CROWN PHOSPHOR-TIN.

BY USING OUR PHOSPHOR-TIN,
Phosphor-Bronze can be made Superior to any now in the Market,
AT 30 PER CENT. LESS COST.
Three cwt. of our tin will produce one ton of Phosphor-Bronze, thereby effecting a considerable saving in carriage, and enabling Manufacturers to use the same stock of Copper for all purposes.
(See our Circular.)

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Agents.—London: HAUGHTON & CO., 110, Cannon Street, E.C.
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The old-established Business carried on for nearly 20 years in the name of ALFRED APPS, 433, Strand, London, and for the past seven years in Partnership with OLAN CHARLES BAGOT, Esq., C.E. (the PARTNERSHIP having CEASED by effluxion of time). This Valuable Business, Stock, Glass Cases, Tools, Materials and Tenants' Fixtures, with GOODWILL of the Business and a 21 YEARS' LEASE of the Premises from Christmas last, will be

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At 38, King Street, Covent Garden, London, on July 11th inst., at 2 o'clock,
UNLESS PREVIOUSLY SOLD BY PRIVATE CONTRACT.

Application to be made to Messrs. HUGHES & KENNEDY, 1, Clements Lane, Strand, W.C., or to A. F. COX, Esq., 14, Hart Street, Bloomsbury, W.C., or to

MR. APPS, 433, STRAND, LONDON. 5232

WOOD ENGRAVING
Draughtsmen & Engravers on Wood
HARE & Co
31 ESSEX STREET
STRAND
LONDON
ESTIMATES ON APPLICATION

MERRYWEATHER & SONS, LONDON.



Gradient 1 in 13.

Gradient 1 in 13.

Steam Tramway Engines are working English Lines at half the cost of other Engines

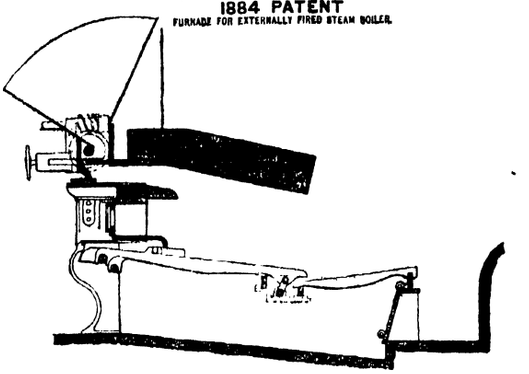
Batley Tramways	-	3.72d. per mile—	4 years.
Stockton „	- -	3.12d. „	2 „

SPECIALITIES.

Well Balanced,
Low Centre of Gravity,
Economy in Fuel.
Effective Brake Power,
Perfect Condensation,
Economy in Repairs.
Constructed to be driven from both ends.

Emits neither Smoke, Fire, nor Heated Vapour to annoy Riders or Passers-by.
The working cost of these Engines for the past four years is 50 per cent. Less than of Vertical Engines, chiefly on account of economy in fuel.
Merryweather & Sons also supply FIRELESS Locomotives. 5080

KNAP'S IMPROVED MECHANICAL STOKER.
1884 PATENT
FURNACE FOR EXTERNALLY FIRED STEAM BOILER.



FOR PRICES AND FULL PARTICULARS APPLY TO
CONRAD KNAP,
SOLE MANUFACTURER.
Office:—11, QUEEN VICTORIA STREET, LONDON, E.C.
ALSO
Sole London Representative for the 5087
"ROOT" STEAM BOILER.

FRANCIS BERRY & SONS,

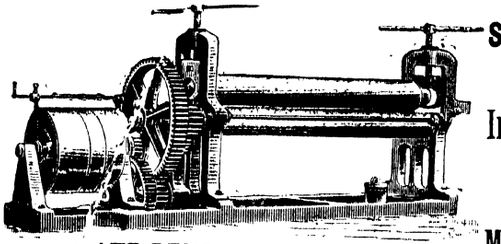
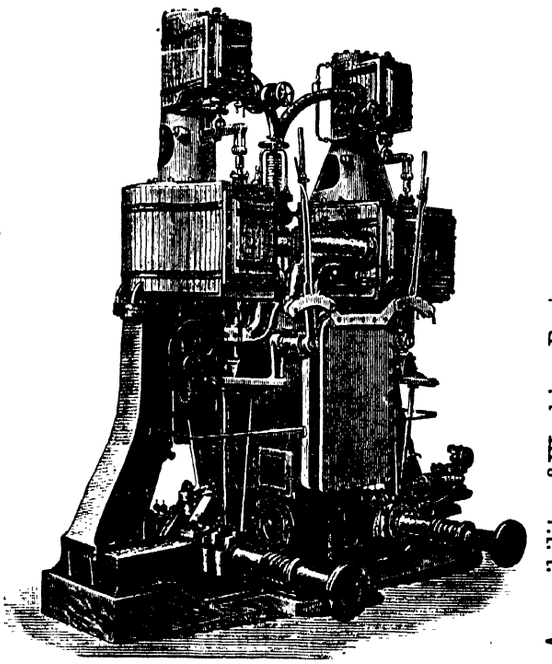


PLATE BENDING MACHINE.

SOWERBY BRIDGE, ENGLAND,
Ironfounders, Engineers, AND 4701
Machine Tool Makers

RANKIN & BLACKMORE, Engineers,
GREENOCK,
MAKERS OF
Rankin's Patent **2-CYLINDER DISCONNECTING COMPOUND ENGINES**
AND
4-CYLINDER DISCONNECTING TRIPLE-EXPANSION ENGINES,
FOR PADDLE AND TWIN-SCREW STEAMERS.

The principal advantages claimed for these Engines, as compared with the ordinary 4-Cylinder Compound and 6 or 8-Cylinder Triple-Expansion Engines, are

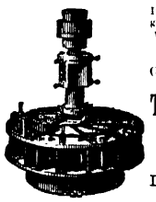


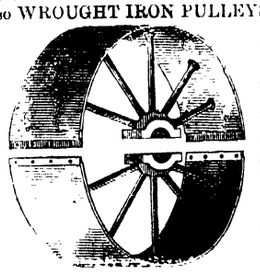
Simplicity of Construction, Economy of Fuel, Accessibility of Working Parts, Superior Efficiency, and Less Tear and Wear.

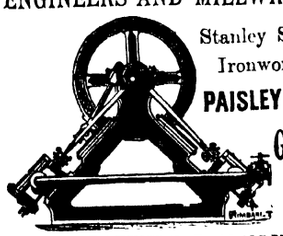
FULL PARTICULARS AND PRICES ON APPLICATION. 5229
For Illustration of 2-Cylinder Paddle Engines, see ENGINEERING of this day Fortnight.

EXORS. OF
JAMES MILLS,
BREDBURY, near STOCKPORT,
MAKERS BY
PATENT MACHINERY
OF
PLAIN OR HEADED KEYS,
TAPER, STUD, & BRACKET PINS,
AND
SPLIT STEEL TAPER PINS
FOR LOCOMOTIVES. 4010

ORMEROD, CRIERSON & CO.,
St. George's Ironworks, Hulme, Manchester,
Have the largest assortment in the trade of
PATTERNS OF SPUR WHEELS, BEVEL WHEELS, AND MITRE WHEELS, WITH TEETH CUT BY MACHINERY.
Also Fly Wheels, Driving Pulleys, and Drums can be supplied Bored and Turned if required.
Catalogues on application. Also Manufacturers of Blast Engines, Colliery and other descriptions of Stationary Engines and Boilers, Mill Gearing Cranes, and Turntables, &c
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IMPROVED AND ECONOMICAL APPLICATION OF WATER POWER.
LEFFEL'S IMPROVED PATENT
AMERICAN
Double Turbine Water-Wheel.

It is applicable to all heights of fall giving the greatest amount of power with the least consumption of water
OVER 10,000 IN USE,
Giving over 400,000 HP.
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LIMITED,
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LONDON, E.C.;
DUBLIN and BELFAST.
SOLE AGENTS FOR EUROPE
FOR 5116
JAMES LEFFEL & CO.

GEORGE CROSSLEY,
ALBION MACHINE WORKS,
CLECKHEATON, YORKSHIRE.
Maker of all Descriptions of
WIRE MACHINERY.
Also WROUGHT IRON PULLEYS,

London Office: DUNCAN BROS., 32, Queen Victoria Street, LONDON, E.C.
With Single or Double Arms and Cast-Iron Bosses (which for CHEAPNESS, LIGHTNESS, and STRENGTH are UNSURPASSED.) Price List on Application. 4411

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ENGINEERS AND MILLWRIGHTS,

Stanley Street
Ironworks,
PAISLEY ROAD,
Glasgow
MAKERS OF
SMITH'S PATENT STEAMING MACHINE
Do. do. CALICO DRYING do.
Do. do. YARN do. do.
Do. do. SOAPING do.
Steam Engines of every description to drive one or more of the above machines, fitted with One, Two, or Three Cylinders.
SPECIAL QUOTATIONS GIVEN,
Also references to firms in England and Scotland where these Machines are working. 4355

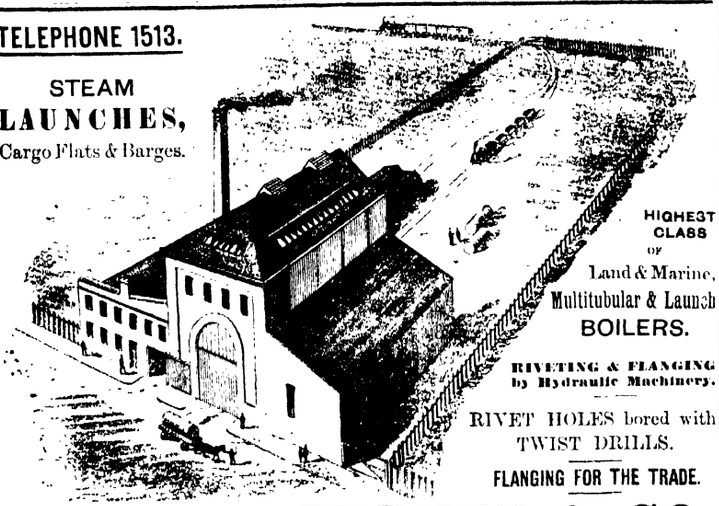
Effects a Saving

on Application.
Testimonials
of 50% over Oil.
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23, BRUNSWICK STREET, LIVERPOOL.

THE DARLINGTON STEEL & IRON CO., LTD.
BESSEMER STEEL RAILS from 10 to 84 lbs. per yard.
STEEL AND IRON FISH-PLATES,
PATENT FLEXIBLE, CLIP, ANGLE, AND OTHER SECTIONS.
—— ROLLED STEEL SLEEPERS. ——
STEEL TRAM RAILS, A SPECIALITY.
STEEL ANGLES, TEES, CHANNELS, BULBS, and BARS of other SECTIONS,
For Shipbuilding and Constructive purposes.
Guaranteed, if required, to stand the Admiralty or Lloyds' Tests.
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Messrs. BARNINGHAM BROTHERS, Agents. 5109

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SILVER MEDAL, MELBOURNE, 1881.
TUBES and FITTINGS for Gas, Steam, and Water; Galvanised, Enamelled, and Hydraulic Tubes, Boiler Tubes and Fittings, Gasfitters' Tools, Brass Cocks. Anti-Corrodo Tubes and Fittings coated by Barff's Rustless Process.
JOHN SPENCER,
GLOBE TUBE WORKS, WEDNESBURY
And 3, Queen Street Place, London, E.C. 4892

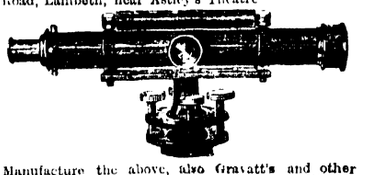
ROBERT HARVEY & COMPY.
(Late D. Cook & Co.)
COLONIAL ENGINEERS,
Park Grove Iron Works,
GLASGOW,
Makers of
Sugar Machinery.
ALSO
STEAM
HAMMERS,
Shipbuilders' and Boilermakers' Tools 4734
PATENT STEAM & HYDRAULIC
RIVETTING MACHINERY.

TELEPHONE 1513.
STEAM
LAUNCHES,
Cargo Flats & Barges.

HIGHEST CLASS OF
Land & Marine,
Multitubular & Launch
BOILERS.
RIVETING & FLANGING by Hydraulic Machinery.
RIVET HOLES bored with TWIST DRILLS.
FLANGING FOR THE TRADE.
LINDSAY BURNET & CO.,
MOORE PARK BOILER WORKS, GOVAN, GLASGOW. 4934

CRANE'S PATENT OIL
FOR
CYLINDERS AND VALVES.
As Supplied to H. M. Navy and the Principal Steamship Companies.
Manufactured solely by
P. MOIR CRANE & Co.,
BANK STREET, MANCHESTER;
4, James Street, Liverpool, and 131, Fenchurch Street, London, E.C.
TRADE CRANE'S PATENT OIL FOR CYLINDERS & VALVES MARK.
PROVED to be the BEST OIL by the EVIDENCE before the COMMITTEE appointed by the LORDS COMMISSIONERS of the ADMIRALTY.
FREE from ACID, leaves no DEPOSIT in the CONDENSERS, PRESERVES the BOILERS and SAVES FUEL.
All oils except those covered by Crane's Patent become acid in passing through the high-pressure cylinders, and consequently corrode boilers, leaving at the same time Deposits in the internal part of the machinery.
AGENTS—GEO. E PHILIP, 18, Renfield Street, Glasgow; G. A. BUSHELL, Lombard Street, Quayside Newcastle-on-Tyne, R BARTON, 18, Commercial Road Hull. 4904
N.B.—As parties are imitating P. Moir Crane & Co.'s Advertisements and Circulars, and offering Oil for Cylinders and Valves professing to give the same results as Crane's Patent Oil, the Patentees distinctly state that their Patent Rights cover THE USE OF ALL THE CLASS OF OILS which give these results, and that for their own security they must proceed against those infringing Crane's Patent Oil, the quality of which is fully established, can be obtained at about the same price as the imitations of it.

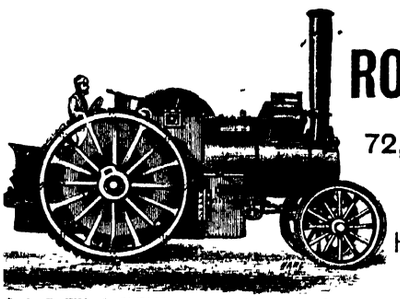
PRICE'S
THAMES AND MERSEY
LUBRICATING OILS.
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Mark.
PRICE'S SPECIAL GAS ENGINE OIL,
Strongly recommended by MESSRS. CROSSLEY BROS., LTD., MANCHESTER.
PRICE'S COMPOUND ENGINE OIL,
For Marine Engines and Locomotives.
PRICE'S SHERWOOD SPERM OIL,
For General Machinery.
PRICE'S CYLINDER OILS.
PRICE'S BELMONT SPINDLE OIL.
PRICE'S RANGOON OIL.
As recommended by
THE WAR OFFICE AUTHORITIES,
"For the preservation of SMALL ARMS and Articles made of Metal from oxidation."
Price Lists on application to
PRICE'S PATENT CANDLE COY., LIMITED,
BATTERSEA, LONDON 4596
BROMBOROUGH POOL, LIVERPOOL.

Contractors' and Builders'
12 inch LEVEL, as per Illustration, complete with Mahogany Case and Stand, price £4 14s. 6d.—J. W. and E. ARCHBUTT, 201, Westminster Bridge Road, Lambeth, near Astley's Theatre.

Manufacture the above, also Gravatt's and other Dumpy Levels, Theodolites, and every description of Surveying and Drawing Instruments at equally low prices. Every article warranted. 840 Illustrated Price Catalogues forwarded on receipt of three stamps.

TRACTION ENGINES

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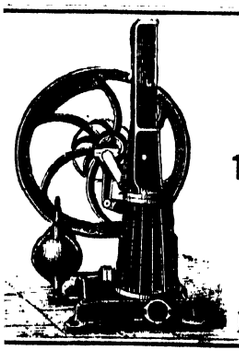
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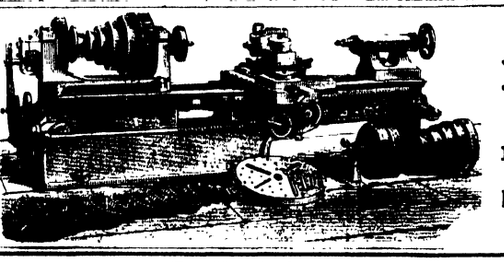
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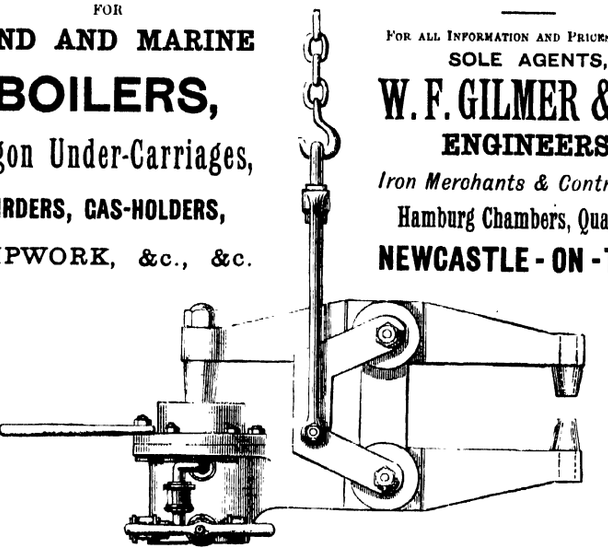
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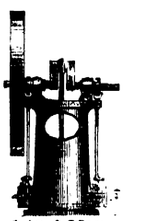
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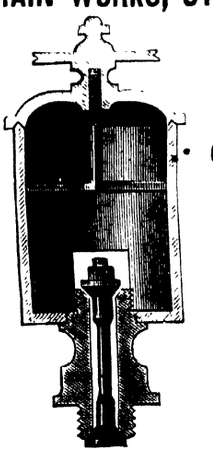
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Cannot get out of order.



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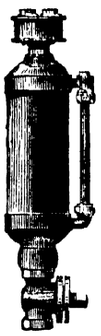
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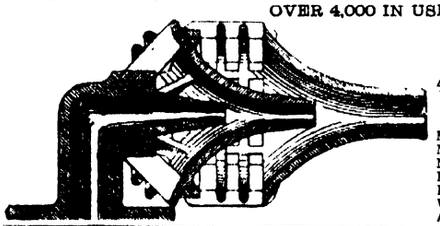
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DEAR SIR,—Referring to your letter of the 23rd instant, I have much pleasure in stating that the two Air Injectors supplied for the Liverpool Pumping Stations have been in use about two years, and that during that time they have acted satisfactorily and have maintained a uniform volume of air in the air vessels.—Yours truly,

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Best and Cheapest Means of Preventing Unequal Expansion.
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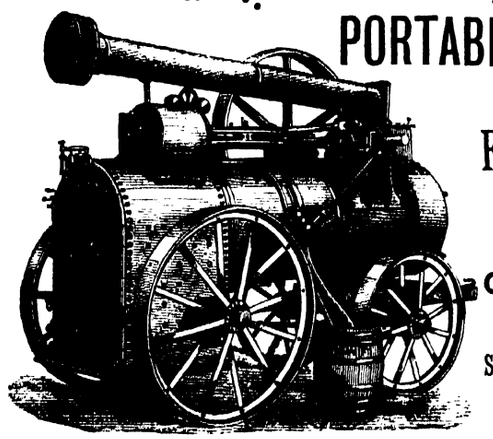


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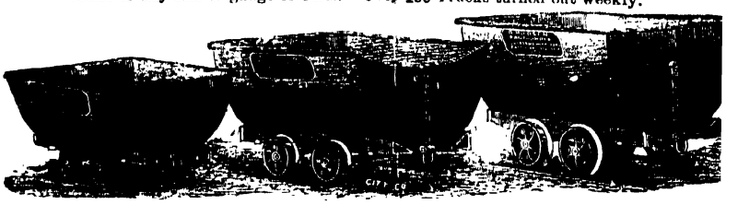
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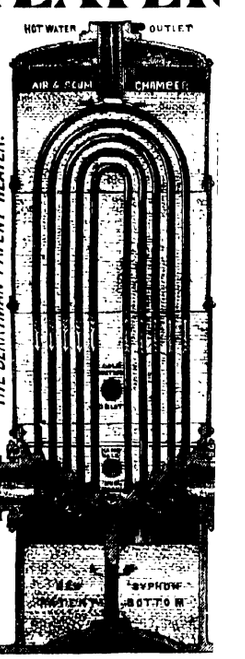


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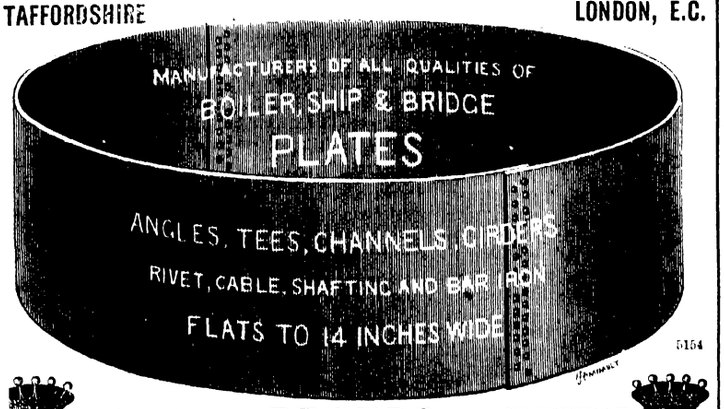
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5154

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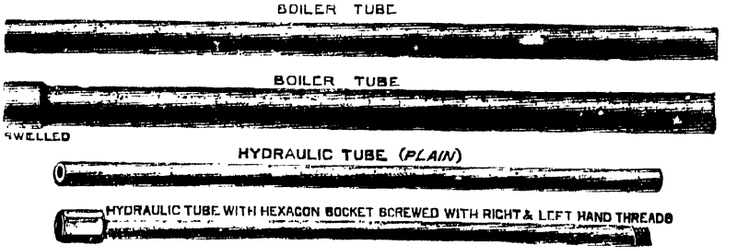
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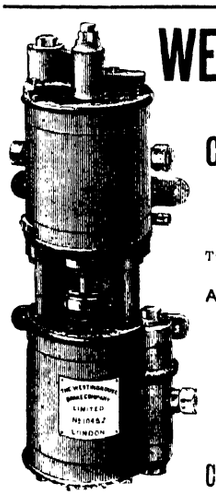
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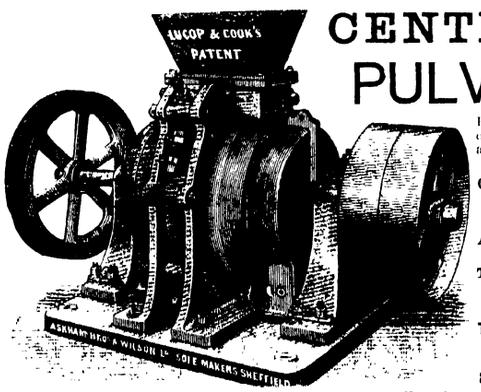
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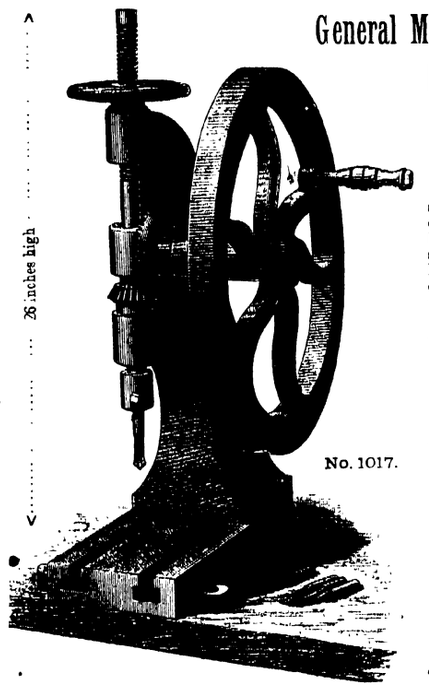
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4216

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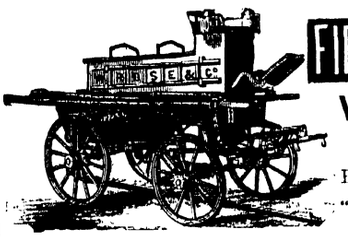
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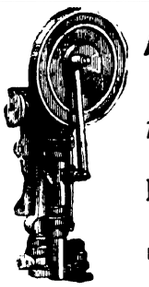
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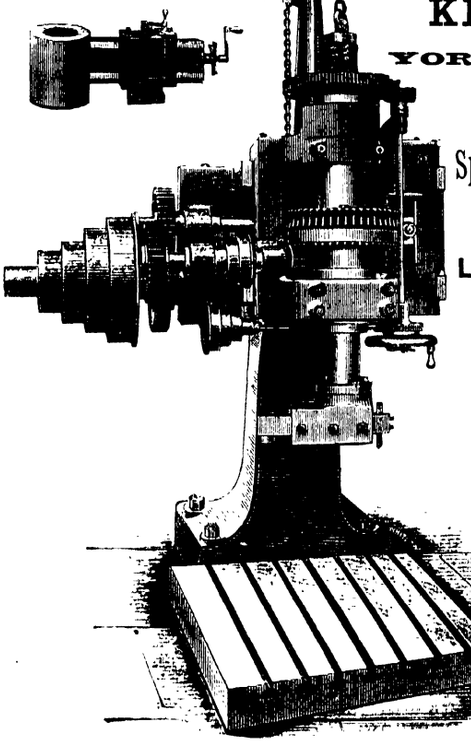
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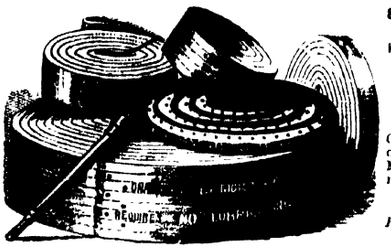
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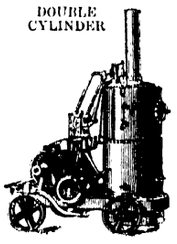
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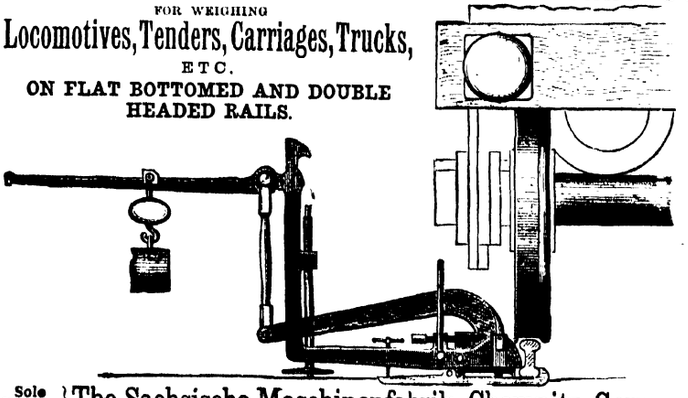
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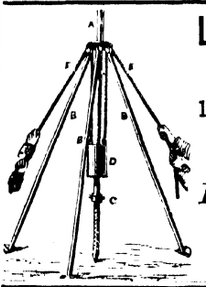


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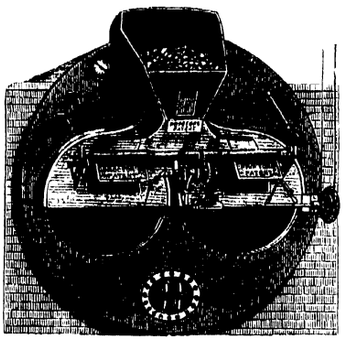
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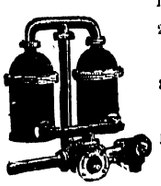


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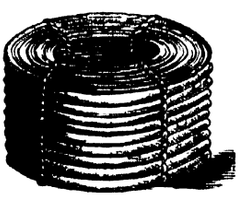
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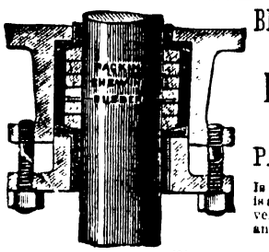
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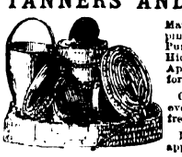


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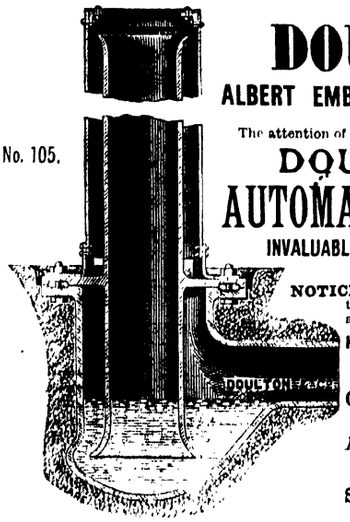
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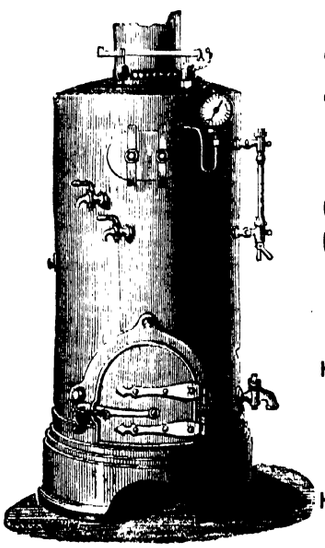
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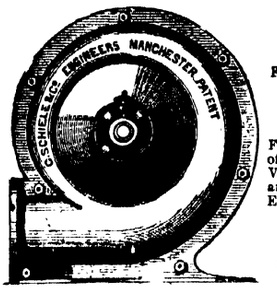
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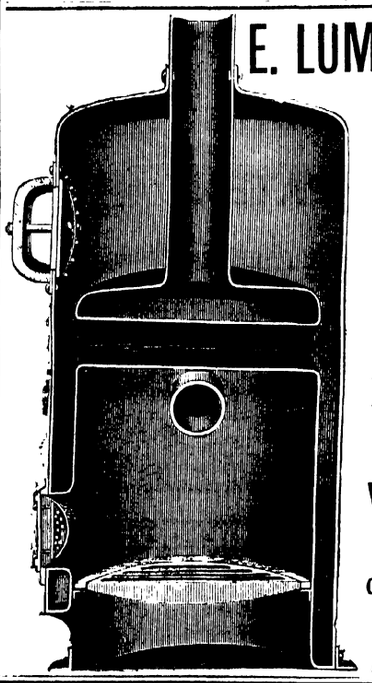
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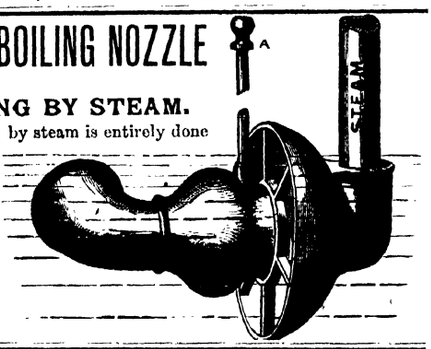
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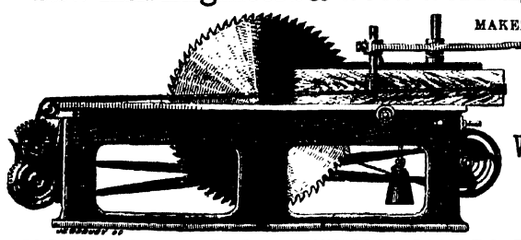
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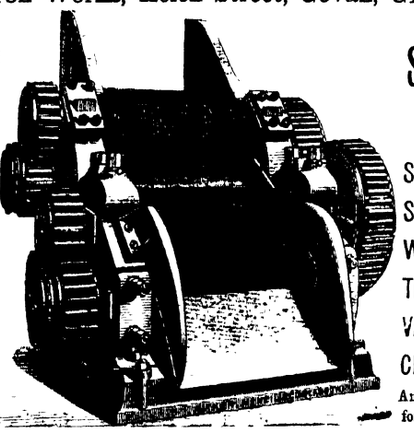
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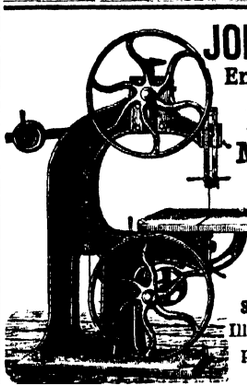
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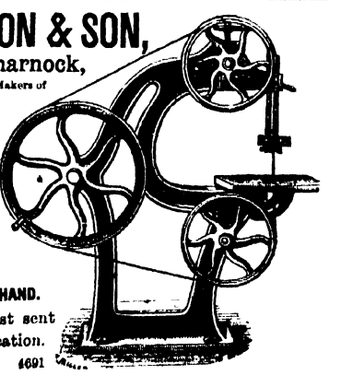
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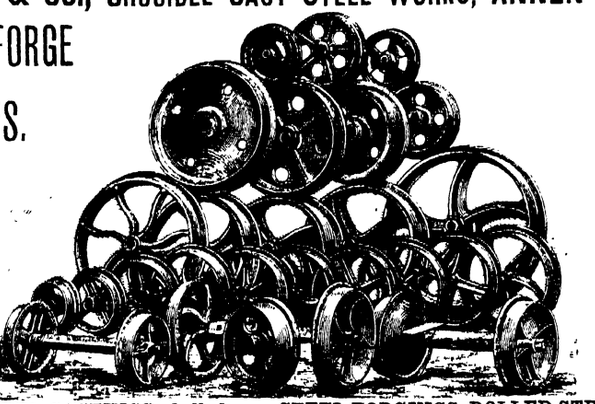
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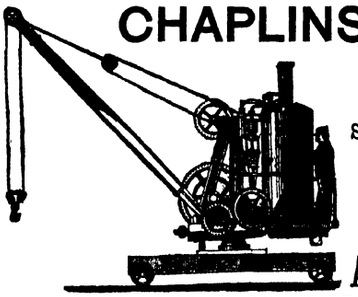
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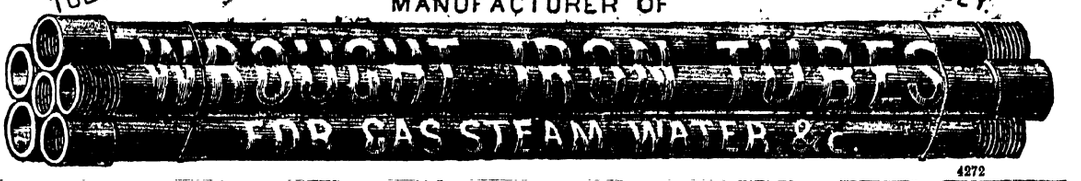
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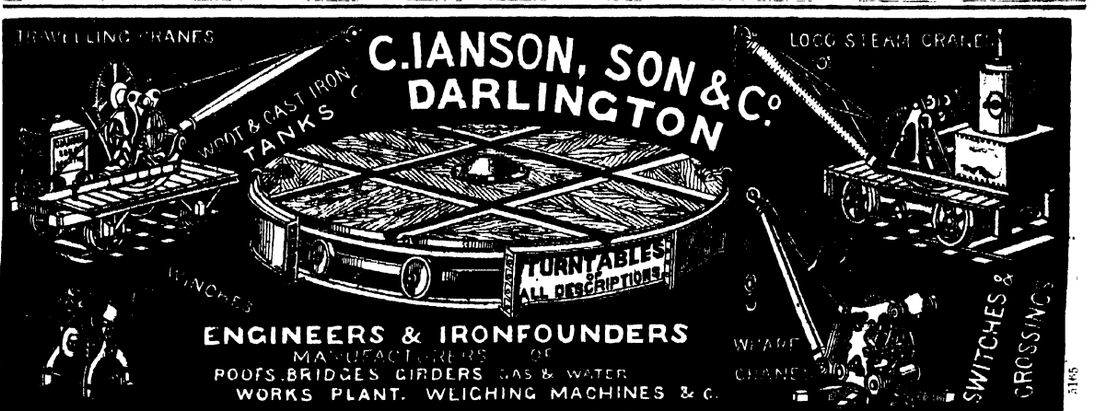
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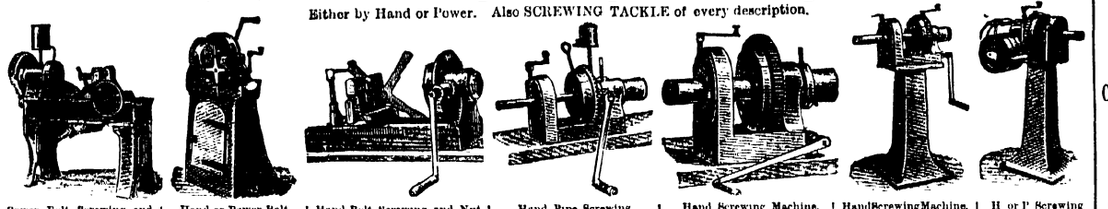
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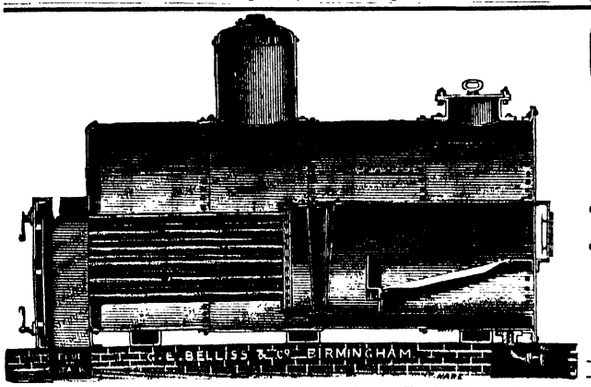
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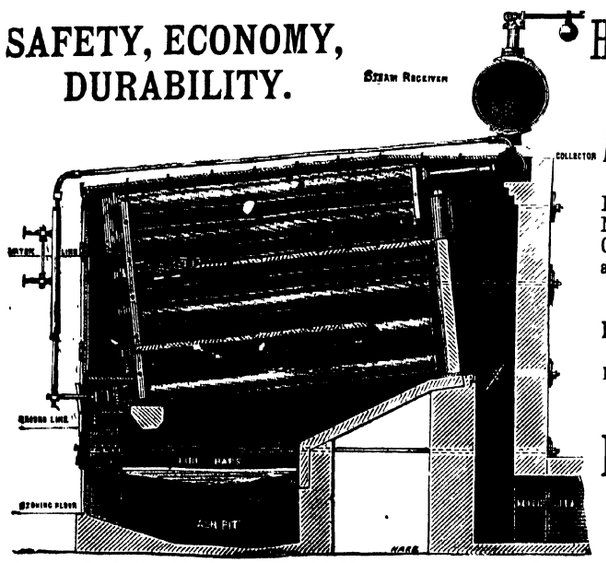
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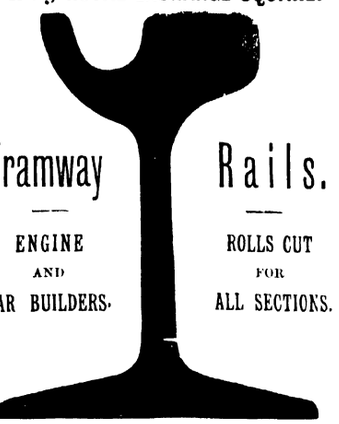
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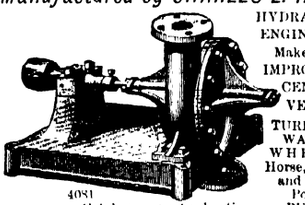
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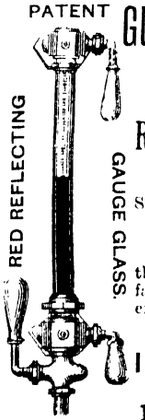
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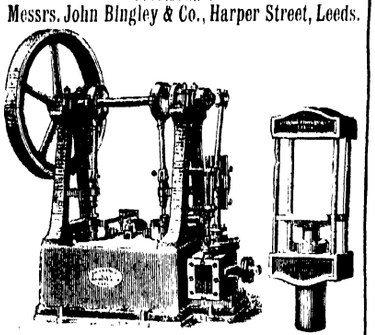
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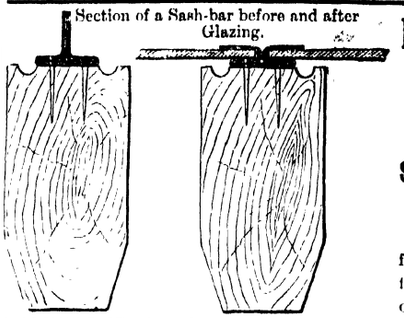
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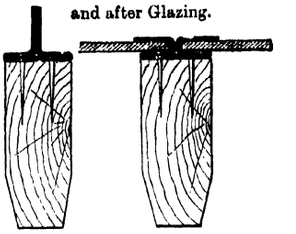
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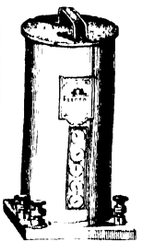
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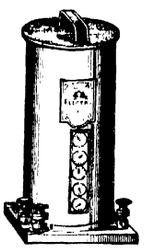
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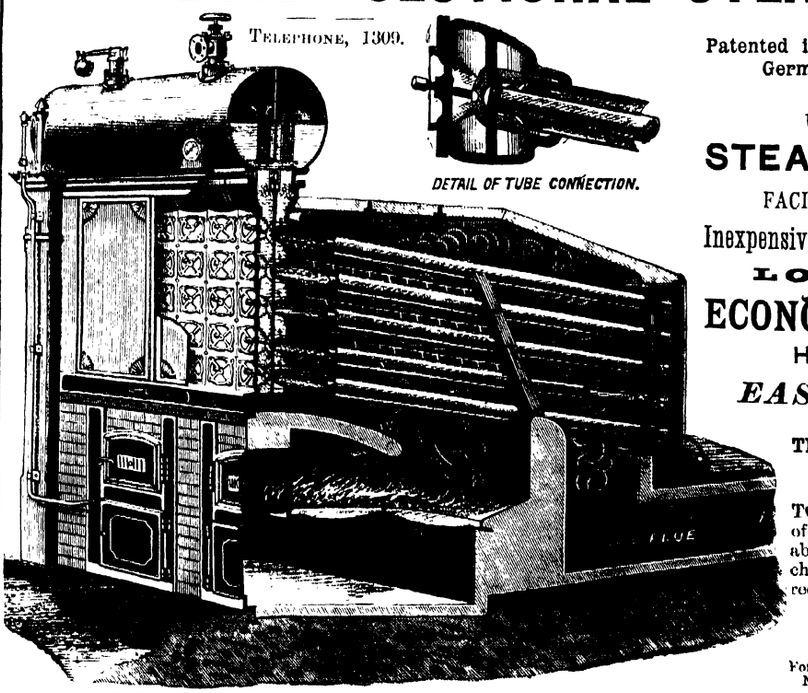
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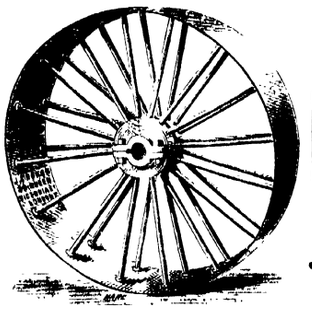
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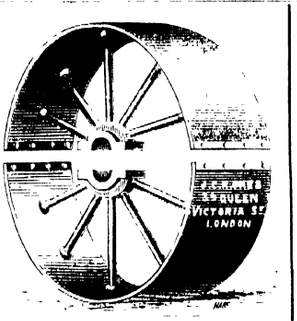
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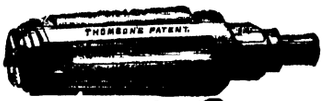
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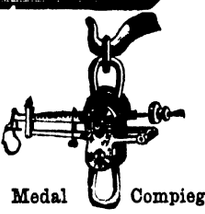


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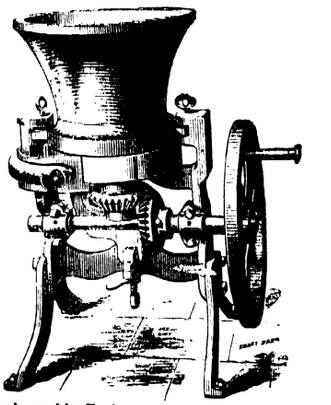
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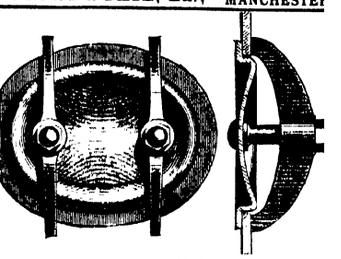
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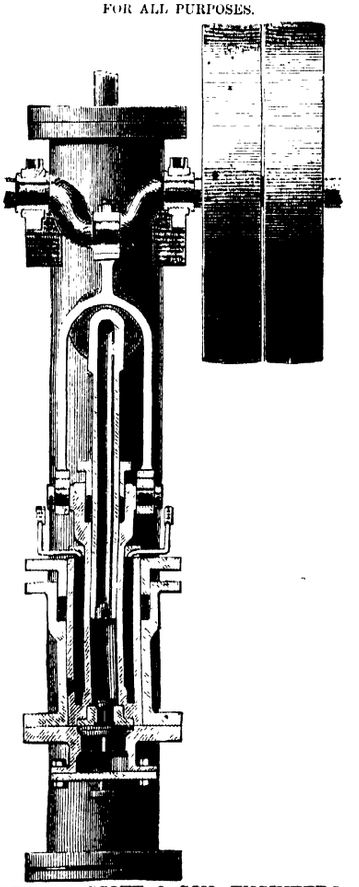
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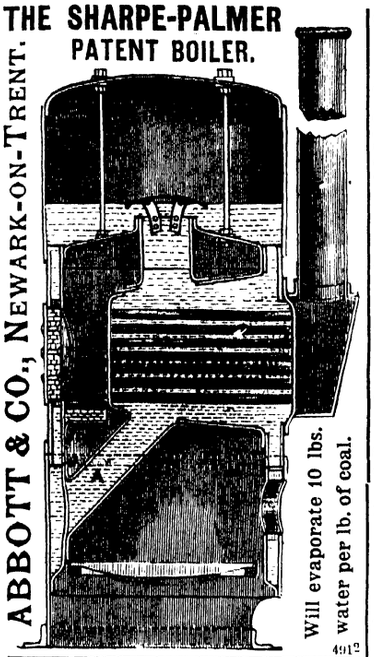
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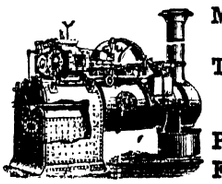
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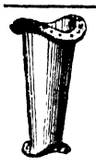
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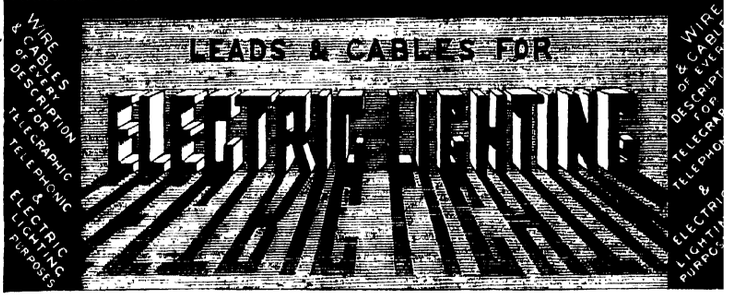


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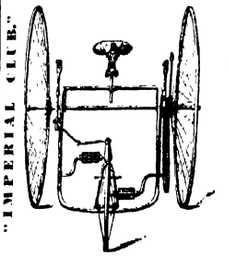
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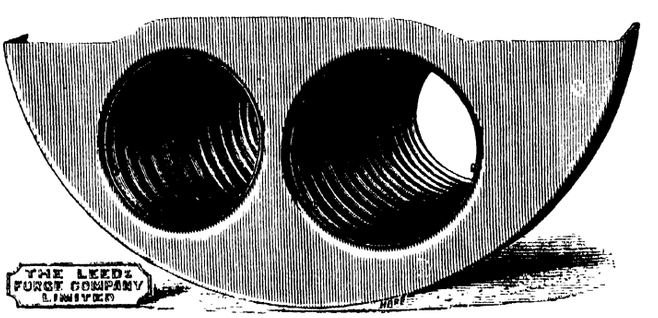
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SECONDARY BATTERIES.—No. I.

By THOMAS WILKINS.

THE great interest which the introduction of the Faure secondary battery awakened a few years since is somewhat remarkable when viewed in the light of previous researches into the phenomena attending the development of voltaic electricity. Within a few months of Volta's announcement of the effects produced by his "pile," and more especially by his *couronne de tasses*, the first of the voltaic batteries consisting of cells containing a fluid and two metals, it was discovered that a voltaic current could be developed by acting upon the opposite sides of the same metal with different fluids; and that on passing a current through a liquid decomposable by that current flowing between pieces of the same metal immersed in the liquid, a reverse current was obtained when the battery was removed, and the ends of the two pieces of metal outside the liquid were brought into contact.

No one seems to have had any idea of utilising this secondary current until Grove constructed his gas battery in 1840, and Planté, taking up the subject, brought out his secondary battery some twenty years later. Indeed, the attention which the secondary current did receive was chiefly with a view to ascertaining its cause and effect in the hope of eliminating from primary batteries themselves those features which caused a wasteful expenditure of the materials used, and of the current generated. Moreover it was not until the question of electric lighting was receiving great attention, and the magneto-electric current was found to give a somewhat unsteady light, that electricians thought that the secondary battery might be used with the electric current, to effect a similar purpose to that fulfilled by the hydraulic accumulator in the case of water of high pressure. They sought, by using the electric current, to cause variations in the chemical condition of the surfaces of extended electrodes, to store a power which could be reconverted into an electric current, when, and as required, by the utilisation of the secondary current, which could be developed when the surfaces of the extended electrodes were allowed to return to their normal condition.

It will thus be obvious that the effects attending modern secondary batteries will be better understood after an inquiry into the researches above alluded to. That inquiry, however, cannot avoid the subject of primary batteries; for the secondary battery is simply one in which the surfaces of two solids immersed in liquid are subject to unlike chemical conditions. The only difference between the secondary battery, and the many similar primary circuits described by Sir Humphry Davy eighty years ago, is that the unlike chemical conditions, instead of being obtained from ordinary sources, are brought about by electro-chemical deposit. To note the close relation between primary and secondary batteries will moreover not merely be of interest to the electrician, but will assist the student to a better comprehension of the subject.

The accidental discovery by Galvani in 1790 that the muscles of dead frogs were convulsed on the discharge of an electrical machine, near which the frogs were lying, led him, after various experiments, which need not here be referred to, to believe that the muscles were negatively and the nerves positively electrified, and that metallic contact restored the equilibrium by discharge. Volta took up the question, and came to the conclusion that the electricity was generated at the point of contact of the metal with the animal tissue; and he showed that similar contractions to those observed by Galvani could be caused by making contact between two muscles or two nerves, or between two parts of the same muscle or nerve; but he found that to produce this effect two different metals were required.

The cases noted by Galvani are examples of a current set up in a circuit consisting of one metal and two different fluids, or of a metal and a fluid in two different conditions at different places; the one fluid contained in the tissue of the nerves, the other in the tissue of the muscles. In the cases noted by Volta, where a nerve or a muscle and two metals were used, obviously the circuit was, like that of the voltaic pile developed from those experiments, one which consisted of two metals and the one fluid contained in the muscle or the nerve, whichever was used.

Volta considered his pile similar, in the relation of its parts, to the natural organ of the torpedo and of the electric eel, because it was composed entirely of conductors of electricity, contained its own exciting force without the necessity of being charged with electricity from a machine, as was requisite in a case of a battery of Leyden jars (for at that time the frictional electrical machine was the only artificial source of electricity), and because it was capable of giving a continuous current, and of giving shocks, more or less strong as desired, which were similar in their effect upon the body of the experimenter to those of the above-mentioned creatures.

From his description it would appear that he frequently used coins for forming his piles in the early experiments, and that generally his piles were constructed with pieces of metal about an inch in diameter. He used discs of cardboard, skin, or some other material of a spongy nature, capable of absorbing moisture, to place between the pairs of metal discs; and he mentions that in order to be successful in an experiment it was necessary that these discs should be well soaked. They were also made a trifle smaller than the metal discs.

Having prepared a sufficient number of these discs, the metal ones well cleaned and dry, and the others well soaked in pure water, or, what he found better, salt water, and afterwards slightly wiped dry, so that the moisture might not be squeezed out and run over the edges of the metal discs when a pile of many sets was formed; he placed a disc, say of silver, as the base of the pile, then one of zinc, then a moist one, then a silver one, then a zinc one, and so on. When he desired to make up a very large pile of sixty or more sets, he considered it best to divide the pile into columns of about twenty sets, connecting the base of one column with the top of the next. These piles are illustrated in Figs. 1 and 2.

His *couronne de tasses*, which he devised as being able to give a current of much longer duration and regularity than the pile, was simply a series of glasses to contain the water, into each of which were placed the different ends of two arcs, each formed of two metals. It is illustrated in Fig. 3. These three illustrations are from sketches taken from the engraving accompanying Volta's letter to Sir Joseph Banks, President of the Royal Society, as published in Philosophical Transactions, 1880. Fig. 1 represents a pile of a single column; Fig. 2 one of four columns. In all three illustrations the discs or plates marked A are of silver or copper;

FIG. 1.

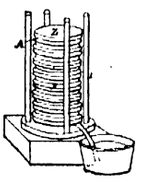


FIG. 2.

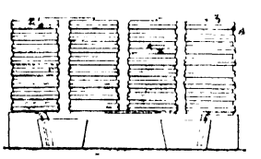




FIG. 3.

those marked Z are of zinc, tin, or lead. Zinc and silver gave the strongest current. The basins of water, into which the terminals were taken, were used for the convenience of making contact with the whole of the hand of the experimenter. The dry finger point was found not to make so effective a contact as was obtained when the skin was moistened.

Carlisle and Nicholson, in 1800, and Ritter, of Jena, somewhat later, succeeded in decomposing water by means of the voltaic current; and Ritter, in experiments with other electrolytes, noticed the deposition of metal on the electrodes, and observed that on disconnecting the battery and connecting the electrodes by a wire outside the fluid electrolyte a current was obtained in the reverse direction; and that the electrodes retained their power of giving this reverse current on replacement after being removed from the electrolyte and dried. Ritter's secondary pile consisted of discs of copper alternated with discs of cloth moistened with solution of ammonium chloride (sal ammoniac).

It was remarked by Sir Humphry Davy in 1801 that all galvanic combinations similar to Volta's, which had then been described by experimentalists, consisted, so far as he knew, of two metals or of one metal and charcoal; and that it was supposed that their agency was in some measure connected with the different powers of the metals to conduct electricity. But he says that he found an accumulation of galvanic influence, exactly similar to the accumulation in Volta's pile, might be produced by the arrangement of single metallic plates, or arcs of one metal with different strata of fluids. The reasoning which led to this discovery was brought about by observations connected with the phenomena accompanying the chemical changes in which there is evolution of galvanic energy. He found that series of double plates, properly arranged, but incapable of galvanic action with water as the medium in which the intervening felt or flannel had been soaked, were capable of such action on being alternated with acids or fluids capable of oxidising one of the metals only. He mentions that silver and gold gave a current with cloths moistened with nitric acid; and that copper and silver also gave a current with cloths moistened with mercuric nitrate.

THE SHAPE

This led him to suppose that the alternation of two metals was only necessary in so far as it supplied two surfaces capable of different degrees of oxidation; and that single plates would do if they were arranged so that they were connected by different fluids in such way that only one side was oxidised. In carrying on his experiments he found that galvanic action was produced not only when oxidation, but when other chemical changes occurred. He divides the galvanic combinations thus obtained into three classes:

The most feeble; when single plate or arcs are arranged so that the two surfaces, or the opposite ends, are in contact with different fluids, the one capable of oxidising the metal, the other not so; and he says that tin, zinc, and some other easily oxidised substances are best in this class. He gives as an example a pile consisting of pieces of tin 1 in. square, $\frac{1}{20}$ in. thick, separated by woollen cloths of the same size moistened, some in water, and some in dilute acid, and arranged in the following order: tin, acid, water, tin, acid, water, and so on, one above the other. Twenty sets formed a feeble battery. He remarks that the acid cloth being placed below the one moistened with water, little mixture of the acid and water occurred.

The second class of these combinations with plates of one material was formed of metals or metallic substances that acted on sulphuretted hydrogen, or on sulphides dissolved in water, arranged in series with portions of a solution of potassium sulphide in water, in such way that one side of a plate, or one end of an arc, was in contact with potassium sulphide solution, and the other side or end, with water. Silver, copper, and lead were all found suitable metals; and plates of either of these metals were arranged thus: metal, cloth moistened in solution of potassium sulphide, cloth moistened in water, metal, and so on. The action with copper proved greater than with silver; and that with silver, greater than that with lead.

The third class of these combinations comprised metals which were oxidisable by acids, and which were also capable of acting on solutions of sulphides, the metal being arranged so that opposite sides underwent different chemical actions. These piles were best arranged with three cloths between each pair of metals; the cloth moistened with dilute acid being separated from that moistened with solution of potassium sulphide, by a cloth moistened with water only.

In piles constructed in any of these three ways the action is transient, owing to both the acid and the solution of sulphide being quickly spent. Count Rumford suggested a box divided into cells by alternate sheets of metal and horn, or other non-conductor.

Fig. 4 shows part of such a box, in which *a* represents the metal plates, *b* the oxidising solution, c the solution of sulphide, *d* strips of cloth



Fig. 4.

connecting the cells separated by the non-conducting material. Fifty metal plates with weak nitrous acid, or ammonium nitrate on one side, and with solution of sulphide of potassium on the other, gave a tolerably strong current.

Davy's experiments with electricity as a chemical agent in the reduction of the metals of the alkalies, gave him opportunities of noticing the phenomena of electrolysis, and in the Bakerian lecture, 1807, he mentioned that when a solution of salt is decomposed by the electric current the base always passes to the negative and the acid to the positive electrode. If three glasses, A, B, C, Fig 5, be



Fig. 5.

taken and A be filled with distilled water, B with weak solution of litmus, and C with solution of potassium sulphate, and the solutions in the glasses are connected by moistened threads D, as shown; then, on passing a current from A to C, the presence of acid was detected at the point where the thread moistened with litmus came into contact with the solution in A. On changing the glass B, and the moistened threads for others containing solution of turmeric, the alkaline reaction was first observed where the thread moistened with tumeric came into contact with the solution in C. This showed that the sulphur compound did not pass from C through B in the form of sulphuric acid. Again, if the solution of potassium sulphate was placed in A and the water in C, the current passing the same way as in the former case, the potassium compound was passed through B to C without affecting the turmeric solution in B; the acid remaining in A. The presence of acid and alkali being respectively noted at the point of contact of the threads with the solutions in A and C.

Grothüss, supposing that in every binary compound or similar body, one of the atoms or radicals is electro-positive and the other electro-negative, suggested that there is a successive combination, disruption, and recombination of the molecules from electrode to electrode; and that atoms or radicals are left free next the electrodes because there they find no free opposite atom or radical with which to combine. It seems impossible that this could occur in the case noted above, for in that case the free acid and alkali ought both to have first shown themselves where Davy expected to see them; in the vessel containing the solution of potassium sulphate. For if the decomposition is first effected at the electrode in the vessel A containing the solution of sulphate, and it is necessary for the sulphur compound set free to effect a recombination with the potassium compound of an adjacent molecule of sulphate of potassium, then it must be equally necessary for the sulphur compound, on reaching the thread between the vessels A and B, to find some substitute, and as sulphuric anhydride, which would probably be the form of the sulphur compound, readily combines with water to form sulphuric acid, nothing could be more natural than Davy's expectation to find the acid manifest its presence at the junction of the thread with the solution in A.

Another theory is that such a compound as potassium sulphate is split up into metallic sodium and a compound of sulphur and oxygen, which compound goes to the positive electrode; that the potassium decomposes water, becoming caustic potash and liberating hydrogen; while the sulphur and oxygen on reaching the positive electrode also decompose water, becoming sulphuric acid and liberating oxygen.

It is, however, only necessary to suppose that, whichever atom or radical has to travel across the electrolyte to the opposite electrode is in a state in which it cannot combine with anything, until, having reached the electrode which formed the terminus of its journey, it then becomes able to combine and manifest acid or alkaline properties.

Clausius objected to the first-mentioned theory on the ground that there would be a great expenditure of energy in causing the repeated decompositions; and supposed that the molecules of liquids were naturally in a state of constant decomposition into their elementary constituents, and of constant recombination; and that the passage of the voltaic current simply classified the free atoms and took them respectively to the negative and positive electrodes. There is, however, no need for this supposition if it be assumed that the atom or radical which has to traverse the electrolyte is in a state of disability to combine with anything until it has fulfilled its mission.

It will be seen from the foregoing remarks that philosophers were, and for that matter still are, divided in opinion as to the origin and method of the voltaic current. On the one hand the origin was traced to the point of contact of different metals in a circuit consisting of two metals and a fluid; on the other, the chemical action that took place at the point of contact of dissimilar substances, whether metal or liquid, was asserted to be the cause of the current set up.

CANADIAN PACIFIC RAILWAY.

No. XII.

Manitoba.

On the union of the two great fur companies in 1821, an entire change in the regulations and working of the concern had to be introduced; the whole internal arrangements were to be reorganised, the best parts of the old system of both companies were to be retained, and the duplicate staff of officials was to be reduced into one harmoniously working body. To carry out this difficult task, a young Scotchman, a clerk in the London house of the Hudson's Bay Company, was selected and sent out to fill the important post of governor. It was a great responsibility for a young and inexperienced man to undertake the management and secure the co-operation of men but lately in armed antagonism to each other, to reconcile the conflicting interests that for years had been accumulating and aggravating the personal dislikes of the officers and employés of the two widely-ramifying establishments, and to smooth over the thousands of petty jealousies that had overspread half a continent. That he should have done this at all, should re-establish the business of both companies upon a new and better basis, should work out the details so as to obliterate the old feuds and contentions, should place the vast establishment upon a sound and satisfactory basis, for forty years guide it all to a successful issue, and that he should finally receive from the hands of his sovereign the honour of knighthood, speaks volumes for the executive ability, the strength of character, the determination of purpose, and the indomitable energy and perseverance of the late Sir George Simpson. Small in stature, but of wonderful vigour, the virtual ruler of half of North America, he held the reins of power with the self-possession of an emperor, and ruled his somewhat lawless subjects with the unflinching grasp of an autocrat. By keeping the Indian tribes that surrounded each of the company's posts, isolated from each other, with sufficient means to carry on their hunting, and yet dependent for their daily food upon their attention to business and their personal exertions, they remained contented and employed, their national animosities were kept within bounds, their internal wars ceased, and the power of the company to rule and control them all, was established without their being reminded of their loss of independence, or, indeed, recognising the yoke which nevertheless kept them under constant and rigid restraint.

The operations of the company, extending over four and a half millions of square miles from Fort Simpson on the North Pacific to the Labrador coast, 4000 miles as the crow flies, and from Fort Vancouver on the Oregon River to Fort Confidence on the Great Bear Lake, 1500 miles north and south, were divided into four divisions or territories, the Northern, Southern, Montreal, and Western. York Factory, near the north, and Moose Factory at the extreme south of the Hudson's Bay, were the depôts for the two first of these, whilst Montreal for all the district embraced by old Canada, and Victoria in Vancouver's Island for the Pacific coast, were the importing points for the last two of these divisions. Included in these were 53 districts, each under the care of a superintending officer, and 152 posts or forts, each under a chief factor or chief trader. There were strictly defined gradations in the service, and by slow promotion, the raw recruit from the north of Scotland rose through these different stages to the highest, which entitled him to a partnership in the profits of the company, but he seldom returned to the land of his birth, or, excepting for a visit, saw again the civilisation of a city. At the reorganisation of the company it was determined to continue the experiment of the Red River Colony, where, as we have remarked before, the dismissed servants of the two companies, thrown out of employment by their fusion, mostly betook themselves, bought land, and established themselves as the aristocracy and bourgeois of the prairie. Here, too, for the half-century preceding the company's giving up its territorial rights to Canada, the old officers of the company passed the half-pay of their old age in the settlement far off from the noise of the outer world, but whose growing conveniences, though still very rude and primitive, were sufficient for men who had passed their life in forest isolation until they had lost the taste or knowledge of any nearer approach to civilisation. But to Sir George Simpson, this Red River settlement was always a thorn in the side; there were always here the elements of contention, the inflammable materials of a mob, and twice within a dozen years it was necessary to induce the Government to send out detachments of troops from England, and after these were ultimately withdrawn in 1848, upwards of fifty pensioners were settled within easy call of Fort Garry, which was made the executive head of the corporation. Most of the late servants of the company, especially those who had wives and families, took up their abode in what is now

the parish of St. Andrews, further north than Fort Garry, and this they named with ambitious loyalty "Little Britain" scarcely foreseeing that their tiny speck of civilisation would ripen so soon to be the centre, probably of a "Greater Britain" than the old one. The gradually loosening hold of the company over the half-breeds round Fort Garry, induced Governor Simpson, in 1831, to remove his residence, and the principal stores of the company, to a new fort some 21 miles further north in the same vicinity, and here by degrees arose, although it never was quite finished, a commodious Stone Fort, by which name it was always known, and which subsequently figured largely in the history of Manitoba. It is near this at the head of the navigation from the lake that the new town of West Selkirk is now rising, and this again was the place selected by the Government engineers as the main crossing of the Red River by the Pacific Railway.

The troublesome element in the settlement was always the half-breeds. These men, brought into existence by the North-West and X Y Companies, principally of French descent, had latterly been largely employed by those companies as trappers and traders. As hunters they were more skilful than the Indians, and as traders they had been entrusted by the companies with the necessary goods to deal with the natives. After the consolidation of the two companies, these men lost their employment under the new Hudson's Bay *régime*, but were too fond of the wild life of the woods to return to civilisation. Moreover the *coureur des bois* had taken to himself somewhere an Indian wife, and in some distant point in the great fur land, olive branches, jabbering a few civilised words, and a great many heathen ones, had multiplied about him. These men had now to take to canoeing and trapping for the trading posts, or more generally became freighters and voyageurs for the main depôt at Fort Garry. To the half-breed children descended the vocation of the father and the nomadic instincts of the mother, resulting in the production of a race which unites the industries of civilised, to the customs of savage, life. Scattered over the vast region from the Ottawa to the Pacific, from the Coté de Missouri to the Mackenzie, the half-breed forms the advance guard of civilisation ahead of the white pioneer. French, Scotch, or Canadian by paternity, Chippeway, Cree, or Sioux by his mother's side, of all shades of colour and admixture of races, his vocation will always be the same, and the straight haired half-breed will remain the social, improvident spendthrift that nature and habit have made him, a good-humoured, handsome fellow, patient and enduring, having all the good qualities of the Indian, with the strength and perseverance of the white. The countenance soon takes the impression of one's daily life, and no class of men are more distinctly marked by the characteristics of their calling. The face deeply bronzed by exposure, the watchful, vigilant eyes, the firm set of the lower jaw, the sudden change in expression at the least excitement, the alert volatile face all alive to dare anything, to plunge into danger for the love of it, the sunken cheek and sparse beard, are the Assyrian types of the hunter, and then, when the hunt is over, the haggard reckless expression, the brutal revelry in blood and slaughter are the vestiges of the degraded traits of the Indians. The Metis or the Bois Brulé is seldom found south of the forty-ninth parallel, the elements of his existence are wanting in the United States, whilst throughout the north-west of Canada the half-breed is an important element, and whatever his tribal origin, or his white paternity, he still remains a half-breed as his grandfather before him was.

In the mean time the question had been agitated in Canada as to the right of the Hudson's Bay Company to the territory which it claimed on this continent, the contention being that this was French territory at the time of the British conquest, and as such had been given up to Great Britain, and formed part of the old province of Quebec. The result was that a commission was appointed in 1857 to inquire into this question, and although the Hudson's Bay influence was sufficient to keep this in abeyance, yet in drafting the Act of Confederation in 1867, special provisions were made for the incorporation of Prince Rupert's Land into the Dominion. At the first Parliament at Ottawa a series of resolutions were introduced by the Hon. William M'Dougal, praying that these north-west territories should be added to the Dominion, and an address embodying these was forwarded to the Home Government. Ultimately a commission was sent to England in 1868 to confer with the Colonial Office on the subject, but it was not till the following year that any terms could be arranged with the company. These terms were that Canada should pay to the company 300,000*l.* sterling on the surrender of their territorial rights to the Imperial Government, that the Imperial Government should retransfer these rights to Canada, and that the Hudson's Bay Company should be entitled to two sections, or square miles, out of the 36 into which each township was to be divided, besides certain reserves round the different trading stations, giving the company altogether about one-fifteenth of the entire area, a landed estate which the settlement and surveying which had to be done at the expense of Canada was about to make of infinitely more value than the whole of the unsurveyed, unexplored, and unrealisable land was worth before this expenditure was put upon it. These preliminaries settled, the date fixed for the transfer was October 1, 1869, subsequently postponed to December 1st. The purchase money was paid to the Hudson's Bay Company May 11, 1870. The Order in Council transferring the territory to Canada was passed June 23rd, the province was formally declared part of the Dominion of Canada July 15th, and Governor Archibald arrived to take charge of the province September 2nd following.

But this Canadian connection was by no means popular in the country. There was a tremendous expanse of rock and lake and forest, between Manitoba and the habitable part of Canada, the shortest way of getting there was through the States if time and trouble were an object, and the general feeling of all but a very few was in favour of annexation to the Federal Government. The policy of the Hudson's Bay Company, and their determination to monopolise the fur trade, which was practically nearly all there was, kept the people in a state of dependence and poverty that was in strange contrast with the well-to-do progress of Minnesota, and it is no wonder that they wished to share the same privileges and to enjoy the same freedom and prosperity. The railways were now approaching the navigable part of the Red River valley, and the isolation that had been their fate for half a century, would be entirely removed if they became a part of the union. In 1867 a serious proposition had been made for a provisional Government, but this crude organisation, although got up in perfect good faith, and intended to promote the cause of law and order, was declared by the Imperial Government to be illegal, and never came to a head. The dissatisfaction was not removed by this, and as the time grew nearer for the union with Canada, the less every one in the colony seemed to like it, even the French Archbishop of St. Boniface, who had a strong prejudice in favour of the Canadian connection, doubted its practicability, and seemed to prefer that matters should remain unchanged. The opportunity was taken by a French half-breed of the name of Louis Riel, and an American Fenian O'Donaghue, to foment the dissatisfaction, and to stir up the half-breeds to resist the entrance of the Canadian Governor or Commissioner M'Dougal, who was sent to organise the province November 2, 1869. The whole of this transaction was a blunder throughout; the Hudson's Bay Company looked on with utter supineness, and there was no one that seemed to know who was the proper party to check the early blustering of this man Riel. M'Dougal returned to Canada, which the half-breeds considered a victory, and they then seized the Stone Fort, where for some months Riel and his friends lived gloriously upon the good things they found there in abundance. Unfortunately for Riel, however, he went too far, and when, after a mock trial, a Canadian of the name of Scott was taken out of the fort and shot, March 4, 1870, the old Canadian blood was aroused; then followed the joint English and Canadian military expedition under Wolseley, and when, August 24, 1870, their bugles were heard on the Red River, Riel and O'Donaghue left in a hurry, and probably saved their lives by not waiting to finish their breakfasts.

In the stirring events that followed each other rapidly in this early history of Manitoba, one man looms up throughout as wielding an immense influence, and representing the conservative element of law and moderation at a time when much prudence was necessary. This was the Catholic Archbishop of St. Boniface, the pretty village across the Red River from Winnepeg, whose fine ecclesiastical buildings form such a conspicuous object for miles along the level prairie. One of the oldest and most illustrious families in Canada was founded in 1739 when Jean Taché arrived in Quebec from France, the great-grandfather of the present archbishop; amongst whose ancestors were Louis Joliette, the discoverer of the Mississippi and the Sierra, Varennes du Verandrye, the first explorer of the Red River, the Rocky Mountains, and the Saskatchewan Valley. Members of his family have occupied most of the influential positions in Canadian political life, and the late Sir Etienne Pascal Taché died Premier of Canada in 1865. The present subject of this sketch was born at Rivière du Loup July 23, 1823, and was left fatherless almost before he learned to lisp a father's name. Educated principally at the college of St. Hyacinthe, he returned there on the completion of his education to take the chair of mathematics. About this time the Order of the Oblates sent some of their priests to Canada; this arrival was an event in the ecclesiastical history of the country, and amongst their earliest adherents was young Taché, who at twenty-one offered his services as a missionary to the Indians of the north-west. This offer being accepted, he left his home in Lower Canada in a birch-bark canoe, and on the 12th of October, 1845, pronounced his religious vows at St. Boniface, the first time such a ceremony had taken place in the north-west. After a period of enthusiastic devotion at the distant post of Isle à la Crosse, 1000 miles to the north of the Red River, exposed to long dangerous journeys amongst fierce Indians, the bare ground generally his bed, the sky his covering, pemican his principal food, he was recalled by his superiors to civilisation and subsequently sent to France, where in 1851 he was created a bishop, and in 1860 consecrated archbishop of the new ecclesiastical province of St. Boniface. Since then the history of Manitoba is so closely woven with that of Archbishop Taché that no important event has occurred in the former without receiving some impetus or in some way being affected by the hand of the latter. To him directly are due the fine cathedral of his diocese, the palace and spacious college of St. Boniface. The cathedral as now seen was not the first ecclesiastical building; the former one was burnt down in 1860, and the new structure, entirely of the beautiful stone of the district, was erected since, and on a much more extensive scale. Though somewhat grim and cold as to the exterior, the cathedral is by no means devoid of attractive points inside, although the good taste of the archbishop has prevented any of that tawdry display of magnificence which offends the eye in many eccleciastical edifices where there might be supposed to be less excuse for it than here. The congregation is still one of the strangest and most varied in Christendom, composed of pure French, English, Irish, and Highland Scotch, with every shade of Scotch and French half-breeds, and some few thorough-bred Indians. It is in such a place as this that one feels, and whatever his own faith, must reverence, the homogeneity of the Catholic religion, the living pervading unity that characterises it, the one adamantine rock of faith upon which the billows of opinion expend their force, but which they cannot affect nor change. Here amidst an upheaval from which is springing the life of a new nation, and a new civilisation, where other churches are sympathetic with the restless spirit of the people, the cathedral of St. Boniface stands out a fitting emblem of the unchangeable. Across the river lives a community that has grown in ten years from 3000 to 30,000, animated by the most advanced spirit of modern civilisation. In St. Boniface we see the old patriarchal system, where a thousand years has effected but little change.

Above us are the bells of which Whittier so sweetly sang in his poem of the Voyageur of the Red River:

> The voyageur smiles as he listens
> To the sound that grows apace;
> Well he knows the vesper ringing
> Of the bells of St. Boniface.
>
> The bells of the Roman mission,
> That call from their turrets twain
> To the boatman on the river—
> To the huntsman on the plain.

These bells have rather a strange history. They were originally cast by Thomas Mears, Whitechapel-road, London, and were sent out by the Hudson's Bay ship to York Factory, whence they were to be brought 800 miles by the company's

COMPOUND ENGINES OF THE SPANISH TWIN-SCREW GUNBOAT "EULALIA."

CONSTRUCTED BY MESSRS. PORTILLA, WHITE, AND CO., ENGINEERS, SEVILLE.

(*For Description, see Page* 6).

Fig 1

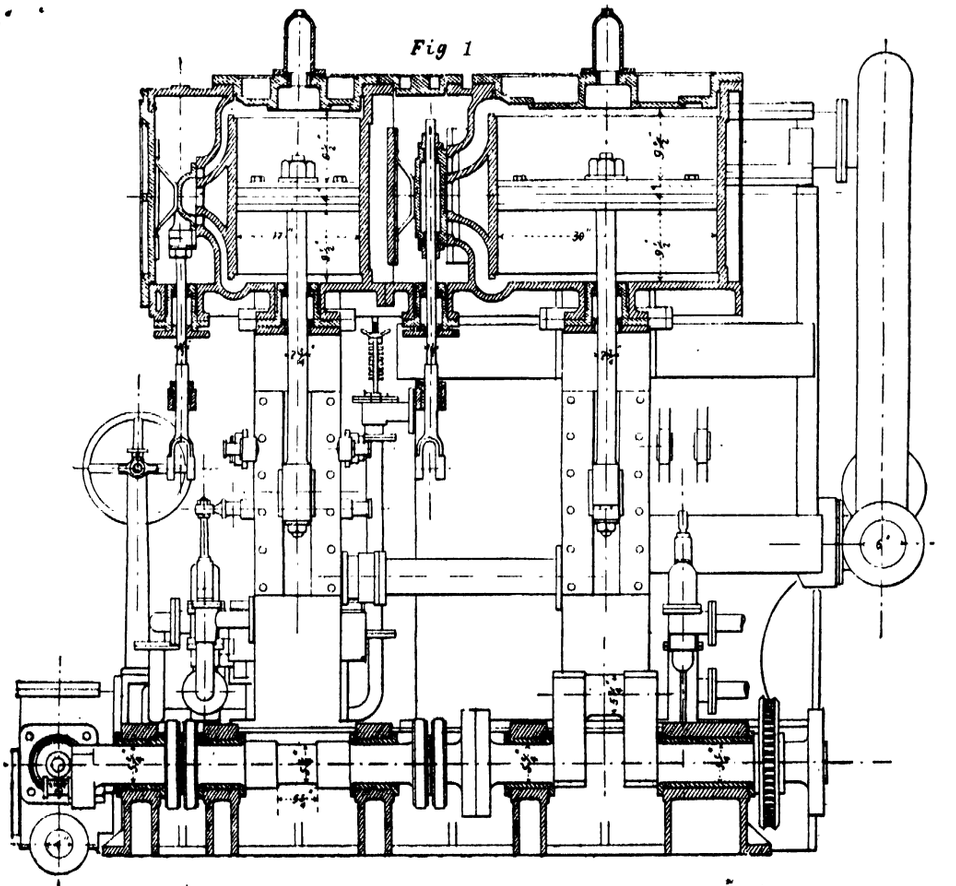
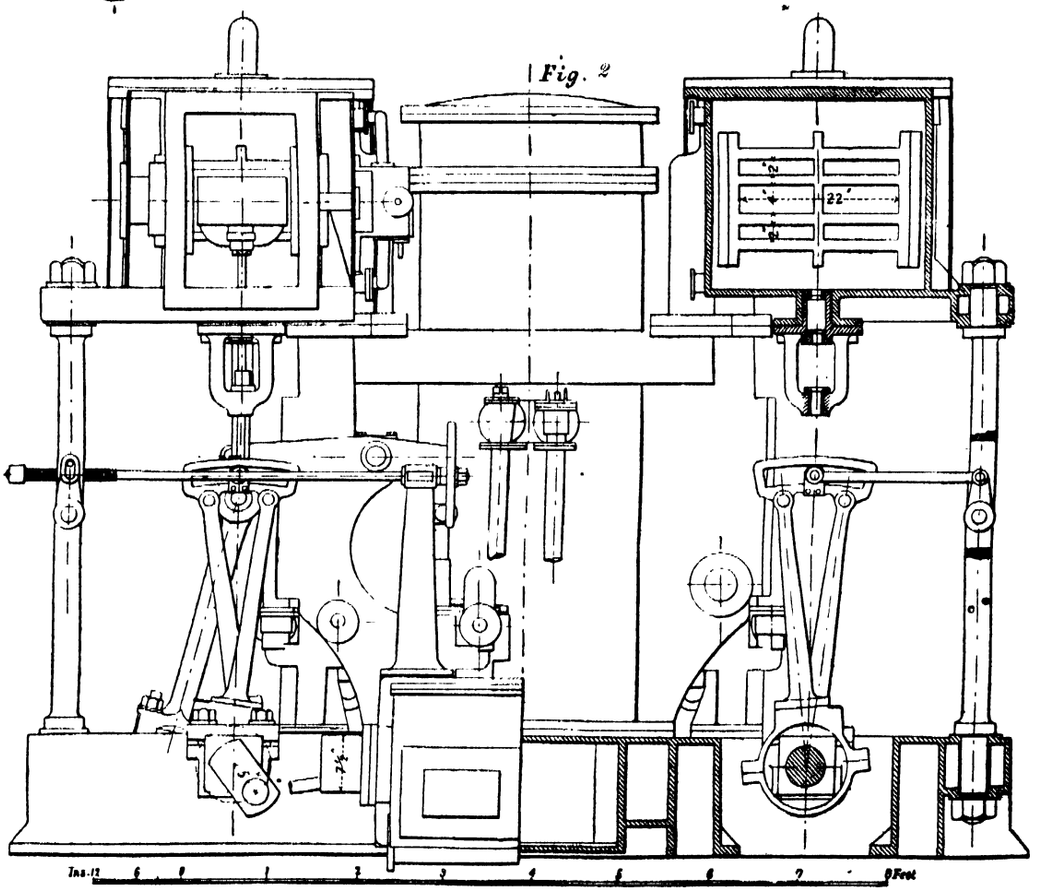


Fig. 2



boats to Fort Garry. On this journey there are thirty-six portages, and being packed in cases and very cumbersome, the three bells were left behind. At the pressing request of the bishop they were ultimately brought forward, and in 1840 commenced pealing forth their sweet music to the delight of the old countrymen and the astonishment of the aborigines. The fire which twenty years afterwards destroyed the cathedral, melted the bells, but a thousand pounds of the molten material was found in the ruins, and in 1862 sent back over the same long boat route, with its portages and delays, over which

ENGINES OF THE SPANISH GUNBOAT "EULALIA."

CONSTRUCTED BY MESSRS. PORTILLA, WHITE, AND CO., ENGINEERS, SEVILLE.

(*For Description, see Page 6.*)

Fig. 3.

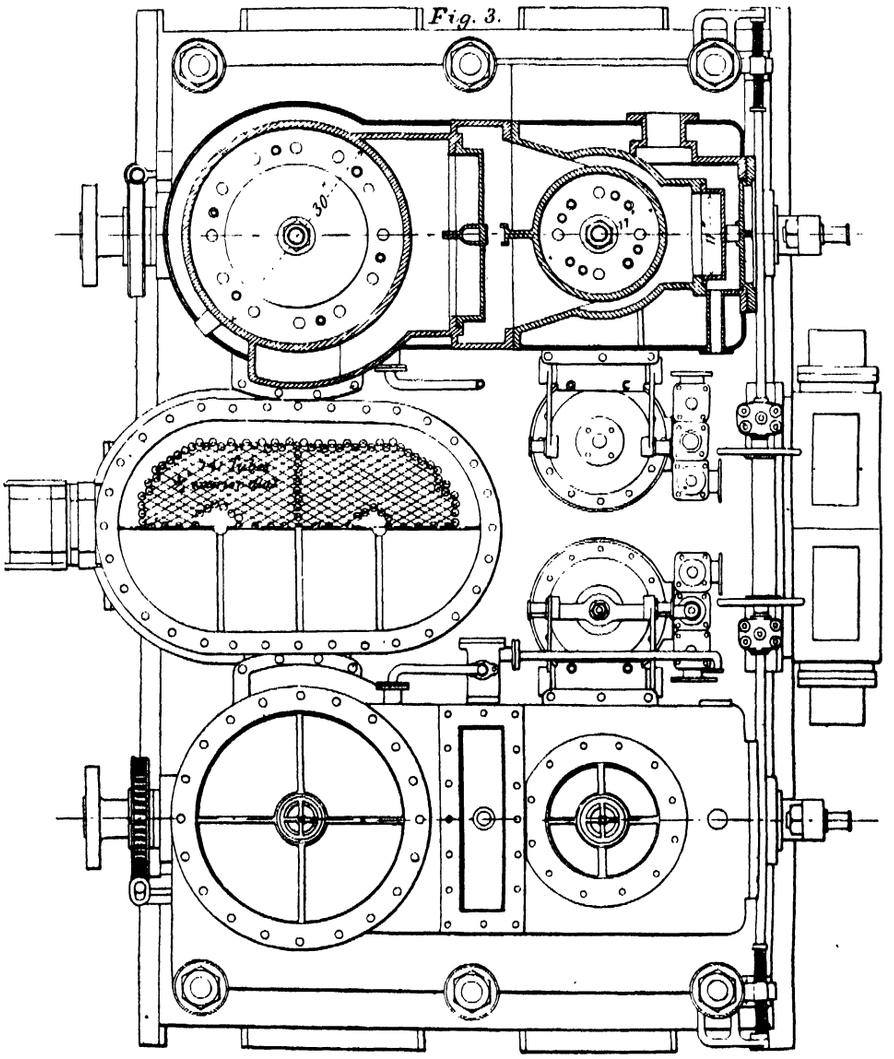


Fig. 4.

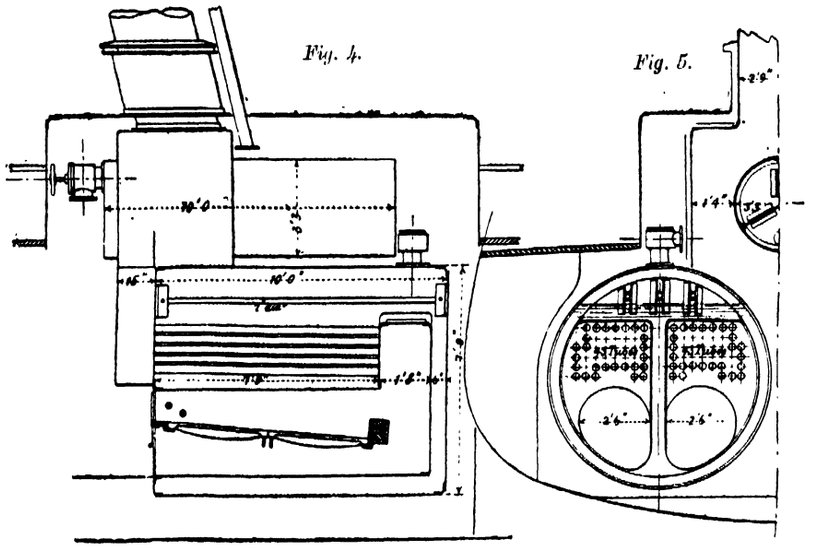


Fig. 5.

they had been transported twenty-two years before. Added to new material, the bells were recast in 1863, and again they crossed the Atlantic. The vessel was seriously damaged by ice in the Hudson's Bay Straits, and put back with difficulty to Newfoundland. From St. John's the bells were shipped to Portland, Maine, whence, *vid* Montreal, Detroit, Chicago, and St. Paul's, they reached St. Boniface, were rung for the first time after their wanderings on Christmas Eve, 1864. For miles out on the prairie they can be heard resonant and clear. In a new country where there is little of history and less of romance, the bells of St. Boniface are at least an interesting episode on the wayside of life.

Sixteen years since, in 1868, Archbishop Taché wrote his "Sketch of the North-West." "The breadth," says he, "of this fertile country from east to west is 1200 miles, its length from north to south 1500, containing the immense area of 1,800,000 square miles. When we compare this vast region with the small and limited countries occupied by some of the most powerful nations of the world, the contrast astonishes us, and we ask if this vast region is destined to remain for ever in the natural state in which Providence has allowed it to lie up to the present time. Isolated in this immense desert we often listen hoping that some echo of the bustle of the world beyond the ocean, or even of the neighbouring republic, may be audible. Our grand rivers, are they to have no other vessels than the bark canoe of the Indian, or the craft of the fur trade? The agricultural resources of this great country, its mineral wealth, the treasures of its forests, are they destined to be never known nor appreciated as they merit?" When his lordship was writing and pondering over this, the future was rapidly preparing a reply. Two years after, Canada was taking the steps to annex these territories, of whose inexhaustible wealth her most far-seeing statesmen had but a most inadequate conception; in a couple of years more the mother country had learned something of the future wheatfields destined to supply her necessities, and within another ten years, the locomotive on its way to the great city of Winnepeg opposite, was running over ground that had formerly been his grace's garden, the great Pacific Railway was well under way in its construction, and what had been the pretty village round the Hudson's Bay, Fort Garry, was the metropolis of a smiling, prosperous, and well-cultivated Canadian province.

The province of Manitoba, as first organised, was a small square block of land about 120 miles long east and west, and 100 miles north and south, between the forty-ninth and fifty-first parallels of north latitude, and the ninety-sixth and ninety-ninth of west longitude. It is as nearly as possible the central point in North America between the oceans, and Winnepeg is as nearly as may be the half-way station on the Pacific Railway, being equidistant from Montreal to Port Moody, and over 1400 miles from each. These provincial limits, comprising under 9,000,000 acres of land, were too small for the western ideas; after considerable agitation the area of the prairie province has been largely extended, and according to the census of 1880, its present extent comprises 123,260 square miles, or 78,848,040 acres, being larger than Ontario, and 50 per cent. more extensive than the bordering State of Minnesota. Compared with the immense expanse of the north-west, it presents even yet the appearance of a small block, not a twentieth of the vast territory that has yet to be peopled in this lately acquired country. But small in comparison as it looks, it includes within its borders an area of wheat-growing land that is destined to make it respectable, and to affect the wheat market of the world in the near future. The traveller's first idea on going across its vast prairie meadows, is that the description given by the late Lord Beaconsfield, when he spoke of that "illimitable wilderness" was correct, but on closer examination he finds that beneath the surface of dried grass and ashes, consequent upon the numerous fires, there is hidden a treasure in fertility of soil that when developed will maintain millions of our race. As compared with Minnesota, or the older wheat districts of America or Canada, there is a difference in the yield of from ten to fifteen bushels of wheat to the acre in favour of Manitoba; as compared with England the condition of affairs is even more striking, and with all the imperfections of the existing routes and expenses, which will soon be done away with or reduced, Manitoban wheat can now be laid down in England at prices with which the British farmer cannot compete. In the Red River district the delegates, who were sent out by the tenant farmers in 1879 at the invitation of the Canadian Government, were shown fields that had been cropped with wheat for fifty-four successive years, which had never received any manure, and which were then producing regularly from twenty to twenty-five bushels to the acre. A writer in the *Philadelphia Press* says: "The greatest wheat-growing district in the world is now being opened up for settlement. It is sufficiently productive to make England independent of the United States or any other county, for breadstuffs, and to create a powerful rivalry elsewhere. The extent of this enormous British territory is comparatively unknown in our country. It contains 2,984,000 square miles, whilst the United States to the south of it has only 2,933,000. In five years, as now being filled up, 4,000,000 acres of this fertile belt will be under wheat, which means 100,000,000 bushels thrown into the market, the total amount of our exports last year. It is evident that our superiority as a wheat-growing country is seriously threatened, and that the mother country will soon be indepen-

dent of any foreign supply." Mr. Chambers, of Stewardstown, one of the tenant farmer delegates says: "The Canadian Government, knowing the immense tract of fertile territory she possessed, and finding that the people of the old country would not believe the accounts given by these agents, wisely decided to bring out British delegates to see for themselves what the country was like, and to report to their brother farmers at home. For my part I would not have believed that any land could have been so fertile, if I had not seen it myself." In his own eloquent language Lord Dufferin thus describes this beautiful province: "From geographical position and its peculiar characteristics Manitoba may be regarded as the keystone of that mighty arch of sister provinces which spans the continent from the Atlantic to the Pacific. It was here that Canada, emerging from her woods and forests, first gazed upon her rolling prairies and unexplored north-west, and learned, as by an unexpected revelation, that her historical territories of the Canadas, her eastern seaboard of New Brunswick, Labrador, and Nova Scotia, her Laurentian lakes and valleys, corn lands and pastures, though themselves more extensive than half a dozen European kingdoms, were but the vestibules and anti-chambers to that, till then, undreamed of Dominion, whose illimitable dimensions alike confirm the arithmetic of the surveyor and the verification of the explorer."

THE SPANISH GUNBOAT "EULALIA."

THE Spanish twin-screw gunboat Eulalia, of which we give a perspective view on the page plate published with the present issue, is one of a number recently added to the Spanish Navy, all of which were built at the Government dockyards, their machinery being made by private engineering firms. They measure 115 ft. in length, 21 ft. 8 in. in breadth, and have a mean draught of 7 ft.; they have a ram-shaped stem and elliptical stern, and are constructed entirely of iron. Their armament consists of a breech-loading rifled gun placed forward, and a Nordenfelt gun mounted near the stern. As will be seen from our illustration, the Eulalia is schooner-rigged.

The machinery of the Eulalia and the Paz was supplied and fitted by Messrs. Portilla, White, and Co., of Seville. The general design of the engines is shown by the views we give on pages 4 and 5, from which it will be seen that the two screw shafts are driven by two pairs of compound engines, placed back to back, with a surface condenser, common to both, between them. The engines have high-pressure cylinders 17 in., and low-pressure cylinders 30 in. in diameter, the stroke being 18 in. The cylinders are not steam-jacketted, and the low-pressure cylinders only are provided with starting valves. The intermediate receiver of each pair of engines is formed around the high-pressure cylinder as shown in Fig. 3, from which view and Fig. 1 the arrangement of the valves, &c., will be seen. The casings fixed on the top covers of the cylinders are for the relief valves. It will be noticed from Fig. 1 that the glands of the piston-rod stuffing-boxes are unusually short. It has been the general practice of Messrs. Portella, White, and Co. to make the glands in this way, and no inconvenience is said to result from it.

The cylinders are supported at the back by cast-iron standards, and in front by wrought-iron columns, the crossheads being provided with slipper guides. The slide valves are actuated by the ordinary link motion. The crankshafts are 5¼ in. in diameter, both at the main bearings and crank-pins, and each has five bearings on the bedplate, as shown in Fig. 1. At the forward end of each shaft is a crank from which a horizontal single-acting circulating pump, 7½ in. in diameter and 10 in. stroke, is driven. The single-acting air pump, 11 in. in diameter and 9 in. stroke, and the feed pumps, are driven by levers from the high-pressure crosshead of each pair of engines, as shown in Figs. 1 and 3. The engines are altogether compact, and yet readily accessible.

The surface condenser, which, as we have said, is common to the two pairs of engines, is situated between the two low-pressure cylinders as shown in Fig. 3. The tubes, which are ⅝ in. in diameter by 6 ft. long, are placed vertically, and are packed with wood ferrules. The condensing surface is 800 square feet, and the condensing water passes through the tubes, the steam being outside them.

Each pair of engines drives a four-bladed screw 6 ft. in diameter, and 11 ft. pitch, the screws together with the stern brackets and tubes, being made of gun-metal, while all the shafting beyond the stern tube is cased in sheet brass.

The engines are supplied with steam by two return tube boilers, the chief dimensions of which are given on the diagram views, Figs. 4 and 5 on page 5. The total heating surface of the two boilers is 1200 square feet and the total grate surface 60 square feet. A large steam drum and partial superheater common to both boilers, is placed between them, as shown by the views just referred to. The stokehold is aft, and there is no bulkhead or cross bunker between the boilers and the engines, the coal being all carried in side bunkers.

The engines of the Eulalia developed during the official trial trip 312 indicated horse-power, of which 152 horse-power was developed by the starboard and 160 horse-power by the port engines, the revolutions in each case being 116 per minute. The boiler pressure was 61 lb. per square inch and the vacuum 26 in. At the trial the Eulalia attained a speed of over ten knots per hour, a speed which was deemed highly satisfactory considering the fulness of the vessel's forward lines.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, June 20, 1884.

THE Eastern Pig Iron Association held their annual meeting in Reading a day or two ago, and have been inspecting the furnaces, one hundred in number, which the Association represents. Though a large number of these furnaces are out of blast, the makers report the prospects for the trade as very favourable to advancing prices and improving demand. This is rather more sanguine a view than the facts of the case seem to justify; but the operators state that, with light production, low stocks, steady demand, and bottom prices, that all the conditions are in their favour, and consumers having no stocks on hand will have to come into market for large lots, when the fall trade opens. Prices cannot decline any further, at least not for the good makes, as producers would rather stock up their production, than to shade prices further; 20 dols., 19 dols., and 18 dols. are the average prices for fair qualities of Nos. 1 and 2 foundry and grey forge iron. There is some talk of more furnaces blowing in on the 1st of August, but it is not at all likely that they will do so, as the market will not bear heavy stocks at present. The only hope of improvement lies in the continuance of the present wise policy of restriction of production to the actual requirements of the market. There will probably be considerable restriction among the mills this summer; the nail makers find prices declining, and stocks accumulating, and though there will be no organised suspension, individual manufacturers will probably shut down, in the hope of improving the market condition. The Western Nail Association will meet at Pittsburg on the 25th inst. to discuss the question of a three months' suspension, which seems to be necessary to the welfare of the trade, owing to the active competition of steel nails, as well as to the large production. Nails are selling at 2.25 dols. in Pittsburg, and 2.35 dols. to 2.45 dols. here. The barbed wire manufacturers have not yet agreed upon the sixty days' restriction of production which has been talked about in the trade, and the result is that concessions are being granted and prices are declining; the production is very large, and demand has fallen off materially during the past few weeks. Quotations are nominally, for car lots, galvanised four-point, 6 cents per pound; painted, 5 cents; broken lots, ¼ cent more. The steel rail market continues very flat. Small lots are selling at 31.50 dols. to 32.50 dols. in eastern mills; it is said that 31 dols. has been taken in some cases, but it cannot be said at what price a large lot for winter delivery would be taken. Prices are going down, and it is probable that 30 dols. will eventually be reached. The mills are turning out a good deal of steel for other purposes than rail making, and this is helping them over the dull season, but all the makers are anxious for new business. Stocks of old rails are large, demand light, and prices declining. A 500-ton lot was sold here during the week at 18 dols.; and other lots at 18.50 dols. to 19.50 dols. Crop ends are quoted at 20 dols. to 20.50 dols. for American, and 21 dols. to 22.50 dols. for English and Welsh; steel slabs and blooms are in light demand. Bessemer pig is selling in a small way at 19.50 dols.; spiegeleisen is dull. A great deal of the Scotch pig which is arriving, is going into store. Only small lots are wanted by consumers. Oliver and Roberts, wire manufacturers of Pittsburg, have put their large new rod mill into operation, and will hereafter manufacture all their own material for barbed wire, instead of importing it. The growth of rod manufacturing in this country is having a serious effect upon importations, which are falling off very sensibly. Prices for steel rods have declined, and stocks can now be had at 46.50 dols.

ROYAL METEOROLOGICAL SOCIETY.

THE concluding monthly meeting of the session was held on Wednesday evening (June 18), Mr. R. H. Scott, F.R.S., President, in the chair. Dr. Benjamin A. Gould, director of the Cordova Observatory, Argentine Republic, was elected an honorary member. The following papers were read:

1. "The Equinoctial Gales; do they Occur in the British Isles?" by Mr. R. H. Scott, F.R.S. The period investigated was the fourteen years 1870-84, and only those storms were selected which had attained force 9 of the Beaufort scale at more than two stations. The results show that the storms are all but exclusively confined to the winter half-year, and also how, for a certain interval, the stream of storm depressions sets over the British Isles, and then for a time takes another path, leaving this country at rest. In some years there are as many as four or five storms in a fortnight, and in others there are none, or only one. It is further shown that there is no strongly-marked maximum at either equinox.

2. "On the Physical Significance of Concave and Convex Barographic or Thermographic Traces," by the Hon. R. Abercrombie, F.R. Met. Soc. The author shows that a falling barogram is convex when the rate of the fall is increasing, concave when decreasing, and conversely, that a rising barogram is convex when the rate is decreasing, concave when increasing. As the rate of barometric change is proportional to the steepness of the gradients which are passing, and the wind also depends on the gradients, the author suggests the following rules for judging the coming force of a gale from the inspection of a barogram: A convex barogram is always bad with a falling barometer, and good with a rising one, and a concave trace is sometimes a good sign with a falling barometer, and not always a bad indication with a rising one. The convexity or concavity of a thermogram is likewise shown to depend on the rate of thermal change. A method is given by which the distribution of diurnal isothermals over the globe can be deduced from the diurnal thermograms in different latitudes, and it is shown that the shape of diurnal isotherms on a Mercator chart, for a limited number of degrees of latitude, is similar to the shape of the curve of diurnal temperature range, if we turn time into longitude, and temperature into latitude, on a suitable scale.

3. "Maritime Losses and Casualties for 1883, considered in Connexion with the Weather," by Mr. C. Harding, F.R. Met. Soc.

4. "The Helm Wind," by the Rev. J. Brunskill, F.R. Met. Soc. This is an account of a wind peculiar to the Crosswell range; and its presence is indicated by a belt of clouds denominated the "helm barr," which settles like a helmet over the top of the mountain.

5. "Climate of the Delta of Egpyt in 1798 to 1802 during the French and British Campaigns," by Surgeon-Major W. T. Black, F.R. Met. Soc. The author has collected and discussed the meteorological observations made in Egypt during the French and British campaigns at the beginning of the present century.

NOTES FROM THE SOUTH-WEST.

Mount Stuart Graving Dock.—The new Mount Stuart graving dock at Cardiff has been formally opened. The new dock has been constructed by the Mount Stuart Shipbuilding, Graving Docks, and Engineering Company (Limited), to meet the requirements of its increasing business. The dock combines in its construction all recent improvements. The walls are of stone, obtained from the Pwllypant and Radyr quarries, the total amount of masonry being 17,500 cubic yards. The hollow quoins and sills are of granite from Messrs. J. Freeman and Sons' quarries, Penryn, the amount used being over 6000 cubic yards. The walls rest on a foundation of Portland cement concrete, and the bottom of the dock is wholly of the same material, no pitching being used on the top. The concrete amounts to about 12,000 cubic yards, and the cement used was obtained from Messrs. C. Francis, Son, and Co., Newport, Isle of Wight. The dock will accommodate two vessels alongside each other, the side blocks affording space to the extent of 360 ft. each. In the event of the dock being required for a vessel exceeding 360 ft., a middle row of blocks can be utilised to take a ship or steamer 420 ft. in length. The width of the dock is 150 ft. at coping level, and 90 ft. at bottom. There are, in addition to the entrance gates, which are 52 ft. wide, a pair of inner gates, which will retain a depth of 20 ft. of water on the keel blocks. The depth on the sill and keel blocks at high water of ordinary spring tides will be 26 ft. Iron staircases of a novel design will be shortly fitted to the sides and ends of the dock. The work was commenced in September, 1882, Mr. P. Whyte, C.E., Leith Docks, being the engineer; and it was executed under the superintendence of Mr. J. M. M'Currick, C.E., as resident engineer. The vessel selected to open the dock was the steamship Mameluke, belonging to Messrs. W. and R. Thomson, of the Bedouin Steam Navigation Company.

Cardiff Water Works.—The water works scheme of the Cardiff Town Council, which includes the construction of a storage reservoir at Llanispen, has sustained a check by the withdrawal of the contractors for that work, Messrs. Hill Brothers, Beckenham, Kent. The Town Council proposes to again invite tenders. The reservoir is to cover 60 acres, and when completed it will hold 300 million gallons of water.

Blaenavon.—The Blaenavon Company is extending its works, and a large furnace has just been erected which will turn out about 600 tons per week. A new blowing engine is also being put up. A furnace on the old site is nearly ready.

The Vernon Tin-Plate Works.—The sale of these works has been completed by Mr. E. E. Morgan. At present only a portion of the works will be started.

The Barry Dock Bill.—The preamble of this Bill has been declared proved by a committee of the House of Commons. The committee sat for 33 days.

Colliery Enterprise.—Operations were commenced on Monday in sinking a new pit in a field nearly opposite the Place Farmhouse, to the east of the Powell's Old Place Pit, to the Mynyddislwyn house coal seam. The contract for sinking the pit has been entrusted to Mr. R.

Treasure, of Blackwood. The site of the pit is above the fault. On the upper side of the above old pit there is an extensive portion of land unworked, and the whole has been taken by Messrs. Bevan and Price, the owners of the Wingfield Colliery, near Gelligaer.

Newport.—During the past week the steam coal marke has continued to present the same tone as that which h prevailed of late. The position of the house coal mar is practically the same. Shipments of iron have a been small. Last week's clearances were 975 tons warded to the following destinations: Maracaibo tons; Carril, 225 tons; and Santa Martha, 52 The rail trade still maintains an exceedingly dull ance. The iron ore trade is still depressed. Las coal clearances were 53,328 tons. From Bilb were received 16,048 tons of iron ore, and 5770 t to hand from other sources.

Caerphilly.—The Caerphilly foundry is to be The foundry is situate about 300 yards from t phily Railway Station, and in close proximit Pontypridd, Caerphilly, and Newport and Rhymr revolu ways. The works possess every facility for and this Operations have ceased at the foundry for some 88 lb. being last worked by a Manchester firm. The proper firm trades under the title of Messrs. Woods. regu

Briton Ferry Iron Works.—In consequence of ressive pressed state of the iron trade, Messrs. G. H. Dave ure of decided to lay off these works until matters improv

Cardiff.—The steam coal trade has during the week shown greater signs of activity; there has, ly of ever, been no material change in prices. In the h the coal trade some local merchants continue to keep t ant collieries going without interruption. Prices rem e practically at the figures recently given. The patent fu market remains without any material alteration. There no improvement to record in the iron ore trade. Last week clearances comprised 162,868 tons, 2560 tons of paten fuel, and 2385 tons of iron. From Bilbao there were received 13,377 tons of iron ore, and 4318 tons came to hand from other sources.

Death of Mr. G. Berbeck.—On Saturday Mr. G. Ber beck, consulting engineer to the Llynvi and Tondu Company, succumbed to injuries received in his garden about three weeks since by falling from some steps.

Dumfries Dry Dock Company.—The first general ordinary meeting of the shareholders of the Dumfries Dry Dock, Shipbuilding, and Engineering Company (Limited), was held at Cardiff, on Monday. Mr. Cory took the chair and read the directors' first report. The company, the report stated, had entered into a contract with Messrs. Clark and Stanfield, by which they would obtain a floating dock capable of taking a vessel of 300 ft. in length, and 3300 tons carrying capacity; and one having special facilities for lifting loaded vessels which had grounded or been in collision, with a view of ascertaining whether any damage had been sustained. According to the terms of the contract the dock will be ready by March, 1885. The report of the directors was adopted.

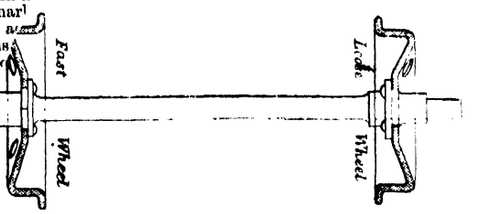
MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.—The annual meeting of the Association of Municipal and Sanitary Engineers and Surveyors is to be held in Newcastle-on-Tyne on Thursday, Friday, and Saturday next. Thursday will be devoted to discussing certain proposed alterations in the rules, to the reading of a paper by Mr. J. P. Spencer "On Testing the Sanitary Arrangements of Houses," and to excursions to the American Laundry and Hawthorn's Locomotive Works. On Friday papers will be read on "Steam on Tramways," by Mr. Jas. Hall; on "Sewage Disposal," by Lieut.-Colonel Jones; and on "The Cost of Local Government, and the Distribution of the Funds," by Mr. F. S. Bruton. Afterwards there will be excursions to the Elswick Ordnance Works and the Swan and Edison Electric Light Works. On Saturday there will be an excursion by steamer to various points of interest on the river, ending at Tynemouth, and including the Cattle Lairs, Messrs. Scott and Co.'s Cement Works, the Tyne Commissioners' Yard, the Whitehill Point Coal Staithes, the new Coble Dene Dock Works, and the piers at Tynemouth.

NORMAL SCHOOL OF SCIENCE AND ROYAL SCHOOLS OF MINES, SOUTH KENSINGTON.—The following is the list of prizes, scholarships, associateships, &c., awarded June, 1884. First Year's Scholarships: Albert G. Hadcock, Frederick Carrodus, William C. Rowden, Thomas Rose. Second Year's Scholarships: George Gibbens, Isaac T. Walls. Edward Forbes Medal and Prize of Books for Biology, Thomas Johnson; Murchison Medal and Prize of Books for Geology, Martin F. Woodward; Tyndall Prize of Books for Physics Course 1, Isaac T. Walls; De la Beche Medal for Mining, Herbert W. Hughes; Bessemer Medal with Prize of Books from Professor Chandler Roberts for Metallurgy, (1) Percy Bosworth-Smith, (2) William F. Grace; Hodgkinson Prize for Chemist First Prize, Books, &c., George T. Holloway; Second Prize, Stephen J. Elliot and William P. Wynne. Associateships Normal School of Science: George Tres et loway, Chemistry, First Class; William P. manu- Chemistry, First Class; Elizabeth Healey, Cl First Class; Benjamin Illingworth, Physics, F Alfred Howard, Physics, First Class; Jos Biology and Geology, Second Class. Royal School of Mines: Herbert W. Hu First Class; George H. Schröder, Minin a description Metallurgy, First Class; Percy Boswi t-off" eccentric, lurgy, First Class; Alfred Sutton, which we have re- Class; Henry G. Graves, Metallurgy, We do not think J. Chaney, Metallurgy, First Class arly in Fig. 4, can mersdorf, Metallurgy, Second Cl Stephenson, Metallurgy, Second C of the eccentric; A

STEEL WHEELS.

OWN AND CO., LIMITED, SHEFFIELD.

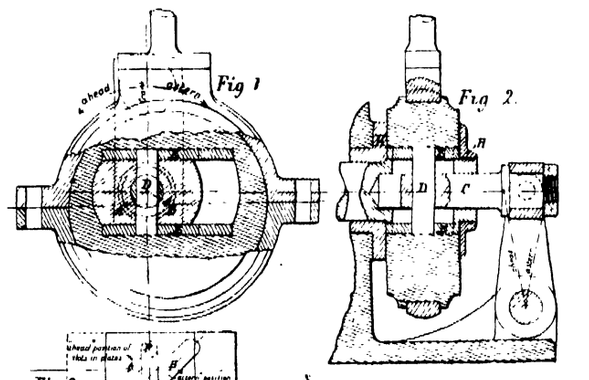
(see opposite Page).



is the ahead, and B the astern position of the eccentric centre. The eccentric is slid across the flats on the shaft in the line A B, by the arrangement shown. The shaft end is bored out to fit the mandrel C, which is shifted out and in by the ordinary reversing lever, or wheel and screw. This mandrel carries at its inner end a steel pin D, which projects through longitudinal slots in the shaft, into diagonal slots cut in steel plates E, let into the eye of the eccentric. Fig. 3 shows the pin and relative positions of the slots in the plates and shaft. The pressure of the pin—while being pulled from F to G—on the sides of the diagonal slots in the plates, causes these to move (carrying the eccentric with them) across the shaft from A to B. The plates and eccentric are prevented moving endways on the shaft by the washer H, and the collar, or bush flange, at K.

With this arrangement the eccentric setting is correct not only for "full speed ahead" and "full speed astern" positions, but the gear is fully as efficient as the link motion for any intermediate position; *i.e.*, the lap and lead remain constant, while the travel (and therefore the cut-off) varies.

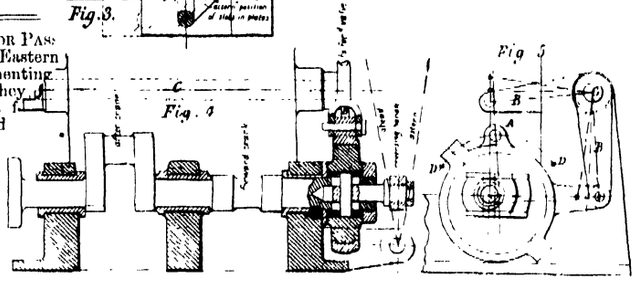
Figs. 4 and 5 show the arrangement for two or three-cylinder engines, by which the engines are reversed or the cut-off varied, with only *one* eccentric for two or three cylinders. The forward valve is coupled by a link direct to the eccentric strap (Fig. 5), and the after valve is



Colle, in the cha to the prop funds at the ing the donation of Norfolk, E.M. Devonshire, K.G., of about 10,300*l.*, a years. The principal report.

STEEL FRAMES FOR PAS Orleans and North-Eastern engaged in experimenting carriages, and if they only carriages, but steel frames instead

MESSRS. DICK, and Co. have ac Engineering W produce the machinery. Calcutta E system wr water ex



Sound through the wypers B B and shaft C, the motion lian being taken off the strap at right angles to A. For Pacific-cylinder engines with cranks at 120 deg., the motion nor the wyper shafts is taken from the eccentric strap at points D D, 120 deg. apart, one wyper shaft being carried in front and one at the back of the engines.

We have fitted this eccentric and gear on single and double cylinder launch (screw and paddle) engines, cranes, winches, and steering gears, and find it works well. The advantages of such an arrangement in the matter of wear, &c., in comparison with the ordinary link motion, are very apparent.

It is out of the question to claim for this or any similar gear that it will act as a governor, though ours has a very special adaptation for being *actuated* by a governor, and as a "variable expansion valve" eccentric in a "non-reversing" engine.

Your obedient servant,
MATTHEW PAUL AND CO.,
PER M. PAUL, JUN.

P.S.—The "lead" or "angle of advance" can be altered very simply, as we have done after an engine has been at work, by thinning one of the steel plates in the eccentric eye, and thickening or packing out the other. We find in practice it requires very little strain on the reversing handle to keep the eccentric in any position; it is, in fact, practically balanced. This shows that none of the work of *actuating* the valve, in the way of driving, is done by the steel pin and plates, but is done by the flats on the shaft; and so the wear on the pin and plates, which at first sight would seem likely to be considerable, is inappreciable.

Levonford Works, Dumbarton, June 7, 1884.

INDIAN PUBLIC WORKS DEPARTMENT.

TO THE EDITOR OF ENGINEERING.

SIR,—Permit me a few lines to reply to your two correspondents, "A Civil Engineer" and "Not a Cooper's Hill Man," in your issues of the 30th of May and 6th June respectively, concerning their objections to my letter on the above subject in your issue of the 23rd May.

"A Civil Engineer" attacks the assertions I have made in the following manner. He first of all paraphrases ten remarks of mine in a series alphabetically enumerated, and having done so proceeds to demolish them. In replying to his objections I shall for convenience' sake adopt the same alphabetical references.

In three instances his paraphrases and comments are deliberate contortions of what I really wrote. They are as follows:

(*a*) *That I assert it would need a special Act of Parliament to have removed military men from the P.W.D.*

I never asserted anything of the sort. A reference to my letter will show at once that I could not have referred to mere removal from the Department, but to their "reduction" in the same sense and manner as befel so many civilian engineers, namely, in being "turned off" altogether from Government employ, as I expressed it a few lines lower down. "A Civil Engineer" cannot be so ill-informed as to believe that it were possible for Government to remove many Royal Engineers from the P.W.D. for employment on military duties, when such duties are so limited. To this there were but two alternatives, either to leave them in the Department, or to forcibly retire them by special Act of Parliament. The latter expedient was not adopted—*hinc illæ lachrymæ*. Can "A Civil Engineer" tell us where and how these redundant military engineers could have been employed if turned out of the P.W.D.?

(*d*) *That I assert that promotion in the Military Works Branch is worse than in the General Branch of the P.W.D.*

Here again is a distinct perversion of what I wrote which was that the promotion of Royal Engineers had fallen off, and their scope of work narrowed, by being confined to the Military Works Branch. Further, his allusion to the General Branch is entirely misleading, as there is no such thing. Instead of there being one general list (including both civilians and military men) there are no less than three branches, namely, "Railway," "Roads and Buildings," and "Irrigation." The two last again are represented under the Governments of Bombay and Madras, by entirely separate establishments to those under the supreme Government. Besides this, a large number of civil engineers are now employed and graded in the Managerial Department of State Railways, and in the Accounts Branch of the P.W.D.

Instead, therefore, of one general list for purposes of promotion, an engineer may be graded in one or another of some half-dozen lists, in each of which promotion goes solely within that list, and as might be expected at varying rates, so that in some it is fairly good, while in others desperately bad. "A Civil Engineer's" appeal to the classified list will prove this, if no more. His assertion that promotion in the Military Works Branch will appear from that list to be better than in his hypothetical "General Branch," may perhaps be explained thus: The Government in fulfilment of its promise to confine military

engineers to military employment has done a great deal the last four years in transferring them to the Military Works Branch, which as I explained in my last letter, was formerly officered by military men and civilians, pretty much as the other branches of the P.W.D.

To do this, however, it was necessary to turn out a number of civilians from that branch and relegate them to others. If, as I believe, the majority of the civilians turned out were of higher rank than the military men who took their places, it is easy to understand that promotion would very likely be somewhat swamped in the branches entered by these displaced civilians, while for the younger military men replacing them it would be somewhat accelerated. Such can, however, be but a temporary result, and the future prospects of Royal Engineers confined to the Military Works Branch is, I have no doubt, gloomy enough. At any rate I fancy Royal Engineers are better judges of this than "A Civil Engineer" can possibly be, and I cited a Royal Engineer correspondent as my authority for this view.

(*f*) *That I asserted the civilian engineers were superseded because of inefficiency, and that they were not qualified for the posts of superintending and chief engineers.*

This is another distortion of what I really wrote, namely, that it was in many cases their want of *administrative* abilities, rather than of professional knowledge, that unfitted them for special appointments and the higher and most coveted posts. Nor did I particularise the special appointments to which I alluded. Certainly, neither of those he mentions was in my mind when writing. Concerning the former, this is the first time I have heard of any serious complaints of jobbery in promotion. As for the latter, "A Civil Engineer" must know that for the very few appointments of Chief Engineer there are yet so large a number of Royal Engineers in the Department who are years before the most eligible civilians in seniority, that the latter cannot reasonably expect their turn to come just yet. I have yet to learn that any civilian has been passed over for the post of Chief Engineer by a Royal Engineer, simply because he was a civilian. The appointments I had in mind were those of secretaries to Government, consulting engineers for guaranteed railway companies (analogous in position and duties to Board of Trade railway inspectors at home), and State railway directors and managers. At all events these were the special instances of grievance cited in a general newspaper growl that occurred some twelve months ago. As was then pointed out, Board of Trade inspectors are always R.E. officers, while a large majority of the State railway managers have been civilians for some time. The real grievance then turned out to be that these appointments were not thrown into one general list to go by seniority, instead of being as now given for merit and special abilities.

I will now notice two instances wherein to a certain extent I am willing to accept "A Civil Engineer's" corrections:

(*h*) *That instead of nearly all the Royal Engineers only about* 100 *out of* 240 *went on field service during the late Afghan war.*

No doubt I should have allowed for those officers employed on the maintenance of Indian fortifications and other defences, who could scarcely be withdrawn for field service, as also for those very senior officers occupying high administrative posts in civil employment, many of whom were not available for field service on account of their rank being too high, and who if not in civil employ, would probably ere then have been laid on the shelf. Deducting these two classes will I fancy make a big hole in the difference of 140 paraded by "A Civil Engineer." This correction in no ways affects the general principle involved, that all Royal Engineer officers are liable at any minute for field service on war breaking out. As to their having all volunteered that is beside the question. As good soldiers this was only to be expected of them.

(*e*) *That instead of the military engineers being chiefly confined to the military works, only about one-third of them are to be found on them.*

"A Civil Engineer" has here again misquoted me. What I wrote was "Royal Engineers," not "military engineers." This will make some difference, as there are still a number of staff corps men employed as civil engineers, who are far too good men to be sent back to ordinary regimental duty. They are men who owe their position to their own abilities, and work for ordinary civilian pay without any military allowances. Several such men were deliberately retained in the P.W.D. in 1879, in preference to certain civilian engineers. I have, however, doubtless overstated the number of Royal Engineers now on military works. I should rather have stated that, excepting special appointments as enumerated above in the latter part of (*f*), Royal Engineers are chiefly confined to military works, and that in the general civil engineer establishments their number is decreasing, the present policy of Government being to gradually civilianise these establishments.

In the following two instances "A Civil Engineer" admits the truth of my remarks, but proceeds to qualify them:

(*h*) *That military men do stick close together, but hold the scales uneven when in power.*

This is a charge of corruption so deliberate that if true it means that the present Viceroy, Minister for Public Works, and the various governors and lieutenant-governors are all in the hands of a designing clique of Royal Engineer advisers. These eminent personages, who are the real founts of promotion, are all civilians and not quite the noodles we must believe them to be if your correspondent's assertion be true.

(*j*) *That at least I am a living proof of a least one civil engineer not sticking to his fellows.*

Certainly not in the utterly futile policy of abusing our more fortunate military colleagues. The sticking together to which I referred was in unanimous action towards bringing pressure to bear on Government for the removal of grievances and the acceleration of promotion by granting better pensions, the key-note, as I take it, of your article giving rise to this correspondence. When yet have the civilian engineers done this as a body? There have been several committees formed at different times for the defence and promotion of their interests. Have any of these received anything like unanimous support? Did the Agra Committee of 1878? Though composed of well-known men and encouraged by the late Minister of Public Works, Sir Andrew Clark, is it not a fact that not only did it fail to receive the support it deserved, but was opposed by a rival committee started in Calcutta? Is it not a fact that neither committee received the support of Cooper's Hill men who complained (and with justice I believe) that the rival schemes propounded would not benefit them. There is now a committee at work with the same object; what proportion of the civilian engineers have yet supported it by subscriptions? As another instance of not sticking together it has often been observed that those civilian engineers who make a grievance of the Royal Engineers, are generally quite as ready to exhibit jealousy of Cooper's Hill men, and fits of this recur periodically in the public press.

(*e*), (*g*), (*k*). I take no note of these remarks, which do not affect those of mine to which they relate.

So much for "A Civil Engineer's" objections. Now a few lines for your other correspondent "Not a Cooper's Hill Man." He facetiously endeavours to repudiate me as an outsider, because I prefer to use the term "civilian" rather than "civil" engineer, which, as I explained, has from originally meaning an engineer who was a civilian, come to signify an engineer practising on a particular class of works. As our grievances relate to our *status* as "*civilian*" engineers, and not to our *practice* as *civil* engineers, I repeat that the former term is more descriptive and appropriate for the present controversy. He is no doubt very angry at my thus exposing a common dodge he and his friends use in trying to make the public believe that, because not civilians, Royal Engineers do not make good civil engineers, are not so good as themselves, and therefore altogether out of place in the P.W.D.

His talk of the union of civilian engineers—Stanleyites, Cooper's Hill men, and a *few others*—in fighting it out with Royal Engineers, has yet to be proved as something better than mere hyperbole and bunkum. No doubt "Not a Cooper's Hill Man" is one of the "few others." It is some of the "few others" who usually are given to abusing Royal Engineers and Cooper's Hill men by turns, and render any real combination of civilian engineers difficult or impossible. If this small band who are the real outsiders, would just shut up, there might be some chance of Government listening to the real grievances of civilian engineers when temperately stated. As it is, their mischievous abuse of military men makes the whole civilian engineer establishment to stink in the nostrils of a despotic government of great military traditions.

I direct both your correspondents to a paragraph in a letter by "De la Hay" in your issue of the 30th of May, explaining "How Civil Engineers are Made," which will possibly go far to explain, as that person thinks, the want of success of certain civil engineers in India and the colonies. Those described are no doubt some of the "few others."

A CIVILIAN ENGINEER, NOT A COOPER'S HILL MAN.

"A REPORT ON WATER METER TESTS."

TO THE EDITOR OF ENGINEERING.

SIR,—Messrs. Tylor and Sons' disclaimer does not alter the results of the tests of water meters, the report of which is, from beginning to end, a model of impartiality; because, forsooth, the tests did not include the characteristic of durability, which would have prolonged the trials indefinitely, they must, according to Messrs. Tylor and Sons, be considered as worthless. The durability of a meter can be pretty accurately judged by engineers, without the necessity of an absolute test, as given that of two meters, one has corrodible, complicated, and delicate mechanism, and the other has a mechanism both simple and incorrodible, it is easy to decide which of the two will be the most durable, but in this trial, conducted as it was by the most distinguished of Alsatian engineers, not one of the meters gave exactly accurate indications. It behoves Messrs. Tylor and Sons and other meter manufacturers, to improve their meters, until they can show indisputably, that a meter is in existence which will satisfactorily withstand such a series of tests as that impartially carried out by the Commission of the Société Industrielle de Mulhouse, and relieve this class of measuring instruments from the suspicion which is at present attached to them by the majority of engineers.

Yours faithfully,
B. H. THWAITE, M. Soc. Ind. Mulhouse.

St. Neots, Hants, June 21, 1884.

"WIND PRESSURE."

TO THE EDITOR OF ENGINEERING.

SIR,—Having given much time to the consideration of the subject upon which Mr. Graham writes, I am in a position to give positive proof that a current, either of water or of air, will, of itself, give out a pressure equal to that due to the "head" it could sustain. Any over pressure *must* be due to vacuum behind any surface impinged upon, and in order to measure both pressure due to current or flow of air, and that due to vacuum, we must do away with all apparatus in which springs or equivalents are employed, as these exhaust, or ease off a great portion of the current's pressure, especially during gusts.

My ideal of a perfect apparatus would be two series of plain surfaces, one series one square foot in surface, and the other two. I would have, say, 30 to 40 of each size, and each attached to weights ranging from 1 lb. to 40 lb., so that there would be *dead lift* whenever a weight were raised by the wind. Behind each surface would be fixed barometers to indicate the vacuum at time of motion.

The reason for having two series of different surface areas, would be, that it is to be expected that the falling in of a current behind different-sized surfaces, will take different times and distances, and this, together with the different effects on the back eddies, will make differences in the vacuums, better to be aimed at by experiment than by calculation.

Yours faithfully,
G. PINNINGTON.

23, Chichester-street, Chester, June 21, 1884.

MILL ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—In your last week's paper, I notice a reply to mine of the week previous, by Mr. George Dixon, in which he says, "I have applied this gear (viz., slide valves regulated by hand, acted upon by an equilibrium throttle valve) to a number of engines running at piston speeds up to 600 ft. per minute, and never had any difficulty in designing it, so as to get within 3 lb. to 5 lb. of the boiler pressure." I should like to know where these engines so constituted are to be seen, and should be further gratified by having them tested by some practical and thoroughly impartial party, and previous to doing so, having both steam gauge and indicator perfectly in accordance with each other. The result I shall look forward to with much interest, for automatic valve gear may as well be discarded, if so near an approach to boiler pressure in the cylinder can be arrived at without it, as Mr. Dixon asserts. Free discussion on this subject is what I earnestly invite, so that parties wanting steam engines may become enlightened before ordering.

I am, yours truly,
JOHN ASHWORTH.

Astley Bridge, Bolton, June 30, 1884.

MECHANICAL EQUIVALENT OF HEAT.

TO THE EDITOR OF ENGINEERING.

SIR,—To prevent, if possible, further controversy betwixt "M.R.C.S." and myself, and which may prove unnecessary when you publish the letter in your hands, on the errors in calculating the mechanical equivalent of heat, I would ask "M.R.C.S." to note that it is only velocity acquired during an acceleration involved into itself that can go to the compounding of v^2 as an element in the specification of energy, and would also ask him to note the incongruous and *impossible* quantity he obtains when multiplying v due to an acceleration and *mean* v together, and perhaps even two different numerical values of the different kinds of velocity.

This will explain, too, what I imply by the disrespectful term "hanky panky" of mathematical manipulation. Any one who chooses to write, in his own way, an algebraical expression *supposed* to denote some physical facts or workings, will afterwards manipulate you the mere outward signs and symbols of ill-understood things, and triumphantly present you with a result and swear by it, as if Nature's workings *must* conform to algebraic juggling. Mathematics, such a one says, cannot err, and *therefore* the result must be correct.

Well, science is *full* of such rubbish as I have instanced (I don't write disrespectfully of "M.R.C.S." personally, he but follows the superficial system he has been educated in; I am thankful I have not been spoon-fed in knowledge, but have had to acquire it myself, and that my nature is such that I cannot accept anything on trust, but have to examine its very foundations ere attaining belief), and as an example of another kind of rubbish also pervading all the scientific work of the day, I here instance that portion of the letter of "H.," which implies that 772 lb. *doing* work during a descent of 1 ft. equals 772 foot-pounds work.

Now, when a mass falls freely, *after* an acceleration the formula $\frac{mv^2}{2g} = ms$ gives us the *work* conserved by the mass. But place a mass at the end of a rope which passes over a pulley and make that mass do work *during* a descent, the case is different; 772 lb. falling freely through 1 ft., has conserved in it power to do 772 foot-pounds work. But 772 lb. *doing* work during a descent, may be lifting, or pressing, a weight infinitesimally short of 772 lb., and taking an all but infinite time to do it in, or it may be lifting or pressing against an infinitesimal weight or pressure and have its own acceleration and conservation, but infinitesimally lessened in doing it.

The mean betwixt the two cases would be 772 lb. lifting, or pressing 386 lb. *during* its descent; but we require to know the *time* of the descent of 772 lb. as compared with the time of a *free* descent, in order to learn what work 772 lb. actually does *during* a descent through 1 ft.

The mistake "H." makes, is perpetuated throughout all works on mechanics. It is taught that if a weight be raised through any height, in its descent it will raise another equal weight through the same height, when the fact is, it will but *balance* another equal weight, and raise a less one only.

And the want of proper insight into the matter is, I believe, one of the causes of error in fixing Joule's mechanical equivalent of heat. It is also the cause of a loss of power, of about 30 per cent., in working dock, &c., systems by hydraulic machinery being attributed to friction, when the fact is *no* accumulator will give out as much as is put into it (on any present system—though the writer can correct the systems) unless in infinite time.

I have examined deeply into this matter, and find that

even (in the case of two unequal bodies connected by a rope passed over a pulley) the formulæ

$$f(P+2) = g(P-2) \text{ and } f = \frac{P-2}{P+2}g$$

give somewhat erroneous results, and are, though agreeable with manipulations of algebra, not agreeable with physical facts nor with true reasoning. The error is *very* subtle in these cases, and not so gross as those I have previously instanced.

I am, Sir, yours faithfully,
G. PINNINGTON.

P.S.—I will show "M.R.C.S." a *true* mode of converting pressure into energy, and *vice versâ*, in another letter.

22, Chichester-street, Chester, June 28, 1884.

TRIAL TRIPS AND LAUNCHES.

ON the 23rd ult., the new steamer Violet, for the Wallasey Local Board, built and engined by Messrs. Allsup and Sons, of Preston, under the superintendence of Messrs. Flannery and Fawcus, of Liverpool, went on her official trial trip. The Violet, which will run with passengers between New Brighton and Liverpool, is the largest of the boats belonging to these ferries. The engines are very powerful, having cylinders 38 in. in diameter and 60 in. stroke. The vessel ran the measured mile three times, the average speed being 12 knots, and the engines indicating 750 horse-power.

On Tuesday, the 24th ult., the Electro, a fine steel screw steamer, built by Messrs. Earle's Shipbuilding and Engineering Co., Limited, Hull, to the order of Messrs. Thomas Wilson, Sons, and Co., of the same town, was taken on her official trial trip. The dimensions of the ship are as follows: Length, 179 ft.; breadth, 25 ft.; depth of hold, 14 ft. She has been fitted by the builders with triple compound 3-crank engines, which developed 554 horse-power, on the measured mile at Withernsea, and propelled the ship at a mean speed of 11½ knots per hour.

On the same day the trial trip of the Centauri, which belongs to the Campanhia Transporte Fluviales, of Buenos Ayres, took place. The vessel, which is constructed of Siemens-Martin steel, is of the following dimensions: Length, 180 ft.; breadth, 30 ft.; depth of hold, 11 ft.; gross tonnage, 550 tons. The machinery consists of two complete pairs of compound surface condensing engines, having cylinders 18 in. and 35 in. in diameter, by 24 in. stroke, with two boilers of extra large size, working at 80 lb. pressure. On her trial trip the vessel attained a speed of over 11 knots per hour, with 400 tons dead weight on board. Both hull and machinery of vessel have been constructed by Messrs. David J. Dunlop and Co., of Port-Glasgow, under the superintendence of Messrs. Flannery and Fawcus, consulting engineers, of Liverpool.

On the following day Messrs. T. B. Seath and Co., Rutherglen, near Glasgow, launched the Warden, a handsome iron twin-screw steamer of 250 tons gross register, and measuring 135 ft. by 22 ft. by 11 ft. 6 in. She was built to the order of the Hon. Corporation of Trinity House, London, and is intended for use as a lighthouse tender and Trinity yacht in the Ramsgate district. Her propelling machinery, which is being supplied by Messrs. William King and Co., Glasgow, consists of two pairs of compound surface-condensing engines of 80 nominal combined horse-power working with steam at an initial pressure of 80 lb. per square inch. It is expected that her speed will be equal to 10½ knots per hour.

Messrs. John Reid and Co., Port-Glasgow, on the 26th ult., launched the Carmen, a handsome screw steam yacht of 220 tons. She was built to the order of Mr. L. Llewellyn Nothway, of Dartmouth, and designed by Mr. Beavor-Webb, London. Her engines have been constructed by Messrs. Walker, Henderson, and Co., Glasgow.

A screw steamer of 800 tons capacity, built and engined by Messrs. Wm. Simons and Co., Renfrew, was launched complete on the same day. She has been built for the Mersey Dock Board, Liverpool, under the direction of Mr. Lyster, their engineer, and measures 185 ft. by 33 ft. by 16 ft.; she has been fitted with compound engines of 500 indicated horse-power and with two steel boilers. She is the eighth steamer constructed by Messrs. Simons and Co. for the Mersey Dock Board.

Also on the same day, Messrs. Charles Connell and Co., Whiteinch, Glasgow, launched an iron screw steamer of about 800 tons gross, named the Charles Morand, and specially designed for the fruit trade. Messrs. Hutson and Corbett, Glasgow, are supplying the machinery, and Captains Watt and Spriggs, of Liverpool, are the managing owners.

Mr. W. B. Thompson, Whiteinch, on Thursday, the 26th of June, launched an awning-decked iron screw steamer named the Languedoc, a vessel of 1700 tons gross register, and measuring 255 ft. by 34 ft. by 24 ft. She has been built to the order of the Société Générale de Transports Maritimes à Vapeur, of Marseilles, under the superintendence of M. Roubaud, chief engineer of the company, and is to be supplied by the builder with engines of 250 horse-power nominal.

The Atlantic, a steel screw steamer of about 1600 tons gross, and intended for the Direct Line of steamers owned by Messrs. Scrutton, Sons, and Co., London, and Messrs. David Caw and Co., Glasgow, trading between London and the British West India Islands, was launched on the same day by Messrs. James and George Thomson, Clydebank. She is being supplied by the builders with engines of 1200 horse-power indicated.

The screw steamer Clansman, built and engined under the superintendence of Mr. W. A. M'Gregor, for the Northern Steamship Company, of Auckland, New Zealand, by Messrs. Blackwood and Gordon, Port-Glasgow, had her trial trip on Thursday, June 26. She has been specially designed for the largely increasing passenger and goods trade to the northern ports of New Zealand, and measures 192 ft. by 26 ft. by 11½ ft. The engines, of 100 horse-power nominal, have cylinders of 26 in. and 48 in. in diameter respectively, with piston stroke of 36 in. The boilers are of steel, and have an extra large heating surface, so as to suit the requirements of the New Zealand trade. On the measured mile at Wemyss Bay an average speed of 12¼ knots was attained, which was considered to be highly satisfactory, being half a knot above the contract speed.

The steel screw steamer Tasmania, a vessel of some 5000 tons, and the latest addition to the already splendid fleet of the Peninsular and Oriental Steam Navigation Company, had her official trial trip on the Firth of Clyde on Thursday, the 26th ultimo. Special importance was imparted to the event by the presence of Mr. Thomas Sutherland, chairman of the company, one of the members of the Load-Line Committee, and one of the Government representatives in the Suez Canal Company. The Tasmania was built by Messrs. Caird and Co., Greenock, like so many other vessels of the P. and O. fleet. She measures 400 ft. by 45 ft. by 31 ft. 6 in., and is fitted with compound engines of 4250 horse-power indicated. The guaranteed speed was 14½ knots, but the mean speed of several runs on the measured mile was 15.496 knots, or about one knot in excess. Prior to running her official trials, the Tasmania was put under a series of inclining experiments, to which considerable interest attaches. On an early occasion we hope to be able to say something regarding those experiments, and to give a fuller account of the vessel and her engines.

On June 27 the new twin screw hopper dredger Platypus, 1000 tons capacity, arrived at Brisbane, Australia, in eighty-nine days. It was despatched by Messrs. W. Simons and Co., Renfrew, and is the eighteenth hopper dredger they have designed and constructed.

On Saturday, the 28th of June, the paddle steamer Adeh, built and engined by Messrs. Blackwood and Gordon, Port-Glasgow, and owned by his Highness Rajah Brooke, of Sarawak, went down the Clyde on her official trial trip. She is a vessel of 450 tons gross, and measures 156 ft. by 25 ft. by 9 ft. She is fitted with engines of 70 horse-power nominal, the cylinders being 20 in. and 37 in. in diameter, respectively, with a piston stroke of 48 in. She has large boilers to provide steam of 80 lb. pressure. On the measured mile, and half laden, she attained a mean speed of 9¾ knots, or ¾ knots over the contract speed.

The Courlis, which is one of the largest iron steam trawlers yet built on the Forth, measuring 100 ft. by 18 ft. by 9 ft. 6 in., had her trial trip on the 28th of June. She has been built and engined by Messrs. Hawthorn and Co., Leith, and is owned by Messrs. H. S. Johnston and Co., Bordeaux. On the measured mile near Aberlady Bay she attained a speed of nearly 10 knots per hour.

The s.s. Alpha, measuring 180 ft. long, 27½ ft. beam, 13 ft. 8½ in. depth of hold, and built for Liverpool owners, was launched on Saturday last from the works of the Netherlands Steamboat Company, Fyjnvord, near Rotterdam. The engines are compound, having cylinders 23 in. and 43 in. in diameter, by 30 in. stroke, with a large boiler to work at 95 lb. pressure. The decks are all of iron, as also most of the deck fittings, which were arranged under the superintendence of Mr. Joseph R. Oldham, consulting engineer, of Liverpool. This is the second launch from the same works during the last month, and both steamers are owned in England.

The Little England, which was launched on May 7 by the Castle Steel and Iron Works, to the order of Mr. W. H. J. Alexander, of St. John's Wharf, London, after several preliminary runs in the Haven, for the purpose of thoroughly testing her machinery, had a four hours' official trial on Saturday last, when highly satisfactory results were attained. The vessel is 73 ft. long, 14 ft. 6 in. beam, and 9 ft. depth of hold, with a mean draught of 7 ft. 3 in., and displacement at that draught of 105 tons. Her engines are compound surface-condensing, with cylinders 16 in. and 30 in. in diameter by 18 in. stroke. The vessel was designed to exceed 12 knots speed, with the engines running at 120 revolutions and boiler pressure 110 lb.

THE ILLUSTRATED NAVAL AND MILITARY MAGAZINE.—The first number of this new periodical is just issued, and appeals for support both to the members of our national forces and to the general public. The latter indeed have been specially considered, and there is nothing in the whole of the 72 pages which a civilian cannot understand, and little that will not interest him. Many of the articles deal with subject which are in the minds of all who take an interest in the defence of the country; torpedo attack, swift cruisers, mounted infantry, and cavalry tactics are each discussed in a popular style. Two articles of non-technical character, "Heroism of Women in War" and "Battle Painters of the Nineteenth Century," deal with the poetic and artistic side of warfare, and serve as a relief to the more serious chapters on the action of gunpowder, the manufacture of arms, and the like. The magazine is well printed in large type on stiff paper, and is liberally illustrated, mostly with reproductions of pen-and-ink sketches.

THE "HARRISON" COAL MINING MACHINE.

A GREAT amount of interest has recently been excited amongst mineowners, mining engineers, and colliery managers in Scotland by the results which have been obtained by a new coal-cutting machine in the Whinhall Colliery, belonging to the Alloa Coal Company. The machine has been known for several years in the United States, where there are now well-nigh 400 such in use. Three of these machines have for a considerable time been running in the Whinhall Colliery, near Alloa, where they were introduced by Mr. Whitcomb, of Chicago, with the co-operation of Mr Roxburgh, the managing partner of the Alloa Coal Company.

While the "Harrison" machines have been at work in the pit named, they have been inspected by many interested persons, both from the north and from the south of the Forth, including on one occasion some forty or fifty members of the Mining Institute of Scotland. On some future occasion we hope to be in a position to place before our readers full illustrative details of the construction of the "Harrison" coal-cutter, and therefore all that we need attempt to do at present is to give a brief description of it, together with some information as to the amount of work that it can accomplish.

The machine in question is, we believe, the smallest and lightest mechanical coal-cutter that has yet been brought into practical use. It measures only 24 in. in height to the top of the throttle and 19 in. wide over all, while its length, from the rear of the guiding handles to the point of the cutting tool, ranges from 5 ft. 6 in. to 7 ft. Consequently the machine is so small that it may be worked around and between props wherever a miner can swing his pick. It cuts an open channel under the coal of any desired vertical height, from 8 in. to 12 in. in front, and tapering to 2 in. in the rear; and according to the length of the tool used the undercut made may vary from 3 ft. to 6 ft. inwards from the face, as may be desired; while the work done is as perfect as if performed by the most skilled manual labour. The machine is actuated by compressed air, and includes a piston rod and head, made solid in one piece and of special homogeneous steel; and this, when fitted with the cutting tool or pick, which is a two-pointed instrument and made of the best tool steel, constitutes the projectile of the machine. The total weight of this projectile is from 60 lb. to 90 lb., according to the length of the rod, and it strikes from 190 to 210 blows per minute. One skilled man can work the machine, and all the assistance that he requires is that of any ordinary labourer, who shovels away the cuttings as they collect, helps to move the machine from place to place as may be required, and does other odd jobs. This machine is efficient in both stoop-and-room and in long-wall workings, and in "shearing" and in undercutting or "holeing." For ease in running the machine the operator uses two boards of convenient size as a temporary floor, and the labourer-attendant lifts these in succession and places them in the required position as the work progresses. On this temporary floor the machine is set, being supported on a couple of wheels on which it is carefully balanced. The operator sits in rear of it with one of his feet pressed against the corresponding wheel, and with the two guiding ring handles he can at pleasure direct where the cutting tool shall strike the coal, or a subjacent stratum in which he may for the time be "holeing;" and when the machine is to be used in "shearing" two wheels of larger diameter are substituted, the diameter varying with the thickness of the coal seams to be cut.

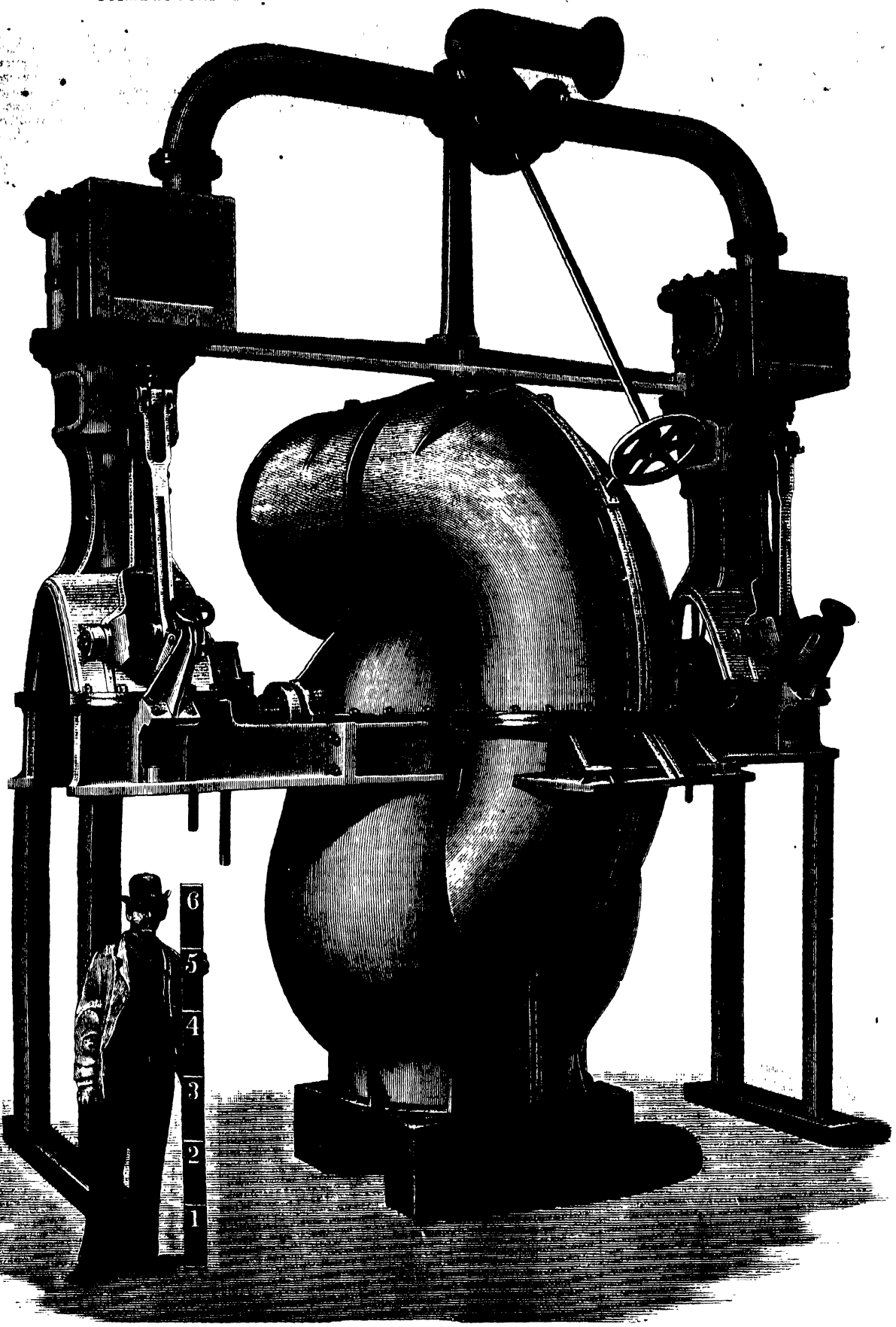
At the Whinhall Pit, as in many cases in the United States, the "Harrison" machine is driven from the pit bank by means of a Norwalk 10 in. air compressor. We should rather say that all three machines are thus driven; two of them are generally working at the long wall face in the lower or "cherry" seam, which is about 50 fathoms from the surface, the other being employed in the upper or splint seam where the stoop-and-room system of working is in vogue. The mean distance of the machines from the compressor is from 2500 ft. to 2700 ft., and the air is conveyed by means of 4 in. malleable iron tubing along the main roads; this ultimately terminates in 1 in. flexible hose at the machines, where the air is delivered at a pressure of from 65 lb. to 70 lb. per square inch.

Generally speaking, the capacity of the machine in coal getting, when it is worked by one skilled runner, assisted by a labourer, is equal to that of eight of the best workers with the hand pick. The "holeing" which the machines are doing at the Whinhall Colliery is one yard deep, and that has sometimes been in tough fireclay at the rate of 3 ft. in five minutes; that is to say, one square yard of undercutting in that time. In a day of eight hours 40 square yards of "holing" in the lower seam have frequently been done by one machine; and as much as 43 square yards have been "holed" in 7 hours 5 minutes. On another occasion one machine undercut in the long wall facing a stretch of 146 ft. one yard deep in 7 hours 55 minutes; and on the following day the same machine "holed" a length of 152 ft. one yard deep in a day of nine hours. Another day's work, when two machines were working, was 153 lineal feet one yard deep for each machine, one of them in 9 hours, and the other in 8 hours 45 minutes. These facts appear sufficiently important to warrant the colliery owners of the United Kingdom to make further inquiry regarding the Harrison coal-cutting machine, and even to make a journey to Alloa, where they may see the machine by application to Mr. Roxburgh.

AMERICAN LIGHTHOUSES.—Two iron lighthouses built by the Phœnix Iron Company, of Trenton, New Jersey, and which were on their way to be put up, have been lost by the wreck of the schooner M. M. Heath within a few miles of the places at which they were to be erected. They cost 25,000*l*.

CENTRIFUGAL PUMPING ENGINE AT THE INTERNATIONAL HEALTH EXHIBITION.

CONSTRUCTED BY MESSRS. SIMPSON AND CO., ENGINEERS, LONDON.



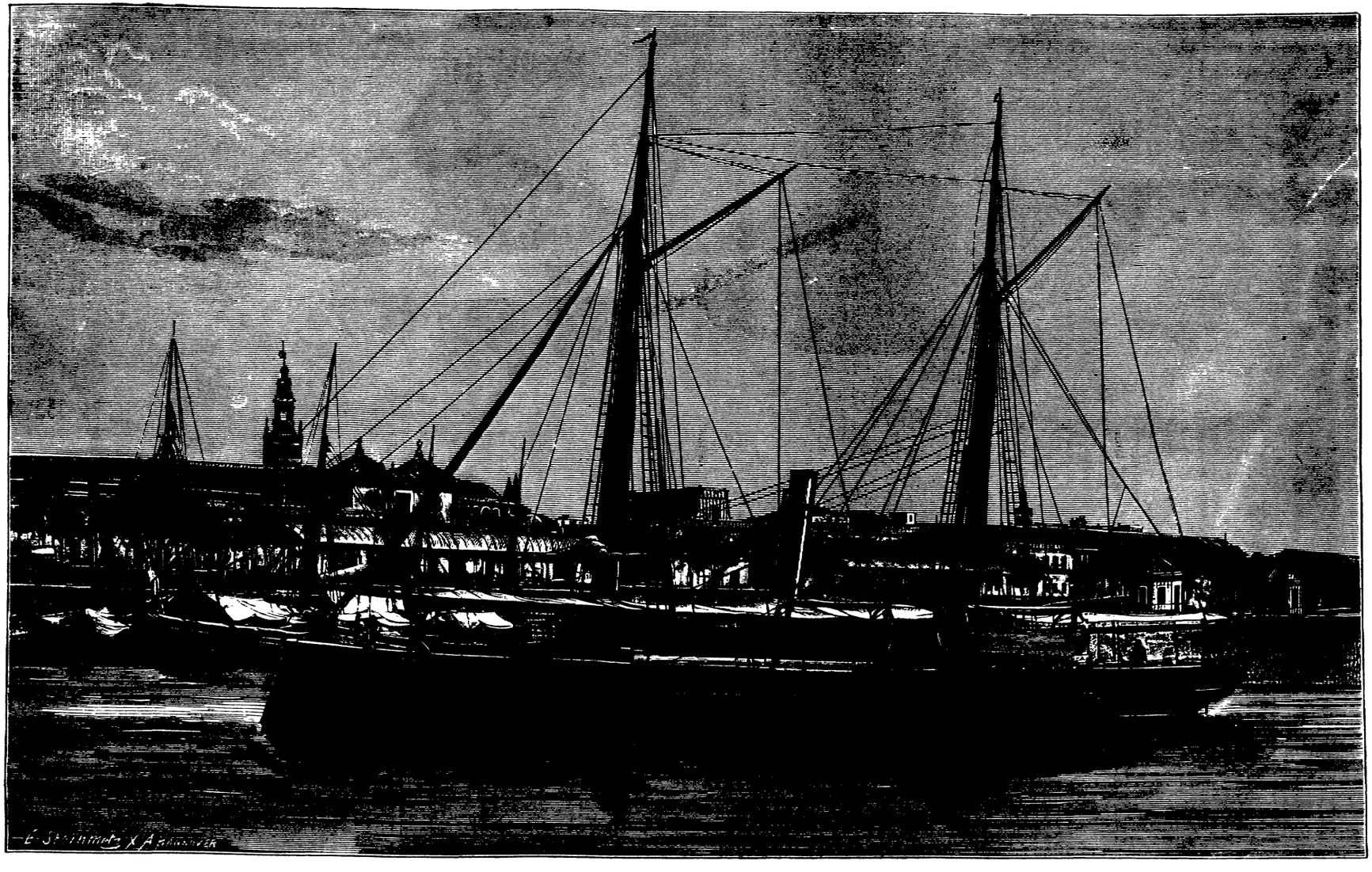
WE give above a perspective view of the pair of powerful centrifugal pumping engines which are being exhibited by the makers, Messrs. Simpson and Co., of Grosvenor-road, Pimlico, S.W., at the International Health Exhibition. These engines form one of four sets which Messrs. Simpson and Co. are making for the four new graving docks of the East and West India Dock Company at Tilbury, of which docks Mr. A. Manning and Mr. D. Barnes are the engineers. The four sets of engines will be together capable of discharging 650 tons, or 145,600 gallons per minute, a quantity equal to a stream about 77 ft. wide by 3 ft. deep running at a speed of three miles per hour.

Referring to the engraving, it will be seen that the pump is driven by a pair of engines coupled direct to the ends of the pump spindle, these engines having cylinders 22 in. in diameter and 16½ in. stroke. They are of substantial, straightforward design, and are fitted with Joy's valve gear, thus enabling the degree of expansion to be adjusted. The pump has a suction pipe 4 ft. in diameter, enlarging to 7 ft., and a delivery pipe 3 ft. 8 in. in diameter tapering to 4 ft. 11¼ in. in diameter.

Steam will be supplied to the four sets of pumping engines by four Lancashire boilers, the furnace tubes of which lead to a combustion chamber, from which tubes are carried through to the rear end. The boilers will be placed in a closed stokehole, and the combustion will be urged by air under pressure supplied by fans. This is, we believe, the first installation on land of boilers thus worked, and the results will be waited for with great interest. No doubt experiments will be made to test the evaporative efficiency of the boilers under various air pressures, the arrangements at Tilbury being such as to enable experiments of this kind to be carried out with readiness and accuracy. The data thus obtained will be of great value and interest, and we hope at a future time to be able to lay them before our readers. We may mention in conclusion that the arrangement of pump we illustrate is one which appears well fitted for use for irrigation purposes in India or Egypt.

THE SPANISH TWIN-SCREW GUNBOAT "EULALIA."

(*For Description, see Page 6.*)



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ENGINEERING.

FRIDAY, JULY 4, 1884.

HEALTH AND THE ELECTRIC LIGHT.

THE good or evil influence of the artificial light we use upon the health, is of the very highest importance, although hitherto, it has been to a great extent overlooked. Ancient custom has so familiarised us with combustion as a source of light that, until recent years, hardly ever dreamed there could be any other. Nevertheless the introduction of the electric light has been opening our minds of late to the advantages of a purer kind of illumination, and our object will be in the present article to illustrate some of these to the reader.

All the older illuminants depend directly upon combustion. They yield light because the oxygen of the air is burned; and the quantity and brilliance of the light they give are higher, as the oxygen consumed is greater. In other words the light is obtained at the expense of the air we breathe; and the richer the light the poorer becomes the air. But it is on the oxygen of the air that we ourselves depend; and if we burn it in our lamps we may destroy it for our breathing. It is estimated that a single gas jet in a room consumes as much oxygen as five or six individuals; hence, the air in a room lighted by two gas jets is as bad and unwholesome as if there were a dozen people sitting in it. Yet many persons who would shrink from joining such a party would have no hesitation in keeping company with the gas jets. The chief difference is that in the one case our instinct brings the evil home to us; and in the other case it does not. The gas jets are permitted to instil their poisons unsuspected, and to give rise to a thousand forms of ill-health and discomfort which are never traced to the real offender.

Pure air is what we all seek when we go to the seaside or the mountain top during our holidays. How important then is it that we should have pure air in our homes. The necessity which obliges us to live in towns, also obliges us to live in a more or less vitiated atmosphere. The mere fact of so many living beings crowded together is of itself sufficient to deteriorate the air. Assuredly it is not desirable that the very light we use should also vitiate the atmosphere. Pure air and light are essential to good health, but in close ill-ventilated city offices and in thousand of homes and workshops, what prospect is there of a pure air while the lights which are burned often half the day, are of themselves polluting it? For not only does a candle, oil, or gas flame waste the oxygen of the air, and thus rob it of its life-supporting virtue, but it actually soils it with noxious vapours, the products of combustion. These are chiefly water or steam, and carbonic acid; but carbon dust, or soot, is also thrown off, and in the case of gas, sulphurous acid.

To explain this more particularly we will take the case of a common gas jet. The chemical composition of average lighting gas is, according to Roscoe:

Hydrogen	47.60	volumes in 100 of the gas.
Marsh gas	41.53	" " "
Heavy hydro-carbon equal to olefiant gas 6.97 ...	3.05	" " "
Carbonic oxide ...	7.82	" " "
	100.00	

When, therefore, an ordinary gas jet is turned on, this poisonous mixture is let into the room at the rate of 5 cubic feet per hour. The application of a lighted match supplies the needed temperature to cause the chemical combination of the hydrogen in the gas with the oxygen in the air. In every 5 cubic feet of air in the room there is a cubic foot of oxygen, and four of nitrogen. This oxygen, which otherwise would support animal life, is united with the hydrogen of the coal gas to form water (H_2O), and with the carbon to form *carbonic acid gas*, or carbon dioxide (CO_2). Moreover, although not stated in the analysis we have given above, it is well known that most kinds of illuminating gas contain sulphuretted hydrogen and carbon disulphide. These gases are also formed and the sulphur in them is given on by the flame and the sulphur sulphuric acid or, as it is commonly called, oil of vitriol.

The following table, from Dr. Tidy's "Handbook of Modern Chemistry," will give some idea of the scale on which these chemical changes are taking place with gas, oil, and candles:

Burnt to give a Light equal to 12 Sperm Candles (Burning 120 Grains per Hour.	Cubic Feet of Oxygen Consumed per Hour.	Cubic Feet of Air Consumed per Hour.	Cubic Feet of Carbonic Acid Produced per Hour.	Cubic Feet of Air Vitiated per Hour.	Heat Produced Reckoned in Pounds of Water Raised 10 deg. Fahr.
Cannel coal gas	3.30	16.50	2.01	217.50	195.0
Common gas	5.45	17.25	3.21	348.25	278.6
Sperm oil	4.75	23.75	3.33	356.75	233.5
Benzole oil	4.46	22.30	3.54	376.30	232.6
Paraffin oil	6.81	34.05	4.50	484.06	361.9
Camphine	6.65	33.25	4.77	510.25	325.1
Sperm candles	7.57	37.85	5.77	614.85	351.7
Wax "	8.41	42.05	5.90	632.25	383.1
Stearine "	8.82	44.10	6.25	669.10	374.7
Tallow "	12.00	60.00	8.73	933.00	505.4

The unit in which the quantity of heat generated is set down, is the amount of heat required to raise a pound of water by a temperature of 10 deg. on Fahrenheit's thermometer.

This is a very instructive Table, and some of the figures, compared with more recent experiments by M. Ferd, a German chemist, agree very well. Thus M. Ferd finds that 100 sperm candles burning for an hour, give off 41.30 cubic feet of carbonic acid; while the same figure according to Dr. Tidy's results would be 47.89 cubic feet. Sperm candles, besides being the best to use in a household, are generally pure, and hence the agreement in the results by independent experimenters employing different methods.

If we accept Dr. Tidy's Table as correct, and it is probably not very far wrong, we find that cannel coal gas, such as is burned in Glasgow, is the best to use. Common gas is, however, that which we ought to consider, since it is most generally employed. The ordinary gas burner yields a light of some twelve candles for a consumption of 5 cubic feet of gas per hour, though better burners give more, say fifteen candles. It follows from the Table that every gas burner in a room consumes 5.45 cubic feet of oxygen per hour, that is to say, it completely deprives 17.25 cubic feet of air of its oxygen in an hour. A sitting-room, 16 ft. long by 10 ft. wide and 9 ft. high, contains 1440 cubic feet of air, and one gas burner would abstract all the oxygen from this room in eighty hours. In eight hours it would abstract one-tenth of the oxygen, provided always there were no fresh air entering. We see then how important it is that a room, in which gas is burning, should be well ventilated. Air without oxygen is of course unbreathable and cannot support life. Nitrogen is an inert substance, and extinguishes both flame and life, because oxygen is absent. In the air it is employed to dilute the oxygen and temper the action of the latter on combustion, and on the blood when taken into the lungs.

But gas and other lights produced by combustion not only rob the air of its health-giving oxygen; they adulterate what remains of it. Carbonic acid gas, which is supplied to the atmosphere from a flame, is an active poison fatal to animal life. It is the "choke damp" of the miner; and though always present in minute quantities in the atmosphere, it becomes dangerous when in excess. In the air expelled from the lungs there is 4 per cent. of it; and air containing this quantity is quite unbreathable. The following data from Professor Huxley's "Physiography" shew the percentage of carbonic acid in air taken from different places:

	Percentage.
On the Thames at London, mean	.0343
In the streets of London, " ...	.0380
From the top of Ben Nevis ...	.0327
From the Queen's Ward, St. Thomas's Hospital	.0400
From the Haymarket Theatre, dress circle at 11.30 p.m.	.0757
From Chancery-court, 7 ft. from the ground	.1930
From Underground Railway, mean ...	.1452
From workings in mines, average of 339 samples	.7852
Largest amount in a Cornish mine ...	2.5000

Dr. Tidy gives the normal quantity of carbonic acid in the atmosphere as .04 per cent., and the above results for the open air would seem to show that his estimate is not too low. He likewise considers that 1 per cent. of carbonic acid in the air is distressing, an estimate which a journey by Chancery Courts, or on the Underground Railway, would seem to confirm. Indeed, to make a slow poisoning for a long time submit oneself to it, must be materially shortened, just as the lives of miners are shortened by working underground. Air containing 2 per cent. is decidedly dangerous; and (if Dr. Tidy is correct) even .1 per cent., or something more than is found in a crowded theatre after the play, may be regarded as a notable pollution. But we gather from Dr. Tidy's Table that at the end of an hour, 3.21 cubic feet of carbonic acid have been delivered to the air of a room from each gas jet; and this on a room 16 ft. by 10 ft. by 9 ft., such as we have considered, and containing 1440 cubic feet of air amounts to .22 per cent. At the end of half an hour the distressing limit (1 per cent.) would be reached, were there no way to bring in fresh air and carry off the foul. At the end of something less than an hour the 4 per cent. irrespirable limit would be reached.

Combining then the [illegible] in consuming the oxygen of the air, with the [illegible] it with carbonic acid, we draw [illegible] a powerful [illegible] the existing [illegible] useful reign and oppression [illegible] all possession of Khatatbeh. The [illegible] ently took up the good work, and [illegible] with an English company to [illegible] Pumps at Cherbine, which would have

struction, including width of spans, were to be left for the approval of the Board of Trade, as they did not wish the navigation to be interfered with more than was necessary to carry out the scheme.

The Barrmill and Kilwinning Railway Bill was the next taken. This is a measure supported by the Caledonian Railway Company, who, by it, will obtain independent access to Kilbirnie, Irvine, Ardeer, and Ardrossan, and will thus be able to compete with the Glasgow and South-Western Company for the important traffic derived from the manufacturies and other industries located in this district. Competition is the only plea for the construction of this line, for a large portion of it, that between Kilwinning and Ardrossan and Irvine, is situate alongside, and not half a mile from the existing lines of the last-named company. The Committee have stated that they do not wish to hear any great amount of evidence in favour of the scheme from the localities which it will accommodate, as it is obvious that every one, not prejudicially affected, would be willing to give evidence on behalf of additional railway facilities, wherever proposed; they therefore desired the promoters to address themselves more particularly to that part of the question relating to the construction of the docks at Ardrossan, to which the proposed line would have access, the execution of which, it was stated, depended upon the success of the application, and asked for evidence for and against the feasibility of those works, and the sufficiency of the estimates.

The Committee, of which Lord Romilly is chairman, have passed the London, Tilbury, and Southend Railway Bill, for the acquisition of lands in Whitechapel, for the formation of a goods station; the Metropolitan Railway Bill, for the deviation of certain portions of their authorised Harrow and Rickmansworth line; the Metropolitan District Railway Bill for the construction of [illegible], according to foot passengers from their South[illegible]tion to the [illegible] vitriol."

Mr. "The eminent chemist, Dr. Prout, exposed water in a drawing-room in which gas was burnt, and found that it absorbed sufficient of these vitriolic emanations to redden blue litmus, and show the presence of free sulphuric acid. The fumes from gas will, indeed, in the long run, discolour every sort of fabric, rust metals, rot gutta-percha, and reduce leather (as in the binding of books) to a scarcely coherent powder with a strongly acid taste. The late Dr. Lethoby, in an able report on the coal gas supplied to the City of London, gives numerous instances of the destructive effects of these products of gas lighting. Enormous damage has been done to the binding of the books in the libraries of the Athenæum Club, the London Institution, and the Royal College of Surgeons. In the first-named, wherever the books had been exposed to the atmosphere containing the vapours of burnt gas, they were as rotten as tinder; indeed, it often happened that the covers gave way in attempting to remove a book from its place on the shelf. . . . The librarian of the Newcastle Literary and Philosophical Society wrote that a book which had been missing for thirty-six years was sound and good when recovered, while the leather on the books in the same binding which had fitted over the library had been utterly [illegible]. A gallon of water wrote that the [illegible] from the gas that is burned [illegible] water is so corrosive from the presence of sulphuric acid that it attacks all kinds of metal fittings with which it comes into contact, and thereby acquires a metallic impregnation of copper and iron. Drapers know to their cost how the edges of pieces of dyed fabrics become faded and rotten when kept long on the upper shelves of gas-lighted shops; no plant will grow in a room where gas is burning, and cut flowers quickly wither; while those who work long and habitually in close gas-lighted rooms become blanched and sickly."

It is for the above reason, as well as for its freedom from fire risks, that the electric light has been introduced into the library of the British Museum. The large "arc" light is employed [illegible], but the smaller incandescence light is still adapted for interiors. This is a light which [illegible] oxygen, gives off no carbonic acid or [illegible] sulphuric acid whatever, and only [illegible] which is given off by gas, oil, [illegible] the experiments of M. [illegible]

able, engineers, as a rule, had not attempted to appropriate such spaces. Furthermore, Parliament having become alarmed at the ugliness of some railway structures, such as the bridges on the Charing Cross line and the station building at its terminus, had in 1868 specially considered the question of railway structures in connection with the architectural features of surrounding buildings, and clauses were inserted in the Metropolitan District Company's Act of 1869 requiring them to make the station at Charing Cross of a design in harmony with the buildings which might be erected in the neighbourhood. As nothing was then decided as to these buildings, the station was constructed in the plainest and cheapest manner, so that it could be rebuilt in the approved style, when that was decided on, with the least possible outlay. If such a piece of vandalism as that now proposed had been suggested in London or Edinburgh, there is no doubt but that it would have been summarily rejected. Notwithstanding all that was urged against the scheme the Committee passed the Bill, doubtless feeling that the matter was one of urgency, and the necessary delay of a year in order to bring in an amended project, would be very prejudicial to public interests.

The Dore and Chinley Railway Bill for the construction of a line between the Sheffield and Chesterfield and the Manchester and Buxton lines of the Midland Railway Company, and which has been specially supported by that company, has been passed by Lord Milltown's Committee.

The Metropolitan District Railways Ventilators Bill has been compromised by an arrangement having been come to by which the ventilators in the roadway in [illegible], as well as be closed and [illegible] Tidy's table, has been in the direction of greater purity with the finer medium employed. The last step reaches to absolute purity, and is unquestionably the light of the future, if for no other reason than this. On the score of health alone, as we have endeavoured to show, its introduction ought to be hastened as much as possible, nor should it be only the luxury of the rich, as a famous electrician, recently deceased, proclaimed it, but the necessity of the poor. Where purity and brightness are most needed, there purity and brightness should first come.

INTERNATIONAL FORESTRY EXHIBITION IN EDINBURGH.

ON Tuesday of the present week there was formally opened in Edinburgh an International Forestry Exhibition, which is not only quite unique and novel in its way, but is the first exhibition of the kind that has ever been held in any part of the world. It is the first outcome in that direction that has resulted from the very laudable desire manifested in recent years to specialise, rather than attempt to cover and illustrate all the departments of human industry when holding exhibitions, to mark the progress made from time to time in the arts and manufactures. A very general opinion now prevails that the days of universal [illegible] are coming to an end, and attempts made by public exhibitions of late years to show what new developments had taken place in the technical arts, have been of a special character.

The Forestry Exhibition, which has just been opened in the northern metropolis, is practically the creation of the Scottish Arboricultural Society, whose existence extends over a comparatively short period, but which has done good work since it came into being. The Marquis of Lothian, who is the President of the Society, has for many years been an acknowledged authority on all matters relating to arboriculture, and it was in his capacity as President that he, a few years ago, opened the proceedings of the Society's annual meeting with a long and elaborate address on the state of arboriculture in this and other countries. When the movement originated for holding the International Forestry Exhibition, Lord Lothian, with the unanimous consent of all interested in the proposal, was appointed President of the Executive Committee, and from the very outset he devoted much of his time, both in Scotland and in England, towards rendering the movement a great success.

Although the first idea of the Forestry Exhibition originated amongst the members of the Scottish Arboricultural Society, the work of arrangement was divided over a number of other bodies, more especially the Town Council of Edinburgh, which has been in the direction of [illegible]. The first part of the lowering, however, is accomplished by means of the pitch chain already mentioned, which is connected to powerful crab winches on the deck of the pontoon. These winches, together with a centrifugal pump and several surging-heads, are driven by a 14 nominal horse-power engine.

The foundation for the blocks is prepared first by dredging, the excavation being subsequently completed and the bottom very carefully levelled by means of a large diving-bell (see Fig. 2), which is also of special construction and consists of a cast-iron chamber 20 ft. square and 6 ft. 6 in. inside height, with a vertical tube and air lock. The bell or chamber is suspended from a suitable shears placed on an iron float containing the engine, air-pumps, winches, &c. With a diving chamber of this description, the bottom—which, when ready for the block is about 26 ft. below low water, and has an area of about 250 square feet—can be levelled with the great accuracy absolutely necessary for the satisfactory setting of such large blocks in quay walls where irregularities in the face are inadmissible.

With the aid of the special appliances above described, an average of 400 lineal feet of blocks can be laid in still water per year, which is equivalent to 6500 cubic yards, or allowing 300 working days to the year, about 22 cubic yards per day. The actual progress has been somewhat less (about 364 lineal feet per annum) owing to slight interruptions of various kinds.

The cost of the special plant required for the

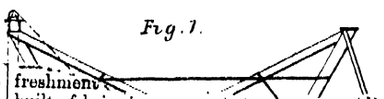


Fig. 1.

[illegible] freshment [illegible] built of brisaving corrugated iron roofs. All the cooking done by means of gas, so as to minimise from fire. Exit from the buildings to the surr[illegible] grounds is abundantly provided for; and th[illegible] and sanitary arrangements have been well a[illegible]to. Several acres of the surrounding [illegible]ave been allotted to nurserymen and others, display of specimen trees, and for other p[illegible] In one of the covered annexes there are[illegible] some excellent examples of wood-wor[illegible]inery, by Scotch and English makers, [illegible]ailing which we shall have something to [illegible]detail on another occasion. Altogether, t[illegible]e the buildings, decorations, &c., will pro[illegible]e considerably over 5000*l.*; and the Ex[illegible]is to remain open during three months. [illegible] amount of floor space provided within [illegible]ese buildings is upwards of 73,000 square f[illegible]

Within [illegible]buildings there will eventually be brought [illegible]r a remarkable display of forest products, [illegible]er with multifarious illustrations of the grow[illegible] management of forests, and an endless v[illegible] of objects in one way or another connected [illegible] forestry and arboriculture, in their scientific a[illegible]mmercial or manufacturing relations. From the [illegible]utset of the undertaking the promoters re[illegible]cordial Government support with the active [illegible]ance of the Colonial Governments and those [illegible] foreign countries as might feel interested in [illegible]jects aimed at by the Exhibition. The invitat[illegible]r such assistance was responded to in the most [illegible]ying manner; for, though some foreign Gov[illegible]nts were, from various reasons, unable to ta[illegible]ve part in the Exhibition, others joined with [illegible]olonial authorities in forwarding representative [illegible]ections; while from various states that have not[illegible]rwise put in appearance, there have generally [illegible] received maps and other publications relating [illegible] their respective forest services, with the intima[illegible] in some cases, that a commissioner had been [illegible]ointed to attend. Officially it is stated that t[illegible] are Government exhibits from about fifty fore[illegible]countries and colonies, and something like 5[illegible]ivate exhibitors.

Latterly, by dir[illegible] very great energy on the part of the Executive [illegible]mmittee and their officials, remarkable progre[illegible]as been made in the way of completing the in[illegible]al arrangements and getting the endless variety [illegible] exhibits into position for the inspection of visitor[illegible]ut on the opening day there were many gaps t[illegible] had still to be filled up, notably a very large [illegible]ount of space set apart for the Japanese collecti[illegible] which is expected to be one of the most attractive[illegible] the Exhibition. It is only within the past few[illegible]ays that it has arrived in

THE STRONGEST OF THE BRONZES.

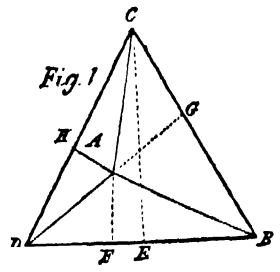


Fig. 1

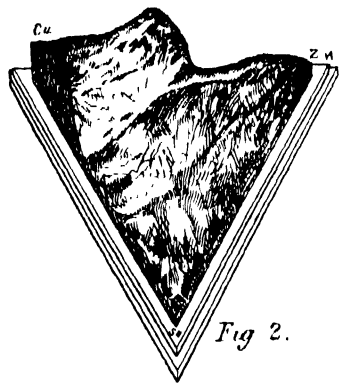
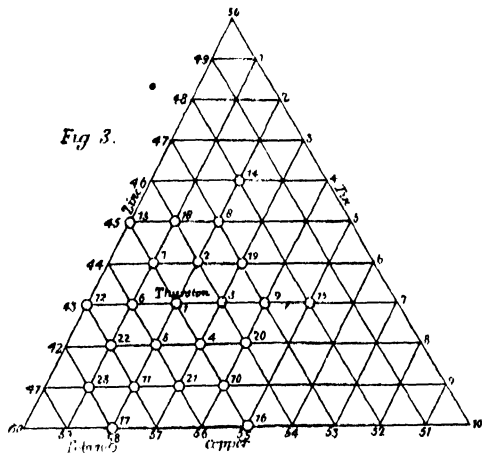
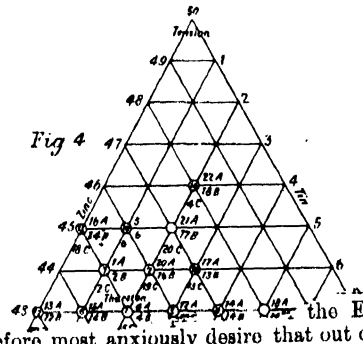
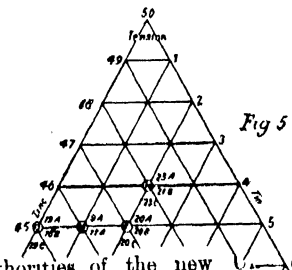
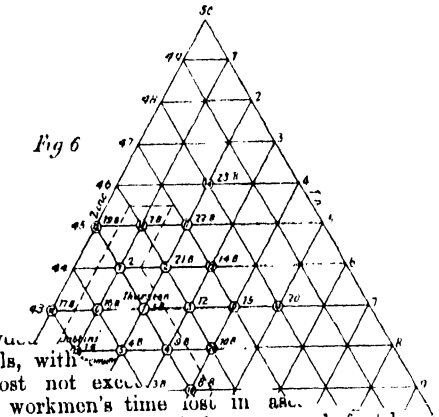


Fig 2.


Fig 3.


Fig 4


Fig 5


Fig 6

knowledge the Exhibition therefore most anxiously desire that out of it may come a school of forestry, and quite naturally they confidently look forward to it being located in Edinburgh. In that city there is a famous Botanical Gardens, in addition to the Arboretum, on which the Corporation have spent about 20,000*l.*, and have placed it at the disposal of the Government for the purpose of improving the education of their students. Besides this, there are varied and extensive forests within reasonable distance of the Scottish metropolis where practical instruction can be obtained by way of illustrating the principles laid down in professional and systematic lectures given in the class room. This country ought certainly to be able to train its own foresters for work in any part of the world, and the Forestry Exhibition now being held in Edinburgh will have done good service if it help to bring the necessity for such technical training home to the public mind.

A NEW TECHNICAL UNIVERSITY.

It is not a mere rhetorical statement to say that June 25, 1884, will be an important date in the development of our manufactures and industries. Other nations have made abundant provision for supplying that technical instruction, without which trades and industries must languish and remain in a perennial state of inferiority. For years we have been complaining of the want of refined skill, and even of the gross inaptitude of the higher orders of our artisan class. To get many things well done, we have had to send abroad, to France or Germany, where the services of skilled workmen could be easily secured. This was neither creditable nor nationally advantageous. It was, indeed, time to make an effort, on a suitable scale, to retrieve our position, to instruct our carvers, builders, architects, decorative artists, and those who may have the superintendence of our manufacturing works, and by such means to react powerfully upon the arts and manufactures of the country. This step has, at last, been taken; and, thanks to the munificence of the various City guilds, His Royal Highness the Prince of Wales was able to open on Wednesday, June 25, our first Technical University.

This Institution is situated in Exhibition-road, South Kensington, and thus enjoys the numerous advantages arising from close proximity to the Natural History and South Kensington Museums. The plans were prepared by Mr. Alfred Waterhouse, and the building was erected under his superintendence. The experience acquired in the erection of science schools and university colleges in several parts of the country, has here been turned to good account, and every effort seems to have been made to render thoroughly efficient the teaching of the authorities of the new [illegible] not only made their fees very moderate, but also had the excellent idea of coming to the help of a class of men who are an important factor in the diffusion of knowledge, viz., technical teachers; and we are glad to learn that it is proposed to offer them gratuitous courses, during the summer months, on subjects connected with technology.

The director of the Institution is Mr. Philip Magnus. His large experience as a teacher and the varied and valuable knowledge acquired abroad as a member of the Royal Commission on Technical Education, eminently qualify him for the responsible office to which he has been appointed. We have no misgivings about the successful *début* and the prosperity of the Institution, knowing, as we do, his skill, tact, and administrative ability. It is expected that the University will be ready for the reception of students in January next.

PRIVATE BILL LEGISLATION.

In the House of Lords, the first Railway Bill considered by the Committee of which Lord Camperdown is chairman, was that of the Stockton Carrs. This was promoted independently to construct from the Murray siding of the North-Eastern Railway, a single line 14 chains in length to the Stockton Carrs, a piece of land about 40 acres in extent having a frontage of about three-quarters of a mile to the River Tees. Upon this are situated a bone mill, an oil mill, and a large flour mill, together with other industries; at present there is no railway access to their works, which necessitates a large outlay in the cartage of materials and products.

This scheme, insignificant in itself, the total cost being under 5000*l.*, gave rise to considerable opposition, because it was proposed to cross on the level, Railway and Trafalgar-streets in South Stockton, along which at various times of the day large numbers of workmen and others pass. Messrs. Head, Wrightson, and Co., who have extensive iron works in close proximity to the crossing of Trafalgar-street, and whose workmen would be most affected, petitioned against the Bill, but their *locus standi* was refused by the referees in the Commons, as it was alleged that no portion of their land was included within the limits of deviation. Notwithstanding this reverse, they organised an opposition upon the third reading of the Bill, which, however, was carried by a small majority, but during which a very acrimonious debate arose because it was alleged that the member for Stockton had issued a circular requesting the members of the House to support this measure in which he through his son and partner, the solicitor of the Bill, was personally interested.

The promoters not having raised any objection in this House to the *locus standi* of the petitioners, the Bill came before a Committee on opposed Bills, and crowded [illegible] meals, with [illegible] a cost not exceeding [illegible] the workmen's time lost in ascending the steps of the proposed foot-bridge, these level crossings could be altogether dispensed with. To carry this out it would be necessary that the line should ascend with a gradient of 1 in 40, a common one in this district, from the junction with the Murray siding to Railway-street, thence run level to Trafalgar-street, crossing both streets by bridges having special floors to admit of shallow construction. The line would then descend with a gradient of 1 in 40 to the level of the Carrs. The only difference between this and the original proposal, would thus be the substitution of a rising and falling gradient of 1 in 40, for gradients of 1 in 50 and 1 in 110, both falling. Should a truck break away on the suggested line it would only run into a blind siding, and no ill effect would result beyond its possible destruction. As the additional cost of the proposed alteration would not exceed 1500*l.*, he considered that the line, as proposed, ought not to be sanctioned. After hearing the whole case the Committee rejected the Bill.

The two following Bills—that of the Midland Railway and the Sutton and Willoughby Railway—were quickly disposed of, the Committee disallowing the *locus standi* of the petitioners against them in both cases.

In continuation of the proceedings on the Manchester, Sheffield, and Lincolnshire Railway (Chester to Connah's Quay) Bill, the opponents representing the city of Chester and others interested in the navigation of the River Dee, called engineers and a large number of nautical witnesses to speak to the obstruction, which the proposed structure would cause to the free passage of the river, and the dangerous effects which it might have upon the shipping. The experience derived from the construction of the Skelton and Keadby Bridge, were again referred to at length. The opposing railway companies confined their evidence to showing that the existing lines in their hands were as convenient and direct as those proposed, and could easily be made available for all the traffic which the latter are designed to accommodate, and that through-rates might be arranged on a satisfactory basis, if there was sufficient traffic to make them reasonable. Without waiting for the reply of [illegible] of the promoters, the Committee [illegible] and, on re-entry of the [illegible] they had arrived at the [illegible] proceed, but that [illegible] struction of the [illegible] while retaining [illegible] recently [illegible] with an English company to [illegible] Abbas at Cherbine, which would have

an upright wire was erec at each of the spots corresponding to the alloys tested. The altitude of each wire was made proportional to the strength of the alloy, and there was thus produced a forest of wires, the tops of which were at elevations above the base plane proportional to the strength of the alloys studied. Similar constructions could be made to represent the elasticity, the ductility, or other property of these alloys. The spaces between the verticals were filled in with plaster, and carefully moulded until the tops of the wires were just visible as shining points in the smooth surface of the model. This was then used as a pattern, and a metal casting made from it of the form shown in Fig. 2.

It is evident at a glance that the alloys of maximum strength lie by the peak of the mountain seen on the furthest or zinc-copper side of the triangle, and it was there that Professor Thurston found what he denominated "the strongest of the bronzes."

Mr. Jobbins took up the inquiry at the point where Professor Thurston left it, taking as his field of investigation the small triangular portion surrounding the peak of the mountain, as it was found that this area embraced all that portion of the field in which the most tenacious alloys had hitherto been discovered. The data obtained from this investigation prove the correctness of this decision, for, though there was found a wide range in the values obtained from the different specimens, yet they all gave exceedingly high figures, the lowest average tenacity being 51,137 lb. As this research extended over but a very limited area, it was possible to conduct the investigation with a much greater degree of exactitude than had been attempted before; and subsequent researches, covering a still smaller field, should settle beyond dispute the composition of the strongest of the bronzes. Probably this trial accomplishes that result.

The metals varied by differences of one per cent. in each case, and twenty-three combinations were chosen; two test-pieces were made of each composition, making forty-six tests in all. In the majority of cases the data obtained from the two specimens of the same composition agreed so closely that the average value was safely made use of; but when there was any marked difference the data agreeing more closely with the results anticipated from analogy were adopted, and the other values rejected as probably erroneous. Had there been time for a chemical analysis each specimen would have been treated separately, whenever the analysis revealed any considerable difference of composition. The copper employed was Lake Superior; the zinc, Bergen Port; and the tin was phosphor-tin from Messrs. Alfred Barber and Co., of Hamburg. The following limits for the field of operation were selected: Copper, maximum 60; minimum 50; zinc, 48 and 38; tin, 5 and 0. These limits include the "Tobin alloy," and also the one Professor Thurston found to be the strongest. Twenty-three alloys were chosen of the compositions given in the following Table:

TABLE I.—*Proportion of Selected Alloys.*

No	Cu.	Zn.	Sn.	No.	Cu.	Zn.	Sn.
1	55	43	2	13	55	45	0
2	54	44	2	14	52	46	2
3	54	43	3	15	52	43	5
4	55	42	3	16	55	40	5
5	56	42	2	17	58	40	2
6	56	43	1	18	54	45	1
7	55	44	1	19	53	44	3
8	53	45	2	20	54	42	4
9	53	43	4	21	56	41	3
10	55	41	4	22	57	42	1
11	57	41	2	23	58	41	1
12	57	43	0				

The total weight of each test-piece was 1.45 lb., and the castings were made in an iron mould 8 in. long by 1 square inch cross section. A mixture of plumbago and water was employed as a "blacking" for the interior of the mould to prevent the castings from adhering. The copper was first placed in the crucible, and was then covered with powdered charcoal to prevent contact with the air and oxidation of the molten metal. After the copper melted its temperature was raised, so that the zinc was added partial solidification occur. Great care was taken in introthe metal being carefully wrapped its being acted on by heat or introduced beneath the The molten metals were thoroughly stirred and the crucible removed from the furnace, after which the tin was added with the same precautions, and after another stirring the metal was poured into the mould, which had been previously heated. The casting was then cooled as rapidly as possible. The pieces were then tested in Thurston's autographic recording testing machine, and the figures deduced from the curves obtained. The machine measured the torsional strength of the specimens and from them the torsional strength was deduced by a formula, the following Table giving the results:

TABLE II.—*Strength of Copper, Tin, and Zinc Alloys.*

No.	Foot-Pounds. Stress in Torsion.		Pounds per Square Inch. Approximate Stress in Tension.		Angles.	
	Ultimate M.	Average.	Ultimate T.	Average.	θ_e. deg.	θ_r. deg.
1 A	270.208	261.065	77309.5	74805.6	1.5	43
1 B	251.922		72301.6		1	40
2 A	178.321	193.361	53940.3	50653.6	1.1	5.05
2 B	208.400		59810.8		0.7	40
3 A	251.922	235.920	75576.6	70778.6	1	13.77
3 B	219.935		65980.5		1	10
4 A	243.892	250.851	78017.6	73065.1	2	19.8
4 B	258.319		74012.5		2	30.3
5 A	268.881	266.212	75824.4	75467.1	4.6	55
5 B	263.543		75109.8		2	46
6 A	227.689	224.151	64208 3	63700.9	2.5	53.3
6 B	220.612		63196.6		2	42.1
7 A	286.847	268.851	80910.9	75826.0	2	54
7 B	250.855		70741.1		2	53
8 A	194.634	189.488	58390.2	56844.8	2	9.1
8 B	184.331		55299.3		2.69	5.72
9 A	222.853	226.725	66853.9	68017.5	1.5	5.78
9 B	230.597		69179.1		1.79	4.5
10 A	249.014	250.948	74704.4	75284.4	2.1	4.6
10 B	252.881		75864.3		2.8	8.8
11 A	260.645	249.014	74629.2	60116.8	2.4	39.8
11 B	237.382		63964.3		1.9	35
12 A	227.689	234.474	61020 7	61390.5	2.3	95.2
12 B	241.259		61762.3		1.6	131.4
13 A	227.689	217.996	64208.4	61058.3	2	52.4
13 B	208.303		57908.2		1.1	65
14 A	163.715	170.450	49113.5	51139.5	2.3	4.9
14 B	177.185		53165.5		2	7.2
15 A	189.886	208.788	56965.8	62636.3	2.6	4
15 B	227.689		68306.7		2	5
16 A	225.760	239.074	67725.5	71842.2	1.6	3.8
16 B	253.198		75959.4		1.6	6.8
17 A	227.689	238.771	68200.3	68344.8	1.4	54
17 B	250.952		73488.3		1.8	43.2
18 A	254.829	259.737	72871.1	72186.5	1.6	43.4
18 B	260.645		71501.9		1.8	54
19 A	231.566	214.119	69459.8	64230.6	2.2	8
19 B	196.671		59001.3		1.4	4.8
20 A	220.628	244.168	66888.4	73250.3	1.6	6 4
20 B	268.707		77612.1		1.8	7.2
21 A	283.908	260.708	81381.6	75135.0	2.9	38
21 B	220.628		0888.4		2.4	8
22 A	305.233	263.508	85770.5	73338.6	2	56
22 B	221.773		60986.6		2.5	76
23 A	225.760	200.499	63084.3	54061.4	1.6	63
23 B	175.247		45038.5		1.2	128

θ_e = the elastic angular limit; θ_r = the angle at rupture.

From these tabulated results, and by comparison of the general characteristics of the test-pieces, Mr. Jobbins has determined the position of the strongest alloys very approximately. Later investigations may, to a very slight extent, change the position of the strongest alloy. Fig. 3 is an enlarged view of a portion of the field shown in Fig. 2, with the positions of the alloys that were tested marked upon it, the numbers corresponding to those in the Table. Fig. 4 is based entirely upon the results obtained by the torsion tests, and Fig. 5 exhibits the tensile strengths of the specimens. Fig. 6 gives the positions of the alloys as determined by a study of Figs. 4 and 5, and the general characteristics of the test-pieces.

In Figs. 4 and 5 the alloys are arranged in three different series: 1. According the average value for torsional moment and tenacity (M and T); these are marked A. This series would be correct if both castings of each specimen were alike, a point which chemical analysis alone can settle beyond doubt. 2. According to highest values of M and T; these are marked B. This series was arranged on the supposition that the lesser values were given by poor castings, and did not represent the true strength of the alloys. 3. After a careful scrutiny of Table II. it will be noticed that the values of M and T obtained for both specimens in each alloy, in some cases agree very closely; when this was the case the average values were taken. In other cases the differences were very large; under such circumstances the higher values were used. From these two classes the third series was formed; thus it will be seen that this series is, in reality, a combination of the second and third. This series is marked C. Fig. 6 was formed from a careful study of Figs. 4 and 5. It will be thus understood that it was a matter of some difficulty to decide satisfactorily as to the relative positions of these alloys.

The first step was to determine which alloy was entitled to the first position; there were two rivals for it, Nos. 7 and 22. The first was a fine alloy with a smooth even fracture, whose surfaces presented a tough fibrous appearance, and which twisted apart slowly and evenly. The second, No. 22, was golden in colour, very close grained, and gave a fracture similar to No. 7. When the average values of M and T were used (Figs. 4 and 5) No. 7 stood first on the list, and No. 22 third and seventh, while in each case when the higher values were taken No. 22 was first and No. 7 second and third. After consideration, the average values were taken for No. 7. In the case of No. 22 one of the specimens appeared to have suffered from volatilisation or some other cause in casting, and was rejected, the other being adopted as the true specimen. As its values were by far the highest obtained, it must be considered the strongest alloy, while No. 7 stands the second.

The next upon the list is No. 21. In this case the values of one specimen only were considered as the second casting was defective. No. 5 ranked as the fourth, and would probably give still better results; the bars showed signs of liquation. No. 1 was a tough metal, the pieces being twisted apart slowly, not snapping suddenly. This was the strongest alloy reported by Professor Thurston to the American Society of Civil Engineers, as mentioned above. After a careful study of the field the conclusion was reached that all within it was empirical. Though No. 22 was the strongest alloy, yet for practical purposes it would always be better and safer to try to obtain an alloy of the composition of No. 5; for a slight change in its constituents would not be likely to produce a defective metal; while No. 22 stands upon the edge of the field, and a very slight change in composition might make a very great change in strength. Therefore in conclusion, No. 22 is Professor Thurston's "strongest of the bronzes," and No. 5 is the best for practical purposes. These two alloys are respectively copper 57, zinc 42, tin 1; and copper 56 zinc 42, tin 2.

BATCHELOR'S MOTION DRAWINGS.

IN the machinery in motion department and also in the Water Companies' Pavilion at the Health Exhibition, Messrs. H. and T. C. Batchelor, of West Kensington, show some very beautifully executed motion drawings. In our notice of the North-East Coast Exhibition, held at Tynemouth two years, ago,* we described the work of Messrs. Batchelor, and pointed out the great value that such moving drawings as those exhibited would be likely to have in spreading scientific knowledge in connexion with the working parts of steam and other machinery.

The principal of the drawings shown at South Kensington are those of the P. and O. Companys' s.s. Ravenna, which was built and engined by Messrs. W. Denny Brothers and Co., of Dumbarton. The model of this fine vessel is shown in the Exhibition at the exhibit of the Shipwrights' Company in "Old London." In the moving drawings exhibited by Messrs. Batchelor, a longitudinal section and transverse section of the engines are given. In these two drawings the relative movements of the cranks, pistons, and slide valve, can be traced throughout. In fact a complete graphic illustration of the relative positions of the working parts of the engines at any part of the stroke can be obtained.

The difficulty of showing the movement of the cranks and eccentrics in a longitudinal view, is got over in an ingenious manner by making the webs of the cranks and the eccentric straps double

* See ENGINEERING, September 15. 1882.

so that one part slides over the other. The illusion is complete, and no doubt many people go away under the impression that the cranks are actually revolving. The cross section affords an accurate representation of the relative motions of crank, connecting rod, eccentrics and link motion, air and feed pump, and levers and links, by which they are worked. It also clearly shows the horizontal motion of the expansion valve by which the cut-off is obtained. The Ravenna, it may be remembered, has a diagonal ported expansion valve, such as Messrs. Denny adopt. In the drawing the cut-off can be adjusted to any desired point. Brown's starting gear with which the engines are fitted, is shown although it is not made workable, but in another very fine example of this art which we lately inspected and which represents the engines of H. M. S. Etna, built by Messrs. Hawthorn and Co., the starting gear is made to act. This latter drawing is now at the Turin Exhibition.

Another drawing shown at South Kensington is that of a longitudinal section of the s.s. Grecian Monarch, which is made to a scale one-eighth full size. This is a more simple design than that of the Ravenna's engines, as there is no expansion valve. A transverse section of the pair of tandem engines of the s.s. Rialto is also shown on this stand. This was made in May, 1879, and has received considerable rough usage at times, having travelled a good deal about the country. The drawing itself is perhaps not so bright as the others, but the working appears to be as true as when it was put together, for no lost motion can be seen in passing centres as would be the case if the working parts had become worn.

Another interesting specimen of this work is the moving drawing of the London, Brighton, and South Coast Railway Company's locomotive "Gladstone," designed by Mr. William Stroudley, the locomotive superintendent for the express passenger traffic. This drawing is exhibited in order to give an example of what would be suitable for technical schools and colleges. In this case the same amount of artistic finish in the matter of colouring, &c., has not been expended on the work as in the Ravenna's drawings, which are indeed very fine specimens of the draughtsman's art. No sacrifice, however, has been made in the accuracy of the working parts, or of the care with which the scale has been preserved. The remaining drawing on this stand is that of one of the feathering paddle wheels Messrs. John Elder and Co. fitted to the Queenborough and Flushing boats, the Prinses Elizabeth and Prinses Marie, which we illustrated very fully at page 218 of volume xxxi. The geometry of the mechanism can be fully traced by this moving drawing.

In the Water Companies' Pavilion another example of this work is exhibited. It consists of the drawing of a 150 horse-power compound beam engine which has been built and erected by Messrs. Simpson and Co., of Pimlico, at the Hammersmith Station of the West Middlesex Water Company. The valve motion is of great interest, and is shown in operation. There are expansion valves on both cylinders, and the exhaust from the low-pressure cylinder is effected by independent valves worked by a cam motion from the eccentrics, through a series of rods and levers. This involves a complex series of joints and working parts, and the success with which the motion is produced on the face of the drawing well illustrates the accuracy of the work.

There is no doubt that the ingenious system that has been devised by Messrs. Batchelor is one of importance, not only to engineers, but to students and lecturers on scientific subjects requiring graphic illustration. The cost of these drawings is less than that charged for a model made in metal to scale with anything approaching accuracy, and in addition to this the idea is better conveyed by the plane surfaces employed than it would be by ordinary models. The great durability of the drawings shows that there is very little wear in the moving parts.

THE INTERNATIONAL HEALTH EXHIBITION.

MR. SAMUEL C. DEAN shows examples of a "sewer gas cremator" called the "Parcœan." It consists of a light sheet iron or earthenware cylindrical casing, the upper part of which is filled with asbestos or some other refractory material. This is kept at a temperature of about 500 deg. by a gas jet. The escaping air or gas from the sewer is filtered through the asbestos and in this way any infectious germs there may be in it are destroyed. A fine wire gauze is placed at the top and bottom of the apparatus, the latter to guard against mishap in the event of there being an accumulation of explosive gas in the sewer. The apparatus may be used as a roof ventilator for hospitals and in chemical works for destroying effluvia, although in the latter case the filtering matter may require to be heated to a higher temperature. It is said that a Parcœan 2 ft. high and 9 in. in diameter will disinfect over 20,000 cubic feet of air per day. On this stand is also shown a drawing of a system of filtration introduced by Mr. Dean. It is used for potable waters or sewage effluent. The water flows through a grid of perforated pipes, on which is placed a layer of filtering carbon. This is a patented composition and consists of 500 lb. of coal, 56 lb. of clay, 20 lb. of tan, 5 lb. of marine shells, ½ lb. borax, or 4 lb. of soda. These are ground together and carbonised in a gas retort, and the gas so produced may be used for ordinary heating purposes. A certain quantity of air is forced into the perforated pipes by power and is mixed with the water. Water filtered in the ordinary way becomes flat and stale by loss of oxygen. This is prevented in the present case by mixing air with the water as it is being filtered. Mr. Dean states that 2,500,000 gallons of water can be filtered daily by his process on an area of 500 square yards.

Messrs. Bailey and Co., of Fulham, show gullies and fat traps of various kinds. Mr. Charles Hawksley, of St. George-street, shows a simple method of testing drains. Suitable adjustable plugs are inserted at untrapped openings, and the whole system to be tested is put under air pressure. Any leakage is shown by means of a syphon gauge. The pressure at which the syphons are forced can also be shown in this way. The plugs are made adjustable by placing a disc of india-rubber between two discs of wood. These are brought together by a screw, and the india-rubber is thus squeezed out to fill the pipe. The system is being supplied by Mr. W. Buckridge, Leinster-street, S.W., Mr. Hawksley merely exhibiting on public grounds. Messrs. Houghton and Co., of Sloane-terrace, show an improved gully which also forms an area drain; a stable gully and interceptor for solids of new design, which has a movable iron pot with a grating for straining off liquid; and a fat interceptor for scullery sinks, all three contrivances simple and effective.

Major Francis H. Noot shows a patent drain pipe, wherein the novelty lies in the junction. The socket only extends half round the diameter of each pipe, the corresponding half being on the adjoining pipe. The arrangement allows of ready inspection by removal of one length. The question, however, may occur whether the continuity of a drain formed in this way might not be too easily broken. Messrs. John Watts and Co., of Bristol, show examples of a patent asphyxiator, which apparently consists of a small centrifugal fan with a smoke generating vessel attached. The smoke test for drains is of the greatest use, and has often been successfully applied. Mr. W. Batten, of Birmingham, shows his patent manhole covers and ventilators for sewers, mention of which was made in our number of January 16, 1880. Since that date a few alterations have been effected, a catch being now provided in place of the drawbar formerly used. In these ventilating covers any solid matter falling through is caught in suitable receptacles, and can be removed either by a tool provided, or by taking out the receptacle according to the arrangement. The method is simple and effective. Messrs. J. Stiff and Sons, of Lambeth, have a good collection of sanitary appliances of various kinds. The Patent Victoria Stone Company also show examples of their special manufacture in the shape of paving, slabs, vases, ornamental work, &c. This paving is laid down in the entrance hall and other parts of the Exhibition. Messrs. Bird and Co., of Great Castle-street, show sanitary fittings of various kinds in iron. The Birmingham Sanitary Association show Potts' patent air chamber sewer trap, by means of which the drains are ventilated and trapped at the same time. A useful lavatory in which the basin is filled by a treadle on which the user stands, is also shown. By means of an ingenious special valve, the water flows until the basin is full and by stepping off the treadle, or footboard, the basin is emptied and an after flush given. The valve is also applied to closets. Mr. John Hewes, of Leicester, shows a model of a "cremator" for disposing of sewage, and at the same time making gas. The refuse matter is introduced into a series of vertical pipes which pass through a furnace. The gas generated can be used for heating purposes and the remaining ash is manufactured into deodorising powder, boiler incrustation solvents, and other articles.

The London Sanitary Protection Association has a most instructive exhibit consisting of a series of "awful examples" in the shape of defective plumbing work and sanitary—or rather unsanitary—appliances. If such fittings are as common as they are reputed to be, it is difficult to imagine how London has escaped being decimated by the many diseases which doctors and sanitarians tell us lurk in the vast network of drains and sewers under our feet. The collection is well worth a visit, and will no doubt have the much to be desired effect of inducing householders to join the association, and thus get protection at a really nominal rate against the dangers of the sewers. Mr. J. W. Cockrill, borough surveyor of Great Yarmouth, shows a pipe sewer junction block, a very desirable appliance for making a connexion between pipe sewers. The inscription on this exhibit is worth quoting: "Great difficulty is experienced in forming proper connexions with pipe sewers. If the pipes are removed to insert junctions the joints are disturbed, and it is nearly impossible, irrespective of cost, to make the sewer good in a proper manner; while if an ordinary pipe is cut into the sewer it is very difficult to insure a proper joint being made. In my experience seven stoppages out of ten of both sewers and lateral drains have been caused by the careless manner in which this work has been done." This block compels the lateral drain being connected at a proper angle with the sewer, and a perfectly tight joint can be made round the collar. It also prevents any projection inside the sewer.

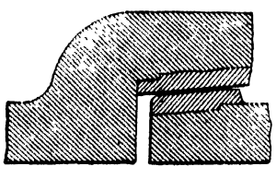
Mr. F. Newman, of Ryde, shows a drawing of a syphon with a conical enlargement to form the seating for a valve. The object is to retain water in the house drain for the purpose of testing the joints, and also for the purpose of flushing. Mr. J. C. Bothams, M.I.C.E., Salisbury, shows a model illustrating a new description of chimney top by which it is claimed that a powerful and uniform draught is obtained. Mr. Charles M. Elstob, of 109, Cheapside, exhibits drawings which illustrate a system for the ventilation of sewers by means of the street lamps. The plan has often been suggested before, but has never been received with great favour. Mr. Hugh Cregeen, of Bromley, Kent, shows an air inlet for house drains. It is arranged so that any dirt or solid matter falling through will be caught in a suitable pocket which can be cleared by opening the hinged grating. Messrs. J. Stone and Co., of Deptford, are the manufacturers. Mr. Edmund Page, of Forest Gate, Essex, exhibits an improved grease trap. This is fitted with a movable wirework grease receiver.

Messrs. George Waller and Co., of Holland-street, S.E., have a large and varied collection of sanitary appliances on their stand. Amongst other things, is an iron sunken street orderly bin for placing in a pit made beneath the pavement. Several small examples of penstocks and flushing valves are shown. These are made up to 10 ft. across, either round, square, or oval; and even larger sizes can be made especially to order. The sizes above 3 ft. in diameter have gearing and balance weights, and are fitted with brass faces and brass worms, or, if required, with brass or iron screw and close box at the back of the door instead of the worm and rack. A tide valve with copper float and brass face to be used in sewers having little fall is also shown, and also a model of a combined self-acting flushing gate and door for connecting a main sewer with a sewage tank or irrigation system. At the entrance, a grating door is fixed, and beyond this is a whole flushing door connected by a rod with a large flushing gate in the main sewer. When the sewage rises to a fixed height it acts upon a tilting apparatus, which opens the large flushing gate and closes the whole flushing door, causing the storm water to pass to the outfall. As the level of the sewage falls, the flushing gate closes and opens the flushing door again. The principles excellent arrangement for side entrance of a powerful cover is also shown, which can either be used the existing as a ventilator, or closed as may be necessary.

of Khatatbeh. The iron cover opens in the middle, took up the good work, and posed of a grating, but with an English company to of which are a number at Cherbine, which would have

these spaces. Each bar p[illegible]s in its respective space, and when it is required to close the opening entirely, the bars are raised and fit into the open parts. When it is desired to use the cover as a ventilator, the bars hang down, leaving the spaces open. The arrangement is extremely simple, but effectually answers the purpose required. Other descriptions of manhole covers and ventilators, with dirt arresters, are also shown, together with a collection of drain and gully-cleaning tools of various patterns. The spring bayonet-joint is said to be quite secure whichever way it is used. It offers little obstruction, and is a handier and better mode of attachment than the bolt-and-nut joint or screwed connexion formerly in use. Altogether Messrs. Waller and Co. have an interesting collection, but we think it a pity they had not more space allotted to them so that they might have shown some of the larger articles they manufacture, which would have been so thoroughly in place in the present Exhibition.

Mr. Henry Ough, of 16, Austin Friars, shows Stanford's patent joint for stoneware pipes. The difficulty of preserving joints water-tight in continuous lengths of drains or water conduits made from stoneware pipes is well known. The Stanford joint is made by means of casting both on the spigot and socket of the pipes, a composition made especially for the purpose. This is shaped



by accurately turned moulds, and thus an exact fit is obtained. The moulds may be either conical or spherical, and in practice, it is said, that the best results have been obtained by giving to the casting on the spigot a spherical or ball form, and making that in the socket the frustum of a cone, or plain taper. In this way the pipes can be laid to any curve within the limits of the play given, and therefore a certain amount of settlement can take place without leakage occurring. We are informed that the composition used for sewer pipes is not affected in any way by water or even hydrochloric acid, and that it will resist any heat it can possibly be subjected to in the soil. Considering the trouble that so often arises with puddled or cement joints, either through sewage or water draining through from inside, or from water percolating through from the wet subsoil, the present arrangement should prove of great benefit to sanitary engineers and builders. The ease with which these joints can be made compared to those of cement or clay, is not the least advantageous part of the system. It has been in use in many important situations for some time, and is highly spoken of by those who have had experience of it.

The North British Plumbing Company, of Upper Baker-street, N.W., exhibit a drainage system for houses in which all the parts are made of cast iron. Pipes, gullies, traps, bends, and junctions of this material are shown, together with air-tight covers and disconnecting chambers. Mr. H. King, of Clarence-place, High-street, Kensington, exhibits a model illustrating a well-drained house. He claims nothing new in that which he shows, but merely a combination of approved devices properly applied. Such exhibits as that of Mr. King are of the greatest value. By them the ordinary citizen may learn what is necessary for perfect sanitation, and also where to look for defective appliances. This is very desirable knowledge for the householder to possess, for many builders have not the same skill in these matters as Mr. King, and should not be left too much to their own devices. Messrs. Candy and Co., of 11, Queen Victoria-street, E.C., have a large collection of stoneware goods, such as pipes, grease traps, and junctions; also silt buckets, ventilators, and gas excludors. A new kind of paving [illegible] is of interest. It is known as the granite [illegible] damp-proof brick or tile, and is said to be [illegible] hardness. Examples of terra-cotta [illegible] facing bricks, architectural orna[illegible] are also exhibited. The display [illegible] fine one. Mr. R. W. [illegible]-Tees, and Paul's [illegible]ows a collection of iron sanitary appliances. The "Stockton" street sewer grate consists of a trap and dirt collector in one. Sewer gratings, trap covers, gullies, and other castings are also shown. Messrs. Joseph Cliff and Sons, of Wortley, Leeds, and King's Cross, exhibit a collection of terra-cotta, fireclay, and earthenware goods, such as white enamelled sinks, white and coloured glazed bricks, firebricks, glazed pipes, and other sanitary appliances. The white enamelled ware and enamelled bricks are worth attention from their good quality. The next exhibit is that of Messrs. H. Wadsworth and Son, of Halifax. It consists of models and full-size examples of the Wadsworth patent wheel, which has an iron hub. The models are in section, and show the arrangement of nave and spoke.

On the stand of the Imperial Stone Company, of 41, Parliament-street, S.W., the most noticeable feature is a length of sewer pipe of 3 ft. 6 in. diameter, which is made from their silicated stone composition. Examples of "Petrosilicon," as manufactured into paving slabs and bricks, sills, steps, &c., are also shown together with other articles of like nature. The "silicated stone" of this firm is composed of suitable natural stones, such as Kentish rag and granite, broken in a crusher, and then mixed with Portland cement in a special machine. The small stone and cement is cast in moulds to which are communicated a jarring motion, so as to shake the mass well together. After the slabs have been in the moulds for a day or two, they are placed in a solution of silicate of soda for about a week and the operation is complete. Pipes are made on the same general principles, but naturally the details have to be varied in process of moulding. It is said that pipes made of the silicated composition will withstand far greater pressure than those of earthenware, and the silicated material is actually benefitted by contact with sewage and the gases generated by it. The pipes are joined by cement which makes a much better joint when applied to the composition pipes than if used with the ordinary stoneware goods. Latham, in mentioning these pipes in his work on "Sanitary Engineering," says, that a 15 in. pipe with a simple ogee rebated joint luted with neat cement, carried over a ton weight suspended to it for a considerable time without failure. Another feature noticed by the same writer is, that a blow which would shatter an ordinary earthenware pipe, will simply drive a hole through the silicated concrete composition. This is a distinct disadvantage from the point of view of the general public, as it is desirable that pipes that have holes in them at all should be placed entirely beyond the possibility of use. Of course contractors think differently, and doubtless the property is a valuable one in cases where junctions have to be extemporised.

Messrs. Banner Brothers and Co., of 11, Billiter-square, have numerous exhibits illustrating the system of domestic sanitation devised by Mr. E. Gregson Banner. Amongst these are the now well-known revolving cowl, a fixed finial exhaust and down-draught ventilators. Soil pipes, grease traps, gullies, manhole iron covers with air-tight joints, and a hollow composition stone kerb are also shown. The latter is a good device for saving space in the streets, and will no doubt meet with a considerable share of success in the present day of crowded thoroughfares.

NOTES.

The Diamond Beds of Brazil.

The diamond beds of Bahia and Minas Géraës, in Brazil, are very similar in character as regards the minerals composing them and their plateau form, or situation on watercourses. A new bed has been recently opened on the Rio Pardo in Bahia, which presents some differences to those hitherto known in Brazil. The country around is low and marshy, and covered with forests. The working of these forests has led to the discovery of the diamonds, which are found in a white clay along with beds of decomposed leaves. The deposit appears of modern formation. The minerals of the clay accompanying the diamond are, according to M. Gorceux, quartz, silex, monazite, zircon, disthene, staurotede, grenat almandine, corindon, and some oxides of iron. There are no oxides of titanium, or tourmalines, as is frequently the case in diamond beds. The clay appears to be from its character and situation the débris of the granite mountains bordering on the Bahia coasts.

Verification of Weights and Measures in Scotland.

Attention has lately been directed in Scotland to a fact which is not generally known, namely, that uniformity of measure and weight is maintained in trade and manufacture by means of standards which are in the keeping of the principal local authorities, a common agreement amongst these standards being maintained by their periodical comparison with the imperial standards, which are deposited with the Government authorities. It has long been felt, however, to be both costly and inconvenient that the standards used throughout Scotland should be sent to London, when their comparison with the imperial standards might as well be effected in Scotland, and some satisfaction is now felt, therefore, that, after communication with the Standards Department, the Lord Provost of Edinburgh has been able to arrange for facilities being afforded at the offices of the Edinburgh Inspectors of Weights and Measures for such comparisons being there made by the Board of Trade officers. Since that arrangement was made the authorities of numerous counties and burghs north of the Tweed have forwarded their standards to Edinburgh, the verification of which is now being carried on under the personal supervision of the Warden of the Standards.

The Late Sir William Siemens.

The Institution of Civil Engineers has taken the initiative in a work which will meet with unanimous approval and support from members of all branches of the profession, and that has for its object the erection of a memorial to the late Sir William Siemens. The idea and the mode in which it is being carried out, are alike happy, as the one prescribes the joint action of the societies of which Sir William Siemens was so prominent and valuable a member, and the other, that the privilege of assisting in the execution of this practical mark of esteem and appreciation, shall be confined to the members of those societies. To carry out this object a meeting was held on Thursday the 28th ult., to which were invited the Councils, Vice-Presidents, and officers of the Institution of Civil Engineers, the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, and the Society of Telegraph Engineers and of Electricians. The object of this meeting was to consider what steps should be taken to give a practical form to the proposal. Sir Joseph Bazalgette, who presided, explained that a general desire had been expressed among engineers that some memorial should be raised as a recognition of the great merits and important services rendered to the profession by Sir William Siemens; and it had been ascertained that it would be agreeable to the authorities of Westminster Abbey that a window should be placed there to his memory. The cost of such a window would be between 600*l.* and 700*l.*, and in order to secure to the largest number of members of the various societies the pleasure of assisting at the work, the subscription would be limited to one guinea. An executive committee composed of the representatives of each of the five societies was then formed as follows: 1. The Institution of Civil Engineers—Sir Joseph Bazalgette, Sir Frederick Bramwell, and Mr. Woods. 2. The Institution of Mechanical Engineers—Mr. I. Lowthian Bell, Sir. Joseph Whitworth, and Sir William Armstrong. 3. The Institution of Naval Architects—The Earl of Ravensworth, Mr. Samuda, and Sir. E. J. Reed. 4. The Iron and Steel Institute—Mr. B. Samuelson, the Duke of Devonshire, and Sir H. Bessemer. 5. The Society of Telegraph Engineers and of Electricians—Professor W. G. Adam, Sir W. Thomson, and Sir F. Abel. Mr. James Forrest acts as secretary to the committee. For such an object, and carried out under such auspices, there is little doubt that the labour of this committee will be a light one, and that one of the chief difficulties they will meet with, will be connected with excess of subscriptions.

Pacific Mail Steamship Company.—The gross earnings of this company in the financial year ending April 30, 1884, amounted to 4,787,389 dols., as compared with 4,102,765 dols. in 1882-3, 4,124,715 dols. in 1881-2, and 4,402,648 dols. in 1880-1. The working expenses and fixed charges of the year ending April 30, 1884, were 3,394,418 dols., as compared with 3,190,507 dols. in 1882-3, 3,223,039 dols. in 1881-2, and 3,172,705 dols. in 1880-1. The net profits for the year ending April 30, 1884, were, accordingly, 1,393,481 dols., as compared with 912,258 dols. in 1882-3, 901,676 dols. in 1881-2, and 1,229,943 dols. in 1880-1.

THE DELTA OF THE NILE.

Notes of a Journey through the North-East Portion of the Delta of the Nile in April, 1884.*

By WILLIAM ANDERSON, M. Inst. C.E.

HAVING been commissioned to ascertain why extensive estates belonging to an English company were wholly unproductive, and, indeed, incapable of earning the Government land-tax, it is thought that the observations then made may be useful to all interested in the true welfare of Egypt. The district visited was that portion of the Delta lying between Mansoura, a large town on the Damietta Nile, and Lake Burlos, a lagoon connected with the Mediterranean, and thus quite outside the usual track of visitors. The inquiries and investigations were of a definite and practical character, and have produced a profound impression as to the state of the administration, and as to the manner in which the resources of the country are destroyed at their very origin.

The welfare of the agricultural industry, the only source of wealth in Egypt, depends mainly on the efficiency of the irrigation, the drainage, and the means of communication. It soon became apparent that the estates visited, and many thousands of acres of land around them, were suffering from startling defects in all the three conditions on which prosperity depends.

First, as regards irrigation. The portion of the Delta inspected, and, indeed, the whole Delta, is intersected by innumerable canals, some used for drainage and some for irrigation. These have been dug at various times, for the most part without reference to any general plan. They are practically devoid of proper locks or sluices for regulating the flow of the water, the method adopted being to throw banks of earth across the canals, leaving gaps of sufficient width to control the water, these gaps being regulated by stakes, planks, or lumps of mud wrapped in rice straw. Owing to the caprice, corruption, or laziness of the officials, the water in the irrigation canals is often too low to command the land, even when the Nile is high enough for the purpose, and at other times the water is allowed to pass so freely as to overflow the banks and submerge large tracts of country. In summer time, between the months of May and of August, during low Nile, many of the canals, for want of proper cleaning and maintaining at the required depth, become quite dry, and thousands of acres of summer crops, such as cotton and rice, perish for want of water. In the district visited, two-thirds of the crop was, last summer, completely lost from this cause. But even when the canals are properly cleaned out, the water is still below the land level, and every drop required for irrigation has to be raised by imperfect sakiehs, and small steam pumps. These may be seen dotting the landscape in all directions, and represent an incredible amount of human and animal labour diverted from the more legitimate work of tilling the soil. The cost of this wasteful mode of raising water is at least ten times greater than that for which the same work could be done by large Government pumping stations, or by a better management of arterial canals. This state of things is peculiarly distressing just at this time, when the number of bullocks has been greatly reduced by a formidable epidemic, so much so, that it will be impossible, this season, to cultivate even so much of the land as is capable of being worked.

In the next place, the drainage canals have been much neglected, especially at their lower ends or outfalls. They all require widening and deepening, so as to carry the drainage waters into the sandy wastes skirting the Mediterranean. The fall of the country is rapid, so that there is no difficulty in securing very efficient drainage. The neglect of the Works Department to attend to this important part of its duties injures not only the lands depending upon the public canals, but also estates such as the ones visited, which, lying on the edges, of the waste, had their own private drainage canals; for it is in vain that these are kept in proper order, when the water standing on the adjoining lands percolates through the soil, and rises in the better drained portions, bringing up with it the deleterious salts with which the whole subsoil of the Delta is more or less impregnated, so much so, that this salt may be seen lying like snow over vast areas of land. It is absolutely essential to the fertility of the land that the drainage canals should be constantly kept clear, and that there should be an unfailing supply of irrigation water all the year round, because it is only by keeping a regular wash of water from the surface downwards that the deleterious salts can be prevented from rising; but when this is done, the fertility of the soil is marvellous, and the richness of the crops is, for the most part, assured. Adjoining one of the estates was a property of 1400 acres which had been abandoned by its owner for no other reason than that the Government drainage canal was choked with mud and aquatic plants. The Government had seized the land for taxes; it had twice put up the property for sale without finding a purchaser, and, of course, had lost the revenue from the lands. A single year's taxes would have sufficed to clean out the canal. This is a particular case, respecting which definite information was obtained, but many thousands of acres of other lands were in a similar predicament, as, for example, of the 100,000 acres belonging to the village of Massara, only 12,000 acres are capable of cultivation, on account of the neglect of the drainage and want of irrigation water.

Lastly, mismanagement has practically destroyed the means of communication. The canals, if properly maintained, would be wide and deep enough to carry cargo-boats as large as those in use in England. These arteries of communication intersect the country in all directions, and yet it costs 26s. a ton to bring the produce from the estates visited, a distance of only 33 miles, to the Damietta Nile, and even that can only be achieved during the dry season, because rain makes the towing and bridle-paths impracticable. This state of things could be remedied at a most insignificant cost.

The impediments to cheap communication in a country so highly favoured with what may be termed natural roads are the following:

When the canals are cleaned, the mud is thrown up on the towing-path, and allowed to harden in the sun, without the least attempt to level it or remove it altogether from the path. The consequence is that the animals using the bank of the canal tread a bridle-path on a slope. This at all times is difficult foothold, and in wet weather, when the mud gets slippery, becomes dangerous, and even impracticable. Trees are allowed to grow between the towing-paths and the canals, so that in many places towing is impossible, and from the opposite bank trees overhang, so that the towing masts cannot pass. Naturally all these obstructions should be removed. The banks thrown across the canals for the purpose of regulating the flow of water render transhipment necessary, and in this way, in the 33 miles of canal specially visited, there were no less than four dams or weirs, necessitating four transhipments. The difference of level between the two sides of the dams is never more than a few inches. It would be very easy and inexpensive, in the tenacious soil of the Delta, to construct wooden dams, with lock gates and sluices, which would allow of the barges being locked through, and dues, which would amply cover all expenses, would be cheerfully paid, as they are in other countries. Again, no control is exercised over the cutting of the canal banks for irrigation or drainage branches. The people cut through the banks, and neglect to make them good again, thus intersecting the roads with innumerable pitfalls, which render travelling in the daytime fatiguing, and at night impossible. Surely a very moderate amount of supervision would put an end to this nuisance.

Egypt depends for its prosperity on its agricultural produce; but the competition of the whole world, the immensely improved ways of communication in America, in India, in Russia, have had the effect of reducing the price of all the products which Egypt can send into the market, more especially that of cereals, and the price is never likely to rise permanently again. How is it possible that those portions of Egypt which lie at a distance from Alexandria can hope to export their produce when the means of communication are so defective? The inevitable result will be that the country must relapse into a state where just enough is raised to feed a miserable population, and no taxes will be paid, because, there being no sale of produce, there can be no money.

Whatever neglect there may be in the maintenance of the canal system there is no slackness in collecting the land-tax, and defalcation is quickly followed by seizure and forced sales, entailing ruin, misery, and discontent among the agricultural population.

The conduct of the administration is inexplicable, because it would entail very little more than the present expenditure to keep the canals in proper order, while it would improve the revenue by making a greater breadth of land cultivatable, and would restore to the land the human and animal labour now lost in raising water in a wasteful manner, and in overcoming the difficulties of transport.

The people do not object to forced labour on their own canals. They have sense enough to know that by no other means can the life-giving streams be maintained, and it is possible so to distribute the work, and so to select the season for doing it, that the task would not press seriously on the people. At any rate it would be an infinitely smaller infliction than that which now exists as the consequence of neglect and mismanagement, by which the poor struggling peasants see the fruits of their labour disappear year by year, for want of irrigation and of drainage, or, if the harvest be haply secured, rendered valueless by the cost of carriage.

Many distinguished men have, from time to time, been sent to Egypt to set right its finances. Many ingenious schemes have been proposed, but it is doubtful if any who have attempted the regeneration of the finances of the country, have turned their attention to the root of the matter. Measures should be adopted to place the cultivatable portion of Egypt in a condition to produce the wealth latent in its lands, in its river, and in its laborious peasantry, and further to provide cheap and expeditious ways of communications, which can alone enable the produce of the lands to be converted into the gold which the financiers thirst for. It would be a worthy task for England to step in and remove the terrible drawbacks under which the fellaheen suffer. In her Indian engineers and their subordinates she has an admirable and experienced staff of administrators. The same men, the same system, and the same honesty of purpose introduced into Egypt would make a garden of a country which is now almost a wilderness.

A step in the right direction has already been made in the appointment of Colonel Scott Moncrieff, R.E., to the post of Under Secretary of State for Public Works. He has earned a high reputation in India, and will assuredly, if properly supported, do much towards the regeneration of the country entrusted to his care.

Unfortunately, long neglect and mismanagement have rendered large expenditure necessary, while that very neglect and mismanagement have crippled the revenue.

Colonel Moncrieff has already been ordered to retrench in every possible way, even when it is certain that expenditure such as he contemplates will yield enormous returns. He is perfectly alive to the importance of the reforms alluded to. In two "Notes" addressed to the financial advisers of the Government, one dated February 13, 1884, on the communications throughout Egypt, and the other dated March 1, 1884, on the public works which he deems essential to the good administration of the country, he points out in terse and vigorous language the real barriers interposed to prosperity, in the absurd and oppressive taxes on navigation, the impediments offered to it by bridges over the main channels, the defects of drainage and irrigation, and the total absence of roads.

It is satisfactory to be able to state that recently in Egypt one great concession was announced, namely, the river and canals were set free for steam navigation, a privilege till then reserved to the Government. It cannot be doubted but that this has been one of the results of the improved administration of the Public Works Department, and it is to be hoped that many other reforms will soon follow.

The uncertainty which surrounds the intentions of the British Government is stopping all public and private enterprise, and the poor farming population, that is to say, the bulk of the people of Egypt, is sinking deeper and deeper into a hopeless condition of poverty and debt. This is not a mere statement of opinion; on the contrary, the existing political situation had to be taken into consideration. The canals and drains on the estates visited had long been neglected. An expenditure of 1500*l.* in cleaning out was absolutely necessary, if advantage was to be derived from the expected improved irrigation and drainage service; and could the company have felt sure of the intentions of the British Government to continue steadily in the course they have entered upon, the work would have been commenced at once. The probabilities are, indeed, in favour of a prolonged occupation, because a great number of British officials have entered the Public Works Department, replacing some able and experienced men, such as Rousseau Pacha and his chief engineer, and it is hardly credible that the British Government would make such appointments if their sway was to be only of a temporary nature. But still the Government assurance is wanting, and it is impossible to advise expenditure of capital which would be fruitless in the event of the withdrawal of the British, for in that case the Government of Egypt would relapse into its original state of inefficiency.

In 1883 the Ministry of Public Works in Shereef Pacha's Government, published a most able paper entitled "Exposé du Ministère des Travaux Publics sur les Irrigations d'Egypte, et examen d'une proposition y relative." It is signed by Ali Pachi Moubarick, then Minister of Public Works, and by Rousseau Pacha, their Director-General. These gentlemen are both men of long experience in the department over which they presided, and Rousseau Pacha, especially, is an engineer of great and varied information. The "Exposé" treats first of the general systems of irrigation and drainage in vogue in Upper and Lower Egypt, discusses the capacity of the Nile at low water, and demonstrates that its volume is barely sufficient for the wants of the existing summer cultivation, and those of navigation. The long standing question of the Barrage is carefully considered, and the conclusion is reached, that even supposing by an expenditure of very large sums of money the Barrage could be repaired, or, as they point out, more properly rebuilt, and the banks of the arterial canals raised to a proper height, to convey the waters pent up behind it, Government might well recoil before the enormous risk of so powerfully altering the regimen of a river such as the Nile, and incurring the consequences of injury to a wide extent of productive land brought on by the infiltrations which would be sure to supervene. In addition, they draw attention to the enormous cost of keeping the arterial canals clear, and the absolute necessity of employing for that purpose forced labour in its most odious form, that is, at a distance from the homes of the labourers, and employed on works in which they have no direct interest. The height to which the banks of the arterial canals have risen from centuries of cleaning, renders the labour more and more severe each successive year, and more and more land is being covered by the mud excavated, and by that means rendered valueless. The Rayah of Khatatbeh, in the western margin of the Delta, for example, which used to bring the waters of the main Nile from above the Barrage to the Khatatbeh canal, which irrigates the province of Behera, though only 26 miles long, required annually the labour of 20,000 men for fifty days to clean it. The bare cost of feeding this army used to amount to 12,000*l.*, and if to this the labour lost to the farms and valued at only 6d. per head per day be added, there was a further loss to the country of 25,000*l.*, making 37,000*l.* per annum for 26 miles of one canal!

In addition, the mud deposited in the arterial canals is the fertilising essence of the Nile water, and should be deposited on the lands irrigated and not in the canals. Too much importance cannot be attached to this point. The canals should be as short as possible, and then their currents can be so regulated that the least possible deposit shall take place.

On all these grounds the Exposé strongly advocates the use of powerful steam-pumps, under Government control, in preference to attempting to patch up the Barrage, or make use of long arterial canals. The system would abolish the most oppressive kind of forced labour, would avoid all risk of infiltration, would assure abundant water at all times at a height to command the land irrespective of the level of the Nile, and last, but not least, would save the Government for some years to come, in a great measure, from the very heavy annual outlay in cleaning canals used for the summer water, which now have to be maintained at a great depth, but which, if pumping be resorted to, may be allowed to silt up permanently to a very considerable extent. The Government of Egypt before the rebellion had already acted on the principles laid down in the Exposé, and had established a powerful pumping station at Khatatbeh, and increased the existing one at Atfeh, so as to save the expense and oppression involved in cleaning the Rayah of Khatatbeh. The Government of Shereef Pacha took up the good work, and all but made a contract with an English company to utilise its powerful pumps at Cherbine, which would have

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supplied the district visited, as f[illegible]ated tenders for the erection and working of another similar station for the Mansourah district. Unfortunately the troubles in the Soudan broke out, Nubar Pacha replaced Sheref, and the arrangements made by the Government of the latter were in a great measure set aside. Colonel Scott Moncrieff (who was appointed about this time) was forced to reduce his budget at the expense of many salutary reforms, and unfortunately with respect to the water supply of the district, which forms the subject of these remarks. At first Colonel Scott Moncrieff seemed favourable to the views advocated in the Exposé of the late ministry; but after the Soudan troubles, driven, perhaps, by pecuniary necessity, he unfortunately determined to make an attempt to raise the waters of the Nile by means of the Barrage, and that work is now being strengthened in a manner which he expects will enable it to perform the office for which it was designed. Most experienced engineers, native and foreign, believe that the attempt will end in failure. Mr. B. Baker's graphic description of the work is of a very discouraging kind, especially as it is known that when the Barrage was being examined with the view to converting it into a railway bridge, a diver was actually able to make his way right under and across a portion of it! Colonel Moncrieff is very frank about his attempt, and is quite prepared for a failure; but a failure may prove very disastrous indeed, because, as Rousseau Pacha points out in the Exposé, the Barrage now serves an invaluable purpose in regulating the amount of water passing down the Damietta Nile. Mr. Baker mentions the tendency of the river to follow the shorter, or Rosetta branch, hence, if any serious failure of the Barrage were to occur, the lands depending on the Damietta Nile would suffer severely. Colonel Scott Moncrieff and his assistant have been but a short time in the country; they have not yet seen the Nile through all its phases. It would surely have been more prudent to postpone the dangerous experiment of dealing with the Barrage to a future time.

Although, on the present occasion, but a small portion of the country was visited, yet at other times the author has traversed many miles of the canal system both in Upper and Lower Egypt, and everywhere the same neglect of the vital interests of agriculture exists. Nothing but a strong Government, served by capable and honest officers, will be able to achieve the reforms which will place the irrigation, drainage, and communications of Egypt on a par with those of the other civilised countries with which it has to compete. The grand schemes which have from time to time been broached for the construction of regulating reservoirs on the Upper Nile are, as Rousseau Pacha points out, works requiring long years and large sums of money. But the immediate necessities of the cultivable lands can be satisfied with but moderate outlay, and the returns will be immediate and abundant if the expenditure is controlled by capable and honest administrators; but the work must be done at once if the revenues of Egypt are to be maintained. The Ministry of Public Works has declared emphatically that "the country cannot wait."

FOREIGN AND COLONIAL NOTES.

Accelerating a Rainfall.—A design has been submitted to the Victorian Minister of Water Supply of a contrivance for bringing down rain. It is in the form of a balloon, with a charge of dynamite underneath, to be sent into the clouds and fired by wire connecting it with the earth. The inventor, Mr. E. S. Haines, of Richmond, intends to try the scheme in the dry districts of New South Wales.

Canadian Drawback on Cut Nails.—An order in council has been issued at Ottawa, allowing a drawback on exports of cut nails manufactured in Canada, not finer than small thirds, of 90 per cent. of the duty paid on iron imported to make them.

Bridge Improvements on the Grand Trunk.—In the course of the half-year ending December 31, 1883, the Grand Trunk Railway Company of Canada expended 27,125*l.* in the replacement of wooden bridges by iron and stone structures.

Wood Paving at Sydney.—The work of paving the streets of Sydney, New South Wales, with wood, is being carried on to a considerable extent, and already the area of these pavements represents between 14 and 15 acres, while about 14 acres more are to be done.

Gas at Paris.—The revenue of the Parisian Company for Lighting and Heating by Gas amounted in the first four months of this year to 1,127,896*l.*, showing an increase of 33,909*l.*, or 3.10 per cent., as compared with the corresponding period of 1883.

The Electric Light in Australia.—For some time past negotiations have been proceeding for an amalgamation of the interests of the Australian Electric Company (Limited) with those of the Australasian Electric Light, Power, and Storage Company (Limited). An arrangement just entered into between the directors of the Australian Company and the general manager of the Australasian Company has been ratified by the directors and shareholders of the latter company in London, and will have the effect of importing fresh capital into the business.

Locomotives on the Philadelphia and Reading Railroad.—The Philadelphia and Reading Railroad Company proposes to build 44 locomotives weighing 42 tons each. They will be run on the Bound Brook route to New York.

French Railways.—At the close of 1883 there were 16,965 miles of railway of general interest in operation in France. The extent of line completed in 1883 was 493¾ miles. The revenue acquired in 1883 upon all the French lines was 43,839,761*l.* The corresponding revenue collected in 1882 was 43,674,760*l.* Having regard to the additional mileage brought into operation in 1883, the traffic results of last year must be considered disappointing.

Isthmus of Corinth Canal.—There are 10,000,000 cubic metres of earth to excavate in connection with this canal. The extraction already effected is returned at 1,800,000 cubic metres. Two powerful excavating machines built at Lyons have been set to work at either end of the canal; it is estimated that these engines will remove about 9000 cubic metres of earth daily. The works of the canal present difficulties; they are expected, however, to be completed in three years.

Iron Minerals in France.—The imports of iron minerals into France in the first four months of this year amounted to 454,595 tons, as compared with 520,978 tons in the corresponding period of 1883, and 430,202 tons in the corresponding period of 1882. The total of 454,595 tons was made as follows: Belgium, 60,566 tons; Germany, 131,140 tons; Spain, 102,495 tons; Italy, 23,860 tons; Algeria, 69,213 tons; and other countries, 7321 tons.

A Curious Customs Dispute.—A dispute has arisen between the Victorian Customs authorities and the Westinghouse Brake Company in regard to the duties payable on the patent parts of that brake. The company considers that the duty should only be charged on the English prices of the brake, 50*l.*, but the Customs authorities desire to charge on the royalty also on each brake. A quantity of brake machinery has been detained pending a settlement.

The Suez Canal—The rough revenue of the Suez Canal Company in 1883 amounted to 2,740,934*l.* After provision had been made for working expenses, statutory allocation to the reserve, interest at 5 per cent. per annum upon capital, &c., a balance of 1,434,542*l.* remained available for the payment of a further dividend. The total distribution upon each 20*l.* share for 1883 has been fixed at 3*l.* 11s. 11d. This is equal to about 17¾ per cent. per annum. In consequence of the appointment of some additional English directors the number of members of the council of administration has been carried from 14 to 32.

South Australian Jetties and Wharves.—The South Australian Government has constructed upwards of sixty jetties and wharves, at a cost of about 373,000*l.*, exclusive of the Goolwa, Port Augusta, and Port Wakefield wharves and jetties at Victor Harbour and Wallaroo, which are included in the cost of railways; the Althorpe Island and Penguin Island jetties, built with funds provided for the lighthouses there, and the Mundy-street, Queen's, and Dockyard wharves, Port Adelaide, Queen's Wharf, Port Pirie, and the Port Wakefield (1000 ft.) Wharf, paid for out of loans for deepening and improving ports. One or two of these structures are useless, several are seldom or ever used, no revenue whatever is received from about a dozen which cost upwards of 30,000*l.*, and only about 370*l.* per annum, or rather more than one-half per cent., for about twenty which cost upwards of 63,000*l.* Many of these jetties were built with money borrowed at no less than 4 per cent., and a considerable sum (about 2000*l.*) is spent every year for maintenance, &c. Most of the jetties have been placed under the control of the South Australian Marine Board, and the total revenue received during 1883 for tolls and leases, including sums paid by owners of private jetties, was about 2400*l.* The tolls charged for goods placed on Marine Board jetties are very low, and a proposal to increase them will shortly be brought forward.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF SPECIFICATIONS PUBLISHED DURING THE WEEK ENDING JUNE 28, 1884.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

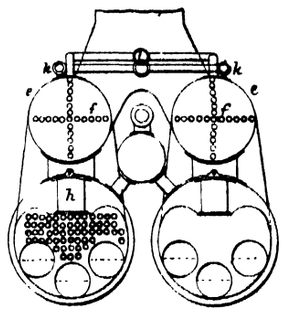
Copies of Specifications may be obtained at 88, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, and addressed to MR. H. READER LACK.

NUMBER OF APPLICATIONS FOR PATENTS.

	1884	1883	1883
June 24th	50	..	13
,, 25th	39	15	5
,, 26th	50	33	—
,, 27th	49	22	6
,, 28th	42	16	6
,, 29th	..	22	10
,, 30th	37	17	9
Total for week	267	125	49
Total from January 1st to June 30th (inclusive)	9593	3258	1582

5033. Arrangement of Circuits and Apparatus for the Distribution of Electricity: J. S. Beeman, London. [6*d.* 12 *Figs.*]—Two or more generators or sets of generators, preferably producing currents of equal or nearly equal electromotive force and also quantity, being fitted when necessary with means whereby the electromotive force and quantity are regulated, are employed. The + conductor from the first generator is taken by a convenient route towards the second generator, and alongside and parallel to the — conductor of the second generator; the + conductor from the second generator is taken by a convenient route towards a third generator, and alongside and parallel to the — conductor of the third generator, and so on; the + conductor of the last generator being alongside and parallel to the — conductor of the first generator. Automatic or other resistances, such as lamps, motors, &c., are placed between the + conductor of one generator and the — conductor of the following generator. Branch and sub-branch circuits are connected between the parallel conductors in the ordinary way. This arrangement is also applicable to circuits having a central compensating conductor. When the translating devices are arranged in series, the + pole of the first generator is connected to the — pole of the second generator through the translating devices, and so on. The generators may be primary or secondary batteries, dynamo or magneto-electric generators, &c. The patentee does not claim the above as applied for telegraphic purposes. He also states that he is aware of the following specifications: 1880, 4548, and 6199 of 1882, and 2304 of 1883. (October 26, 1883).

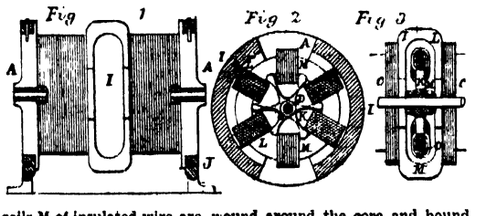
5175. Steam and Hot Air Generator: W. Turnbull, London. [8*d.* 7 *Figs.*]—A portion of the heat or waste heat from the furnace of a steam boiler is utilised in tubular receptacles for heating air, the receptacles being supplied with compressed air forced therein by pumps. Referring to the illustration, the hot gases from the boiler furnace and combustion chamber pass through the boiler tubes into the smokebox and from thence they



pass through the tubes *f* of the hot air generator *e* into the chimney. A pipe *h* connects the combustion chamber and the flue of the hot air chamber and is provided with dampers by which the quantity of gases passing directly is controlled. The air is supplied by a pump through the pipes *k* and passes off through the pipes *l*. These improvements are also shown applied to locomotive and stationary boilers. (October 31, 1883).

5202. Electric Meters: R. Belfield, Tulse Hill, Surrey. [6*d.* 13 *Figs.*]—In order to measure electric potential, and especially the potential of rapidly alternating currents, four double quadrants are mounted upon an insulating base, and connected together in pairs, the opposite quadrants forming a pair. A needle having approximately the form of one pair of quadrants is suspended by a wire between the upper and lower surfaces of the double quadrants. One terminal of the circuit is connected through the suspending wire to the needle, and also to one pair of quadrants, and the other terminal is connected to the other pair, the needle being then repelled by one pair and attracted by the other pair, and is thus caused to leave its zero point. It is brought back to the zero point by turning the capstan head to which the suspending wire is attached, and the amount of the movement of the head is read off upon a scale which may be graduated to read directly in volts. The axis of needle is guided so as to retain the needle parallel to the quadrants. In another arrangement two discs are employed, the one fixed and the other suspended over it. The discs are connected to the terminals of the circuit, and the attraction between them is measured. In order to measure electric currents, a wheel or drum is mounted to revolve between a pair of coils having their axes coaxial with the axis of the wheel or drum. The current to be measured passes through the wheel or drum and also through the coils. The wheel or drum consists of radial arms fixed upon two bosses, the two sets of arms being connected by conductors parallel to the axis. The current passes from the boss up one set of arms to the conductors, down the other set to the other boss. The same or another portion of the current passes in opposite directions through the two coils. A fly revolving in a trough of mercury or other fluid is arranged on the axis of the wheel or drum, and the axis is connected to a registering train of wheelwork. In order to convert this into an ampère meter, the fly and registering train is dispensed with, and the axis is caused to lift a weight at a varying leverage by means of a curved arm attached to the axis, or to strain a spring. The deflection of the axis can be made proportional to the current. (November 1, 1883).

5238. Electric Generators: H. J. Haddan, London. (*Bain Electric Company, Chicago, U.S.A.*) [10*d.* 18 *Figs.*]—As will be seen from the illustrations, the field magnets consist of two core pieces I provided at their ends with semicircular yoke pieces A and at their centres forming hollow pole-pieces. The armature shaft D revolves in bearings in the pieces A which are clamped together, and to the baseplate by rings J and bolts. The object of this construction is to make each part of the field magnets interchangeable and so that they can be "turned" at one chucking. A segment of the yoke rests in a concaved piece in the base, so that the field magnets will not fall apart when the rings J are loosened, and they can be turned round to any angle and again clamped. The armature consists of a spider frame K, the ends of the arms being provided with blades o upon which are wound insulated iron wires L to form the body of the ring. The



coils M of insulated wire are wound around the core and bound with cloth canvas and shellac. The coils are connected to the commutator by conductors lying in grooves in the shaft D and covered by a sleeve forming a bearing for the shaft, and having discs at either end with grooved peripheries to prevent the oil coming in contact with the conductors. The coils, of that type of armature in which the coils are connected in a closed circuit, passing at or near the neutral points of the field, are utilised in a separate circuit. Supposing there to be six coils on the armature, the two opposite coils are connected in a single circuit and the terminals of this circuit are each connected to a separate commutator each consisting of three equal segments insulated from each other. The other pairs of coils are connected in a similar manner to the other segments of the commutators. Brushes bear on opposite points of each com-

mutator, and the two brushes of one commutator being connect to the terminals of the main circuit, and the two brushes of t other commutator together, it will be seen that the two coils pa ing through the neutral parts of the field are out of circuit, and th the other four coils are connected in series; or, if the correspon ing brushes of each commutator are connected to the terminals of the main circuit, the two circuits of the coils will be in multiple arc. When the number of coils is some multiple of four, the terminals of each circuit of a pair of opposite coils may be connected to opposite segments of a commutator, there being either one, or, preferably, two commutators, the arrangement being similar to that described above. The terminals of each pair of coils are s connected to opposite segments of a commutator having six eq segments, the brushes bearing on the segments so that the circuit of the pair of coils is closed just as it is opened at the other two commutators. If a continuous current be desired in this minor circuit, each segment is divided into two equal and insulated parts, each part being connected to the nearer part of the opposite segment. This circuit may then be employed for exciting the field magnets. In another arrangement the two circuits of the four coils cutting the lesser number of lines of magnetic force are connected in parallel circuit, and the two coils cutting the greater number in series. In this arrangement each of the brushes of the two commutators (described above) of the main circuit is divided into two parts, one being slightly in advance of the other, or the stripe of the commutator may overlap or be arranged spirally. The minor commutator has six insulated and six conducting segments, the brushes being connected together so as to short-circuit the two coils passing through the neutral position, the other four coils being then in series; the circuit connecting the brushes of the minor commutator may include a very high resistance which may be adjustable. (November 5, 1883).

5244. Apparatus for Producing Intense White Light: C. D. Abel, London. (*C. Clamond, Paris*). [6*d*. 8 *Figs.*]—The combustible gas passes into an annular chamber and issues from perforations and comes in contact with a heated central air supply producing a series of small flames that rise up into a cage of refractory material. (November 5, 1883).

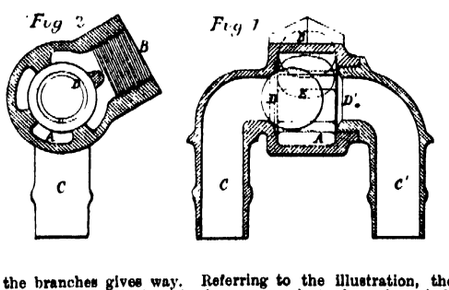
5249. Steam Engines: T. Hunt, Manchester. [6*d*. 17 *Figs.*]—In steam engines for tramways, &c., the uptake of the engine boiler is placed on the side farthest from the firedoor, the intervening space being provided with pendent tubes or water spaces. The chimney consists of two concentric tubes, the space between which is filled with a non-conductor of sound. A valve varies automatically the area of escape for the exhaust steam according to its pressure. The overflow from the injectors is led back to the water tanks. The reversing gear and steam regulator are actuated by pressure from the boiler. (November 5, 1883).

5301. Multiple Drilling, Boring, Turning, and Tapping Machines: J. Carver, Nottingham. [6*d*. 5 *Figs.*]—A long horizontal shaft drives by means of worm gearing a series of vertical spindles, any or all of which can be disconnected by means of clutches. (November 9, 1883).

5318. Apparatus for Signalling at Sea: W. Balch, Greenwich. [6*d*. 4 *Figs.*]—A signal rocket comprises an outer casing, a cap chamber with cap, a fuzo, a detonated charge, and stars which are red or green as required. The discharging apparatus comprises a hinged barrel or tube provided with a central firing pin and passages for the escape of gases. (November 10, [illegible]

5348. Bridges, &c.: W. R. Kinipple, Greenock. [illegible] *gs.*]—Carriages on rollers are capable of being travelled [illegible] gitudinally backwards and forwards on high level girders and the meeting ends of the girders of the two movable parts of a low level roadway are suspended from these carriages. The shore ends of these girders are supported on rollers on the adjacent fixed spans. Several arrangements are described. Swing bridges are pivotted at one end and their other end is carried by carriages travelling on high level girders. (November 13, 1883).

5349. Connection of Pipes for Communicating Fluid Pressure to Work Brakes on Railway Trains: C. D. Abel, London. (*G. Westinghouse, Pittsburgh, Penn., U.S.A.*) [6*d*. 5 *Figs.*]—Two separate hose pipes or two separate sets of jointed pipes are arranged to extend from a valve box on one carriage to a similar box on the next. The valve box has in each case a middle chamber communicating with the metallic pipe that is fixed on the carriage, and has two lateral branches communicating respectively with the two flexible pipes. These branches are governed by a duplex valve, which in its middle position clo neither branch, but moves to close the unsound passage when



of the branches gives way. Referring to the illustration, the middle chamber A of the valve box communicates by a branch B with the fixed pipe of the carriage, and is provided with two branches C C1. D D1 are the valve seatings and E the valve. As shown in Fig. 1, the flexible connection to the pipe C is supposed to have been damaged. In order to avoid the duplication of the coupling and uncoupling arrangements, a single intermediate coupling has attached to each part a valve box of the kind described above, the two lateral passages being governed by the valve and connected to the flexible pipes, and the other passage being open to the coupling. (November 13, 1883).

5351. Lowering, Raising, and Releasing Ships' [illegible]. C. J. Fox, Birkenhead. [8*d*. 6 *Figs.*]—This consists essentially of a rocking arm pivotted at one end to the deck, and at the other to a supporting bar connected to a crutch arm which bears the boat. (November 13, 1883).

5357. Hydro-Carbon Furnaces: A. J. Boult, London. (*O. D. Orvis, Chicago, U.S.A.*) [8*d*. 7 *Figs.*]—The hydro-carbon liquid is forced by means of steam into a retort heated directly by a furnace, and rises and escapes in the form of vapour to the fire chamber. (November 13, 1883).

5361. Manufacture of Ammonia and Hydro-Carbon Gases: W. R. Lake, London. (*T. B. Fogarty, Brooklyn, U.S.A.*) [8*d*. 2 *Figs.*]—This consists mainly in converting the atmospheric nitrogen, discharged with the hydro-carbon gases and other products of furnace combustion, into ammoniacal gas, removing the ammonia from the gases, and then passing the remaining nitrogenous gas deprived of carbonic oxide and carbonic acid into retorts containing bituminous coal mixed with an alkali or alkaline earth while undergoing destructive distillation for the generation of illuminating and heating gas. (November 13, 1883).

5373. Controlling an Engraving, Cutting, or Im[illegible]rm, &c.: H J. [illegible] *Company, Chicago,* [illegible].A.) [6*d*. 2 *Figs.*]—The position of the cutting or forming tool is adjusted by means of an electrical regulating device. A transparent or translucent pattern moves in unison with the plate to be engraved, and is subjected to rays of heat or light which are afterwards received upon a selenium cell or its equivalent in connection with the regulating device. (November 14, 1883).

5381. Hydraulic Lifts: J. H. Johnson, London. (*H. M. L. Crouan, Paris*). [10*d*. 17 *Figs.*]—The distributing apparatus is operated by eccentric studs causing either of two main valves to open, and at the same time maintaining the other main valve closed according as the controlling wheel is turned in one direction or the other, the said main valves being provided with auxiliary or relieving valves and trunks working in cylinders, and with pendent cylindrical projections on the lower side, whereby the flow of water is graduated. Ropes are employed for actuating the distributing apparatus. (November 14, 1883).

5411. Petroleum Heating Apparatus: R. Schulz, Dresden, Saxony. [6*d*. 2 *Figs.*]—The hydro-carbon is converted into spray by means of an ejector, and compressed air or steam, and passed through a series of three concentric fire tubes. (November 16, 1883).

5420. Tool Holders for Lathes, &c.: M. C. [illegible] Esher, Surrey. (*G. S. Jones, Cawnpore*). [6*d*. 4 *Figs.*]—The tool holder is constructed with a cylindrical swivel-head carrying an internal plug, through slots in both of which the tool is passed. A screw bolt passes through the stem of the swivel-head and bears against the plug so as to grip and hold the tool, and a nut screws on to the exterior of the stem of the swivel-head to lock it to the shank. (November 17, 1883).

5422. Dynamo-Electric Machines and Electro-Motors: Sir C. T. Bright, London. [6*d*. 4 *Figs.*]—The system described in Specification 2280 of 1883 is applied to alternating current generators. Referring to the illustration, the iron or steel shaft is divided into two parts N and S by a piece of brass, the adjacent faces of the two parts being expanded into discs, from the

Fig 7.

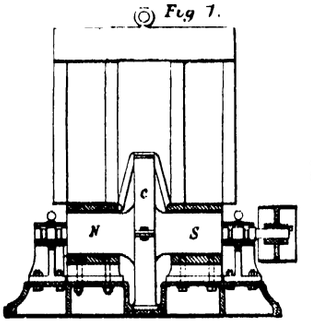
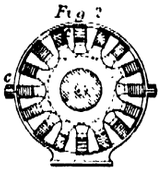


Fig 8



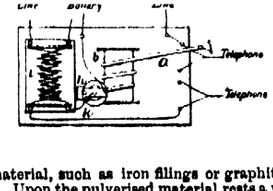
outer edges of which are cut spaces dividing the discs for a suitable depth into radial arms forming the poles. A fixed ring C co-axial with the shaft N S carries a series of coils *f* with or without soft iron cores. The shaft is polarised by electro-magnets excited by a separate generator, or by permanent magnets, or by a combination of the two. The stationary armature coils are connected to fixed terminals. (November 17, 1883).

5425. Automatic Feeding of Boilers: A. Mayhew, [illegible]ondon. [6*d*. 4 *Figs.*]—This comprises two cylinders connected together at the base, and fitted with suction and delivery valves. The water is drawn into the apparatus by means of a vacuum created by the action of the steam. A pipe extends from the suction and delivery valves to nearly the top of one vessel. A U shaped pipe connects the bottoms of these vessels, the top being connected by a passage controlled by a valve. (November 17, 1883).

5431. Steam Engines: W. P. Thompson, Liverpool. (*F. D. Cumnver, Detroit, Mich., U.S.A.*) [8*d*. 14 *Figs.*]—The exhaust valves are arranged at a lower level than the cylinder and the main steam and exhaust valves are operated simultaneously by one eccentric, eccentric rod, and rocker arm. Secondary valves may be combined with the main exhaust valve and distribute the steam to the auxiliary heater and a condenser. The cut-off valve is operated by an independent eccentric. (November 17, 1883).

5446. Facilitating the Coupling and Uncoupling of Railway Vehicles. G. W. von Nawrocki, Berlin. (*P. Madsen, Berlin*). [6*d*. 5 *Figs.*]—The coupling link is connected by a short link with a toggle link turning on nuts guided in the drawbar and controlled by a screwed rod operated by worm gearing from a horizontal shaft. The engaging and disengaging is effected by a divided lever supported on a transverse shaft, the coupling being drawn up tight by the worm gearing. (November 19, 1883).

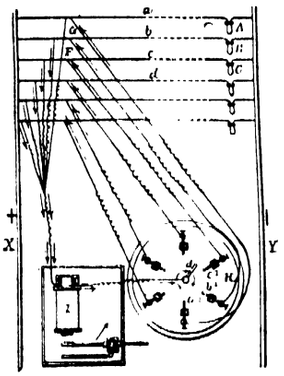
5448. Telephonic or Microphonic Apparatus: H. H. Lake, London. (*J. Berliner, Hanover*). [6*d*. 7 *Figs.*]—A pulverised or granulated conducting material is employed under pressure, either in a dry state or moistened with water or other liquid. Referring to the illustration, the flexible speaking tube *a* is wound around a drum B and one end is fixed in a metallic sleeve screwed into a brass disc connected by screws to a ring of insulating material. Between the ring and disc is a perforated plate covered with a thin sheet of platinum serving as a support for the



granulated material, such as iron filings or graphite contained in the chamber. Upon the pulverised material rests a weight covered on the underside with a sheet of platinum and surrounded by cotton wool. The disc or weight carries a small rod connected by a conducting band *h* to a screw fixed to an insulating plate and connected by a conductor *k* to an induction coil *l*. The other terminal of the induction coil is connected to one pole of a battery and the brass disc to the other pole of the battery. The connections are clearly shown in the illustration. Slight modifications are shown. (November 19, 1883).

5462. Railway Signalling: H. [illegible]. Norris, Manchester. [6*d*. 10 [illegible] his previous specifications 1796 of 1881 and 1527 of 1882. The tilting rail mentioned in the latter specification is raised by an arm fixed on a shaft carried under the rail to the side of the line, the counterweight being fixed to this shaft by means of an elbow lever. The semaphore signal may be combined with a bell or other audible signal which can be disconnected. (November 20, 1883).

5465. Meter for Electric Currents: A. M. Clark, London. (*J. Hours-Humbert, Besancon, France*). [6*d*. 8 *Figs.*]—A clock actuates a rotating contact arm passing over a series of contacts, the arm and contacts being connected to the sub-derivations in which the lamps are placed. The arm completes the circuit through an electro-magnet which operates the registering mechanism. Referring to the illustration A B C, &c., are the lamps arranged in multiple arc derivations *a b c*, &c., between the



mains X Y. The circular series of contacts a^2 b^2 c^2, &c., are connected to the derivations *a b c*, &c., and the arm *o*, which makes contact with these contacts, as it is uniformly rotated by clockwork, is connected through the electro-magnet Z with the main or with each of the derivations. If the corresponding lamp is in circuit when the arm *o* makes one of the contacts, a current will pass through the electro-magnet Z, which attracts its armature and operates the registering mechanism. This n [illegible] the number of lamp hours. (November 20, 1883).

5468. Rivetted Joints: J. A. Rowe, North Shields. [6*d*. 9 *Figs.*]—The joints are constructed so as to leave between the edges of the adjoining plates a space sufficient to allow of caulking the edges of the plates against the butt straps, the rivets being closely pitched. (November 20, 1883).

5469. Secondary Batteries: F. M. Lyte, Putney, Surrey. [4*d*.]—This refers to electrodes of secondary batteries constructed as described in Specification 3452 of 1882. The electrode is constructed of a pair of non-conducting plates serving as supports for studs, prisms, or bars of active material held in contact with an intermediate plate of conducting material. The studs or bars are caused to adhere securely by placing their bases on the central conducting plate and moulding or pouring around them some suitable material such as pitch. The prisms, strips, or bars may be reduced either before or after being placed in contact with the central plate and may be securely held in place by a grating of lead cast or made to fit over them, the studs projecting through apertures, or if the central plate is of metal, the studs or prisms may be passed through holes therein, or wire gauze is coated on both sides with the active material. Short wires pass transversely through the active material and through the intermediate plate. Solutions of sulphates or acid sulphates of the alkaline metals or phosphoric acid may be employed as the exciting solution. (November 20, 1883).

5471. Telegraph and Telephone Lines, &c.: H. H. Lake, London. (*J. C. Chambers, Cincinnati, Ohio, and N. C. Gridley, Chicago, Ill., U.S.A.*) [6*d*. 7 *Figs.*]—One or more induction wires are arranged in close proximity to the aërial conductors and are insulated from the supports, conductors, and earth. If the conductors are insulated they may surround the induction wire. (November 20, 1883).

5472. Electric Lamps: H. H. Lake, London. (*T. J. McTighe and J. T. McConnell, Pittsburgh, Penn., U.S.A.*) [6*d*. 3 *Figs.*]—A short circuit, across the terminals of the lamp, has two interruptions or "breaking points," one adapted to be closed by the weakening of the feed or main magnet or the abnormal strengthening of a shunt magnet, and the other adapted to be opened by the pressure of one carbon upon the other, and closed by their separation. Referring to the illustrations, the top plate, which is rigidly connected to the bottom plate, carries the main magnets C and the shunt magnets D. A horizontal lever F is pivotted to a fixed bracket, and one end is pivotted to a vertical arm carrying the crosspiece *b*, to which the cores of the hollow main magnets C are attached, and the other end is connected to the cores of the shunt magnets D in a similar manner. A vibrating lever *f*, pivotted at one end to a fixed support, fulcrums upon a curved surface of the lever F, and the other end is connected to a standard *g* projecting upwardly from a box *h* surrounding the toothed carbon-holder G. A small pinion, journalled in the box *h* and engaging with the rack teeth, carries on its shaft the escapement wheel *i*, which is controlled by a weighted escapement pallet pivotted to the standard *g*, and engages with a detent *m* pivotted to an arm projecting from the box *h*. The magnets C when excited raise the end of the lever F, thus lifting the lever *f*, box *h*, and (the wheel *i* being locked by the detent *m*) the rod G, and establish the arc, the change in the fulcrum of the lever *f* compensating for the increasing attraction as the cores are drawn into [illegible] magnet. When the arc becomes abnormally long, the magnets D lower the lever *f*, box *h*, and rod G, and eventually the toe of the detent *m* comes against an adjustable stop, releasing the wheel *i*, and allowing the rod G to descend, the descent being regulated by the weighted pendulum. The rod G and standard *g* pass through an opening in the lever F, to which is attached near one end the adjustable retractile spring *p*[1]. The vertical arm connecting the lever F and crosspiece *b* is insulated from the piece *b*, but has a slight vertical play in relation to the piece *b*, which piece when unattracted rests in contact with an insulated metallic washer on the vertical arm and a pin depending from the washer bears against a contact brush *t*. The lower carbon-holder slides in an insulated metallic socket, and an insulated pin on its stem bears upon a spring P, which holds the carbon-holder slightly raised and also makes a contact, except when the upper carbon rests upon the lower. The spring is in connection with the brush *t* and the contact piece to the insulated metallic socket and by a conductor to the — terminal. The normal circuit of the lamp is from the + terminal through the coils C and by a brush to the rod G, carbons, metallic socket and — terminal. The attraction of the magnets C on the piece *b* breaks the contact with the washer. The arc being struck the contact at P is made. If the normal circuit

supplied the district visited, and invited tenders for the erection and working of another similar station for the Mansourah district. Unfortunately the troubles in the Soudan broke out, Nubar Pacha replaced Shereef, and the arrangements made by the Government of the latter were in a great measure set aside. Colonel Scott Moncrieff (who was appointed about this time) was forced to reduce his budget at the expense of many salutary reforms, and unfortunately with respect to the water supply of the district, which forms the subject of these remarks. At first Colonel Scott Moncrieff seemed favourable to the views advocated in the Exposé of the late ministry; but after the Soudan troubles, driven, perhaps, by pecuniary necessity, he unfortunately determined to make an attempt to raise the waters of the Nile by means of the Barrage, and that work is now being strengthened in a manner which he expects will enable it to perform the office for which it was designed. Most experienced engineers, native and foreign, believe that the attempt will end in failure. Mr. B. Baker's graphic description of the work is of a very discouraging kind, especially as it is known that when the Barrage was being examined with the view to converting it into a railway bridge, a diver was actually able to make his way right under and across a portion of it! Colonel Moncrieff is very frank about his attempt, and is quite prepared for a failure; but a failure may prove very disastrous indeed, because, as Rousseau Pacha points out in the Exposé, the Barrage now serves an invaluable purpose in regulating the amount of water passing down the Damietta Nile. Mr. Baker mentions the tendency of the river to follow the shorter, or Rosetta branch, hence, if any serious failure of the Barrage were to occur, the lands depending on the Damietta Nile would suffer severely. Colonel Scott Moncrieff and his assistant have been but a short time in the country; they have not yet seen the Nile through all its phases. It would surely have been more prudent to postpone the dangerous experiment of dealing with the Barrage to a future time.

Although, on the present occasion, but a small portion of the country was visited, yet at other times the author has traversed many miles of the canal system both in Upper and Lower Egypt, and everywhere the same neglect of the vital interests of agriculture exists. Nothing but a strong Government, served by capable and honest officers, will be able to achieve the reforms which will place the irrigation, drainage, and communications of Egypt on a par with those of the other civilised countries with which it has to compete. The grand schemes which have from time to time been broached for the construction of regulating reservoirs on the Upper Nile are, as Rousseau Pacha points out, works requiring long years and large sums of money. But the immediate necessities of the cultivable lands can be satisfied with but moderate outlay, and the returns will be immediate and abundant if the expenditure is controlled by capable and honest administrators; but the work must be done at once if the revenues of Egypt are to be maintained. The Ministry of Public Works has declared emphatically that "the country cannot wait."

FOREIGN AND COLONIAL NOTES.

Accelerating a Rainfall.—A design has been submitted to the Victorian Minister of Water Supply of a contrivance for bringing down rain. It is in the form of a balloon, with a charge of dynamite underneath, to be sent into the clouds and fired by wire connecting it with the earth. The inventor, Mr. E. S. Haines, of Richmond, intends to try the scheme in the dry districts of New South Wales.

Canadian Drawback on Cut Nails.—An order in council has been issued at Ottawa, allowing a drawback on exports of cut nails manufactured in Canada, not finer than small thirds, of 90 per cent. of the duty paid on iron imported to make them.

Bridge Improvements on the Grand Trunk.—In the course of the half-year ending December 31, 1883, the Grand Trunk Railway Company of Canada expended 27,125*l.* in the replacement of wooden bridges by iron and stone structures.

Wood Paving at Sydney.—The work of paving the streets of Sydney, New South Wales, with wood, is being carried on to a considerable extent, and already the area of these pavements represents between 14 and 15 acres, while about 14 acres more are to be done.

Gas at Paris.—The revenue of the Parisian Company for Lighting and Heating by Gas amounted in the first four months of this year to 1,127,896*l.*, showing an increase of 33,909*l.*, or 3.10 per cent., as compared with the corresponding period of 1883.

The Electric Light in Australia.—For some time past negotiations have been proceeding for an amalgamation of the interests of the Australian Electric Company (Limited) with those of the Australasian Electric Light, Power, and Storage Company (Limited). An arrangement just entered into between the directors of the Australian Company and the general manager of the Australasian Company has been ratified by the directors and shareholders of the latter company in London, and will have the effect of importing fresh capital into the business.

Locomotives on the Philadelphia and Reading Railroad.—The Philadelphia and Reading Railroad Company proposes to build 44 locomotives weighing 42 tons each. They will be run on the Bound Brook route to New York.

French Railways.—At the close of 1883 there were 16,965 miles of railway of general interest in operation in France. The extent of line completed in 1883 was 493¾ miles. The revenue acquired in 1883 upon all the French lines was 43,839,761*l.* The corresponding revenue collected in 1882 was 43,674,760*l.* Having regard to the additional mileage brought into operation in 1883, the traffic results of last year must be considered disappointing.

Isthmus of Corinth Canal.—There are 10,000,000 cubic metres of earth to excavate in connection with this canal. The extraction already effected is returned at 1,800,000 cubic metres. Two powerful excavating machines built at Lyons have been set to work at either end of the canal; it is estimated that these engines will remove about 8000 cubic metres of earth daily. The works of the canal present difficulties; they are expected, however, to be completed in three years.

Iron Minerals in France.—The imports of iron minerals into France in the first four months of this year amounted to 454,595 tons, as compared with 520,978 tons in the corresponding period of 1883, and 430,202 tons in the corresponding period of 1882. The total of 454,595 tons was made as follows: Belgium, 60,566 tons; Germany, 131,140 tons; Spain, 162,495 tons; Italy, 23,860 tons; Algeria, 69,213 tons; and other countries, 7321 tons.

A Curious Customs Dispute.—A dispute has arisen between the Victorian Customs authorities and the Westinghouse Brake Company in regard to the duties payable on the patent parts of that brake. The company considers that the duty should only be charged on the English prices of the brake, 50*l.*, but the Customs authorities desire to charge on the royalty also on each brake. A quantity of brake machinery has been detained pending a settlement.

The Suez Canal—The rough revenue of the Suez Canal Company in 1883 amounted to 2,740,934*l.* After provision had been made for working expenses, statutory allocation to the reserve, interest at 5 per cent. per annum upon capital, &c., a balance of 1,434,542*l.* remained available for the payment of a further dividend. The total distribution upon each 20*l.* share for 1883 has been fixed at 3*l.* 11s. 11d. This is equal to about 17¾ per cent. per annum. In consequence of the appointment of some additional English directors the number of members of the council of administration has been carried from 14 to 32.

South Australian Jetties and Wharves.—The South Australian Government has constructed upwards of sixty jetties and wharves, at a cost of about 373,000*l.*, exclusive of the Goolwa, Port Augusta, and Port Wakefield wharves and jetties at Victor Harbour and Wallaroo, which are included in the cost of railways; the Althorpe Island and Penguin Island jetties, built with funds provided for the lighthouses there, and the Mundy-street, Queen's, and Dockyard wharves, Port Adelaide, Queen's Wharf, Port Pirie, and the Port Wakefield (1000 ft.) Wharf, paid for out of loans for deepening and improving ports. One or two of these structures are useless, several are seldom or ever used, no revenue whatever is received from about a dozen which cost upwards of 30,000*l.*, and only about 370*l.* per annum, or rather more than one-half per cent., for about twenty which cost upwards of 63,000*l.* Many of these jetties were built with money borrowed at no less than 4 per cent., and a considerable sum (about 2000*l.*) is spent every year for maintenance, &c. Most of the jetties have been placed under the control of the South Australian Marine Board, and the total revenue received during 1883 for tolls and leases, including sums paid by owners of private jetties, was about 2400*l.* The tolls charged for goods placed on Marine Board jetties are very low, and a proposal to increase them will shortly be brought forward.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF SPECIFICATIONS PUBLISHED DURING THE WEEK ENDING JUNE 28, 1884.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

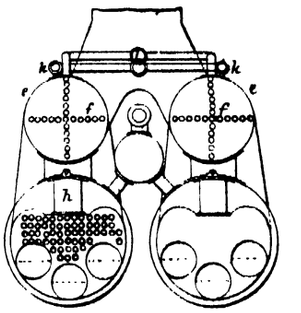
Copies of Specifications may be obtained at 88, Cursitor-street, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, and addressed to MR. H. READER LACK.

NUMBER OF APPLICATIONS FOR PATENTS.

	1884	1883	1858
June 24th	50	..	13
,, 25th	39	15	5
,, 26th	50	33	—
,, 27th	49	22	6
,, 28th	42	16	6
,, 29th	..	22	10
,, 30th	37	17	9
Total for week	267	125	49
Total from January 1st to June 30th (inclusive)	9593	3258	1582

5088. Arrangement of Circuits and Apparatus for the Distribution of Electricity: J. S. Beeman, London. [6*d.* 12 *Figs.*]—Two or more generators or sets of generators, preferably producing currents of equal or nearly equal electromotive force and also quantity, being fitted when necessary with means whereby the electromotive force and quantity are regulated, are employed. The + conductor from the first generator is taken by a convenient route towards the second generator, and alongside and parallel to the — conductor of the second generator; the + conductor from the second generator is taken by a convenient route towards a third generator, and alongside and parallel to the — conductor of the third generator, and so on; the + conductor of the last generator being alongside and parallel to the — conductor of the first generator. Automatic or other resistances, such as lamps, motors, &c., are placed between the + conductor of one generator and the — conductor of the following generator. Branch and sub-branch circuits are connected between the parallel conductors in the ordinary way. This arrangement is also applicable to circuits having a central compensating conductor. When the translating devices are arranged in series, the + pole of the first generator is connected to the — pole of the second generator through the translating devices, and so on. The generators may be primary or secondary batteries, dynamo or magneto-electric generators, &c. The patentee does not claim the above as applied for telegraphic purposes. He also states that he is aware of the following specifications: 1380, 4548, and 6199 of 1882, and 2204 of 1883. (October 26, 1883).

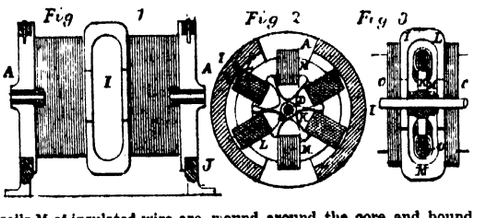
5175. Steam and Hot Air Generator: W. Turnbull, London. [8*d.* 7 *Figs.*]—A portion of the heat or waste heat from the furnace of a steam boiler is utilised in tubular receptacles for heating air, the receptacles being supplied with compressed air forced therein by pumps. Referring to the illustration, the hot gases from the boiler furnace and combustion chamber pass through the boiler tubes into the smokebox and from thence they



pass through the tubes *f* of the hot air generator *e* into the chimney. A pipe *h* connects the combustion chamber and the flue of the hot air chamber and is provided with dampers by which the quantity of gases passing directly is controlled. The air is supplied by a pump through the pipes *k* and passes off through the pipes *l*. These improvements are also shown applied to locomotive and stationary boilers. (October 31, 1883).

5202. Electric Meters: R. Belfield, Tulse Hill, Surrey. [6*d.* 13 *Figs.*]—In order to measure electric potential, and especially the potential of rapidly alternating currents, four double quadrants are mounted upon an insulating base, and connected together in pairs, the opposite quadrants forming a pair. A needle having approximately the form of one pair of quadrants is suspended by a wire between the upper and lower surfaces of the double quadrants. One terminal of the circuit is connected through the suspending wire to the needle, and also to one pair of quadrants, and the other terminal is connected to the other pair, the needle being then repelled by one pair and attracted by the other pair, and is thus caused to leave its zero point. It is brought back to the zero point by turning the capstan head to which the suspending wire is attached, and the amount of the movement of the head is read off upon a scale which may be graduated to read directly in volts. The axis of needle is guided so as to retain the needle parallel to the quadrants. In another arrangement two discs are employed, the one fixed and the other suspended over it. The discs are connected to the terminals of the circuit, and the attraction between them is measured. In order to measure electric currents, a wheel or drum is mounted to revolve between a pair of coils having their axes coaxial with the axis of the wheel or drum. The current to be measured passes through the wheel or drum and also through the coils. The wheel or drum consists of radial arms fixed upon two bosses, the two sets of arms being connected by conductors parallel to the axis. The current passes from the boss up one set of arms to the conductors, down the other set to the other boss. The same or another portion of the current passes in opposite directions through the two coils. A fly revolving in a trough of mercury or other fluid is arranged on the axis of the wheel or drum, and the axis is connected to a registering train of wheelwork. In order to convert this into an ampère meter, the fly and registering train is dispensed with, and the axis is caused to lift a weight at a varying leverage by means of a curved arm attached to the axis, or to strain a spring. The deflection of the axis can be made proportional to the current. (November 1, 1883).

5238. Electric Generators: H. J. Haddan, London. (*Bain Electric Company, Chicago, U.S.A.*) [10*d.* 18 *Figs.*]—As will be seen from the illustrations, the field magnets consist of two core pieces I provided at their ends with semicircular yoke pieces A and at their centres forming hollow pole-pieces. The armature shaft D revolves in bearings in the pieces A which are clamped together, and to the baseplate by rings J and bolts. The object of this construction is to make each part of the field magnets interchangeable and so that they can be "turned" at one chucking. A segment of the yoke rests in a concaved piece in the base, so that the field magnets will not fall apart when the rings J are loosened, and they can be turned round to any angle and again clamped. The armature consists of a spider frame K, the ends of the arms being provided with blades o upon which are wound insulated iron wires L to form the body of the ring. The



coils M of insulated wire are wound around the core and bound with cloth canvas and shellac. The coils are connected to the commutator by conductors lying in grooves in the shaft D and covered by a sleeve forming a bearing for the shaft, and having discs at either end with grooved peripheries to prevent the oil coming in contact with the conductors. The coils, of that type of armature in which the coils are connected in a closed circuit, passing at or near the neutral points of the field, are utilised in a separate circuit. Supposing there to be six coils on the armature, the two opposite coils are connected in a single circuit and the terminals of this circuit are each connected to a separate commutator each consisting of three equal segments insulated from each other. The other pairs of coils are connected in a similar manner to the other segments of the commutators. Brushes bear on opposite points of each com-

mutator, and the two brushes of one commutator being connected to the terminals of the main circuit, and the two brushes of the other commutator together, it will be seen that the two coils passing through the neutral parts of the field are out of circuit, and that the other four coils are connected in series; or, if the corresponding brushes of each commutator are connected to the terminals of the main circuit, the two circuits of the coils will be in multiple arc. When the number of coils is some multiple of four, the terminals that described above. The terminals of each pair of coils are also connected to opposite segments of a commutator having six equal segments, the brushes bearing on the segments so that the circuit of the pair of coils is closed just as it is opened at the other two commutators. If a continuous current be desired in this minor circuit, each segment is divided into two equal and insulated parts, each part being connected to the nearer part of the opposite segment. This circuit may then be employed for exciting the field magnets. In another arrangement the two circuits of the four coils cutting the lesser number of lines of magnetic force are connected in parallel circuit, and the two coils cutting the greater number in series. In this arrangement each of the brushes of the two commutators (described above) of the main circuit is divided into two parts, one being slightly in advance of the other, or the strips of the commutator may overlap or be arranged spirally. The minor commutator has six insulated and six conducting segments, the brushes being connected together so as to short-circuit the two coils passing through the neutral position, the other four coils being then in series; the circuit connecting the brushes of the minor commutator may include a very high resistance which may be adjustable. (November 5, 1883).

5244. Apparatus for Producing Intense White Light: C. D. Abel, London. (*C. Clamond, Paris*). [6*d*. 3 *Figs.*]—The combustible gas passes into an annular chamber and issues from perforations and comes in contact with a heated central air supply producing a series of small flames that rise up into a cage of refractory material. (November 5, 1883).

5249. Steam Engines: T. Hunt, Manchester. [6*d*. 17 *Figs.*]—In steam engines for tramways, &c., the uptake of the engine boiler is placed on the side farthest from the firedoor, the intervening space being provided with pendent tubes or water spaces. The chimney consists of two concentric tubes, the space between which is filled with a non-conductor of sound. A valve varies automatically the area of escape for the exhaust steam according to its pressure. The overflow from the injectors is led back to the water tanks. The reversing gear and steam regulator are actuated by pressure from the boiler. (November 5, 1883).

5301. Multiple Drilling, Boring, Turning, and Tapping Machines: J. Carver, Nottingham. [6*d*. 5 *Figs.*]—A long horizontal shaft drives by means of worm gearing a series of vertical spindles, any or all of which can be disconnected by means of clutches. (November 9, 1883).

5318. Apparatus for Signalling at Sea: W. Balch, Greenwich. [6*d*. 4 *Figs.*]—A signal rocket comprises an outer casing, a cap chamber with cap, a fuzo, a detonated charge, and stars which are red or green as required. The discharging apparatus comprises a hinged barrel or tube provided with a central firing pin and passages for the escape of gases. (November 10, 1883).

5348. Bridges, &c.: W. R. Kinipple, Greenock. [1*s*. 14 *Figs.*]—Carriages on rollers are capable of being travelled longitudinally backwards and forwards on high level girders and the meeting ends of the girders of the two movable parts of a low level roadway are suspended from these carriages. The shore ends of these girders are supported on rollers on the adjacent fixed spans. Several arrangements are described. Swing bridges are pivotted at one end and their other end is carried by carriages travelling on high level girders. (November 13, 1883).

5349. Connection of Pipes for Communicating Fluid Pressure to Work Brakes on Railway Trains: C. D. Abel, London. (*G. Westinghouse, Pittsburgh, Penn., U.S.A.*) [6*d*. 5 *Figs.*]—Two separate hose pipes or two separate sets of jointed pipes are arranged to extend from a valve box on one carriage to a similar box on the next. The valve box has in each case a middle chamber communicating with the metallic pipe that is fixed on the carriage, and has two lateral branches communicating respectively with the two flexible pipes. These branches are governed by a duplex valve, which in its middle position closes neither branch, but moves to close the unsound passage when one

Fig 2

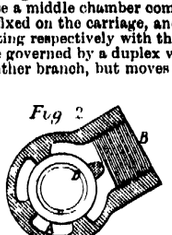
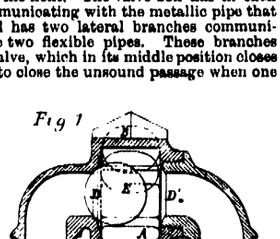


Fig 1



of the branches gives way. Referring to the illustration, the middle chamber A of the valve box communicates by a branch B with the fixed pipe of the carriage, and is provided with two branches C C¹. D D¹ are the valve seatings and E the valve. As shown in Fig. 1, the flexible connection to the pipe C is supposed to have been damaged. In order to avoid the duplication of the coupling and uncoupling arrangements, a single intermediate coupling has attached to each part a valve box of the kind described above, the two lateral passages being governed by the valve and connected to the flexible pipes, and the other passage being open to the coupling. (November 13, 1883).

5351. Lowering, Raising, and Releasing Ships' Boats: C. J. Fox, Birkenhead. [8*d*. 6 *Figs.*]—This consists essentially of a rocking arm pivotted at one end to the deck, and at the other to a supporting bar connected to a crutch arm which bears the boat. (November 13, 1883).

5357. Hydro-Carbon Furnaces: A. J. Boul[illegible] (O. D. Orvis, Chicago, U.S.A.) [8*d*. 7 *Figs.*]—The hydro-carbon liquid is forced by means of steam into a retort heated directly by a furnace, and rises and escapes in the form of vapour to the fire chamber. (November 13, 1883).

[illegible]d Hydro-Ca[illegible] Gases: W. R. Lake, London. (*T. B. Fogarty, Brooklyn, U.S.A.*) [8*d*. 2 *Figs.*]—This consists mainly in converting the atmospheric nitrogen, discharged with the hydro-carbon gases and other products of furnace combustion, into ammoniacal gas, removing the ammonia from the gases, and then passing the remaining nitrogenous gas deprived of carbonic oxide and carbonic acid into retorts containing bituminous coal mixed with an alkali or alkaline earth while undergoing destructive distillation for the generation of illuminating and heating gas. (November 13, 1883).

5373. Controlling an Engraving, Cutting, or Impressing Machine according to Pattern, &c.: H. J. Had[illegible] (*The Bain Electric Company, Chicago, U.S.A.*) [6*d*. 2 *Figs.*]—The position of the cutting or forming tool is adjusted by means of an electrical regulating device. A transparent or translucent pattern moves in unison with the plate to be engraved, and is subjected to rays of heat or light which are afterwards received upon a selenium cell or its equivalent in connection with the regulating device. (November 14, 1883).

5381. Hydraulic Lifts: J. H. Johnson, London. (*H. M. L. Crouan, Paris*). [10*d*. 17 *Figs.*]—The distributing apparatus is operated by eccentric studs causing either of two main valves to open, and at the same time maintaining the other main valve closed according as the controlling wheel is turned in one direction or the other, the said main valves being provided with auxiliary or relieving valves and trunks working in cylinders, and with pendent cylindrical projections on the lower side, whereby the flow of water is graduated. Ropes are employed for actuating the distributing apparatus. (November 14, 1883).

5411. Petroleum Heating Apparatus: R. Schuls, Dresden, Saxony. [6*d*. 2 *Figs.*]—The hydro-carbon is converted into spray by means of an ejector, and compressed air or steam, and passed through a series of three concentric fire tubes. (November 16, 1883).

5420. Tool Holders for Lathes, &c.: M. C. Despard, Esher, Surrey. (*G. S. Jones, Cawnpore*). [6*d*. 4 *Figs.*]—The tool holder is constructed with a cylindrical swivel-head carrying an internal plug, through slots in both of which the tool is passed. A screw bolt passes through the stem of the swivel-head and bears against the plug so as to grip and hold the tool, and a nut screws on to the exterior of the stem of the swivel-head to lock it to the shank. (November 17, 1883).

5422. Dynamo-Electric Machines and Electro-Motors: Sir C. T. Bright, London. [6*d*. 4 *Figs.*]—The system described in Specification 2280 of 1883 is applied to alternating current generators. Referring to the illustration, the iron or steel shaft is divided into two parts N and S by a piece of brass, the adjacent faces of the two parts being expanded into discs, from the

Fig 7.

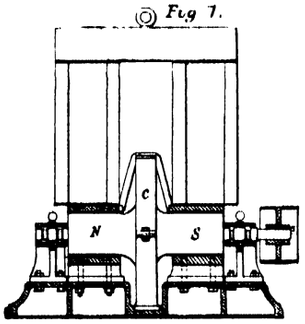
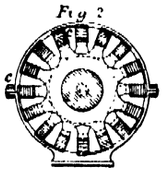


Fig 8



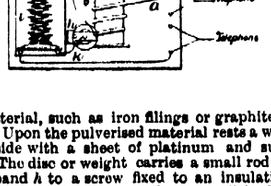
outer edges of which are cut spaces dividing the discs for a suitable depth into radial arms forming the poles. A fixed ring C co-axial with the shaft N S carries a series of coils *f* with or without soft iron cores. The shaft is polarised by electro-magnets excited by a separate generator, or by permanent magnets, or by a combination of the two. The stationary armature coils are connected to fixed terminals. (November 17, 1883).

5425. Automatic Feeding of Boilers: A. Mayhew, London. [6*d*. 4 *Figs.*]—This comprises two cylinders connected together at the base, and fitted with suction and delivery valves. The water is drawn into the apparatus by means of a vacuum created by the action of the steam. A pipe extends from the suction and delivery valves to nearly the top of one vessel. A U shaped pipe connects the bottoms of these vessels, the top being connected by a passage controlled by a valve. (November 17, 1883).

5431. Steam Engines: W. P. Thompson, Liverpool. (*F. D. Cumnver, Detroit, Mich., U.S.A.*) [8*d*. 14 *Figs.*]—The exhaust valves are arranged at a lower level than the cylinder and the main steam and exhaust valves are operated simultaneously by one eccentric, eccentric rod, and rocker arm. Secondary valves may be combined with the main exhaust valve and distribute the steam to the auxiliary heater and a condenser. The cut-off valve is operated by an independent eccentric. (November 17, 1883).

5446. Facilitating the Coupling and Uncoupling of Railway Vehicles. G. W. von Nawrocki, Berlin. (*P. Madsen, Berlin*). [6*d*. 5 *Figs.*]—The coupling link is connected by a short link with a toggle link turning on nuts guided in the drawbar and controlled by a screwed rod operated by worm gearing from a horizontal shaft. The engaging and disengaging is effected by a divided lever supported on a transverse shaft, the coupling being drawn up tight by the worm gearing. (November 19, 1883).

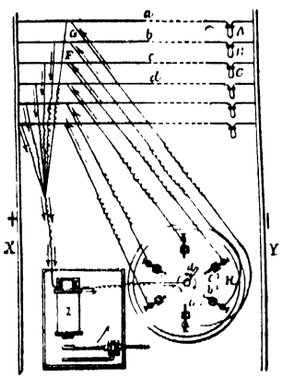
5448. Telephonic or Microphonic Apparatus: H. H. Lake, London. (*J. Berliner, Hanover*). [6*d*. 7 *Figs.*]—A pulverised or granulated conducting material is employed under pressure, either in a dry state or moistened with water or other liquid. Referring to the illustration, the flexible speaking tube *a* is wound around a drum B and one end is fixed in a metallic sleeve screwed into a brass disc connected by screws to a ring of insulating material. Between the ring and disc is a perforated plate covered with a thin sheet of platinum serving as a support for the



granulated material, such as iron filings or graphite contained in the chamber. Upon the pulverised material rests a weight covered on the underside with a sheet of platinum and surrounded by cotton wool. The disc or weight carries a small rod connected by a conducting band *h* to a screw fixed to an insulating plate and connected by a conductor *k* to an induction coil *l*. The other terminal of the induction coil is connected to one pole of a battery and the brass disc to the other pole of the battery. The connections are clearly shown in the illustration. Slight modifications are shown. (November 19, 1883).

5463. Railway Signalling: H. [illegible]orris, Manchester (6*d*. 10 *Figs.*)—The patentee refers to his previous specifications 1796 of 1881 and 1527 of 1882. The tilting rail mentioned in the latter specification is raised by an arm fixed on a shaft carried under the rail to the side of the line, the counterweight being fixed to this shaft by means of an elbow lever. The semaphore signal may be combined with a bell or other audible signal which can be disconnected. (November 20, 1883).

5465. Meter for Electric Currents: A. M. Clark, London. (*J. Houre-Humbert, Besancon, France*). [6*d*. 8 *Figs.*]—A clock actuates a rotating contact arm passing over a series of contacts, the arm and contacts being connected to the sub-derivations in which the lamps are placed. The arm completes the circuit through an electro-magnet which operates the registering mechanism. Referring to the illustration A B C, &c., are the lamps arranged in multiple arc derivations *a b c*, &c., between the



mains X Y. The circular series of contacts a^2 b^2 c^2, &c., are connected to the derivations *a b c*, &c., and the arm *o*, which makes contact with these contacts, as it is uniformly rotated by clockwork, is connected through the electro-magnet Z with the main or with each of the derivations. If the corresponding lamp is in circuit when the arm *o* makes one of the contacts, a current will pass through the electro-magnet Z, which attracts its armature and operates the registering mechanism. This meter thus gives the number of lamp hours. (November 20, 1883).

5468. Rivetted Joints: J. A. Rowe, North Shields. [6*d*. 9 *Figs.*]—The joints are constructed so as to leave between the edges of the adjoining plates a space sufficient to allow of caulking the edges of the plates against the butt straps, the rivets being closely pitched. (November 20, 1883).

5469. Secondary Batteries: F. M. Lyte, Putney, Surrey. [4*d*.]—This refers to electrodes of secondary batteries constructed as described in Specification 3452 of 1882. The electrode is constructed of a pair of non-conducting plates serving as supports for studs, prisms, or bars of active material held in contact with an intermediate plate of conducting material. The studs or bars are caused to adhere securely by placing their bases on the central conducting plate and moulding or pouring around them some suitable material such as pitch. The prisms, strips, or bars may be reduced either before or after being placed in contact with the central plate and may be securely held in place by a grating of lead cast or made to fit over them, the studs projecting through apertures, or if the central plate is of metal, the studs or prisms may be passed through holes therein, or wire gauze is coated on both sides with the active material. Short wires pass transversely through the active material and through the intermediate plate. Solutions of sulphates or acid sulphates of the alkaline metals or phosphoric acid may be employed as the exciting solution. (November 20, 1883).

5471. Telegraph and Telephone Lines, &c.: H. H. [illegible] (*J. C. Chambers, Cincinnati, Ohio, and N. C. Gridley, Chicago, Ill., U.S.A.*) [9*d*. 7 *Figs.*]—One or more induction wires are arranged in close proximity to the aërial conductors and are insulated from the supports, conductors, and earth. If the conductors are insulated they may surround the induction wire. (November 20, 1883).

5472. Electric Lamps: H. H. Lake, London. (*T. J. McTighe and J. T. McConnell, Pittsburgh, Penn., U.S.A.*) [6*d*. 3 *Figs.*]—A short circuit, across the terminals of the lamp, has two interruptions or "breaking points," one adapted to be closed by the weakening of the feed or main magnet or the abnormal strengthening of a shunt magnet, and the other adapted to be opened by the pressure of one carbon upon the other, and closed by their separation. Referring to the illustrations, the top plate, which is rigidly connected to the bottom plate, carries the main magnets C and the shunt magnets D. A horizontal lever F is pivotted to a fixed bracket, and one end is pivotted to a vertical arm carrying the crosspiece *b*, to which the cores of the hollow main magnets C are attached, and the other end is connected to the cores of the shunt magnets D in a similar manner. A vibrating lever *f*, pivotted at one end to a fixed support, fulcrums upon a curved surface of the lever F, and the other end is connected to a standard *g* projecting upwardly from a box *h* surrounding the toothed carbon-holder G. A small pinion, journalled in the box *h* and engaging with the rack teeth, carries on its shaft the escapement wheel *i*, which is controlled by a weighted escapement pallet pivotted to the standard *g*, and engages with a detent *m* pivotted to an arm projecting from the box *h*. The magnets C when excited raise the end of the lever F, thus lifting the lever *f*, box *h*, and (the wheel *i* being locked by the detent *m*) the rod G, and establish the arc, the change in the fulcrum of the lever *f* compensating for the increasing attraction as the cores are drawn into the magnet. When the arc becomes abnormally long, the magnets D lower the lever *f*, box *h*, and rod G, and eventually the toe of the detent *m* comes against an adjustable stop, releasing the wheel *i*, and allowing the rod G to descend, the descent being regulated by the weighted pendulum. The rod G and standard *g* pass through an opening in the lever F, to which is attached near one end the adjustable retractile spring *p*[1]. The vertical arm connecting the lever F and crosspiece *b* is insulated from the piece *b*, but has a slight vertical play in relation to the piece *b*, which piece when unattracted rests in contact with an insulated metallic washer on the vertical arm and a pin depending from the washer bears against a contact brush *t*. The lower carbon-holder slides in an insulated metallic socket, and an insulated pin on its stem bears upon a spring P, which holds the carbon-holder slightly raised and also makes a contact, except when the upper carbon rests upon the lower. The spring is in connection with the brush *t* and the contact piece to the insulated metallic socket and by a conductor to the — terminal. The normal circuit of the lamp is from the + terminal through the coils C and by a brush to the rod G, carbons, metallic socket and — terminal. The attraction of the magnets C on the piece *b* breaks the contact with the washer. The arc being struck the contact at P is made. If the normal circuit

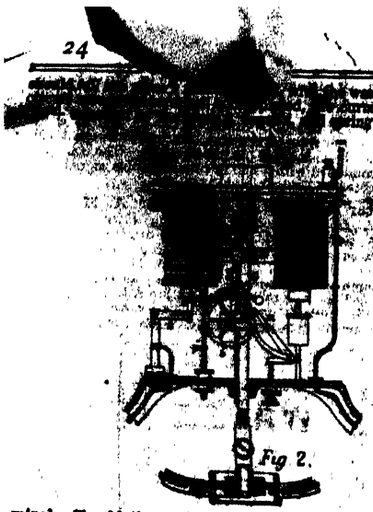


Fig 2.

minal. Should the carbons come in contact this circuit is broken at P and the lamp again brought into action. (November 20, 1883).

5478. Manufacture of Oxide of Zinc: A. P. Price, London. [2d.]—Metallic zinc, contained in the combustible and other gaseous products arising from the treatment of ores or compounds containing zinc, are burnt and oxidised. (November 21, 1883).

5475. Steam Hammers: J. Cochrane, Barrhead, N.B. [6d. 3 *Figs.*]—The edges of the valve and of the ports by which the steam enters the top of the cylinder are made of an angular form, and the valve can be turned independently of its longitudinal movement. The valve gear can be changed from self action to hand action. (November 21, 1883).

5488. Furnaces for Heating Ingots, &c.: E. W. Richards, Middlesbrough. [8d. 6 *Figs.*]—The furnace is provided with a series of vertical chambers so connected with one another and the source of heat that the heating medium travels over the entire length of each ingot. (November 22, 1883).

5489. Treatment of Alkaline Salts at High Temperature, &c.: C. A. Faure, Paris. [6d. 7 *Figs.*]—Electric conductors are embedded in the material joining the bottom of the pan, which is preferably of compressed magnesia, and serve to heat the furnace. (November 22, 1883).

5496. Sugar Cane Mills: F. M. Rogers, London. (*A. Leblanc, Cienfuegos, Cuba*). [6d. 3 *Figs.*]—This relates to the arrangement of the rollers, to the injecting knives which are placed on the underside of the bagass, and have two or more chambers with oblique openings, so as to prevent the retention of acid liquid, and to the arrangement of brake by which both ends of the roller can be slackened or tightened at the same time. (November 23, 1883).

5502. Blast Furnaces: G. G. M. Hardingham, London. (*L. D. York Portsmouth, Ohio, U.S.A.*) [6d. 2 *Figs.*]—An air-heating stove is connected to the blast furnace. Air is forced through a heating stove into the base of the gas-producing furnace, and having traversed the same is conveyed and supplied to the blast furnace. The air is also supplied from the air-heating stove direct to the furnace. (November 23, 1883).

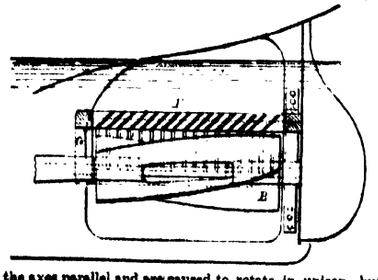
5503. Telegraphic and Telephonic Apparatus: H. H. Lake, London. (*F. Van Rysselberghe, Schaerbeele, Belgium*). [8d. 12 *Figs.*]—This relates to means whereby ordinary telegrams sent by the Morse, Hughes, Wheatstone, or other apparatus, and telephonic conversations may be simultaneously transmitted by the same wire over long distances. This comprises two conductors with two condensers and two induction coils coupled on a differential system in such manner that one extremity of the primary of each coil is connected with the earth, the secondary circuit being in connection with the telephonic station. (November 23, 1883).

5509. Miners' Lamps: E. Evans, Llanrwst. [6d. 1 *Fig.*]—A cylinder is suspended by an easily fused connection placed near the wire gauze on the inside in such manner that if the gas begins burning on the inside the connection is destroyed, and the cylinder falls and cuts off all communication between the lamp combustion chamber and the outside air. (November 24, 1883).

5519. Ship Railways and Carriages: J. B. Eads, London. [1*s.* 12 *Figs.*]—This relates to means for raising ships from the water on cradles over carriages adapted to run upon two or more lines of rails, and for lowering them upon the carriages so as to maintain each of the ships in proper position and distribute its weight over all the carriages; and to the construction of turntables for ship railways, the object being to deflect the carriages and their locomotives on to other lines. This will be fully illustrated and described in an early issue. (November 24, 1883).

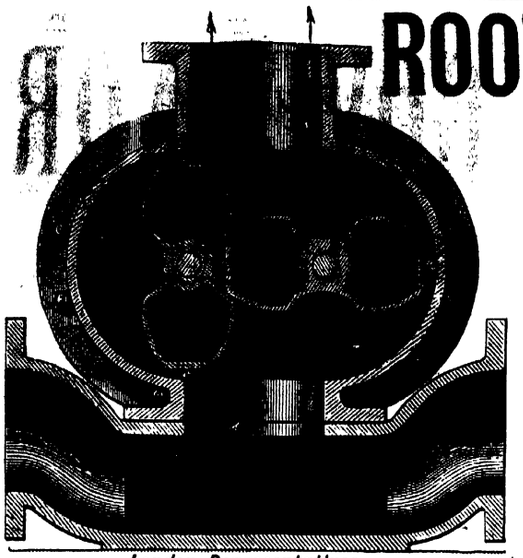
5530. Burners for Increasing the Luminosity of Gas Flames: F. Siemens, Dresden. [6d. 4 *Figs.*]—The lower part of the flame is surrounded with a heat absorbing and conducting casing which is utilised for heating the air and gas supply. (November 26, 1883).

5528. Propelling and Steering Ships: B. Dickinson, Bourne End, Bucks. [6d. 2 *Figs.*]—Two screw propellers having blades of quick or coarse pitch, the one being right-handed and the other left-handed, are arranged side by side



with the axes parallel and are caused to rotate in unison, but in opposite directions. The patentee states that as the blades approach each other in the lower portion of their spheres they press with equal power upon the water for the time being within their in-

[illegible] and thereby respectively create an increased resistance to their own rotation. The [illegible] gripped" against rearwardly [illegible] and, [illegible] pitch of the blades, the [illegible] B which [illegible] [illegible] of the [illegible] [illegible] [illegible]



ROOT'S PATENT ROTARY PUMP

HAS HIGH EFFICIENCY
and GREAT SIMPLICITY.
NO PUMP VALVES.

THE BEST PUMP FOR
IRRIGATION, DRAINAGE & WATER WORKS,
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BROTHERHOOD'S PATENT

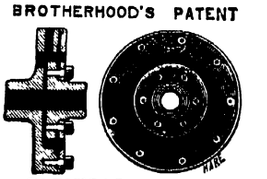


FLEXIBLE COUPLING

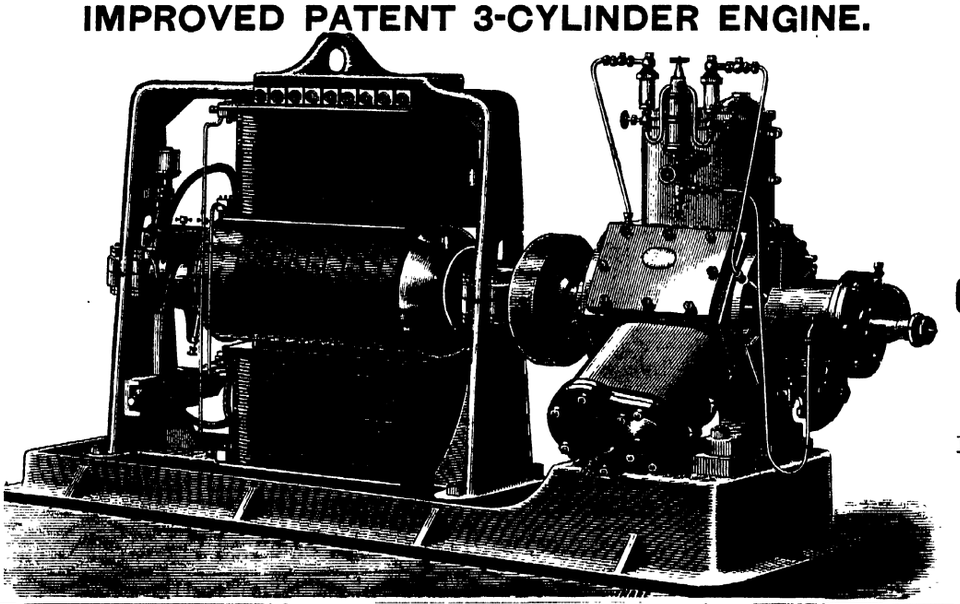
PETER BROTHERHOOD,

MECHANICAL ENGINEER,
BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.
IMPROVED PATENT 3-CYLINDER ENGINE.

BROTHERHOOD'S PATENT



FLEXIBLE COUPLING



THE MOST
ECONOMICAL
AND
EFFECTIVE
FOR
SHIP LIGHTING

As in General Use in the British, French, Italian, Danish, &c., &c., Navies.

FOR DRIVING
FANS,
CENTRIFUGAL PUMPS,
AND OTHER
HIGH-SPEED
MACHINERY.

5204

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MAKERS OF

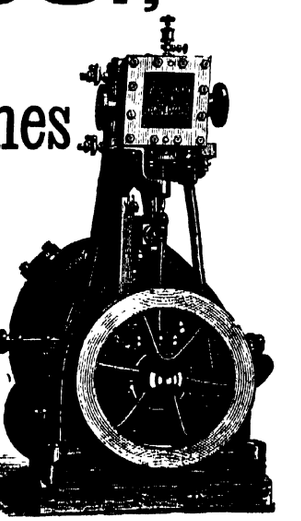
The Improved Centrifugal Pumping Engines



AS APPLIED FOR RAISING WRECKS.

FOR SALVAGE PURPOSES,
RAISING WRECKS,
AND SUNKEN SHIPS.

First Prize Silver Medal,
NORTH-EAST COAST EXHIBITION,
-1882.-



4808

Established 1838. Telegrams—"EVANS," Wolverhampton.

THE

PICKERING PATENT GOVERNOR

FOR

STATIONARY, PORTABLE AND MARINE ENGINES.

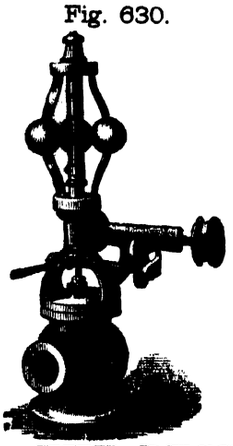
PARIS, 1867. NEW YORK, 1872. VIENNA, 1873. PHILADELPHIA, 1876. PARIS, 1878.

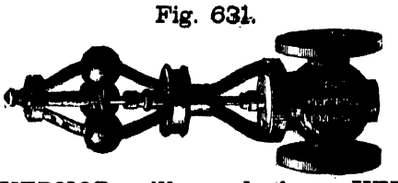


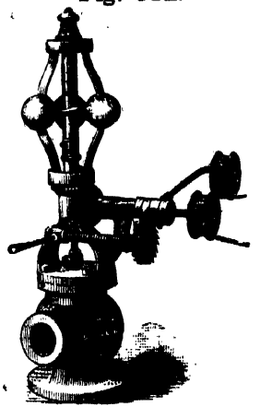




Fig. 630. Fig. 631. Fig. 632.



HORIZONTAL  GOVERNOR.



The PICKERING GOVERNOR will work in a VERTICAL, INCLINED, or HORIZONTAL position.

50 THOUSAND of these Governors have been Sold, and numerous Testimonials received bearing testimony to their VAST SUPERIORITY.

A LARGE STOCK ALWAYS ON HAND.

THE BEST GOVERNOR in the WORLD for ELECTRIC LIGHT ENGINES.

DESCRIPTION.

THE object of this invention is to obtain the requisite centripetal force and stiffness without making the springs too heavy, and consists in the peculiar construction of the spring, and also in the shape of the curve given it, by the manner in which the ends and middle portion are secured, so as to keep those parts at all times parallel with the centre of motion. By this arrangement, we can use steel so thin that all liability to break, or tendency to "set," or lose its elasticity, is dispensed with; while, by using two or more strips together, we can obtain the required centripetal force. The peculiar curve obtained by this arrangement is called a double cyma, by the use of which, two or more strips, firmly secured together, will work freely, without any tendency to buckle or interfere with each others action.

As may be seen by the engravings, the ends of the springs are secured to flanges, the lower of which resting on steel washers, and having a collar to prevent its rising, is capable of only a rotary motion; while the upper one, being at liberty to move lengthwise as well as to rotate, receives its rotary motion from the lower one through the springs, and communicates any lateral motion due to the varying centrifugal force immediately to the balanced valve to which the Governor is firmly secured by the bracket, a part of which forms a long bearing for the horizontal spindle, which communicates motion from the power to the Governor through the mitre gearing.

This Regulator is offered entirely on its own merits. Its price is less than that of any other good Governor. Having no joints, it is extremely sensitive. Its durability is beyond question. Its economy in fuel has been fully proved.

— REDUCED PRICE LIST. —

Sizes and Prices of the "Pickering" Spring Governor, with Gun-Metal Balanced Valve, Speeder and Pulley complete.

SIZE OF VALVE OR DIAMETER OF STEAM PIPE	¾ in.	1 in.	1¼ in.	1½ in.	1¾ in.	2 in.	2½ in.	3 in.	3½ in.	4 in.	5 in.	6 in.	7 in.	8 in.	10 in.
Diameter of Steam Cylinder, suitable for.....inches	2½ to 3	3 to 4	4 to 5	5 to 7	6 to 8	7 to 9	9 to 12	12 to 14	14 to 17	17 to 20	20 to 24	24 to 28	28 to 32	32 to 36	40 to 44
Size of Pulley attached to each Governor..... "	2	2	2	3	3	3	4	5	5	6	7	8	8	8	10
Speed arranged to work up to .....revolutions	500	400	400	380	380	380	360	320	300	300	250	250	250	250	225
Extreme Height.....inches	17	18¼	20	24¼	26	27½	31	36¾	38½	43	48	52	54	56	66
Distance from Centre of Governor to end of Horizontal Bearing .....inches	5⅞	5⅞	5⅞	7½	7½	7½	9	10¼	10¼	12	12½	12½	12½	14	16
Diameter of Bottom Flange..... "	4	4¼	5	6	6¼	7	7½	9	10	11	13	14	14	16	18
Diameter of Side Flange ..... "	3½	4	5	5	5½	6	7½	7½	8½	8½	10	11	12	14	16
PRICE OF FIG. 630 COMPLETE, WITH PULLEY AND SPEEDER ...	£3 10	£4 0	£4 5	£5 0	£5 5	£5 15	£8 5	£9 10	£12 0	£15 0	£18 10	£24 10	£28 0	£34 0	£41 0
PRICE OF FIG. 632 COMPLETE, WITH PULLEY, SPEEDER AND STOP VALVE	£4 0	£4 10	£5 0	£6 0	£6 5	£7 0	£9 15	£11 5	£14 5	£18 10	£22 10	£29 10	£35 0	£42 0	£51 0
Extra for the above with Stop Motion, same as Fig 632	8/-	9/-	10/-	11/-	12/-	13/-	18/-	20/-	24/-	28/-	40/-	52/-	72/-	80/-	100/-
Extra for Nickeling the above	6/-	7/-	7/6	8/-	9/-	9/6	12/6	13/6	16/-	20/-	27/-	35/-	40/-	45/-	50/-

PRICES OF Fig. 631 ON APPLICATION.

SOLE LICENSEES

JOSEPH EVANS & SONS,

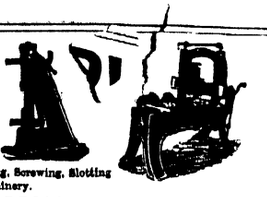
WOLVERHAMPTON,

And 52, QUEEN VICTORIA STREET, LONDON, E.C.

1881




SCOTT WEST IRON WORKS, **BROS.,** MOUNT HALIFAX.


Have the largest Stock in England of Self-Acting Slide and Screw Cutting Lathes, Radial Wall, Vertical, and Bench Drilling Machines. Shaping, Screwing, Slotting Punching and Shearing and Plate Bending Machines, Steam Hammers, Horizontal and Vertical Engines and Wood-working Machinery.

ILLUSTRATED LISTS ON APPLICATION. QUOTATIONS FOR SPECIAL TOOLS. 4305

Calcutta, 1884.—HIGHEST AWARD.

PARIS ELECTRIC EXHIBITION, 1881. Highest Award

LANCASHIRE PATENT SYDNEY 1880. FIRST GOLDEN MEDAL

MAIN DRIVING BELTS

HEAT MOISTURE STEAM PROOF

& ALL PARTICULARS ON APPLICATION

LANCASHIRE PATENT BELTING & HOSE CO. WIRE WORKS MILL STRANGEWAYS MANCHESTER.

ALWAYS IN STOCK

MELBOURNE, 1880-1881. FIRST DEGREE. 5000

BRUCE INSTRUMENT MAKER

AMP SWAN HARTNELL

4060

THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

Baker's Patent Rotary Pressure Blower and Gas Exhauster

—:o:—

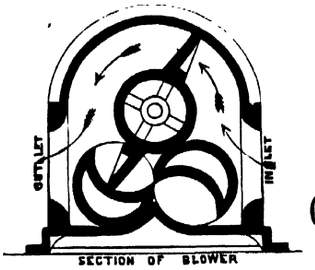
BAKER'S PATENT ROTARY PUMP.

—:o:—

HALL'S PATENT STONE BREAKER.

—:o:—

CRUCIBLE STEEL CASTINGS.



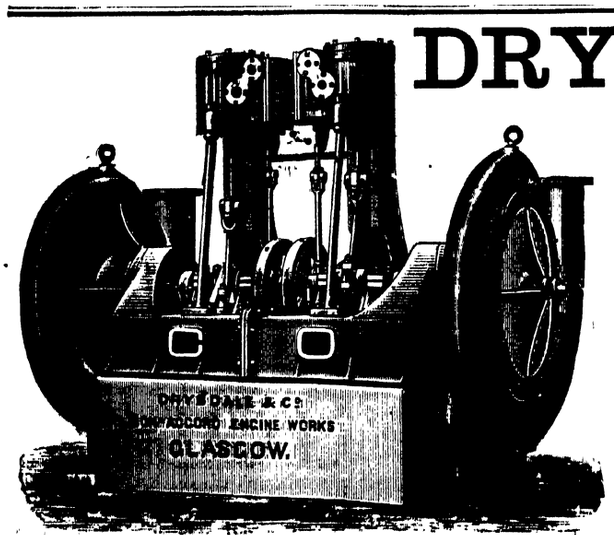
SECTION OF BLOWER

General Machinery of Every Description.

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4658

DRYSDALE & CO.

LONDON ROAD, GLASGOW.



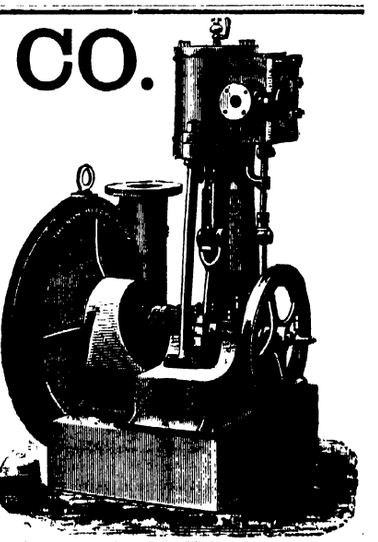
DIRECT-ACTING

Vertical Centrifugal

PUMPING ENGINES

FOR

Circulating or Ballasting Purposes.

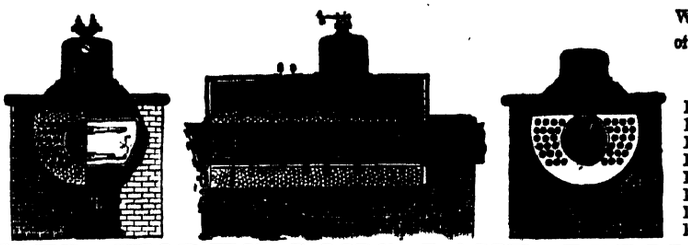


RECEIVED AWARD AT THE NORTH-EAST COAST EXHIBITION, TYNEMOUTH, 1882. 4661

. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

most important features connected with these Boilers are—
Simplicity of Construction. 2. Saving of Fuel. Greater Heating Surface. 4. Decidedly cheaper. Can be Easily Cleaned. 6. Most Durable. Accessible for Repairs without Disturbing the other Parts.
Great Economy in Boiler Space.
Will Burn either Tan, Breese, Small Coal, or Sawdust.
Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft.	long,	5ft. 0in.	diameter,	29-horse	power.
10ft.	,,	5ft. 6in.	,,	30	,,
12ft.	,,	6ft. 0in.	,,	40	,,
13ft.	,,	6ft. 6in.	,,	50	,,
14ft.	,,	7ft. 0in.	,,	60	,,
15ft.	,,	7ft. 6in.	,,	70	,,
16ft.	,,	8ft. 0in.	,,	80	,,
17ft.	,,	8ft. 0in.	,,	90	,,
18ft.	,,	8ft. 0in.	,,	100	,,

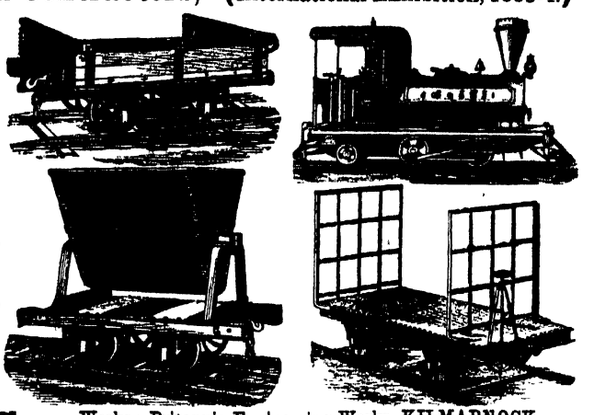
OUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

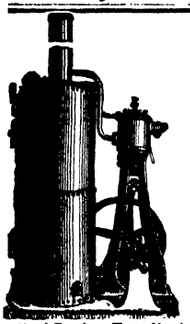
)ICK, KERR & CO., Engineers and Contractors, (Five Medals awarded, Calcutta International Exhibition, 1883-4.)



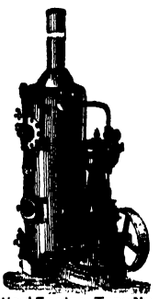
SOLE MANUFACTURERS OF
KERR'S PATENT
PORTABLE
RAILWAY
SUITABLE FOR MINES AND PLANTATIONS.
WAGONS & LOCOMOTIVES
FOR ALL CLASSES OF WORK.
Catalogues and Prices on application. 5024



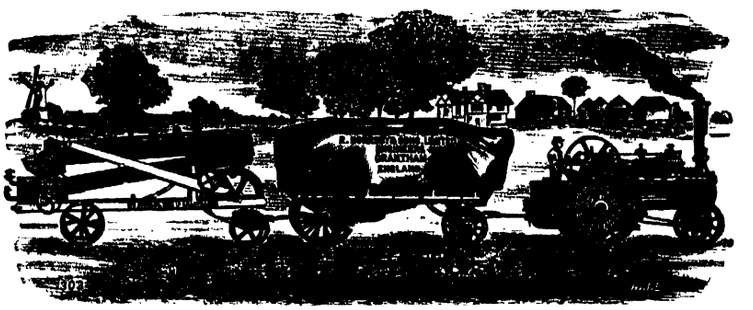
101, LEADENHALL ST., LONDON, E.C. Works: Britannia Engineering Works, KILMARNOCK.



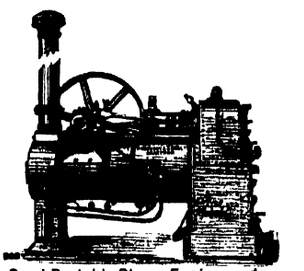
ertical Engine, Type No. 1, vith Vertical Cross Tube Boiler, 2½ to 12 HP.



Vertical Engine, Type No. 2, with Vertical Multitubular Boiler, 1 to 3 Horse Power.



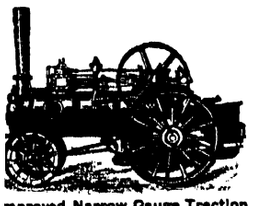
Traction Engine with Finishing Thrashing Machine and Straw Elevator on the Road.



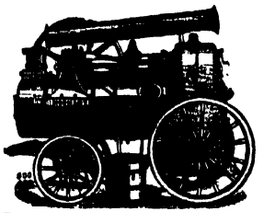
Semi-Portable Steam Engine made with Single or Double Cylinders, 2½ to 35 Horse Power.

R. HORNSBY & SONS, Limited,

General and Agricultural Engineers, Ironfounders, Boilermakers, &c.



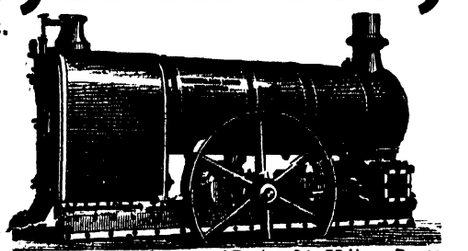
mproved Narrow Gauge Traction Engine, or Agricultural Locomotive.



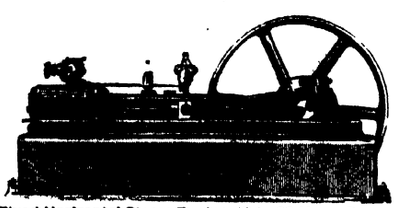
Patent Portable Steam Engine, made with Single or Double Cylinders, and from 2½ to 35-HP.



Patent Thrashing, Shaking, and Finishing Dressing Machine.



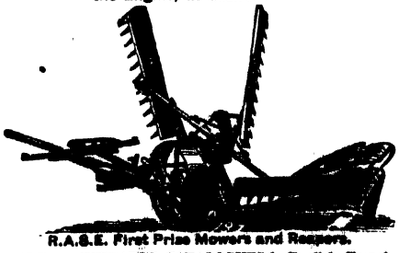
Patent Undertype Compound Engine, 6 to 50 Horse Power with Boiler above (as shewn) or separate from the Engine, as desired.



Fixed Horizontal Steam Engine, 10 to 60 Horse Power, with New Patent Automatic Expansion Gear.



Highland Society's £100 First Prize String Sheaf-B nding Harvester.



R.A.S.E. First Prize Mowers and Reapers.

For Particulars of the most modern improved and successful Agricultural Machinery, Ploughs, Dressing Machines, Corn Screens, Turnip Cutters, Root Pulpers, &c., SEE ILLUSTRATED CATALOGUES in English, French, German, Spanish, Russian, &c., sent GRATIS and POST FREE on application.

PLOUGH SHARES OF CAST IRON, CHILLED, WROUGHT IRON, MALLEABLE IRON AND STEEL. OF PATTERNS TO SUIT EVERY VARIETY OF WORK.

At the most important Exhibitions and trials since 1874, R. HORNSBY & SONS' Specialities have gained 587 PRIZES, including 45 Gold Medals, 117 Silver Medals, and 369 FIRST PRIZES

SPITTLEGATE IRON WORKS, GRANTHAM. 4998

London Office: 84, LOMBARD STREET. Telephone No. 1294. South African Depot: EDINBURGH BUILDINGS, DOCK ROAD, CAPE TOWN.

JAMES FARMER & SONS,

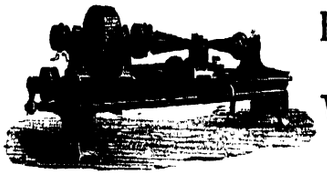
ADELPHI STREET IRONWORKS, SALFORD, MANCHESTER,

MAKERS OF

STEAM ENGINES, BLEACHING, FINISHING, DYEING & CALICO PRINTING MACHINERY,

WIRE MACHINERY

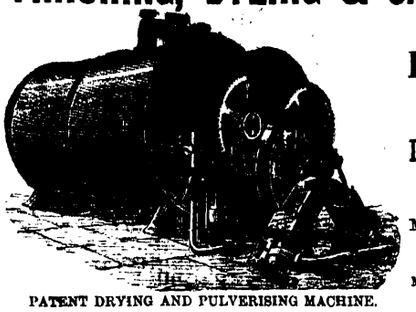
Consisting of Continuous and other Rolling Mills, Wire Pointing Machines, Wire Looms, Wire Testing Machines, Wire Blocks, &c.



COPPER TUBE ROUGHING LATHE.

BRASS & COPPER TUBE MILLS.

Wrought Iron TUBE MACHINERY.



PATENT DRYING AND PULVERISING MACHINE.

LINOLEUM

FLOOR-CLOTH MACHINERY

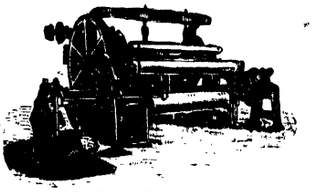
For Making Floor-Cloth Two or Four Yards wide.

"PATENT"

Drying & Pulverising MACHINE

For Excrementitious Matter & other Materials and Compounds.

MACHINERY IN GENERAL.



POWER WIRE LOOM. 4859

FOR BRICK, TILE, & PIPE MACHINES,

JOHN WHITEHEAD & CO.,

ALBERT WORKS, PRESTON, LANCASHIRE,

HAVE BEEN AWARDED

FOURTEEN PRIZES by the Royal Agricultural Society of England,

INCLUDING THE SOCIETY'S SPECIAL SILVER MEDAL FOR SUPERIOR EXCELLENCE.

Also Awarded the PRIZE MEDALS of the INTERNATIONAL EXHIBITIONS of LONDON, 1851, 1862, and 1874; PARIS, 1855, 1856, 1867, and 1878.

ILLUSTRATED CATALOGUES FREE ON APPLICATION. 4907

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

BELL'S Asbestos Works, Southwark. S.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure.....110 lbs. Vacuum.....29 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record. Yours obediently,

D. HENDERSON, Chief Engineer, S.S. "Ruapehu"

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory. Yours truly,

Mr. J. BELL. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts, Admiralty, Whitehall, 20th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core.....square. Elastic core.....round

To Mr. JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 60 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

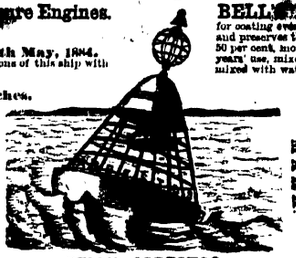
BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



TRADE MARK.

— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depôts and not through agents or factors.

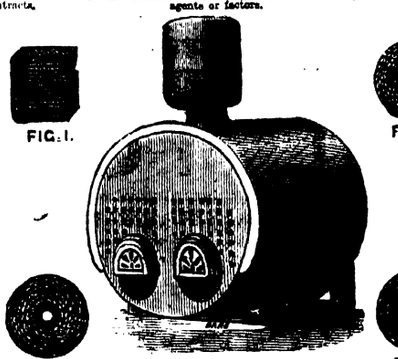


FIG. 1.

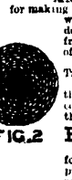


FIG. 2

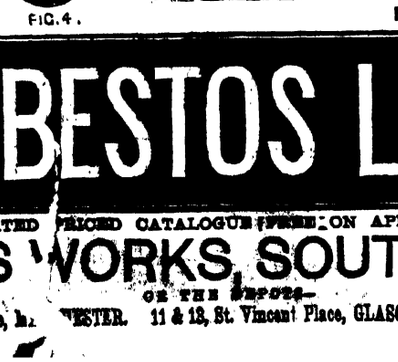


FIG. 4.



FIG. 3.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates..... 188 deg.

" " Covering..... 94 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 90 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 28th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly, "W. SANTO CRIMP, C.E., F.S.S."

The Tamar and Kit Hill Granite Company, Limited, Gunnislake, Tavistock, 8th April, 1884.

MR. JOHN BELL, Southwark, S.E.

SIR, I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ⅛ in. to 3 in. wide, and any thickness from 1 16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and 1 millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts, Admiralty, Whitehall, S.W., 17th May, 1884.

SIR,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,

Mr. JOHN BELL. Director of Navy Contracts.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REGD.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

4042

OR THE DEPOTS—

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

THOS. McCULLOCH & SONS, KILMARNOCK,

Makers of Pumping, Winding, and other STATIONARY ENGINES, TANK LOCOMOTIVES, IRON WORKS, and COLLIERY PLANT, RICK MACHINERY

And all kinds of STEAM BOILERS, ENGINES, of various sizes always in stock or in progress. Specifications, Photos., or Tracings on Application. ESTABLISHED 1848.

LONDON REPRESENTATIVE— 4175

MR. WILSON WINGATE, 11, QUEEN VICTORIA ST, E.C.



JOHN I. THORNYCROFT & CO.,

STEAM YACHT AND LAUNCH BUILDERS,

CHURCH WHARF, CHISWICK, LONDON, W.

YACHTS AND LAUNCHES FOR SEA OR RIVER SERVICE, from 25 to 100 feet in length, and Speeds from 10 to 25 Miles per Hour.

Thornycroft's Patent Screw Propellers made for all sizes of Vessels. Efficiency superior to any hitherto brought out.

TORPEDO BOAT FOR THE DANISH GOVERNMENT.—Speed 20 knots on a run of three hours, carrying 12½ tons.



5009

SINGLE CHAIN GRABS.



SUPPLIED TO ORDER WHEN PREFERRED.

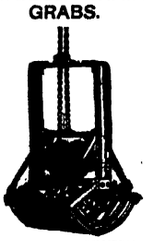
WORKS: Holderness Foundry, HULL.

PRIESTMAN BROTHERS.

CONTRACTORS FOR BARGES TO H.M. GOVERNMENT & THE INDIAN BOARD.

LONDON OFFICE: 52, QUEEN VICTORIA STREET.

DOUBLE CHAIN GRABS.



PARTICULARS, SHOWING GREAT ADVANTAGES, ON APPLICATION. 5057

AWARDS

DIPLOMA of HONOUR AMSTERDAM, Paris, Melbourne, Adelaide.

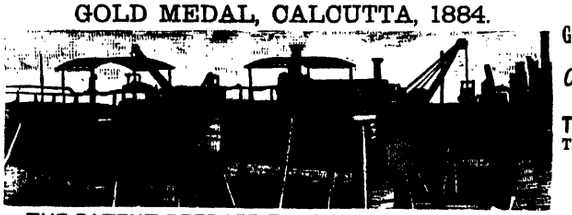
Contractors for Dredgers to

THE ENGLISH GOVERNMENT

THE CROWN AGENTS FOR THE COLONIES

The German Government
" French Government
" Italian Government
" Cape Government
" Danish Government
" Chinese Government
" Chilian Government

GOLD MEDAL, CALCUTTA, 1884.



THE PATENT DREDGER EXCAVATOR & ELEVATOR.

AWARDS

GOLD MEDAL FISHERIES LONDON, Sydney, New Zealand, Tynemouth.

Contractors for Dredgers to

THE INDIAN BOARD

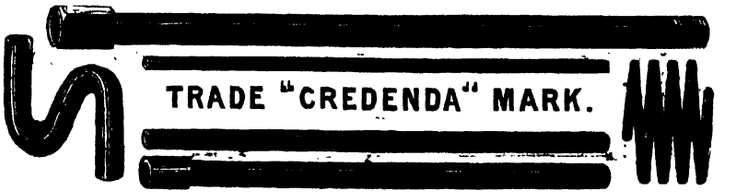
THE MERSEY DOCK & HARBOUR BOARD

The South Australian Government
" New Zealand Government
" Spanish Government
" Victorian Government
" New South Wales Government
" Dutch Government
" Queensland Government

—:- PATENT -:—

COLD-DRAWN SEAMLESS

THE CREDENDA COLD-DRAWN SEAMLESS STEEL TUBE COMPANY, BIRMINGHAM.



BIRMINGHAM WORKS & OFFICES: LEDSAM STREET, MONUMENT LANE STATION.

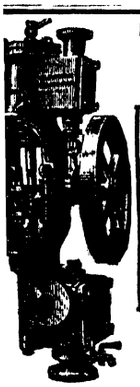
LONDON OFFICE: 4, WATER LANE, GT. TOWER STREET, E.C.

4990

FOR BOILERS AND STAYS, HYDRAULIC PRESSES, AIR RESERVOIRS,

STEEL TUBES.

BORING RODS, COUPLINGS, BUSHES, SPINDLES, COLLARS, BICYCLES & OTHER USES.



The "CLYDE" STEAM and BALLAST PUMPS.

"CLYDE" STEAM PUMP (STANDARD PATTERN). LIST OF STANDARD SIZES.

Size Double-Acting.	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Price, with Gun-Metal Valves, Plunger, &c.
	in.	in.	in.	£ s. d.
1	4	2½	4	17 15 0
2	4½	3	4	21 10 0
3	4½	3½	4½	24 10 0
4	5	3½	5	26 0 0
5	5½	3	5½	27 10 0
6	6	3½	6	29 10 0
7	7½	4	7½	41 0 0
8	8	4½	8	53 0 0

For Feeding Marine and Stationary Boilers, Pumping Water Supply to Railway Stations, Mansions, Warehouses, Mines, Dye Works, Breweries, and for use as Stationary Fire Engines, and for General Contractors' Purposes; for Tar and other Thick Liquids.

"CLYDE" STEAM PUMP (PATTERN A). LIST OF STANDARD SIZES.

Size.	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Capacity per hour.	Suitable for Boiler.	Price, with Gun-Metal Valves and Plunger.
	in.	in.	in.	Galls.	HP.	£ s. d.
0A	3	1½	3	240	20	16 0 0
1A	4	2½	4	960	80	19 10 0
2A	4½	2½	4	1220	85	22 10 0
4A	5	2½	5	1680	125	28 10 0
6A	6	3½	6	2350	175	32 0 0
8A	8	4½	8	4275	300	58 10 0

The "Clyde" Connecting Rod Steam Pump, with Swivel-box, capable of working horizontally, vertically, or in an inverted position.



"CLYDE" BALLAST PUMP (PATTERN B). LIST OF STANDARD SIZES.

Size.	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Suction and Delivery Pipes diam.	Discharge in Tons per hour.	Price.
	in.	in.	in.	in.		£ s. d.
1B	6	6	8	4	40 to 80	80 0 0
2B	6½	6½	8	4½	47 ,, 94	83 0 0
3B	7	7	9	4½	55 ,, 110	87 10 0
4B	7½	7½	9	4½	68 ,, 136	90 0 0
5B	8	8	10	5	70 ,, 140	95 0 0
6B	8½	8½	10	5½	85 ,, 170	70 0 0

This Pump is very compact, and works with the greatest steadiness. The crosshead is of cast steel, and so arranged that it can be readily detached from the pump piston rod, if the engine is required to work alone. The Pump is reversible, that is, by merely changing the position of the Valves the suction can be converted into delivery and vice versa. 4739



TRADE DISCOUNTS AND FURTHER PARTICULARS ON APPLICATION.

OUDON BROTHERS,

THWELL STREET, GLASGOW, AND UPPER THAMES STREET, LONDON.

Manchester Depot: 5, Todd Street, Corporation Street.

Cardiff Depot: T. BEER, 7, Bute Docks.

CLASS A.



LOCO. PATTERN, SINGLE LEVER.

ONLY GOLD MEDAL Paris, 1878.

THE HANCOCK

INSPIRATOR

FIRST AWARD, Sydney, 1879.

60,000 IN USE.

THE DONKEY PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND RELIABLY.

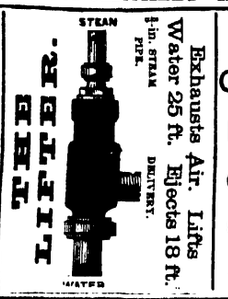
No Adjustment.

Draws Water at 140°.

All Sizes lift water 25 ft.

Delivers to Boiler up to 212°.

ESTIMATES FOR FIXING COMPLETE with Guarantee to start in good working order, and all information on application to—



THE LIFT.

Exhausts Air. Lifts Water 25 ft. Ejects 18 ft.

Feeds through Heaters.

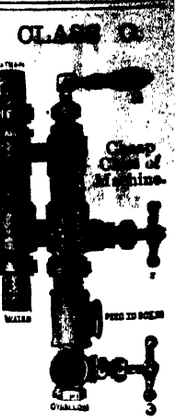
Can be used as a Pump only.

No Valves or Wearing Parts.

Can be examined instantly.

THE HANCOCK INSPIRATOR CO., 108, Upper Thames St., London, E.C.

CLASS C.



STATIONARY PATTERN. 5115

Henry Bessemer and Co., Limited,

Manufacturers of Cast Steel,

SHEFFIELD.

FORGINGS

In Steel of any size.—Quotations given either for uses or finished complete.

STEEL CASTINGS

Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0.30 per cent. carbon, and to bear a tensile strain of 34 tons to the square inch.

TYRES AND AXLES.



SOFT CAST STEEL

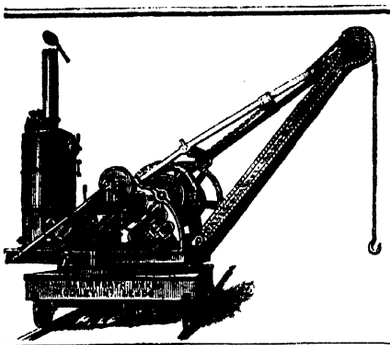
In bars and rods, for general use in Engineering Works.

BLOOMS, BILLETS, & SLABS

Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,

Of superior quality. 2137



EXORS. OF WM. BALMFORTH,

RODLEY, NEAR LEEDS,

MANUFACTURERS OF

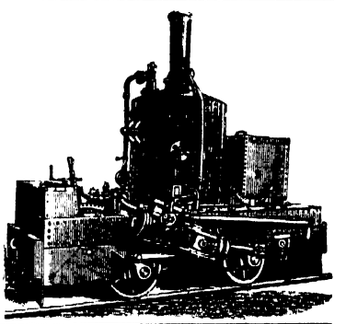
LOCO. STEAM CRANES, CONTRACTORS' LOCOS.,

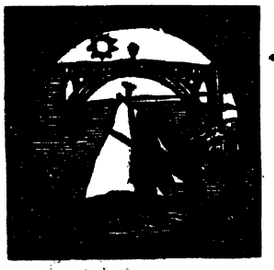
TRAVELLERS, HOISTS,

AND ALL KINDS OF LIFTING MACHINERY.

4607

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes.





THE COALBROOKDALE COMPANY, LIMITED

MAKERS OF

STEAM ENGINES,

HORIZONTAL AND VERTICAL,

AND

OTHER MACHINERY.

MAKERS OF

STEAM PUMPS.

PARKER & WESTON'S PATENT

PUMPING ENGINES for Mines, Sewage and Water Works.

BOILER FEEDERS and SLIP PUMPS.

AGENCIES { LIVERPOOL - 19, SWEETING STREET.
MANCHESTER, 29, PRINCESS STREET. 5139

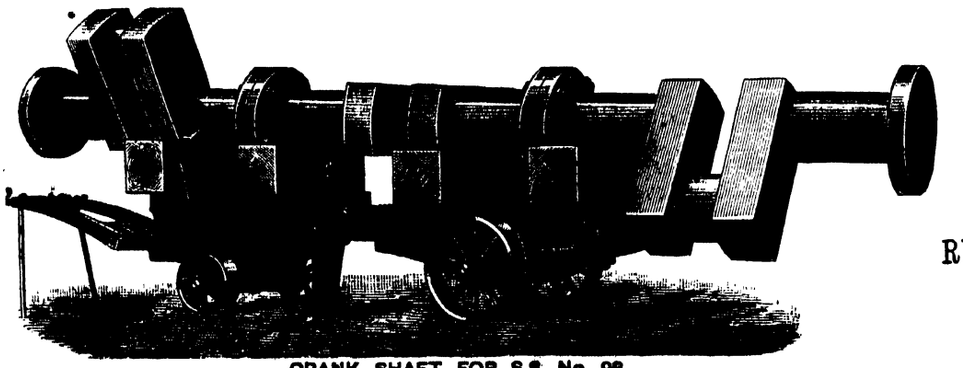
WORKS & OFFICES: COALBROOKDALE, SHROPSHIRE.

THE MERSEY FORGE, Ltd., LIVERPOOL,

MANUFACTURERS OF

MARINE AND OTHER CRANK SHAFTS

FORGINGS OF ALL KINDS IN IRON & STEEL.



STERN AND RUDDER FRAMES.

4983

CRANK SHAFT FOR S.S. No. 98.
FORGED WEIGHT, 60 Tons. FINISHED WEIGHT, 41 Tons 8 Cwt.

WORKS: GRAFTON STREET. Town Office: 5, Harrington Street.

BRICKMAKING MACHINERY.

THOMAS C. FAWCETT, OLD VICTORIA FOUNDRY, MANOR ROAD, & BURMANTOFTS FOUNDRY, CROMWELL ST., LEEDS,



Maker of Patent Semi-dry & Plastic Brickmaking Machines,

Steam Presses, Pugmills, Solid and Perforated Bottomed Clay Pans, Clay Rollers, Clay Mixers, and Sieves,

BOILERS, ENGINES, MARINE AND STATIONARY

SHAFTING AND MILLWRIGHT WORK,

DRUMS AND PULLEYS OF ALL SIZES,

SPUR, BEVIL, MITRE,

And other Wheels by Patent Moulding Machine.

ILLUSTRATED CATALOGUES FREE. 4088



POINTS & CROSSINGS

FROM EVERY SECTION OF RAIL.

Portable Railways, and General Railway Plant.

HARTLEY & ARNOUX BROS.

STOKE-ON-TRENT

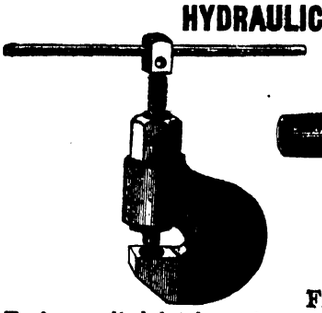
4468

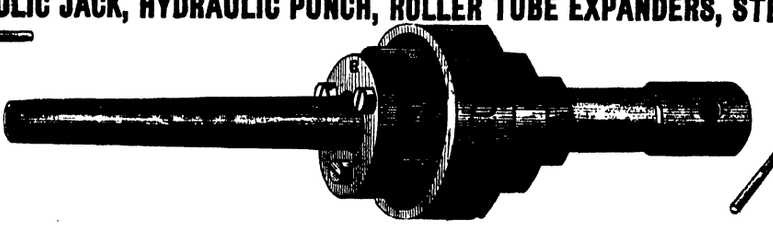
RICHARD DUDGEON,

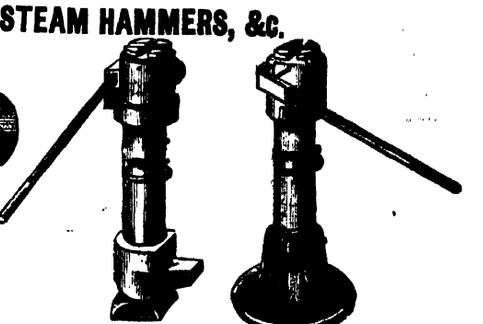
114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF THE

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, STEAM HAMMERS, &c.







THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "DUDGEON'S ROLLER TUBE EXPANDERS" R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only bear the stamp for the American Patent (still in force), as under:—

R. DUDGEON, N.Y.
PATD. FEB. 5TH 1867.

On the Guide-ring of each Tool,

WITHOUT WHICH NONE ARE GENUINE.

These can always be obtained at R. Dudgeon's English Depôt, 114, Fenchurch Street. If more convenient to get them through Merchants care should be taken to specify "*Dudgeon's own make*" on the *Order*, but as R. Dudgeon observes with regret that *imitations* bearing his *stamp counterfeited* are being sold as his, he would respectfully recommend both Merchants and Users requiring Expanders of his make to apply direct. In urging this he merely seeks to secure the identity of what is made by himself, by which he is content to stand or fall.

R. Dudgeon takes this opportunity of returning thanks for past favors, either by orders or recommendation, and it being his intention strictly to maintain the Quality and Workmanship so essential for such a Tool as the Expander, begs to solicit a continuance of the same.

CATALOGUES AND PRICE LISTS ON APPLICATION TO R. DUDGEON, 114, FENCHURCH STREET, LONDON, E.C.

3940

18 PRIZE MEDALS.] **THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED,** [13 PRIZE MEDALS.

4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1882, 1.



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 4794

100 TO 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

New Patent TWIN-ENGINES, Impulse every Revolution.

THE "OTTO." GOLD MEDAL at Crystal Palace, & HIGHEST AWARD at Paris Electrical Exhibitions.



New Patent SELF-STARTER. Best, Safest, and Simplest made, may now be applied.

CROSSLEY'S NEW VERTICAL ENGINE, Requiring little floor space.

½ TO 100 HP. IND. MANY IMPROVEMENTS. OVER 14,000 IN USE.

LONDON: 24, POULTRY, E.C. GAS ENGINE GLASGOW: 58, UNION STREET 4775

CHEAP GAS FOR MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·3 lb. per ind. H. P. per hour.

The DOWSON ECONOMIC GAS COMPANY, Ltd., 3, Gt. Queen St., Westminster, S.W. 4333

JESSOP'S CRANES

For Particulars see last Week's "ENGINEERING," or WRITE FOR HANDBOOK.

J. JESSOP & SON, LEICESTER. 5113

Or 113, CANNON STREET, LONDON.

Engineers, Machinists,

TAYLOR & CHALLEN, BIRMINGHAM,

Founders, and Smiths,

Makers of MACHINERY for the PRODUCTION of

—:o:— TUBES, BOLTS AND NUTS. —:o:—

COINS, GUNPOWDER, —:o:— SMALL ARMS, CARTRIDGES.

MAKERS OF STEAM ENGINES.

SHAFTING—Patent and other Shaft Fittings.

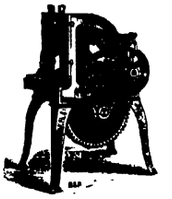
CAST IRON PULLEYS, &c.



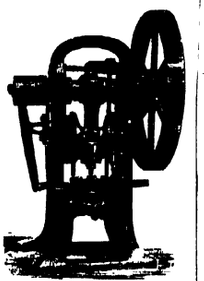
TABLE PRESS.



HORIZONTAL PRESS.



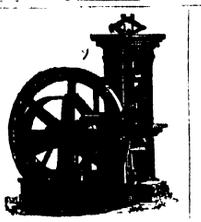
EXTENDING PRESS.



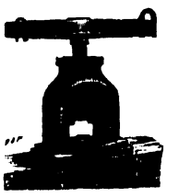
HEADING PRESS.



PRESS WITH TURNTABLE.



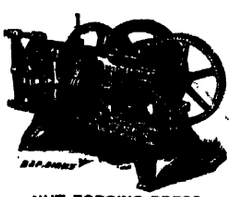
COINING PRESS.



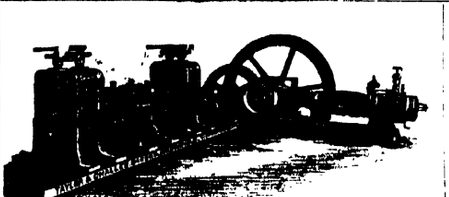
PRESS to STRIKE MEDALS and SINK DIES.



PUNCHING & SHEARING PRESS.



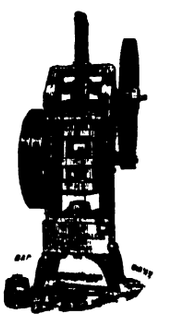
NUT FORGING PRESS.



METAL ROLLING MILL AND ENGINE.



DISC SHEARS.



4181 DRAWING PRESS.



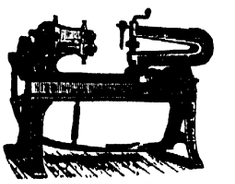
ROLLING MILL with Wedge Adjustment.



ROLLING MILL with Screw Adjustment.



TRIMMING LATHE.



DISC SHEARS.

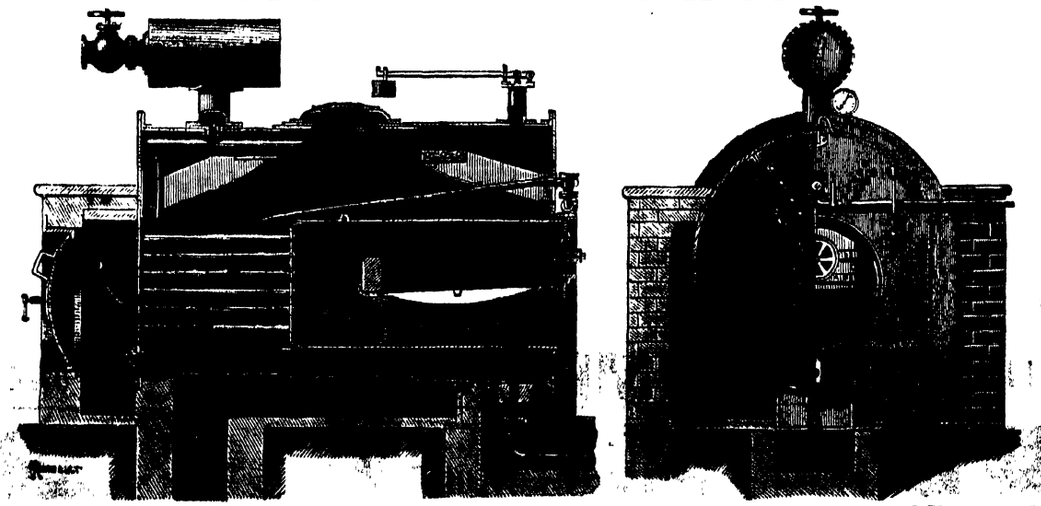
JOHN BELLAMY, Millwall, LONDON,

SOLE MAKER OF

BELLAMY'S PATENT IMPROVED MULTITUBULAR BOILER.

BY ROYAL LETTERS PATENT.

Well Adapted for Export.



Suitable for every description of work.

Specially designed to secure quick Steaming, combined with great Economy of Fuel and Space.

Steady in work, no priming, easily accessible all over for inspection, requires no expensive brickwork setting. Confidently recommended to all users of Steam Power as the most economical and effective Steam Generator yet introduced.

PRICES AND FULL PARTICULARS UPON APPLICATION. CAN BE SEEN AT WORK AS ABOVE.

CORNISH, LANCASHIRE, and every description of STEAM BOILERS in IRON or STEEL.

WROUGHT IRON TANKS AND CISTERNS.

Iron and Steel Buoys, Steam Pans, Coolers, Salt and Sugar Pans. Every description of Riveted Wrought Iron Work made to order. 4923

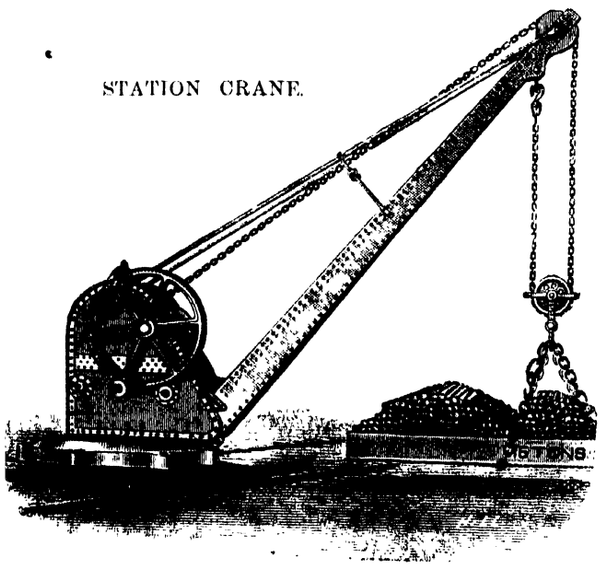
BELLAMY'S PATENT HORTICULTURAL BOILER FOR GREENHOUSES, CHURCHES, AQUARIA, &c.

COWANS, SHELDON & CO., LTD.,

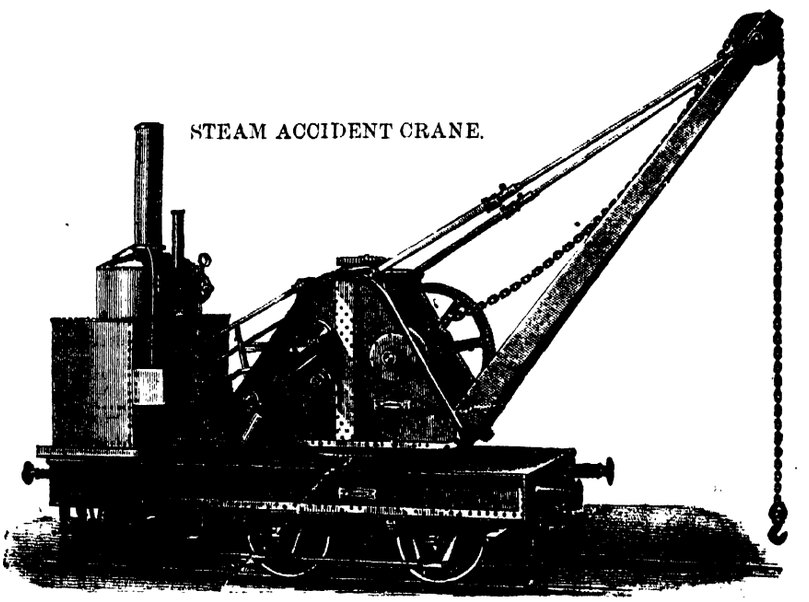
ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.

STATION CRANE.



STEAM ACCIDENT CRANE.



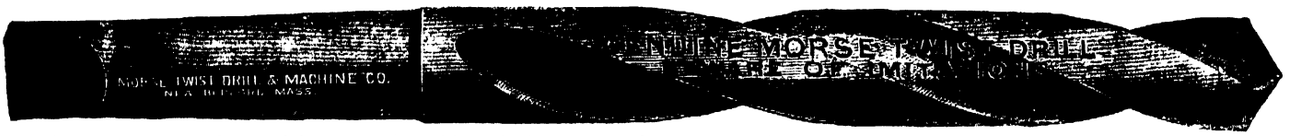
TURNTABLES, CRANES, MASTING SHEERS, AND TRAVERSERS OF EVERY DESCRIPTION BY STEAM, HAND, OR HYDRAULIC POWER.

CHARLES CHURCHILL & CO.,

AMERICAN MACHINERY AND TOOL IMPORTERS,

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ESTABLISHED IN 1862.



C. C. & Co. have just removed to much larger premises with ample show rooms and warehouse, and will carry a greatly increased stock of all the best American tools.

SOLE AGENTS FOR

THE ONLY GENUINE AMERICAN MORSE TWIST DRILL,

WITH CENTRE GRINDING LINE, STOCKS AND DIES, REAMERS AND MILLING CUTTERS,

Stephens' Patent Vices, Horton Chucks, Cushman Chucks, Westcott Chucks, Sweetland Chucks, Stanley Rule & Level Co.'s Planes, &c., &c., Gould's Manufacturing Co.'s Pumps, and a great variety of New American Tools.

New Catalogue for 1883 just issued, 215 pages Quarto, sent on receipt of One Shilling in Stamps.

(THE LARGEST CATALOGUE OF AMERICAN TOOLS EVER PUBLISHED IN GREAT BRITAIN.) 4124

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MAKERS OF ALL KINDS OF

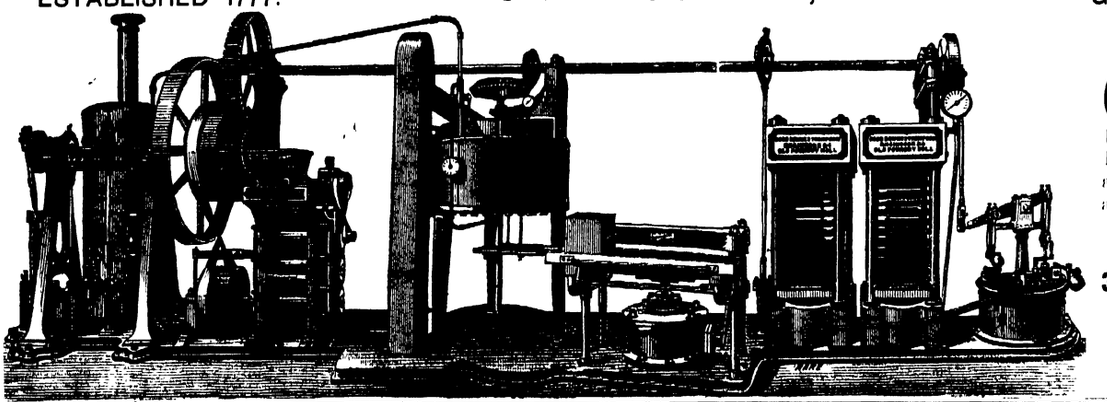
SUGAR MACHINERY

NOTTINGHAM, ROUEN, & LONDON.

SEE FUTURE ADVERTISEMENTS. 5076

ROSE, DOWNS & THOMPSON

ESTABLISHED 1777. OLD FOUNDRY, HULL. GOLD MEDAL, CALCUTTA.



MAKERS OF THE

ANGLO-AMERICAN

OIL-MILL MACHINERY

For crushing Linseed, Cotton Seed, Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent. in labour and power, and 2 to 4 per cent. in Oil.

(See *Engineer*, May 6, 1881, and Nov. 23, 1883.)

300,000 TONS OF OIL SEEDS,

PER ANNUM,

Are Crushed by Mills made on this system by us. 5127

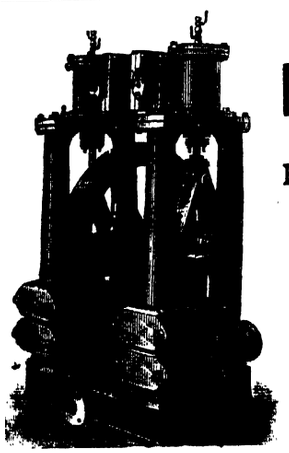
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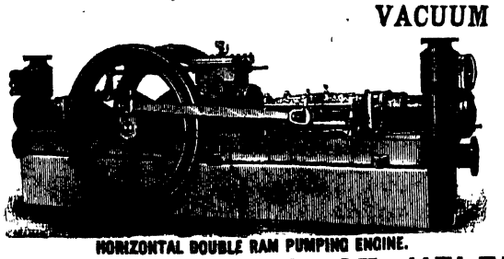
ENGINEERS. IRON & BRASS FOUNDERS, BOILER MAKERS. &c.

MANUFACTURERS OF

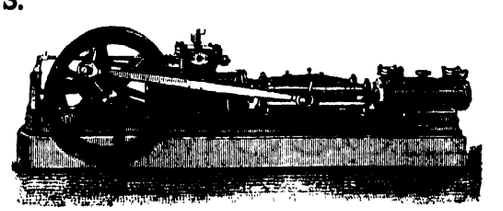
PUMPING ENGINES, BLOWING ENGINES, STEAM ENGINES, AIR COMPRESSORS, and VACUUM PUMPS.



DOUBLE RAM PILLAR PUMPING ENGINE.



HORIZONTAL DOUBLE RAM PUMPING ENGINE.



BLOWING ENGINE AND AIR COMPRESSOR. 4253

BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.

The Edison and Swan United Electric Light Company,

LIMITED.

Contractors to the Admiralty, H.M. Office of Works, Houses of Parliament, War Office, Science and Art Department South Kensington, &c.; to the principal Shipping Companies, and Criterion Theatre, Holborn Restaurant, Gatti's Restaurant, &c., &c.

EDISON & SWAN INCANDESCENT LAMPS from 2½ to 100 C.P.

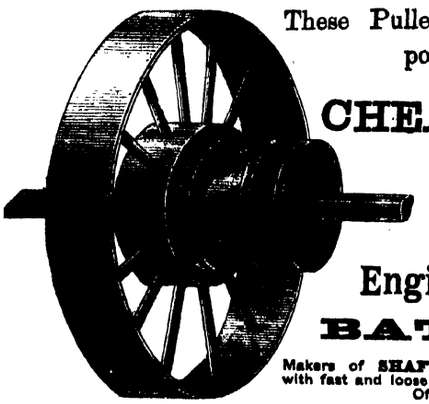
ELECTRIC METERS, SWITCHES, ELECTROLIERS, &c.

DYNAMOS: *The Company are prepared to Supply the NEW and IMPROVED Type of EDISON Dynamos.*

PRICES AND PARTICULARS MAY BE HAD UPON APPLICATION TO 4534

THE SECRETARY, 57, HOLBORN VIADUCT, LONDON, E.C.

TURNED WROUGHT IRON PULLEYS.



These Pulleys are **TURNED IN A LATHE,** and not polished on a Grindstone like those generally sold.

CHEAP, STRONG, AND TRUE.

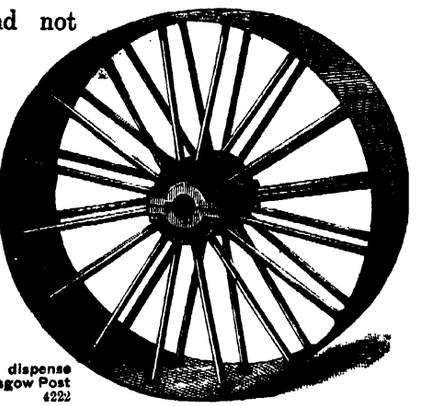
Illustrated Circular Post Free.

J. BAGSHAW & SONS,

Engineers, Ironfounders & Millwrights,

BATLEY, YORKSHIRE,

Makers of **SHAFTING** and **FRICTION PULLEYS** for Electric Lighting Machinery, which dispense with fast and loose Pulleys: one Pulley answers for both. In use at L.S.W. Railway, Nine Elms; Glasgow Post Office; King's Cross Station; and all principal Factories home and abroad. 4222

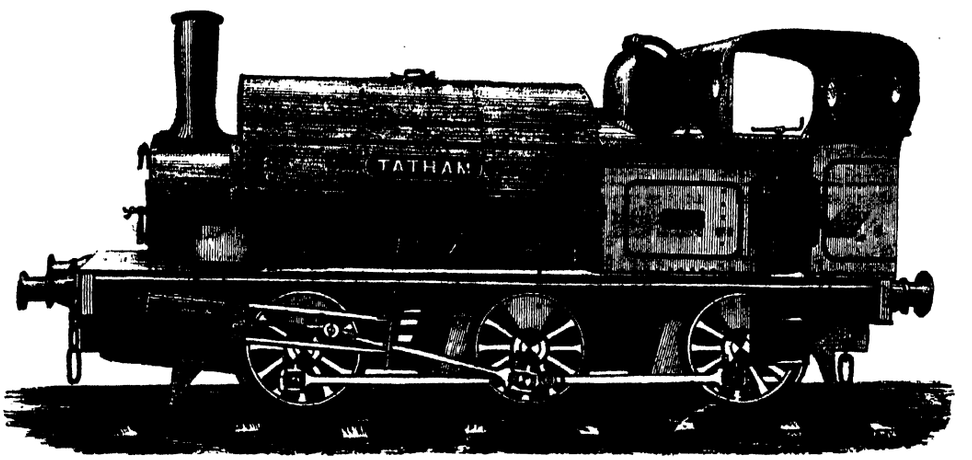


ESTABLISHED 1860.

HUDSWELL, CLARKE & Co.,

RAILWAY FOUNDRY, LEEDS.

PRICES and SPECIFICATIONS on Application.



FOR CASH or DEFERRED PAYMENTS.

LOCOMOTIVE TANK ENGINES

OF ALL SIZES AND TO SUIT ANY GAUGE OF RAILWAY, 4038

For Main Line or Branch Railways, Contractors, Ironworks, Collieries, &c.

CRANES! CRANES!



SEE HALF-PAGE ADVERTISEMENT JUNE 27th, Page 30.

RAILWAY PLANT!!

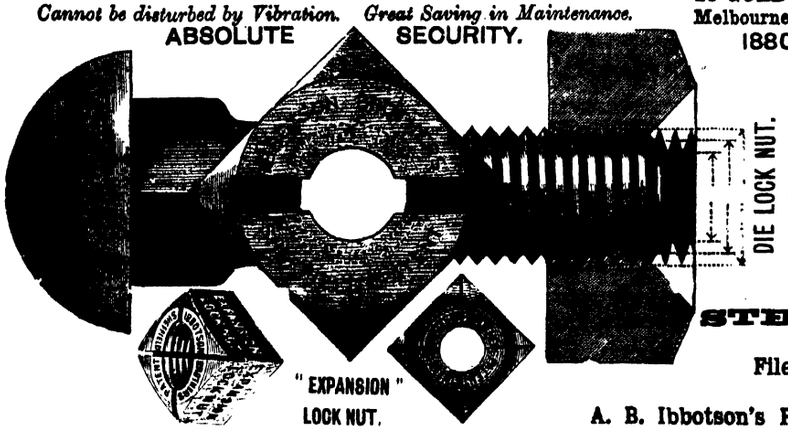


SEE HALF-PAGE ADVERTISEMENT JUNE 13th, Page 33.

RANSOMES & RAPIER, 5, Westminster Chambers, LONDON, S.W., and Waterside Ironworks, IPSWICH. 5052

Patent Steel Lock Nuts and Steel Fish Bolts.

Cannot be disturbed by Vibration. ABSOLUTE *Great Saving in Maintenance.* SECURITY.



FIRST-CLASS MEDALS, LONDON, PARIS, SYDNEY, ADELAIDE, &c.

18 GOLD MEDALS Melbourne Exhibition, 1880–81. { ONLY FIRM awarded GOLD MEDALS for Nuts and Bolts, Buffers, Couplings, Cradles, Springs, Steel Sleepers, Rail Joints, &c. GOLD MEDALS for Steel, Files, Saws, Steel Forgings, Railway Appliances, &c.

IBBOTSON BROTHERS

AND COMPANY, LIMITED,

GLOBE IRON AND STEEL WORKS

SHEFFIELD.

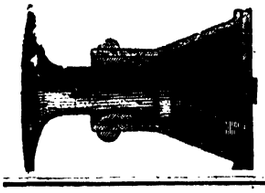
Manufacturers of

STEEL OF EVERY DESCRIPTION

STEEL FORGINGS, AXLES, &c., RAILWAY SPRINGS OF ALL KINDS.

Files (Hand Cut only), Saws, Edge Tools, and Patent Automatic Central Coupling Buffers.

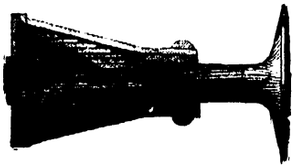
A. B. Ibbotson's Patent Steel Die and Expansion Lock Nuts, and Steel Bolts, Railway Fastenings, &c., &c.



GEORGE TURTON'S PATENT WROUGHT IRON BUFFERS,

AND PATENT COMPOUND CAST STEEL SPRINGS. { 4120 3813

LONDON OFFICE: 4, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W.



Paris, 1878.—GOLD MEDALS AWARDED.—Melbourne, 1881.

MANUFACTURERS OF

Steel Gearing

MOULDED BY PATENT MACHINERY.

ALL KINDS OF

STEEL CASTINGS

Weighing up to 20 tons.

For Mills, Machinists, Engineers, Marine, & Mining Purposes.

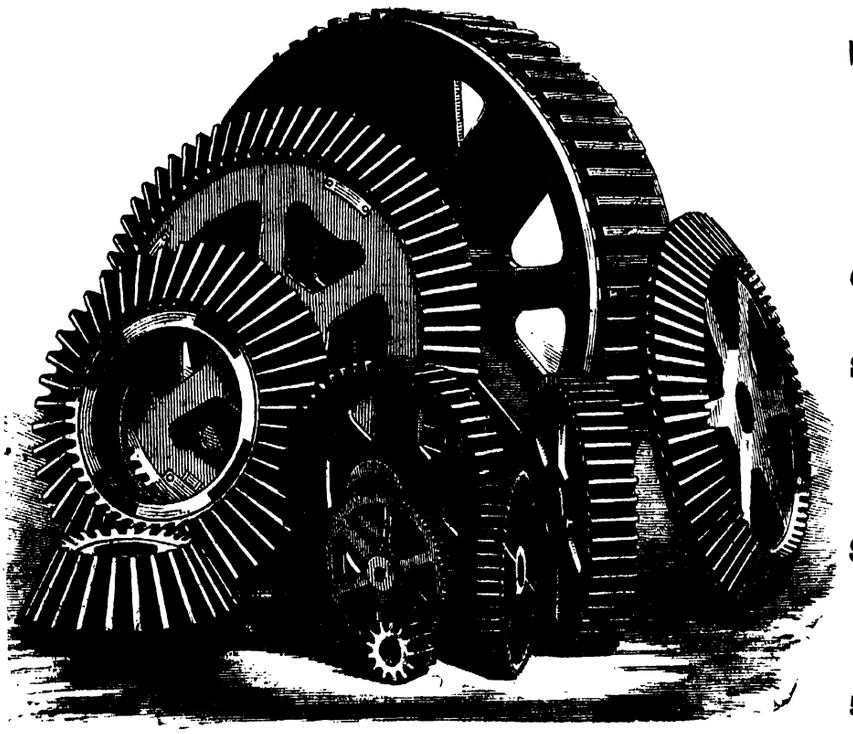
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PROPELLER BLADES, MARINE CRANKS, RUDDERS, AND **STERN FRAMES.**

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CORNES, CALVERT & CO.,

80, WALBROOK, E.C.



MANUFACTURERS OF

TOOL STEEL

OF SUPERIOR QUALITY.

SPINDLE STEEL.

CAST, SHEAR, GERMAN, SPRING, BLISTER, AND Sheet Steel FOR ALL PURPOSES.

STEEL PLATES;

FORGINGS of all Kinds.

Manchester Warehouse;

55, DALE STREET.

WM. JESSOP & SONS, Limited,

BRIGHTSIDE WORKS, SHEFFIELD. 5138

ESTABLISHED 1839.

TRADE MARK. SANS CHANGER

ESTABLISHED 1839.

JOHN MUSGRAVE & SONS, Ltd.,

GLOBE IRON WORKS, BOLTON,

Manufacturers of the only Patent Safety Starting, Turning, or Barring Engine.

Makers of STEAM ENGINES up to 3,000 HP.

With Patent Automatic Cut-off Motion. Adaptable to Stamper Valves, Slide Valves, and Corliss Valves, which can also be applied to existing Engines.

STEAM HAMMERS,

On Condie's principle, with Patent Valve Motions, from 3½ cwt. to 25 tons.

Wrought-Iron and Steel STEAM BOILERS with drilled rivet holes only.

MILL-GEARING IN ALL ITS BRANCHES.

LARGE ROPE OR BELT DRUMS UP TO 35 FEET DIAMETER.

BLEACHING MACHINERY.

ALSO THE ONLY MODERN PLATE-GLASS MACHINE MAKERS. 4730

GOODFELLOW & MATTHEWS,

(LATE B. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

MAKERS OF

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS.

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

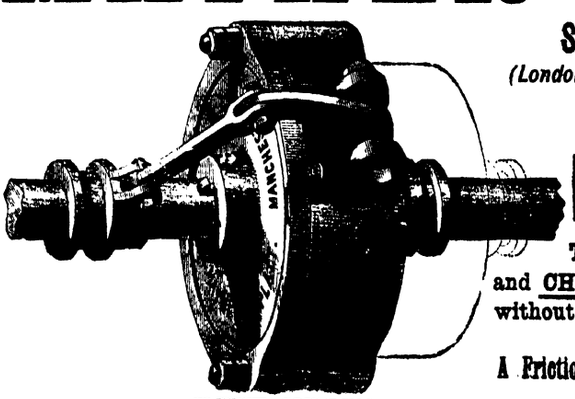
CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 5066

MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.



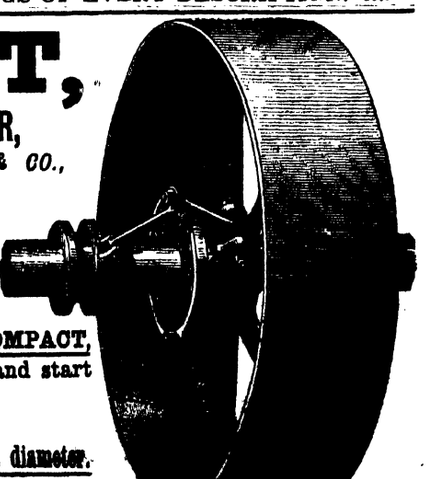
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PATENT

FRICTION CLUTCH.

These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.



CLUTCH AND PULLEY 4661

LIBERAL TERMS TO THE TRADE.

PRICES ON APPLICATION.

HAWKSLEY, WILD & CO.'S

PATENT FLANGED FLUED BOILER.

THOUSANDS of these BOILERS

Are now at work, large numbers having been working at very high pressures night and day for upwards of ten years, and with a success both in

Safety, Economy, and Freedom from Repairs



END VIEW.



LONGITUDINAL SECTION OF DOUBLE-FLUED BOILER

Which has not been equalled by any other Flued Boiler in the Market.

Circulars free by Post giving full details.

The strength of this Flue and its provision for contraction and expansion are unrivalled.

HAWKSLEY, WILD & Co., Patentees and Manufacturers,

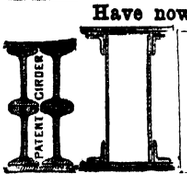
BRIGHTSIDE BOILER AND ENGINE WORKS, SHEFFIELD. 4756

H MEASURES BROS. & CO., SOUTHWARK STREET, LONDON,

Manufacturers of Patent Girders, Rolled Joists in Iron or Steel, Rivetted Girders, Flitch Plates, Bulb and Channel Iron, Contractors' Rails, Tee, Angle, and Sash Iron, Bonding Hoops, Bolts, Rivets, Washers, Chequered Flooring Plates, Patent Fire-proof Floors, Cast or Wrought Iron Columns, Stanchions, Tanks, and every description of Builders' Iron Work,

Have now in their TOWN STOCK 5,000 TONS, and can guarantee prompt delivery at lowest Market Prices.

ESTIMATES, SECTION SHEETS, AND BOOKS FREE ON APPLICATION.



ANGLES.

8 × 4	3½ × 3½
6 × 6	3 × 3
6 × 3½	2½ × 2½
5 × 3½	2 × 2
4 × 3½	1½ × 1½
4 × 4	1 × 1

SECTION OF JOISTS.

3 × 3 = 10lbs.	4½ × 3 = 13lbs.	7 × 2½ = 14lbs.	9½ × 3½ = 24lbs.	12 × 5 = 42lbs.
3 × 1½ = 5 ,,	5 × 4½ = 23 ,,	7 × 3½ = 20 ,,	9½ × 4½ = 29 ,,	12 × 6 = 56 ,,
4 × 1½ = 7 ,,	6½ × 2 = 11 ,,	8 × 4 = 22 ,,	10 × 4½ = 32 ,,	14 × 6 = 60 ,,
6 × 3 = 12 ,,	6½ × 3½ = 16 ,,	8 × 5 = 29 ,,	10 × 5 = 36 ,,	16 × 6 = 62 ,,
4½ × 1½ = 8 ,,	6 × 5 = 29 ,,	8 × 6 = 34 ,,	10 × 6 = 56 ,,	17½ × 6½ = 82 ,,
				19½ × 7½ = 100 ,,

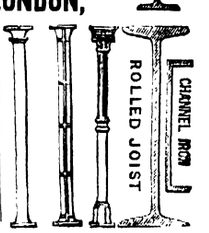
JOISTS—Lengths, from 6 to 36 ft. PLATES—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to ¾". 5126

TEES.

5½ × 5½
4 × 4½
5 × 3
3 × 3
2½ × 2½
2 × 2
1½ × 1½
1 × 1

CHANNELS.

12 × 3
9½ × 3⅛
9½ × 3⅛
8 × 3½
5½ × 2½
4⅛ × 2⅛
2½ × 1⅛
1½ × ⅝



THOMAS TURTON & SONS,

MANUFACTURERS OF RAILWAY SPRINGS AND BUFFERS,

Files and Cast Steel of Superior Quality, Spring Steel, Shear Steel, &c. 4927

SHEAF WORKS, AND SPRING WORKS, SHEFFIELD.

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SHAFTING, DRUMS & PULLEYS.

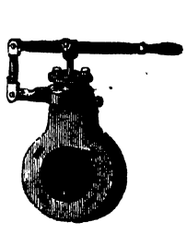
From 2 in. to 3 in. diameter up to 20 ft. long (Whitworth's standard), at 16s. per cwt. HANGERS, PEDESTALS, WROUGHT-IRON DRUMS with Cast-Iron Boss.

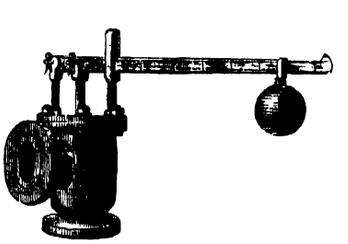
J. YATES & CO., SHEAF WORKS, HUNSLET ROAD, LEEDS. 3289

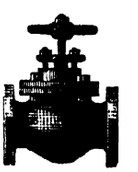
ISAAC STOREY & SONS,

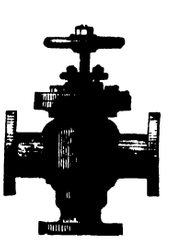
ESTABLISHED 1837











BRASS FOUNDERS,

ENGINEERS' COPPERSMITHS AND BRASS FINISHERS.

Large Stock Kept of Engine and Boiler Mountings.

KNOTT MILL, MANCHESTER.

LONDON AND CONTINENTAL AGENTS—THOMAS BAINES & SON, 59 & 63, QUEEN VICTORIA STREET, LONDON, E.C. 5036

Established 1831.

THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

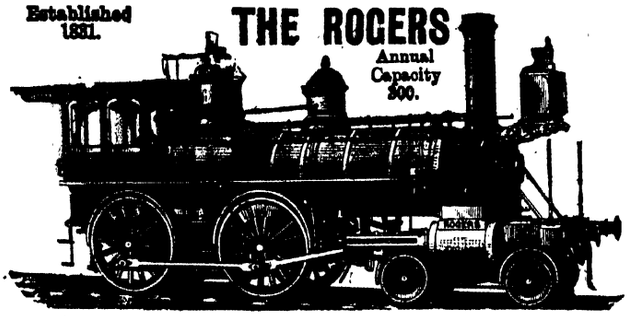
Annual Capacity 500.

BUILDERS OF LOCOMOTIVE ENGINES OF ALL GAUGES

And for every variety of service,

PATERSON, NEW JERSEY,

UNITED STATES OF AMERICA.



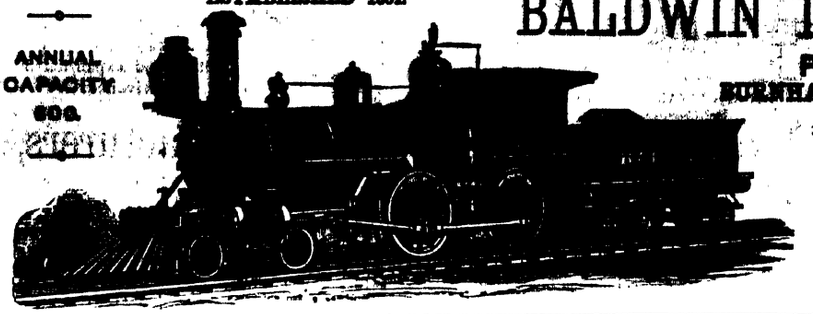


4117

ESTABLISHED 1831.

BALDWIN LOCOMOTIVE WORKS,

ANNUAL CAPACITY 600.



PHILADELPHIA, U.S.A.

BURNHAM, PARRY, WILLIAMS & Co., Proprietors.

MANUFACTURERS OF

LOCOMOTIVE ENGINES,

Adapted to every variety of service, and built accurately to standard gauges and templates. Like parts of different engines of same class perfectly interchangeable,

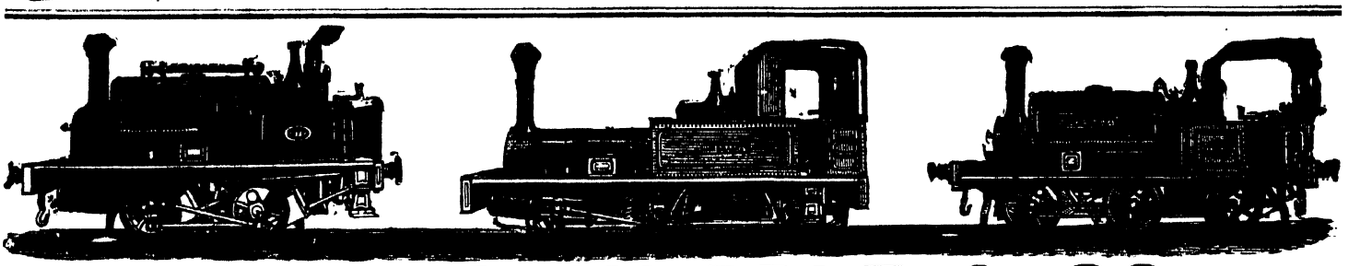
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STEAM STREET CARS, &c.

ILLUSTRATED CATALOGUES FURNISHED ON APPLICATION OF CUSTOMERS.

ALL WORK THOROUGHLY GUARANTEED. 1234



MANNING, WARDLE & CO.,

BOYNE ENGINE WORKS, LEEDS,

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MANNING, WARDLE & Co., having designs and models of such a great variety of Engines, are enabled to execute orders for Locomotive Engines adapted to most requirements in a very short time.

Locomotive Tank Engines from 8 inches to 15 inches Cylinders on Four or Six Wheels all coupled, always in Stock or in Progress. 2466

SPECIFICATIONS, PHOTOS, AND PRICES, ON APPLICATION.

R. & W. HAWTHORN,

NEWCASTLE-ON-TYNE,

MANUFACTURERS OF

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OF EVERY DESCRIPTION.

TRAMWAY LOCOMOTIVES.

MAKERS OF 5050

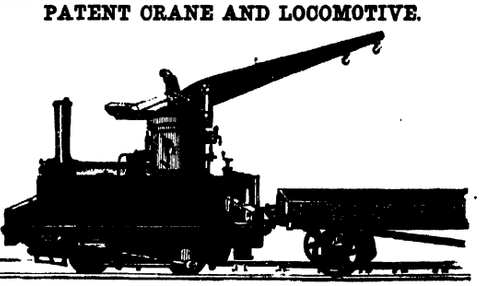
WROUGHT IRON WHEELS & FORGINGS.

TANK LOCOMOTIVE.



VARIOUS CLASSES IN PROGRESS.

PATENT CRANE AND LOCOMOTIVE.



PHOTOGRAPHS ON APPLICATION.

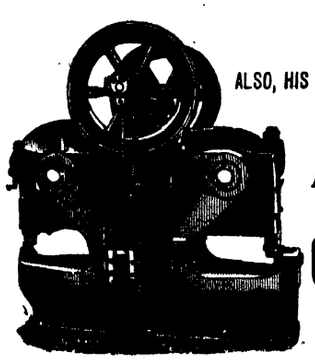
JOHN CAMERON'S SPECIALITIES

ESTABLISHED 1852.

CONTINUE TO BE HIS

STEAM PUMPS

For all purposes, and of which he continues to manufacture by far a larger number than any of his imitators. 8,000 Sold.



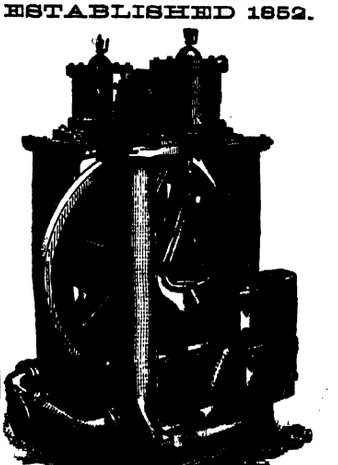
ALSO, HIS

PATENT CAM AND LEVER,

Punching and Shearing Machines

As used in all the principal Shipbuilding Yards (public and private) throughout the World.

ALWAYS READY OR IN PROGRESS TO ALL SIZES.



OLDFIELD ROAD IRON WORKS, SALFORD

MANCHESTER. 5209

FOR LONDON AND DISTRICT: PRICE & BELSHAM, 52, QUEEN VICTORIA STREET, E.C.;

FOR NEWCASTLE AND EAST COAST: E. BECKWITH & CO., SUNNISIDE, SUNDERLAND.

COLONIAL MACHINERY.

SUGAR, SALTPETRE & FARINA PANS, CORN & OIL MILLS,

SUGAR MILL MACHINERY, COTTON & INDIGO PRESSES.

COLONIAL ENGINES, PORTABLE ENGINES, PUMPING ENGINES, FIRST CLASS ROUND VERTICAL

THOMAS PIGGOTT & Co. BIRMINGHAM.

GAS MAKERS, ENGINEERS, &c. ESTD 1822. MAKERS OF RETORT MOUTHPIECES & LIDS, GAS HOLDERS & EVERY REQUISITE FOR GAS WORKS.

STEAM PUMPS, HAND PUMPS, TAR AND LIQUOR PUMPS.

ICE-MAKING & COOLING MACHINERY

of the highest class & most approved construction & of

GUARANTEED ECONOMY OF PRODUCTION.

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For Price, &c., apply SMEDLEY BROTHERS,

PORTABLE ENGINES. MORTAR MILLS. "SPECIAL CLAY MILLS."

STEAM BOILERS

(CORNISH, LANCASHIRE, AND VERTICAL.)

TESTIMONIAL from Messrs. J. & R. BOWDEN. Marple, near Stockport, Jan. 7, 1876.

GENTLEMEN,—We have now had one of your Portable Engines and 7 feet pan Mortar Mills, in constant work for the last twenty months, and have great pleasure in stating that they have given us every satisfaction, and for construction, strength, and workmanship are the best we have seen.—Yours respectfully,

MESSRS. SMEDLEY BROS. J. & R. BOWDEN (Builders)

EAGLE IRONWORKS, BELPER.

VERTICAL Combined Engines and Boilers. 5109

HORIZONTAL ENGINES.

"PEARN'S" PUMP.

DIAM. OF WATER CYLINDER ..in.	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14
DIAM. OF STEAM CYLINDER.....	4 in.	5 in.	6 in.	6 in.	7 in.	7 in.	8 in.	10 in.	12 in.	12 in.	14 in.	14 in.	16 in.	18 in.
Length of Stroke	9 in.	9 in.	9 in.	9 in.	12 in.	12 in.	12 in.	12 in.	12 in.	18 in.	24 in.	24 in.	24 in.	24 in.
Content, Galls. per hour	960	1500	2160	2940	3840	4860	6000	8640	11590	15360	19440	24000	34350	46360
Price .....£	18	21	24	28	35	38	45	60	70	85	130	140	180	230

CUSHIONING.

PEARN'S combination of the SLIDE VALVE and PORTS in the AUXILIARY CYLINDER is the Simplest and most PERFECT CUSHION.

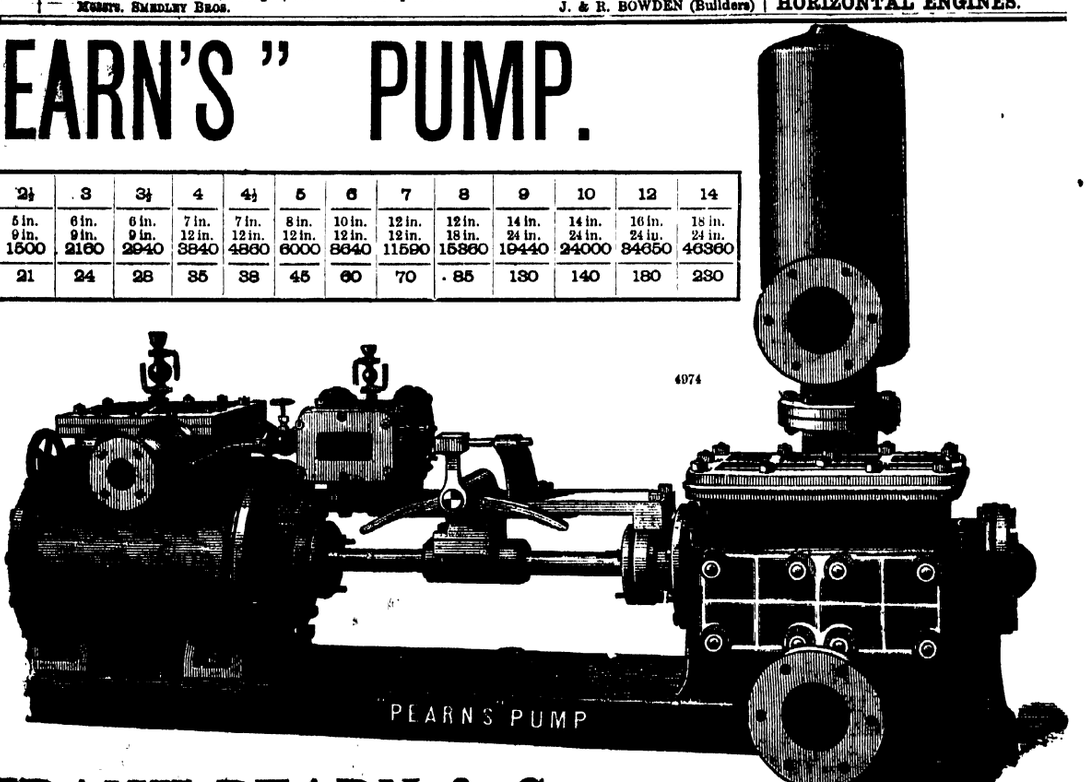
SIMPLICITY AND DURABILITY.

It has NO INTRICATE PARTS.

The WORKING PARTS are the same as used in the ordinary STEAM ENGINE.

It is as simple and as DURABLE as any Fly-Wheel Pump, and cannot possibly become deranged.

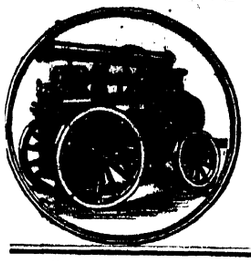
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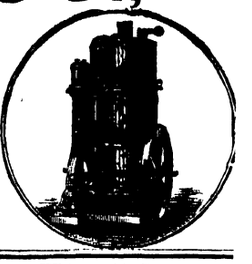
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STRONGEST, BEST, SIMPLEST, MOST DURABLE, EFFICIENT AND ECONOMICAL

ENGINES AND BOILERS

IN THE MARKET.



Prize Medals—London, Vienna, Brussels, Sweden, Philadelphia, Royal Society, & many others.

FOR FULL PARTICULARS, PRICES, &c., ADDRESS— 3987

DAVEY PAXMAN & Co., Colchester.

SHAFTING

Turned true and bright to Whitworth's Gauges, any length, from 2 in. to 3 in. diameter, 14s. per cwt. at Nottingham. Also Couplings, Pulleys, Plummer Blocks, Hangers, Machine-made Spur, Bevel, and Mitre Wheels, Friction Gearing, &c.

H. HIND & SON, NOTTINGHAM, AND 62, BLACKFRIARS ROAD, LONDON, S.E. 4157

THE CLAY CROSS COMPANY,

COAL, LIME, & IRON WORKS, CLAY CROSS, near CHESTERFIELD,

SUPPLY HOUSE, GAS, AND STEAM COAL,

AND ARE MAKERS OF

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In connection with Gas and Waterworks, Collieries, Engines, Pumps, &c. 5125

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An analysis of a sample of this shows it to contain neither Free Alkali nor Acid. It is purely Vegetable matter, and has *no injurious action upon Iron.*

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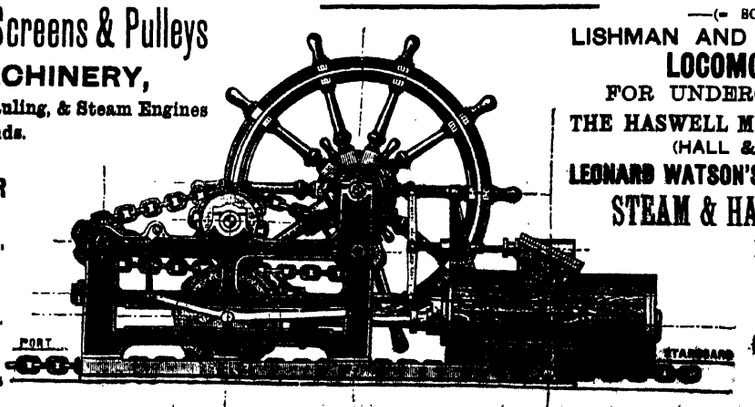
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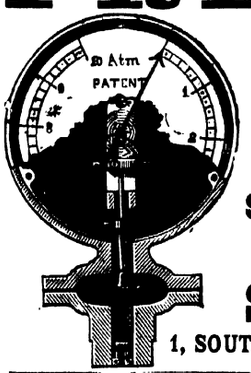
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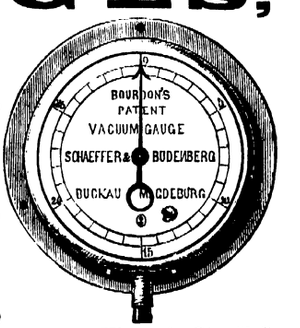


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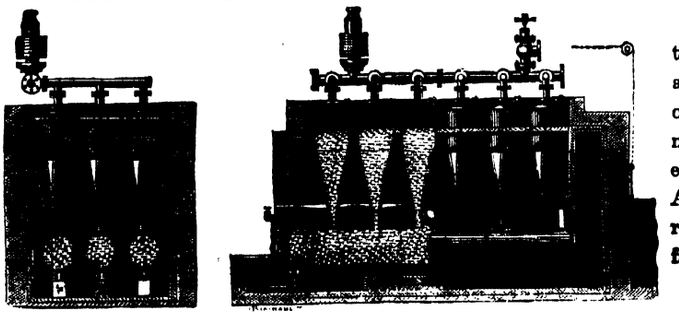
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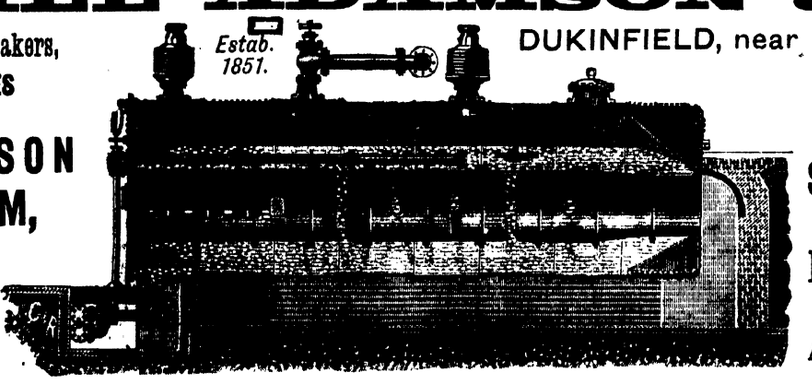
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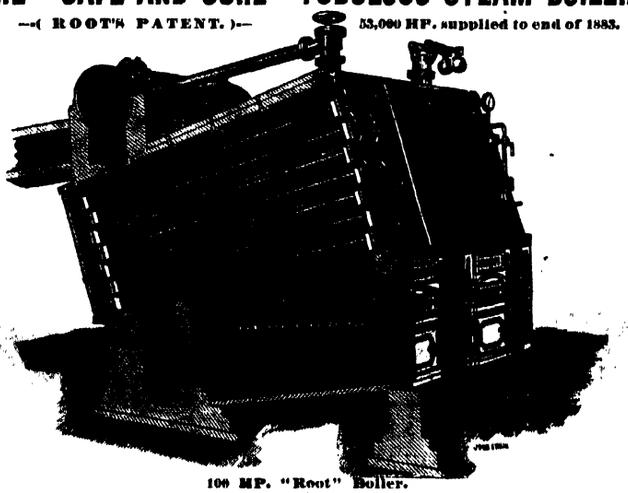


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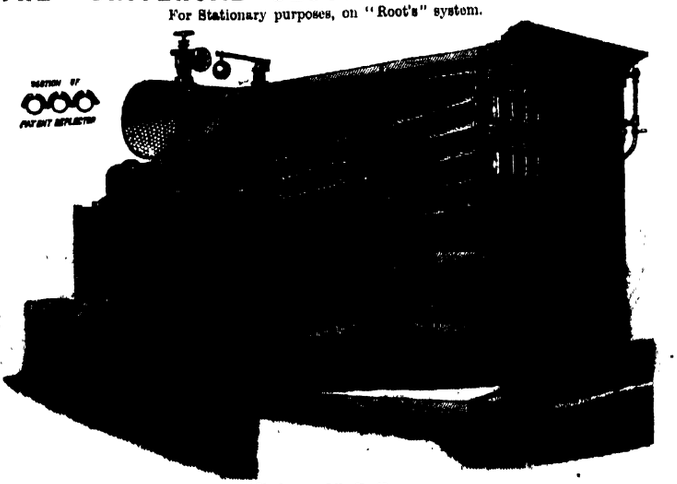


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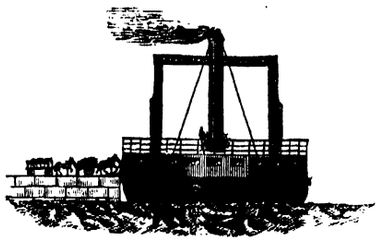
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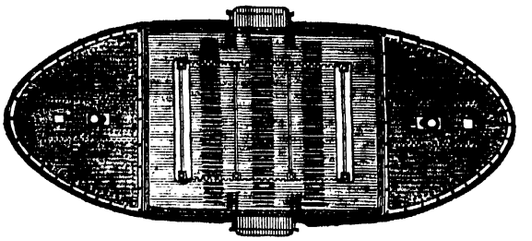
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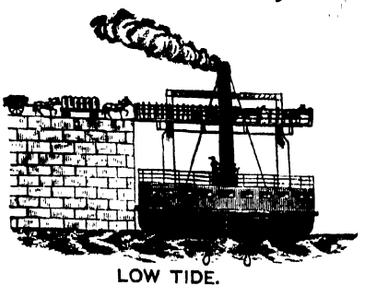
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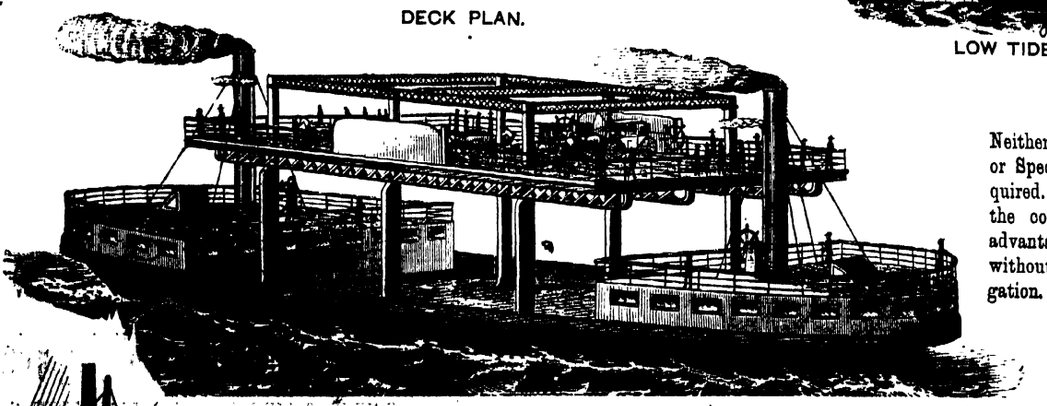


DECK PLAN.

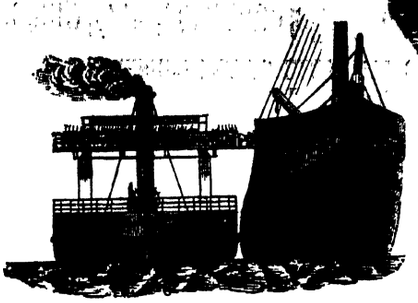


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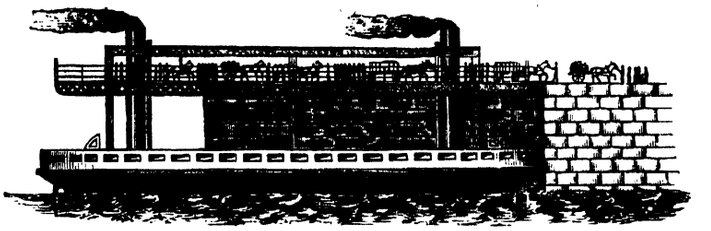
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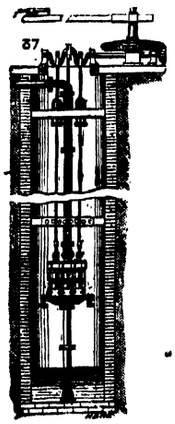
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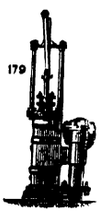
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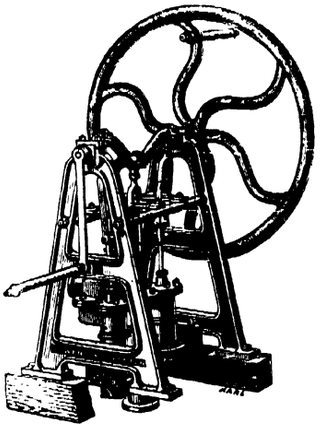




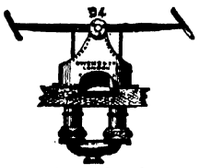
eep Well Pumps or Hand Power. Deep Well Pumps for Horse or Cattle Power



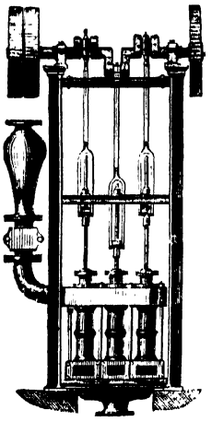
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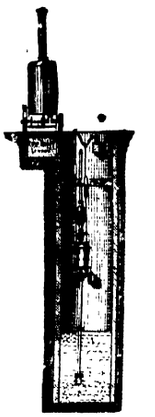
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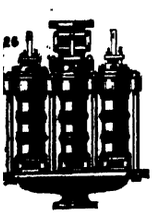
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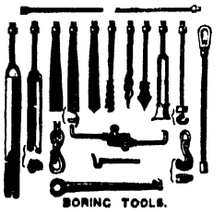
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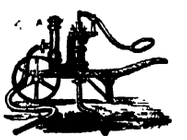


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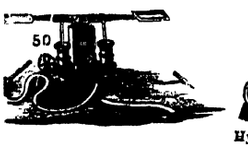
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Seven „ „	28 ft.	by	7 ft. 0 in.	„	75 lbs.
Three „ „	28 ft.	by	7 ft. 0 in.	„	80 lbs.
Three „ „	28 ft.	by	7 ft. 0 in.	Steel	80 lbs.
One „ „	24 ft.	by	7 ft. 0 in.	Iron	75 lbs.
One „ „	24 ft.	by	7 ft. 0 in.	Steel	80 lbs.
One „ „	26 ft.	by	6 ft. 6 in.	„	100 lbs.
Ten Lancashire Boilers	30 ft.	by	8 ft. 0 in.	Steel	90 lbs.
One „ „	30 ft.	by	7 ft. 6 in.	Iron	70 lbs.
One „ „	26 ft.	by	7 ft. 6 in.	„	80 lbs.
Three „ „	30 ft.	by	7 ft. 0 in.	Steel	80 lbs.
One „ „	22 ft.	by	6 ft. 0 in.	Iron	70 lbs.
Two Cornish „	30 ft.	by	7 ft. 0 in.	Steel	80 lbs.
One „ „	14 ft.	by	5 ft. 0 in.	Iron	70 lbs.

Total, 41 Boilers completely finished, besides many others in progress of construction. 4836

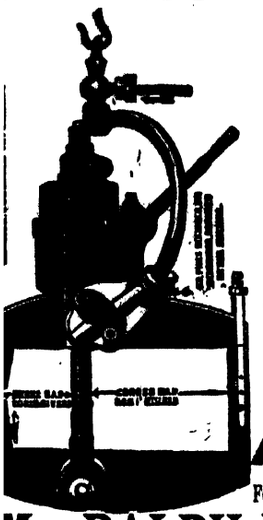
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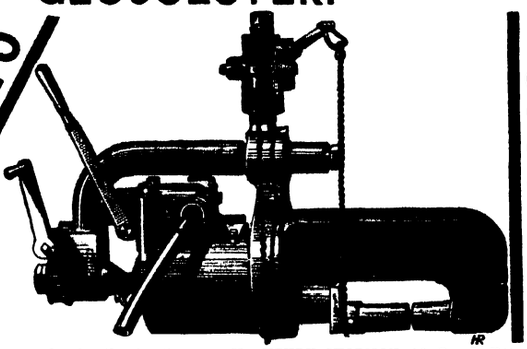
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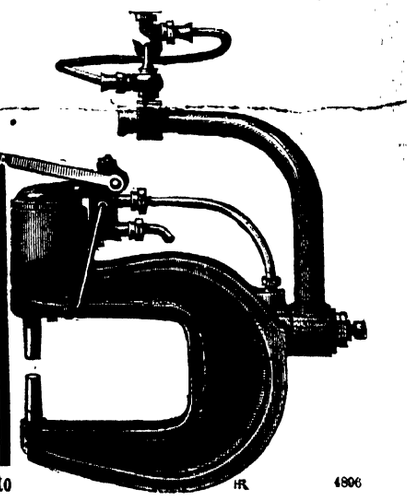
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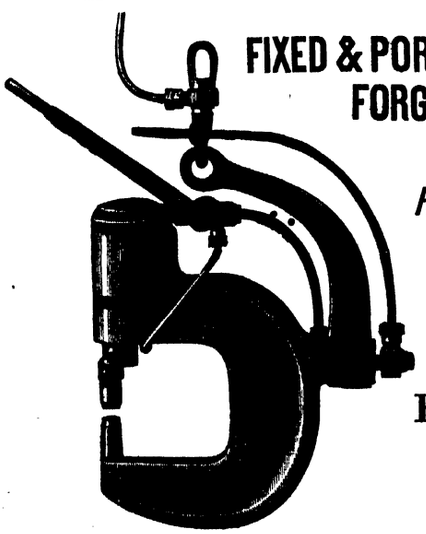
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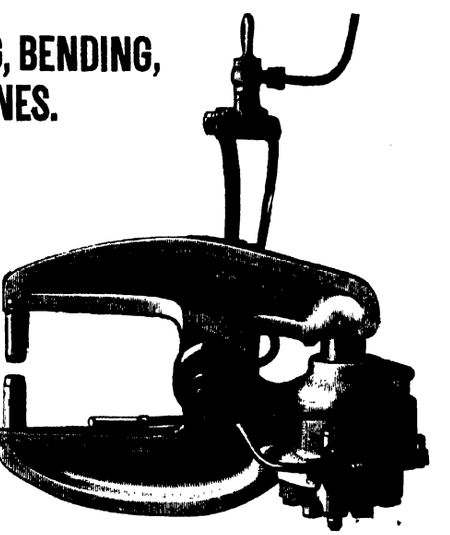


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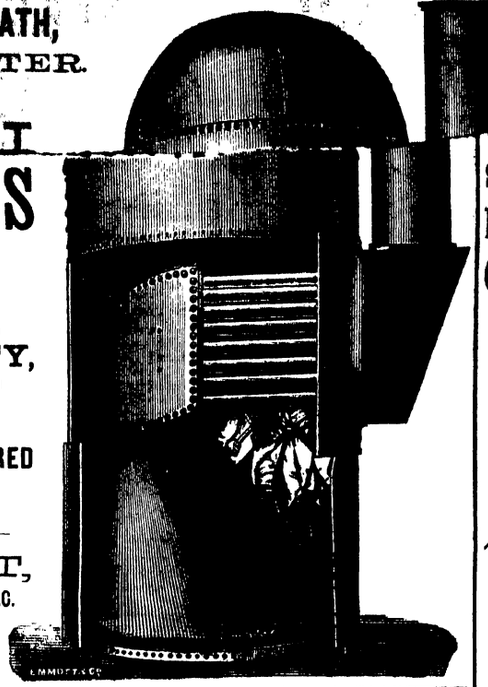
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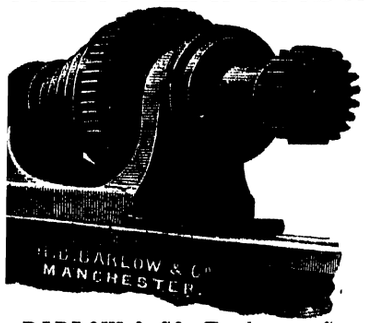
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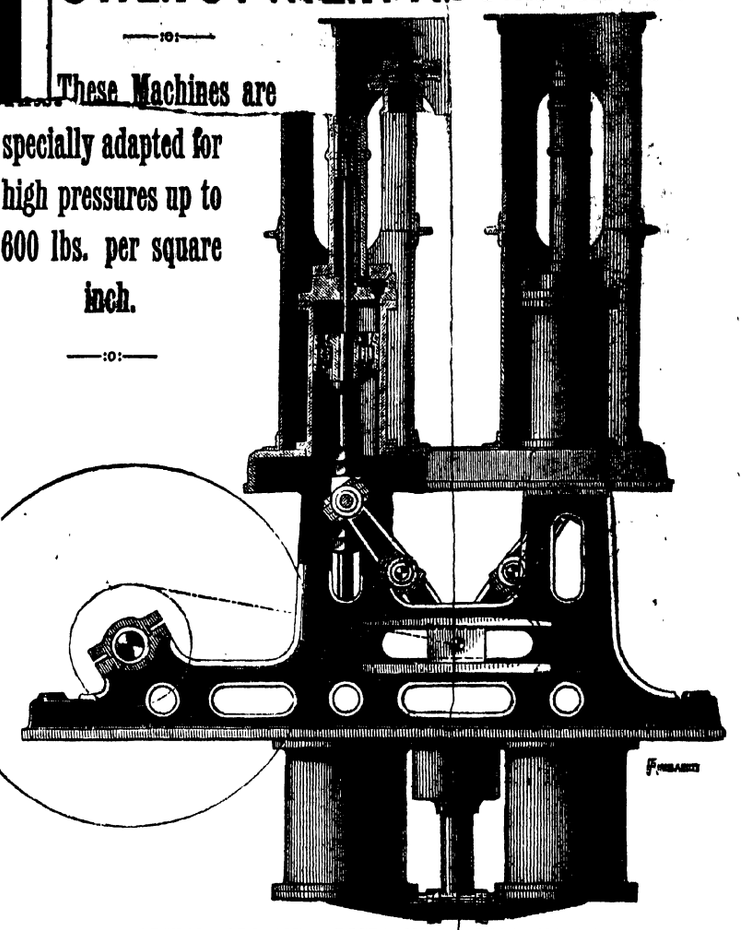
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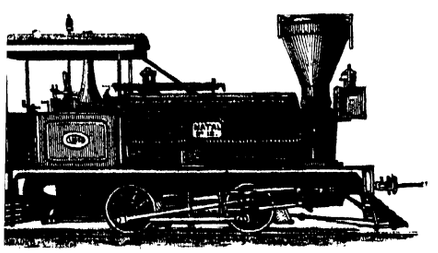
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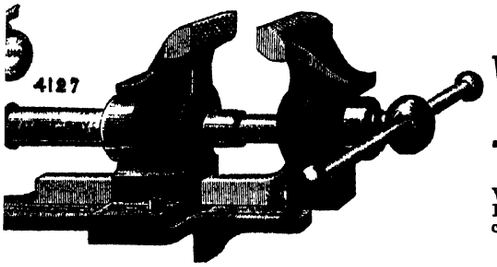
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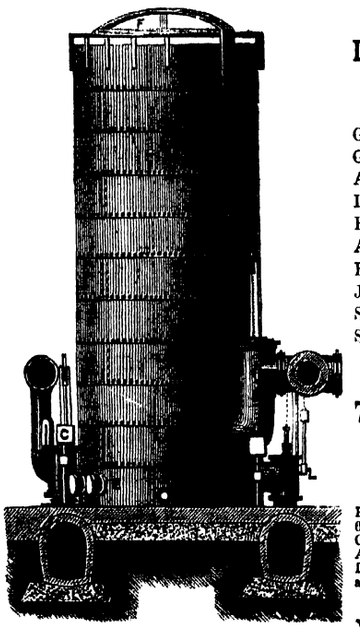
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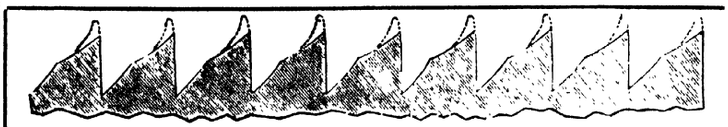


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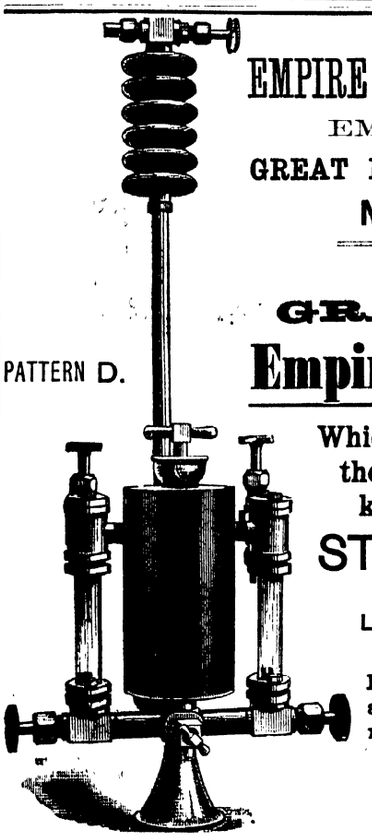
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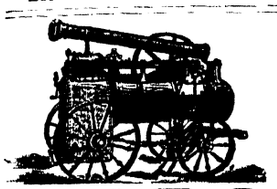
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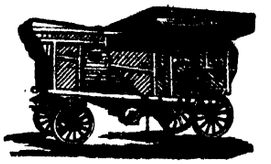
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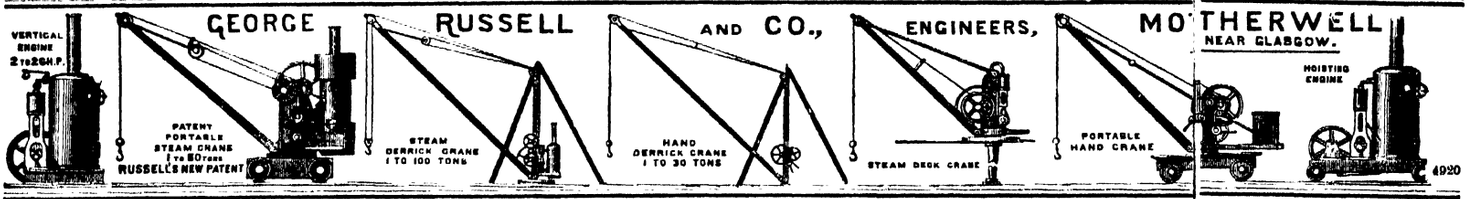
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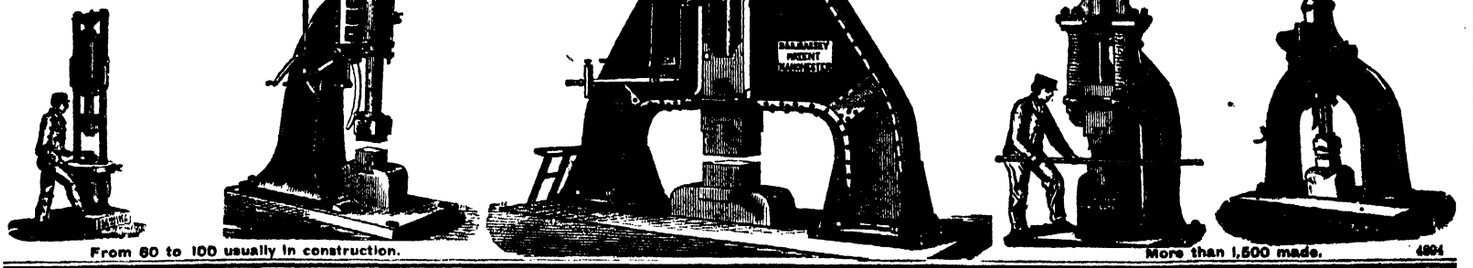
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Steam Boilers, Ready for Delivery.

W. & J. GALLOWAY & SONS, Manchester, always keep a large stock of "GALLOWAY" and "TWO-FLUED" Boilers ready for dispatch. 5000

Stone Breakers.— For Catalogues, apply to MESSRS. S. MASON & CO., Stone Machine Works, Leicester, England. Machines let out on Hire; a few Second-hand Machines cheap; refitted and are equal to new. Send for Lists of our New Patent Breakers. 4950

Iron Roofs, Sheds, Buildings, Houses. Best work, reduced prices. Dixon's special CURVED IRON ROOFS are the most economical for spans up to 45 ft. Catalogues, Designs, Estimates, on application. ISAAC DIXON, Windsor Ironworks, LIVERPOOL. 4933

Hunter and English, ENGINEERS AND MILLWRIGHTS, IRON AND BRASS FOUNDERS, BOW, LONDON, E.

DREDGING MACHINERY.
HYDRAULIC MACHINERY.
"WILLIAMS'" PATENT CAPSTANS.
LAND AND MARINE STEAM ENGINES.
DISTILLERY AND BREWERY PLANT.
FLOUR AND RICE MILLS.
WATER AND GAS VALVES, CRANES, LOCK GATES, &c. PUMPING MACHINERY.
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STEAM LAUNCH MACHINERY. 4955

Boiler Tubes, Iron, Steel, and HOMOGENEOUS. EDWIN LEWIS AND SONS, Wolverhampton. 4863

Tubes. MARINE, LOCO', STEAM, BORING, COLLIERY. LARGE TUBES LAP-WELDED TO 12in. DIAM.

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LONDON OFFICES: 46, QUEEN VICTORIA STREET.

MANCHESTER: QUEEN'S CHAMBERS, 5, MARKET ST.

MR L. W. SUTCLIFFE, M.E., AGENT. 5189

James Russell and Sons, LIMITED, CROWN TUBE WORKS, WEDNESBURY. London Warehouse: 108, Southwark Street, S.E. Leeds Warehouse: 6, Mark Lane, Briggate Price Lists on application. 5001

The Patent Corliss Engine And PATENT CORLISS GEAR ENGINE, with special Improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N.B. These engines are made Horizontal or Beam, Condensing, Non-Condensing, and Compound. Also makers of Rice Mills, and Paper Mills, and General Engineers. Machinery shipped or trucked direct from the premises. Makers of

Lightfoot's Patent Self-con- TAINED DRY AIR REFRIGERATOR, For Preserving Meat, Fish, &c., on Board Ship or on Shore. 3599

Dennis' Patent Straight Full- WAY HIGH-PRESSURE VALVES, for Steam, Water, Gas, &c. For list and terms, apply to T. H. P. DENNIS & CO., Chelmsford, London Office—Mansion House Buildings, E.C. AGENTS: *Glasgow*—H. BENNETT & Co., 131, Hope St. *Liverpool*—RANSOME & MARSHALL, 172, Scotland Road. *Nottingham*—NEW & Co., Clumber Street. *Leeds*—W. HEPTON & SON, Hunslet Lane. 5004

The Only First Award for WOOD-WORKING MACHINERY granted to European Exhibitors at the SYDNEY INTERNATIONAL EXHIBITION, 1879-80, was awarded to

John M'Dowall & Sons, Saw Mill Engineers and Wood-Working Machinists, Walkinshaw Foundry, Johnstone, near Glasgow. LONDON AGENT 5020

J. B. GUTHRIE, 70, Bishopsgate Street Within.

Okes,

LONDON AGENT FOR

Atkinson's Patent Gas Engines.

5054

39, QUEEN VICTORIA STREET, LONDON, E.C.

Field's Patent Boilers and TUBES. LEWIS OLRICK & CO., London. 5046

See Illustrated Advertisement, page 27.

George Russell & Co., ENGINEERS and BOILERMAKERS, ALPHA STEAM CRANE and ENGINE WORKS, MOTHERWELL, near GLASGOW SILVER MEDAL, PARIS, 1867. 4921

Steam Hammers.— Massey's Patent Hammers RECEIVED THE *ONLY* PRIZE MEDAL PARIS 1878. More than 1500 made. Drop Hammers · Hasse's Patent Power Hammer. B. & S. MASSEY, MANCHESTER, Birmingham Depôt: 2, Corporation Street. 4805

The "Differential" Pumping ENGINE.—DAVEY'S PATENT for Draining Mines; Water Supply of Towns; Irrigation; Supplying Docks; Pumping Sewage; and General Pumping Purposes. HATHORN, DAVEY, & CO., LEEDS. H., D., & Co. have Patterns of "Differential" Engines of all sizes from 5 to 500-horse power, and have facilities for supplying very powerful Engines and Pumps at a short notice. 4750

Locomotive Tank Engines designed and constructed by MANNING, WARDLE, AND COMPANY, Hoyne Engine Works, Leeds. 2487

See their Illustrated Advertisement, page 43.

Locomotive Tank Engines, TRAMWAY ENGINES AND CARS. Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough. 5206

See Illustrated Advertisement, page 43.

Patent Spring Safety Valves. THOMAS ADAMS, WORKS OF THE "ANT AND BEE," WEST GORTON, MANCHESTER.

SEE LARGE ILLUSTRATED ADVERTISEMENT, JUNE 20, PAGE 35. 4872

Stannah's Pendulum Pumps. For Prices see alternate weeks. 3238

Steel Hydraulic Cylinders.— HENRY BESSEMER & CO., Limited, SHEFFIELD.

See Advertisement last week, page 33 3627

Tweddell's Hydraulic Rivetting Machines

14, DELAHAY STREET, WESTMINSTER, LONDON, S.W. 4897

See Illustrated Advertisement last week, page 49.

L. Sterne & Co., Limited. ENGINEERS, Sole Makers of

Clerk's Patent Self-Starting Gas Engine.

HIGHEST AWARD, BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881.

GOLD MEDAL, CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifiers, WITH STERNE AND WAINWRIGHTS PATENTED IMPROVEMENTS

Emery Wheels, Emery Machines, Spiral Springs.

The Crown Iron Works, GLASGOW.

The Crown Iron Works (Hollinwood), MANCHESTER.

10, Victoria Chambers, WESTMINSTER.

City Office and Show Rooms, 40, CANNON STREET, E.C.

10, Rue Laffitte, PARIS. 2568

Professor Armstrong, of the Yorkshire College, Leeds, proposes to hold a LONG VACATION CLASS in Field-work (Surveying, Levelling, &c.), at Grasmere, Westmoreland, early in August. — For particulars, address, Professor ARMSTRONG, St. Oswalds, Grasmere, R.S.O. G 468

Owen's College, Manchester. —The Council propose to appoint to THREE BERKELEY FELLOWSHIPS of the value of £100 each for the year 1884, FIVE in one or more of the following subjects:—I. Classics. II. English Language and Literature. III. History. IV. Philosophy. V. Pure Mathematics. VI. Applied Mathematics. VII. Engineering. VIII. Physics. IX. Chemistry. X. Biology (including Physiology). XI. Geology (including Palæontology).

The appointments will be made after consideration of documentary evidence furnished by the applicants.

The conditions of award and tenure will be forwarded on request.

Applications to be sent to the Registrar on or before the 18th September. G 418

J. HOLME NICHOLSON, Registrar.

TENDERS.

THE NEWPORT (MON.) SLIPWAY DRY DOCK AND ENGINEERING COMPANY, LIMITED.

Tenders are invited by the above Company for the CONSTRUCTION of a DRY DOCK

Plans and Specifications may be seen at the Offices of Mr. O. REICHENBACH, C.E., 6, Victoria Road, Westminster, London, and at the Offices of the above Company, 80, Dock Street, Newport, Mon.

Tenders may be sent in on or before Eleven o'clock a.m. on the 17th July next, addressed to the undersigned, at the Offices of the Company.

The lowest or any Tender not necessarily accepted.

By order of the Board,
WILLIAM WEST, G 419
Newport, Mon., 10th June, 1884. Secretary

BOROUGH OF WEST BROMWICH.

TO PIPE FOUNDERS.

The Corporation are prepared to receive

Tenders for the Supply and DELIVERY of about 682 tons of 39 in., 120 tons of 38 in., and 176 tons of 30 in. CAST IRON PIPES, in connection with the main drainage works.

Specification, conditions, and quantities may be obtained, and the drawings inspected at my Office, on and after the 18th inst., on payment of Two Guineas, which will be returned on receipt of a *bona fide* Tender.

Tenders to be sent in on the proper forms, on or before Two o'clock p.m., the 30th day of July, addressed to the Town Clerk, Town Hall, West Bromwich, and endorsed "Tender for Cast Iron Pipes."

JOHN T. EAYRS, Assoc. M. Inst. C.E.,
Town Hall, West Bromwich, Borough Surveyor.
7th July, 1884. G 493

GREAT WESTERN RAILWAY.

The Directors of this Company are prepared to receive

Tenders for the Construction of a CANAL BASIN and GOODS WAREHOUSE and other Works at the Stourport Station, Worcestershire.

Plans and Specifications may be seen, and Forms of Tender and Bills of Quantities obtained, at the Office of the Engineer at the Hereford Station.

Tenders, addressed to the undersigned, and marked outside, "Tender for Works at Stourport," will be received on or before Tuesday, the 29th instant.

The Directors do not bind themselves to accept the lowest or any Tender.

FRED. G. SAUNDERS,
Paddington Station, London, Secretary.
8th July, 1884 G 507

COUNTY OF MONMOUTH—MONMOUTH GAOL.

TO CONTRACTORS, &c

The Magistrates of the County of Monmouth are prepared to receive

Tenders for the Old Materials now standing and known as Monmouth Gaol.

A Block Plan and Specification may be seen at the Office of the County Surveyor, 2, Bridge Street, Newport, Mon., or on application at the Police Station, Monmouth.

Tenders, for the whole or part of the materials, to be delivered at my Office at Usk, on or before the 31st instant.

The highest or any Tender not necessarily accepted.

O. A. WYATT, G 514
Usk, 3rd July, 1884. Clerk of the Peace

GREAT WESTERN AND LONDON AND NORTH WESTERN JOINT RAILWAYS

The Joint Committee of the Great Western and London and North Western Railway Companies are prepared to receive

Tenders for the Construction of the West Kirby Extension Line, which is about seven and three-quarter miles in length.

Plans can be seen, and Specification with Form of Tender and Statement of Quantities obtained, on application to Mr. ROBERT E. JOHNSTON, Engineer's Office, Woodside Station, Birkenhead, on and after Tuesday, the 15th instant.

Tenders endorsed "Tender for West Kirby Extension," to be delivered to the undersigned, not later than noon on Wednesday, the 30th instant.

The Directors do not bind themselves to accept the lowest or any Tender.

Birkenhead, J. WAIT, Secretary,
2nd July, 1884 G 477

DUTCH STATE RAILWAY COMPANY.

The Company wants to

Sell about 6,000 tons of old IRON RAILS, IRON FISH-PLATES, BED-PLATES, &c., of good quality (Dutch tests), in Lots as desired by purchasers.

Conditions and information, from 20th July, 1884, at the Offices of said Company, Utrecht (Holland), and at the Offices of Resident Engineers at Groningen, Meppel, Zutfen, Nymegen, Rotterdam, Breda, and Venloo.

Copies of Conditions are sent after the 20th July, 1884, on free application to the Offices of said Company, Utrecht (Holland).

Tenders are to be delivered on or before the 12th of August, 1884, at the Offices of said Company, Utrecht (Holland). G 454

EAST INDIAN RAILWAY COMPANY.

The East Indian Railway Company is prepared to receive

Tenders for the Supply and DELIVERY of:—
BESSEMER STEEL RAILS, and
WROUGHT-IRON TIE BARS, KEYS and COTTERS,
as per Specifications and Drawing to be seen at these Offices.

Tenders are to be delivered in sealed envelopes, addressed to the undersigned, marked "Tender for Bessemer Steel Rails," or, as the case may be, not later than One o'clock p.m., on Thursday, the 24th day of July instant.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
A. P. DUNSTAN,
Nicholas Lane, London, E.C. Secretary,
10th July, 1884. G 515

HULL CORPORATION.
SPYVEE STREET BRIDGE.—CONTRACT No. 2.

TO ENGINEERS AND CONTRACTORS.

The Corporation of Kingston-upon-Hull are prepared to receive

Tenders for the Ironwork (comprising about 70 tons wrought iron and 10 tons cast iron) for a Bridge across the Sutton Drain at Spyvee Street.

The Plans may be seen at this Office, where also copies of the Specification and Form of Tender may be obtained, after Wednesday, the 16th inst., upon payment of Two Guineas, which will be returned to parties tendering in accordance with the Specification.

Tenders endorsed "Tender for Spyvee Street Bridge, Contract No. 2," are to be addressed to the Chairman of the Works Committee, and delivered under cover to C. S. TODD, Esq., Town Clerk, Hull, on or before Thursday, the 31st day of July, 1884.

The Corporation do not bind themselves to accept the lowest or any Tender.

By order,
J. FOX SHARP, G 513
Town Hall, Hull, 9th July, 1884. Borough Engineer.

APPOINTMENTS OPEN.

The Royal Indian Engi- NEERING COLLEGE, COOPERS HILL, STAINES.

APPOINTMENT OF PROFESSOR OF HYDRAULIC ENGINEERING AND MECHANISM.

This appointment becomes vacant in Sept., 1884.

The salary is £600 (first year £450 only), with bachelor quarters in the College (partly furnished), including the use of coals and gas.

The new appointment will be made by the Secretary of State for India, on the recommendation of the President of the College.

A statement of the duties may be obtained from the Secretary of the College, to whom also applications for the appointment, accompanied by testimonials, may be made before the 23rd July next. G 421

County or District Surveyor- SHIP IN IRELAND.

An OPEN COMPETITION for Two County or District Surveyorships in Ireland, will be held in Dublin, in August next, under the Acts 7 and 8 Vict., c. 106, and 25 and 26 Vict., c. 106.

The Examination will extend over the four days commencing with 12th August, and the six days commencing with 26th August, and will be in the following branches of knowledge.

PART I.	Maximum of Marks.
Mathematics—including Geometry, Trigonometry, Algebra, Differential and Integral Calculus, and Geometrical Optics	100
Mechanical Philosophy including Statics and Dynamics, Hydrostatics and Hydraulics, Pneumatics, and Heat regarded as a source of Power	100
Experimental Science—including Inorganic Chemistry, Heat, Electricity, and Magnetism	100
Geology and Mineralogy	40

No Candidate will be eligible who does not show some proficiency under one at least of the heads included in Part I.

PART II.	Maximum of Marks.
Strength and other Properties of Materials, and the Calculation of Strains	100
(A) Railway and Canal Engineering	140
(B) Marine Engineering—including Harbour Dock, Sea, and Reclamation Works	140
(C) Hydraulic Engineering — including Water Supply, Sewage, and Irrigation	140
(D) County Works—including Architecture, Roads, Drainage, and River Works	140
	1000

*** Each of the groups lettered A., B., C., D., to include Designs, Estimates, Specifications, and the mechanical contrivances connected with it; and Candidates will be required to show that they have been engaged in the practice of their profession on adequate works for a sufficient time, or have had in some other way satisfactory opportunities of becoming acquainted with the practice of their profession in some one of the branches thus indicated.

Limits of age, 26 and 40.

Persons wishing to compete for those appointments, or to be reported qualified to act as Deputies to County Surveyors, must make written application to the SECRETARY, Civil Service Commission, London, S.W.

No person will be admitted to compete from whom the Secretary, Civil Service Commission, has not received, on or before the 1st August, an application on a prescribed form, which may be obtained from him at once.

Such enquiries as may be necessary will be made by the Civil Service Commissioners, with regard to the age of Candidates, and also as to their health and character.

NOTE.—All the Candidates who reach the prescribed standard, and furnish the required proof of age, health, character, and professional training, will, if they so desire it, be certified. Two of them will be appointed County Surveyors, and the others will be eligible to act temporarily as Deputies, but will have no claim to be appointed County Surveyors.

Dublin Castle, June 28th, 1884. G 472

SOUTH METROPOLITAN SCHOOL DISTRICT.

To Engineers and Smiths.— The Board of Management of this School District REQUIRE for the Schools in the Brighton Road, Sutton, Surrey, the services of a thorough practical ENGINEER, to take charge of the whole of the machinery and plant of the Establishment, and to keep the same in proper repair; also to supply steam for cooking purposes, and for working the machinery in the laundries and bakehouse. He must be competent to impart, in a practical manner, instruction in Engineering and Smiths' work to the boys placed under his care. Hours from 6 a.m. to 5.30 p.m., and whenever his services may be required. He will be expected to give his whole time to the managers.

Salary thirty-five shillings per week, with cottage upon the school premises, and an allowance of coals, gas, milk, and vegetables.

For forms in which the particulars of the application must be submitted to the managers, apply by letter to me, at the Vestry Hall, Walworth. Selected candidates will have notice to attend on the day of election. The person elected will be required to enter upon his duties on or about the second day of August next.

By order,
HENRY BURGESS.
Vestry Hall, Walworth, Clerk to the Board.
3rd July, 1884. G 492

Experienced Draughtsman WANTED for an Engineering and Millwrights' Works, Lancashire.—Apply, by letter, to A. B. C., Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C., with references. G 488

Wanted, Two efficient Loco- MOTIVE DRAUGHTSMEN; state experience and salary.—Address, BOX 572, Post Office, Manchester. G 506

Working Foreman (non-society) PATTERN MAKER WANTED, accustomed to piece-work.—Apply, stating qualifications, BOX 38, Wolverhampton. G 491

Travellers and Agents wanted to push fine durable compound Machinery Oils, largely and increasingly adopted. Liberal commission.—Address J. B. TYLOR, 24, Finch Street, Whitechapel, London. G 374

SITUATIONS WANTED.

Sugar Refiners, Planters, &c. —WANTED, a SITUATION as MANAGER by a scientific and practical man; great experience in responsible management in large works; good references and testimonials.—Address G 490, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 490

Mining Engineer and Colliery Viewer of long experience is open to take the MANAGEMENT of a Colliery or Mine at home or abroad, or to Inspect and Report. Thoroughly competent skilled accountant. First-class testimonials and references. Would join an established Firm of Consulting Engineers, Mining Agents or Brokers.—Address E 87, care of C. BIRCHALL, Advertising Agent, Liverpool. G 501

Wanted position of General MANAGER of Bridge and Roof Building Works, by Engineer thoroughly competent to undertake the duties (varied experience and satisfactory references).—Address G 511, Offices of ENGINEERING. G 511

Draughtsman and Engineer DISENGAGED; sixteen years' experience in hydraulic, pumping, beam, Corliss, and compound marine engines; university education; thorough French; moderate German.—Address, S., 20, Annandale Road, Greenwich, S.E. G 512

Good Draughtsman desires SITUATION, would assist engineer, and be useful in office; speaks five languages.—Address, G 500, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 500

Mechanical Draughtsman SEEKS WORK. General Engineering; age 28; good references.—Address, H. F., 28, Octavia Street, Battersea, S.W. G 499

Contractors.—Engagement as ASSISTANT AGENT or ENGINEER wanted, home or abroad; good experience on country and town railways, sewers, &c. First-class references.—E. PAULSWORTH, West Malling. G 509

PARTNERSHIPS.

Civil Engineer, 20 years' professional and commercial experience, desires to JOIN a well-established connection, or would take up *bona fide* business having remunerative prospects. —Address M. Inst. C.E., Box 108, Post Office, Swansea. G 510

WANTED, &c.

Overhead Travelling Crane WANTED; 48 ft. span, or thereby, for 20 ton loads, driven by rope preferred.—Price and sketch to DAVIS & PRIMROSE, Leith, N.B. G 505

Wanted, an Engineering FIRM, with a good connection amongst Gas Companies, to take up the manufacture and sale of a newly patented Gas Exhaustor.—For particulars, apply to J. C. R. OKES, M.I.M.E., 39, Queen Victoria Street, London, E.C. G 456

Agents Wanted for the Sale of TIN PUTTY POWDER for needle makers. —Apply, stating references, to R 4828, care of RUDOLF MOSSE, Cologne. G 489

Agents Wanted, to push First- class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool. 5233

FOR SALE.

For Sale or Hire, Locomotive TANK ENGINE (Second-hand). Cylinders, 12 in. diam.; 18 in. stroke; four wheels coupled; photograph on application. New Locomotives in progress.—THOS. PECKETT, Atlas Engine Works, near Bristol. G 496

For Sale, Largest Stock in England, Engineers' Machine Tools, Steam Hammers, Steam Engines, Wood-working Machinery, all sizes, best materials and workmanship, low prices; send for stock list.—SCOTT BROTHERS, Halifax.

TO CONTRACTORS, HARBOUR BOARDS, &c.

For Sale, at Wicklow Harbour Works, an 8-ton Russell Self-Propelling Steam Derrick Crane, with 60 ft. jib.; 10-ton Cameron ditto, with 72 ft. jib; Priestman Steam Travelling Crane, for "B" size grab; two specially strong Priestman Grabs; Punching and Shearing Machine; Chaplins' Locomotive; several large Iron Skips; several tons 6 in. by 6 in. Angle and Tee-Iron; 40 tons Steel Rails; large quantity sound sawn Pitch Pine; three good Barges; one specially good rectangular Barge, on which Priestman crane works.—Apply to JOHN JACKSON, Harbour Works, Wicklow, Ireland; or 9, Victoria Chambers, Westminster. 5122

For Immediate Sale, at low prices for cash.

SECOND-HAND.

LANCASHIRE BOILER, 18 ft. 3 in. by 7 ft. diameter.
CORNISH BOILER, 12 ft. by 4 ft. diameter.
VERTICAL CROSS TUBE BOILER, 7 ft. 6 in. by 3 ft. 3 in. diameter.
TANK LOCOMOTIVE, 4 wheels coupled, cylinders 10 in. by 20 in.
A New 9 HP. CHAPLIN'S LOCOMOTIVE.
5 ft. 6 in. FACE PLATE LATHE, by Whitworth.
RAIL STRAIGHTENING MACHINE, with engine attached, by Collier.
No. 6 ROOTS BLOWERS, by Thwaites.
Two No. 4½ PATENT BLOWERS, by Ellis.
Two SCOTT WHEEL MOULDING MACHINES.
10-ton RAILWAY WEIGHING MACHINE.
STEAM WINCHES, from 5 in. to 7 in. cylinders.

For prices and full particulars of any of above apply to "PHILLIPS' MONTHLY MACHINERY REGISTER," Newport, Mon. 4804

On Sale, One Pair Vertical ENGINES, indicating 520 horse-power; one HORIZONTAL ENGINE, indicating 200 horse-power; three BOILERS, 30 ft. by 7 ft.—All can be seen working at the LANCASHIRE COTTON SPINNING CO., Ltd., Heyside, near Oldham. G 497

On Sale, a Pair of Horizontal CONDENSING ENGINES, 16 in. and 22 in. cylinders, 36 in. stroke, fly spur 12 ft. diameter; about eight tons weight: pinion 4 ft. diameter; vertical air pumps; also two Boilers, each 28 ft. long, 7 ft. diameter, working pressure 50 lb., insured in the Yorkshire Boiler Insurance Company. Delivery in about three months. All in first-class condition.—Address, GEO. CRADOCK & Co., Wakefield. G 475

A No. 1 Second-hand Sissons and White's STEAM PILE DRIVER FOR SALE. —Apply SISSONS & WHITE, Hedon Road, Hull. G 498

6 and 7 ft. Mortar Mills, new; 8 HP. Portable by Middleton, Chain, Blocks, Jacks, Crabs, Slings, &c., for Hire; Lubricating Oil, 2s. 6d. and 3s. per gallon; two 40 ton Hydraulic Jacks.—HASNETT & COWDY, Machinery Dealers, 146, Southwark Bridge Road, S.E. G 502

To Museums.—For Sale, as a Curiosity, a large BEAM ENGINE, by Boulton and Watt, with sun and planet motion, wood beam, connecting rod, &c.; been at work in London over 90 years; can be seen in use now if required.—For particulars apply to G. J. WORSSAM & SON, Wenlock Road, City Road Basin, N. G 496

Patents for Sale.—The English, French, German, Belgian, and American PATENTS for a new self-gripping and self-adjusting spanner and pipe wrench, already in use by various railway, steamship, dock and gas companies, and many engineering firms, gasfitters, plumbers, &c.—Address J. C. BAUER, Engineer, Brockley, London, S.E. G 494

Hornbeam Plank, all thick- nesses, dry; warranted English growth; very large stock; cogs cut to any pattern at moderate prices.—J. KEEN, 264, Waterloo Bridge Road, London, S.E. 5191

Compound Surface Conden- sing MARINE ENGINES FOR SALE; cylinders 10 in. and 20 in. diameter by 12 in. stroke, fitted with Payton and Wilson's patent circular balanced and double-ported slide valves, and link motion reversing gear.—Address ALEX. WILSON & CO., Vauxhall Iron Works, Wandsworth Road, London, S.W. 4998

16 HP. Portable Steam ENGINE, high class, now, with or without link motion reversing gear, FOR SALE on advantageous terms. 8 HP. PORTABLE STEAM ENGINE, high class, new, FOR SALE, cheap for the quality, with a 6 ft. pan Mortar Mill and a 5 ft. by 2 ft. 6 in. Saw Table complete.—For price, or to view, apply to BARROWS and STEWART, Engineers, Banbury, Oxon. 503

Boilers! Boilers!! Boilers!!! The Largest Stock in London of Cornish or Vertical Boilers for Sale or Hire from 2 to 80 horse power.—F. BONE, South London Boiler Works, Long Lane, Borough. Boilers repaired by practical men only. 5141

Boring Machine. — Very largest Vertical Machine, for boring cylinders, in perfect condition, self-acting, cost £5,000.

CHUCKS.—Five powerful Chucks, the largest 14 ft. 2 in. diameter.

SLOTTING MACHINE.—Powerful compact Tool, 5 ft. 2 in. stroke, longitudinal traverser and circular tables, self-acting.

HOISTING SHEERS.—Largest size, 160 feet high, all iron, three legs, back, &c., to traverse, blocks, chains, steam gearing, hand ditto, complete.

All at the SALE at CANAL IRON WORKS, Millwall, London, E., next week. G 503

Tank Locomotives, 4 or 6 wheels coupled. Specification and workmanship equal to Main Line Engines.—Apply to R. & W. HAWTHORN, Engineers, Newcastle-on-Tyne.
See Advertisement last week, page 42. 4964

Locomotive Tank Engines always in stock or progress.—HUDSWELL, CLARKE and CO., Railway Foundry, Leeds, Sole Makers of RODGERS' PATENT WROUGHT IRON PULLEYS. See Illustrated Advertisement, page 38.

Locomotive Tank Engines for Main Line Traffic, Short Line, Collieries, Contractors, Iron Works, Manufactories, &c., from a superior specification, equal to their first-class Railway Engines, and specially adapted to sharp curves and heavy gradients, may always be had at short notice from Messrs. BLACK, HAWTHORN, and Co, Locomotive, Marine, and Stationary Engine Works, Gateshead-on-Tyne 1524

Machine Tools for Sale.—Ready for Delivery:—One powerful Treble Geared Lathe, 36 in. centre, with blocking up pieces to raise it up to 48 in. centres when required, face plate 7 ft. 6 in. diameter, two saddles, and will admit 22 ft. between centres, right-hand saddle fitted with screw-cutting gear, &c., weight 38 tons.
One 18 in. stroke Slotting Machine, will admit 5 ft. 9 in., quick return motion by elliptic gearing, ram balanced.
One 7 in. stroke Slotting Machine, will admit 3 ft. diameter.
Apply, WM. HOLDSWORTH, Machine Tool Maker, Leeds. G 504

Machine Tools for Sale.
PLANING MACHINE, 14ft. by 6ft. 1 in. by 6 ft. 3 tool boxes.
" " 12 ft. by 4 ft. by 4 ft., 2 "
" " 8 ft. by 3 ft. by 3 ft., 1 "
" " 6 ft. by 2 ft. 6 in. by 2 ft. 6 in., 1 "
" " 4 ft. by 2 ft. by 2 ft., 1 "
Shaping Machine, 15 in. stroke, 6 ft. bed, 2 tables.
" 8 in. stroke, 4 ft. bed, 1 table.
Slotting Machine, 8 in. and 12 in. stroke.
Radial Drilling Machine, 5 ft. arm, 2¼ in. spindle.
Steam Hammers, 2 and 5 cwt. (Massey's pattern).
Lathe, 16 in. centre, 20 ft. gap bed. G 508
Lathes, 12 in. centre, 16 ft. and 20 ft. gap beds.
Lathes, 6 in. to 10 in. centres, 6 ft. to 20 ft. gap beds.
JOHN MOORE & CO., 32, Victoria Street, Manchester.

Ready for Delivery:—
One Radial Drilling Machine, 6 ft. arm.
One 14 in. stroke Shaping Machine, 6 ft. bed.
One 12 in. ditto ditto ditto.
One 14 in. centre Sliding, Surfacing, and Screw-cutting Lathe, 14 ft. gap bed.
One 10 in. ditto ditto ditto, 16 ft. gap bed.
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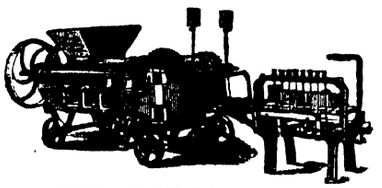
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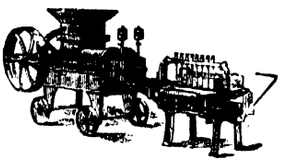
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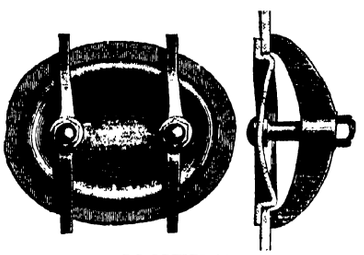
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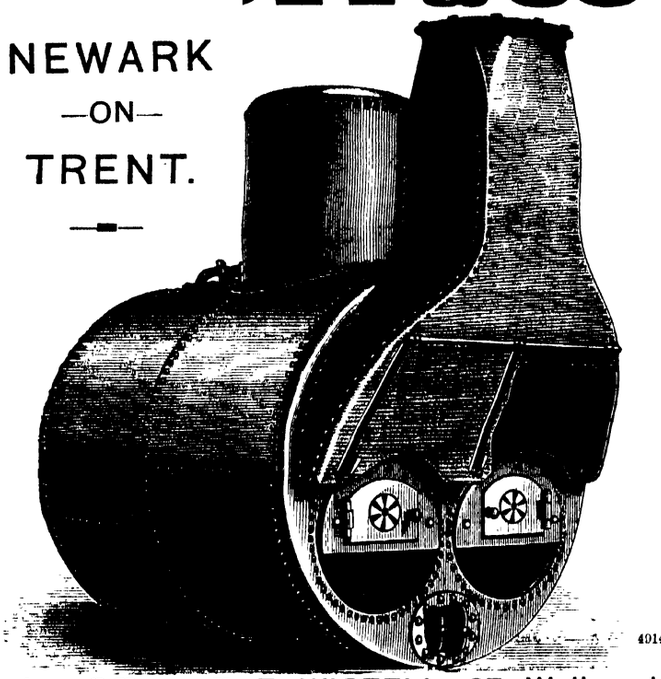
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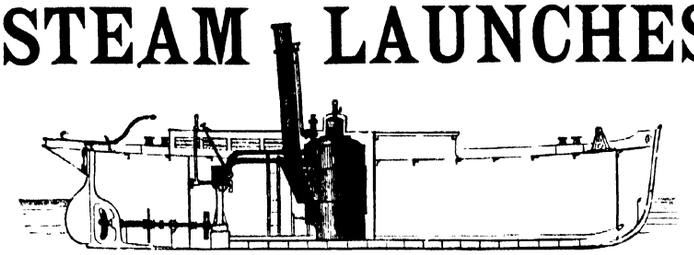
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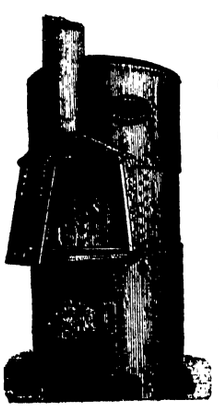


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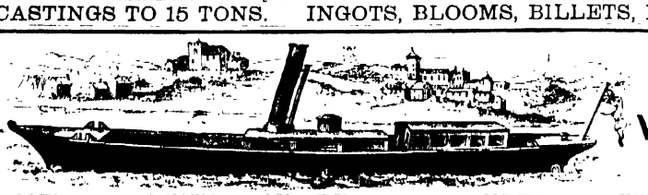
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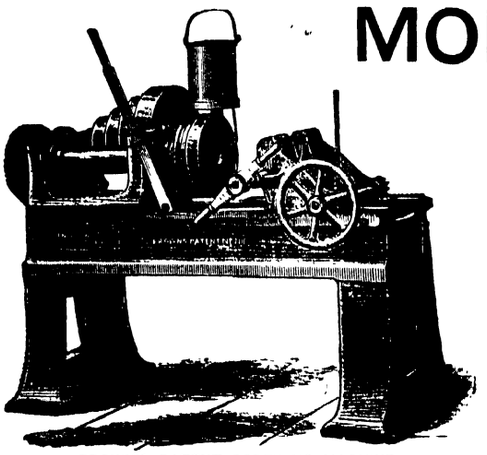
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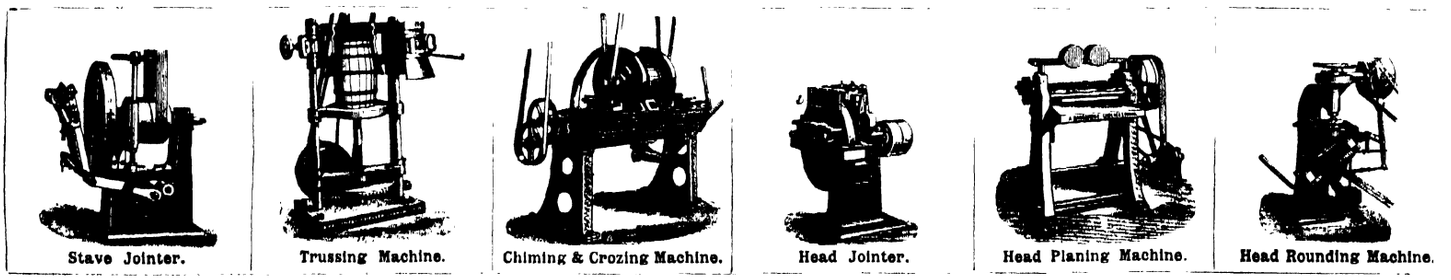
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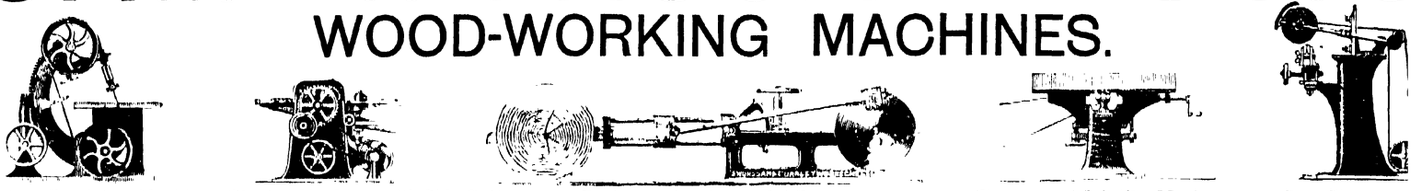
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NEW ITALIAN ASBESTOS ROLLED CLOTH PACKING,

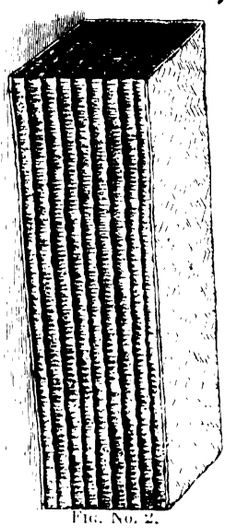
WITH INDIA-RUBBER CORE. (FIG. No. 1.)



This is similar to "Tuck's" Packing, except that it has the great advantage of being made of fine ITALIAN ASBESTOS CLOTH instead of ordinary canvas, which is soon destroyed by the heat. Specially recommended for Steam Hammers, Winding and Pumping Engines, and for Hydraulic Work.

ITALIAN ASBESTOS CLOTH PACKING

(SQUARE), WITH INDIA-RUBBER BACK. (FIG. No. 2.)



This Packing is composed of the same materials as those employed in the construction of the *round* Packing (Fig. No. 1). Both Packings are remarkable for their thorough efficiency and durability, and are recommended for HP. Engines with the fullest confidence. The square Packing consists of a base of soft vulcanised india-rubber, upon which there are built up edgewise a number of layers of thick Italian Fibrous Asbestos Cloth. Sufficient elasticity is thus imparted by the rubber back, whilst great durability and protection to the rubber is ensured by the use of Asbestos in place of more perishable fibres and substances used in this well known and approved form of Packing.

The Packing should be lubricated before being put into the gland, and screwed up very lightly in the first instance, as, being principally composed of Asbestos, which is a mineral substance, it expands with the heat of the steam, and so makes itself tight. A little Powdered Black Lead rubbed over the surface of the Packing is also an advantage. This also applies to the *round* Packing.

PURE ITALIAN ASBESTOS PATENT WOVEN PACKING FOR GLANDS.

The following refers to the above Packing:—

THE STANDARD IRON WORKS, COLCHESTER,
10th September, 1883.

To the UNITED ASBESTOS COMPANY, LIMITED.

DEAR SIRS,—After having used your Asbestos Packing for a considerable time, we are quite satisfied and pleased with the results. It is a decided advance in this direction.—Yours faithfully,

DAVEY, PAXMAN & CO.

N.B.—This Packing was used in all Davey, Paxman & Co.'s Engines employed at the Crystal Palace Electric Exhibition in 1882-83 and at the International Fisheries Exhibition, South Kensington, 1883.

FIG. No. 1. FIG. No. 2.

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MESSRS. THE UNITED ASBESTOS COMPANY, LIMITED

BEAUFORT IRON AND TIN PLATE WORKS, MORRISTON, R.S.O., GLAMORGANSHIRE, 18th March, 1884.

DEAR SIRS,—We have pleasure in stating that the Asbestos covering supplied by you for our Boilers and Steam Pipes gives us entire satisfaction, and we find it a considerable saving in fuel, in addition to preventing the condensation of the steam between Boilers and Engines.

Yours truly, for the Beaufort Tin Plate Company, DAVID DAVIES.

ADMIRALTY CONTRACT FOR ASBESTOS PACKING.

After making severe critical examinations and tests of the goods of five competing firms, the LORDS of the ADMIRALTY have recently selected this COMPANY'S PACKING for use in Her MAJESTY'S NAVY. The following letter refers to the Asbestos Rolled Cloth Packing with India Rubber Core:—

GREAT WESTERN RAILWAY, MARINE SUPERINTENDENT'S OFFICE, NEW MILFORD, June 10th, 1884.

DEAR SIRS,—In continuation of the latter part of my letter of 10th ulto. relating to some round packing of yours that we have had on trial, I now write to say that for trunnions we have found it very satisfactory, and so long as it continues to give equally good results it is my intention to supply it to such of our Steamers as have oscillating engines. The orders will come to you through the stores department.

The United Asbestos Co., 161, Queen Victoria Street, London.

Yours truly, SQUIRE T. S. LUCKY.

SEE LAST ISSUE FOR PARTICULARS OF OUR ASBESTOS PATENT FIRE-PROOF AND OTHER PAINTS.

Important Notice. { With a view to meet the requirements of Consumers with whom CHEAPNESS in FIRST COST is an object, the United Asbestos Company now supply, but do not recommend, Packing, Millboard, &c., made in the best style, from CANADIAN ASBESTOS, as a SECOND-CLASS article, at prices from Fifteen to Thirty per cent. less than those of the ITALIAN material.

"SALAMANDER" "SALAMANDER"

Special Terms to Merchants & Dealers.

N.B.—ITALIAN ASBESTOS IS THE BEST

For all Steam purposes. Please see that all Millboard, Sheeting, Tape, and every 15 ft. length of Packing bears our Trade Mark, without which none is genuine.

Specify United Asbestos Company's "SALAMANDER" BRAND.

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The UNITED ASBESTOS Company, Limited,

(Sole Makers of the Pure Italian Asbestos Goods,)

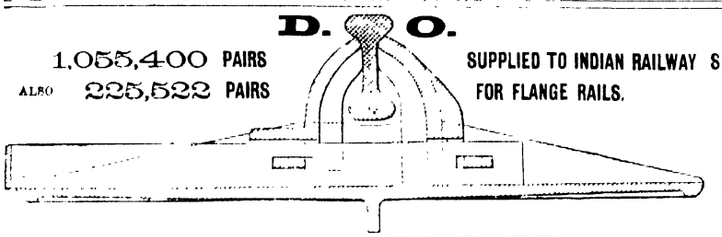
161, QUEEN VICTORIA STREET, LONDON, E.C. 4726

BRANCH DEPOTS:

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D. O.

1,055,400 PAIRS
ALSO 225,522 PAIRS
SUPPLIED TO INDIAN RAILWAYS FOR FLANGE RAILS.



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PATENT TRANSVERSE CAST IRON PLATE SLEEPERS,

For any Gauge and for any form of Rail; without Wooden Keys or any perishable part.
As in use on Guaranteed and State Railways in India.

COST IS LESS THAN INDIGENOUS TIMBER.

Vide "Minutes of Proceedings of the Institution of Civil Engineers," Nov., 1881, Vol. LXVII., p. 37)

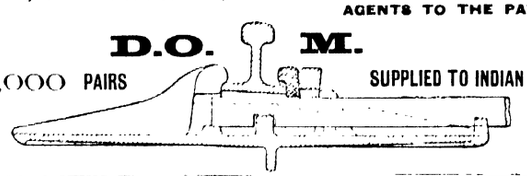
FOR PARTICULARS APPLY TO

MESSRS. THOMSON & BROWNING,
3, VICTORIA STREET, WESTMINSTER ABBEY, S.W.

AGENTS TO THE PATENTEES.

D.O. M.

230,000 PAIRS SUPPLIED TO INDIAN RAILWAYS.



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The old-established Business carried on for nearly 20 years in the name of ALFRED APPS, 433, Strand, London, and for the past seven years in Partnership with OLAN CHARLES BAGOT, Esq., C.E. (the PARTNERSHIP having CEASED by effluxion of time). This Valuable Business, Stock, Glass Cases, Tools, Materials and Tenants' Fixtures, with GOODWILL of the Business and a 21 YEARS' LEASE of the Premises from Christmas last, will be

OFFERED FOR SALE BY MR. J. C. STEVENS

At 38, King Street, Covent Garden, London, on July 11th inst., at 2 o'clock,

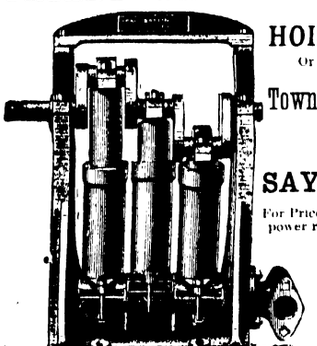
UNLESS PREVIOUSLY SOLD BY PRIVATE CONTRACT.

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PATENT WATER ENGINES & STEAM PUMPS



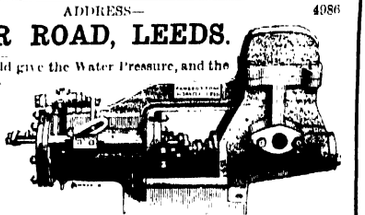
Are for **HOISTING USES,** Or Driving all kinds of Machines by **Towns' Water Pressure** Where sufficient.

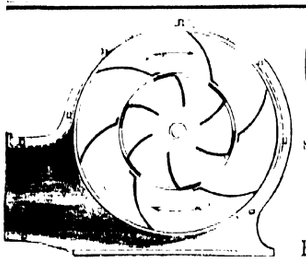
This Pump is **UNSURPASSED** Either for **SIMPLICITY, PRICE,** Or for General Efficiency.

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SAYNOR ROAD, LEEDS.

For Prices, should give the Water Pressure, and the power required.





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CAPELL Double-Power FAN

(PATENT),

THE MOST POWERFUL YET MADE.

See *Engineer*, February 16th, 1883, and Tests of Mr. D. K. CLARKE, C.E., *Engineer*, March 28th, 1884.

Agents for London:
Messrs. HOPKINSON & PRINCE, 15, Walbrook, E.C.

Licensees for the North:
R. LLOYD & CO., 136, Steelhouse Lane, Birmingham.

ACORN AND MIDLAND WORKS, Darlaston, 3rd June.—"DEAR SIRS,—In reply to yours of the 29th, the CAPELL 20-in. FAN we had of you is working satisfactorily, and is doing quite as much work as the 30-in. it replaced, and *taking less power* to drive it.—Yours truly, J. SIMPSON & SONS."

From S. NORTHWOOD & SON, Viaduct Foundry, Birmingham.—"We have much pleasure in testifying to the excellent manner in which the CAPELL FAN works which you supplied to us some time ago. Although a larger Fan than we had previously in use, it takes *considerably less power* to drive, while at the same time we get a better and more uniform blast, and Fan we do not drive up to speed."

REV. G. M. CAPELL.—From WATFORD STEAM LAUNDRY CO.—"I have had your 22-in. Open FAN tested twice this week by closing all exits and filling the wash-house with steam. In less than three minutes from the starting of the Fan the whole place has been cleared. I believe it will be invaluable to us.—SIDNEY MARTIN, Secretary."

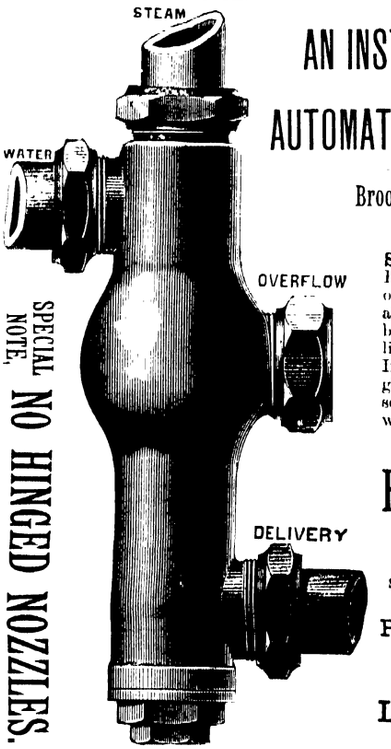
From Messrs. THOMPSON & Co., New Fairfield Works, Old Bailey.—"DEAR SIR,—In reply to yours of yesterday, we have the Fan at work. It is running between 1,000 and 1,100, and as far as we are able to judge it answers well. Yours faithfully, W. S. THOMPSON & Co."

This is a 22-in. open Fan ventilating three large workshops, drawing air through several hundred feet of 12-in., 9-in. and 3-in. Tubing. 5251

THE "INFLUX"

AN INSTANTANEOUS STARTING AND AUTOMATIC RESTARTING INJECTOR

Brooke, Holden, & White's Patent.



SPECIAL NOTE, NO HINGED NOZZLES.

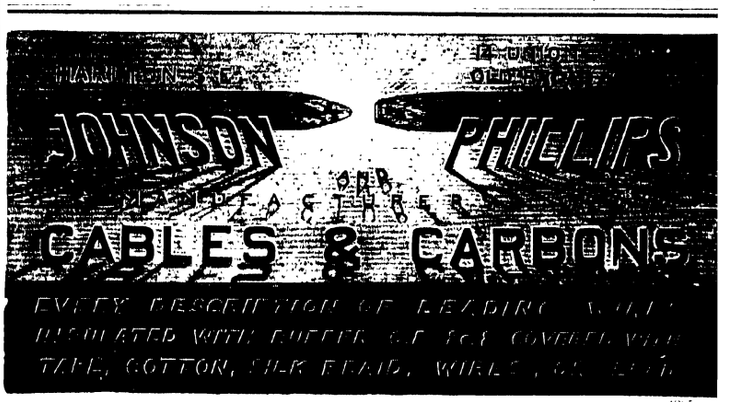
The **only** Lifting Injector **devoid** of **Spindles**, Levers, Adjustable Internal Parts, or **hinged** Nozzles which lifts without manipulation and restarts automatically. **Instantaneous action** on Steam being turned full on. Works equally well lifting up to 12 ft., or as a "non-lifter." Invaluable for Locomotives, Traction Engines, Marine, and other Boilers. Can be seen working on application; or reference will be given as to their perfect reliability.

For Prices, &c., apply to

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ST. SIMON WORKS,
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SOLE MANUFACTURERS.—Also Sole Makers of

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PATENT BOILER DRILL
For Drilling Boiler Shells.

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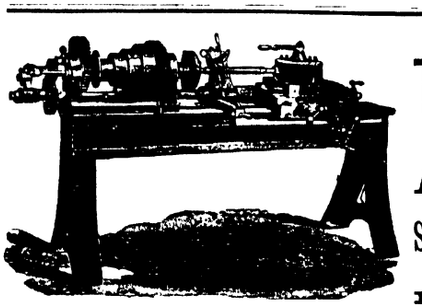
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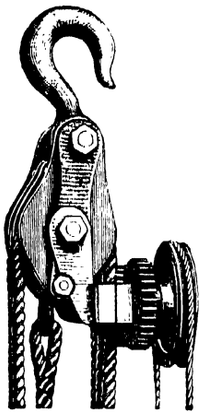
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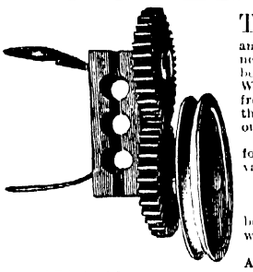
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Important to Engineers, Manufacturers, and all Users and Makers of Pulley Blocks.



THE Friction Brakes supply a want long felt, and will save their cost in half a day. They will sustain, instantaneously, any weight the blocks are capable of lifting, without the necessity of fastening the rope to any fixture. Any weight can be lowered with safety, by relieving the friction as required. When a weight is being raised, the brake may be used whilst a fresh hold is being obtained for each fresh pull. They grasp all the ropes at the same time, thereby giving frictional power without undue pressure or friction, and securing increased safety.

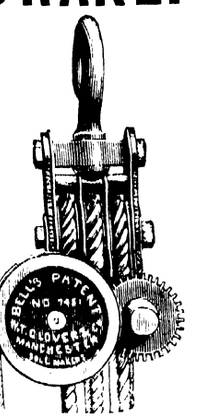
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They will reduce very materially the wear and tear of the ropes.

They give absolute security to life and material.

They are applicable to any existing pulley blocks, and can be attached instantly, being supported by the same bolt or pin which carries the sheaves.

In ordering, send dimensions of top block and size of rope. All sizes of blocks kept in stock, with Bell's Patent Brake attached.



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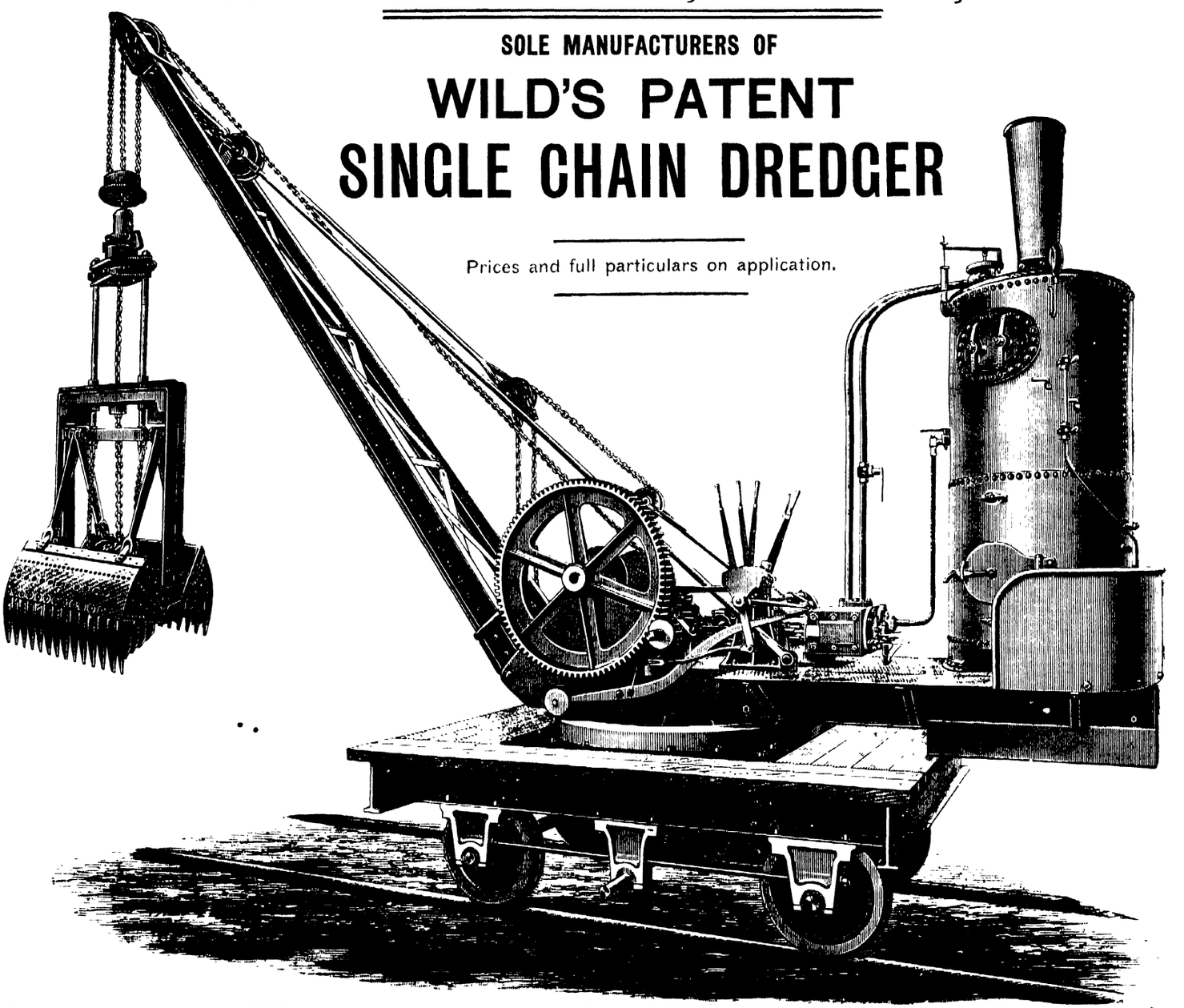
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WIGZELL, POLLITT & MELLOR'S PATENT STEEL COILS.



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STEEL COIL

ADVANTAGES.

Perfect Tightness, Enduring Durability and elasticity, with Equal Expansion, and **REVOLVING TENDENCY** in the Packing Rings

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Manufactured by

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IS UNSURPASSABLE 5089

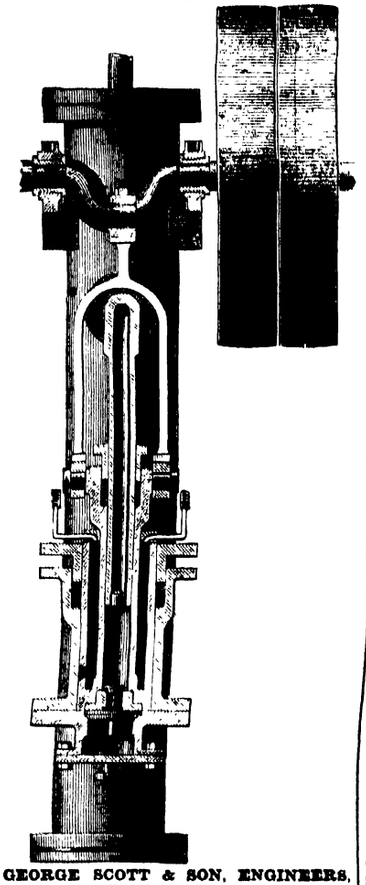
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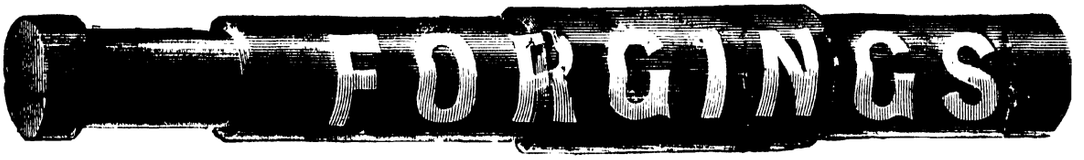
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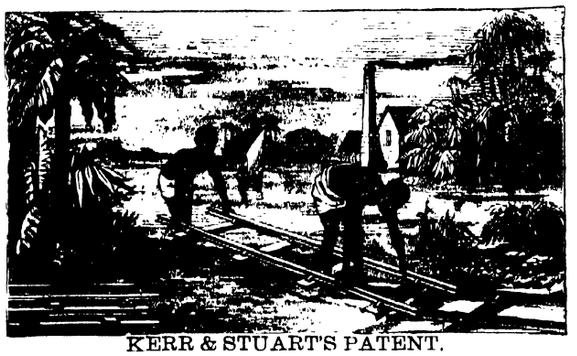
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STEAM LAUNCHES AND STEAMERS

Specially Designed for Light Draught. 4605

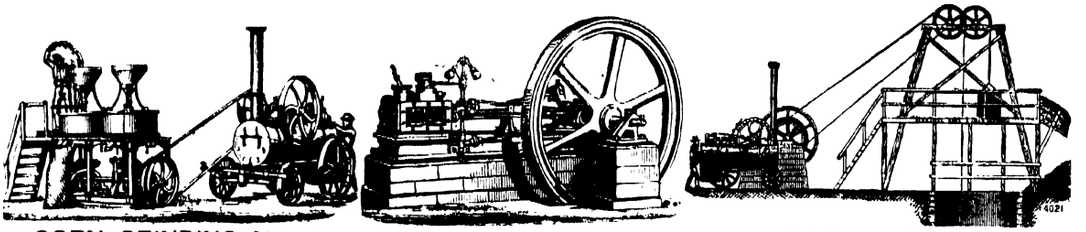
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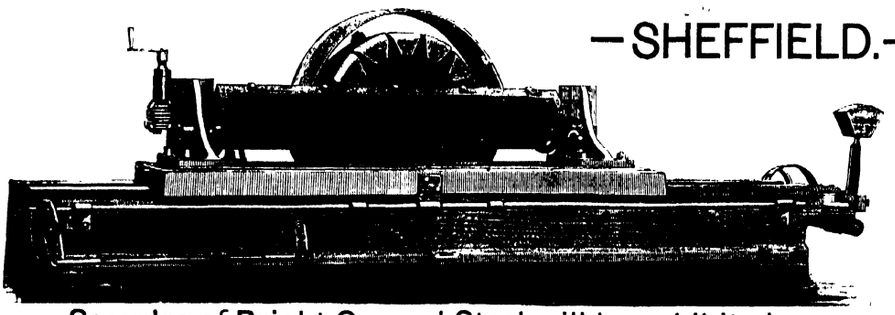


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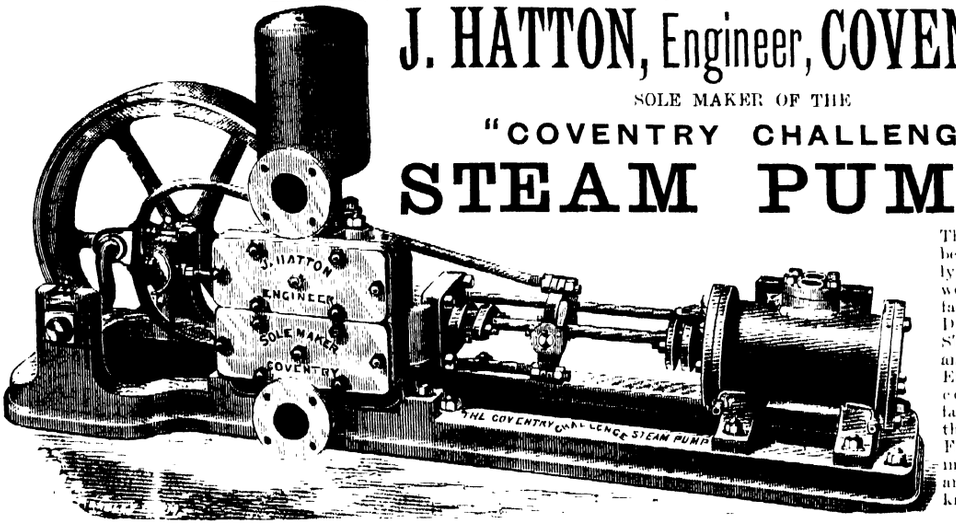


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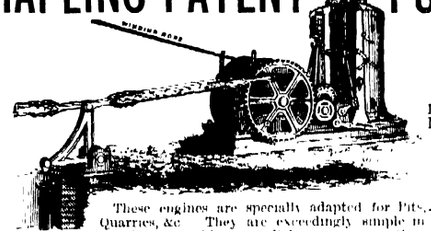
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STEAM PUMPS.

These Pumps will be found absolutely certain in their working, and are far superior to any Direct acting STEAM PUMP; and for Price and Efficiency will compare most favourably with the best class of Fly wheel Pumps in the Market, and are suitable for all kinds of Pumping purposes.

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For Winding or Pumping, either separately or combined

PORTABLE WINDING ENGINES, on Carriage and Wheels,

With One or Two Drums, suited for Pit Sinking, &c.

Improved STEAM EXCAVATOR or "NAVVY," STEAM CRANES, HOISTS, LOCOMOTIVES, and others of our CHAPLINS' Patent STEAM ENGINES and BOILERS

ALWAYS IN STOCK OR IN PROGRESS

These engines are specially adapted for Pits, Quarries, &c. They are exceedingly simple in arrangement, and no Foundation or Chimney Stalk being necessary, they can be erected or removed with very little trouble or expense, and are well adapted for home or foreign use. Sizes from 2 to 25 horse-power.

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CRUCIBLE STEEL CASTINGS

UP TO ANY SIZE AND WEIGHT.

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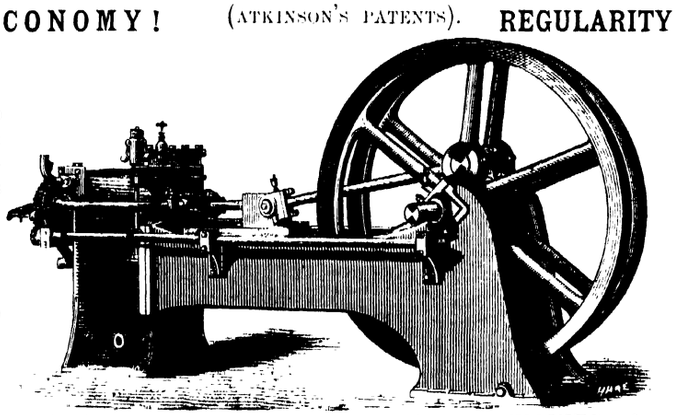
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PLANT FOR

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For transmitting power

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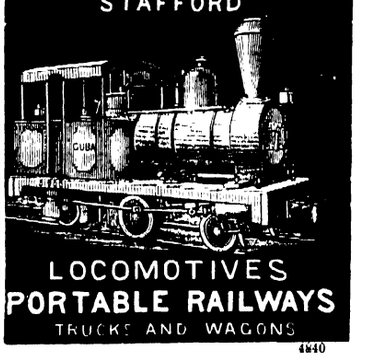
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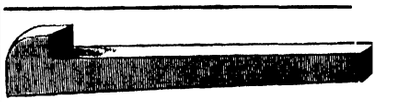


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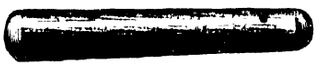


H. FORD SMITH,

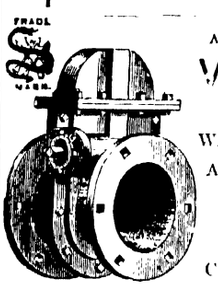
Seddon Street, Salford, MANCHESTER.

FINISHED, PLAIN, & HEADED KEYS

TAPER PINS. 4947



Improved Gas Valves.



ALSO MAKERS OF

VALVES

FOR

WATER, STEAM, AMMONIACAL LIQUOR, TAR, AND CHEMICALS

AND SOLE MAKERS OF

J. Beale's New Patent Gas Exhausters.

B. DONKIN & Co.,

SOUTHWARK PARK ROAD, 2060

BERMONDSEY, LONDON, S.E.

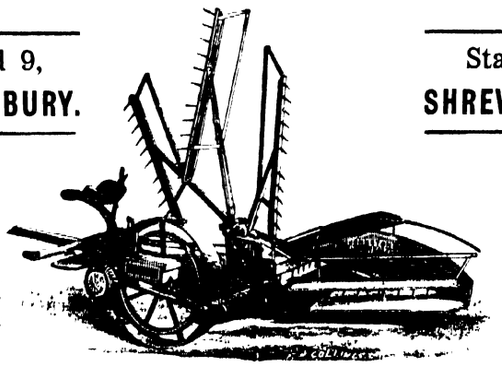
THE JOHNSTON HARVESTER CO.'S

REAPERS, MOWERS, AND STRING SHEAF-BINDERS

Have been Awarded the Greatest Number and the Most Important Prizes.

Stand 9, SHREWSBURY.

Stand 9, SHREWSBURY.



The Wrought-Iron HARVESTER is unequalled for great strength and lightness of draught.

For laid or tangled grain it cannot be surpassed, and is well known to be the "King of Reapers."

THE "CONTINENTAL" REAPER, THE CHEAPEST AND LIGHTEST KNOWN.

THE NEW LIGHT HARVESTER & BINDER

Is giving Unbounded Satisfaction, and is unrivalled by any machine in the market.

70 & 71, CHISWELL STREET, LONDON, E.C.

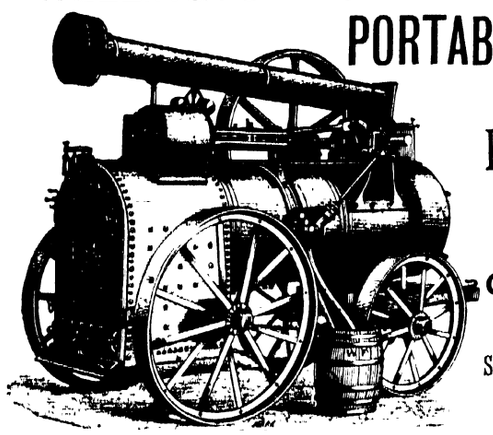
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MACHINERY IN MOTION YARD.

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WM. FOSTER AND CO., LIMITED,

WELLINGTON FOUNDRY, LINCOLN.



PORTABLE ENGINES,

HORIZONTAL & VERTICAL

FIXED ENGINES

Boilers of All Kinds.

THRASHING MACHINES.

CORN MILLS.

SAW BENCHES, &c.

SECOND-HAND ENGINES.

CATALOGUES & PARTICULARS ON APPLICATION. 4448

SLAG WOOL *Loose* *and* SILICATE CLOTH *Felted.*

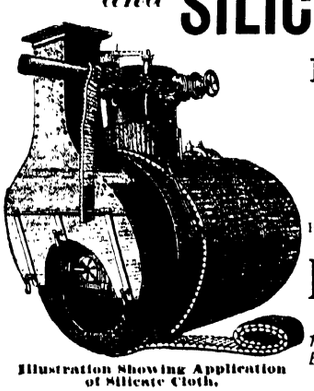


Illustration Showing Application of Silicate Cloth.

Incombustible.
Best Non-conductor Extant.
Easily Applied.
Removable.
Re-applicable.

PRICES, ESTIMATES, AND FULL INSTRUCTIONS FREE ON APPLICATION TO

D. ANDERSON & SON, Ltd.,

PATENT FELT MANUFACTURERS, 6223

10, London Street, Fenchurch Street, LONDON; 118, Broomielaw, GLASGOW; and Lagan Felt Works, BELFAST.

ROYAL SHOW, SHREWSBURY.

STAND 189.

E. R. & F. TURNER,

IPSWICH,

EXHIBIT

PORTABLE STEAM ENGINES

AND

"GIPPESWYK" VERTICAL AND HORIZONTAL STEAM ENGINES.

Above Engines are fitted with **Patent Automatic Expansion Governor**, ensuring important **fuel economy** unattainable with Engines not provided with this apparatus; uniform speed while running under varying loads is also obtained by this Governor. E. R. & F. TURNER direct special attention to these engines.

The "Gippeswyk" Vertical Engines are fixed on Boilers of highly improved construction, with Horizontal Water Tubes; ample heating and evaporating surface; priming, usual to Vertical Boilers, is avoided; Durability of the Boiler and increased facilities for cleaning and repairs are ensured in the "Gippeswyk" Boilers.

E. R. & F. TURNER also Exhibit their

CORN GRINDING MILLS

AND

CORN AND SEED CRUSHING MILLS.

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Awarded the last FOUR MEDALS.



Our Machine, tested by the Judges at Calcutta, broke 7 tons to 2¼ in. ring in 45 minutes, for which we were awarded First Class Certificate and Gold Medal in competition with the Improved Blake Machine.

SEE OUR MACHINES AT THE CRYSTAL PALACE EXHIBITION, LONDON,

ALSO

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AND AT THE

HIGHLAND SHOW, EDINBURGH, JULY 22ND TO 25TH. 52-9

W. H. BAXTER & CO., ALBION STREET, LEEDS.

Ships' Engine and Steering Telegraphs.

Over 3000 Vessels have been fitted with **CHADBURN & SON'S** Patent Telegraphs, including all the noted Steamers in the World, also 200 Vessels for English and Foreign Navies.

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ENGINE AND STEERING REPLY TELEGRAPHS.

ORDERS INDICATED BY SOUND & SIGHT.



A DEEP GONG from Astern to Ahead.

A SHRILL GONG from Ahead to Astern.



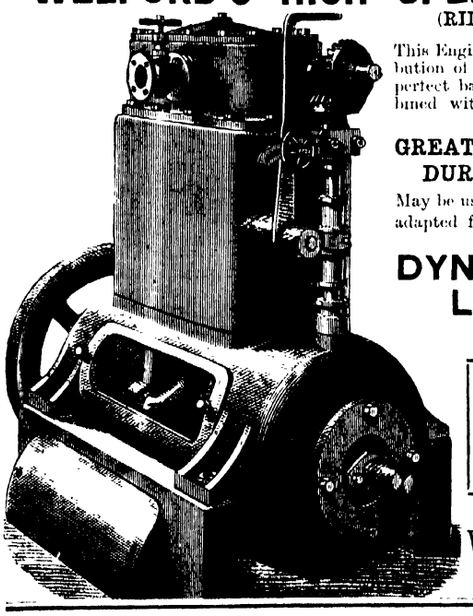
TELEGRAPH WORKS—WATERLOO ROAD,

GLASCOW 69, ANDERSTON QUAY. **LIVERPOOL.** LONDON 96, FENCHURCH ST.

5040

WELFORD'S HIGH SPEED ENGINE.

(RIDEALGH'S PATENT.)



This Engine has most economical distribution of steam, and its design ensures perfect balancing of moving parts combined with extreme simplicity of construction.

GREAT ECONOMY, SIMPLE, DURABLE, and STEADY.

May be used for all purposes. Especially adapted for working coupled direct to line shaft. FOR

DYNAMOS, SAWS, LAUNCHES, FANS.

MAKERS OF

ECC-ENDED, CORNISH, & VERTICAL BOILERS.

APPLY

WELFORD BROS., SUNDERLAND. 4040

DIVING APPARATUS.



BARNETT & FOSTER,

"NIAGARA WORKS,"

25Q, EAGLE WHARF ROAD,

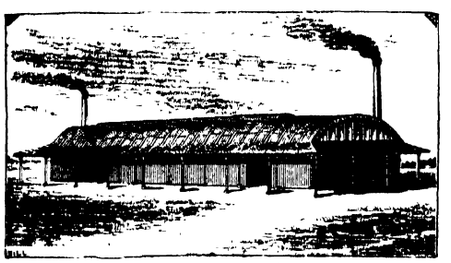
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Have in constant readiness a staff of competent DIVERS, and a large stock of Apparatus, which enables them to undertake on the shortest notice submarine operations of all kinds, requiring skilled and experienced men, such as repairing submerged Pumps, Dockgates, Locks, &c.

Several most important improvements have been made in connection with Diving and Mining Operations. 4010

Illustrated Catalogues forwarded Free.

IRON ROOFS & FIRE-PROOF BUILDINGS.



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Galvanizing Baths.

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Galvanized and Painted Corrugated Sheets.

IRON ROOFS, IRON BUILDINGS,

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Constructional Iron Work and Smiths' Work of every description. 5027

DAVIES BROS. & CO., Crown Ironworks, Wolverhampton.

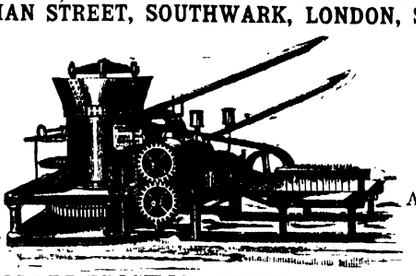
MURRAY'S PATENT BRICKMAKING MACHINERY.

Sole Manufacturers, THOMAS MIDDLETON & Co., Engineers,

LOMAN STREET, SOUTHWARK, LONDON, S.E.

Patent Steam Driven Cutting Tables.

Patent Lubricating Solid Die, for all sorts of Clay.



Patent Plunger Brick Press, for Bricks or Tiles.

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IMPROVED ROLLER BRICK MACHINE, 12,000 to 40,000 Bricks per day, for Clamp and Kiln Burnt Bricks. 3164

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WHITEFRIARS STREET, LONDON, E.C.

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SOLE MANUFACTURERS OF

MANN & OWENS' PATENT GAS VALVES

Supplied to upwards of

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THE MOST RELIABLE VALVE MANUFACTURED

Sizes from 2-in. to 48 in.

All Valves are carefully tested before leaving the Works

Also

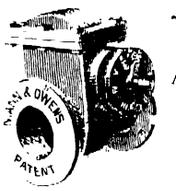
MANUFACTURERS OF

Improved Gas-Exhausters, Steam Engines, Boilers,

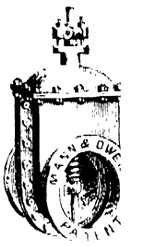
BLAKE'S PATENT STEAM PUMPS

For Tar, Water, and Ammoniacal Liquor.

PILLAR VALVES, SELF-ACTING BYE-PASS VALVES, OUTSIDE RACK AND PINION VALVES, HYDRAULIC MAIN-VALVES, DISC-VALVES



Full Way Rack and Pinion Gas Valve



Screw and Cam Gas Valve.

Every description of Pumping Apparatus, Hydraulic Lifts, &c., suitable for use in Gas-Works, made to order.

PRICE LISTS AND FULL PARTICULARS FURNISHED ON APPLICATION

CROWN PHOSPHOR-TIN

BY USING OUR PHOSPHOR-TIN,

Phosphor-Bronze can be made Superior to any now in the Market,

AT 30 PER CENT. LESS COST.

Three cwt. of our tin will produce one ton of Phosphor-Bronze thereby effecting a considerable saving in carriage, and enabling Manufacturers to use the same stock of Copper for all purposes

(See our Circular.)

BILLINGTON & NEWTON,

LONGPORT, STAFFORDSHIRE. 61

Agents.—London: HAUGHTON & CO., 110, Cannon Street, E.C.

North of Europe: A. SINGTON & CO., St. Peter's Square, Manchester

TRADE OTTO MARK REGISTERED.

PHOSPHOR-COPPER

MANUFACTURED BY

W. G. OTTO, DARMSTADT,

GUARANTEED ABSOLUTELY PURE AND TO CONTAIN FROM 14 TO PER CENT. OF PHOSPHORUS.

Is the CHEAPEST and BEST adapted material for producing PHOSPHOR BRONZE (only 15 to 20 lbs. being required per ton of metal) and all other COPPER ALLOYS, as well as Castings from pure Copper, Brass, German Silver, and Alloys of all kinds with without admixture of Tin; also for re-casting old Metals and Filings.

NO WASTE OF METAL BY OXYDATION.

OTTO'S PATENT STIRRER

For producing homogeneous Metal Castings. *Particulars on application to*

G. HARTMANN,

16, GREAT ST. HELEN'S, LONDON, E.C.

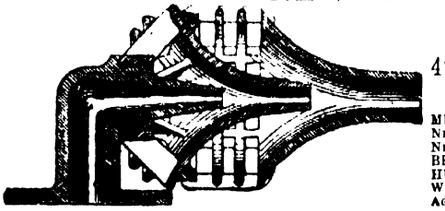
SOLE AGENT FOR GREAT BRITAIN AND COLONIES. 479

HIGH PRESSURE MARINE BOILERS

Best and Cheapest Means of Preventing Unequal Expansion.

"WEIR'S" PATENT HYDROKINETER

OVER 4,000 IN USE.

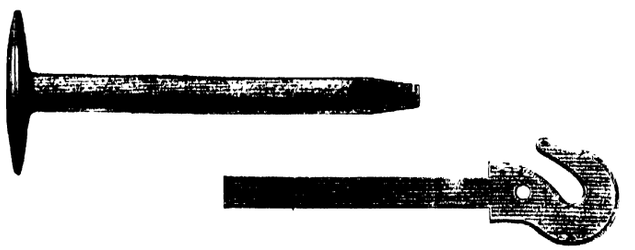


G. & J. WEIR,

49, JAMAICA STREET,

GLASGOW.

MENZIES & BLACKBURN, KING STREET, NEWCASTLE-ON-TYNE WM. REID & CO., NEW LONDON STREET, LONDON, E.C. A. & BROWN, WATERLOO ROAD, LIVERPOOL. HUGHES & CO., FULTON STREET, DUBLIN. W. S. VON ESSEN, ENGINEER, HAMBURG. AGENT FOR SCANDINAVIA & GERMANY. 46



Apply—THE KIRKSTALL FORGE CO., near Leeds. 1636

"STANDARD" STEAM BOILING NOZZLE

FOR

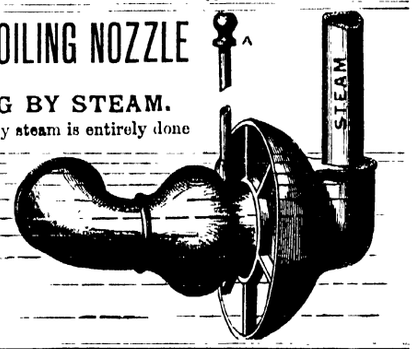
HEATING OR BOILING BY STEAM.

The objectionable noise when boiling by steam is entirely done away with, and the liquor Heated or Boiled QUICKLY, ECONOMICALLY, and SILENTLY.

½ ¾ 1 1½ 2 3 4 in pipe

50/- 60/- 65/- 100/- 130/- 175/- 260/-

NUMEROUS TESTIMONIALS. 4091



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SUGAR, RICE AND FLOUR MILLS, STEAM ENGINES, Boilers, LINOLEUM MACHINERY.

SUGAR MACHINERY

JAMES LANDALE,

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THE BOWLING HOOP OF EVERY DESCRIPTION IN IRON OR STEEL

STEEL CASTINGS

THE BOWLING IRON Co LTD BRADFORD YORKS

ORIGINAL PATENTEES AND SOLE MAKERS

4567

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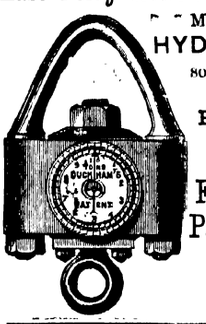
MILLWALL, LONDON, E.

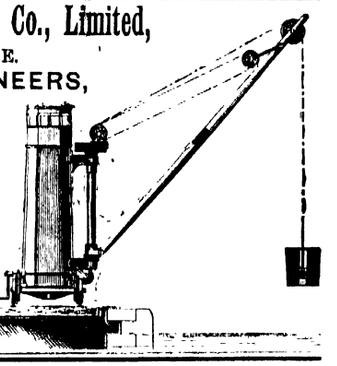
HYDRAULIC ENGINEERS,

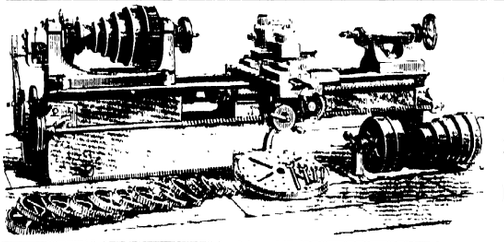
SOLE MANUFACTURERS OF

Parkes's Patent Portable Hydraulic Cranes, Lifts, and Hoists.

F. E. Duckham's Patent Suspended Weighing Machines. 5123







SPECIALITY IN LATHES.

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Makers of all kinds of

Improved Self-Acting, Sliding, and Screw Cutting Lathes,

For Foot or Power. 4668

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IN IRON OR STEEL.

WROUGHT IRON AND STEEL BUOYS OF EVERY DESCRIPTION.

Tar Stills, Steam Pans, Jacket Pans, Shoots, Hoppers, TANKS, CISTERNS, *&c.*

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BELLAMY'S PATENT TUBULAR BOILER,

Unsurpassed for quick Steaming and Economy of Fuel. Also

BELLAMY'S PATENT HEATING BOILER,

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PATENT VOLUTED FRESHWATER CONDENSERS

(SANCTIONED AND APPROVED BY THE BOARD OF TRADE),

For Emigration, Troop, Passenger, and Cattle Ships. Also

THE FOLLOWING ARE SOME OF THE USERS OF THE CONDENSER:-

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Pearse & Co.	Stockton-on-Tees.
Duncan & Co.	Port Glasgow.
London & Glasgow Engineering Co.	Glasgow.
Holmes, Esq.	Hull.
Pascal Atkey & Son	West Cowes.
Worthington & Co.	Burton-on-Trent.
Turney Bros.	Nottingham.
Union Line	Southampton.
The Straits Settlement.	
Sir Allen Young, for S.S. "Hope."	
John Swire & Son	London.

Surface Condensers

FOR ENGINES, REFRIGERATORS, BREWERS, &c.

Smallest and Best in the Market.

Made entirely of Sheet Copper, BRAZED TOGETHER, with Gun-Metal Fittings

Gallons per day.	Dimensions Dia.	Height.
750	7 in.	14½ in.
1000	9½ in.	16 in.
2000	10½ in.	24 in.
3000	12½ in.	24 in.
4000	14 in.	26 in.
6000	14 in.	32 in.

This quantity is guaranteed perfectly cold and fit to drink at exit.

The Highest Testimonials and Price Lists ON APPLICATION TO

SUFFIELD & BROWN,

Coppersmiths & Sole Manufacturers,

JAMES ST. AND DEVONPORT ST.,

Commercial Road East, London, E.

4684

TELEPHONE No., 5307.

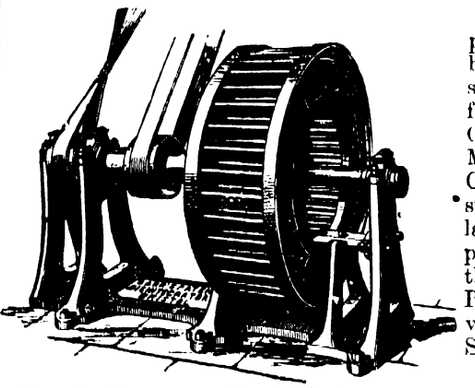
FEED WATER HEATERS MADE ON THE SAME PRINCIPLE.

"CARR'S DISINTEGRATOR,"

Registered Trade Mark, No. 6380.

AWARDED BRONZE MEDAL, PARIS UNIVERSAL EXHIBITION, 1878.

CARR'S PATENT DISINTEGRATOR.



This Machine effectually pulverizes by the combined influences of percussion and of centrifugal force, Iron, Zinc, and other Ores; Asphalte, Artificial Manures, Phosphates, Fire Clay, and many other substances. It is also largely in use for the pulverization of Coal for the manufacture of Coke, Patent Fuel, &c.; and is very effective for mixing Sugar.

These Machines are capable of reducing to a fine granular powder from 50 to 200 tons per day (according to size) of any unfibrous material. Machines made to order from 18 inches diameter, to suit special requirements of purchasers; these small machines being specially adapted to the requirements of Chemical Manufacturers for Mixing and other purposes.

No Agents. All Machines will in future bear the Registered Trade Mark ("Carr's Disintegrator") in three places—viz. on Bedplate, and on outside Face of each Cage.

A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee, 2523

PHILIP TRIGGS, Albion Chambers, BRISTOL.

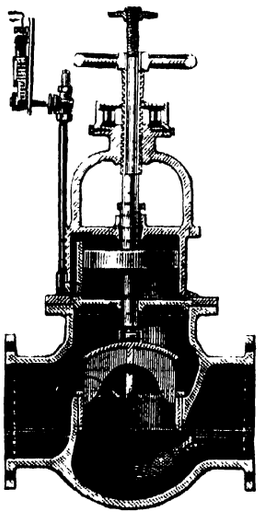
TATE'S PATENT

Electric Valve-Closing Apparatus

FOR STEAM ENGINES.

Medals Awarded AT THE INDUSTRIAL EXHIBITION, BRADFORD, 1882.

INTERNATIONAL FISHERIES EXHIBITION, LONDON, 1883.



THIS *APPARATUS* IS LARGELY USED ON STATIONARY ENGINES WITH THE GREATEST SUCCESS.

DUNCAN BROS.,

32, QUEEN VICTORIA ST., LONDON, E.C.

AND

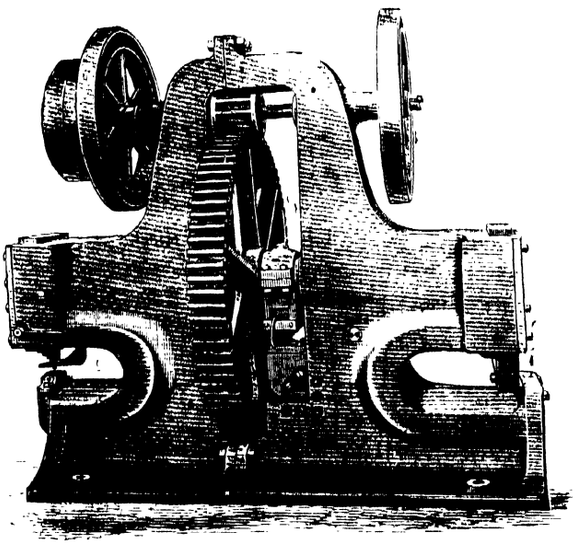
79, COMMERCIAL STREET, DUNDEE.

TELEGRAPHIC ADDRESS—"DOUCINE, LONDON."

Monthly List of New Machinery in Stock, POST FREE. 4190

GEO. BOOTH & CO.,

HALIFAX, ENGLAND.



MAKERS OF

LATHES,

PLANING, SLOTTING, SHAPING, BORING, DRILLING, AND SCREWING MACHINES.

SPECIALITY:

PUNCHING AND SHEARING,

PLATE BENDING, PLATE PLANING, ANGLE-IRON BENDING,

AND ALL CLASSES OF SHIPBUILDERS' AND BOILERMAKERS' TOOLS.

ALSO SELF-ACTING STEAM HAMMERS.

Contractors to the British and Foreign Governments. 4118

LEE, HOWL, WARD & HOWL,

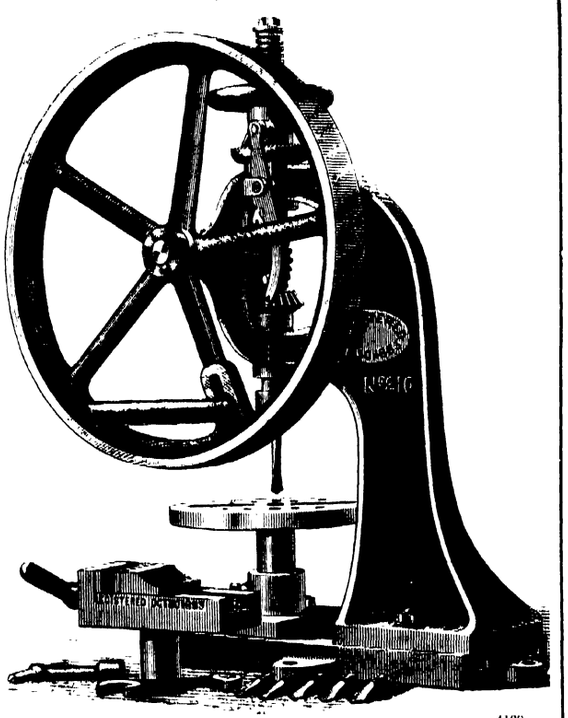
ENGINEERS, TIPTON.

Registered Self-Feeding Bench Drilling Machine

WITH REGISTERED VICE.

This Machine is suitable for Hand or Power. Prices on application.

SIX DRILLS AND A SET OF SPANNERS SENT WITH EACH MACHINE.

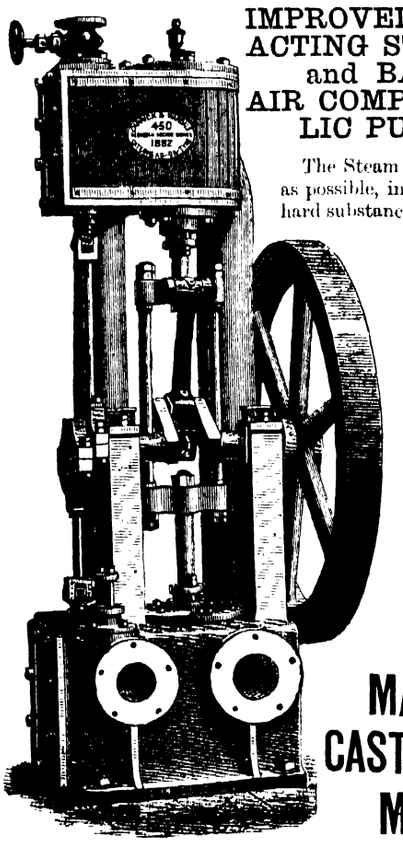


4128

No.	Height.	Weight.	Depth of Feed.	Diameter of Table.	Drills up to
210	2 ft. 3 in.	100 lbs.	2½ in.	9½ in.	⅜ in.

CARRICK & WARDALE,

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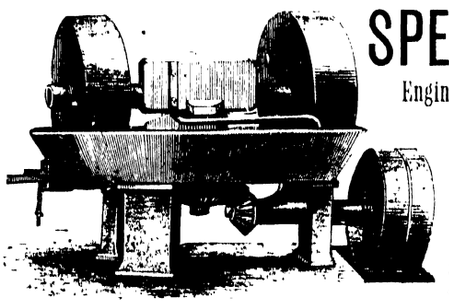
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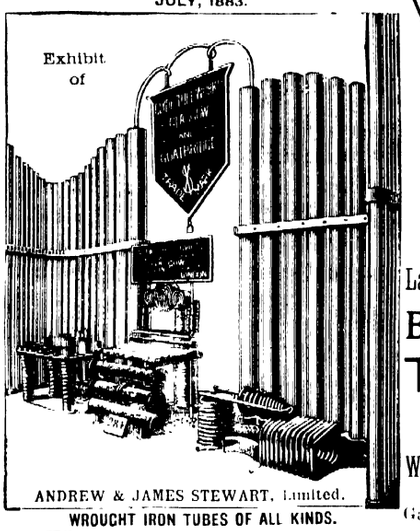
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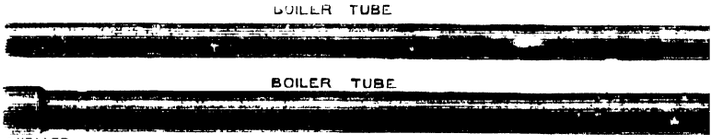
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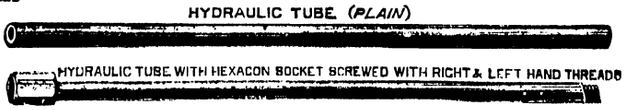
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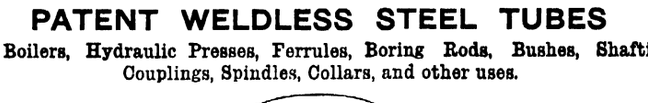
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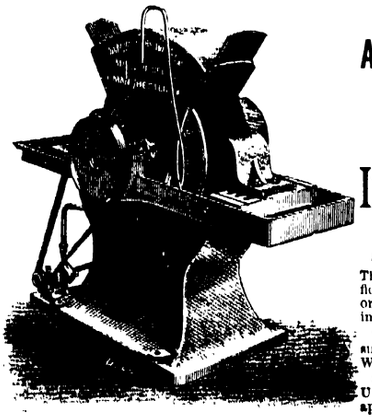
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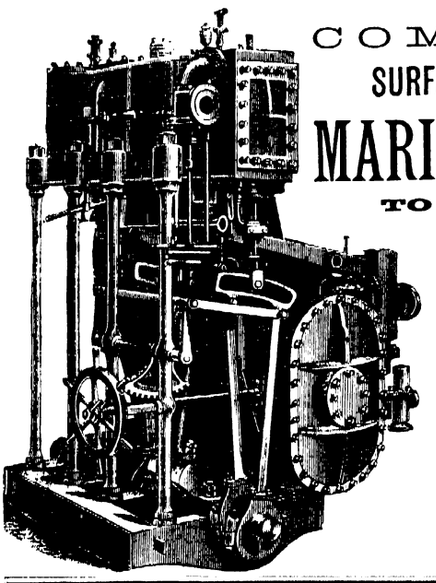
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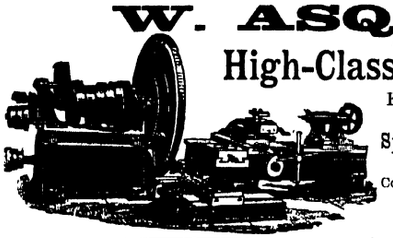
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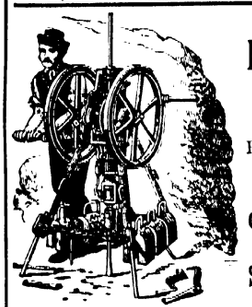


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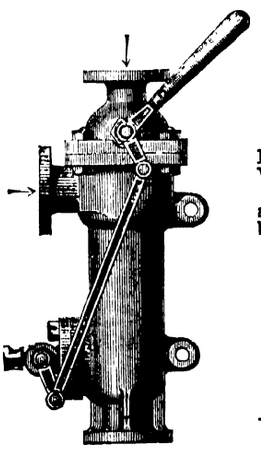
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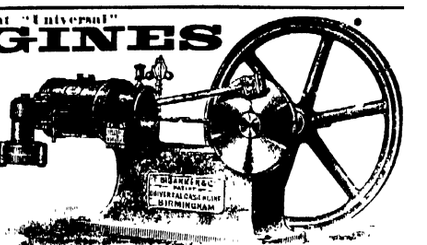
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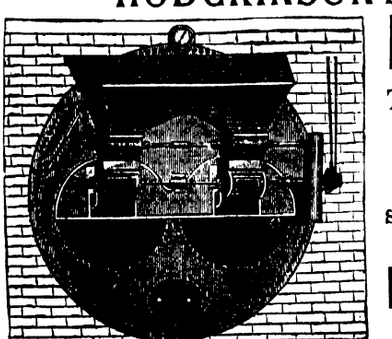
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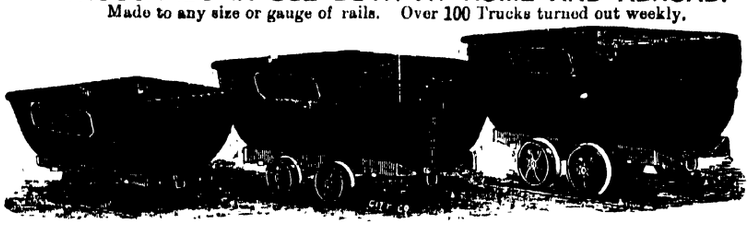
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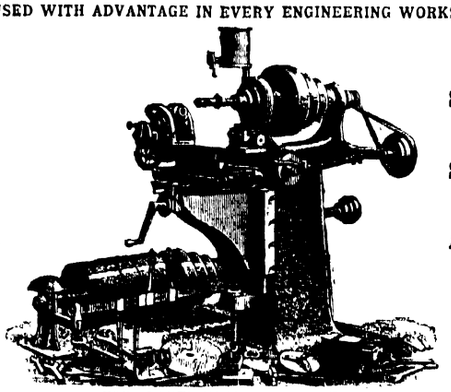


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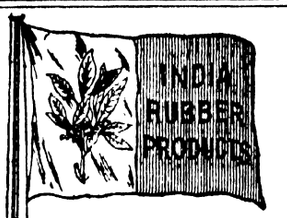


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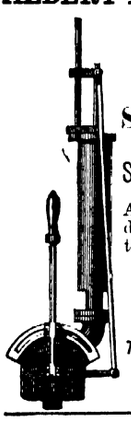
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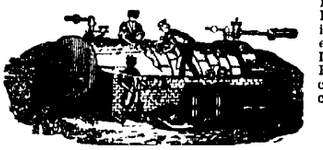
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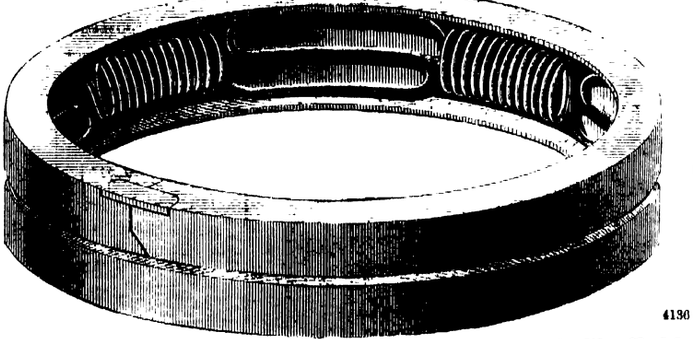
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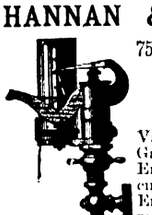
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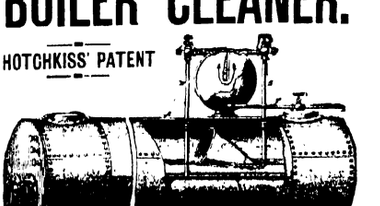
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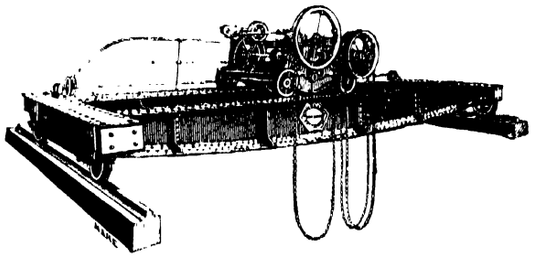
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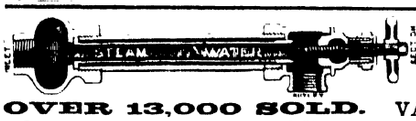
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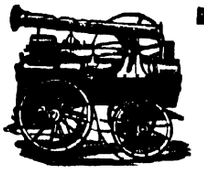
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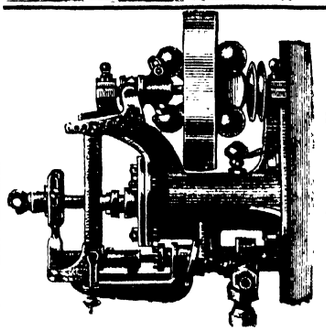
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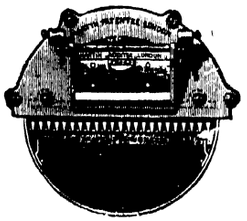
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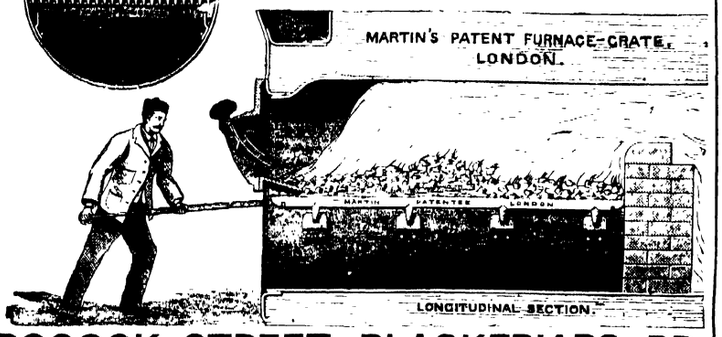
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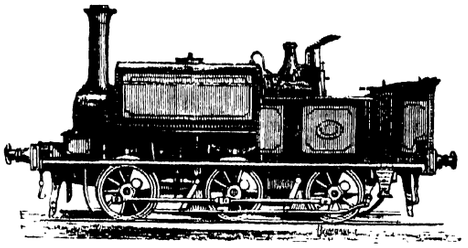
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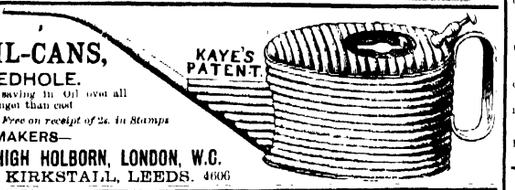
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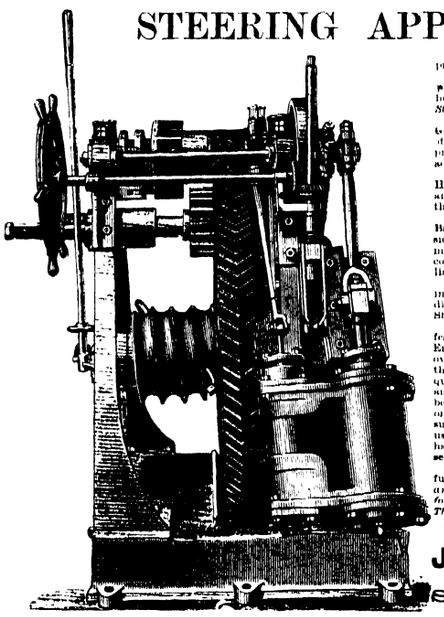
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This Machine is the strongest and most compact at present in the market

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The Gear is perfectly automatic, the Engine responding to the action of the Steersman instantly in either direction, so that at speed a course can be steered by Steam as by Hand power.

The economical working is another conspicuous feature in that Machine, only 20 revolutions of the Engine being necessary to put the Rudder from "hard over" to "hard over," as compared with 120 to 180 in the Worm-and-Wheel type of Gears in use, consequently there is a great saving in Steam, and wear and tear are reduced to a minimum. This will also be found advantageous in steering a Compass Course, only half a revolution of the Engine either way being sufficient for the purpose, although we recommend the use of Hand power only at sea, which (in this Machine) has been proved to answer the purpose admirably, reserving the Steam power for rivers and narrow channels.

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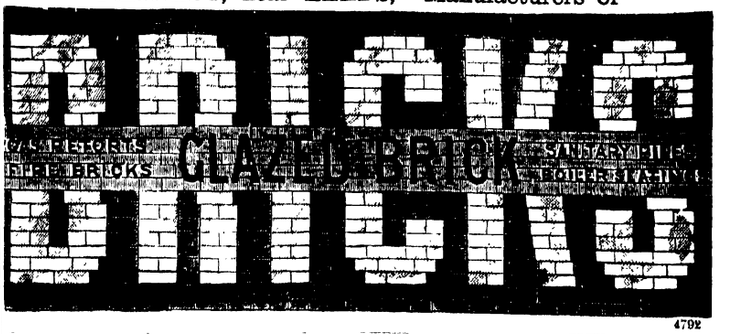
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Gas produced without fire or heat For Lighting all places where Coal Gas is unobtainable

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Prices, **16 GUINEAS** upwards.

Machine Muller'd Gaz de la plate Alpha.

Elle produit le gaz sans feu et sans chaleur. Elle sert à éclairer tous les endroits où l'on ne peut se procurer du gaz de charbon

Types, de 12 à 500 becs et au dessus

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Zum Erleuchten von Orten an denen kein Steinkohlengas zu haben ist

Für 12 bis 500 Brenner

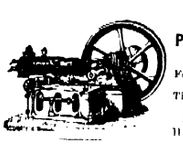
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Produce gas sin fuego ni calor Sirve para alumbrar lugares en que no puede proporcionarse gas de carbon.

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The Engine makes the Gas by which it is driven.

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Die Maschine bereitet das Gas welches sie in Bewegung setzt

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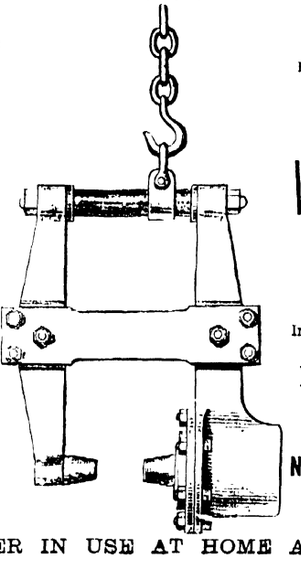
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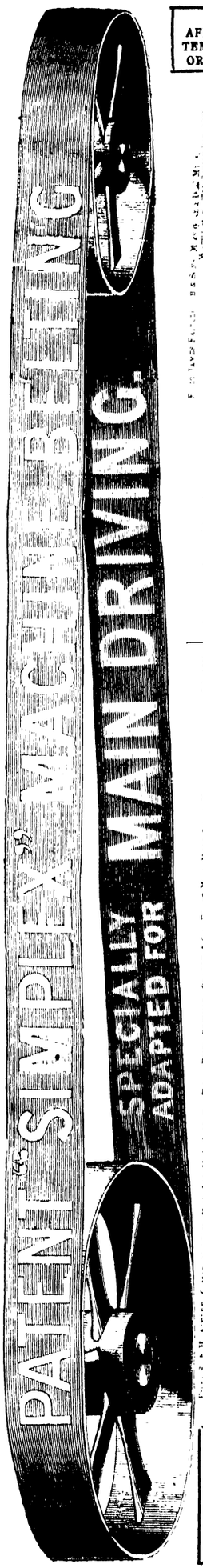
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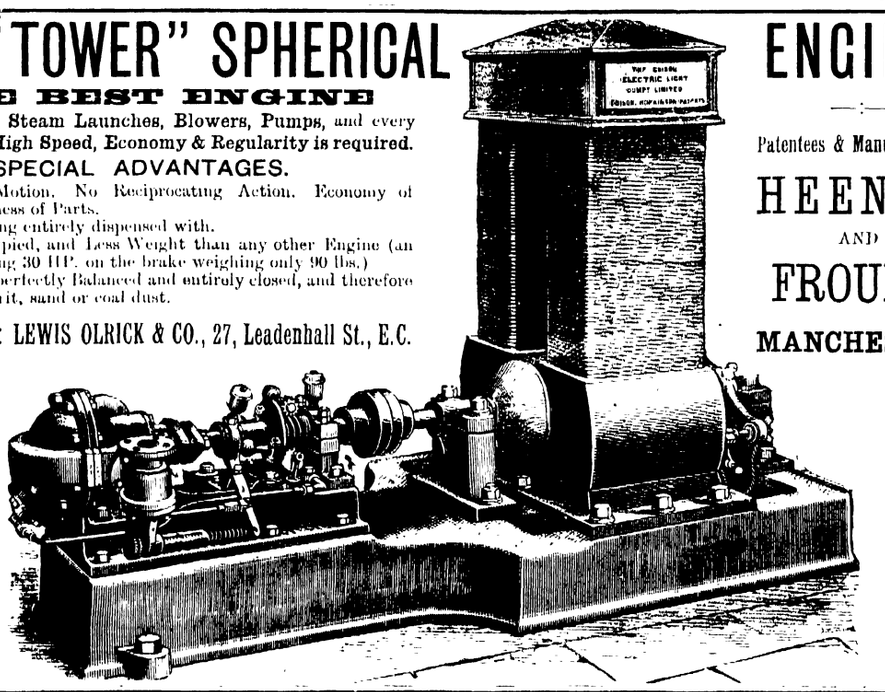
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For Dynamos, Steam Launches, Blowers, Pumps, and every purpose where **High Speed, Economy & Regularity is required.**

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Less Space occupied, and Less Weight than any other Engine (an Engine realising 30 HP. on the brake weighing only 90 lbs.)
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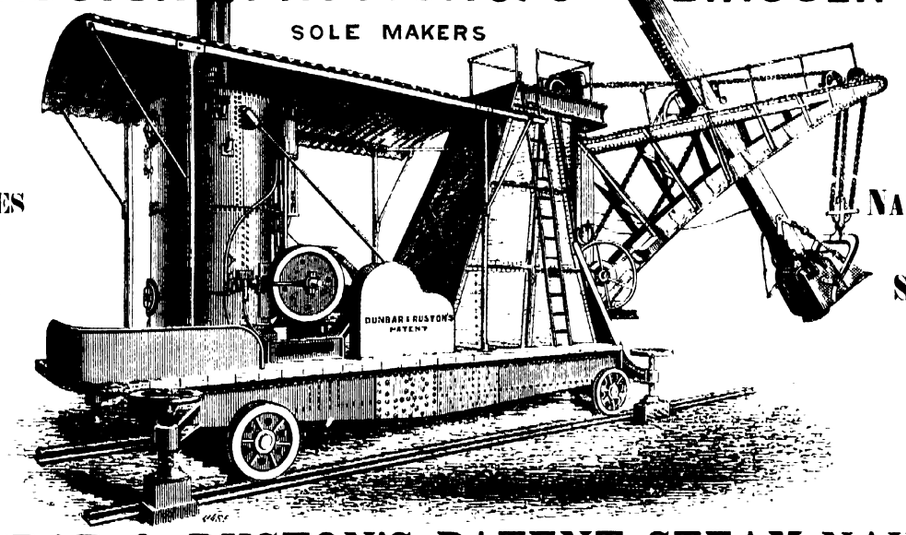
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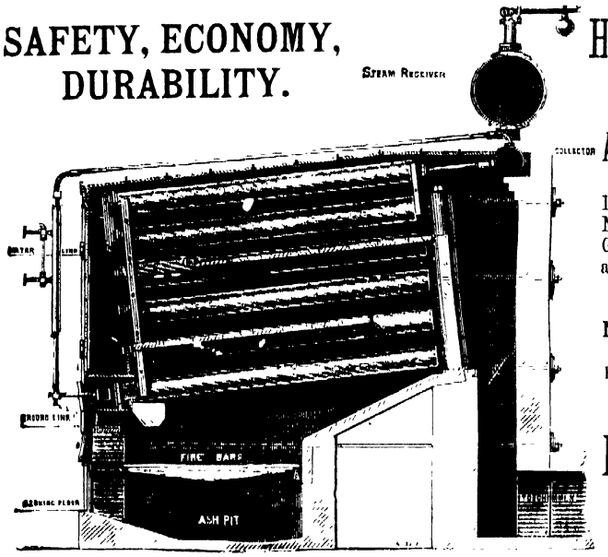
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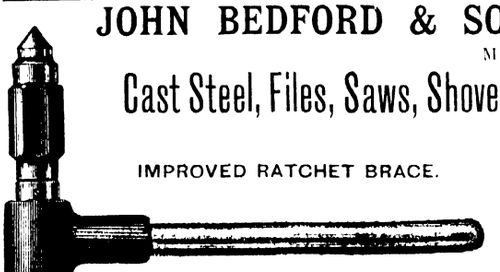
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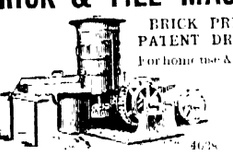
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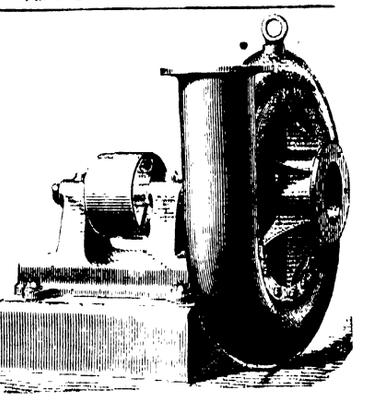
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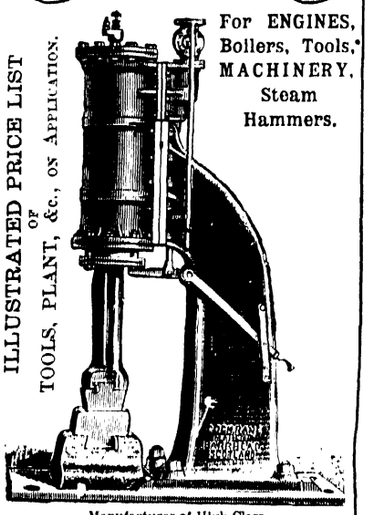
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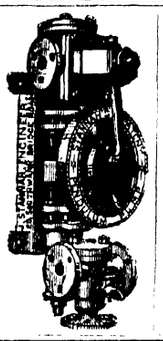
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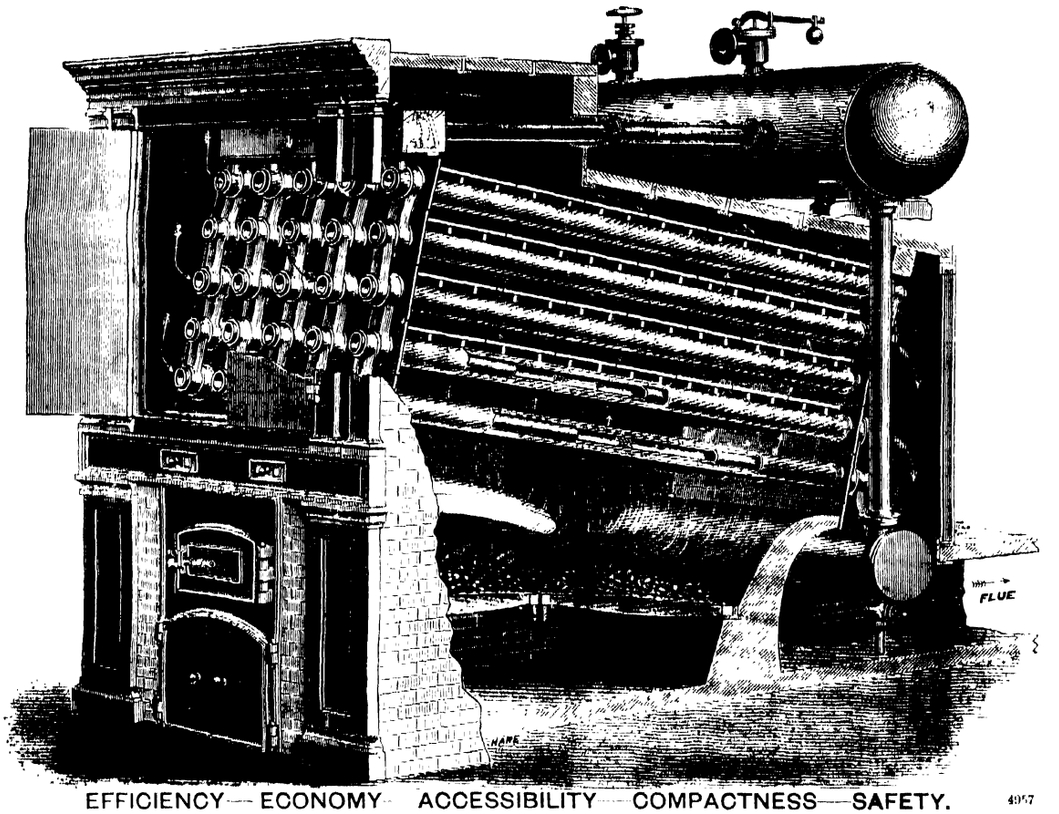
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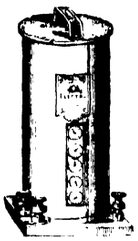


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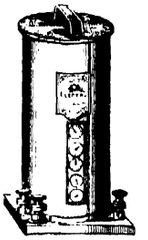
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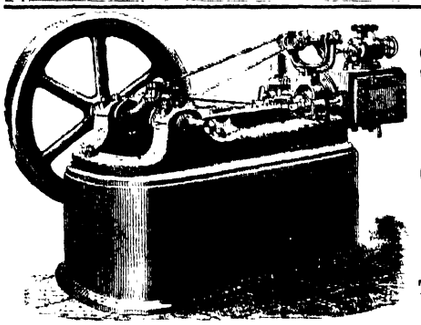


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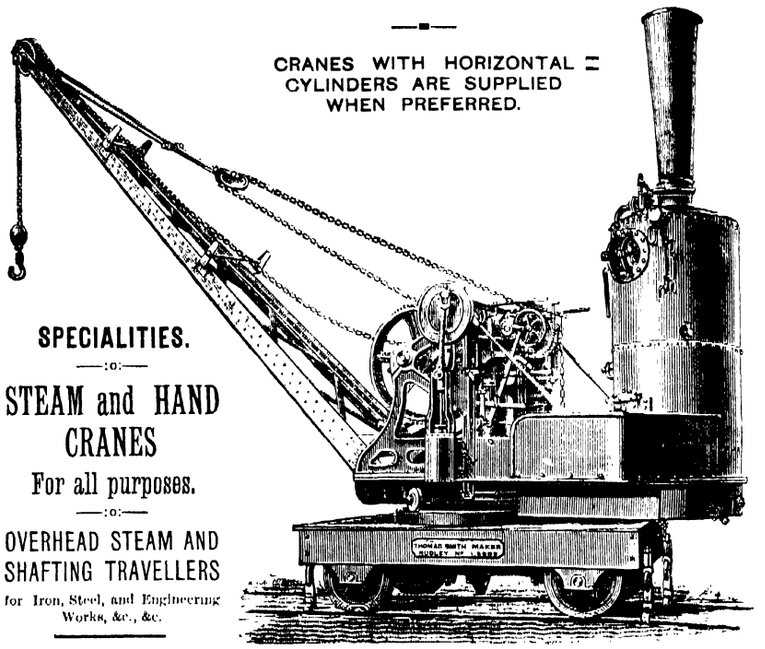
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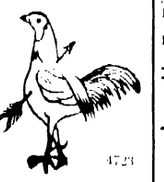


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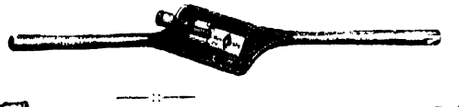
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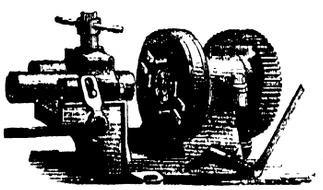


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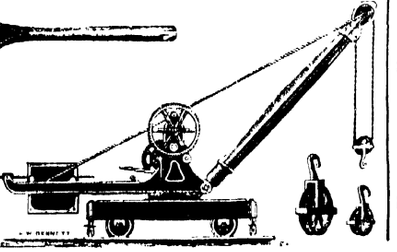




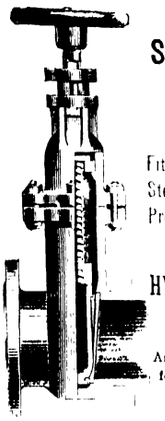




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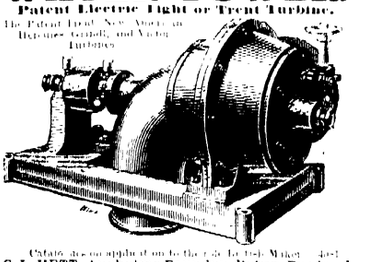
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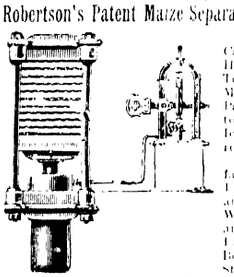
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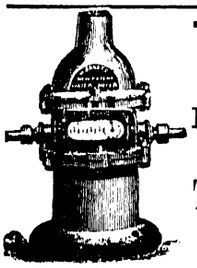
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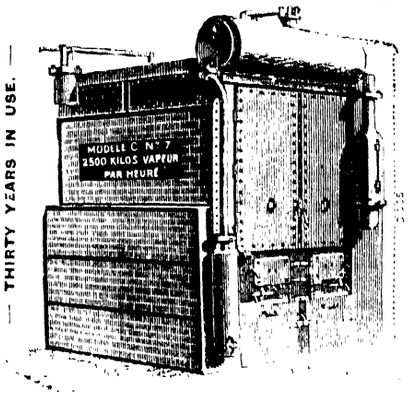
AT the Bath and West of England Show, held at Maidstone, from the 2nd to the 6th June, various belts were in use on the Machinery in motion there. On the 4th, about noon, the rain came on, and continued up to the close of the Show on the 6th. *During the whole of the rain, out in the open,* one of GANDY'S PATENT AMERICAN COTTON BELTS *continued to do its work satisfactorily,* driving a set of Messrs. TAYLOR & NEAT'S three-throw Pumps. This was the only Belt that continued to work in the rain. All the Leather and Rubber Belts *had to be taken off, owing to their inability to drive in wet weather.* This fact alone speaks volumes. How long will it take to convince Englishmen (the Americans are already convinced) that the "GANDY" BELT is the **CHAMPION** Belt of the **WORLD?** 3149

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1877 PATTERN (PATENTED).

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PRINCIPAL ADVANTAGES:

Complete Security. Important Economy of Fuel. Smallness of Bulk Full Pressure obtained promptly—**Production of Steam** at very high pressure without danger. **Steam always Dry—Regularity,** the heat of the fire being automatically controlled according to use of the steam. **Working** and maintenance extremely easy.

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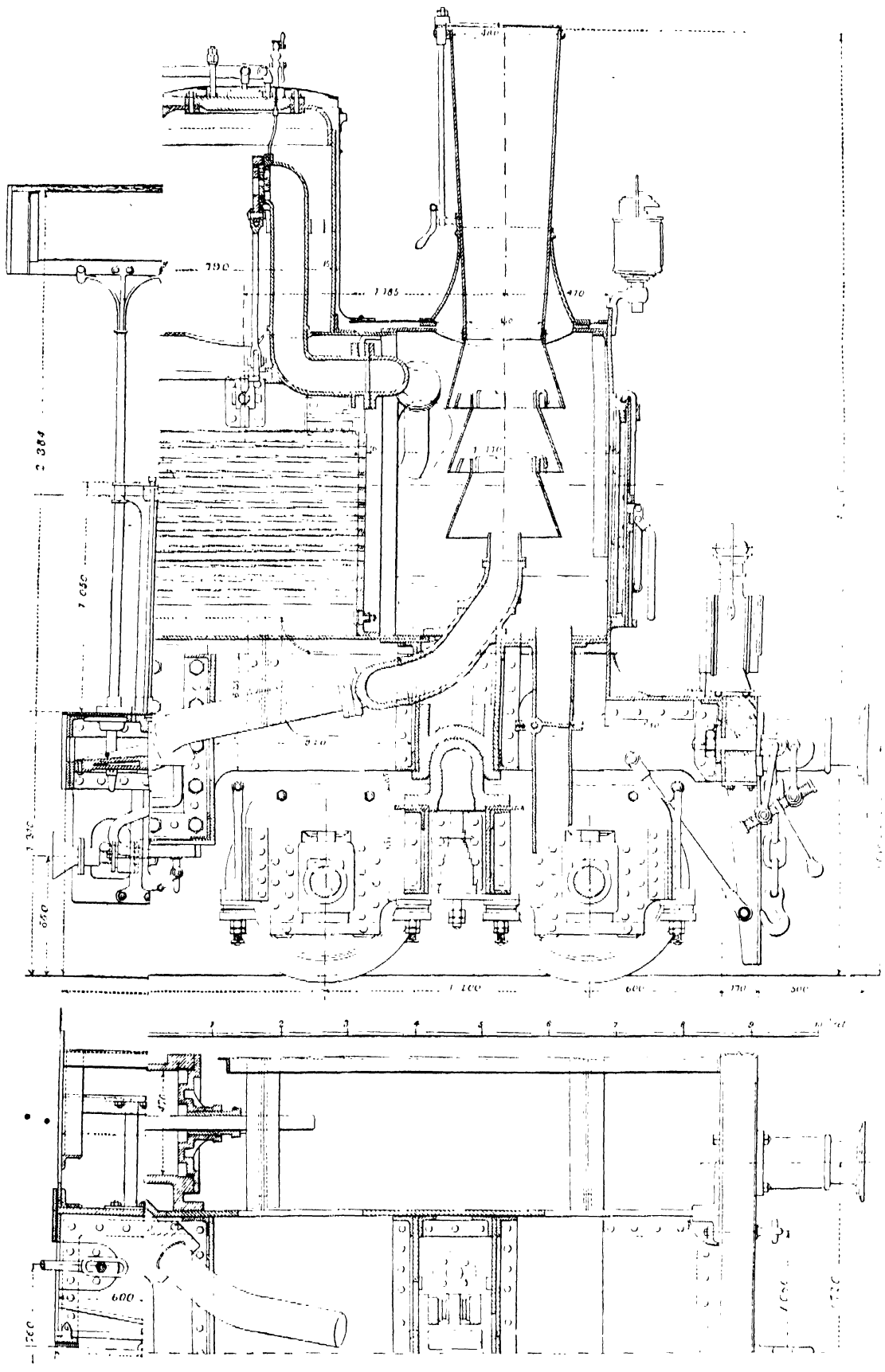
BELLEVILLE REDUCING VALVES for Limiting and Reducing Steam Pressure.

Semi-Metallic Anti-Friction Paste for Stuffing Boxes. **Anti-Friction Grease for Steam Cocks.**

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THE TURIN EXHIBITION.

ENDENT.



LITERATURE.

British Mining, a Treatise on the History, Discovery, Practical Development, and Future Prospects of Metalliferous Mines in the United Kingdom. By ROBERT HUNT. London: Crosby Lockwood and Co. [Price 63s.]

THIS large book of nearly a thousand pages in quarto is the result of a compilation, extending over thirty-seven years of labour, made by a Government official. Mr. Hunt, as Keeper of Mining Records of the United Kingdom, has had opportunities for such a task not enjoyed by any one else, and has evidently made the most of them. He organised a voluntary system of collecting returns of mineral produce, with the help of which the "Mineral Statistics of the United Kingdom" was produced annually. He assisted in establishing a system of technical instruction for young miners in their own districts, under the title of "The Miners' Association of Cornwall and Devonshire." He collected a large amount of information of a practical character from mine agents in every division of these islands, and studied every useful publication bearing on his subject. Finally, he has now completed one of the most valuable works of reference of modern times under the title of "British Mining."

The divisions of Mr. Hunt's volume consist of books. Book I., of 188 pages, is historical. Book II., of 110 pages, treats of the formation of metalliferous deposits. Book III., of 250 pages, is about practical mining. Book IV., of 60 pages, deals with the bases of future prospects. An appendix of 22 pages contains a large amount of valuable statistics of produce, sale, and export; and a glossary of mining terms aptly concludes the whole.

The language and style adopted are good, and the treatment of the various subjects, laborious, conscientious, and scientific. For those not practically interested in mining operations of any sort, the introductory book dealing with the archæology and history of British mining will form an attractive and interesting study. In such matters, new lights on old subjects sometimes appear vividly. For instance, there is a very prevalent belief that the ancients were incapable of mining to any great depth, and confined themselves to surface working of a very crude sort. Yet in a quotation from Carew's "Survey of Cornwall" we find him thus referring to Diodorus Siculus "These load works, *Diod. Sic. l. 5, cap. 8*, seemeth to point at where, he saith, that the inhabitants of *Velerium Promontune* digge up tin out of rockie ground From some of their bottoms you shall at noonedayes descrie the starrs."

The long-abused King John appears to have been the champion of liberty in mining matters, as well as with regard to ecclesiastical and papal oppression. His charter of October 29, 1201, declares the freedom of all the tin workers of Cornwall and Devon; he also drove away the speculative Jews that had enriched themselves out of the serfdom of the tinmen, and had maintained the monopoly of the profits; the Stannaries thus came under direct Crown ownership, a moderate toll per pound of tin was fixed, and the tinmen were not only quit of all pleas of serfdom, but also "free to dig tin anywhere in the moors and fees of bishops, abbots, and earls," as well as to divert watercourses. How many practical monopolies exist at the present day, without the ability of a Wrotham, or the courage of King John, as removing influences!

The fac-simile at page 134 of a rude map of the Myne deeps, or Mendip minerys, made about 1480, with accompanying sketches, is certainly a curiosity well worth examining.

To the mineralogist, Book II. is of special value: the laws of distribution of mineral deposits, and the phenomena observed in deposits of metalliferous ore, are thoroughly and clearly dealt with. After the sententious and frequently hazy styles adopted by many mineralogists, it is refreshing to turn to a sensible, plain, and practical mode of treating this important subject. Extracts from the valuable papers of Mr. R. W. Fox, of Falmouth, contribute greatly to the more positive information given on this subject; but the theories of many German, as well as other foreign physicists, are also set forth in a plain, intelligible manner.

The section about practical mining is divided into five chapters: 1. On the search for and discovery of mineral lodes. 2. On practical operations for the extraction of metalliferous ores. 3. On the ventilation and drainage of mines. 4. On dressing metalliferous ores. 5. On the extraction of iron ores from veins and other deposits.

Though the whole of this portion of the book is undoubtedly good, the parts relating to rock-boring, drills, explosives, charging and blasting, are especially worthy of notice; also the portions on the physical treatment of ores, sizing, dressing, crushing, pulverising, and calcination. A remark of Mr Hunt as to the *personnel* is instructive, and may account for some losses. "The dresser superintending the stamp floors or frames has almost the sole responsibility of treating the tin-stuff, yet for his supervision he receives about two-thirds the pay of an able miner." This is at Wheal Agar. If such a principle were applied to bishops and pastors it might be reasonable; but in practical work it seems very false economy. As to future prospects, Mr. Hunt sees little hope of profitably working *very deep* mines in England He advocates the strictest economy and the highest principles of honesty as necessary to success.

Fire Protection of Mansions. How to Prevent Fires and how to Extinguish them With Practical Remarks upon Water Supply and Fire Apparatus. By JAMES COMPTON MERRYWEATHER, M.I.M.E London: Merritt and Hatchel.

The numerous disastrous conflagrations which during the last few years have occurred in country mansions—fires often resulting in the destruction of buildings and objects of high historical interest which no money can replace have afforded ample evidence of the great want of efficient protection against fire which still exists in so many houses of this class. As Mr Merryweather points out in the introductory chapter of the book before us, the fire risks of country mansions are vastly greater than those of houses in the metropolis, and we entirely agree with his remarks as to the duty of the owners of such residences to take all necessary steps to insure their safety.

Our author divides his subject into two main parts, namely, fire prevention and fire extinction Under the first of these divisions he deals with the common causes of fire and the means of avoiding them, while under the second section he treats of water supply, the various forms of fire extinguishing apparatus, and their management. Mr. Merryweather is thoroughly conversant with his subject, and deals with it most judiciously, describing succinctly and clearly the qualities which fire extinguishing apparatus should and should not possess, and explaining thoroughly how such appliances can be utilised to the best advantage A final chapter containing particulars of a number of fires which have during recent years occurred in country mansions enforces the lessons which the book teaches. Altogether we regard Mr Merryweather's treatise as a work which should be in the hands of every owner of an isolated country residence, while ordinary householders who regard themselves as under the protection of the local fire brigade may read it with both pleasure and profit.

BOOKS RECEIVED.

A Text-Book on the Method of Least Squares By MANSFIELD MERRIMAN. New York: John Wiley and Sons. London: Trübner and Co

Practical Electric Lighting By A. BROMLEY HOLMES, Assoc Inst. C.E With Sixty Eight Illustrations. Second Edition. London and New York: E. and F. N Spon. [Price 3s. 6d.]

The Blow Pipe in Chemistry, Mineralogy, and Geology By Lieut Col. W. A. ROSS, R.A. (retired), F.G.S. With One Hundred and Twenty Illustrations by the Author London: Crosby Lockwood and Co.

A Treatise on the Application of Iron to the Construction of Ordnance. By JAMES ATKINSON LONGRIDGE, Memb Inst. C.E London and New York: E. and F. N Spon. [Price 25s.]

A Treatise on Earths and other Minerals and Mineral By D. C. DAVIES, F.G.S London: Crosby Lockwood and Co. [Price 12s. 6d.]

Traité Pratique d'Analyse Chimiques et d'Essais Industriels. Par RAOUL JAGNAUX Paris: Otave Doin [Price 6 francs.]

Draht und Drahtwaaren. Von EDUARD JAFING. Mit 119 Abbildungen Vienna, Pesth, and Leipzig: A Hartleben.

The Collieries, Coalfields, and Minerals of New South Wales, Australia. By ALFRED J. G. SWINNEY. London: *Colliery Guardian* Office. [Price 3s.]

International Health Exhibition Handbooks - Healthy Schools. By CHARLES E. PAGET. *Fires and Fire Brigades.* By CAPT. EYRE M. SHAW, C.B. *Health in the Village.* By HENRY W. ACLAND, C.B., F.R.S. *Water and Water Supplies, and Unfermented Beverages* By JOHN ATTFIELD, Ph. D., F.R.S. *Ambulance Organisation, Equipment, and Transport.* By SURGEON MAJOR G. J. H. EVATT, M.D. *On the Principles of Cooking.* By SEFT. BERDMORE. *Food and Cookery for Infants and Invalids.* By CATHERINE JANE WOOD. London: W. Clowes and Sons, Limited.

Stone Working Machinery and the Rapid and Economical Conversion of Stone. By M. POWIS BALE. With numerous Illustrations. London: Crosby Lockwood and Co. [Price 9s.]

The Naval Architect's and Shipbuilder's Pocket Book of Formulæ, Rules, and Tables By CLEMENT MACKROW. Third Edition, Revised London: Crosby Lockwood and Co. [Price 12s. 6d.]

Steam and Machinery Management. By M. POWIS BALE, M. Inst. M.E., Assoc Memb. Inst C.E London: Crosby Lockwood and Co [Price 2s. 6d.]

Text Book of Descriptive Mineralogy. By HILARY BAUERMAN, F.G.S. London: Longman, Green, and Co. [Price 6s.]

Applied Mechanics. An Elementary General Introduction to the Theory of Structures and Machines With Diagrams, Illustrations, and Examples. By JAMES H. COTTERILL, F.R.S. London: Macmillan and Co.

CANADIAN PACIFIC RAILWAY

No. XIII.

RAILWAYS ROUND WINNIPEG.

WINNIPEG, 1434 miles from Montreal, 1172 from Port Moody, and 1827 miles from New York, by the three main radiating lines from its Union Station, bids fair to be the central city of the continent, and probably one of the largest, within the very near future. It is here that the great wheat districts of the north west, where 200 million acres of land are now ready for immediate cultivation, and only await the arrival of the agriculturist, must ultimately pour in their surplus produce, and whence it will be distributed over the world. It has already become the centre of gravity of the Canadian Pacific Railway system, and every mile added to this young leviathan to the west of this, must pay tribute to, and derive its instructions from, the central bureau of Winnipeg. Here, too, must be placed the large mercantile and banking institutions, the business and educational establishments of the whole north-west Three great transcontinental lines must, for the next decade at least, share between them, the through business between the Atlantic and Pacific—the Canadian, Northern, and Union Pacific Railways and of the three, from its physical characteristics, its favourable grades, low pass through the Rocky Mountains, accessibility to navigation at its termini, and other advantages, the first of these must largely control that immense business which will pass over this continent from Asia to Europe. From China or Japan this is the shortest route by a thousand miles to Europe, and much shorter than either of the others, even to New York or Chicago Neglecting for a moment the saving of distance on the Pacific Ocean, it is 3331 miles by the shortest railway line in the United States from San Francisco to New York, whilst by the Canadian Pacific it is only 2870 from Port Moody to the same Atlantic port Even to Chicago it is 66 miles nearer *viâ* Winnipeg to the Pacific than by what is supposed to be the direct route of the Union Pacific Railway, and as the Canadian railway terminus is some 500 miles nearer to the leading Asiatic ports than San Francisco, it is easy to see that traffic, which always flows like water in the line of least resistance, must ultimately take the shortest and easiest route, the lowest summits and the most favourable gradients, where the greatest practical result is obtained from the same mechanical effort Although this was not the main object in its original construction, which was to remove the isolation of the Red River settlement, and open an easy access to the province, it is the particular value that attaches to what is known as the Emerson Branch at the present time, which, in conjunction with the St Paul, Minneapolis, and Manitoba Railway forms a direct line from Winnipeg to Chicago. St Vincent, which is one of the northern termini of this line, is an American town, just south of the international line which is here the 49th parallel of north latitude, and on the Canadian side of the line is the British town of Emerson, practically the terminus of the Canadian Pacific. It is 66 miles from Emerson to Winnipeg, or 65 to the junction at St. Boniface. This was the first piece of road that was commenced by the Government of the Pacific system, and the first completed, and was, till last year, the only means of reaching Manitoba by rail. Always worked as part of an important main line between Winnipeg and St. Paul, it has more the appearance and bustle of that than a branch, and is in fact the main line between one Pacific system and the American lines to the south. Emerson, since its birth, some ten years since, has become quite an important place, and if the energy and determination of its people would build up a city, this certainly deserves its

DREDGING OPERATIONS AT OAKLANDS HARBOUR, CALIFORNIA.

(*For Description, see Page* 30.)

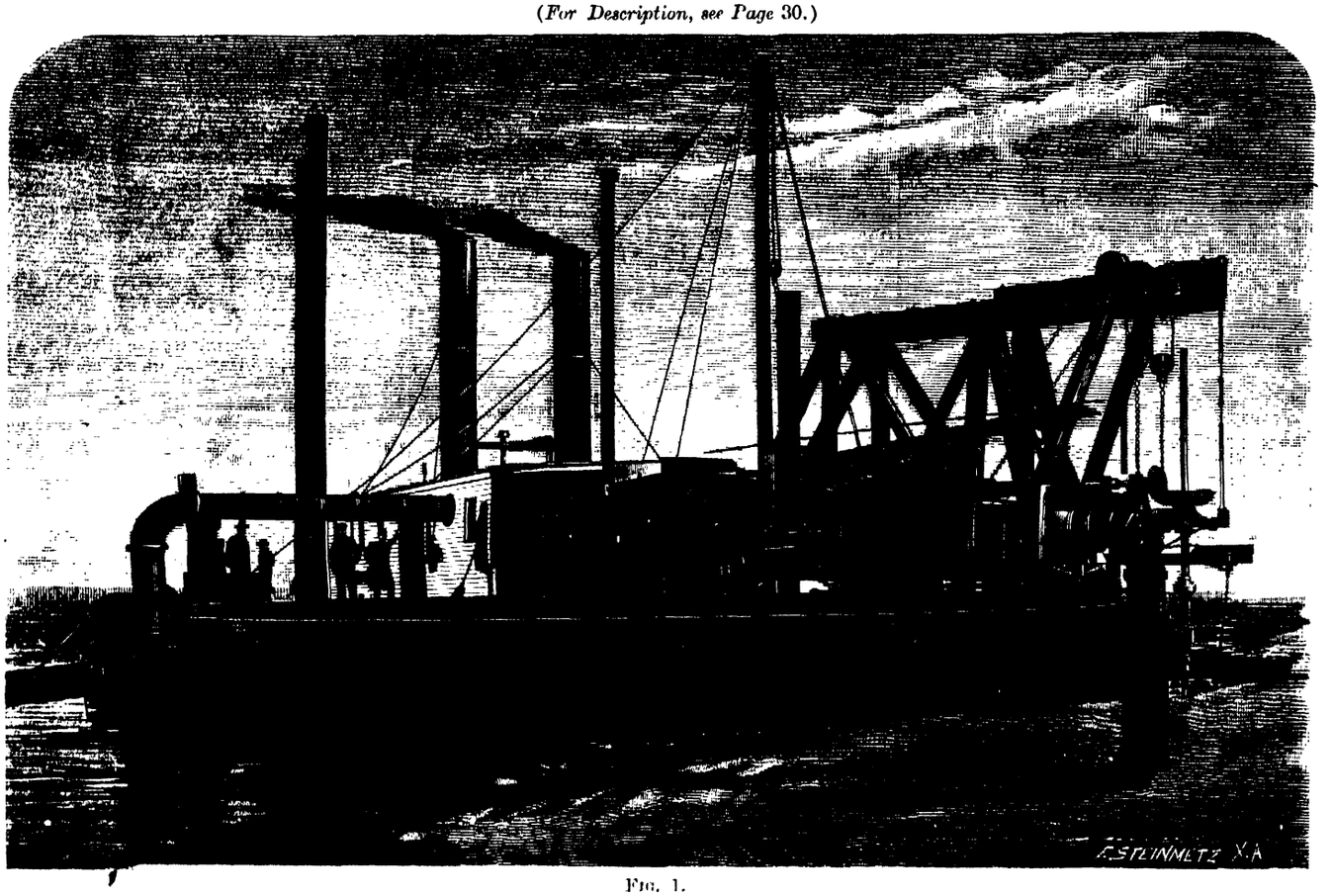


FIG. 1.

success. The station is quite a large building, as befits the important position it occupies, and as is intended to be the point of transfer of all the freight that requires handling or bonding, and for the making up and despatching of trains, has a large siding accommodation, which is often fully taxed. Immediately opposite Emerson, the "Gateway City," as the Emersonians call it, was the town of West Lynne, on the opposite bank of the Red River, which started into existence after Emerson was a few months old, under the fostering protection of the Hudson's Bay Company, who owned the land. There was a great deal of jealousy between these two places. One had the railway, and the large staff of customs and other officials, together with the facilities that the railway afforded them for handling and despatching their freight. The other had at the back of it an immense extent of the richest prairie land and an old-established country, for this was the earliest start of the Red River settlement, and the district at the back of it was the first to attract immigration, when a second time the country began to fill up, whilst Emerson has only a narrow strip of prairie between the bank of the Red River and the rising ground of a not very good quality, on the top of which, some 80 or 90 miles distant, is the Lake of the Woods. To secure the business that was thus naturally the perquisite of West Lynne, the Emerson people, with commendable enterprise, taxed themselves to build a fine new free traffic bridge across the river, thus doing away with the superiority claimed by their rivals, and giving, of course, facilities as to the railway that the others could not offer. The bridge was 400 ft. long in deep water with a treacherous bottom, and required a draw in it not to impede the navigation, which, however, as far as the Red River is concerned, is becoming a thing of the past. The bridge cost 30,000 dols., which, for a town of under 2000 people, formed rather a serious addition to their taxes. Worse than this, however, it did not long continue as an ornament, if it ever was one, to the town. A short year after its completion, the terrible flood that swept down the Red River valley in April, 1882, removed this, and most of the other obstructions to its path, leaving nothing

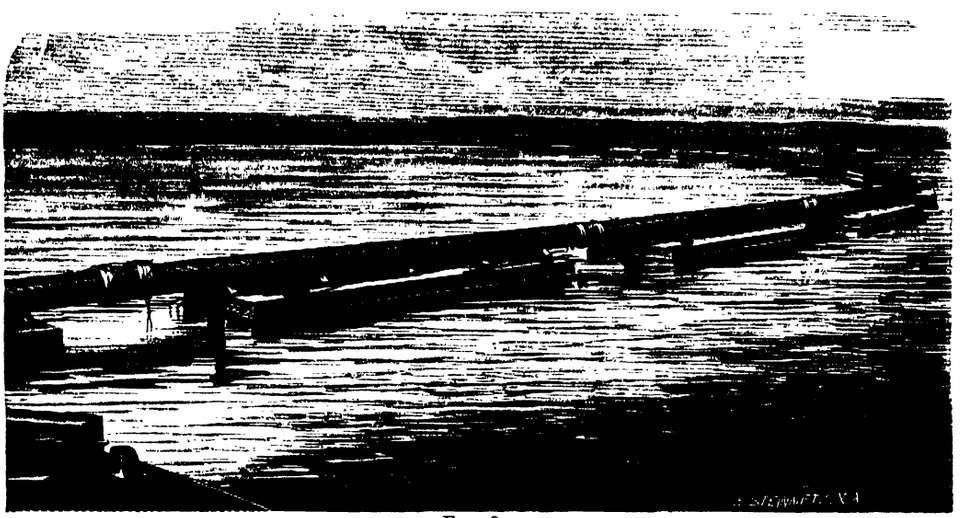


FIG. 2.

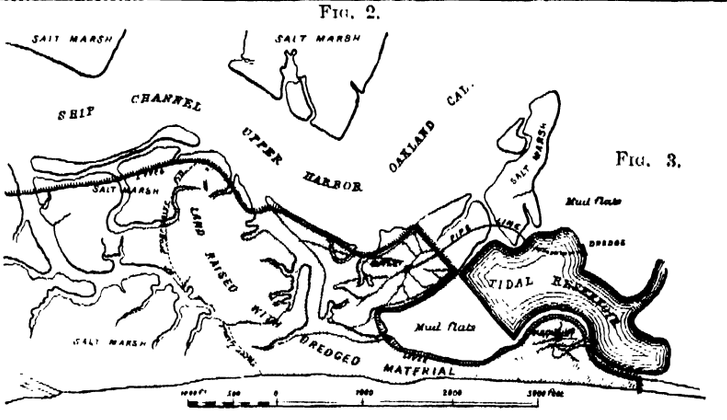
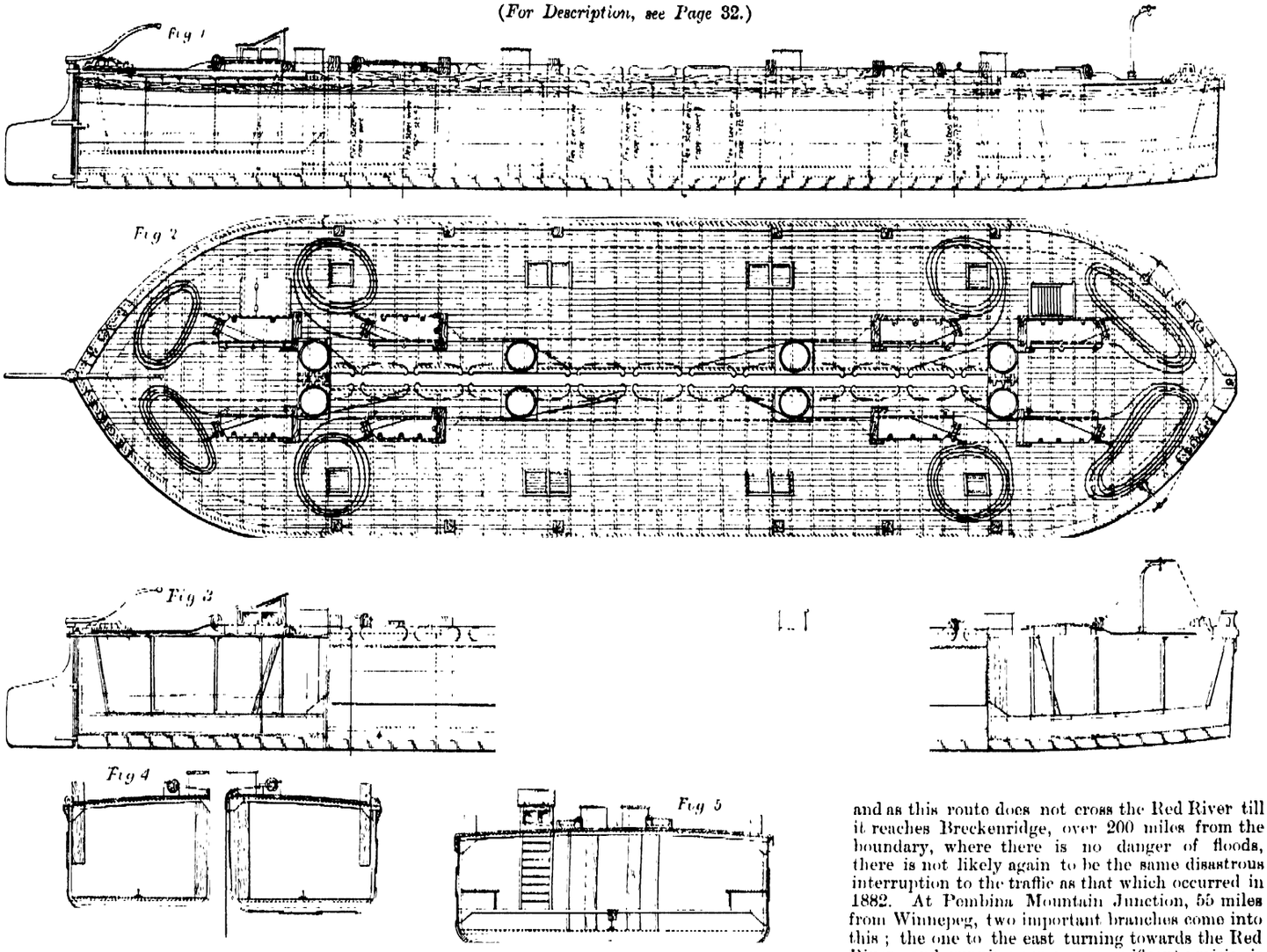


FIG. 3.

WRECKING LIGHTER FOR THE THAMES CONSERVANCY.

CONSTRUCTED BY MESSRS. J. AND G. RENNIE, ENGINEERS, LONDON.

(*For Description, see Page* 32.)



but some Emerson Bridge bonds, with a long string of coupons, to remind the town that it once existed. Like many other things which we call misfortunes, this was not a bad thing for the two towns. The bridge had existed long enough to show both places how necessary it was for each of them, and after its destruction the loss was equally inconvenient to both. Healing up their quarrels and forgetting their jealousies, the two rivals now determined to unite their corporate existences, and having obtained, in the session of 1882, a vote of 30,000 dols. from the Federal Government towards the construction of a new bridge, the two former rivals, now united as Emerson, prepared to make the new structure, not only sufficient for their traffic purposes, but wide enough and strong enough to carry the Emerson and North-Western Railway, a line that, so far, had been merely on paper. This enterprise, the Dominion Government now endowed with a subsidy of 50,000 dols., and the charter of the railway falling into the hands of the Canadian Pacific, the work was at once put in hand, and is now complete.

Twelve miles north of Emerson, and now about four years old, is a place with the ambitious name of Dominion City. The whole of the railway is on the prairie, skirting the east bank of the Red River, and to the right, going north, is the sloping ground mostly covered with alder and other trees that like a wet swampy soil, and forming the base of the Laurentian hills, a spur of the primitive rocky range crossed by the Dawson rou and the Lake Superior division of the Pacific Railway. In places, streams furrow the sloping sides of this somewhat uninviting middle land, and one of the largest of these, empties into the Red River at Dominion City, which covers the ground at the mouth of this Roseau River. Due probably to the better drainage afforded by the river, and to the fact that a gravel ridge runs inland for some distance parallel to the Roseau, the land at the rear of the village is dryer and better than it is elsewhere above the prairie level, and the forest is composed of a better and more valuable class of timber. There is a very good agricultural district for some distance all round the place, and this, with the advantages of wood, water, and gravel, induced its settlement and the commencement of the town. Some four years since it was announced that both anthracite and bituminous coal were traceable in distinct exposures along the banks of the Roseau, but so far there has, for some reason or other, been nothing done about these coal discoveries. The proximity of this coal to Winnepeg (when at the time it was said to have been found fuel was 25 dols. per ton, something over a halfpenny a pound), would make this a most valuable industry, and one that could not but be immensely profitable to the owners. Passing along the railway which follows the river bank, some other smiling villages and well-stocked farms are passed, till the spires of the buildings of St. Boniface mark the approach to the city, the junction of the two railways being immediately east of the Louise Bridge, which carries the joint traffic into the city.

From the central station a second branch line starts off to the south, and runs along the west side of the river through the old settlement commenced by Lord Selkirk to the international line at a place formerly called Smugglers' Point, but now Gretna, 70 miles from Winnepeg and about 15 or 16 miles along the boundary line from the Red River at Emerson. Here a second line of the St. Paul, Minneapolis, and Manitoba Railway meets it, the two forming a complete duplicate line all the way from Winnepeg to Minneapolis, over 450 miles; and as this route does not cross the Red River till it reaches Breckenridge, over 200 miles from the boundary, where there is no danger of floods, there is not likely again to be the same disastrous interruption to the traffic as that which occurred in 1882. At Pembina Mountain Junction, 55 miles from Winnepeg, two important branches come into this; the one to the east turning towards the Red River, and running across a magnificent prairie, is the former Emerson and North-West Railway shorn of its ambitious character, and now a duplicate line to Emerson, passing through what was the village of West Lynne, over the new bridge into the joint station of the two main roads that have their terminus at Emerson. The other branch from Pembina Mountain Junction, which is 14 miles from Gretna, and due north, turns off from the line at right angles and runs due west at about that distance from the international boundary, and is intended ultimately to continue for a couple of hundred miles or more to the Souris district, but at present it is only complete to Manitoba City or Manitou, 56 miles from the junction, or 102 from Winnepeg. It is between this line and the boundary, that the Mennonite reserve has been established, which comprises seventeen townships, and extends 40 miles along the boundary line. This reserve contained in 1880 a population of 3921 people, divided amongst thirty-four villages. The first settlement of these people was made in 1876, and in 1880 they had under cultivation 10,656 acres, and a surplus of wheat that year of 300,000 bushels. There are Mennonites scattered all over the United States, and some few in older Canada, not generally in large numbers, but here and there in small bodies. They or their ancestors left Germany when it became law that every male subject should become a soldier at a certain age. Some of them came to America before this with William Penn; these settled in Pennsylvania, and thence hived off to other States and Canada, but the greater number went to Russia, where they were allowed to remain peaceably and without the necessity of military service until recently, when the same obligation that had driven them out of Germany again led to their expatriation from Russia. Sending off as their *avant couriers* some of their number

to negotiate with the Canadian and United States Governments, a large party of them were accommodated at this place, where they have proved most excellent and thrifty citizens. They claim to be the oldest Protestant denomination in existence, and to be analogous in their religious views and observances to the Waldenses. They take their name from Menno Simon, who was a powerful evangelist amongst the Waldenses, the founder of the new sect, and by whose name they were ultimately called.

A third branch from Winnepeg contains the Gretna line, along the west bank of the river, extending north from the city to a point near the mouth of the river, opposite to Selkirk, and called West Selkirk, 22 miles long, passing all the way through the old Red River settlement, where the land has been under cultivation almost seventy years, and still shows no sign of exhaustion. The main line from Lake Superior to St. Boniface, and forward by the Emerson branch on the east bank of the river, left out all the old settlement, which had been, excepting near St. Boniface, entirely on the west bank, and this new branch to West Selkirk was partly to rectify this local need, passing through Kildonan, St. Paul's, and St. Andrew's, and following the course of the old road along which the original farms were laid out, narrow in front and extending back about a mile. The track ends on a new wharf at the foot of the Rapids, and in direct connection with the navigation of Lake Winnepeg. It is expected that a very heavy timber business will be done at this point, as along the shores of Lake Winnepeg and on Winnepeg River there is a large quantity of valuable timber, and a number of sawmills have been erected at suitable localities to convert it into the required dimensions for building and other purposes. A large establishment, the North-West Lumber Company, have erected mills at Selkirk, with a capacity of 25 million feet of boards per annum, and it is expected that this enterprise will not be the only one to be put into operation at this point. Large quantities of cord wood also will find their way by this access to Winnepeg as fuel for the city, and the general idea seems now to be, that this West Selkirk will be the shipping port for Winnepeg, the Greenock of this western Glasgow. A short branch from the main line at East Selkirk comes to the river on the opposite side called the Colville Branch, two miles long. Lake Winnepeg is 264 miles long by an average of 35 miles wide, containing an area of certainly not less than 9000 square miles, and is probably half as large again as Lake Ontario. Connected with it, and parallel to it, are two other lakes, Manitoba and Winneposis, being together nearly as long as Winnepeg and about half its breadth. The water area of these three lakes may equal if it does not exceed Lakes Erie and Ontario put together. Besides the Red River and the Winnepeg, which come into it at the south end, it is the recipient of the two Saskatchewans with their 4000 or 5000 miles of navigable waters draining the land almost to the foot of the Rocky Mountains, and a great number of other rivers from the east and west, which together drain 400,000 square miles of territory, probably more than any other lake in the world. The waters of this lake have been variously estimated at from 630 ft. to 710 ft. above the sea, and they find their outlet by the noble Nelson River, a little over 400 miles long, and in every respect a first-class stream, which breaks its way through a low pass in the great Laurentian range. Port Nelson, at the mouth of the river, is about 80 miles nearer to Liverpool than New York, and although but little known at present is destined to be an important sea-port. For 200 years, from two to five vessels per annum have sailed from this place for European or American ports, and often under the convoy of a man-of-war. It is this port or a place to the north of it, Fort Churchill, towards which Canadian aspirations now tend as the future shipping place of the wheat crop of the north-west, and whenever this great desideratum is carried out, it effectually settles the question of the wheat supply for England. The south end of Lake Winnepeg is very shallow, as might be suspected from the immense amount of detritus brought down by the Red and Winnepeg rivers, the marshy shores abound with fresh-water shells, and are the haunt of innumerable aquatic birds, amongst which are eight or ten varieties of ducks, two of geese, pelicans, cranes, bitterns, and plovers.

The Red River enters Lake Winnepeg through an immense area of rushes and willows by four mouths, the surface of the land being about on a level with the lake, and it is six or seven miles from the lake before what can fairly be called dry land is reached. The exact junction is indicated by a sand bar, on which there is not more than 3 ft. of water in its normal condition. During the summer months an immense area round this delta, which is covered by water the whole spring, produces a rank profusion of those species of grasses which delight in a rich marshy soil, and large quantities of this "marsh hay" are made by the Red River farmers during the summer and fall, which must all be removed before the winter is over, or the freshets in the spring would take it away. About six miles above the bar, Netley Creek comes in from the west, which seems to be the outlet for an immense quantity of the spring freshet, which, leaving the river above, flows over the low wet prairie to the back of the settlement, and is intercepted again by Netley Creek, which restores it to its original channel. A little below Indian Village, which is 14 miles from the mouth of the river, the whole land rises, the river banks are 20 ft. above the water, the timber grows to an imposing size and in considerable variety, and all the aspects of a level fertile country gradually come into view. The old Stone Fort, which is the basis of the settlement of West Selkirk, is seven miles above this, and 21 miles above that again was Fort Garry, which now is Winnepeg.

Two miles on the main line west from Winnepeg, a fourth branch turns off, originally a portion of the old line to Portage la Prairie, which was not pulled up when that line was condemned, and which is now the Stonewall Branch, 18 miles long from the junction, or 20 miles from Winnepeg. By this old route it was 70 miles to Portage la Prairie; it is by the new air line only 56 miles. Twelve miles along the road from Winnepeg is what is called Stony Mountain, which is about the smallest mountain perhaps that ever was designated by that name. It is in fact an upheaval of a bed of limestone 60 ft. above the prairie level, which shows a bold front facing to the west. The rock is highly magnesian, containing often small embedded masses which appear to hold magnesia in a greater proportion than lime, but it supplies Winnepeg with an excellent building material, harder and whiter than the Niagara formation, and laminated in layers from 2 in. to 2 ft. in thickness; when burnt it makes excellent lime, better and harder than the ordinary mortar of the older provinces. The provincial penitentiary has been built at this point, close to the railway, and one of the noticeable objects at present there is a herd of tame buffaloes running with the domestic cattle, and so far this experiment of the warders of the penitentiary appears to be a success. These bisons are hearty, vigorous-looking animals, fat and sleek, and excellent representatives of the original cattle of the district, but after a few crosses the buffalo characteristics seem to disappear, as the half-bred calves show much more of the domestic than the bison peculiarities. Excepting this little rise at Stony Mountain, the whole of this branch, in fact the whole of the district to Portage la Prairie by either route, is flat, excellent farming land of the pure prairie type. The soil is a thick stratum of rich black loam, overlying a light-coloured clay often mixed with fine stone gravel, and a sand of a light shade containing more or less lime. In some places there are poplar ridges crossing the country, and many of the low lands are too wet at present to be of much use for wheat growing, but there is very little land that cannot be drained, and as breaking the sod proceeds, all will alike come into work, and prove, as may be seen at the Portage now, one huge wheatfield divided only by almost invisible barb wire fencing, stretching over vast areas, and giving in the season a magnificent forecast of what the future of this great prairie will be when it is fully peopled and brought into thorough cultivation.

Besides the two main lines of the Canadian Pacific and the four branches which diverge from Winnepeg, there is a seventh railway that has made some progress, and has already some fifty miles in operation known as the Manitoba and South Western, ; at least two others are tolerably certain to be commenced at an early date, thus making this ten-year old city already a considerable railway centre. The main line west follows generally the valley of the Assiniboine River for the next 180 miles, so far as such a tortuous stream can be said to be followed by any road with any approach to directness. This river runs through the rich prairie soil in a trench from 30 ft. to 40 ft. in depth, and with an average and very uniform breadth of about 180 ft. Its course from the junction with the Red River is north-west, until it makes its first main bend 23 miles by the winding of the river, and 16 by the road, where its direction is first south-west and then west. After making this bend its course is so remarkably crooked that a straight line drawn through the tract of country in which it meanders for a distance of 12 miles, would be cut eighteen times by the river, and yet in only four places would the river be 1000 yards from this centre line. In 1858 the last farm-house going west was 33 miles from Fort Garry, and in this distance there were only nine houses and farms.

Portage la Prairie, the first town of any pretensions, 56 miles from Winnepeg by the new route, the air line, unlike most of the stations on the railway, is not altogether a new creation; for the place has been known and named for a century as being the nearest point that the Assiniboine approaches Lake Manitoba. The old portage or carrying place between the two waters is nine miles long, and it is stated that at seasons of extraordinary high water the canoes from each can approach the other within a very short distance. This was in the old days a very important line of communication, and preferable to Lake Winnepeg as the route to reach the Saskatchewan and all the north-west country to the back of it, as Lakes Manitoba and Winneposis are far quieter and safer for canoeing than the rough tempestuous waters of the larger Lake Winnepeg. The Portage, therefore, early became a place of importance; here Verandrye built his "Fort à la Reine," and this was followed by others, until the Hudson's Bay Company made this an important business depôt.

Indian tradition tells us that this country was formerly occupied by the Mandans, one of the most advanced of the Indian communities; that the Crees occupied the prairie country to the north-east, whilst the Assiniboines, the natural enemies of the Crees, lived to the south-west and south. Both of these nations at an early period came into possession of firearms, the Crees from the Hudson's Bay Company and the Assiniboines, who traded with Du Luth, and these two finally drove out the Mandans, who took up their abode on the Coteau de Missouri. After their expulsion this was the battle ground of the Crees and the Assiniboines, both at that time numerous and powerful nations, and the only point upon which they were in accord was the occasional pillage and murder of the white traders. In 1780 the Assiniboines were in full possession of the country, and at that time there were at the Portage three small forts belonging to three different fur companies and each guarded by a few men. The Indians came as usual noiselessly and without the least warning, and in a short time two of the small parties were massacred and the booty carried off. The third post was defended by a Mr. Bruce, who was known amongst the Indians by the formidable name of Ketchie Minkman, that is Big Knife, and he proved true to his name, for they had to draw off their diminished numbers, leaving the resolute Bruce in possession of their slain and of his fort. Next year the small-pox broke out amongst the Assiniboines, and as late as 1815 their bleached bones might be seen near their former encampments in this and the Red River valleys; since that time they have been only the miserable remains of their once powerful tribe.

The more modern history of Portage commences about 1854, when a clergyman of the Church of England, Archdeacon Cochrane, who was visiting the country with missionary views, purchased from a Salteaux chief who had the "right of occupancy," for the sum of 10*l.* sterling payable in merchandise, a parcel of land comprising thousands of acres, worth as much to-day per acre as he paid then for the whole lot. Here a mission was commenced by this earnest and shrewd pioneer of the Cross; a church and parsonage were built, and as the archdeacon had a view to the earthly as well as the heavenly interests of his parishioners, he also built a windmill and other secular structures, which, together with the more sacred edifices, formed the nucleus of a half-breed settlement henceforth to be known as the Portage. To this a detachment of whites and half-breeds from the Red River betook themselves, and so it became a village even before Winnepeg could boast such an advantage. In 1870 it was incorporated as a town, and the population in a short time afterwards almost jumped up from

800 to 2000. Building operations for the last three years have been very brisk, and its position and continued progress are now assured. Last year no less than nine hotels were in existence, and the rush was so great that it was a privilege often to have the floor to sleep upon. It is undoubtedly the most promising agricultural district near Winnepeg, and so far the best developed, the whole of the land between the river and the lake being taken up and in thorough cultivation. It is this lake which has given its name to the provinces, and which itself is named after a small mysterious island, in the lake from which, in the stillness of the night, issues strangely sweet musical sounds. The Ojibway Indians, who dwell in that neighbourhood, believe this island to be the home of the "speaking god," which the word Manitoba means in their language, and will not land upon or approach it on any consideration, thinking that this would be a desecration which would be followed by some terrible fate for their impiety. The sound is caused, it has been ascertained, by the beating of the waves on some large and peculiar-shaped pebbles along the shore. These, with fragments of fine-grained, compact, sonorous limestone, that have fallen from the cliffs above, are rubbed together by the action of the water, and give out a tone like distant church bells. This natural music is heard when the wind blows from the north, and as it subsides low plaintive notes, resembling the voices of an invisible choir, are audible. It has been compared to a chant of the voices in some of the Catholic churches in Europe, when the sound is deadened and mellowed by the heavy drapery which conceals them from the congregation. The effect here is very impressive. Tourists in the vicinity have been awaked at night, under the delusion that chimes of bells were ringing at a distance, and that their tones were heard rippling over the lake. The Ojibways have a great number of legends about their speaking god, whom they profoundly and religiously revere.

THE INTERNATIONAL HEALTH EXHIBITION.

THE DAIRIES.

THE large retail dairy establishments which have been organised in London within the last few years form a notable feature in the economy of our metropolitan food supply. These are well represented at the Exhibition by means of three working dairies in which the complete processes of preparing dairy produce for consumption are carried on. These establishments are all situated in the great south gallery, or rather in special structures built for the purpose which open into the south gallery. The first exhibit met with in passing from the main entrance, is that of Messrs. Welford and Sons, Limited, of Elgin-road, Maida Vale, and the Home Farm, Willesden. This is a model dairy intended to illustrate the system carried out by this firm, and which has been perfected under the supervision of Drs. B. W. Richardson and F. A. Mahomed. Adjoining this is the exhibit of the London and Provincial Dairy Company (Messrs. Fuller and Watts, proprietors), who have several London establishments, the chief being at 4, Halkin-street West, Belgrave-square, and whose produce is obtained from their farms at Whistley, near Devizes. The third display of this nature is that of the Express Dairy Company, Limited, of Bloomsbury Mansions, W.C., and Goat Farm, Dorking.

There is a good deal of similarity about all these establishments, although Messrs. Welford's may perhaps claim to be the most artistic in design, the south gallery front being a pleasing representation of an old English exterior. The cows are placed in suitable sheds at the back of the premises, the centre part is occupied by the utensils used, whilst in front there is a retail bar from which buns and milk, curds and whey, strawberries and cream, and other delicacies are dispensed to the public with a briskness that should prove highly encouraging to the proprietors.

The principal objects of interest on these stands are the centrifugal separators which are used for skimming milk. Since Mr. Wannieck, of Brünn, introduced Lefeldt's apparatus to the British public in 1879* the centrifugal system has made great progress in the estimation of dairy produce workers, and at the present time the old system of separating cream from milk by allowing them to stand may be considered almost obsolete in large dairy establishments. Of late several new descriptions of separators have been introduced, the Swedes and Danes apparently having taken the lead in this field of inventive ingenuity. It was stated, however, at the recent milk conference held at Gloucester that a new design was coming from America that will distance in effectiveness everything that has preceded it.

At the present time De Laval's apparatus, which we illustrated on page 341 of our thirty-second volume, is probably the one best known. This is shown at work on all three of the stands under notice. As in Lefeldt's machine, a containing vessel is mounted on a vertical spindle. In De Laval's separator, however, the operation is continuous, whilst the former had to be stopped in order to empty out the skimmed milk.

In the machines shown at the Exhibition the separating cylinder is about a foot in diameter, and at the bottom of this is placed a cup containing a small cone. On to this cone the milk falls in a continuous stream and escapes from the bottom of the cup, through a small pipe provided for the purpose, into the cylinder, where the separation takes place forthwith. The heavier constituents force themselves to the outer part of the cylinder, and find an exit through a bent pipe, which terminates in a small orifice in the upper part of the revolving vessel, which in turn leads to an outer stationary compartment, which is provided with a suitable outlet pipe. The cream remains in the centre of the revolving mass, forming an annular core. As this increases by the constant addition of milk, it rises in the upper part of the vessel until a small opening is reached which allows of its exit into a stationary outer casing from whence it is drawn off by a pipe. The machines are designed to run at the excessive speed of from 6000 to 7000 revolutions per minute, and it is said that 60 gallons of milk can be separated in an hour, although in ordinary practice we believe that 35 to 45 gallons would be a fair estimate. This machine obtained a gold medal in 1882 at the Royal Agricultural Society's Show at Reading, and since its introduction over 1700 have been sold. One horse-power is required to drive it.

The Express Dairy Company show two novel centrifugal separators, viz., the Nakskov, manufactured by the Dairy Supply Company, and a large double machine known as the Hamburg. The former has a vertical spindle, but unlike others we have referred to, the driving pulley is above the revolving chamber, so that there is less likelihood of the belt getting wet and slipping. The method of extracting the products of separation is, we believe, novel in this machine, and it is also claimed that improvements have been introduced in the lubricating arrangements of the foot-step bearing of the vertical shaft. We have not seen the machine in work and have failed to get further information on its special features. The second separator shown on the Express Company's stand is a double horizontal machine, that is to say, the shaft lies horizontally in its bearings, the separating vessels revolving in a vertical plane. The latter overhang at each side of the foundation on which the apparatus is mounted. The centre part of the casing of the containing vessels is left open, and through the orifice thus left a tube can be projected, until it is brought in contact with the interior surface of the revolving mass of milk and cream, the latter of course being in the more central part owing to its less specific gravity. The tube strikes the interior of the cream annulus at a tangent, and its edge therefore detaches a continuous stream of cream which flows downwards through the bore of the tube into a suitable vessel provided for it. The action of the tube may be likened to that of a lathe tool turning out a piece of hollow work, and indeed so far is the similitude carried that, we are informed, the machine will spring or "chatter" if the cutting edge of the tube is not kept fairly sharp. We cannot say that we noticed any phenomena of this description in the machine at the Exhibition, but probably in this case the "tool" had been recently ground. The running speed is 1500 revolutions per minute, at which rate it is said that from 120 to 140 gallons of milk can be separated in an hour.

At the recent Gloucester Milk Conference, to which we have already made reference, Mr. Algernon Fawkes, the manager of Lord Vernon's Dairy Factory at Sudbury, Derbyshire, gave some interesting particulars of the value of centrifugal separation. Taking as an example the fixed quantity of a million gallons of milk, Mr. Fawkes assumed that 330,000 lb. of butter would be produced, and if this were made from sweet cream it would realise 2d. per pound more, which would represent an additional 2750*l.* on the receipts. The separated or skim milk would amount to 900,000 gallons, and under the old system this would be only fit for the pigs, and worth accordingly about a penny per gallon, or 3750*l.* Separated milk, however, as opposed to skim milk, can be sold for 3d. per gallon, which would give a total of 11,250*l.* Referring to the quantity of butter obtained from a given quantity of milk, Mr. Fawkes stated that last year 5,001,321 lb. of milk were received at Sudbury Dairy, and for each pound of butter produced 29.9 lb. of milk were required, but better returns were expected in future. After a separator had had 952 gallons of milk passed through it, 4¼ lb. of sediment, consisting principally of manure, were taken out. This was in the summer when the cows were out to grass, in the winter the quantity of refuse matter would undoubtedly be greater, yet, even with the proportion mentioned, the refuse matter in a million gallons of milk would amount to about two tons. The value of centrifugal separation in this respect was pointed out in our first notice of the system in the year 1879.

Machines running at the remarkably high speed of six or seven thousand revolutions a minute naturally require to be well kept up, as any slight inaccuracies of adjustment would be likely to become speedily exaggerated. In order to attend to this point a skilled mechanic with a special knowledge of the apparatus would be necessary, and in addition to this a competent and reliable man is required to superintend the working of the machines. It is this fact principally that limits the range of usefulness of mechanical separators to large establishments. Mr. Fawkes gives an instance of a farm consisting of 252 acres of pasture and 66 acres of arable land, the milk produce of which was a little over 39,000 gallons a year. One separator working eight hours a day and passing 35 gallons an hour would dispose of 280 gallons of milk, whilst a large Danish separator would be capable of dealing with over 600 gallons a day. Now, one operator could manage six machines almost as easily as one, in addition to which a motor capable of driving half a dozen separators would not be very much dearer than that required for one, and practically would want no more keeping up.

There are several varieties of churns exhibited on the three establishments. Messrs. Welford appear to favour Taylor's eccentric, which is composed of an octagonal vessel made of hard wood staves and having projecting bosses or points inside. The journals on which the barrel rotates are placed on the ends eccentrically, and are not opposite to each other, so that the barrel revolves on an imaginary line diagonal to its axis. It is claimed that the projecting points break the butter up whilst in the churn, so that it does not require the same amount of working afterwards. On another part of the stand a larger churn of this description is shown, which will produce 150 lb. of butter at one churning. A novelty of this description is a churn the barrel of which is made of marble.

Both Messrs. Welford and the London and Provincial Dairy Company show a good many of Messrs. Bradford and Co.'s dairy appliances. Amongst them may be noticed the "diaphragm churn," which consists of a horizontal barrel of octagonal shape which is mounted in a wooden frame. The diaphragm, which divides the barrel horizontally in two parts, and acts as a beater, consists of four flat pieces of wood placed at different angles to each other, and held together by a stout frame. The pins of which the barrel revolves do not run in bearings but are mounted on friction wheels being held in position by a slotted guide. Another churn shown is Bradford's "Cotswing," which is simply an oblong box with flat sides swinging in a suitable framing. The principal churn on the London and Provincial Company's stand is a large "Hathaway," which is composed of a cylindrical barrel mounted horizontally in a frame and fitted with fixed diagonal slats on the inside which act as beaters. Perhaps the most interesting of all the churns is one by Hathaway. It consists of one oblong flat-sided box, supported in the centre by an oscillating iron rod, which, with the containing vessel, forms an inverted pendulum. At one end the vessel has attached to it a crank, the revolution of which causes the ends of the box to rise and

* See ENGINEERING, vol. xxviii., p. 21.

GIRARD TURBINE FOR HIGH FALLS.

CONSTRUCTED BY MR. CHARLES L. HETT, ENGINEER, BRIGG.

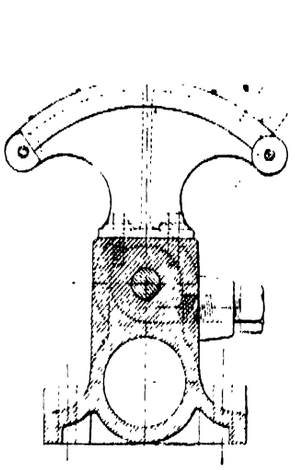


Fig. 2

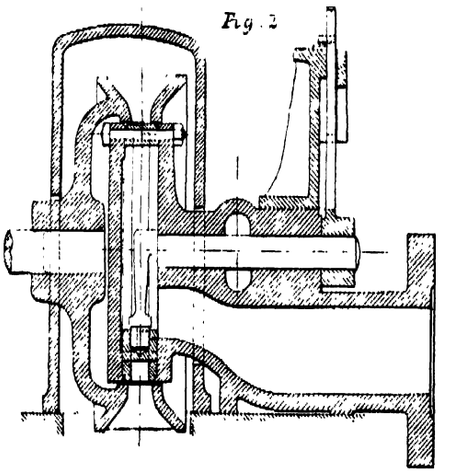
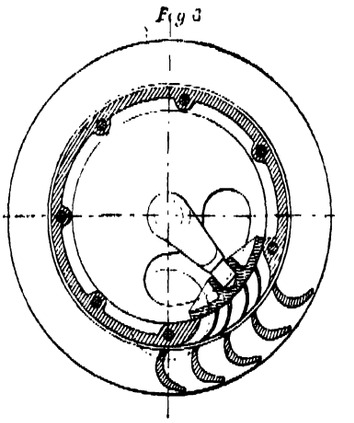
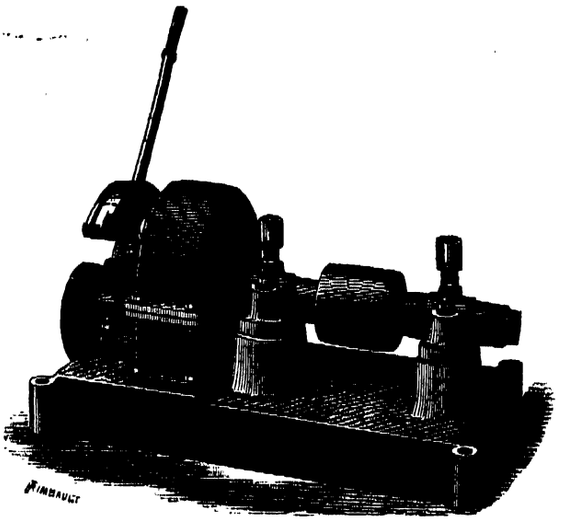


Fig 3





fall at the same time, that is oscillates on the pivot formed by the attachment to the rod. The upper part of the box is curved at each end, and in this way a movement is given which causes two constantly falling streams of cream to meet each other in the centre. This is an excellent machine, and will no doubt soon make a good reputation for itself. The object to be aimed at in designing a churn, is to produce such an action as will cause the fatty particles of the cream to adhere together and so form butter. This is produced by the concussion of the oil globules when thrown against each other, and in the churn we are now considering the action appears to have been brought to something very near perfection. No beaters are required, the two streams meeting in the centre, and indeed the churn may be run with the lid off.

Of butter workers there are numerous examples. Bradford's Albany is shown on all the exhibits This consists of a table on which a fluted roller is made to revolve by hand. The London and Provincial Company show Bradford's "Springfield" worker in operation, it being power-driven. In this the fluted roller and the circular tray beneath both revolve, so that a compound action is obtained, which is very effective in breaking up the butter and extracting the whey. An admirably designed butter worker is shown by the Express Company. It consists of parts of two wooden cylinders, which are mounted in a frame, and by means of levers are made to move face to face through segments of circles. The butter is placed between these faces and receives that direct squeezing motion which is so desirable, as opposed to any grinding or tearing action, which is liable to render it soft and greasy and to destroy the firmness which is so much prized by dairy workers. Amongst other apparatus shown is Lawrence's capillary milk cooler, which may now be said to be an indispensable adjunct to all large dairy establishments; an ingenious lift for lifting the railway churns and tilting the milk into the tank used for containing it; and many other dairy appliances of various descriptions are also exhibited.

The London and Provincial Company have one of J. and E. Hall's cold air refrigerators, and two of the establishments are driven by Crossley's Otto gas engines, which are doing so much good work throughout the Exhibition.

AMERICAN DREDGING MACHINERY.

A PART of the extensive harbour improvements in progress at Oaklands, near San Francisco, consists in the excavation of a tidal basin to improve the scour, at or near the harbour entrance. The material removed by the dredging operations is deposited in adjoining salt marshes, and retained there by means of embankments constructed along the shore line, so that a considerable area will be reclaimed. The plan on page 26 shows the extent of this part of the work. The dredging machines employed are on the same principle as those used at the Grand Amsterdam Canal works, that is to say, they belong to the type in which the material to be raised is first reduced by suitable machinery to a condition of mud, and then pumped to the surface, and delivered by means of a pipe line. Fig. 1 illustrates the general form of the dredging machinery used at Oaklands Harbour. The submerged and mixing part of the arrangement consists of a horizontal wheel with ploughshares attached around the lower face. By means of steam power on the boat, rotation is given to this wheel, which is inclosed in a casing, so that water can enter only on the under side. On the top of this casing is fixed the rising main, 20 in. in diameter, of a centrifugal pump, 6 ft. in diameter, placed on the boat. The delivery main of this pump, also 20 in. in diameter, is extended from the vessel by a line of wrought-iron pipe, with ball-and-socket joints and rubber connections; it is supported in position to the marsh where the mud is delivered. By this arrangement, which is shown clearly in the engravings, the material excavated, after being mixed, passes directly through the pump and delivery mains, and only comes to rest when it is discharged. As much as 40 per cent. of solid matter can be carried in this way, but 15 per cent. is found by experience to be the most convenient amount; one obvious advantage resulting from this dilution being that the solid material is more widely and uniformly distributed over the area to be reclaimed. The pump is driven by a pair of engines having cylinders 16 in. in diameter and 20 in. stroke, and two other engines with cylinders 12 in in diameter and 12 in. stroke, drive the cutting and mixing gear, the winches, hoists, &c. Steam of 90 lb. to 95 lb. pressure is supplied by two 100 horse-power boilers. The greatest length of delivery pipes employed has been 2850 ft., and through this length 41,000 cubic yards of mud were delivered in 190 hours. During a period of eight months one of these machines raised and deposited 250,000 cubic yards, or an average of 30,000 yards per month. In one month of this period there were moved over 60,000 yards, through a distance of 1100 ft. The total expense per day of ten hours of one of these machines, including interest, depreciation, and insurance, amounts to 100 dols., or about 20*l.*, and in connection with the work there are other expenses, as follow: 1. The construction and maintenance of levees or embankments for confining the freshly-dredged material. 2. The services of nine or ten men to guide the flow and distribution of the material as it is delivered. The cost of previous dredging operations on the Pacific coast by ordinary appliances has averaged 24 cents, or 1s. per yard, while the maximum expense per yard, with the system we now describe, is a maximum of 6 cents, falling in some cases to 5 cents per yard. The Oaklands Harbour dredging operations are under the control of Colonel G. H. Mendell, of the United States Corps of Army Engineers.

HETT'S GIRARD TURBINES.

AMONG Continental hydraulic engineers the Girard free-deviation turbine is almost invariably adopted for all heights of fall. On this side of the Channel much greater variety exists. Many turbines of the Fourneyron, or outflow type, are working successfully. Scheill's type met with a very favourable reception, and Williamson's vortex, with its offspring as now imported from the United States, have been very largely employed. None of these turbine wheels answer well under heavy pressures, and tangent wheels with an inward flow fed by a series of one to four to five jets acting on the buckets, have been almost exclusively used when dealing with high heads. They are not, however, economical, as a great portion of the water passing into the wheels is again caught by the buckets, and after passing outwards through them, is delivered with a velocity nearly equal to that of the wheel itself, robbing it of a portion of the energy which it had previously received. The Girard wheel is free from this objection, as the water passes outwards, and on leaving the buckets drops into the tail race and flows away. It is also capable of giving a very satisfactory efficiency under high falls, although not quite equal to that which can be obtained by well-constructed wheels under medium falls.

Our illustration above represents a small turbine of this class specially constructed by Mr. Hett, of Brigg, Lincolnshire, for use in the Lake District. The water is directed on to the bucket through five openings, any number of which can be closed at will to suit the variations of power which may be required. The gate is, in these smaller sizes, moved by a crank within a water chamber; by this novel arrangement a Stanah gland shaft takes the place of the usual rectangular stuffing-box through which the curved gates slide.

The Girard, in common with other outward flow tur-

PASSENGER LOCOMOTIVE FOR THE RAILWAYS OF UPPER ITALY, AT THE TURIN EXHIBITION.

CONSTRUCTED AT THE WORKS OF THE COMPANY, TURIN; MR. C. C. FRESCOT, LOCOMOTIVE SUPERINTENDENT.

(For Description, see Page 32.)

Fig. 3

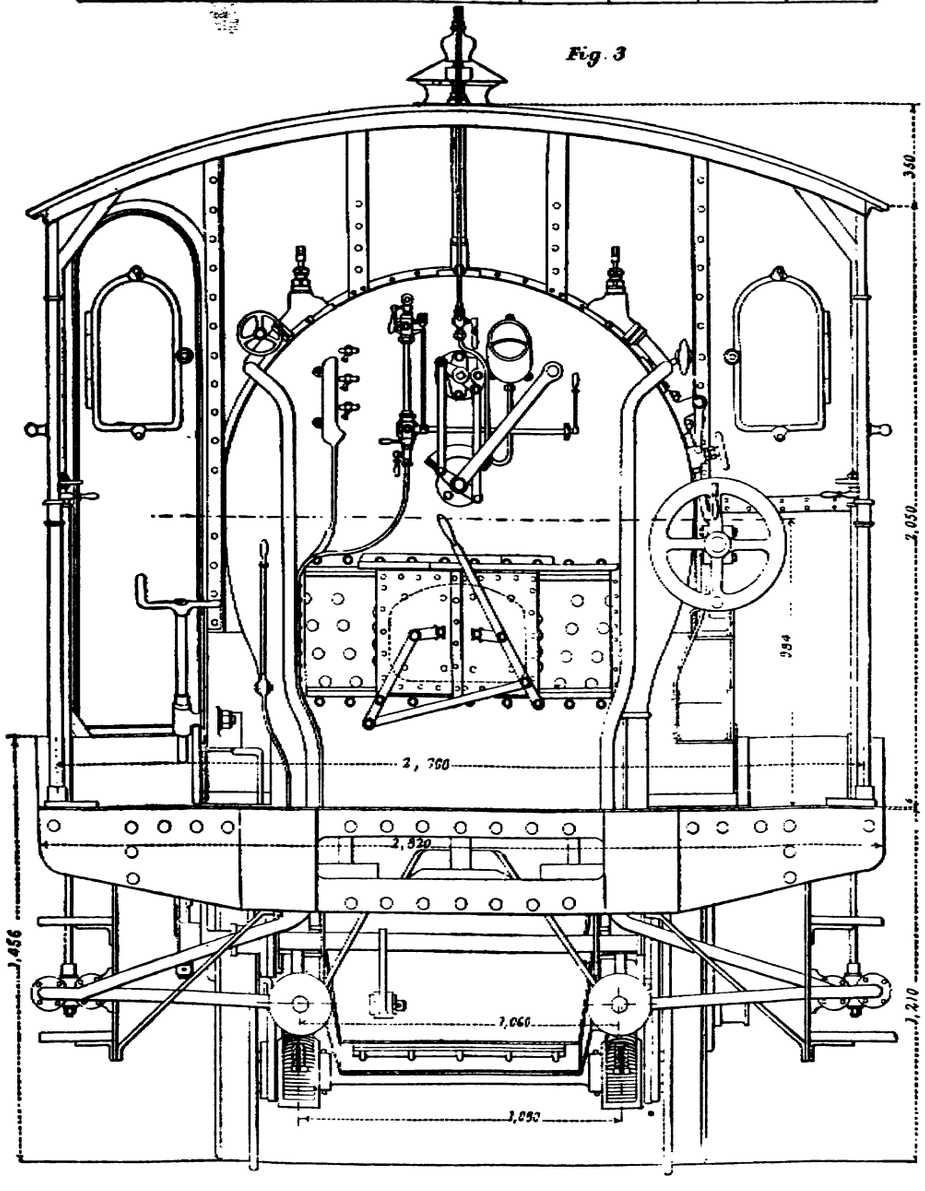
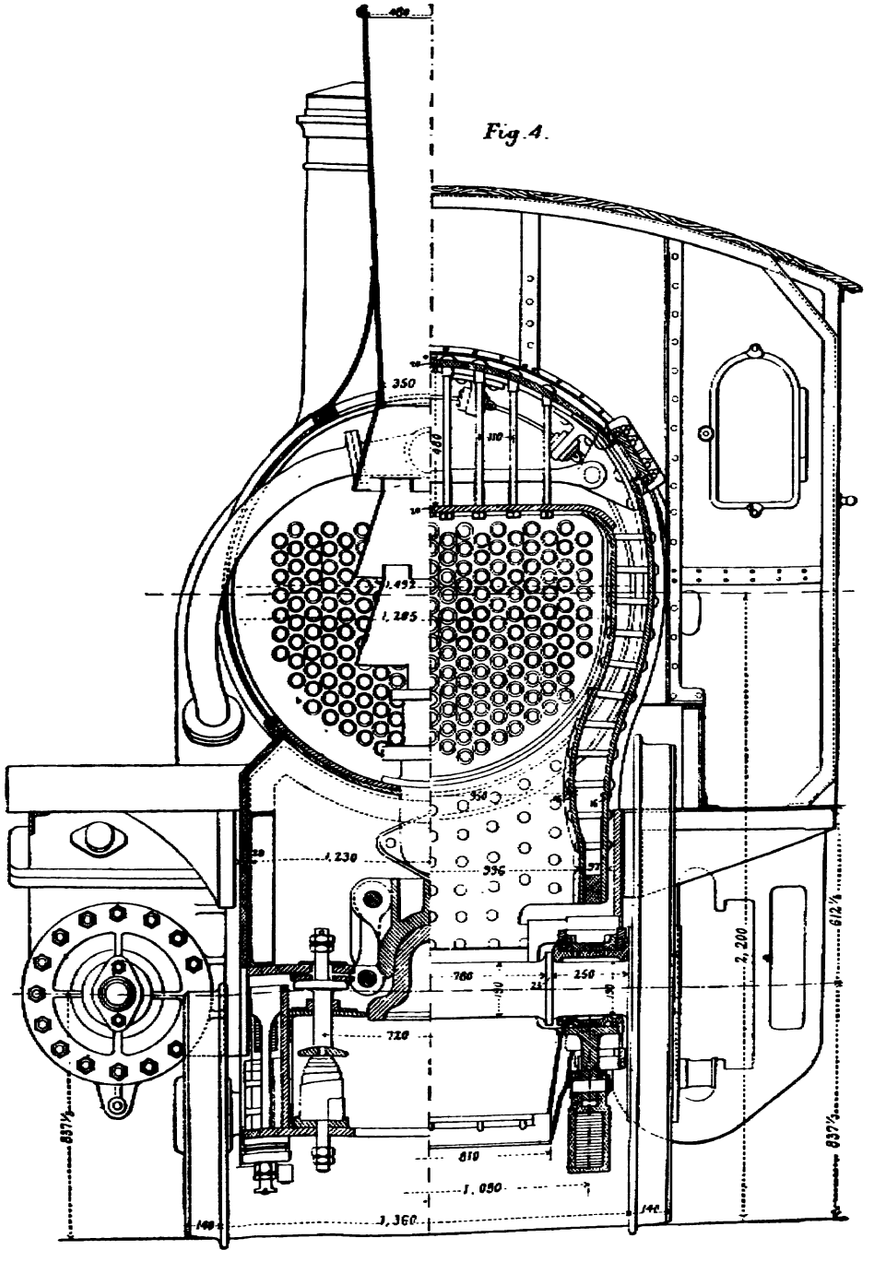


Fig. 4.



bines permits of a form of bucket which agrees very closely with theory.

It is expected that little wheels of this type will be largely employed for electric lighting for private residences amongst the lakes.

We understand that Mr. Hett has recently arranged two Girard wheels of 125 horse-power, each with 300 ft. fall, for driving a cotton mill in India.

WRECK RAISING.

WE illustrate on page 27 of the present number a lifting lighter or pontoon which has been lately constructed by Messrs. J. and G. Rennie, of Greenwich, for the Thames Conservancy, and the design and equipment of which embraces the results of the great practical experience which the officers of the body just named have acquired in dealing with wreckage and sunken vessels. The pontoon referred to is built of iron, and differs from the usual form of lifting lighter in several points. The old style of lighter consisted of a strongly built iron barge with an athwartship bulkhead at the bow and stern, a strong purchase bumpkin and davits, and some good bollards. When engaged in lifting, these lighters were secured to a sunken wreck by flexible steel wire hawsers, the bight of which would be brought under the keel of the wreck, and the ends passed up one each side of the lighter, and firmly knotted about the centre of a shifting crossbeam laid across the deck. The Conservators of the Thames have for years past used the flexible steel wire hawsers manufactured by Messrs. Bullivant and Co. for wreck raising and all other purposes, in lieu of hempen hawsers or chain cables, and by the application of Messrs. Bullivant's patent automatic nipper for holding, slacking up, or letting go the flexible steel wire hawsers, they have been enabled to construct the present improved lifting lighter.

The new vessel differs from the old type by the adoption of a system of construction similar to that applied to ordinary dredgers, and by an arrangement of water-tight compartments the whole length and breadth of the lighters.

A well or open space is provided through the centre of the lighter. This well is 60 ft. long, 2 ft. in breadth at the bottom, and 1 ft. 6 in. at the top. At the fore and after ends of the well stiff athwartship bulkheads are placed, making the foremost and after compartments perfectly water-tight. The sides of the well are plated in a similar manner to the ordinary side plating, and six water-tight compartments are formed on each side of the well between the fore and after bulkheads. Other arrangements are made to insure great strength in construction with the result that ample longitudinal and vertical rigidity is provided to withstand very heavy lifting strains, leaving at the same time sufficient surplus buoyancy to lift 400 tons with each lighter. The sections, plan, and elevations shown in our illustration on page 27 will explain the general arrangement of the hull.

As before stated, the Conservators of the Thames have for years past used the flexible steel wire hawsers manufactured by Messrs. Bullivant and Co. on account of their great handiness and light weight. These hawsers are admitted to be far more durable than hemp and and so pliable that they can be worked round any bitt or bollard, round which a hemp hawser of equivalent strength will work, whilst being one-third the weight of hemp they are more easily handled.

In addition to the advantages gained by the reduced weight and increased strength of these hawsers, provision is made for instantaneously gripping and holding the ropes or letting them go inch by inch if necessary. For this purpose Messrs. Bullivant and Co. supply eight of their automatic nippers to each lifting lighter, these nippers being able to safely hold each hawser up to a strain of 100 tons. The weight of the flexible steel wire hawsers supplied to each lighter is about 3¾ tons, whilst the weight of chain cable of equivalent strength would be 20 tons and the weight of tarred hemp rope 11 tons. This difference in weight of the rope, and convenience of the holding arrangements enables the work of wreck raising to be carried out with about one-third the amount of labour formerly required, and at the same time insures an equal average strain being brought on each hawser, which was before impossible.

It will be seen from the illustrations that the hawsers are passed up through the well of the lighter, and by means of a series of cast-iron fairleads fitted at the top of the well may be snatched at any point and led to the nearest nipper, where as before explained the holding strain on each can be regulated as required.

PASSENGER LOCOMOTIVE; UPPER ITALIAN RAILWAYS.

THE locomotive which forms the subject of our two-page engraving this week, and which is further illustrated on page 31, is one which is being shown at the Turin Exhibition by the Administration of the Railways of Upper Italy. It was built at the works of the company at Turin, under the direction of Mr. C. C. Frescot, the engineer-in-chief of the locomotive and rolling stock department, and it is intended for passenger service on a heavy portion of the system. Before describing the engine itself we may say a few words respecting the work for which it is intended.

The existing line from Alessandria to Genoa—a line constructed more than thirty years ago—crosses the Apennines at the Giovi Pass, and includes gradients of from 30 to 35 per 1000 (1 in 33⅓ to 1 in 28.6). This lines unites the most important port in Italy with the valley of the Po, and thence with Central Europe, and the traffic upon it, steadily increasing, has rendered necessary the laying out of a new railway which should supplant the Giovi line and present more favourable features. This line is now in course of construction, and will soon be opened. It will present gradients not exceeding 12 to 16 per 1000 (1 in 83 to 1 in 62.5), and the merchandise service upon it can be well performed by the powerful goods locomotives which the administration already possess. This being so, it was natural that steps should be taken to improve the passenger service. The character of the existing Giovi line is such as to necessitate two changes of engines on each run from Genoa to Alessandria, or *vice versâ*, a distance of but forty-seven miles, and these changes of course increase the time occupied on the journey. Under the new conditions, the problem to be dealt with was the production of a locomotive capable of hauling trains of 120 to 130 tons up gradients of 1 in 83 to 1 in 62.5 at speeds of from twenty-five to twenty-eight miles per hour, and capable also of taking the trains over the remainder of the line without change, developing a speed of 60 kilometres (37¼ miles) per hour on the levels. It was to meet these conditions that the engine we now illustrate was built.

Referring now to our illustrations, it will be seen that the engine has three pairs of coupled wheels with a four-wheeled bogie in front, this arrangement being adopted to give a large amount of adhesion combined with the necessary flexibility for traversing the curves. The springs of the two hind pairs of coupled wheels are connected by compensating beams, and all the springs are fitted with india-rubber cushion springs applied to the spring links as shown. The framing is substantial, the main frame plates being well stayed transversely. The cylinders are outside, as is also the valve gear, which is of the Gooch stationary link type. The eccentrics are carried by return cranks, and the slide valves work on inclined faces above the cylinders. A special feature in the design of the engine is the boiler, which is of a pattern which has been little used in Europe, although it has been employed to a considerable extent in America. As will be seen from our engravings, the firebox is provided with a combustion chamber which extends into the barrel of the boiler, thus keeping the tubes of moderate length notwithstanding the great length of the boiler, and increasing the amount of direct heating surface. The use of the combustion chamber also facilitates the attainment of complete combustion, and renders the tube-plate less liable to injury. The boiler has also a large water capacity.

The structural details of the boiler are clearly shown by our engravings. From these it will be seen that the firebox crown is stayed direct to the outer shell, the tendency of the crown of the latter to spread transversely being resisted by strong cross-stays. There are no longitudinal stays, the back plate of the firebox casing and the smokebox tube-plate being stiffened by plate stays as shown. The girder stay on the back plate of the firebox casing is made very deep, and is perforated to allow of the passage of the roof stays as shown in the longitudinal section.

The boiler carries a large dome at the front end, this dome containing the regulator, which is of the gridiron type, the main valve having a relieving valve on the back. The smokebox is fitted with petticoat pipes, the exhaust nozzle being kept low as in American practice. The boiler is fed by two Friedmann injectors, and the engine is fitted with the Westinghouse automatic continuous brake.

The chief dimensions of the locomotive under notice are as follows:

	ft.	in.
Cylinders and Valve Gear:		
Diameter of cylinders	1	6.7
Stroke	2	0.4
Distance apart of cylinders from centre to centre	6	9.9
Throw of eccentrics	0	2.44
Angle of advance of eccentrics	32 deg.	
Outside lap of valves	0	1.18
Inside " "	0	0.00
Frame and Wheels:		
Distance apart of frames	4	0.4
Diameter of coupled wheels	5	6
" " bogie "	2	9
" " bearings of coupled axles	0	7.5
Length " " " " "	0	9.8
Diameter " " bogie "	0	5.5
Length " " " "	0	9.45
Boiler:		
Length over all	26	10.3
" of barrel	18	10.4
Boiler:	ft.	in.
Diameter of barrel inside largest plate	4	5.9
Length of firebox casing	7	11.9
Width " " at top	4	10.7
" " " bottom	3	10.8
Length of smokebox inside	3	7.7
Diameter " "	4	5.9
Thickness of plates of firebox casing	0	0.63
" " barrel	0	0.61
" of smokebox tube-plate	0	1
Length of inside firebox at top	7	2.6
Height " " front	5	10
Width " "	3	11.4
Length of combustion chamber	2	11
Width " "	3	10.2
Height " "	2	11.8
Thickness of tube-plate (copper)	0	1
" side and end plates (copper)	0	0.63
Thickness of crown plate (copper)	0	0.79
Number of tubes (brass) 202		
Diameter " (outside)	0	1.97
Length " between tube-plates	12	6
Thickness "	0	0.12
Least diameter of chimney	1	1.6
Working pressure	147 lb. per sq. in	

Heating and Grate Surface:	sq. ft.
Heating surface of firebox	163.6
" " tubes	1171.2
Total	1334.8
Firegrate surface	23.7
Flue area through tubes	3.3
Least area through chimney	1.04
Ratio of grate surface to total heating surface	1 : 56.3
Ratio of flue area through tubes to grate area	1 : 7.18
Ratio of least area of chimney to grate area	1 : 22.8

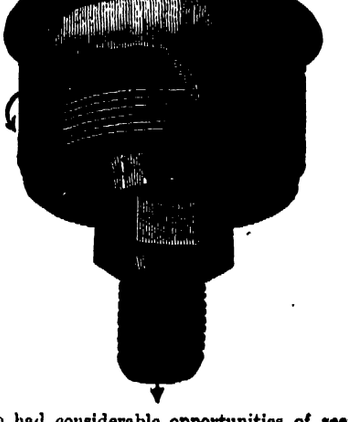
The weight of the engine is 49 tons empty, and 53 tons in working order, this latter weight being distributed as follows:

	tons.
On bogie wheels	15½
" 1st coupled wheels	12½
" 2nd " "	12½
" 3rd " "	12½
Total	53

From the dimensions which we have given above it follows that the tractive force which the engine is capable of exerting for each pound of effective pressure per square inch on the pistons is $= \frac{18.7^2 \times 24.4}{66} =$ 129.3 lb. The tractive force which the engine will be capable of developing in regular work is calculated by its designers as 7400 lb., while its maximum tractive effect is put down as 5 tons, a pull which there is ample adhesion for utilising. We may add that on taking the trains for which it is designed up the gradients of 1 in 62.5 named above, it is probable that the engine will have to exert a pull of fully 4 tons, this pull at the speed of about 28 miles per hour being equivalent to the development of over 650 horse-power. Altogether, the engine we have been describing is an interesting example of recent Continental locomotive practice.

STAUFFER'S LUBRICATOR.

THE system of lubrication known under the name of its inventor, Mr. Stauffer, of Berne, includes both a lubricating material, and an apparatus for its application. It is in extensive use upon the Continent, and is steadily gaining ground in this country, although not at the rate that its good qualities would warrant.



We have had considerable opportunities of seeing it in operation and can testify to its economy and efficiency. The lubricant is a grease prepared from mineral and vegetable oils of such consistency that it will flow under pressure, but not otherwise. Its melting point varies from 176 deg. Fahr. to 212 deg.

Fahr. according to the purpose for which it is prepared, and it is applied by means of the cup shown in the annexed illustration. This is made in two parts; the lower is provided with a small central hole and is screwed into the bearing, and the upper is filled with lubricant, and screwed on to the lower. As the upper one is rotated its contents are forced forward into the bearing, a partial turn at a time being amply sufficient. Half a turn once a fortnight suffices to keep an ordinary shaft bearing in good condition, one turn every four or five days is sufficient for a high-speed loose pulley, one turn a day for an engine crank-pin, and one turn every six hours for a dynamo machine running at 900 revolutions per minute. Bearings of difficult access can be supplied through a pipe and the crank-pin of a constantly running engine through a hole drilled up the shaft and crank-arm, and emerging in the centre of the pin. Nothing is wasted in drippings, and there is no danger of the oil-ways becoming clogged, because being constantly filled with the composition, air and dust cannot enter them. Messrs. Trier Brothers, of 19, Great George-street, Westminster, are the manufacturers in this country.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The warrant market was a turn weaker last Thursday, and prices closed ½d. under those of the previous day's close. There was a fair demand during the forenoon and prices advanced from 41s. 5d. to 41s. 6d., but fell again to 41s. 4½d. cash, and from 41s. 7d. up to 41s. 8d., declining to 41s. 6½d. one month, the close being sellers at 41s. 4½d. cash and 41s. 7d. one month, with buyers offering ½d. per ton lower. The quotations in the afternoon were 41s. 5d. down to 41s. 4d. cash and 41s. 7d. to 41s. 6½d. one month, the market closing with sellers at 41s. 4½d. cash and 41s. 7d. one month, and buyers at ½d. less per ton. Friday's market was rather firmer, with business done on forenoon 'Change at 41s. 4d. and 41s. 4½d. cash, also from 41s. 5½d. to 41s. 6½d. one month, with buyers at the close offering the top prices, and sellers asking ½d. per ton higher. Prices advanced in the afternoon to 41s. 5d. cash and 41s. 7½d. one month, and sellers at the close were wanting 41s. 5½d. cash and 41s. 7½d. one month, with buyers offering ½d. less per ton. There was an easier market on Monday, with transactions reported during the forenoon at 41s. 5d. 41s. 5½d., and down to 41s. 4d. and 41s. 4½d. cash, also at 41s. 7½d. down to 41s. 6½d., one month, the close being sellers at 41s. 4½d. and 44s. 7d. cash and one month respectively, with buyers offering ½d. per ton lower. Very little change took place in the afternoon. Yesterday's market was characterised by a lower tone, the prices in the forenoon being down to 41s. 3½d. cash and 41s. 5½d., while in the afternoon, 41s. 2½d. cash and 41s. 4½d. one month were accepted, the close, however, being a slight degree firmer. During this day's forenoon market the prices ranged between 41s. 4½d. and 41s. 3½d. cash, and from 41s. 4½d. to 41s. 5d. one month, and in the afternoon the top prices were 41s. 2½d. and 41s. 5½d. one month, which were still quoted at the close. Almost the whole of the business now doing in the Glasgow pig iron market is in the hands of the trade, and although somewhat large operations occasionally take place they seem to be carried on for only the turn of the market. The lifeless condition of the trade is generally acting as a check on the public taking much practical interest in pig iron. Not only does the market continue dull and inanimate, but the prospects do not appear to be in any way improved. A good demand is still showing itself in respect of some of the special brands, the quotations for which are firm, while other brands are neglected. It is stated that although things remains quiet in general trade, the tone is more hopeful in some departments. American and Canadian orders now coming to hand are both few and for limited quantities, and the demands on Russian account have now been pretty well met. There are at present 96 blast furnaces in actual operation, an additional furnace having been blown in during the past week at Coltness Iron Works. A year ago there were 113 furnaces blowing. Last week's shipments of pig iron from all Scotch ports amounted to 14,612 tons, as against 8138 tons in the preceding week, and 12,398 tons in the corresponding week of last year. They included 1850 tons to the United States, 600 tons to Canada, 450 tons to Australia, &c., 377 tons to France, 925 tons to Italy, 1223 tons to Germany, 2785 tons to Russia, 657 tons to Holland, 135 tons to Belgium, 164 tons to Spain and Portugal, 175 tons to China and Japan, and lesser quantities to other countries. During the six months ending 28th of June, the shipments of Scotch pig iron amounted to 281,322 tons, as compared with 314,616 tons in the corresponding period of 1883, and 315,076 tons for the same period of 1882. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores yesterday afternoon stood at 588,066 tons, as against 588,852 tons yesterday week, showing for the week a decrease of 186 tons.

Clyde Shipbuilding Trade.—If we were judged by the new shipping put into the water last month it might be concluded that the shipbuilding trade of the Clyde was very busy, but as is well known that is not the case. The total output was certainly heavy, namely, 29 vessels of a total of 33,221 tons, an amount which, however, was exceeded in the corresponding month of 1883 and 1882, when the output was, respectively, 45,426 tons and 41,810 tons; but never in any preceding month of June was last month's tonnage output exceeded. During the past six months the returns are—143 vessels and 140,928 tons, the total in the corresponding six months, of the three years immediately preceding being, respectively, 195,986 tons, 167,608 tons, and 156,670 tons. In the corresponding six months of 1880 the total output of new shipping on the Clyde was not any more than 112,000 tons. One of the most remarkable facts connected with last month's output is that the steel shipping launched, amounted to 27,000 tons, or fully three-fourths of the whole. Another interesting fact is that three of the steamers launched last month gave an aggregate of 17,000 tons. They were the Cunard Liner Umbria, 8000 tons; the Awara, 5000 tons, built by Messrs. Denny and Brothers for the London and New Zealand passenger and cargo service, and the Allen Liner Siberian, 4000 tons. None of the other steamers exceeded 1700 tons, whereas a steel sailing vessel of 2441 tons was launched by Messrs. John Reid and Co. All the steamers launched last month were screws, with one exception. There are now between 90 and 100 vessels in hand in the various shipbuilding yards on the Clyde.

Castlehill Iron Works.—The Shott's Iron Company have intimated that the workmen employed at the Castlehill Iron Works, and the pits connected therewith are now to hold themselves as engaged from day to day, no notice or warning to quit being required on either side.

Wages in the Malleable Iron Trade.—Notice has been given to the ironworkers employed at the malleable iron works in the Motherwell district that reductions of 2½ per cent. are to be made on the wages of millmen, foremen, and shinglers, and 3d. per ton on the wages of puddlers; and the workmen are all on one day's notice. This is the second reduction of wages made this year, and the rates now paid are the lowest known in Scotland in the history of the malleable iron trade.

Depression in the Dundee Engineering Trade.—At present the engineering trade is in a very depressed state in Dundee. Up till the autumn of last year great activity, as a rule, prevailed in all the foundries; but work then became comparatively scarce, and the unsatisfactory condition of the shipping trade and the depression in the textile industries having resulted in the cancelling of several important orders, matters now present a very gloomy aspect. In one of the foundries in the town, where a night shift till recently was required, over forty men were dismissed on Thursday night, making in all 200 dismissals within a short time, while in other workshops corresponding reductions in the staffs have been necessitated.

Engine Works Extension at Dumbarton.—Messrs. Denny and Co., engineers, Dumbarton, have just received authority from the Dean of Guild Court to erect an engine-house and electric light apparatus house in connection with their works. It is stated that the two firms in which Messrs. Denny are the leading partners have now secured for their exclusive service an electrical engineer, who will take charge of all the electric lighting on the ships which Messrs. Denny build.

The New Railway from Keith to Buckie.—So much progress has been made recently with the Highland Railway Company's new branch line from Keith to Buckie and Portessie, that it is understood there is every likelihood of the line being opened for traffic very shortly. The Government Inspector, will, it is stated, go over the works about the 12th or 15th of this month, and as the line has been laid and finished with great care, it is believed that the works will meet with his approval. The new railway branches off from the Highland Railway Company's present line at Keith, and travels in a northerly direction as far as Buckie, and then in an easterly direction until Portessie is reached, a total distance of 13¼ miles. There will be five stations along the line, at Forgue, Enzie, Rathven, Buckie, and Portessie. The distance from Keith to Buckie, including stoppages, will be run in less than half an hour. The number of bridges which had to be erected was considerable, yet the works have not proved to be of a very expensive character. The total estimated cost was 95,000*l.*, and it is believed the line will be completed and opened for this sum.

The New Harbour Works at Wick.—The financial arrangements with the Public Works Loan Commissioners, for an advance of 50,000*l.*, at 3½ per cent., for the improvement and extension of Wick Harbour, have now been completed. The improvement scheme, as recently modified by Mr. Rendel, civil engineer of the Board of Trade, and Mr. Barron, the resident engineer, will, it is estimated, cost 97,000*l.*, and the balance beyond the sum to be advanced by the Loan Commissioners will be made up from surplus revenue.

More Rapid Steaming.—It is claimed on account of the last outward run of the new Dominion Line steamer Vancouver from Liverpool to Quebec that it is the fastest passage on record, namely, 6 days 16 hours 15 minutes. She was built by Messrs. Charles Connal and Co., and engined by Messrs. John and James Thomson, Glasgow.—Last Saturday night, the Belfast steamer Corilla, belonging to Messrs. G. and J. Burns, Glasgow, made the passage from Belfast to Greenock, over 120 miles, in about six hours, being the fastest run on record of a vessel of her class between those two ports.—Another fast run of the Oregon (now a Cunard Liner) has to be put on record. Her last run home from New York to Queenstown was accomplished in 6 days 14 hours. On the 30th ult. she logged 440 knots.—The Allan Liner Parisian arrived at Moville from Quebec last Sunday morning and at Liverpool the same evening, making one of the fastest passages home from the St. Lawrence yet on record, and only surpassed by a former run of the same vessel.

Opening of a New Harbour at Johnshaven.—Last Saturday afternoon a new harbour, constructed at Johnshaven, at the expense of Mr. Hercules Scott, a well-known Kincardineshire landed proprietor, was formally opened by that gentleman for the benefit of the fishing population of the district. It was designed by Mr. Willet, C.E., Aberdeen, and has cost upwards of 4000*l.*

Greenock Railway Compensation Case—Claim for 4 000l.—Messrs. John Fullarton and Co., Bogston Saw Mills, near Greenock, has lodged a claim for 48,000*l.* with the Glasgow and South-Western Railway Company, as compensation for ground, &c., required for a line of railway in course of construction from that company's system to the James Watt Dock at Garvel Park.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the quarterly meeting of the North of England iron and allied trades was held in the Royal Exchange. There was a thin attendance, and the tone was quiet. The nominal price of No. 3 Cleveland pig was 37s. per ton, but very little business was transacted. Buyers did not seem disposed to pay the price, preferring to take the chance of buying on better terms later on. There is more pressure to sell forge iron, which is quoted under 35s. 6d. Shipments continue fairly good this month, but there are not such large exports to Russia as there were in June.

The Make and Disposal of Pig Iron in Cleveland.—Of the 156 blast furnaces in the North of England 99 were in operation during June, 57 being out.

The Wages Question.—Under the sliding scale which regulates the wages of blast furnacemen in the North of England and Cleveland ironstone miners, the accountant's certificate leaves the wages of the blast furnacemen unaltered for the ensuing quarter, and slightly reduces the miners'.

The Manufactured Iron Trade.—There is no improvement in the manufactured iron trade. Prices are unchanged. Most of the works are only in partial operation, and a large number of men are out of employment. At present there is no indication of better trade.

Engineering and Shipbuilding.—On the northern rivers the aspect of affairs is most discouraging. The marine engine builders have little or nothing to do, and the shipyards, which a year ago were in full swing, are silent and empty. So long as so many steamers are laid up owing to unremunerative freights there will be no demand for new vessels.

The Coal and Coke Trades.—There is no alteration in the fuel trade, and prices are the same as those last quoted.

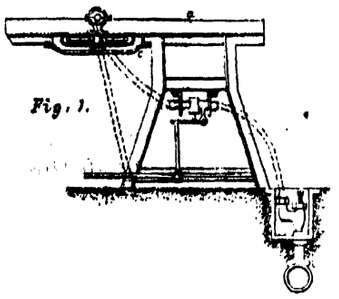
The Salt Trade.—Messrs. Bell Brothers continue to work successfully their salt pans at Port Clarence, Middlesbrough. As the pioneers of the salt trade, they are reaping the reward of their enterprise. Near their great iron works they are building alkali works, which will soon be ready to utilise the salt. Other companies who intended to work the salt seem to make slow progress with their boring operations.

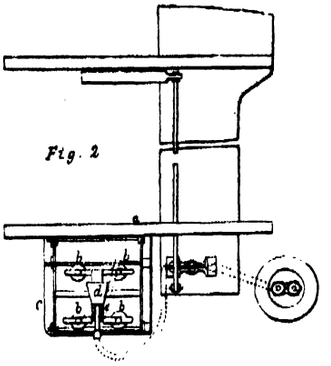
WATER SUPPLY OF THE AGRICULTURAL SHOW AT SHREWSBURY.—The water supply for the Show ground this year is on such a scale as to more than equal the requirements for the water works of many a small township. No less than 15,000 gallons per hour will be required to meet the wants of the exhibitors and cattle; and this year for the first time Norton's Abyssinian tube well system has been adopted. For this purpose Messrs. Le Grand and Sutcliff, of London, have furnished eight 3-in. tube wells coupled to one cast-iron main, and an abundant supply of pure clear water has been obtained. A steam pump draws the supply from the central 6-in. outlet in the main and forces it up to the distributing tank, a distance of about 800 yards, the whole forming a complete water works.

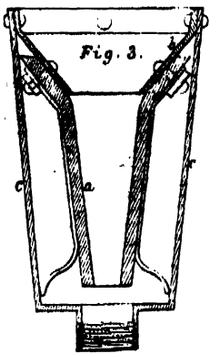
SOUTH AUSTRALIAN RAILWAYS.—A discussion has been proceeding with reference to the construction of a railway from some point on the Great Northern Railway of South Australia to tap South-Western Queensland and a part of the south-west of New South Wales, but particularly the former. The matter has been referred to over and over again in the South Australian Parliament, and there is a general conviction that a line must be made. The difficulty is what route should be adopted. On this point a controversy has been going on for months between persons of opposite opinions, both sides claiming equal knowledge of the country and equal disinterestedness. Two routes have been suggested. Along one a survey has been made, and by that survey one section of disputants are prepared to stand. The other side suggest a different route, which is now being surveyed.

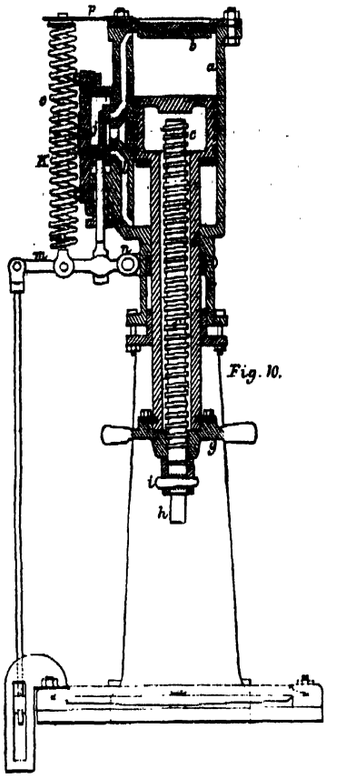
PUTNEY (NEW) BRIDGE.—The ceremony of laying a memorial stone in this structure will be performed by the Prince and Princess of Wales to-morrow (Saturday) at 3 p.m. The official programme is as follows: Their Royal Highnesses will proceed from Marlborough House *vid* Knightsbridge and Fulham-road, over Putney Bridge to the entrance to the new bridge at the northern end of High-street, Putney. They will there enter the works and see models and plans of the bridge in a small pavilion close to the stone to be laid. After laying the stone their Royal Highnesses can, if they are so disposed, proceed for a short distance over the temporary bridge to see the piers in course of construction within the dam. Returning to the entrance where they left their carriage, their Royal Highnesses will then drive back by way of Putney High-street, Wandsworth High-street, York-road, through Battersea Park and over Chelsea Bridge.

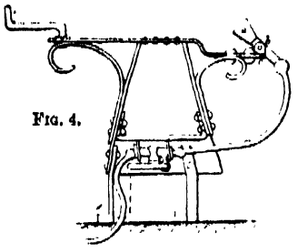
APPERTS' GLASS-BLOWING APPARATUS AT THE HEALTH EXHIBITION.

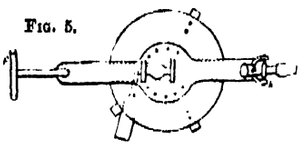

Fig. 1.

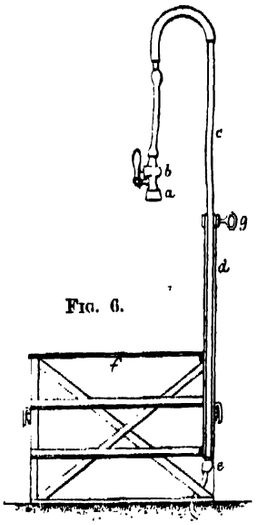

Fig. 2

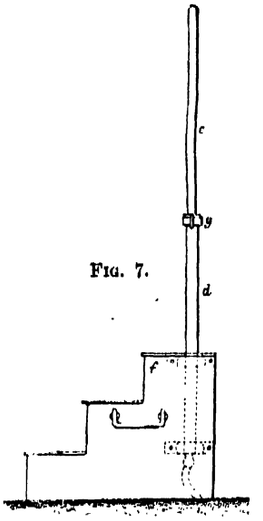

Fig. 3.


Fig. 10.


Fig. 4.


Fig. 5.


Fig. 6.


Fig. 7.

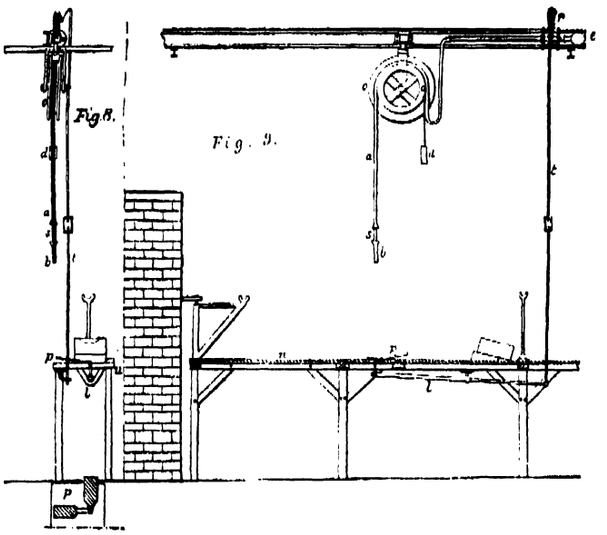
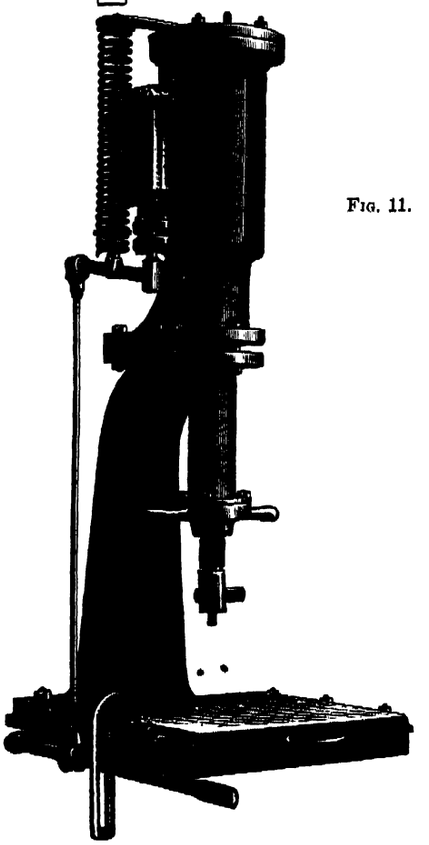

Fig. 8.

Fig. 9.


Fig. 11.

One of the most striking exhibits in the French Court at the Health Exhibition is that of Messrs. Appert Brothers, of 5, Rue des Chasses, Clichy, Seine, and consists of apparatus for blowing glass by means of compressed air. On the present page we give illustrations of the various parts of this apparatus and annex a description of the method of working. The compressed air required for the glass blowing operations is obtained by an engine which should have by preference two cylinders arranged so as to work, if necessary, independently of each other, and each one to be capable of supplying the different apparatus at work with air compressed to the requisite degree. Independent reservoirs to act as accumulators are also supplied, and into these the air is forced at a pressure of about 70 lb. to the square inch. This is considered the most advantageous pressure, not only as tending towards the greatest economy in the utilisation of motive power, but also because it allows of accumulators of a moderate size and weight. The total capacity of the reservoirs should be sufficient to enable them to supply the plant in use with air for twelve hours at least. The compressed air is also used for the process of pressing glass, and in this case a storage capacity of two hours is considered sufficient if the engine is capable of keeping up the supply.

The reservoir pressure of 70 lb. is much too high for the purpose of blowing under the ordinary conditions of glassmaking, and in practice it is reduced to a lower constant pressure by means of an expansion regulator. The latter may be on the liquid principle, either water or mercury being used, although a dry regulator is preferred.

In the Exhibition the reservoir shown consists of a long cylinder with closed ends fitted with a pressure gauge and having a Pintsch's regulator for controlling the eduction of the compressed air. The expanded air should vary in pressure according to the nature of the glass being manufactured, but should always be constant for the same work. The following are given as minimum pressures:

2	lb.	per	square	inch for window glass.
2½	,,	,,	,,	crystal.
3	,,	,,	,,	white goblet glass or half crystal.
3½	,,	,,	,,	bottle

CROMPTON'S ARC LAMP.

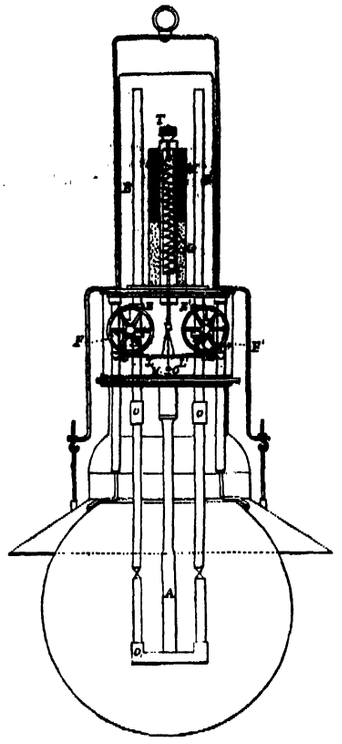


FIG. 1.

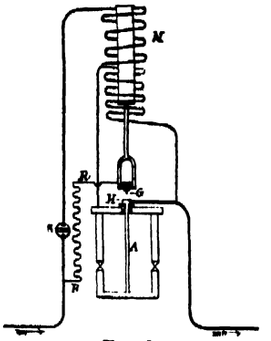


FIG. 2.

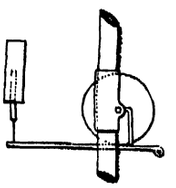


FIG. 3.

The various pipes for the conveyance of the air may be of lead or cast iron, but wrought-iron tube is preferred. It is desirable that the pipes and connections should be easy of access in case of leakage. For the pressing of glass, or blowing bottles and window glass, Messrs. Appert prefer the air pipes to be placed in the upper part of the workshop, whilst for blowing goblets in crystal or glass the air connections should be placed under the floor. In the latter case the communication would be by means of openings provided with stop-cocks which would be placed in convenient positions near the furnaces. Each connection should be furnished with a gauge for indicating exactly the amount of compression. Water gauges are used for low pressures, whilst metal gauges are required for higher pressures.

The most prominent feature in the stand at the Exhibition is a glassmaker's bench, of which Fig. 1 is an end elevation and Fig. 2 a plan. This consists of an ordinary bench, on each side of which is placed a couple of long arms as shown, the right-hand one being marked *a*. These serve as rests or supports on which, during work, the blowing tube rolls in a horizontal position. The latter is not shown in the illustration, but fits into the socket *d*, Fig. 2, which is shown in detail in Fig. 3. This socket is supported on a small carriage, which in turn travels on the frame *c*, being guided by the four horizontal guide-wheels on rollers *b b b b*, and resting on a vertical wheel running on a cross rail as shown in Fig. 1. The socket, or "blowing sleeve," has an india-rubber cone *a* (Fig. 3) attached to the conical ring *b*, and this in turn is fixed to the case *c*. The end of the blowing tube forms a plain nipple which fits into the cone and makes a joint. The socket will rotate on its axis, as it is attached to the flexible air tube (shown in dotted lines in Fig. 2) by means of a swivel joint at *e*, Fig. 2, and the blowing tube can therefore be rolled along the bench arms as required. A self-closing cock for controlling the air admission is fixed underneath the bench, and is worked by a pedal.

This bench or chair can be employed for all the various operations of glass-blowing, and also for piercing the mass of glass. By it the service of the blower, ordinarily a boy, can be dispensed with. On the stand at the Exhibition a large glass globe produced by this machine is shown. It is about 3 ft. 6 in. in diameter, and was blown at a pressure of 28.5 lb. per square inch. This however is smaller than a globe originally intended for exhibition, but which unfortunately got broken in unpacking. These balls are used for cutting up into watch glasses.

Figs. 4 and 5 show a sectional elevation and a plan of a second description of apparatus. This is for blowing glass in a vertical position. In this case the blowing sleeve *a* is mounted on a horizontal pivot *b*, which in turn pivots at *c*, so that a universal motion is obtained. The fork *f* is for holding the tube when not in use. This apparatus is more especially applicable to the blowing of thick gas globes of large dimensions, and matrasses for chemical purposes, such as the preparation of camphor. It also serves for blowing the balls out of which thin annular pieces of glass placed on candlesticks are made.

A "swan-neck" apparatus, especially designed for blowing glass moulds, is shown in Figs. 6 and 7. In this case the chair or bench is transformed into a stool with steps *f*. The swan-neck *c*, which will revolve in the guide tube *d*, has attached to it a flexible tube by which the compressed air is brought to a hand expansion cock *b*. A set screw *g* clamps the swan-neck when required; *a* is the blowing sleeve, and *e* the air-pipe connection. The apparatus may be moved from place to place as required. It is used for moulding in fixed or revolving moulds and making bottles, gas and lamp glasses, decanters, perfumery bottles, and articles of a like nature.

At the back of the stand is shown a "Universal glass-blowing apparatus," which we illustrate in Figs. 8 and 9. This is used for producing such articles as globes, tubes, cylinders, clock shades, &c., or for enabling the glass to be pierced in all possible positions of the blowing iron. The two pedals *p* project above the platform *u*, and by means of a rod *l* and lever *t* work a stop-cock *r*, situated at the upper part of the workshop. This cock is placed in a branch tube of the compressed air main and is attached to the flexible tube *a*, which passes over a pulley *o*, *d* being a counterbalance weight. The coupling sleeve *b* fits on to the end of the blowing iron, and is connected to the tube *a* by a swivel *s*, which turns in a stuffing-box joint. By pressing on one or other of the two pedals *p* the cock *r* is opened for the purpose of effecting the various operations of blocking, elongating, and piercing the cylinder or other article under process of manufacture.

Several glass tubes are shown at the Exhibition. Two about 6 ft. long and 10 in. in diameter, blown by an air-pressure of 3 lb. per square inch, and two others about 14 ft. to 15 ft. long and 6 in. in diameter, which were blown by a pressure of 14 lb. per square inch. The machines we have described are all exhibited at the Exhibition, but in addition to these Messrs. Appert Brothers employ other apparatus used in the process of manufacturing glass. Although none of these have, up to the present, been shown at South Kensington, we give engravings from the drawings of two of them which have been forwarded to us, as they cannot fail to be of interest to many of our readers. In Fig. 10 will be found a sectional elevation of a press used for moulding glass, either by means of compressed air or some other fluid, elastic or otherwise. A perspective view is also given in Fig. 11. The cylinder *a* is lined at top and bottom with sheets of india-rubber, which act as a cushion to deaden the shocks produced by the strokes of the piston *c*. A hollow cast-iron piston-rod *d* is fitted as shown, and works through the stuffing-box *e*. The screw *f* can be raised or lowered within the hollow piston-rod by means of a fixed nut *g*, and is prevented from turning in the piston-rod by a feather guide. The core *h* is attached by the collar *i*. The slide valve is marked *j*, and the pressure is admitted to the valve chest through the orifice *k*. The lever *m*, pivotted at *n*, is used for working the slide valve. By pressing down on the lever *r*, which works in the slot *s*, the slide valve is drawn down and pressure is admitted above the piston; when the pressure is taken off the lever a spring *o* causes the valve to rise so that the core *h* is automatically raised. The use of this machine relieves the attendant of all heavy work, and enables one man to perform operations that require two people. A much heavier pressure can also be applied than is possible by hand work, and this pressure can be regulated to a great nicety, as may be required. Articles of excessive thinness can also be produced, owing to the rapidity with which the pressure can be applied. This machine can be used equally as well for producing pieces in open or closed moulds, and is applicable for working any kind of glass. Although steam can be used for producing the motive power, the use of compressed air is considered most advantageous for the following reasons: 1. It can be conveyed greater distances without suffering any great loss of pressure. 2. There is no fear of the work being injured by dropping of water of condensation through the stuffing-box. 3. It allows the pieces to be cooled rapidly and effectually by the air used for compression.

If, however, in spite of these advantages, it is found desirable to use steam, an apparatus is employed, in which the cylinder is placed beneath the mould, and the piston actuates the core by means of two connecting rods.

Messrs. Apperts' exhibit strictly deserves a position in the present Exhibition as, by means of their system, the labour of a number of children, who are now employed simply in blowing through the tube, can be dispensed with. The various machines described enable the workman to husband his strength and spares him the infliction of certain affections which are apt to become chronic. The cost of the power for the apparatus should not be expensive in ordinary cases, as the waste heat from the melting furnaces can be used for raising steam.

MESSRS. CROMPTON AND CO.'S NEW ARC LAMP.

MESSRS. CROMPTON AND CO. have recently introduced a very simple form of arc lamp which has proved remarkably successful in practice. It is known as their DD pattern, and its mechanism consists solely of a rack, a pinion, a brake wheel, a brake lever, and a solenoid. In Fig. 1 it is shown arranged as a duplex lamp, and consequently many of the parts appear twice, taking away somewhat from the apparent simplicity of the arrangement. Each upper carbon-holder, B or B^1, slides vertically through bearings in the framing, and is provided at one side with rack teeth. Upon the holder there slides a gun-metal sleeve E carrying a short horizontal spindle, upon which is a pinion gearing into the rack, and a brake wheel. The sleeve is prevented from sliding down the holder by means of a brake lever L, pivotted at one end to the side rod of the lamp, and at the other end connected to the core of the regulating solenoid by a chain. This lever stands directly under the brake wheel, and also under a spur or peg F^1 projecting downwards from the sleeve. This spur is nearer the centre of oscillation of the lever than is the point of contact between the wheel and the lever, consequently when the lever is inclined downwards the weight of the sleeve is borne on the spur, and when the lever is inclined upwards the weight is borne by the wheel. The practical effect of this arrangement is that in the former position of the lever the wheel is free to revolve, and therefore the holder can slide down through the sleeve; in the latter position the wheel is held against rotation, and there can be no relative motion of the sleeve and the holder. Nevertheless they are free to move together, and advantage is taken of this to establish the arc. As soon as the current circulates in the solenoid the core is drawn strongly upwards. The lever is raised first to the horizontal position, and then above it, carrying with it the sleeve, the carbon-holder, and the carbon, and thus forming the arc. As the carbons consume, the lever gradually falls to the horizontal position, when the smallest additional depression releases the brake wheel, and allows the carbon to feed downwards. The details of the feeding mechanism are shown to a larger scale in Fig. 3.

In a duplex lamp it is necessary that one pair of carbons should remain out of action until the other are consumed. This is attained in this case by making one spur rather longer than the other, so that one carbon feeds when the lever is just above the horizontal line. When this carbon is nearly exhausted, the further descent of the holder is prevented by a stop, and the solenoid core descends until the second holder begins to feed.

Fig. 2 illustrates the electrical connections for a

lamp intended to be used in series, the main circuit being shown in thick lines, and the shunt circuit in fine lines. S is a switch by which the lamp can be cut out, and replaced by a suitable resistance R R. When the circuit is broken, either purposely, or by any accidental cause, such as the sticking of a rack, the main portion of the solenoid M loses its power, and the core falls, closing the circuit across the contacts G and H, which thus form an automatic cut-out. For single lamps, or for lamps arranged parallel, the shunt coil G of the solenoid is omitted or temporarily disconnected. The lamp is regulated by the screw T which varies the tension of the spring by which the core is suspended.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, June 27, 1884.

THE American iron trade shows very little activity as yet, though there are signs of a coming improvement, as a result of the rigid restriction policy which has been followed for months past; consumers are very scarce of stocks, and as the demand for finished products increases, as it must when fall requirements begin to be presented, some more activity must take place. The blast furnaces are making about the usual output, and it is not likely that the capacity in operation will be increased for some months to come. Pig iron of good make is holding its own fairly well, considering the declining tendency in other directions. Good makes of No. 1 iron, bring from 19.50 dols. to 21 dols. per ton; No. 2 from 18.50 dols. to 19 dols., and grey forge, about 18 dols.; foreign irons are very quiet. Some little business has been transacted in German spiegel iron at about 24 dols.; Bessemer is quoted at 19 dols. to 19.50 dols., and a cash offer at less would be accepted. Offers of 75 per cent. ferro-manganese are made at 72.50 dols. The steel rail mills are all busy, making up a good deal of steel for miscellaneous purposes, though they are securing very good orders for rails. Railway building is very slow this season, and buyers are only willing to buy in retail lots, for the work that is being done. The expected drop to 30 dols. for large lots has been made, but it does not have the effect of bringing in new business. Buyers still expect a further drop, and will not place their orders. It is impossible to say where prices of rails will stop. The barbed wire manufacturers have failed to agree to any regular restriction, but each one will reduce his output as he chooses. The demand for wire has fallen off heavily during the past week or two, and should full production be continued, a serious break in prices will take place. The demand for wire rods has fallen off in consequence of the reduced demand for wire, and very little is being done at 46.50 dols. to 47 dols. for future delivery. The bar mills are working along quietly, taking small orders, but with a fair prospect for good business a little later on. The structural and plate mills have been taking more business, and there is a good deal of inquiry for large lots. It is rumoured that an order for 5000 tons of shaped iron for the Brooklyn Elevated Railway has been placed with establishments here; at any rate, the business is to be done, the mills are slowly filling up and prices are about steady at 2.10 to 2.20 for angles, 2.75 for Tees, 2.25 for bridge plates, and 3.50 for beams and channels.

REVERSING ECCENTRICS.

TO THE EDITOR OF ENGINEERING.

SIR,—With reference to Messrs. Matthew Paul and Co.'s communication, accompanied by an illustration, regarding their reversing eccentric, I beg to inform you that I have applied a similar arrangement with much success to the steam cranes and hoisting machinery which I have manufactured during the last three or four years.

Yours truly,

Southwark, S.E., July 8, 1884. HENRY J. COLES.

TO THE EDITOR OF ENGINEERING.

SIR,—Seeing in your last issue that Messrs. Matthew Paul and Co., of Dumbarton, throw a doubt on the efficiency of M. Tripier's reversing and cut-off eccentric, I have no hesitation in saying that M. Tripier's arrangement will make a superior and easier mechanical movement than a pin working in slots placed in an acute angle—practically Dodd's sliding eccentric, as old as the hills.

Although an inventor and patentee of valve gear myself, I do not wish to advertise it here, but simply like to see a bit of fair play.

J. JENSEN.

124, Conway-street, Birkenhead, July 9, 1884.

MECHANICAL EQUIVALENT OF HEAT.

TO THE EDITOR OF ENGINEERING.

SIR,—In my last letter on this subject—published in your issue of July 4—the printer has put the numeral 2 instead of the capital letter Q in the formulæ at the end of it.

If readers will substitute $M+M^1$ for $P+Q$, and $M-M^1$ for $P-Q$, the formulæ will perhaps be more familiar to many.

At the latter part of the letter—in same issue—on "Wind Pressure," for *admed* at, read *arrived at*.

Yours faithfully,

G. PINNINGTON.

23, Chichester-street, Chester, July 5, 1884.

HEALTH AND GASEOUS ILLUMINATION.

TO THE EDITOR OF ENGINEERING.

SIR,—Although agreeing in the main with your admirable and instructive article on "Health and the Electric Light," I think it is only fair to point out that the sanitary evils of coal gaseous illumination are the result of irrational arrangements. If gaseous illumination was carried out as suggested by me in a contemporary some time ago, that is, by recuperation and the conduction of the products of combustion to the outer air in such a way as to aid ventilation, gaseous illumination, instead of being unhealthy, would be hygienically superior to the incandescent electric light, in proportion to the extent it aided in producing ventilation. I may add that impressed with this idea, I invented in 1879 a lamp which I termed the "hygienic lamp," for effecting gaseous combustion, as recommended. The lamp was fully described in your contemporary, the *English Mechanic*, in the early part of 1881.

Yours faithfully,

B. W. THWAITE, F.C.S.

St. Neots, Hunts, July 5, 1884.

MILL ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—Mr. Dixon's letter, in your issue of June 27th, cannot convince me that the question whether steam engines should not, in any case, preferably be regulated by automatic variable expansion, as against throttling, is to be reopened. I fully believe that, in a few particular cases, a throttle valve may be used without much loss of pressure, viz., when the load varies so slightly that the valve is generally full open. But how many mills or factories have such regular work that their engines require so little governing? And, besides, there being now scores of good automatic gears in the market, with which new engines can be provided at a trifling extra cost, why should a purchaser preclude himself from the advantage they offer of working his engines with equal economy and regularity of speed under varying or steady loads? I am inclined to think that the throttle valve, as a means of governing new engines, is dying a slow but certain death. The question of the disappearance of this wasteful appliance from existing, engines appears, however, to call

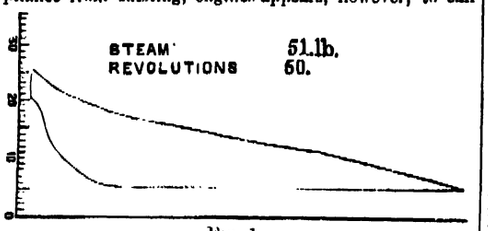


FIG. 1.

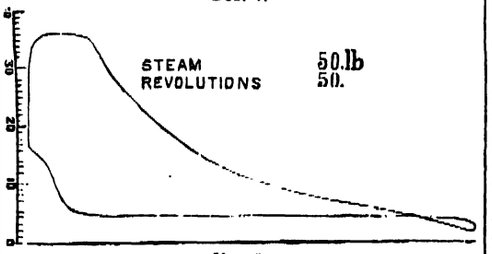


FIG. 2.



FIG. 3.

even more urgently for the attention of steam users, as there are, perhaps, fifty old throttle valve engines at work to every new engine yearly laid down. The process of replacing the former can, of necessity, be only slow, as in most cases it would require such a considerable outlay and interruption of work, that the expense and annoyance would outweigh the anticipated advantages. I think therefore, that Dr. Proell's expansion apparatus, for existing engines, to which you referred in your issue of March 21st, may be considered a step in the right direction, as it places the most economic use of steam within easy reach of every owner of throttling engines. The first installation of this apparatus was made nearly three months ago, at the pianoforte works of Messrs. F. B. Cramer and Co., Kentish Town, and is so arranged that the engine may be run with the throttle valve, or with the precision gear; inclosed I beg to hand you indicator diagrams taken under both conditions. Fig. 1, taken with the throttle valve in action, shows 33 indicated horse-power, using steam at the rate of 30 lb. per horse-power per hour, while Fig. 2, taken a few minutes afterwards, under the action of Proell's gear, indicates 24.5 horse-power, with the consumption of only 21 lb. of steam per horse-power per hour. The practical results are very likely to turn out even more favourable than these theoretical ones, pointing, so far, to a reduction of fuel consumption of 35 per cent. I may add that the regularity of speed which, under the throttle arrangement, varied from 46 to 60 revolutions per minute, is now kept by the Proell apparatus at an absolutely steady level of 50. It may be said that the diagram Fig. 1 certainly left much room for improvement, but on the other hand it should be pointed out that the striking improvement, as illustrated by the second diagram, has been attained without touching the old engine at all, but simply by dropping Proell's apparatus in the place of the throttle valve, and connecting it with an existing pump-eccentric and a bell, an operation which it took only one afternoon to finish. In fact, neither the valve chest nor the cylinder have ever been opened for the purpose of applying Proell's gear. The diagrams on card Fig. 3, taken at the starting of the engine, represent the first four consecutive strokes, and it will be observed how quickly the automatic action of the governor on the cut-off takes place. I shall be very glad, on appointment, to show the engine with this gear to any of your readers interested in the matter, and to take indicator diagrams similar to the inclosed in their presence.

Yours faithfully,

HERMANN KUHNE.

34, Great St. Helen's, London, E.C., July 2, 1884.

TO THE EDITOR OF ENGINEERING.

SIR,—Replying to Mr. John Ashworth's letter in your last issue, I have applied the condemned valve gear to the engines at Cobden Mill, Ramsbottom, and at the Bury Commercial Company's weaving shed, Fernhill, Bury, besides the engines you notice, and others.

All these engines are capable of working within 3 lb. to 5 lb. of the boiler pressure, and give steady turning. The engine at Fernhill, Bury, has a separate boiler, and is working economically. The particulars of its performance Mr. Ashworth can obtain on inquiry.

I do not wish to be understood to condemn the Corliss gear, which I consider to be one of the best in the market, and I should never think of recommending a hand-gear where the load was variable. The engines you illustrated, however, replaced a pair of Corliss engines made by a well-known Manchester firm about ten years ago, but they were subject to frequent breakdowns, and it was finally decided to replace them. The best form of valve gear to adopt with any particular engine must depend upon the size, speed, and type of engine, and cannot be decided off-hand as your correspondent seems to think.

Yours truly,

WILLIAM SHARPLES,

July 9, 1884. Per GEORGE DIXON, Manager.

GREAT NORTHERN TELEGRAPH COMPANY.—The number of telegrams forwarded by this company in the first five months of this year, was 474,179, as compared with 472,885 in the corresponding period of 1883. The revenue acquired by the company in the first five months of this year was 106,560*l.*, as compared with 100,351*l.* in the corresponding period of 1883.

PORT ADELAIDE.—The South Australian Marine Board, in sending out a recently prepared chart of the Port Adelaide river, inform the public "that on completion of the operations on which two (and there will shortly be three) large dredgers are now engaged, the channels between the lighthouse and the inner harbour will not be less than 250 ft. wide, and 20 ft. deep at ordinary low-water springs, or about 28 ft. 3 in. at ordinary high-water springs. Other navigable parts of the river will be, and in fact are now, both wider and deeper. The depth in the harbour will be not less than 22 ft. at low water, or about 30 ft. 3 in. at high water, for a width of from 300 ft. to 500 ft., which, however, is not the full width of the harbour. Wharfage accommodation may at present be found for vessels drawing 24 ft. The lowest tide recorded during March was 18 ft. 6 in., the highest 26 ft. 9 in., and fifty-eight observations at high-water gave from 22 ft. to 27 ft. It may, therefore, be said that, apart from the improvements effected from day to day, ship-masters may find, in the shallowest part of the channel, twice in every twenty-four hours, a depth of from 22 ft. to 27 ft.; and in many places a much greater depth."

THE WESTINGHOUSE BRAKE.—In reply to inquiries respecting the details of the railway accident which lately took place near Chicago, Mr. Joseph Wood, superintendent of the Pittsburgh, Fort Wayne, and Chicago Railroad, gives the following information: "The facts in the case are as follows: The train consisted of an engine, one baggage and three sleeping cars, weighing about 190 tons. At the time of the accident, the train was on a descending gradient of 1 in 125, and was going at a speed of from forty to forty-five miles per hour. After leaving the rails, the engine went partly down an embankment taking with it the baggage and the first sleeping car, and stopping at a point 240 ft. from the point of derailment, the other two sleeping cars remained on the road-bed; the rear end of the rear car being 75 ft. ahead of the point of derailment, showing that from the time of the application of the brakes (when the engine was derailed and broken loose from the tender) to the point of stopping of these cars, they had gone a distance of 370 ft. These facts so strongly emphasise the efficiency of the brake, that further words seem unnecessary. I may had, however, that none of the passengers were injured sufficiently to delay their journey."

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We beg to announce that we have appointed the firm of John Wiley's Sons, 15, Astor Place, New York, the sole agents for ENGINEERING in the United States, and all subscriptions for the United States will in future be payable to them. They will also be prepared to receive advertisements for ENGINEERING, and will afford full information as to terms, &c., on application.

The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

ENGINEERING.

FRIDAY, JULY 11, 1884.

THE AMALGAMATED SOCIETY OF ENGINEERS.

THE thirty-third annual report of the Engineers' Society contains much that is deserving of attentive study. In his opening remarks the secretary says: "1883 has been to us, on the whole, a good year. The year opened hopefully and well in nearly every department of our trade, and three-fourths of its course continued bright and prosperous." He then refers to the unusual activity in the shipping trades and to its almost sudden collapse. This great change in the condition of shipbuilding caused a partial depression in the engineering trades, the effects being felt as early as July, when the numbers out of work nearly doubled those of the month of May. As regards exports of machinery, 1883 was the best year ever known in the engineering trades. Taking the year 1872 as the standard of good trade, the exports of machinery for that year amounted to 10,019,929*l.*; in 1882 they rose to 11,962,660*l.*; while last year they reached a total of 13,443,584*l.*, an increase of 1,480,924*l.* over the previous best year on record for engineering productions. The home trade was almost equally good; and, as a consequence, the wages of engineers increased from 5 to 10 per cent. in various parts of the country. Statistics of the exports are given in the report, and also the quantities exported to each country, according to Government returns; the increase during the last three years applies to machinery and millwork of all kinds, under the two general heads into which these exports are divided in the Board of Trade returns.

The annual report for the year ending December 31, 1883, consists of 382 pages, and 24 pages of introductory matter, general tables, and summaries. The branch reports occupy 269 pages, and 20 additional pages are devoted to an abstract of their accounts. The total number of branches at the end of the year was 424, being a net increase of four during the year. Two of the new branches are in the United States and one in Melbourne, Australia. The geographical distribution of these 424 branches is as follows: In England, 305; Scotland, 41; Ireland, 14; United States, 41; Australia, 10; Canada, 6; New Zealand, 3; Queensland, 1; India, 1; Malta, 1; and France, 1. The branch which for a long time existed in Turkey, at Galata, is closed. The total number of members is now 50,418, a net gain during the year, after allowing for deaths and exclusions, of 2030. The total number at the close of 1882 was 48,388. The total number of admissions was 4265; and of exclusions 1431; the former were fewer than in 1882, while the latter show a slight increase; nevertheless there has been a substantial gain, on the whole, in 1883.

The total income for the year was 134,649*l.* 2*s.* 5*d.*; being the second highest amount recorded in the history of the Society. The highest amount was reached in 1879, which was also the highest as regards expenditure; extra levies being made to meet the enormous outlay then entailed by out-of-work payments to members on the funds. The levies in 1883 were also rather numerous, amounting in the aggregate to 3*s.* 3*d.* per member, besides a weekly trade levy of 3*d.* per member for the last six weeks of the year. The principal sources of income were as follow: Contributions, levies, and fines, 124,504*l.* 12*s.* 10*d.*; entrance fees and proposition money, 4297*l.* 4*s.* 5*d.*; bank interest, 4181*l.* 9*s.* 1*d.*; rules, cards, emblems, reports, lists, &c., 273*l.* 5*s.* 6*d.*; cash refunded from donation, sick, superannuation, contingent, and other benefits; railway fares repaid, benevolent grants, and other payments repaid, 853*l.* 13*s.* Other remittances, surpluses, and receipts, 538*l.* 7*s.* 6*d.* The total receipts show a net increase of 10,241*l.* over 1882. The total expenditure amounted to 124,724*l.* 0*s.* 10*d.*; an increase over 1882 of 22,569*l.* This increase was chiefly due to the Sunderland dispute, and to the decline of trade during the last five or six months of the year. The principal heads of expenditure were, for benefits, as follow:

	£	s.	d.
Sick benefit, including sick stewards and medical certificates ...	27,448	15	1
Superannuation benefit ...	28,496	6	7
Funerals—members and their wives	8,620	0	0
Accident benefit	1,500	0	0
Out-of-work benefit (donations, &c.)	31,469	14	8
Benevolent grants to distressed members	2,259	9	10
Loss of tools by fire	85	19	9
Contingent benefit (strike pay, &c.)	7,974	16	3
Grants to other trades and Parliamentary Committee ...	397	6	8
Total	108,252	4	10

Sick benefit shows an increase of expenditure over 1882 of 1141*l.*; and over 1881, of 1744; and funeral allowance was 972*l.* more than in the previous year. Superannuation involved a higher expenditure by 2184*l.*, but the increase was less than in 1881. Grants from the benevolent fund were also higher than in 1882 by 328*l.*; but the expenditure on account of accidents absorbed a less amount than the usual average of the past few years. The expenditure on account of out of work—including railway fares and beds for non-free members—increased by 9275*l.* over 1882. The greatest increase, however, was under the two heads of contingent benefits and grants to our own trade, the former being 2922*l.* more than in 1882, when the total only amounted to 860*l.*; and the latter from 389*l.* in 1882 to 4775*l.* last year. Both of these amounts were mainly due to the Sunderland strike against an excessive number of apprentices, quite a new feature in the engineering trade, at least for a great number of years past. In reference to this strike the report refers to the large number of surplus hands in the trade when employment is at its best. The secretary computes that during the busiest month of the best year in the history of the trade, there were at least about 2000 mechanical engineers idle. And yet, he says, the masters complain that the labour market is understocked with men, and that there are an insufficient number to carry on the work of the country. Acting upon this conclusion the number of apprentices in some shops have been enormously increased, so much so that in many localities the proportion of boys to men is such that the future outlook for middle-aged and elderly men is rather dismal. "For thirty years," he continues, "our trade has been open to all comers. Other trades have kept down the number of apprentices by a severely restrictive policy. As a result, those who were shut out from other trades have rushed into ours. The Sunderland strike is an attempt to remedy a state of things which we believe to be unjust in itself and dangerous to our interests as working engineers."

The expenditure on account of management may be summarised thus:

Salaries:	£	s.	d.
424 branch secretaries, and general secretary and assistants, and district offices	3,320	6	1
424 branch treasurers, and auditors of branch and general office accounts	1,386	8	4
Other branch officers and committees	1,749	0	1
Central and local district committees	869	16	8
Local council meetings	410	7	0
Delegations and lost time, &c. ...	403	7	2
Banking expenses...	433	0	10
Rents, club rooms, general and district offices, &c.	1,679	4	1
Fuel, gas, rates and taxes, insurances, dues, &c.	213	17	3
Printing and stationery including reports, rules, &c....	2,818	5	4
Postages, parcels, telegrams, &c.	729	4	6
Furniture, branch property repairs, and removals	267	0	8
Depreciation of currency, foreign branches, &c.	7	15	0
Law costs and expenses	301	4	6
Total	14,588	17	6
The other expenses included loss by bank failure	11	18	10
Errors and deficiences	65	7	7
Moneys returned, entrance fees, &c.	196	17	2
Other remittances (exclusive of branch remittances)	1,508	10	0
Total	16,371	11	1

An analysis of the relative expenditure shows that the cost for all benefits, grants, &c., was 2*l.* 3*s.* 2½*d.* per member for the year; for salaries of all kinds, and lost time and expenses, 3*s.* 5*d.*; printing, stationery, postage, &c., 1*s.* 5*d.*; rent, fuel, gas rates, &c., 9*d.*; property and repairs, 1½*d.*; total 5*s.* 8*d.* per member per year. All other expenditure 3*d.* per member.

The general office accounts are separately itemised though included in the foregoing totals. The total receipts at the office, including balance, was 4684*l.* 0*s.* 8*d.* The disbursements include cost of 253 council meetings, 410*l.* 7*s.*; 89 district and sub-committee meetings, 189*l.* 10*s.* 1*d.*; secretary's salary, 208*l.*; assistants, 400*l.* 13*s.* 4*d.*; rent, fuel, gas, rates, 164*l.* 9*s.*

The cash balance at the end of the year was 178,125*l.* 7*s.* 10*s.*, or 3*l.* 10*s.* 8*d.* per member. The increase on the year's transactions was 9925*l.* There was also due as arrears the sum of 16,282*l.* 8*s.* 4*d.*, or 6*s.* 6*d.* per member; so that the total assets were, exclusive of branch and office property, stock, &c., 194,407*l.* 16*s.* 2*d.*; total worth about 200,000*l.* The total admissions during the year were 4235, the average age of the new members being 25¾ years. The exclusions numbered 1431, mostly for arrears, but some for misconduct. The death-roll consists

of 667 members, and 322 members' wives. The average age of members at death was 45½ years, and their wives 43 years: the chief causes of death were lung, chest, and heart diseases, and drowning. Hence their support of the Merchant Shipping Bill. About 650 were assisted out of the benevolent fund; and fifteen trades were granted assistance during the year.

The following is a summary of the benefit payments during the last thirty-three years:

	Amounts.	Per Member.
	£	£ s. d.
Donation (out-of-work) benefit	1,099,894	36 10 2¾
Sick pay	495,611	15 5 5
Superannuation allowance	270,516	6 18 4½
Accident benefit ...	40,200	1 6 6¾
Funeral allowance ...	156,403	4 15 5¼
Benevolent grants ...	53,117	1 8 1¾
Assistance to own and other trades ...	53,486	1 10 1½
Total ...	2,169,227	67 14 8¾

A not unworthy record of mutual self-help by a single trade.

IRRIGATION IN SOUTH AFRICA.

THE great enemy of the South African colonist is drought. He lives on a soil capable of producing enormous crops and of supporting endless flocks of sheep, and yet every few years his crops fail, fresh vegetables rise to prices unheard of even in Covent Garden, and his sheep die by hundreds and thousands. In fact he lives by and on the rainfall, and a record of its amount is a fair index of his material condition; when it is abundant his wealth increases, his herds multiply, and he enjoys all the benefits of a teeming vegetation; when it is scanty his sheep have to be driven far to seek for pasturage, his fields yield a poor return, and his life is one of labour without recompense; while, if it fail, as unfortunately it often does, ruin comes and takes up its lodging with him. Unfortunately the first picture, that of abundant rain, is very seldom realised, the climate, like most other climates, having a tendency to develop in the least pleasant direction. This fact is shown by the steady importation of cereals into the colony, which amounted in 1882 to 434,800*l.*, and in 1883 to 489,800*l.* Indeed an inspection of the list of imports dispels at once the popular idea that a colonist is a man who, if he have but little money in his pocket, is at least surrounded with a rude plenty, in which all kinds of farm and dairy produce are most abundant. Last year there were imported, butter to the value of 94,000*l.*, cheese to 37,000*l.*, lard to 16,000*l.*, salted meats to 39,000*l.*, and rice to 54,000*l.*, every one of which articles ought to have been grown or manufactured in the country itself, and doubtless would have been, if experience did not deter the farmer from investing in stock dependent for its existence upon a plentiful water supply.

The exports of the colony for 1883 amounted to 4,229,000*l.*, of which wool represented 1,992,000*l.*, ostrich feathers (the trade in which has been on the decline for the last three years) 931,380*l.*, and copper ore 454,113*l.* Thus it is shown that sheep farming is the staple industry, the reason being that it is better able to live through a period of drought than agriculture. The Dutch settlers, who early made their home in this country, were not famed for either industry or intelligence, and they found the care of sheep peculiarly suited to their disposition, as the flocks could be confided to native servants, who drive them afield for pasture during the day, and back to the kraal for security at night. With tolerable luck they were able to get a fair living, of the sort it was, with little exertion, and were content. And the English settlers who followed, naturally copied the ways of those whom they found on the spot, the result being that a colony, which has been established for years, cannot to-day feed its own people.

And yet there are drier climates than South Africa which produce enormous harvests. The sands of the Egyptian deserts, and millions of acres of the black loam of India are made exuberantly prolific by the simple application of water raised by the patient Hindoos and much enduring Fellaheen by aid of primitive appliances, which have descended to them through a long line of generations. In Algeria the French have reclaimed whole tracts, and even in the desert itself they have created similar oases as resting-places for the caravans. And now the South African colonists are asking themselves if something of the same kind cannot be done by them, so that they may avail themselves of the rich soil, and ardent sunlight which are so abundant in their land. The country has progressed by leaps and bounds of late, and material prosperity undreamt of ten years ago, is to be seen in all parts. Railways have been made, harbours constructed, roads cut, and town water works constructed in many parts. The Kimberley diamond fields have been the means of bringing large sums of money into the colony, while the frequent wars have caused a great circulation of currency in parts where before the system of exchange was mostly barter. For years the more advanced party have been hammering at the doors of the Government to obtain official aid in exploiting the resources of the colony, and breaking down the dull monotony of its wool culture. They ask a department which shall take charge of agriculture and irrigation, and shall lend its aid and countenance to all schemes for the introduction of new animals and products. They have got an Irrigation Act, but its administration is so shackled by red tape and officialism, that it is of but little avail, and has not been taken much advantage of. Seeing that effectual Government assistance is not forthcoming, a scheme has been floated to undertake a piece of irrigation work by private enterprise on the Oliphant's River, Clanwilliam District, where a moderate outly may be confidently expected to give a most abundant return.

The area has been very carefully chosen to secure a successful result, and the idea of increasing its natural facilities by the aid of art is not new, as ten years ago the capabilities of the Oliphant's River for navigation and irrigation was reported on. Last year one of the Government surveyors was sent, in answer to a petition from the inhabitants, and after a careful investigation he made a lengthy report to the hydraulic engineer of the Crown Lands. From this report we gather the following particulars. The drainage area of the Oliphant's River is approximately 21,000 square miles, and it flows between banks which are unequalled for fertility anywhere in South Africa, the soil being formed of silt deposited from the flood waters of the Doorn, Troe Troe, and Holle rivers. The deposit is of great depth, and is found in horizontal layers of unequal thickness proportioned to the magnitude and duration of the floods which deposited them. If it be submerged in May or June for twenty-four hours it usually returns to the cultivator one hundredfold. It is related by one of the chief inhabitants that his father once sowed on the delta of the Troe Troe River one quarter of a muid of wheat, and reaped one hundred, and the next year he cut another hundred muids without sowing. The climate is a very dry one, and the region is practically rainless.

Yet with all these advantages the inhabitants are sunk in poverty and wretchedness. In the course of years the river has widened and deepened its bed and now keeps to its channel instead of spreading over the adjacent land. There is abundance of water, but no means of bringing it in contact with the springing seed, and hence thousands of acres of the richest soil in South Africa are lying waste and unproductive, and its nominal cultivators scratch a precarious living on the low-lying patches by the river's bank, which are still below the flood line. A proper irrigation scheme would reclaim a tract of land, which is estimated by Mr. Balfour at 8642 acres, and by others who have gone over the ground, at nearly double that amount. The crops that can be gathered with a regular supply of water are enormous, when the cultivation is carried on with industry and intelligence. In some of the South African towns the presence of German emigrants has transformed the aspect of the market. These people, possessed of no capital but thrift and perseverance, settled along the river banks and commenced market-gardening, raising the water by mechanical means, and in a few years they established a new industry. It is also related that the owner of a two-acre lot of irrigated land at Warrington on the Vaal River, 50 or 60 miles from Kimberley, sold produce to the value of 780*l.* between October 17, 1883, and January 14, 1884, all from the two-acre lot. Of course vegetables and fruit were very dear then at Kimberley, but they were dear because the land was short of water, not because it was deficient in fertility.

It is scarcely to be feared that the present scheme will fail of achievement for want of financial support. The location is well chosen and contains all the elements required to secure success, unless it be energy in the inhabitants. These poor people have been waiting and watching since 1871, like so many Micawbers, for another flood to turn up and enrich their land, and in the mean time capita and hope have alike disappeared. The undertakers of the irrigation works must enter upon their business in a broad spirit, and not only render the land fertile but see that its fertility is made available to the higest degree. Agriculture carried on under the most favourable conditions has a tendency to become rude, and to neglect the aids of science. Land which "laughs into a harvest" produces an easy-going disposition in the farmer, who satisfies himself with half what might be obtained. In a local affair this is no great harm; where peace and plenty reign, men may be well excused from being well contented with their lot. But the present scheme is in its essence colonial; upon its success or failure will depend many others of a like nature, which will not only add to the revenue of the country, but will also bring into it considerable capital from the outside. It is not sufficient that it should not be a failure; it could scarcely be that under the favourable conditions in which it is situated, but it must also be a great success in order that other districts less happily situated may be encouraged to follow the example. Affairs at the Cape are at this moment under a cloud; the inflation produced by the war expenditure has been followed by its natural reaction, the diamond mines give signs of being exhausted, traders are drawing in their operations, and are watching the course of events. At such a time a scheme for increasing the natural resources of the country is most welcome, and will receive not only the warm approval of the most enlightened and far-seeing of the inhabitants, but also the material support of capitalists in this country.

THE WEATHER OF JUNE, 1884.

THE weather of June has been delightful for holiday makers, if not altogether pleasing to agriculturists. The latter would no doubt have liked a little more rain. However, the temperature was about 2 deg. below the normal, though the atmosphere was more than usually clear. Referring to extreme positions of the British Isles, to which the Isle of Man is central, the mean atmospheric pressure and temperature were as follows:

Positions.	Mean Pressure.	Difference from Normal.	Mean Temperature.	Difference from Normal.
	in.	in.	deg.	deg.
North ..	29.96	above 0.09	50	below 2
South ..	30.06	,, .04	57	,, 2
West ..	30.07	,, .04	56	nil
East ..	30.00	,, .04	55	below 2
Central ..	30.04	,, .09	55	,, 2

The distribution of rain, as regards its frequency and amount, may be roughly inferred from the following results:

Places.	Rainy Days.	Amount.	Difference from Normal.
		in.	in.
Sumburgh	16	1.48	below 0.56
Scilly	14	0.73	,, 1.16
Valencia	12	1.36	,, 2.16
Yarmouth	8	0.33	,, 1.79

The resultant of all the daily general directions of the winds is N.W. by W., the normal being W.S.W. The mean distribution of barometric pressure indicates prevalent north-westerly winds. These winds account for the little rainfall, the clear atmosphere, and the low temperature. In Ireland alone was the temperature seasonable. The lowest temperature, 33 deg., occurred at Loughborough on the 1st, the highest, 84 deg., at Bawtry on the 28th. Thunderstorms occurred in England on the 5th, 6th, 7th, 8th, and 29th. At Jersey 1.2 in. of rain was measured on the 2nd, and at the same isle 1.1 in. on the 29th. Atmospheric pressure was as low as 29.5 in. on the 2nd, and attained 30.5 in. on the 15th.

The rain which fell between the 5th and 12th must have been very beneficial to the country after the drought, which threatened to be a serious drawback to vegetation. Wheat promises well, but other crops have suffered from lack of moisture.

On the 5th, 8 A.M., a shallow barometric depression passed over the Skager Rack, north-westerly from the Baltic. Thence it continued its westerly progress, arrived near the Shetlands on the 6th, 8 A.M., and passed through the Pentland Frith

during the morning. This is noticed on account of the unusual direction of progression. From the 11th to the 16th the weather was rainy in the north of Scotland, fine and dry elsewhere. From the 16th to the 23rd the weather continued fine and warm in the south-west of England, but became cloudy and cool in the other districts. From the 23rd to the 30th the weather in Ireland was cloudy, in Great Britain fine and bright, with thunderstorms locally in England.

Clear weather prevailed from five days in the north to fourteen in the east, and overcast from five in the south to eighteen in the north. The duration of bright sunshine, estimated in percentage of its possible duration, for the five weeks ending June 30th, was 36 for these islands generally, the Channel Isles had as much as 56, south-west England 45, east England 41, north-west England 37, south England 35, west Scotland 34, east Scotland, north-east and central England, and South Ireland 32, north Scotland 29, north Ireland only 26.

THE HEALTH EXHIBITION.

EDUCATIONAL EXHIBITS.—No. I.

IT was a happy idea of the organisers of the Health Exhibition, to add to it an Educational Section, to bring together methods and results, text-books, furniture, and the appliances that form part of the complex machinery of education. The general public may thus see and evaluate the energy, talent, and skill that are rightly lavished upon the young, whilst the professional teacher is offered a golden opportunity for the comparative study of the work of other educationists and nations, from which he must needs gather many valuable suggestions.

It is, however, a matter of regret that an exhibition of such intrinsic importance should have been organised on so small a scale. We know that numbers of applications have been declined for want of space, and it is evident that some of the exhibiting bodies are unable to adequately show the sequence and proper development of their methods, than which nothing would be more useful to those whose duty it is to direct the educational interests of the country. Besides, this incomplete collection must prevent, for years to come, the possibility of a successful scholastic exhibition on a fitting scale.

The only foreign Governments that have accepted the invitation to exhibit are France and Belgium. To these should be added the wide-spread Society of the Christian Brothers who, at the request of the Executive Council, have got together at South Kensington, a collective exhibit of the highest value, representing their system of instruction and the working of their methods in France, Belgium, the United States, Canada, Spain, Italy, Egypt, and India.

The collection exhibited by this useful and energetic body is arranged in the French section of the Technical Institute. Ascending the grand staircase the visitor finds a picturesque display of freehand and architectural drawings, and a large statistical map showing the geographical distribution of the Christian Brothers, and he cannot fail to be struck with the systematic arrangement of the whole, the devices adopted to economise space, and the varied character of the exhibits, which come not only from the elementary, but also from the collegiate, technical, and agricultural schools conducted by the Brotherhood.

A short examination of the works and appliances for the teaching of geography is sufficient to confirm the remarks made in a recent number of *Nature*, as to the rational and efficient manner in which geography — political, mathematical, and physical — is taught in the Brothers' schools. The method appears to us eminently calculated to give correct notions of the real configuration of the earth's surface. The pupils are first familiarised with a small model representing mountains, hills, valleys, watersheds, &c., all inclosed by four vertical plates of glass, forming a watertight compartment. When this little vessel is nearly filled with milk of lime, the tops only of the highest peaks are visible above the surface of the opalescent liquid. The boy is then made observe that the water-line forms a continuous and closed curve, and thus he has the first idea of a contour line. By means of a tap some of the liquid is drawn off; other prominences rise accordingly above the new surface, and a second contour line is formed; in a similar way a successive series is obtained having definite, relative numerical values. To the principal lines of these series corresponds a conventional colour, so that when, after these initiatory lessons, the boy looks upon the physical maps on which he finds the same conventional colours, he instinctively judges and correctly estimates the surface condition of the country. He has then the key to the construction of hypsometrical maps.

The merit of having introduced this precise and scientific system of map construction into schools, belongs to Brother Alexis; and the Institute of which he is a member, deserves to be congratulated for having afforded him the time and means necessary to evolve and develop his really excellent system of hypsometrical maps. The result of this excellent teaching is evident in the albums of cartographical work sent to the Exhibition. Here again the power of method as an educational lever, is strikingly apparent. The geographical tyro is first required to fill in outline maps and colour them, then to copy specimen maps; and, lastly, when sufficiently advanced, to reproduce them from memory within a given time. The Institute also exhibits several hand-books of geography, and a small but very suggestive treatise on method written by Brother Alexis.

Among other interesting geographical appliances, we should mention (1) various ideal reliefs intended to bring home to the youthful mind the terminology of geography, and (2) small reliefs illustrating the topography of certain places, such as the Côte d' Or, Langres, Quebec, Montreal, &c. With such helps, geography becomes intensely interesting and valuable.

A few steps from the physical wall maps of France and Europe, we find ourselves in presence of a very large number of drawing models, some of which are in plaster, and show the principles of screws, spiral staircases, and arches; others are in wood and illustrate carpentry; whilst there are others in zinc, which are intended as helps to the conception of the penetration of solids. We noticed that those which bear more directly upon technical instruction are provided with the principal sections required for professional demonstration, whilst there are others which are specially constructed to illustrate planes in space, their intersections, and projections.

On the tables, open to the inspection of visitors, is a collection of drawings, the work of pupils, and affording abundant proof of the skill and patience with which this educational body carries out its excellent method. Especially in the portfolios containing some 390 architectural and machine drawings will be found specimens of work well worthy of our best schools. That system indeed deserves commendation which breaks away from the slavish and perfectly useless routine of copying from printed models, and leads the student, by graded steps, to reproduce from actual measurement and in detail, the portal of a church, the plan of a cottage, a Giffard's injector, or a given portion of an engine. We found quite a number of sketches of machinery made by the students when visiting factories and engineering works; and beside these, many of the corresponding designs fully developed. One of the Brothers' technical schools, that of La Salle at Lyons, has sent three albums of sketches of all the machinery used in the establishments for silk weaving. This bespeaks real scientific direction on the one hand, and a very fair degree of proficiency on the other. In our next article we shall conclude our inspection of the contents of this well-stocked room.

A MODERN FLOUR MILL.

VIENNA flour has long been the cook's and confectioner's standard of excellence, beyond which the art of the miller cannot go, and consequently, as wealth has increased and the art of cookery has improved in this country, the imports of flour from Austro-Hungary have risen until they have attained a most serious amount. And, as if this were not sufficiently embarrassing to the English miller, he has had to contend with an opponent in the United States. The rapid extension of wheat-growing on the plains outstripped the milling resources of America, and manufacturers there went to what was considered the best school, to Buda-Pesth, to learn how the abundant products of the Western States could most economically and advantageously be turned into flour. With many failures and much expense the Austrian method was modified to suit the exigencies of American trade, and a steady stream of flour, approaching in quality the Vienna brands, was poured across the Atlantic into this country, where it rapidly met with appreciation and a steady sale. This meant ruin to the old-fashioned English miller, who had been accustomed to supply the neighbourhood in which he lived. The pastrycook and the housewife needed the Austrian flour to be successful in their light and dainty manufacture, while the baker gave the preference to the strong American flour, out of a sack of which he could make several four-pound loaves more than he could from that ground in his own district. Consequently the small miller is becoming extinct. Those in a large way of business, with capital at command, bestirred themselves to adapt their processes to the altered condition of affairs, and with considerable effect. The old plan of feeding the wheat between a pair of millstones, and grinding it until it became flour and clean bran, was definitely abandoned, and in its place some method of "gradual reduction," more or less elaborate, was adopted, and the problem of evolving a new system, which should be neither Austrian nor American in its entirety, but suitable for the English trade, was entered upon. Many experiments had to be made before the correct principles of working were determined, and even now there is considerable diversity of opinion on the subject.

The latest and most efficient development of the English gradual reduction process is seen at the Albert Bridge Mills of Messrs. Marriage, Neave, and Co., Battersea. These mills, which have been running tentatively for some weeks, were formally opened on Wednesday last, when a large company of millers, corn factors, engineers, and others gathered to inspect them and Ransome's dock upon which they are situated. Messrs. Marriage, Neave, and Co. have been active supporters of the recently formed Association of English and Irish Millers, an institution framed to diffuse useful information among a trade, which has suffered in the past from the exclusiveness of its individual members. In pursuance of the more liberal policy which they are seeking to popularise, Messrs. Marriage, Neave, and Co. threw their mill open to the inspection of many of those with whom they maintain a friendly rivalry. While flour is arriving in all our ports, and when the demand is enormously above the production of all the English millers, there is neither room nor excuse for trade jealousies, and Messrs. Marriage feel, and never cease to proclaim, that it is only by co-operation and the freest interchange of information that the home millers can oust the foreigner from the position he has attained in the flour market, and until that has been done they need not seek to guard their individual methods of manufacture.

The Albert Bridge Mills have been erected with the avowed intention of producing flour equal to the best Austrian brands from the same or similar wheat, and distinctly superior to them from the higher class material which is to be obtained in this market, and which does not penetrate into Hungary. They have been erected upon a site which will give the greatest facilities for carriage. It is situated between the Albert and old Battersea bridges, and forms a portion of one side of a new dock lately constructed by Mr. Allen Ransome, of Messrs. Ransome and Co., Stanley Works, Chelsea. The dock has been built to supply the want of waterside premises resulting from the extension of the Embankment along both sides of the river, and converts what was lately a piece of grazing ground into valuable wharfage. The dimensions of its entrance are such as to allow of the passage of sailing barges, and even coasting steamers, indeed of almost any vessel that will be likely to come above bridge, and the bed of the river has been excavated to a corresponding depth. The dock basin is over 100 ft. wide in the widest part, so that the river tugs can turn in it, and at its narrowest part will allow two rows of craft passing each other. The dock wall measures 1500 ft. in length, and the ground around it is of sufficient width to allow of large and extensive premises. Part of it is occupied, as already stated, by the flour mills, and part by the Battersea Foundry, and it is probable that the necessities of the neighbourhood will soon find a use for the remainder.

The new mills have thus the utmost facilities in the way of water carriage. They are built in the Queen Anne style of architecture from the designs of Mr. Frederick Bath, of London and Salisbury, and are divided by interior party walls, without perforations, into three portions, the granary, the wheat-cleaning house, and the mill. In an early issue we hope to give illustrations and detailed descriptions of the building and machinery, and shall

now content ourselves with a general explanation of the salient features of the method of manufacture. The most noticeable characteristic is the perfectly automatic manner in which the processes succeed one another. From the moment the wheat is shot into the bins until the flour falls into the sack, it is entirely untouched by hand, and goes from one machine to another, ascending to the upper floors, and falling to the lower, time after time, without any check or intermission. At every stage there is a reassortment of the products, each going off in its own direction, and flowing to the machine where it is to be next treated. Thus the process is continuous for the time being, and if the raw material were uniform, and only one product were desired, it would be absolutely so.

The wheat-cleaning department occupies a building to itself. The essential condition of high-class flour is that it shall contain nothing but flour. But wheat carries with it much that must be removed before this condition can be attained. It comes mixed with with all manner of other seeds, and covered with dust and dirt. At one end it has a beard, and at the other end a germ, each of which must be removed, and it is not until external cleanliness has been attained, that the actual process of milling can be commenced. At that point the removal of the internal impurities begins. The interior of the wheat berry may be roughly compared to a bunch of grapes bound together, not by stalks, but by cobweb. The grapes are represented by the gluten granules, and the cobweb by the cerealin, and it is in the perfect removal of all the latter, and the most careful assortment of the former, that the plant we are describing differs from others in existence. The process is due to Mr. W. H. Williamson, a member of the firm of Thompson and Williamson, of Wakefield, who manufactured the greator part of the machinery, and it is remarkable for the thoroughness and perfection of the purification.

The whole of the grinding is done by rollers, there being no stones in the building. The wheat is subjected to five breaks, with a smooth pair of stones to straighten out the bran. The rolls for the breaking operation are corrugated, those for the first two breaks leading on with the back edge of the groove, and the subsequent breaks with the sharp edge. The first breakings of the wheat, which are simply divided along the crease, are elevated to scalping reels clothed with plated wire cloth. The small quantity of flour which is unavoidably formed in the breaking is removed, and the broken wheat and the semolina discharged on to a sizer, which assorts the semolina and delivers the broken wheat to the second break rolls. Semolina, it may be explained, is the broken interior of the wheat berry, free from bran, and may be compared, to return to our former illustration, to small clusters of grapes broken away from the main bunch. When still further reduced, and before it actually becomes divided into flour, semolina is called dunst.

After every breaking the same process is carried out, the light particles being removed by aspirators placed above each set of rolls. The wheat is thus reduced to bran, semolina, and a small quantity of flour, the semolina being, of course, the chief product. At this stage the semolina from the different breakings is already divided according to its size, and the next process, that of dividing it according to its specific gravity, is perhaps the most interesting of the whole. This is done on centrifugal purifiers. A vertical rotating shaft carries a number of light iron dishes, one above the other, and each rotating within a fixed conical guide. The semolina is poured on to the first dish and falls in a sheet from its edge, like drops from the edge of a wet umbrella when it is rotated. The heaviest particles are projected the furthest, and are caught in one compartment of the fixed guide, and the lighter particles in a second compartment. This process is repeated several times in the course of each particle through the machine, and the result is that the semolina is divided into two portions differing in specific gravity. At the same time a steady current of air flows over each dish, and carries all the light particles of cerealin still adhering to the semolina, into a central trunk in communication with the offal chamber. In an early issue we hope to illustrate this machine, which is difficult to explain clearly without engravings.

It happens that the heaviest semolina is the best, and consequently the highest class flours are made entirely from that which falls in the outer division. The semolinas are each reduced on smooth rolls, and the resultant flour dusted out. The finer semolinas thus produced are again sized and purified, and after further rolling are dressed in Sutcliffe's centrifugal dressing machines to produce "patent flour." The lighter semolina is subjected to similar processes and gives flour of a lower grade.

The above description is necessarily very incomplete. All that we desire in this article is to give a general description of the process, and to call the attention to the points in which Messrs. Marriage and Co.'s practice differs from that of existing mills. The building has the best facilities for receiving and delivering goods, the process is self-acting, the elimination of detrimental matters, both from the exterior and interior of the wheat being carried to the highest degree of perfection, and above all this the whole process is conducted under the most rigid and complete system of inspection. Every sample of wheat is tested, and is watched all through its progress, so that while the purification is complete there shall be no waste. Under conditions such as these, it is absurd to think that English manufacturers cannot hold their own against all the world, and bring back to the country an industry which would never have left it, if the spirit of Messrs. Marriage, Neave, and Co. had animated the last generation of millers.

BRITISH NAVAL GUNNERY.

(*Continued from page 552 of our last volume*).

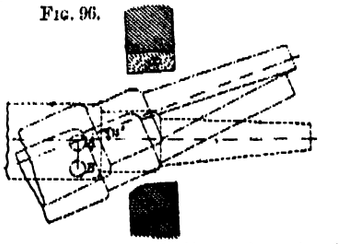
GUNS IN TURRET SHIPS.

Placing the Guns.—In the construction of the ship, care must be taken that the planes on which the turrets work should be horizontal, the ship being upright and in her sea trim. In order to make the working of turrets clear to those who may not have had an opportunity of studying the matter, we will give a short description of how the turrets are fitted. The circular walls, somewhat like the tyre of a wheel, rest on concentric rollers, which work on a circular racer placed on the deck below. Down the centre of the turret, and extending from just below the slides on which the guns work, to a distance far enough below to give sufficient strength, runs a hollow circular shaft which may be taken to correspond with the axle of the wheel. Round this is a framework of iron or steel (representing the nave), and the spokes are a great number of iron or steel stays, somewhat similar to those in a bicycle wheel connecting the circumference of the turret with the centre framework. The outside circumference is toothed at the lower extremities, below the water line, and the turret is rotated by means of one or more pinions working in these teeth, and connected to a steam or hydraulic engine. Arrangements are also made to disconnect the engines and apply manual power when required. The outside circumference of the turret is marked in degrees, just below the upper deck, the graduations being arranged so that when the gun is directed on either beam, the pointer on the deck is opposite the zero mark, and when ahead or astern it shows 90 deg. The starboard side is as a rule marked in green and the port side in red. There are no converging marks on the turrets, the convergence being arranged otherwise, as will be hereafter explained. In the original turret ships, guns were mounted in much the same way as in broadside ships, the only difference being that the slide irons were fixed in the turret, and the training was obtained by moving the whole turret. The more modern ships have the slide irons fixed higher up in the turret, and the carriage proper is abolished, the trunnions resting in boxes which travel along the slide irons, while an elevating bar supports the breech and at the same time gives the necessary elevation or depression.

Size of Ports.—In all turret ships it is of course desirable to have the ports as small as possible in order to make the defence against projectiles more efficient, and since the sighting is all done from the top of the turret, there is no reason for the ports to be larger than is required for the actual working of the gun. We have already said that the slides are fixed, therefore the width of the ports need be only sufficient to allow the muzzle to move up and down. The height of the port is however a very different matter, for owing to the circular shape of the turret the gun cannot be run very far out, and of course the further the trunnions are inside, the greater the height necessary to work the gun in. This is remedied by raising or lowering the trunnions. Thus, when great depression is required, the trunnions are raised up a few feet, and the muzzle, on being depressed, occupies about the same position in the port as when horizontal. In the same way, when the gun is to be elevated the trunnions must be lowered.

In Fig. 96 the dotted lines represent a gun laid

FIG. 96.



horizontal, while the full lines show it elevated through an angle of 15 deg. The position is also indicated when the trunnions are lowered through the distance A B, the gun having still the same elevation, 15 deg. The small space x shows by what amount the port might be made shorter in using this latter arrangement. In the original turret ships, this alteration was effected by means of actually working the trunnions up and down in the carriages, which, as we have said, were comparatively high, but in the more modern ships, such as the Dreadnought, the whole fore part of the slide is raised or lowered. This latter is a much simpler operation. In both cases the height of port is so arranged that the gun, when on the middle or ordinary working step, can be given from about 8 deg. elevation, to 9 deg. depression, which is ample for all ordinary purposes. When lowered to the lower step, the range lies between 4 deg. to 18 deg. elevation, while if raised on the top step, from 4 deg. elevation to 8 deg. depression is the limit. What we have said thus far applies generally to all turret ships, but some consideration is necessary of the two classes: 1. Hand-loading; and, 2, Hydraulic loading, into which turret ships may be divided.

Hand-Loading Turret Ships.—In these ships the working of the gun proper is all done by manual labour, no steam or hydraulic power being used, except to change the gun from step to step. The system is now confined to the smaller and less powerful vessels, such as the Glatton, Prince Albert, &c., some of the larger ones, Devastation, &c., though originally without hydraulic power, having now been altered. In order to show how these guns are worked, it will be as well to follow the process of clearing away and getting the gun ready for firing.

When not in use, the guns are run right in, and so placed entirely inside the turret. With the new guns the length is such that there is not room for the muzzle to come inside the turret, but as these are all fitted to load hydraulically, they do not affect the hand-loading arrangements with which we are now dealing. The gun then is, as we have said, run close back on the slide, and secured in this position by means of chains and struts. The turret is trained so that the muzzles of the guns are forward or aft, and is secured by chains to the deck. The crew for a 12-in. calibre gun consists of the captain of the turret, second captain of the turret, and twenty-one men to each gun. On the bugle sounding for "action," the numbers above eleven clear away the turret, casting off the securing chains, removing the covers on the turret, and clearing away everything on the upper deck which might interfere with the fire of the guns. The other men go inside the turret, and clear away the guns, getting everything ready for loading them, and as soon as all is clear on the upper deck (which is notified by the bugle sounding "advance") the loading is proceeded with. This is done as follows: The powder which has been previously brought up by two men from the magazine, is passed into the turret and placed in the gun by two men standing on either side of the muzzle. It is pushed in at arm's length, and the loading is proceeded with in exactly the same way as previously described for muzzle-loading broadside guns. When loaded, the gun is run out, by two men putting it on the rear rollers by means of a hydraulic pump connected with the eccentrics, and allowing it to run out of its own weight, the slide being inclined for this purpose. From this point the method of working both systems is somewhat similar.

Hydraulic Loading Guns.—These are secured in the same way as those above described, but the fittings for loading are different. In Fig. 97,

which shows the fitting in H.M.S. Dreadnought, A A is the level of the upper deck, the hydraulic rammer V works on the deck below, so that in order to load the gun, the muzzle has to be depressed as shown. The rammer head is covered with sponge cloth, so that it can answer the purpose of both sponge and rammer. A small valve in the head of the rammer (which has a conical recess to take the head of the projectile) is in connexion with the water supply, and is worked by a small

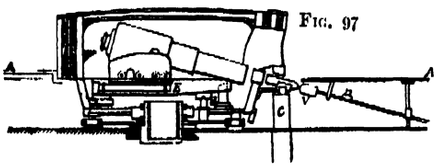


FIG. 97

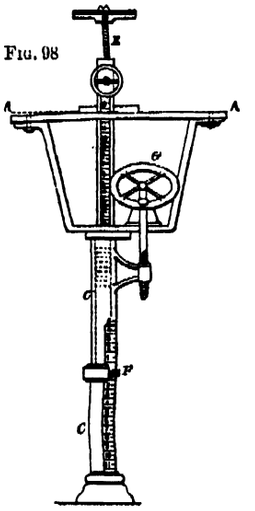
stud. The action is as follows: The sponge being forced home to the bottom of the bore, the stud presses against the metal there and this pressure opens the valve; jets of water immediately spring forth which wash out the bore of the gun. This arrangement is fitted as an extra precaution, and to insure the extinction of any sparks that may have been left in the bore from the previous round. Should any sparks be thus left, and the powder and shell be rammed home, an explosion would follow; and since the muzzle is pointing down directly into the ship, the results of such an explosion would be, as may be imagined, most disastrous. When the shot is being rammed home, the point of it fits into the conical recess above mentioned, and so the stud is not touched. The hydraulic ram mentioned above, is for raising or lowering the fore part of the slide, when extreme depressions or elevations are required; E is the ram for running the gun in or out, and for checking the recoil on firing.

The gear on the upper deck being cleared away and the gun being ready for loading, the latter by means of the elevating wheel, is depressed to the loading position and run up close to the loading trough *f*. The projectile, with the powder above it, having been previously placed on the lift C, is raised by moving a handle until the powder comes opposite the trough, when it is stopped by an automatic arrangement. The powder is then pushed some way into the gun by the rammer, which is then withdrawn. The lift being lowered a little, the automatic arrangement which stopped it, is freed, and pressure being again applied, it rises till the projectile is opposite the muzzle, when it again stops automatically. The projectile and charge are now pushed home together to the bottom of the bore. The rammer is then withdrawn, the shot lift lowered, and the gun elevated and run out into the firing position. This system has two objections; the turret must be always trained to a fixed position for loading, and the muzzle of the gun, pointing as it does down into the ship, opens the door to a tremendous catastrophe should any accident occur when loading. With the introduction of breechloading guns this latter defect will be remedied, as the breech will be the part to be depressed for loading. The fixed loading positions, however, still remain, though ere long we may see even this difficulty overcome, by bringing the loading arrangements inside the turrets, the powder and projectile coming up through the centre shaft, and the rammer being constructed of flexible material to save space. This plan, however, has also its objections, as the powder is more exposed during the process of loading, and an explosion inside the turret would be as bad, if not worse, than firing through the ship's side.

We have carried both systems to the point where they merge into one, that is, readiness for firing; but before proceeding with the latter we must describe the turret sights and other details. In turret ships, as we have before explained, the sights are not on the guns themselves, but on the turret. Every turret has three sets of sights, three hind, and three fore sights. The latter are ordinary fixed sights placed on the front part of the turret and vertically over the trunnions of the guns. The hind sights are placed in the rear part of the turret, one in the centre and one on either side of it, the lines passing through the back and fore sights being vertically parallel to the axis of the guns below. These back sights are constructed as shown in Fig. 98.

A A represents the top of the turret; C is a hollow brass tube, inside which works a hollow bar *d*, and inside this again the steel bar E, the top of which is fitted with a sight and deflection leaf. The bottom of the bar *d* carries a pointer F, which works in a slot in the tube C, the sides of the slot being graduated in degrees subdivided to 10 min. The bar *d* is also graduated in the same way to 13 deg. up, and 5 deg. down, the reading being taken from the top of the tube C. The small steel bar is graduated in yards in the same

FIG. 98



way as the sights of a gun, and has a deflection scale fitted in the same manner. This bar does not work in the hollow bar parallel to its axis, but is inclined to the left slightly, to compensate for the drift of the projectile, as will be hereafter explained. The sights are so placed, that when the upper one E is close down, and the sight *d* at zero, the line passing through the hind and front sights will be in the plane of the racer on which the turret works. The elevating arc of the gun is marked in a similar way, so that when everything is at zero, the lines passing the sights, the axis of the gun, and the plane of the racers, are all parallel to one another.

(To be continued.)

NOTES.

ELECTRO-MAGNETIC INDUCTION.

AT the Physical Society recently Mr. C. V. Boys exhibited the phenomenon first observed by Faraday, in which a copper disc suspended bifilarly between the poles of an electro-magnet, so as to cross the lines of magnetic force at an angle, is suddenly kicked or twisted parallel with the lines of force when the magnet is excited. If the disc be perpendicular to the lines of force it is repelled by a pole when the magnet is made and attracted by the same pole when the magnet is unmade. Mr. Boys has investigated the phenomenon very fully, and points out that it offers a quick and ready means of measuring the intensity of an electro-magnetic field, as well as a means of finding the electric resistance of plates and discs of metal.

NEW STANDING ORDER.

On Wednesday the new standing Order proposed by Sir Bernhard Samuels on May 21, was passed by a majority of ten in the House of Commons. It is in these words: "When a Chamber of Commerce or Agriculture, or other similar body sufficiently representing a particular trade or business in any district to which any Railway Bill relates, petitions against the Bill, alleging that such trade or business will be injuriously affected by the rates and fares proposed to be authorised by the Bill, or is injuriously affected by the rates and fares already authorised by Acts relating to the railway undertaking, it shall be competent to the referees on Private Bills, if they think fit, to admit the petitioners to be heard on such allegation against the Bill or any part thereof, or against the rates and fares authorised by the said Acts or any of them. The provisions of this order relative to rates and fares already authorised, extend to traders and freighters, and to a single trader, in any case where a *locus standi* would have been allowed to them or him if this order had not been made. Nothing in this order shall authorise the referees to entertain any question within the jurisdiction of the Railway Commissioners."

COLOUR-BLINDNESS.

There is every reason to believe that the new apparatus for combining colours, devised by Mr. Offert and by Lord Rayleigh, will lead to a thoroughly scientific investigation of colour-blindness. Considering how common Daltonism is, and how essential it is that railway men and others working with coloured signals should be free from it, or at least know the extent to which they suffer from it, some simple means of investigating it is desirable. Lord Rayleigh's apparatus is based on double refraction, and the obtaining of two overlapping spectra, which the person under examination looks at, and describes as green, blue, or purple, or whatever it appears to his or her sight. Lord Rayleigh has, we believe, tested the vision of numerous friends, and is willing to extend his observations further. So far, he has found that the majority of persons tried require only half as much red in the mixed spectra to turn a given yellow into green as he himself does. People vary from each other in matching colours, and there are grades of "colour-blindness." Ordinary colour-blindness is blindness to red, but the father of Mr. Stanley, the optician, was colour-blind to green. As an engineer, when engaged in colouring plans, he had to single out his green pigments by their names. To him they appeared a kind of brown. Lord Rayleigh has not, we understand, noticed any striking differences between the two eyes of the same person; except what is due to fatigue of one eye and freshness of the other. Dr. Guthrie, who is colour-blind to red, believes himself more than usually sensitive to blue; and Lord Rayleigh has found persons abnormally sensitive to red, as well as abnormally insensitive to it. It would be interesting to discover whether such persons can see further down the red end of the spectrum than is usual. Perhaps the modification of Lord Rayleigh's apparatus, by Mr. Glazebrook, for measuring the distance on the spectrum, which any one can see, will answer this part of the inquiry.

HALL'S EFFECT.

Some experiments on the obscure phenomenon known as Hall's effect, were made last year by Professor Silvanus P. Thompson and Mr. C. Starling, of University College, Bristol. In employing a pear or peg-top shaped electro-magnet with a pointed pole, they found that the equipotential lines in the metal strip, which before magnetisation had crossed the strip at right angles to its edges, were slightly curved round the pointed pole by excitation of the magnet. Subsequent tests of the strip for its resistance, showed that this curving meant a diminution of electric resistance in the strip, produced by the magnetisation. The diminution was observed in strips of tin, gold, &c., but iron showed a slight increase of resistance due to the magnetisation. Professor Thompson, in eliminating thermo-electric effects, did not succeed in getting Hall's effect with the pointed pole, so that his results do not clash with those of Mr. Shellford Bidwell, as mentioned in our recent Note on the subject. The effect he did get was due to a change of resistance in the strip, and though similar to Hall's, inasmuch as points could be found on the strip which gave a current on magnetisation, was not reversible, like Hall's, on reversing the magnetisation. M. A. Leduc has also communicated an interesting paper on the same subject to the French Academy of Sciences. M. Leduc took a plate of bismuth (which as Righi found gives a large effect) and gummed it on glass by Canada balsam. The plate was 0.05 metres long, 0.03 metres wide, and 0.04 millimetres thick. The current was sent through it by means of pincer contacts, and the equipotential points were connected through a Lipmann electrometer. M. Leduc's conclusion is, that if the magnetic intensity does not surpass a certain value, the deviation of the equipotential line and the lines of force at the points where they cut it can be represented by the formula $D = k M (1 - a t)$, where k is the deviation of the equipotential line produced at the temperature 0 deg. at a point where the magnetic intensity is equal to it, and a another constant. For bismuth a is very small; for silver it is from 0.008 to 0.009. M is the magnetic intensity of the field. M. Leduc has also remarked that in silver the Hall effect depends on temperature, and diminishes by .004 of its value for each 1 deg. Cent. It is very feeble in an alloy of bismuth and lead.

A CHEAP STANDARD BATTERY.

Mr. Frank L. Pope, the well-known American electrician, has devised a cheap sulphate of copper

or Daniell battery, which practical electricians may find useful for testing or other purposes. When a large number of cells are required, as for testing submarine cables and land lines, the price of jars becomes a serious item, and Mr. Pope therefore makes his cells of ordinary glass bottles, such as are used for holding sweets and other confections. The bottom is cut off by a lathe or glazier's diamond, or by putting a small quantity of water in a saucer and setting the bottle in it with a little turpentine or other inflammable liquid on the surface of the water, then setting fire to the turpentine, and thus cracking off the bottom at the surface level. The sharp cut edges ought to be filed or ground off by a grindstone. These bottles are inserted in a frame or rack side by side. The rack may be formed of two thin boards run one over the other, the lower having holes cut to admit the necks of the bottles and the upper having larger holes to admit the shoulders of the bottles. A cork is inserted in the neck of each bottle and a stout copper wire runs through it and is bent into a spiral, which fully occupies the shoulder of the bottle. This wire is further bent outside the cell, so as to support the zinc of the next element. Each copper wire is about 3 ft. 3 in. long and No. 10 American gauge. The spiral, of course, forms the negative plate of the cell; and the positive plate is preferably formed of a hollow split cylinder of rolled zinc plate, $\frac{1}{16}$ in. thick and 6½ in. long by 4 in. wide. An upright lug is left on the cylinder and two holes are drilled in it, one above the other, to twist the copper wire into and thus support the zinc. This joint is hammered tight, and may also be soldered; but the zinc is not amalgamated. The cell is started by filling up with soft rain water and dropping in a teaspoonful of pulverised sulphate of copper into the copper spiral at the bottom. The resistance may be lessened and the action hastened, by a tablespoonful of zinc sulphate added to the liquid of each cell. The cells can be made of any size, from that of a quart bottle down to an ounce vial, the other parts being in proportion, and when made small the battery is quite portable.

HULL AND BARNSLEY RAILWAY.

Mr. J. Grierson, general manager of the Great Western Railway, has presented a detailed report to the directors of the Hull and Barnsley Railway Company, as to the position and prospects of that undertaking. Mr. Grierson expresses his opinion that the capacity of the Alexandra Dock, which is being constructed by the company, will be very great, and, he adds, that it is so laid out that the hydraulic power, having been already provided, traffic may be commenced, and carried on with facility by the provision of a portion of the sheds, tips, lines of railway, &c., which will be eventually required, and he, accordingly, recommends that, at present, only two transit sheds, in addition to the one over the west jetty, and two coal tips, with the lines of rails as shown upon a plan which Mr. Abernethy has prepared, should be carried out, leaving the warehouses and other works and conveniences to be added from time to time, as required by the increase of trade. It might, however, Mr. Grierson thinks, be desirable to erect one grain warehouse forthwith, and he suggests for consideration whether one of the south jetties might not advantageously be used for accommodating fish traffic at a comparatively small outlay. As regards the principal stations which it is in contemplation to provide in Hull, Mr. Grierson thinks that a temporary passenger station should be erected on the site where it has been proposed to erect a carriage shed, near Carron-street. By this means a large saving will be effected, and temporary and reasonably convenient accommodation will be afforded, within half a mile of an intended station in Charlotte-street. As to the Victoria Dock Junctions, Railway No. 5 B might, he considers, be safely abandoned; while the construction of Railway No. 5 A might, at all events, be deferred. The provision of workshops cannot, he considers, be long postponed. The works which are in progress for connecting the line with certain collieries, should, Mr. Grierson thinks, be completed, and arrangements should be made for obtaining access to the South Kirkby and Monckton Main Collieries as soon as practicable. The number of engines ordered by the directors appears to Mr. Grierson to be quite sufficient for present requirements, but some further amount of rolling stock will probably be required, when the line is opened throughout. With reference to a proposal to open a portion of the railway between Hull and Howden for local traffic, Mr. Grierson thinks there is no reason why, if considered desirable, this may not be done as soon as station accommodation is provided in Hull; and as a bridge over the Ouse is nearly finished, he thinks it desirable that the directors should also open, as soon as practicable, the section to Hensall, which is the point of junction with the Lancashire and Yorkshire Railway.

THE ABSOLUTE CAPACITY OF A CONDENSER.

At the last meeting of the Physical Society, Mr. R. T. Glazebrook, M.A., F.R.S., of Cambridge University, described some interesting experiments he had made to determine, in absolute measure, the electrical capacity of a condenser sent to him for the purpose by Messrs. Latimer Clark, Muirhead, and Co., the well-known makers. The general method employed by Mr. Glazebrook is that given by Clerk Maxwell in his treatise on "Electricity," vol. ii., § 776. A commutator driven, by a tuning-fork, is fitted to the condenser in such a manner that the plates of the condenser are alternately connected to two points at different electrical potentials, and then put into communication with each other. The condenser and commutator are inserted as one of the arms of a Wheatstone bridge, and Maxwell has shown that if the period of vibration be sufficiently slow, the combination is approximately equivalent to a resistance of $\frac{1}{n\,C}$, where n is the frequency of the tuning-fork, and C the capacity of the condenser. Thus, if a be the resistance of the arm conjugate to the condenser, c and d resistances of two other conjugate arms, we have the condition for a balance $\frac{a}{n\,C} = c\,d$, or $n\,C = \frac{a}{c\,d}$. Thus C can be found if a, c, d, and n be known. Mr. J. J. Thomson has, however, shown ("Phil. Trans.," part iii., 1883) that Maxwell's formula is only approximate, and has given the correct formula. It was this which Mr. Glazebrook used in his tests. The tuning-forks used had frequencies of 16, 32, 64, and 128 to the second, as determined by careful comparison with a clock, by the method of Lord Rayleigh. The corresponding values of the capacity were, in terms of the legal ohm, .3336 mf. (microfarads), .3340 mf., .3335 mf., and .3337 mf.; the mean being .3337 microfarads. The experiments do not show any variation in the capacity, as the time of charging is changed from $\frac{1}{64}$th to $\frac{1}{128}$th of a second. The formula also gives a ready and accurate means of determining the pitch of a tuning-fork, for if the capacity of the condenser used is known, the value of n can be determined. Mr. Glazebrook has successfully used it for this purpose. A question arose at the meeting as to the efficacy of mercury contacts in such experiments, and Dr. W. H. Stone stated that he found mercury and iron contacts to be free from sticking. Whether this is an advantage or not in making a good contact is doubtful. Recent experiments within our knowledge would seem to point to a microphone action in such contacts.

THE PREVENTION OF INCRUSTATION.

THE inventors and manufacturers of compounds for the prevention of incrustation in steam boilers have almost uniformly had to face the opposition of the insurance companies, who object to chemical experiments being carried on in boilers in the integrity of which they have a pecuniary interest. As, however, some reagent is necessary with many kinds of water a few exceptions have been made, soda, either as carbonate, or in the caustic form, being the most generally recommended, although its action is not always very efficacious. We learn that lately the companies whose head-quarters are in Manchester, have been experimenting with a new compound which is offered under the name of Litholine, and that the trials have been so successful that its use is being recommended by several of the principal assurance associations. The new compound has been found to have no corrosive effect either upon the plates or fittings of the boiler, its action being confined to the reduction of the old scale to a crumbling condition, and to the prevention of the formation of any further hard deposit. It is capable of application in two different ways. It may be added to the heated feed-water in tanks, and will then cause the precipitation of the greater part of the lime, chalk, &c., in the form of mud, or it may be injected into the boiler, and the precipitate removed by blowing off from time to time. About one pint of compound per day is sufficient for an ordinary Lancashire boiler working with moderately hard water, the exact quantity being determined by the amount necessary to keep the water sufficiently alkaline to affect litmus paper. The manufacturers, the Litholine Water Purifying and Scale Prevention Company, of 213, Park-road, Oldham, undertake the analysis of feed waters, and vary the composition of their product accordingly. They do not recommend it for every case that comes up, as some water is so heavily charged with mineral matter that nothing but the most extravagant use of this or any other compound, could prevent scale. The composition of the fluid is kept a secret, but a sufficient guarantee that it is both harmless and effectual, is afforded in the approval of such a careful and able investigator as Mr. E. Lavington Fletcher, of the Manchester Steam Users' Association.

ELECTRIC LIGHTING NOTES.

A DEPUTATION from the City Commissioners of Sewers visited Wimbledon on Wednesday, June 18, to see the result of the experiments in electrical street lighting which have been conducted for some months past by Mr. Preece. From these it appears that the most efficient practical mode of distributing light for a main street, like that of Wimbledon, is by means of 50-candle lamps, fixed 20 ft. high, at intervals of 100 ft. Many forms of reflectors have been tried, but the best results have been obtained by a polished nickel-plated iron surface of slightly convex form, and by a dioptric system devised by Mr. Trotter. The effects at Wimbledon were admitted to be remarkably striking, and to furnish a capital example of efficient street lighting.

The Anglo-American Brush Electric Light Corporation has just issued a new priced catalogue in which great prominence is given to the machinery for incandescence lighting manufactured by the company. The "Victoria" dynamo, which is a modified Schuckert machine, is made in various sizes designed to feed from 10 to 1000 lamps of 20-candle power, and a special slow-running type is manufactured for ship lighting, the larger sizes not exceeding 500 revolutions per minute. They are all compound wound, and will supply any number of lights from their full capacity down to one. Improvements have been made in the manufacture of the lamps to secure uniformity and durability, but their life is not stated. A speciality is made of ten-candle lamps.

The steamer Thistle, belonging to the Glasgow and Londonderry Steam Packet Company, has been fitted with the electric light by the Pilsen-Joel Electric Light Company, of London, under the superintendence of Professor Jamieson. The installation includes 41 lamps, each of 20-candle power, distributed over almost the whole of the ship, including the steerage and cattle holds. In all cases the lamps are inclosed in ground glass shades or wire frames, and in the portion of the ship set apart for the first-class passengers, the lamps are fitted both in the saloon and the adjoining state-rooms. There are in all 17 lamps in the saloon circuit; there are ten lamps in the steerage circuit, which includes the engineer's room and chart room on the upper deck adjoining the engine casing. For the cattle holds there are two circuits, so that if goods rather than cattle are being carried, one or both of them can be cut out at pleasure. In each of these circuits there are four lamps. The rest of the lamps—six in number—form the engine-room circuit. The dynamo used is of the Schuckert type, manufactured by the Pilsen-Joel Company. It develops an electromotive force of 102 volts, and supplies each lamps with .66 ampères, or a total of 27.2 ampères for the 41 lamps. The speed required, which has been made low in order to suit ship lighting, is 450 revolutions per minute. The engine, which is direct-driving, is of the Westinghouse type, and has been manufactured by Messrs. Alley and M'Lellan, Glasgow.

NEW SOUTH WALES.—Major-General Scratchley has retired from his position as consulting engineer to the Government of New South Wales. It is understood that Major-General Harding Steward, late of the Royal Engineers, now fills the office.

FRENCH RAILWAY ROLLING STOCK COMPANY.—The accounts of this company for the financial year ending March 31, 1884, show a net profit of 26,312*l*. The dividend for the financial year 1883-4 was fixed at the rate of 8 per cent. per annum, the reserves being carried to 32,640*l*.

CABLE RAILROADS FOR BROOKLYN.—It is reported that 2,000,000 dols. have been subscribed for the formation of a Rapid Transit Cable Railroad Company in Brooklyn, similar to the system now in operation in Chicago and San Francisco. The papers of the new company have been forwarded to the Secretary of State, and upon their return the organisation will be perfected.

IRON HIGHWAY CROSSINGS.—The Boston and Providence Railroad Company has laid down some iron crossings upon trial near the West Roxbury Station, Massachusetts. In the place of planks, which are generally used, but which rapidly wear out and decay, cast-iron plates have been put down. They are about 2 ft. wide, and in length fill up the space between the rails. They are made with blunt projections of 1 in. or 2 in., so as to give horses a firm footing, and the whole plate is slightly convex.

RAILWAY ROLLING STOCK.

STATEMENT OF THE DESCRIPTION, NUMBER, AND COST OF NEW ROLLING STOCK, &c., ACQUIRED BY THE UNDERMENTIONED RAILWAY COMPANIES, YEAR ENDING DECEMBER 31, 1883.

(The average Cost of each Description of Vehicle, &c., where obtainable, is shown in Parenthesis under the Numbers in the Respective Number Columns).

C. Corpse Van.—F. Fish Van.—I. Invalid Carriage.—M. Mail Van.—P. Post Office Van.—R. Road Van Truck.—S. Stores Van.—T. Thirty-ton Double-Bogie Trolley Wagon.

	Locomotive.				Passenger, &c.										Goods, &c.									Total Rolling Stock.	Sundries.						Total Charge to Capital for the Year.
					Carriages.						Horse Boxes.	Carriage Trucks.	Luggage Brake Vans.	Special.		Goods.															
	Tank Engines.	Engines.	Tenders.	—	Saloon.	Composite.	First.	Second.	Third.							Open.	Covered.	Coal and Mineral.	Cattle.	Timber.	Brake Vans.	Special.	—		Machinery and Tools.	Electric Communication.	Fitting Gas to Trains.	Patent Brakes.	Carts, Lurries, Bhittes, &c.	Total Sundries.	
				£											£																
Caledonian	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	911 (61l.)	..	..	..	—	55,813	55,813	..	..	4230	9,377	..	13,607	69,420
Furness	..	..	..	..	..	..	..	..	..	..	..	..	5 (291l.)	..	1,455	75 (75l.)	..	..	..	..	..	..	5,625	7,080	..	..	..	..	..	..	7,080
Glasgow and South-Western	..	..	10 (2495l.)	Gds.	24,950	..	..	..	7 (350l.)	..	..	..	..	C 1 (110l.)	2,564	..	..	..	..	..	..	T 1 (583l.)	583	28,047	..	..	2716	3,304	..	6,020	34,067
Great Eastern	..	..	20	13	49,000	..	19	20	30	121	24	10	72	I 1	85,554	201	17	..	130	23	24	..	33,963	168,537	21,823	..	..	24,597	3,201	49,621	218,158
Great Northern	..	..	14	9	27,291	5	8	18	12	6	..	..	..	..	18,094	475	..	..	40	..	51	..	74,600	92,694	5,736	..	..	2,968	..	8,704	101,398
Great Northern (Ireland)	..	..	1 (2386l.)	1	2,385	..	..	..	..	7 (340l.)	..	..	3 (340l.)	..	3,400	20 (80l.)	16 (95l.)	..	..	..	..	..	3,120	8,905	..	..	..	1,633	..	1,633	10,538
Great Southern and Western	..	..	..	Dec.	..	..	10	Dec. 8	..	..	..	..	..	F 2	..	113	Dec. 18	..	..	..	..	..	..	15,682	..	..	..	..	..	..	15,682
Great Western	..	..	22	26	25,370	..	36	6	Dec. 8	59	..	..	58	..	63,925	443	200	..	100	200	40	..	66,791	156,086	..	..	..	..	..	..	156,086
Lancashire and Yorkshire	..	..	35 (2455l.)	..	85,935	..	20	..	39		..	..	..	..	26,725	12	200	..	..	..	..	..	16,526	129,186	..	..	..	7,853	4,546	12,399	141,585
London, Brighton, and South Coast	..	..	13 (2232l.)	..	29,023	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	29,023	..	1278	..	6,470	..	7,748	36,771
London, Chatham, and Dover	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	R 6	Ac. 243	243	4,421	..	..	..	..	4,421	4,664
London and North-Western	..	..	40 (?)	..	42,657	..	Dec. 15	..	16	61	..	35	..	P 3	35,134	2313	..	..	..	..	..	..	133,793	211,584	..	..	..	..	..	..	211,584
London and South-Western	..	..	31	23	..	..	18	37	13	19	..	10	50	..	..	161	..	..	..	25	..	..	..	171,093	..	..	..	21,724	..	21,724	192,817
London, Tilbury, and Southend	..	..	..	..	..	..	..	6	..	40	..	..	4	..	14,909	..	..	..	..	..	..	..	..	14,909	180	..	..	..	..	180	15,089
Manchester, Sheffield, and Lincolnshire	..	4	15	15	41,940	..	12	..	..	24 (403l.)	..	..	6	..	19,002	128 (87l.)	1	..	..	..	1	..	11,365	72,307	..	..	..	9,497	..	9,497	81,804
Midland	..	..	49	38	111,670	..	9	70	..	69	..	..	3	..	76,148	2787	20	16,144*	145	121	..	..	678,847*	886,865	13,072	..	..	9,526	..	22,598	889,463
North British	..	..	20 (2000l.)	19	40,000	..	..	..	..	..	..	..	..	..	..	412 (55l.)	200 (99l.)	500 (55l.)	25 (92l.)	..	10 (126l.)	..	73,354	113,355	..	..	..	3,468	2,415	5,883	119,238
North-Eastern	..	..	..	..	..	..	16	2	..	66	..	..	1	..	27,504	Dec. 47	30	298	..	..	18	S 1	24,390	51,894	..	..	..	..	..	..	51,894
South-Eastern	..	..	10	..	..	..	..	..	Dec. 2	Dec. 6	..	2	Dec. 1	M 1	..	..	..	..	..	..	..	..	..	19,070	..	..	Est. 2000	Est. 2,000	..	Est. 4,000	23,070
Waterford and Limerick	..	..	3 2 (2500l.)	Sold 2	Cr. 6,130 5,000	1	2	..	..	6	4 (126)	..	..	..	503	..	100 (75l.)	..	..	..	2 (170l.)	..	7,811	13,314	320	..	..	..	..	320	13,634
Totals	..	..	11	272	..	Est. 583,000	6	150 Dec. 15	151	61	473 39	28	57	201	8 Est. 460,000	7093	766	17,853	440	369	146	8	1,182,687	2,225,687	45,552	1278	8946	102,417	10,162	168,355	2,394,042

Automatic Power Brake.

During the year the Lancashire and Yorkshire fitted automatic power brakes to 47 engines at a cost of 2251*l.*, or an average of 48*l.* per engine; and to 633 carriages at a cost of 5600*l.*, or an average of about 8*l.* 17*s.* per carriage.

* Including private wagons taken over from traders 624,645*l.*, at an average of about 39*l.* each wagon.

	£
Cal.—Paid also their proportion of post office vans, added to West Coast Joint Stock	220
G. S. and W.—Paid also their proportion of 25 compos., 10 thirds, and 10 brake vans added to Mid. Scotch Joint Stock	6885
G. E.—Paid also "on account" of carriages, wagons, &c.	8700
L. and N. W.—Paid also their proportion of additional West Coast Joint Stock	3695
N. B.—Paid also their proportion of 25 compos., 10 thirds, and 10 brake vans added to Mid. Scotch Joint Stock	6885

Steamboats.

There was also the undermentioned capital expenditure on steamboats:

	£
Great Eastern, on account	62,416
Great Western, Pembroke	46,051
London, Chatham, and Dover, on account, Invicta	17,151
London and North-Western	83,221
(Cost of Holyhead, lost, 35,817*l.*)	
London, Tilbury, and Southend ferry boats	10,816
Total	219,655

THE ALLEGHENY SUSPENSION BRIDGE.

On Repairing the Cables of the Allegheny Suspension Bridge at Pittsburgh, Pa., U.S.A.

By FRANCIS COLLINGWOOD, M. Inst. C.E.*

THE author was called upon, in August 1883, to examine the suspension bridge across the Allegheny river at Pittsburgh, and to report upon its condition. The bridge had been in constant use since 1861, having been built by the late Mr. John A. Roebling, well known as a designer of this type of bridge. It consists of two full spans of 343 ft. 2 in. in length each, and two half-spans of 179 ft. 1 in. each. The floor is about 41 ft. wide, and is supported on four cables made of iron wire of an average diameter of 0.145 in. The inner cables are 22 ft. between their centres at the lowest point, spreading to 26 ft. at the points of suspension. Each cable contains 2200 wires laid up in seven strands, and measures 7½ in. in diameter. The outer cables are 42 ft. between their centres at the lowest points, reduced to 38 ft. at the point of suspension. Each cable contains 700 wires laid up in two strands, and is 4½ in. in diameter. There are heavy iron parapets at the outer sides of the sidewalks, and a system of long stays to each cable, to stiffen the bridge against vertical oscillations. The serving, or so-called wrapping wire, on the cables measures 0.098 in. in diameter, and is included, of course, twice in the diameter given for the cables.

The strands pass at the anchorages round cast-iron shoes, and the shoes are attached by pins to wrought-iron anchor bars. At each end of the small cables there are three, and at each end of the large cables nine such bars. Those for the large cables are in two sets, so arranged that a rectangle surrounding the strands at the point of attachment is 22 in. square. These bars are the upper set of a series of similar ones, the lowest of which take hold of the anchor plate, and all the bars and the strands (to the clamp to be mentioned) were buried in the masonry of the anchorage.

From the shoes the strands converge for about 12 ft., at which point they are brought to a round form and held in close contact by a heavy iron clamp. From thence they are wrapped throughout, except where they pass over the saddles at the towers. Between the shoes and the the wires in each strand are brought compactly together by a seizing of several turns of annealed wire at intervals of about every 7 in. As originally finished, this unwrapped part of the cable was inclosed in heavy cotton duck, and all interior spaces were filled in solid with hot coal tar, which had been boiled and treated with quicklime to neutralise any acid it might contain.

As an additional precaution, that portion from the clamp 3 ft. back into the masonry, was surrounded by ¼-in. boiler plate tightly clamped on, and coal-tar pitch was poured

* Reproduced by permission from the Transactions of the Institution of Civil Engineers.

around the outer end. The whole cable for 12 ft. back, including the shoes, was then inclosed in brickwork and cement; 6 in. flags were laid in cement over the brickwork, and finally a second set of flags above these to form the sidewalk. Over the side cables, the foundations of the tool-houses took the place of the sidewalks.

Examinations had been repeatedly made at the points where the cables emerged from the masonry to see that the coverings were intact, but no more extended examition had been deemed necessary. The author felt, however, that the responsibility was too grave to allow him to assume that all was sound simply because the exterior appeared so. The sidewalk and flagging were therefore removed from over one end of a large cable, and on cutting through the canvas it was found that the tar had partially disappeared, and that the cavity was nearly full of a dirty, greyish liquid. There was also extensive rusting of the wires, so that the seizing wires, 0.06 in. in diameter, were in many places rusted through, and the cable wires deeply pitted. A second cable end was opened with similar results. A general survey of the bridge was then made, revealing fine cracks in the paint on the cables which admitted moisture, grave defects in the masonry, particularly of one of the piers, and a number of other minor flaws.

A full statement of the facts was thereupon made to the directors, with the recommendation that every cable should be examined throughout and repairs made immediately; also that the cables and other ironwork should be scraped and repainted, all defective stones in the piers replaced by sound ones, the masonry repointed, and that the wrought-iron protecting plates to the pier nosings should be repaired, &c.

Authority was given to the author to proceed with the work at once. As parts of it were entirely novel, it required close personal attention throughout. The first step was to determine how far the damage to the cables extended. One of the openings already made was therefore enlarged, and the boiler plate and wrapping removed, so as to expose the strands back to and around the shoes. It was found that the rust extended outside of the anchorage and under the wrapping. It was then decided to remove every seizing, to cut out a slit about 45 ft. in the bridge floor to where the cable emerged above it, and to remove the clamp and also the wrapping, so far as might be necessary, to discover the full extent of the damage. Accordingly about 10 ft. length of cable was unwrapped, leaving the wires exposed and entirely free for about 22 ft. of their length.

On examination the serious damage to the wires was found to extend about 3 ft. from the anchorage outward. Beyond this there was a little dry rust, but no pitting; and still farther from the anchorage the paint on the interior wires was yet gummy.

The rust seemed to be of two kinds. First, a red oxide, where the wire appeared to have been attacked as if by acid, the so-called fibre being exposed. In some such cases the rust had eaten through the exterior in a narrow slit, and had then attacked the interior, leaving a shell only. The second form of rusting was by the formation of a hard blackish substance containing much sulphur, which when scaled off, left a deep pit, as if gouged out by a chisel.

In one cable end eight wires had been eaten entirely through, and one wire or more in each of the others. Referring to the composition of the rust and the liquid found among the strands, the following letter to the author is pertinent. The writer, Professor Otto Wuth, is a practical chemist residing in Pittsburgh, and has been engaged in the manufacture of the various products resulting from the distillation of coal-tar.

"Pittsburgh, Aug. 18, 1883.

"I have carefully examined the specimens of scales you took from the wires of the cables of the suspension bridge, and found them to be a combination of the hydrated peroxide of iron and sulphate of iron. The liquid consisted of a weak solution of carbonate and sulphate of ammonia, coloured by tarry matter, and is almost identical with tar-water from the gas works. The cables, as you stated, were first coated with boiled linseed oil and afterwards with coal-tar. The tar had evidently not been heated long enough and high enough to drive off all the water and the salts of ammonia contained in all coal-tar at the rate of 5 to 7 per cent.

"The action of coal-tar is always alkaline—*very* alkaline—never acid. The reaction of the acids contained, such as carbolic and cresylic, is also alkaline; they do not act like the mineral acids on iron. By heating coal-tar with caustic lime you only convert the carbonate of ammonia into caustic ammonia. Now the action of the coal-tar upon the wires has undoubtedly been this.

"The oils contained in the tar first dissolved the coat of linseed oil; then the sulphuret of ammonia, which is contained in the tar in considerable quantity, acted upon the surface of the iron, converting it into the sulphuret of iron, which again was converted into the sulphate by the oxygen of the air, which could not have been completely excluded. This alternate action of the sulphuret of ammonia and air was continued until the sulphuret was entirely exhausted. The oxidation was further carried on by the atmospheric air in the presence of water and carbonate of ammonia."

How the water came to be where found it is not easy to say. The upper surface of the strands was but 18 in. below the surface of the sidewalk, and exposed to considerable alternations of heat and cold. A cavity was evidently formed by the tar gradually oozing into the surrounding brickwork when exposed to the heat of hot summer days. Air would then slowly percolate to and fro as the masonry changed in temperature, and moisture would probably be condensed, and the water slowly collected. It is possible that part of the sulphur and ammonia accumulated in this way, as they must be constantly present more or less in the atmosphere of such a smoky city as Pittsburgh.

It was evident that the only course to pursue was to cleanse the wires thoroughly. This was at first attempted by the use of solvents such as benzole, kerosene, &c.; but it was impossible to cleanse the interior strands in this way, even by drenching them. Scraping each individual wire was then reluctantly resorted to. After trying various scrapers, none of which worked satisfactorily, one was adopted which proved cheap and effective. A ⅜-in. steel rod had one end flattened and turned up for about ½ in., so as to make with the rod an angle of about 80 deg. A semicircular notch, of about the same diameter as the wire, was then filed in the end, and the edge made sharp, hardened, and tempered. With these, four men could clean about 175 wires in ten hours. To get at the interior strands, wedges were used to force them apart. Whenever a damaged wire was found it was marked by a bit of wire twisted on. All such wires were examined, and if the loss of strength was 10 per cent. or more, it was repaired, otherwise it was passed. It was soon found that the damage was almost entirely confined to the outer two layers of wires in each strand. The seizings around the strands had held the wires so closely in contact that the destructive agent had not penetrated farther.

While this preliminary work was going on, experiments were made to determine the best method of repairing the damaged wires. The only previous work of this kind, so far as known, was that done at Niagara Falls, where, in making the final splice, the two parts of a wire were kept under strain by a bar having a lever pivotted across each end. The shorter arms of these levers were provided with clamps and thumb-screws for taking hold of the ends of the wire to be joined, and gave a lever arm of 2 in. The other arms were 10 in. long. The short lever ends having been clamped to the extremities of the cable wire, one of the long arms was fastened by a wire to some fixed object; to the second long arm a spring balance was attached, and to this a pair of small pulleys and tackle, leading finally to some other fixed object. By this means a definite pull on the balance could be transmitted to the two branches of the cable wire, since the separation of the long arms would draw the short ones towards each other.

The difficulties with this apparatus were, first, that it was not self-contained; secondly, the range of motion being small, it required exact fixing on the wires to insure the ends being in line when the strain was on; thirdly, the room was insufficient for wrapping the splice.

The author devised an apparatus as follows: A stiff square bar 2 ft. 6 in. long had its sides finished smooth; one end was flattened, and to this end a stiff crosshead about 7 in. long was firmly rivetted. One end of the crosshead was provided with a clamp and thumb-screw for holding the wire to be spliced. The other end of the crossbar had a notch for receiving the ring of a heavy spring balance. A second crossbar about 11 in. long was fitted with a long socket near its centre, so as to slide freely on the long bar. One end of the sliding bar had also a clamp and thumb-screw for holding the opposite end of the wire to be spliced. Through the remaining end of the sliding bar was a hole parallel to the main bar of the machine, through which an eye-bolt passed freely. The eye-bolt had a long thread cut upon it, and carried a handwheel with a corresponding internal thread. The hook of the balance passed through the eye of the bolt.

This machine gave plenty of movement for extending the balance, and taking up the slack of the wire, and was very convenient in all contracted places.

According to Mr. Roebling's original notes, an abstract only of which was available, the maximum working strain per wire is 267 lb., of which 109 lb. or 41 per cent., is live load, and 158 lb. or 59 per cent., is dead load. A piece of wire said to be from the original bridge wire was tested, with the undermentioned results: The stretch in this and the following tests was taken on 1 ft. of length by a finely divided vernier gauge, having a multiplying lever, and a second vernier for the finer readings.

Diameter of specimen, 0.144 in.; area, .016286 square inch. The readings were uncertain up to 200 lb. strain, owing to inaccuracy in the adjustment of the gauge.

Strain. lb.	Gauge Reading. ft.	Difference. ft.
200	1.00017	
300	1.00040	0.00023
400	1.00064	0.00024
500	1.00087	0.00023
600	1.00109	0.00022
700	1.00131	0.00022
800	1.00151	0.00020
900	1.00184	0.00033

At 1260 lb. the wire broke with a measured set of 0.013 ft. Diameter at point of rupture, 0.110 in.; strength per square inch at full section, 77,365 lb.

A new splice in a wire when tested gave, under a strain of 300 lb., an addition of 0.018 in. in length by slip and stretch. Now in splicing in a new piece of wire, the final splice must evidently be made under an excess of strain sufficient to compensate for three things; first, for the probable slip in the splice in taking up a working strain; secondly, for the stretch that will occur in the part (about 2 ft. long) contained in the machine while splicing, when it comes under strain; and, thirdly, for the extra strain induced by pulling the wire out from a straight line while splicing. To determine this excess of strain the following calculations were made:

	in.
The slip at the splice is, say	0.0180
Taking 200 lb. as the average strain in a wire with the bridge in use, and 0.00023 ft. as the stretch per 100 lb., the 2 ft. length of wire in the machine will stretch $0.00023 \text{ ft.} \times \frac{200}{100} \times 2 \text{ ft.}$ $\times 12 =$	0.0110
Suppose the wire in splicing to be drawn 4 in. from a straight line at the centre of 20 ft. in length, the additional length required is = ...	0.1332
Total excess of length requisite in making the splice	0.1622

On the supposition that the wrapping around the cables is tight enough to oblige the first 10 ft. length under the wrapping to take up the extra strain, and inasmuch as the wires pass around the shoes and have therefore a double length, the strain would act on about (12 ft. + 10 ft. + 10 ft.) × 2; or, say, 60-ft. length of wire. According to the previous test, to stretch 60 ft. of wire 0.1622 in. a strain would be required equal to

$$\frac{0.1622 \text{ in.}}{12} \div \frac{0.00023 \text{ ft.} \times 60 \text{ ft.}}{100} = 98 \text{ lb.}$$

This would give the strain on the balance as 200 + 98, or, say, 300 lb.

A balance with 400 lb. capacity was therefore provided, but on trial it was found that a pull of about 500 lb. was necessary to insure a full strain in the wire after the completion of the splice. The reasons for this seemed to be, first, that the stretch did not probably reach so far as 10 ft. under the wrapping; secondly, the friction in passing around the shoe had not been taken into account; thirdly, the wires were frequently partially bound by other wires, and the final splice was nearer one end of the free wire than 10 ft.

Another element of uncertainty was the constantly varying load, as the traffic on the bridge is very heavy and subject to rapid and extreme fluctuations. Still another practical difficulty was the fact that from loosening the strands and removing the clamps and wrappings, the angle made by the unwrapped strand, with the round cable was removed 10 ft. farther from the shoes and the several cable wires were no longer equally strained.

For these various reasons it became necessary to assume limits of strain, within which differences would be allowed. As the limit of elasticity of the wire was from 800 lb. to 1000 lb., and the extreme working strain 267 lb., it was evident that if the minimum strain per wire was sufficient, the maximum might be largely increased without danger of rupture or inharmonious working. Furthermore, any excess in pull in the sound new wires would tend to relieve the slightly damaged wires which were not to be repaired. This reasoning of course would not apply if carried too far, since an excess of strain introduced into a large number of wires for a considerable length would have changed the curve assumed by the cable.

The minimum fixed upon was 200 lb. per wire, and was insured in the following manner. Each wire, as spliced, was marked by a tag, and once a day all the wires were tested, by applying a spring balance at the centre of their free length, and pulling them out 2 in. from a straight line. Supposing the balance to then mark 8 lb., by the parallelogram of forces the proportion

$\frac{1}{12}$ in. : 10 ft. = 8 lb. : 240 lb. = strain of wire.

This simple test saved all necessity for immediate inspection of each splice.

Two men could repair from eight to ten wires daily, making two splices in each. They soon found that they were able to dispense with the weighing apparatus, and to judge the tension closely enough by feeling.

A simpler tool was then constructed for holding the wire while splicing. It was made of two bars or legs hinged together, and each bent so as to assume a form much like a pair of pin dividers when they are opened wide, and the pin and point are in position for use. A tightening rod, with a head at one end and a thumb-screw on the other, passed through the legs at the knuckles. The lower end of each leg was grooved across on one side; and a wedge key fitted for clamping an end of the wire to be spliced. Most of the splicing was done with this tool; but the one with the balance was best where the space was contracted.

The total number of wires spliced was 484, of which 175 were in one cable end and 107 in another. Care was taken to distribute the splices lengthwise, so as not to interfere with the smooth wrapping of the cable. The splices were made by filing the end of the wire to a flat sloping face of 3 in. length, and so as to reduce the wire at the extremity to about one-third its diameter. The wire was then laid face downwards on an iron anvil, and the convex side nicked for 3½ in. with a tool, having spaces of 0.033 in. to correspond with the diameter of the splicing wire.

After preparing the two ends, they were placed in the machine, the proper strain was applied, and the flat surfaces were brought in contact and tightly clamped by a hand vice on each side of the centre of the splice.

The splicing wire was next tightly wrapped by hand; beginning at the middle of both splice and wrapping wire, and wrapping up to one of the hand vices, then removing this vice to a second and third hold and each time wrapping up to it. The final finish at this end was given by wrapping ¾ in. beyond the filed portion of the wire, and fastening the splicing wire by passing it twice under its own coils. The opposite half splice was finished in the same manner.

The integrity of the splice depends upon the care taken in adjusting the parts accurately to each other, and keeping a constant strain on the splicing wire.

Comparative tests were made of a piece of wire from one of the cables, and of a new splice in the same, and the results are given below.

Diameter of wire = 0.144 in., area = .016286 square inch. The whole wire behaved as follows:

Strain. lb.	Gauge Reading. ft.	Difference. ft.
200	1.000050	
300	1.000290	0.000240
400	1.000535	0.000245
500	1.000785	0.000250
600	1.000995	0.000210
700	1.001265	0.000270
800	1.001540	0.000275

At 1450 lb. the wire broke with a set of 0.0208 ft. on 1 ft. The reduction of area at the point of rupture was 51 per cent. The strength per square inch was 89,015 lb.

The splice from the same piece of wire gave results as follows:

Strain. lb.	Gauge Reading. ft.	Difference. ft.
100	1.000390	
200	1.000615	0.000225
300	1.001280	0.000665
400	1.001785	0.000505
500	1.002335	0.000550
600	1.002740	0.000405
700	1.003190	0.000450
800	1.003475	0.000285
900	1.003655	0.000180

At 1350 lb. the spliced wire broke with a set of .00234 ft. on 1 ft. The rupture occurred in one wire at 2½ in. from the end, or 1 in. from the centre of the splice, and with a large local reduction in area. In making the test the coils of wrapping wire were left slightly loose at the ends to represent a probable case in actual work.

In comparison with the uncut wire the splice shows a strength of 93 per cent. Since the splice at one end of each piece of new wire introduced has been subjected to a strain far above the working strain, and the final splice has resisted a pull of at least 200 lb., it is evident that the greatest possible additional slip would be that arising from the slip at the final splice, due to the difference between a strain of 200 lb. and a maximum strain of 207 lb. As this amount, which is very small, must be distributed over about 60 ft. length of wire it may be neglected.

A piece of new Bessemer steel wire was tested with the following results:

Diameter of wire = 0.147 in., area = 0.01697 square inch.

Strain. lb.	Gauge Reading. ft.	Difference. ft.
300	1.000725	
400	1.000925	0.000200
500	1.001155	0.000230
600	1.001500	0.000345
700	1.001625	0.000125
800	1.001855	0.000230
900	1.002135	0.000280
1000	1.002405	0.000270
1100	1.002740	0.000335
1200	1.003145	0.000405

At 1550 lb. the Bessemer steel wire broke with a set of 0.0243 ft. on 1 ft. The reduction of area at the point of rupture was 47½ per cent. The strength per square inch was 90,442 lb.

The tensile strength of similar sized iron wire is given by the Trenton Iron Company at 91,278 lb. per square inch.

Considering that the old wire was more or less damaged by rust, its uniformity of stretch, large reduction, and close approximation in strength, shows it to be entirely unchanged by use.

All the wires in a cable having been repaired, the first step towards closing it up was to jar it thoroughly with mallets, and to get out all loose rust and dirt, after which it was thoroughly saturated with raw linseed oil. To reach the interior wires with the oil, a chisel bar had to be forced through in every direction until no uncoated wire could be found. Two days afterward a coating of boiled linseed oil was applied, and then the seizings were replaced on the part of the strands not to be wrapped. The most serviceable tool for compacting the wires of a strand to a round form, prior to replacing the seizings, was one devised for the occasion. It consisted of two semicircular pieces of iron hinged together at one end of each, and with the free ends bent radially outward. One of the free ends was left longer than the other, and had a hole slotted radially in it, to allow play for the passage of the screw. The other free end was tapped for the screw. The screw had a thread about 4 in. long, and a stem about 1 ft. long terminating in a T for convenience in turning. A collar between the screw and stem gave a bearing against the slotted end of the clamp. The interior strands, which were hard to get at, were compacted with this clamp with facility.

The work of bringing the strands together again to the round form of the cable, just within the anchorage, was troublesome but not new. The wrapping of that portion outside the anchorage was at first accomplished with the special wrapping machines used when the bridge was built. As it was impossible to employ these at all points, the ordinary serving mallet familiar to sailors was afterwards adopted, as with care it was found that good work could be effected.

The cable was saturated with white lead and oil in advance of the wrapping. Several coats of the same composition were afterwards applied over the wrapping and strands. Wherever direct vision could not be obtained, the aid of a mirror was found necessary to insure a perfect covering.

As it would afterwards have been difficult to paint thoroughly that portion of the strands near to where they converge to a round form, it was considered best to protect them by filling for a space of 2 ft. back from the clamp with paraffin. To do this a dam of putty was made across the cable, and the 2 ft. length was surrounded by canvas, into which melted paraffin was poured until when cold the canvas would hold no more. Changes of temperature have thus far had no effect upon the paraffin as a protection.

Experience having demonstrated the imperative necessity of having all parts of the cable accessible for examination, it was decided to leave tunnel openings around the strands in the anchorages. The bottom of each opening in the masonry was therefore cut so as to drain to an opening in the front wall. The sides were removed to about 6 ft. by 16 ft., and lined with 13 in. brick walls laid in cement mortar, the cable passing freely through the front wall, with space all round for painting. A jacket was afterwards put on each cable to keep out moisture as far as practicable. As the head room was insufficient for brick arches, the side walls were capped by an iron box frame, which was covered by a series of cast-iron plates grated on the upper surface, which surface was at the sidewalk grade. The plates were locked together and cemented, to prevent water from dropping on the cables; and the last plate of the series was provided with lifting rings.

In the alternation of mild and extreme cold weather, water of condensation was found to drip from the plates; to prevent this a light wooden frame has been covered with well-painted canvas and placed in the tunnel in an inclined position over the cable. Cork paint may be hereafter applied to the interior of the tunnels.

The only other point of interest was the method pursued in removing the old paint from the cables preparatory to repainting. The necessity of this was made apparent by the cracks retaining moisture after every shower; as it was reasoned that fresh paint would soon crack in the same lines, and but temporarily cure the evil. Ordinary scrapers were first tried, but were ineffective on account of the gumminess of the paint. This led to the use of cutting tools such as chisels and drawing knives, by which to slice it off. By keeping these sharp, the work was fully trebled in quantity over that at first attainable. The average length of large cable cleansed by one man in a day was above 25 ft

STANDARDS OF LENGTH.

*Standards of Length and their Subdivision.**

By GEORGE M. BOND, Hartford, Conn.

WE are all, no doubt, familiar with the old table of English measures of length beginning "3 barleycorns make one inch." I, for one, can remember having vague ideas in regard to barleycorns in general, and their exact size in particular, though I imagined I knew exactly what constituted an inch. Later in life I began to doubt my knowledge in this respect, having had considerable difficulty in reconciling the differences between two separate inches not exactly alike, one or both evidently not $\frac{1}{36}$ part of a standard yard.

It may be of interest to glance over the history of the gradual development of the modern science of minute measurement; to notice how such crude standards as the human foot or arm, and standards called cubits, fathoms, or the foot made up of "36 barleycorns, round and dry, placed end to end," in the course of time grew into the more exact determinations of scientific research, as shown in the results of the labours of men like Kater, Baily, Bessel, Sheepshanks, Shuckburgh, and Sir George Airy in the great problem of establishing a standard of length from a natural unit. They gave us so closely the relation of the length of a pendulum beating seconds of time to the length of a yard, that it was thought they had determined, beyond further doubt, the means for restoring a lost standard should it become necessary to do so from any cause.

However good these crude standards, such as a barleycorn, a human arm or foot may have been for practical purposes at the time they were adopted, they certainly are in our times, completely out of the question and useless for precise determinations. As all measures derived from them were purely arbitrary, and sanctioned by law, no reference made to any of these sources could be presumed to restore a lost original standard, even such as a common yard-stick, except within a very liberal margin of error. We need not be surprised then to find that there happened such wide ranges of value for a foot as that of the Pythic of 9⅞ in., to that of Geneva of 19 in.

The adoption of an invariable unit as a standard of length, while seemingly only applicable to the refined methods of science, really becomes a necessity in our ordinary workshop practice, as we shall see later.

The arm of King Henry the First, or the barleycorn, though possibly furnishing a standard good enough at that time, would hardly satisfy the requirements of our modern mechanics or tool makers, who work very often within the limit of a thousandth of an inch, and even one-tenth of this apparently minute quantity, with surprising unconcern and no less accuracy.

To the celebrated philosopher and scientist Huyghens, is due the honour of having demonstrated the fact, that the times of the vibrations of pendulums depend entirely upon their length. About the year 1670, his inventive genius conceived the plan of using this fact to establish the length of a standard which should be the unit for measures of length. This he divided into three equal parts, each of about 13 in., calling this third part the "horary foot."

Picard, in 1671, also proposed using the length of a pendulum beating seconds of mean time, which should be adopted as the unit of length, thus endorsing the plan of Huyghens. It was Picard who first measured the arc of the meridian from Paris to Amiens in 1669, deducing from it the value of a degree to be 68.945 miles. Picard was the first to suggest that the diurnal revolution of the earth necessarily affected the times of oscillation of a seconds pendulum, and that it ought to vibrate more rapidly at the poles than at the equator. His experiments at different latitudes, however, failed to confirm this fact, probably owing to the lack of sufficiently accurate apparatus for his work, and it was left to Richer, in the same year, 1671, to prove that at the equator, or 4 deg. 56 min. north, where the observations were made, the difference of the length of a seconds pendulum at that place, as compared with the length at Paris, or 48 deg. 50 min. north, was about a line and a quarter, or nearly one-tenth of an inch.

Cassini, in 1718, proposed a unit which should be $\frac{1}{10^{0}0}$ part of a minute of a degree of a great circle of the earth, and which would be nearly equal to a third part of our yard.*

M. de la Condimine, who had measured a degree at the equator in Peru, in a memoir read before the Academy of Sciences at Paris, advocated the use of a pendulum as the unit of length, proposing that it should beat seconds at the equator, a place least likely to cause prejudice that might follow from national jealousy, were the latitude of any particular place selected.

Talleyrand, in 1790, proposed to the Assembly of France that a commission be appointed to consult with a similar commission from the English Government, to consider the subject of a uniform international system of metrology. He favoured the length of a pendulum as compared with the unit obtained by the subdivision of a quadrant of the earth's meridian, but after a careful consideration of the three plans proposed, the pendulum, a quarter of the equator, and a quadrant of the earth's meridian, they concluded to recommend the latter method.

In 1790, one year before the International Commission had adopted the ten-millionth part of the quadrant, as settling the question of a natural unit for a standard measurement of length, and before any steps had been taken by them in the matter, Thomas Jefferson, then Secretary of State, in obedience to a resolution of Congress calling upon the secretary to propose a plan for establishing a uniformity in the currency, weights, and measures, for the United States, recommended, in his report, a decimal system of metrology, and that the unit be derived from a natural and invariable standard of length.

Jefferson considered that though the globe, or its great circles, might be invariable, the means to be employed to obtain an accurate subdivision of a quadrant, from previous trials, had showed their unreliability, and promised too great a degree of uncertainty; he also objected to the ordinary form of the pendulum as "not without its uncertainties," the length not being possible to be accurately determined, owing to variations in the clockwork mechanism and the barometric and thermometric variations. He recommended the latitude of 45 deg. and a mean temperature of the year at that location.

Instead of using the ordinary pendulum of 39 in., he advised the use of a seconds rod of 5 ft., known as Leslie's pendulum rod.

This was a simple straight bar, without a disc or bob, suspended at one end, and free to swing at that point, its centre of oscillation being at a distance of two-thirds of its length from the point of suspension. It would be one-half longer than the ordinary loaded pendulum.

A rod of this kind, vibrating seconds, is 58.72 in. long.

He proposed that this rod be made of iron, of such a length that at the level of the sea, at a latitude of 45 deg., and with a constant temperature, it should beat seconds of mean time; its length, given exactly, would be 58.72368 in.

Jefferson then proposed dividing this length into five equal parts, calling each part a foot, which would give 11.7449 in. as the length of the new foot. He then divided the foot into ten equal parts, affording a decimal subdivision to correspond with the decimal character of the coinage of the country.

The French Commission, after carefully determining the length of a quadrant of the earth's meridian, and dividing it into ten million equal parts, presented science and the world with the meter as a universal standard to which posterity might ever afterward refer.

Its length, as they computed it, is very nearly the length of the seconds pendulum, or 39..70788 in., or a little more than 3 in. longer than the yard.

This meter, which is an end measure standard, was made of a pure alloy of platinum and irridium, ninety parts of the former to ten of the latter. It is called the "Mètres des Archives," and is kept in the buildings of the International Bureau, at Breteuil, between Paris and Versailles.

Having thus briefly touched upon the history of individual and national efforts to secure a unit for a standard of length, covering a period of about 200 years preceding the legal adoption of our standard yard, it may be interesting to know that just 500 years after the statute of 17th Edward II., A.D., 1324, which enacted that "three barleycorns, round and dry, make an inch, and 12 in. make one foot," it was, by Act of 5th George IV., cap. 74 (1824), that a legal definition of the yard was made, and by it was declared that the yard-bar, made by Bird in 1760, should be the standard beyond any question or doubt.†

* A lecture delivered before the Franklin Institute, February 21, 1884.

* Report on Weights and Measures, by Dr. Alfred B. Taylor, Eighth Annual Session, Pharmaceutical Association, Boston, September 15, 1859.

† This act was introduced into the House of Commons in 1822, but failed to pass the House of Lords. It was again introduced, with modifications, in 1823, but was not passed until June 17, 1824, to go into effect as stated, May 1, 1825. This was however postponed to January 1, 1826.

It may be in place to quote here an abstract of the Act of June 17, 1824, legalising this standard, and which reads as follows :

Section I. Be it enacted . . . that from and after the first day of May, one thousand eight hundred and twenty-five, the straight line or distance between the centres of the two points in the gold studs in the straight brass rod, now in the custody of the clerk of the House of Commons, whereon the words and figures "standard yard 1760" are engraved, shall be and the same is hereby declared to be the extension called a yard ; and that the same straight line or distance between the centres of the said two points in the said gold studs in the said brass rod, the brass being at the temperature of sixty-two degrees by Fahrenheit's thermometer, shall be and is hereby denominated the "imperial standard yard." . . . .

Section III. And whereas it is expedient that the said standard yard, if lost, destroyed, defaced, or otherwise injured, should be restored to the same length by reference to some invariable natural standard ; and whereas it has been ascertained by the commissioners appointed by His Majesty to inquire into the subject of weights and measures, that the yard hereby declared to be the imperial standard yard, when compared with a pendulum vibrating seconds of mean time in the latitude of London in a vacuum at the level of the sea, is in the proportion of thirty-six inches to thirty-nine inches and one thousand three hundred and ninety-three ten thousandth parts of an inch ; be it therefore enacted and declared, that if at any time hereafter the said imperial standard yard shall be lost or shall be in any manner destroyed, defaced, or otherwise injured, it shall and may be restored by making a new standard yard, bearing the same proportion to such pendulum as aforesaid, as the said imperial standard yard bears to such pendulum.

Just ten years afterward, October 16, 1834, occurred the calamity for which the carefully worded text of Section III. was intended to provide ; a contingency certainly most wisely considered. This was the destruction of the standard yard by fire, when both Houses of Parliament were burned.

The bar was recovered, but in a damaged condition, and all hopes of restoring its usefulness were abandoned, when it was found that one of the gold plugs had been melted out. The provisions of the Act now came into service, in order to reproduce the lost standard, and it became necessary to decide whether it could be restored by the use of the method so carefully prescribed.

It had been proved conclusively since the passage of the Act that there were errors in the determination of the specific gravity of the pendulum employed ; the reduction to the sea level had been shown by Dr. Young to have been doubtful, the reduction for the weight of air was also proved erroneous, and Kater showed that sensible errors had been introduced in comparing the length of the pendulum with Shuckburgh's scale, this bar having been compared with Bird's "Standard, 1760," and found to agree closely.

Shuckburgh's scale was marked (0—36 in.), and was made by Troughton, in 1798, and had been compared with the pendulum and with the meter. It may be interesting to know, that as previous to Shuckburgh, all transfers of the yard were made by the use of beam compasses, and comparisons were also made in the same way.

It was not until 1798 that optical instruments were used for this purpose, and Troughton must be credited with having introduced this wonderfully improved manner of dealing with minute measurements, and which afterward, no doubt, led to the discovery of the errors found to have crept in when the relation of the yard to the length of the pendulum was established.

All attempts, therefore, to use the pendulum for the purpose of reproducing the lost standard were abandoned. The next step was to approximate this result by the use of standards then in existence, which had been compared with the original yard.

The bars used for this purpose were :

(*a*) Shuckburgh's scale (0 – 36 in.).
(*b*) Shuckburgh's scale, with Kater's authority.
(*c*) The yard of the Royal Society, constructed by Kater.
(*d*) Two iron bars, marked A_1 and A_2, belonging to the Ordnance Department, and kept in the office of the Trigonometrical Survey.

To Sir Francis Baily was intrusted the work of the restoration of the yard. His death occurred in 1844, before the work was completed. He had then only completed the provisional or preliminary investigations necessary for this most important undertaking.

He had, however, made a great many experiments to determine the proper material for the new standard, and finally decided upon the alloy of which bronze No. 1 was afterwards made. It is still known as Baily's metal. Its composition is copper 16, tin 2½, and zinc 1.

The work was now intrusted to the Rev. R. Sheepshanks. He constructed first, a brass bar as a "working standard." This bar was compared with all the standards considered by him necessary for the purpose, and which were those just mentioned. Taking the average of all the values of each as compared with the brass bar No. 2, as the working standard was designated, and reducing to an assumed value of the original standard yard, he found as the relation of the new yard, brass bar 2=36.00025 in. of the lost imperial standard, taken at 62 deg. Fahr. The brass tubular scale of the Astronomical Society did not appear in the list of bars used as references (see Phil. Trans. 1857, page 661), and the statement that this was the principal authority for the new standard is therefore incorrect.

Bronze 19, as the new yard was designated, or now known as No. 1, was graduated according to this value, in terms of the lost imperial standard. It was found from the comparison of these five standards, and is made, as just stated, of Baily's metal, the dimensions are : length, 38 in., depth, 1 in., width, 1 in. The graduations are upon gold plugs inserted in wells of such a depth as to bring the polished surface of the plugs at a distance from the top, one half the depth of the bar, the plugs being 36 in. apart.

The bar which is now before you is a copy in every respect, except that it has the subdivision of feet besides ; but we have the same material, the same dimensions, and the same conditions in the graduations, while more than all, the distance between the two defining lines, as compared with bronze No. 1, varies less than one hundred thousandth of an inch at 62 deg. Fahr.

This bar was constructed by Professor W. A. Rogers, of Harvard College Observatory, Cambridge, for the Pratt and Whitney Company, of Hartford, Conn., for their use as a final reference standard. It has been compared directly with bronze 11, at the office of the Coast survey, by Professor J. E. Hilgard and Professor Rogers, and allowing for the known relation between bronze 11 and bronze No. 1, its value was found to be within this minute limit, in terms of the imperial yard.

The reason assigned for placing the lines at the centre of the depth of the bar, was that errors arising from flexure were liable to occur ; that is, by the bending of the bar, the distance between the lines becoming less. Having the graduations at the centre was thought would neutralise this effect. We all know that if a beam is supported at the ends and loaded in the middle, the beam is compressed at top, and stretched or extended at the bottom, and if we were to measure between finely drawn lines, before and after the load was applied, we should find that the lines were nearer together when the beam was under strain than when free, measuring, of course, in a straight line, so it was thought that having the lines midway between the top and bottom of the standard bar, this error would be reduced.

Captain Kater was the first to discover the variations due to the flexure of standard bars upon which graduations were traced, and he first proposed a "neutral plane," which would have the effect, within certain limits, of reducing this error to zero. He first located this plane in the centre of the bar, as was done in the case of the imperial yard, but from further investigations he concluded that it was not quite one-third the thickness of the bar below the graduated surface.

He found that the errors from the effect of flexure depended upon the thickness of the bars compared with each other, and when resting upon a surface which is not plane (Phil. Trans. 1830). He also found that this error far exceeds that which would arise from the difference of the length of the arc and its chord under the same circumstances ; so much so, that in a bar an inch thick, with the versed sine, that is the distance at the centre of the bar from the horizontal plane joining the two ends to the curved surface, equal to one hundredth of an inch, the sum of the errors would be nearly one thousandth of an inch in the length of a standard yard. To overcome the objection of a variable result at every position of a standard bar, the number of supports for it has been carefully determined, and in the case of the imperial bronze 1, the number of these supports is eight, and having been decided by Mr. Baily to be necessary, this was adopted for the national standards. The distance between the supports is about 4½ in.

Sir George Airy gave a formula for determining the distance between the supports for any standard bar, in order to neutralise the effect of flexure. It is

$$\frac{\text{Length of the bar,}}{\sqrt{n^2-1}}$$

"n" being the number of supports.

In the bar we now have before us, the conditions under which it was transferred, and also when investigated, was when resting upon two supports, and using the formula just given, the distance between them is about 22 in., the total length being 38 in. You will notice in places the supports a little less than one quarter the length of the bar measured from each end. This gives the surface a certain permanence or equilibrium of position when resting upon any level surface, whether a true plane or not, and if used thus under the same conditions of temperature, the distance between the defining lines remains the same. If we move the supports each nearer the ends, say 1½ in., the surface changes slightly, and the result is to bring the lines at the end nearer together, as we have mentioned before.

According to the report of Professor J. E. Hilgard, Chief United States Coast and Geodetic Survey, in charge of Verification of Standards, in 1877, bronze No. 1 is kept at a very uniform temperature within the walls of the Houses of Parliament, while bronze No. 6, which is the accessible national standard, is preserved in the strong room of the Old Treasury, now No. 7, Old Palace-yard. There is not now any perceptible difference between these two standards.

The Imperial yard is in charge of Dr. Chaney, his official position being warden of the standards.

In order to secure, as far as possible, accurate duplicates of the new standard, four Parliamentary copies were constructed, one of which is kept in the Royal Mint, one is in charge of the Royal Society, one is preserved in the new Westminster Palace, and the other is kept at the Royal Observatory as Greenwich.

There were also forty copies made of Baily's metal for distribution among the different governments, only two of these forty bars are exactly standard at 62 deg. Fahr., these are bronze 19 and bronze 28. Both are kept at the Royal Observatory for reference, as representing the national standards. All the other copies have a certain relation to bronze 1, and instead of giving this relation, the temperature at which they are standard is established for each.

The standards prepared by Mr. Sheepshanks were legalised by Act of Parliament, June 30, 1855, and in 1856 bronze 11, one of the forty copies made of Baily's metal, was presented to the United States Government by the British Board of Trade, and was standard at 61.79 deg. Fahr. This bar is deposited in the office of the United States Coast Survey at Washington. It has since been found that bronze No. 11 is short by 0.000088 of an inch at 62 deg. Fahr. from comparisons made by Professor J. E. Hilgard, in charge of the Bureau of Weights and Measures, United States Coast Survey, who, in 1878, compared it directly with the Imperial yard at the British Standard Office in London, and consequently, to be standard, it must be considered so at 62.25 deg. Fahr.

Previous to 1856, the distance between the 27th and 63rd line of the brass scale made by Troughton, was taken as standard. Though never having been legalised by Act of Congress, it had an indirect authority, as it was adopted by the Treasury Department, and copies of it were made for distribution among the different States under the charge of Mr. Joseph Saxton.

The fact is noticeable that all the copies of the Imperial yard are made of the same material as that of the original bronze 1. This is no doubt owing to the greater uniformity in the coefficient of expansion for each standard bar, admitting of comparisons at any temperature. This would not be possible, except for bars of other metals whose coefficient or rate of change for each degree of temperature was definitely known, and this would make it an exceedingly nice operation.

To illustrate this in a few words. If a steel bar or a platinum standard be compared with one made of brass or Baily's metal, and each were standard only at 62 deg., if we should compare them at 72 deg. we should find them not alike in length, because brass expands more for each degree of rise of temperature than does the steel or the platinum ; the difference would be greater in the comparison of platinum with the brass standard, as steel and brass have a coefficient more nearly alike.

(*To be continued.*)

NOTES FROM THE SOUTH-WEST.

Caerphilly.—A blasting operation of unusual magnitude was conducted at the Pwllypant quarries, Caerphilly, on Monday, by Messrs. Mitchell and Scott, sub-contractors under Messrs. T. Nelson and Co., contractors for the new Bute Dock, Cardiff. The operation took place in the presence of Mr. Farmer, Mr. Simmons (engineer for Messrs. Nelson and Co.), Mr. Kircol (from the Nobel's Explosive Company, Glasgow). The charge, which consisted of 16 cwt. of gunpowder, was deposited in a hole 50 ft. deep. The powder was ignited by Mr. Farmer ; and, after a lapse of twenty minutes, an explosion occurred which displaced an immense head of rock. In rolling down the great height from the top to the bottom of the quarry, the rock was broken into pieces, varying in weight from half a ton to five tons. The quantity of rock brought down by the blast is estimated at 10,000 tons.

Cardiff.—Business in steam coal has continued active. In the fuel market, although no improvement can yet be recorded in prices, a slightly better tone is noticeable. The iron ore market is without alteration. Last week's clearances comprised 148,550 tons of coal, 6453 tons of patent fuel, 200 tons of iron, and 420 tons of coke. From Bilbao there were received 6751 tons of iron ore, and 457 tons came to hand from other sources.

Cribbwr Main Colliery.—The proprietors of this colliery have just succeeded in proving the "Lantern" seam of coal under their taking ; the coal is of good quality, and well suited for manufacturing purposes. The seam is in one solid block, 4 ft. 3 in. thick, with an excellent rock roof, requiring little or no timber. The company is pushing on rapidly with the heading driven to prove the coal, and fully expect to have the workings opened in a few weeks.

The Dowlais Iron Works.—The whole of the mills in the upper works have been again started, as have also the blast furnaces. In the lower works, however, the "Goat mill" and one or two other smaller branches are stopped, the former, it is stated, owing to a breakdown of the machinery. It is calculated that the present supply of water in the old mine pits on the mountain at Pontywaun and elsewhere, is sufficient to keep the works going for about another fortnight.

Working Hours on the Taff Vale.—A mass meeting of train men from all parts of the Taff Vale Railway system, was held at Cardiff on Sunday to consider a letter from the directors reducing the standard hours of labour from 72 to 66 per week. The men wanted a reduction to 60 hours. The directors proposed doing away with the bonuses now paid to drivers. This caused unpleasantness, as the guards and brakesmen gained an advantage at the expense of the drivers. The men accepted the offer of the directors, at the same time deeply regretting that such a condition was imposed on the drivers. A committee was formed to continue the agitation until the standard hours were reduced to 60 per week.

The Avonmouth Dock.—The Coronet s.s. from New York, 1122 tons, and the Paramatta, 1085 tons, arrived at the end of last week, and on the list of vessels to arrive during the next two or three weeks are seven steamers, the aggregate net register tonnage of which is 10,109 tons. Besides these there were several sailing vessels bound for Avonmouth, and expected to arrive during the same period. Among the steamers are no less than four vessels of the Anchor Line. It may be mentioned that there was a slight decrease in the arrivals for June, but this will be more than made up by the July tonnage, which

will show a considerable increase on the corresponding month of last year.

Tasmania and England.—A contract for a proposed direct steam service between Tasmania and London has finally collapsed, Messrs. M'Gregor and Co. declining to make themselves responsible in any way. The Tasmanian Government will endeavour to make another arrangement, probably with two lines of steamers, one of which will be the Orient Company.

Powell Duffryn Coal.—An agreement between the Powell Duffryn Company and the Taff Vale Railway Company came into force on Tuesday. It has not transpired whether the agreement between the Messrs. Nixon and the Taff Vale Railway Company will come into force before the siding which the former are making in the direction of the Aberdare Junction is completed. Two miles of the siding have already been constructed, but it is intended to carry it at least one mile further, on to a point near Pontcynon.

Newport.—Steam coal has presented a slightly better tone. Shipments of iron, &c., have been more active than they were during the week immediately preceding, and show a total of 5000 tons to the following destinations: New York, 3150 tons; Montreal, 200 tons; and Halifax, 1650 tons. The iron ore trade has shown scarcely any change. Last week's coal clearances amounted to 65,583 tons. From Bilbao there were received 6750 tons of iron ore.

Colliery Enterprise.—It is stated that Mr. G. Hoskins and Mr. Rossen have bought the Ebbw Vale and Abersychan Elled Vein Pit, from which there is a good supply of house and steam coal. It will be shipped at Newport.

FOREIGN AND COLONIAL NOTES.

Paris and New York Telegraph Company.—The profit acquired in 1883 by this company (which is an affiliation of the Anglo-American Telegraph Company, Limited) was 83,563*l.* Out of this balance a dividend at the rate of 4 per cent. per annum has been declared for the past year upon the share capital of the company. The present price of the 20*l.* shares in the company is about 7*l.* 10*s.* each.

Water Supply of Dunedin.—A new water main from the Faversham tunnel to Dunedin has been satisfactorily completed, and it is answering expectations formed regarding it. The highest house connected with the supply can now obtain water day and night, and a high-level tank can be filled at night, when the south reservoir is full. The total cost of the undertaking has been 7423*l.*, and the city surveyor has been instructed to take steps to ascertain the cost of further improvements which are contemplated.

France in the East.—A meeting of merchants has been held at Paris, to found a French, Tonquin, and Indo-China Company, to follow up commercially recent successes obtained by French arms. The programme is an ambitious one, as it proposes to create establishments in Tonquin and Cochin-China for trading in merchandise, working lines of railway and steamers, opening mines and quarries by purchase or concession, carrying merchandise, building and working manufactories, and undertaking banking, financial, commercial, industrial, and agricultural operations, in what are regarded as conquered districts.

Lake Albycuta.—It has been determined by the Victorian Lands Department to turn the land usually covered by Lake Albycuta, in the Wimmera district, to practical account. The lake, the area of which is about 30 square miles, is at present nearly dry, and the land, which will no doubt prove very fertile, will be divided into grazing areas. In the licenses which will be issued, the right of all persons to water stock at any water holes remaining, will be reserved.

New South Welsh Railways.—The New South Wales engineer-in-chief for railways has given instructions that the following railway surveys are to be resumed immediately: Naarabri to Walgett, from a point on the Mudgee and Coonamble survey near Mendooran, to Coonabarabran and Walgett, and Nyngan to Cobar and Wilcannia.

Union Pacific Railroad.—The land sales of the Union Pacific Railroad Company continue heavy. From Jan. 1 to May 20, this year, there were sold 1,459,703 acres, realising 3,542,058 dols., an average of 2.46 dols. per acre. Of this enormous aggregate there were sold between May 15 and May 20, 276,143 acres, for 445,510 dols. Nearly all the lands recently sold are in regions hitherto considered barren. The purchasers are in the main cattle ranchers. They propose to develop these so-called worthless lands by establishing large ranches for the breeding of cattle for the markets of the Eastern States. A large share of the lands has been taken by English and Scotch capitalists for similar purposes.

Northern Pacific Railroad.—The gross earnings of the Northern Pacific Railroad Company for April are officially reported at 1,441,514 dols. The working expenses were 598,167 dols., or about 41½ per cent. of the gross earnings, leaving the net earnings at 843,347 dols., against 436,676 dols. in March.

Indian Railways.—The Umritsur and Pathankote Railway was opened for public traffic to Dinanagar, 51 miles, January 1. The line promises to be a valuable feeder to the Scinde, Punjaub, and Delhi system. The remaining portion of the new line to Pathankote, 15 miles, is probably opened by this time. The Rajpoora and Patiala Railway, 16 miles in length, which is under construction by the Scinde, Punjaub, and Delhi Railway Company, is making good progress.

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NUMBER OF APPLICATIONS FOR PATENTS.

	1884	1883	1853
July 1st	63	..	6
,, 2nd	44	10	5
,, 3rd	42	26	—
,, 4th	28	20	6
,, 5th	45	24	8
,, 6th	..	24	10
,, 7th	56	18	6
Total for week	278	126	41
Total from January 1st to July 7th (inclusive) ..	9871	8384	1623

4988. Heating Fluids: H. Defty, London. [6*d.* 6 *Figs.*]—"The most important novel feature of this said invention is the arrangement of fixing both vertical and elongated tubes in a consecutive order, so as to absorb all heat generated by the tubular or annular arrangement of burners to give an intense momentary effect." (October 18, 1883).

5133. Signal Lamps, &c.: J. Rogers, London. [6*d.* 3 *Figs.*]—This refers to the lenses described in Specification 1035 of 1883, wherein a disc of coloured glass was fitted between two lenses of ordinary glass. The signal lamps are [illegible] with two lenses, between which a frame, carrying [illegible] coloured [illegible] arranged to move. Other arrangemen[illegible] are described. (October 30, 1883).

5144. Mounting the Wheels of Railway Carriages, &c.: J. E. S. and E. Thornhill and T. Forknall, Manchester. [6*d.* 3 *Figs.*]—Each wheel is mounted upon a separate axle, each axle being provided with two journals, one on each side of the wheel, and the journals being made smaller than is usual. (October 30, 1883).

5487. Rotary Engines: A. A. W. Van Reede, Dordrecht, Holland. [6*d.* 8 *Figs.*]—A cylindrical block is mounted eccentrically in a cylinder, which in cross-section is in the form of an elongated circle, the width of which is the same as the diameter of the block, and the length is elongated so as to enable the axis and block to rotate, the cylinder having a reciprocating motion in guides in a direction parallel to its shortest dimension (or as shown horizontally). Steam is admitted to the working chamber alternately at the top and bottom by a sliding valve upon the cover, to which a vertical movement is imparted by an eccentric upon the shaft. The exhaust passages are connected to the steam ports through the hollow of the valve, and lead to a similar low-pressure cylinder, from which the steam passes to a condenser. In order to reverse the engine, a screwed sleeve on the main shaft can be rotated by bevel gearing, causing a nut to move longitudinally along the shaft. A projection on the nut engages with a collar on a sleeve, which has a projection passing through a straight slot in a sleeve, on which the eccentric is mounted, and through an inclined slot in the shaft. (November 22, 1883).

5496. Purification of Water: W. Anderson, London. [6*d.* 2 *Figs.*]—The water is caused to pass through a rotating apparatus containing spongy iron, which, by the movement of the apparatus, is kept in agitation. (November 28, 1883).

5507. Mechanically Cooling Air for Preservative and other Purposes: J. J. Coleman, Glasgow. [6*d.* 2 *Figs.*]—The steam, air-compressing, and re-expansion cylinders are all arranged horizontally and in two parallel lines extending from the cranks to the other end of the machine, the steam cylinder being nearest the crank, the compression cylinder next, and the re-expansion cylinder at the further end. The two steam cylinders act together as a compound engine, or either cylinder can be used alone, the crankshaft being in two parts connected by a coupling. A rocking shaft placed below the shaft and working the pumps is connected to a crank-pin on each end of the shaft. (November 24, 1883).

5518. Sculls and Oars: J. O. Spong, London. [6*d.* 8 *Figs.*]—The oars are made in two parts, the adjacent ond being connected to shoes, straps, or supports centred or pivotted on studs carrying toothed wheels or quadrants gearing into each other. The pins or studs are fixed on a plate hung on a pintle or axle supported on the gunwale. The person rowing faces the direction in which the boat is propelled. Means are provided for effecting a mechanical "feathering" of the oar. (November 26, 1883).

5558. Cutting and Dressing Marble, &c.: W. H. Burke, London. (*Puissant frères Merbes le Chateau, Belgium*). [6*d.* 5 *Figs.*]—The block of stone is fixed to a table which can be traversed at variable speeds beneath a series of cutters rotating around a fixed axis, or be held stationary while the rotating cutters are caused to descend, thereby enabling mouldings to be formed. (November 28, 1883).

5602. Working Railway Switches: A. M. Clark, London. (*The Railway Specialty Manufacturing Company, New York, U.S.A.*) [6*d.* 5 *Figs.*]—This relates to means for operating switches which when closed are held in place by a spring so that a train passing through the closed switch is permitted to force it over and so pass on to the main line. The lever for actuating the points is combined with a powerful spring and a moving fulcrum connected to the lever and automatically locked and unlocked, so that when the spring is locked the switch may be moved freely in either direction by a lever, but when set as desired and the lever locked, the spring and movable fulcrum is automatically unlocked, leaving the switch under the control of the spring. (December 1, 1883).

5626. Electro-Telegraphic System, Particularly Applicable for Long Cables: S. Rocs, Turin. [6*d.* 6 *Figs.*]—The transmitter consists of a wheel having conical teeth which engage in holes in a perforated strip (perforated by a Wheatstone or similar perforator). A small lever is applied to the right and left of this wheel, and they serve to establish electric communication every time one of these levers meets with one of the holes in the paper strip whose various combinations represent signals. A clock movement provided with a fly serves to unwind the paper strip and to automatically transmit the signals. The printing mechanism comprises an escapement consisting of two crown wheels, the teeth of one alternating with those of the other, and between which plays the stop piece of the escapement. The flanks of the teeth are straight and the ends are bevelled to cause the stop to oscillate from one wheel to the other. The teeth of one crown wheel correspond with projections on a cam wheel, and the teeth of the other with the recesses; the cam acting on a lever bearing an ink printing wheel, the more or less prolonged stoppage of the stop piece against one crown wheel or the other, serves to regulate the length of the dot and dashes or the blank spaces. The electro-magnetic part of the apparatus consists of a flat thin soft iron blade A capable of oscillating slightly in its own plane on a central pivot *a* and surrounded by a coil of insulated wire B. The blade is held in the axial positions by means of two brass levers *c*, two springs and a stop (Fig. 2). The lower end of the blade plays between the poles of a local electro-magnet E, and this end is attracted to one or the other pole according to the direction of the currents in the coils B and E. The other end of the blade engages with a lever F whose other end forms the stop-piece between the two crown wheels. Normally the blade is retained against one of the poles and the

Fig 1

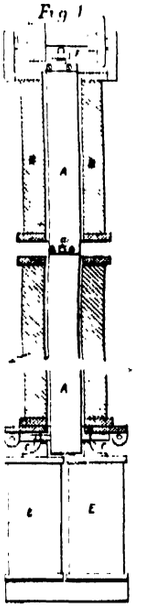
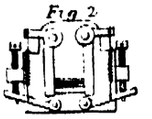


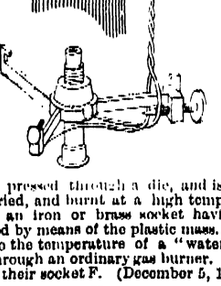
Fig 2.



escapement of the printing mechanism is arrested. If the line current be now reversed or the local circuit be momentarily interrupted or short-circuited, the blade will return to its central position, the printing escapement will be released, and the escapement, acting on the stop lever, will cause the blade to be thrown over to the opposite pole of the local electro-magnet, and the line commutator will at the same time change the direction of the line current and the blade will be retained in this position. At the receiving station the direction of the line current being reversed, the blade will be repelled by the pole to which it adhered, and the printing mechanism be released and the blade thrown over against the other pole of the local magnet and be retained. In order to stop the transmitting station, a reverse current of double intensity is sent from the receiving station to the transmitting station. (December 4, 1883).

5641, Decorticating Rice, Wheat, &c.: J. H. C. Martin, Walthamstow, Essex. [6*d.* 2 *Figs.*]—A stone or emery drum revolves rapidly within a concentric case set at an angle of 45 deg., and which, when perforated, is caused to revolve on fixed ends. The lower end of the case is provided with an outlet aperture and regulating slide and the upper end with an inlet aperture. (December 4, 1883).

5646. Illuminating by Means of the Incandescence of Refractory Substances: W. H. Spence, London. (*O. Fahnehjelm, Stockholm*). [6*d.* 5 *Figs.*]—A finely powdered refractory oxide (such as the oxide of magnesium, calcium, zirconium, or silicon), is mixed with a solution of starch, gum, or other gelatinous substance, and the plastic mass is reduced to the form

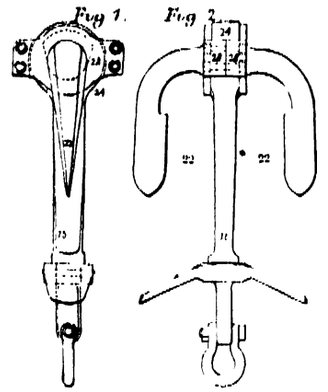


of a wire by being pressed through a die, and is then cut to the desired lengths, dried, and burnt at a high temperature. These wires are fixed in an iron or brass socket having a U shaped section, and secured by means of the plastic mass. These filaments are then exposed to the temperature of a "water gas" flame, the gas being passed through an ordinary gas burner. The illustration shows the wires in their socket F. (December 5, 1883).

5659. Seal Traps for Wash-Basins, &c.: W. P. Thompson, Liverpool. (*A. Edwards, Asbury Park, N.Y., U.S.A.*) [6*d.* 11 *Figs.*]—The trap comprises a body designed to contain a mercury seal chamber, and provided with induction and eduction pipes, a cleaning out opening provided with a suitable stopper, and a sealing tube aligned with the conduction pipe and dipping into the mercury. (December 6, 1883).

5663. Anchors: J. Barton, Glasgow. [6*d.* 20 *Figs.* —Referring to the illustrations, the middle of the fluke piece 22 fits and can turn in a round eye formed in the head 24 of the shank 25, and its movement to either side is limited by a projection on the fluke piece working in a recess in the head 24. The fluke

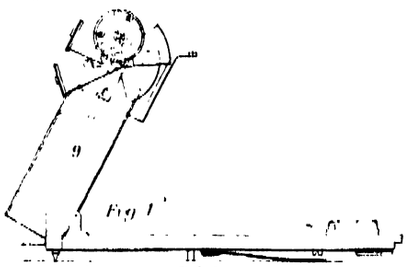
piece is secured by plates 28, which are bolted together so as to move with the fluke piece, and are made with angular inner corners, the other corners being rounded. The fluke arms are

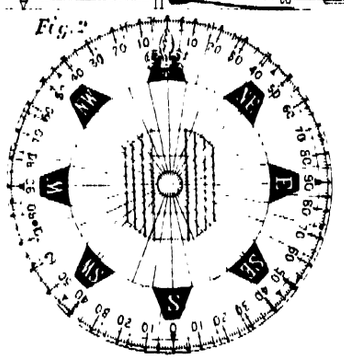


made of the shape shown. A slight modification is shown and described. (December 7, 1883).

5667. Motive Power Engines: H. G. Hosmer, London. [6*d.* 8 *Figs.*]—"The power is derived from the swinging of two or more pendulums," each pendulum in its flight being "caused to raise and release another pendulum, the raising being necessary to insure the proper length of swing." (December 8, 1883).

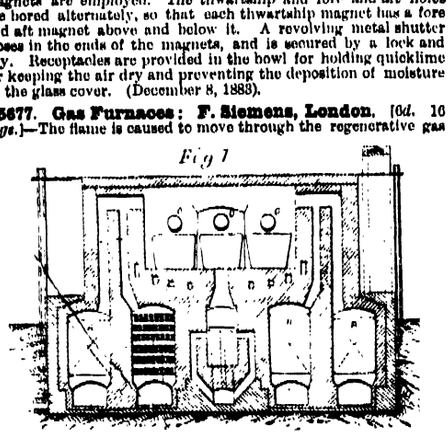
5676. Mariner's Compass: Sir W. Thomson, Glasgow. [10*d.* 12 *Figs.*]—A totally reflecting pinion is substituted for the ordinary mirror in the azimuth mirror described in Specifications 1339 and 4876 of 1876. The prism is so made as to be able to turn round on a horizontal axis so that bearings can be taken either by reflecting the object in the prism and looking direct through the lens at the degrees of the compass card, or by reflecting the degrees of the card in the prism and looking over the prism at the object, the bearing of which is required. An eccentric lens is employed to facilitate the adjustment of the instrument, which is arranged for using two or more lens of different focal length, one for taking bearings of objects on the horizon, and the others for taking bearings of the sun or stars at different altitudes. Fig. 1 shows the prism *a* mounted in a frame supported by bearings *c*, the shaft being pressed into the bearings by springs; *f* is the eccentric lens, whose centre is not concentric with that of the tube *g* containing it. The compass card is constructed so that



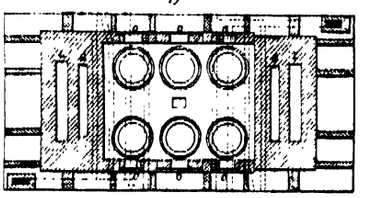


it can be used for steering, and read off by direct numbers engraved on a circle, while each degree has its number engraved on it inverted. The card is shown in Fig. 2. In order to correct the semicircular error, the fore and aft magnets and thwart ship magnets are placed in holes nearly through the centre of the binnacle. Two vertical rows of fore and aft magnets, one on each side of the middle of the binnacle, and one row of thwartship magnets are employed. The thwartship and fore and aft holes are bored alternately, so that each thwartship magnet has a fore and aft magnet above and below it. A revolving metal shutter closes in the ends of the magnets, and is secured by a lock and key. Receptacles are provided in the bowl for holding quicklime for keeping the air dry and preventing the deposition of moisture on the glass cover. (December 8, 1883).

5677. Gas Furnaces: F. Siemens, London. [6*d.* 16 *Figs.*]—The flame is caused to move through the regenerative gas



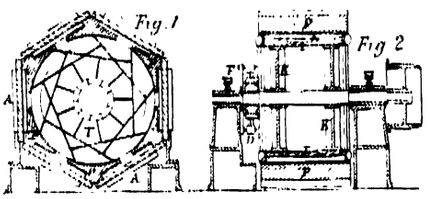
furnace without coming in contact with the objects or materials in the furnace, or with the roof or walls, and to act chiefly or entirely by radiation. The illustrations show in longitudinal section and in sectional plan a furnace for melting glass in pots, R

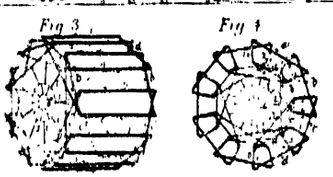


being the regenerators, G the gas flues, and L the air flues. The flame is arranged to be kept away from the working doors O, and, as will readily be seen, passes clear of the pots. (December 8, 1883).

[6*d.* 10 *Figs.*]—The springs are acted upon in tension so as to be straightened out or deflected, the indications being made upon a scale or dial acted upon through a pinion and a quadrantal rack. A bearing or loose or independently yielding piece receives the effect of sudden strains or shocks. (December 8, 1883).

5682. Magneto and Dynamo-Electric Machines with Continuous Currents: A. de Meuron and H. Cuenod, Geneva. [6*d.* 5 *Figs.*]—The armature consists of a drum wound with any suitable number of coils. Each coil is rectangular in shape, the two sides being parallel to the axis and the two ends forming chords, which subtend an arc equal to the whole circumference divided by the number of polar fields. As shown in *Fig.* 3, each chord is equal to the radius of the drum, there being six fields as shown in Fig. 1. The end of the coil 4, *a*, 1 is connected to the beginning of the coil 6, *b*, 3 by a conductor, and the end of this coil is connected to the beginning of the coil 8, *c*, 5 by a conductor, and so on, the coils being connected together to form a single circuit. The chords *a*, *b*, *c*, &c., are each equal in length to the radius of the drum, and each of the conductors is connected to a strip of the commutator; as shown in Fig. 2, there are nine coils and nine strips. Fig. 4 shows the above arrangement adapted to a disc





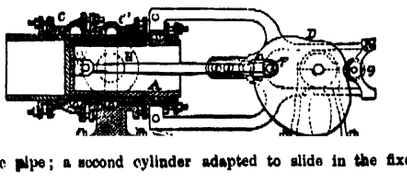
armature, the sides of the coils being radial and the sides forming chords. The letters of reference on this figure correspond to those in Fig. 3. The field magnets in this case are doubled, one set for each side of the disc. Figs. 1 and 2 show a complete generator, A being the field magnets, P the pole-pieces. The drum T is preferably composed of metallic discs K carrying the insulator I on which is wound iron wire. The brushes correspond in number to the polar fields, and are secured in the adjustable holders D carried by the piece F which may turn on a socket fixed to the standard. The lead of the brushes can be thus varied or the current reversed by turning the piece F through 60 deg. In a modification the ends of the brushes bear on the commutator, the brushes being fixed to a pivotted axis from which the curve of the brush is described. By this arrangement the point of contact is not changed by the wear of the brushes. The field magnets are supported on the bed-plate by non-magnetic standards. (December 8, 1883).

5683. Breaking Cannel Coal, Coke, &c.: J. Woodward, Manchester. [6*d.* 3 *Figs.*]—A plate serrated on the face is placed in a vertical position, and is attached to the framing so as to be adjustable towards a series of rollers placed one over the other, the distance of the rollers from the plate increasing gradually from the lowest one. (December 10, 1883)

5684. Manufacture of Rope: A. J. F. G. Telschow, London. [4*d.*]—Powdered resin is applied to the fibres in the process of manufacture. (December 10, 1883).

5687. Rock-Boring Apparatus: J. T. Jones and J. H. Wild, Leeds. [6*d.* 3 *Figs.*]—A tube is lowered from the staging on to the rock in which the bore-hole is to be made. The staging may be a floating structure, as described in Specification 5014 of 1881. The drill is provided with suitable flexible pipes to convey the compressed air or steam to the cylinder, to exhaust from the cylinder, and to convey water to the bore-hole to wash it out, and is let down into the tube by means of a chain or rope passed over a pulley at the jib head of a crane on the staging. An easily removable crosshead is attached to the top of the tube, and a screw works in the crosshead. The lower end of the screw is connected by a swivelling connection to a link of the hoisting chain when the drill is in position in the guide tube, and will thus support the drill in the tube. The screw is gradually turned by hand to allow the drill to descend, the hoisting chain being slackened. (December 10, 1883).

5688. Pump: H. J. Haddan, London. (*A. Reis, ... 2 Figs.*]—The reversible pump comprises in its construction a fixed cylinder, made of two parts fitted together, each part having an annular cavity leading to the suction or dis-



charge pipe; a second cylinder adapted to slide in the fixed cylinder and provided with apertures corresponding with the cavities in the fixed cylinder. The second cylinder is operated by a specially formed cam serving also as a crank for a ram piston working in the movable cylinder. Referring to the illustration, the ram piston A works in the cylinder B forming the piston of a fixed cylinder C formed in two parts C C¹ carrying the suction and discharge pipes H. The cylinder C¹ has three stuffing-boxes, between which are the annular cavities G, one serving to admit and the other to discharge the fluid. The pistons A and B are set in motion by a cam D which carries the crankpin F. The cam D operates the distributing cylinder B by means of two friction rollers *g*; the crankpin being connected to the piston A. The cam causes the apertures to be placed alternately opposite the suction and discharge opening *g*. (December 10, 1883).

5691. Brush-Making Machinery: F. Wirth, ... fort-on-Main. (*Bürsten and Pinselfabrik Donaus ... Mez and Co., Germany*). [1*s.* 2*d.* 22 *Figs.*]—This relates to a machine in which the successive operations of feeding single tufts of bristles, fibres, wires, &c., of proper size from a container, drawing them into the brush stock, and cutting them off to the proper length are automatically performed. (December 10, 1883)

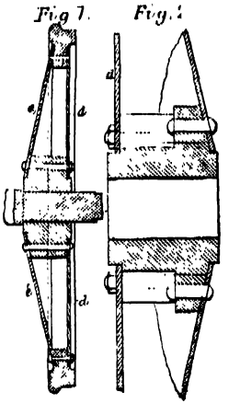
5692. Type-Writing Machines: H. H. Lake, London. (*J. L. Young, Tarrytown, New York, U.S.A.*) [6*d.* 3 *Figs.*]—A wheel with raised letters on its edge is moved over the surface of the paper. Over this wheel is an index wheel having letters corresponding to those of the type wheel, the wheels being connected by gear and moved outward together by an arm pivotted to the centre of the index wheel. By moving the arm and the index wheel to the letter desired, and carrying it around to the fixed point, then pressing down the lever on which the type wheel and index wheel are placed, the desired letter is printed or impressed. (December 10, 1883).

5706. Insulating Electric Conductors: A. J. Boult, London. (*J. B. Hyde, Brooklyn, U.S.A.*) [4*d.*]—The conductors to be insulated are wrapped with two or more layers of cotton thread, and are drawn through a trough containing a hydro-carbon fluid such as petroleum preferably heated. They are then passed into a heated mineral bitumen and coal tar pitch used separately or mixed, the petroleum being evaporated and ... by the composition. This composition may be replaced by peat powder mixed to a paste with a mineral or vegetable oil or other hydro-carbon fluid, and added to melted asphaltum, coal-tar pitch, or petroleum coke. Finely divided raw cotton tow, or silk cord waste may be added to this composition. After the conductors are passed through this latter composition, they are passed through apparatus similar to a maccaroni press, which will cover the wires to a fixed diameter, or they may be moulded between grooved rollers, having sheets of the composition on each side with the conductors between. The conductors may then be covered with a narrow strip of thin paper, tin foil, or woven fabric, wound spirally from end to end or with lead. (December 11, 1883).

5723. Treating Timber with Preservative Fluids: S. B. Bulton, London. [4*d.*]—The timber is impregnated with an oily solution of tar acids or with naphthaline accompanied or not by tar acids or with distillates of heavy oils of tar or with solutions of metallic salts with or without admixture of tar acids, and is then subjected to the action of heated creosote or other oily or bituminous body in closed vessels. The patentee refers to his previous Specifications 1954 of 1879 and 62 of 1882. (December 12, 1883).

5733. Galvanic Batteries: F. H. Gossage, Widnes, Lanc. [2*d.*]—The electrodes are of iron, cast-iron, or other suitable material, or of carbon or other suitable non-metallic material, and of zinc, and are immersed in a solution of caustic soda or potash. (December 13, 1883).

5817. Metallic Wheels for Vehicles, &c.: J. Hodgkins, Warwick. [6*d.* 6 *Figs.*]—The wheels are constructed with a separate central box; two circular metallic discs, one being flat or nearly flat, and the other conical, constituting the sides of the wheel; and of a flanged or plain rim or tyre. Referring to the illustrations, the discs *c d* are secured at their middle to the boss by rivets or screw bolts or nuts, each disc having its own set of rivets or bolts, the holes in the boss being arranged circularly,



alternate holes receiving the rivets or bolts of one disc, and the intermediate holes those of the other. The boss is thinner at those parts in which the holes for receiving the rivets or bolts of the conical disc *c* are situated. The inner conical disc *c* is first secured to the boss, and afterwards the outer disc *d* is fixed temporarily in place, and the edges of the two discs are turned; the disc *d* is then removed, the rim or tyre placed in position, the disc *d* replaced and the rim or tyre connected to the margins of the two discs by bolts or rivets. (December 20, 1883).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

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BROTHERHOOD'S PATENT

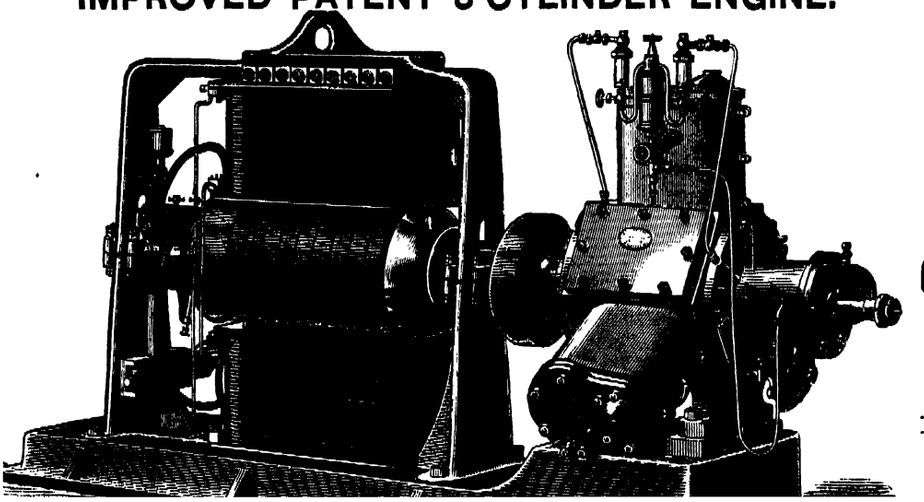


FLEXIBLE COUPLING

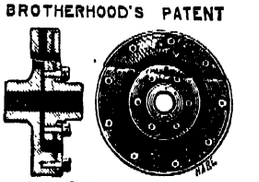
PETER BROTHERHOOD,

MECHANICAL ENGINEER,
BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.

IMPROVED PATENT 3-CYLINDER ENGINE.



BROTHERHOOD'S PATENT



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As in General Use in the British, French, [illegible], Danish, &c., [illegible]c., Navies.

FOR DRIVING
FANS,
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AND OTHER
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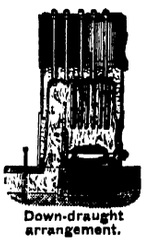
Uptake arrangement.

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140,000 TUBES HAVE BEEN SUPPLIED FOR INSERTION IN EXISTING BOILERS. 5011

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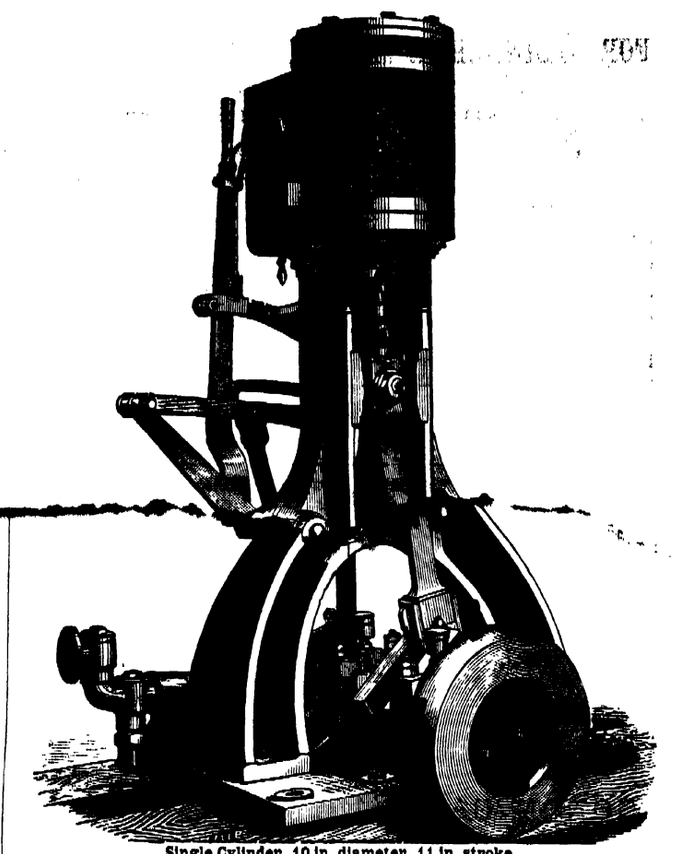
ENGINEERS.

SINGLE-CYLINDER SCREW ENGINES.

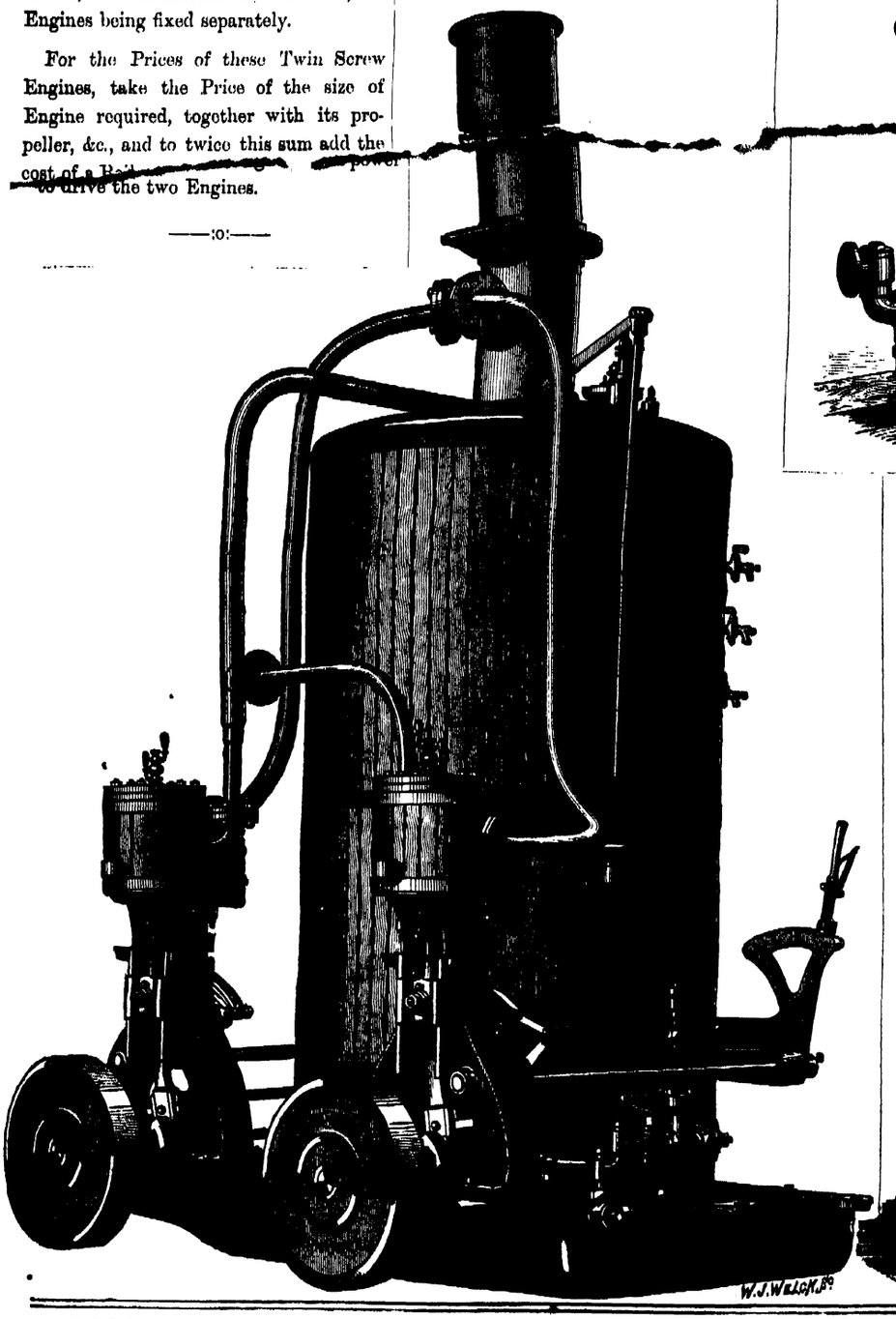
The woodcut below represents an Engine for driving a Boat with Twin Screws. The size shown has two independent Single Cylinder Engines, 5¾ in. diameter, 6 in. stroke, which are mounted complete on Bed Plates, and are attached to the base of a Vertical Boiler. This is a very useful type for Small Boats of light draught, and is easily fixed in the Boat. We can supply any of our Engines adapted for Twin Screw Boats, either of the Single or Double Cylinder High Pressure, or of the Compound Surface Condensing Types, and either with Vertical Boiler, mounted as shown, or with Return Tube Boilers, the Engines being fixed separately.

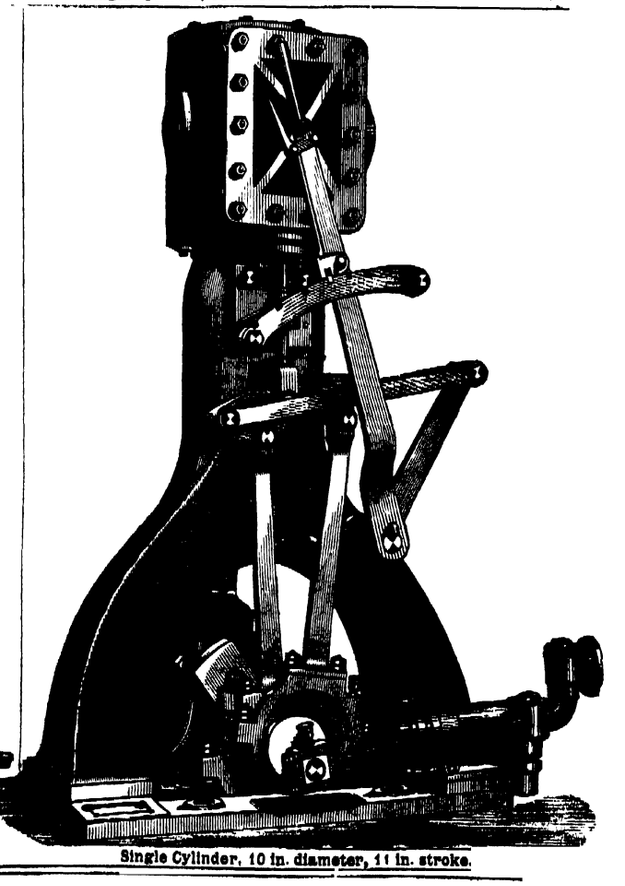
For the Prices of these Twin Screw Engines, take the Price of the size of Engine required, together with its propeller, &c., and to twice this sum add the cost of a Boiler of sufficient power to drive the two Engines.

—:o:—



Single Cylinder, 10 in. diameter, 11 in. stroke.



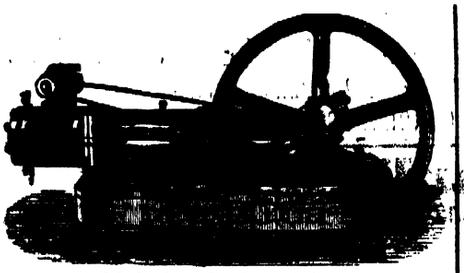


Single Cylinder, 10 in. diameter, 11 in. stroke.

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THESE ENGINES ARE THE CHEAPEST AND MOST POWERFUL IN THE MARKET.



"Caledonian" Horizontal Engine.

PRICES.

4 HP.	...	... £35	16 HP.	...	... £120
6 HP.	...	... 45	20 HP.	...	... 150
8 HP.	...	... 60	25 HP.	...	... 200
10 HP.	...	... 70	30 HP.	...	... 250
12 HP.	...	... 88			



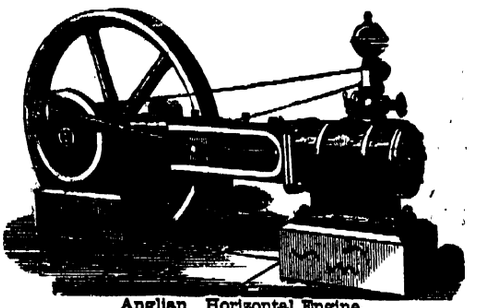
Vertical Engine & Boiler combined.

PRICES.

2 HP.	...	... £70
3 HP.	...	... 80
4 HP.	...	... 90
5 HP.	...	... 100

PRICES.

6 HP....	...	£110
8 HP....	...	150
10 HP....	...	175
12 HP....	...	200



Anglian Horizontal Engine.

PRICES.

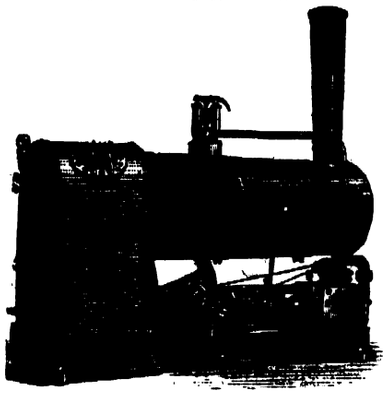
6 HP.	...	... £57 10s.	16 HP.	...	... £145
8 HP.	...	... 77 10s.	20 HP.	...	... 175
10 HP.	...	... 95	25 HP.	...	... 210
12 HP.	...	... 110	30 HP.	...	... 240

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of MASSIVE CONSTRUCTION and LARGE WEARING SURFACES. The Smaller Surfaces are CASE-HARDENED, and all others provided with GUN METAL BEARINGS, with suitable provision for adjustment.

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With Locomotive Multitubular Boiler

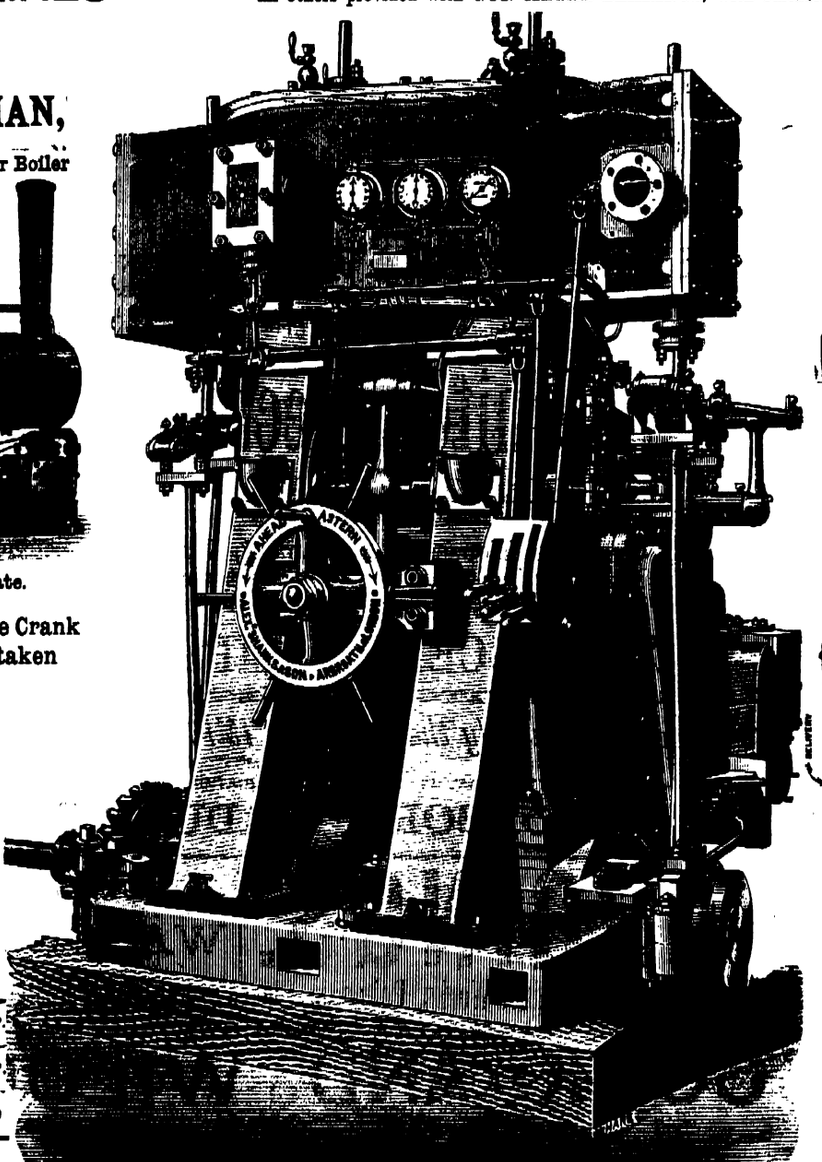


Combined on one Sole Plate.

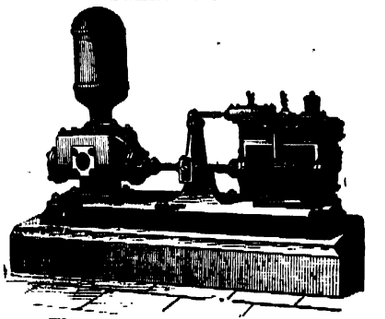
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Size of Engine	4 HP.	6 HP.	8 HP.	10 HP.	12 HP.
Size of Boiler	6 HP.	8 HP.	10 HP.	12 HP.	14 HP.
Engine & Boiler as above	£130	£155	£210	£250	£300

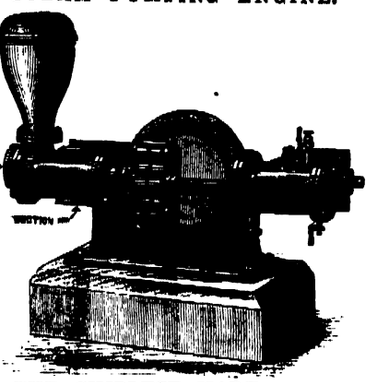


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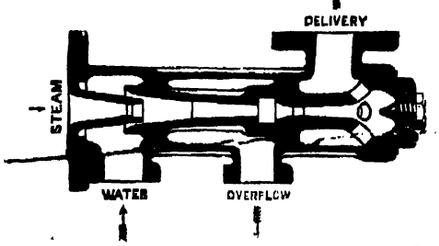
Gresham's Patent Improved Giffard's Injectors

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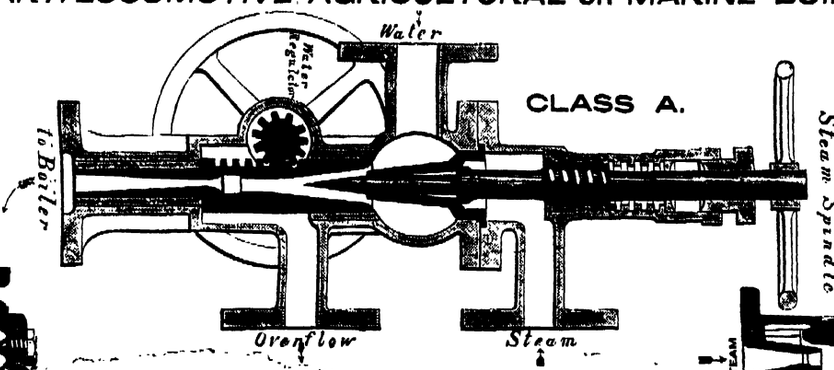
CLASS C 2.

Combining and Receiving Cones removable without breaking pipe joints.

(GRESHAM'S PATENT.)



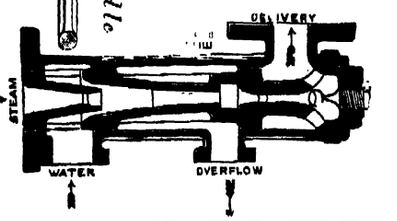
CLASS A.



CLASS G

All Cones removable without breaking any pipe joints.

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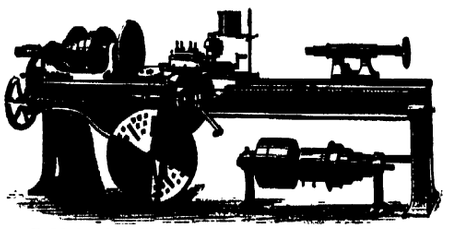
Safe, Economical (as to space and fuel), and Durable; Having Perfect Water Circulation, and Spacious Steam-room; Easy of Transportation, and perfectly Accessible for Cleaning external and internally

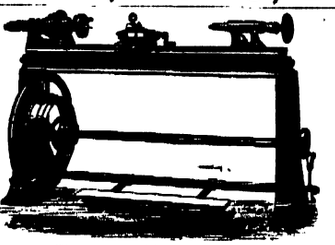
For Illustrated Circular and full particulars apply to our European Offices,

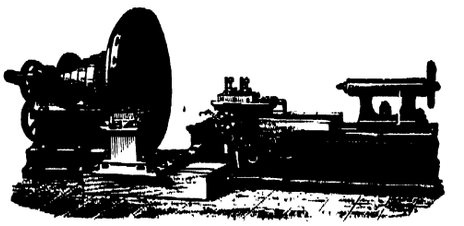
107, HOPE STREET, GLASGOW, SCOTLAND;
40, CANNON STREET, LONDON, E.C.; and
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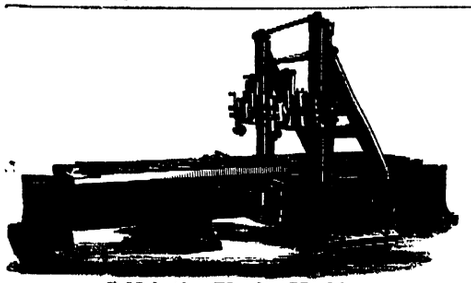
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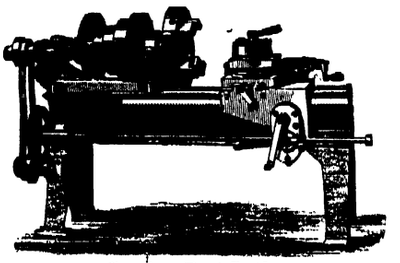
TANGYES MACHINE TOOL CO., LTD.,
OXFORD WORKS, SOHO, BIRMINGHAM.

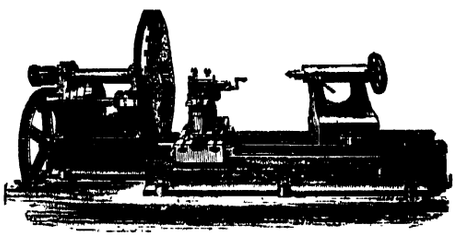

Self-Acting Slide and Screw-Cutting Lathe.

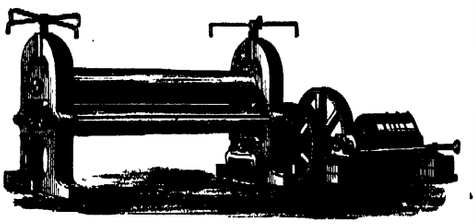

Engineers' Foot Lathe.

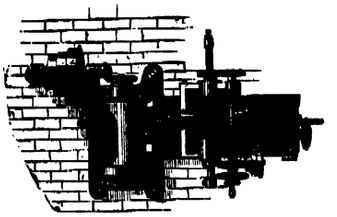

S. A. Slide Surfacing and S. C. Break Lathe.

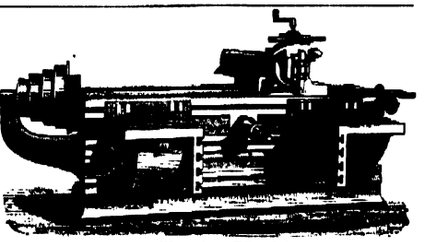

Self-Acting Planing Machine.


Capstan Rest Lathe.

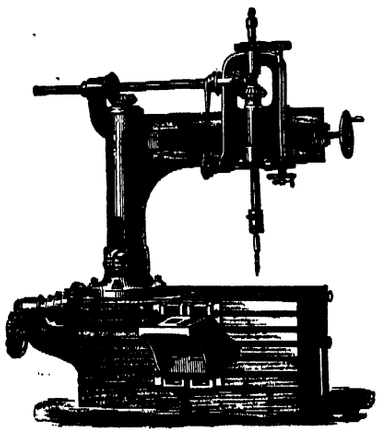

Single Railway Wheel Lathe.

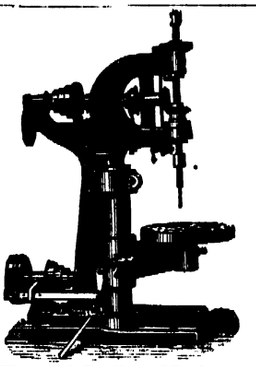

Plate Bending and Straightening Rolls.

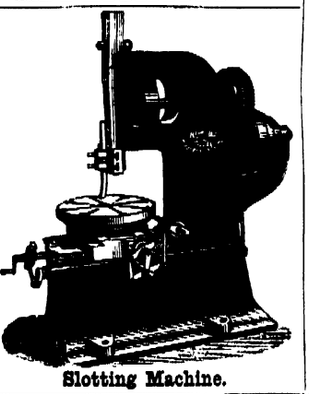

Radial Wall Drilling Machine.

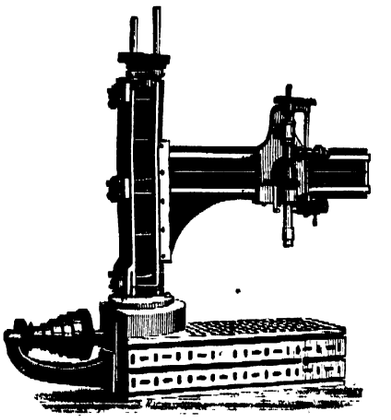

Self-Acting Shaping Machine.

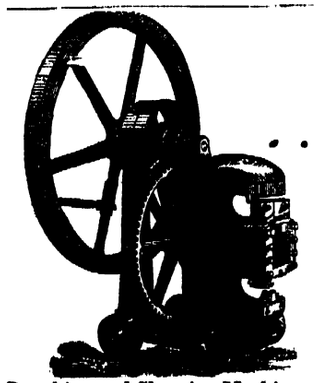
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OF EVERY DESCRIPTION.
CATALOGUES ON APPLICATION.

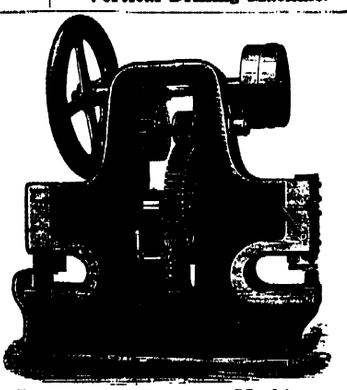

Radial Drilling Machine.

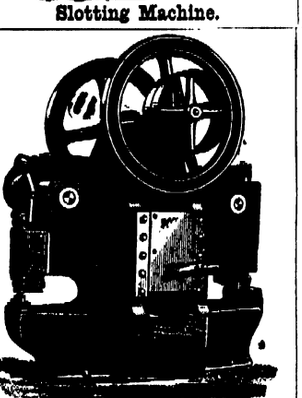

Vertical Drilling Machine.

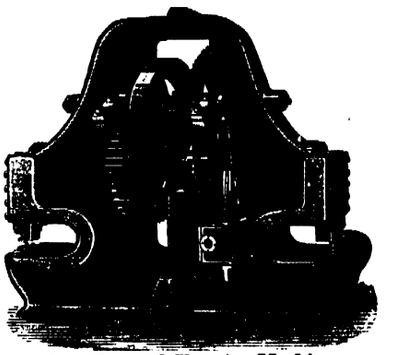

Slotting Machine.


Radial Drilling Machine.


Punching and Shearing Machine.


Punching and Shearing Machine.

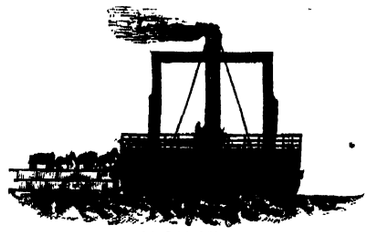

Punching and Shearing Machine.


Punching and Shearing Machine.

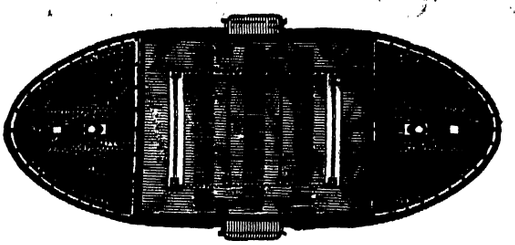
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4509

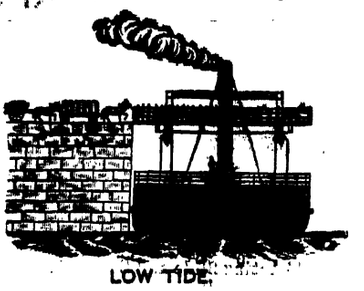
PATENT ELEVATING STEAMER,



HIGH TIDE.

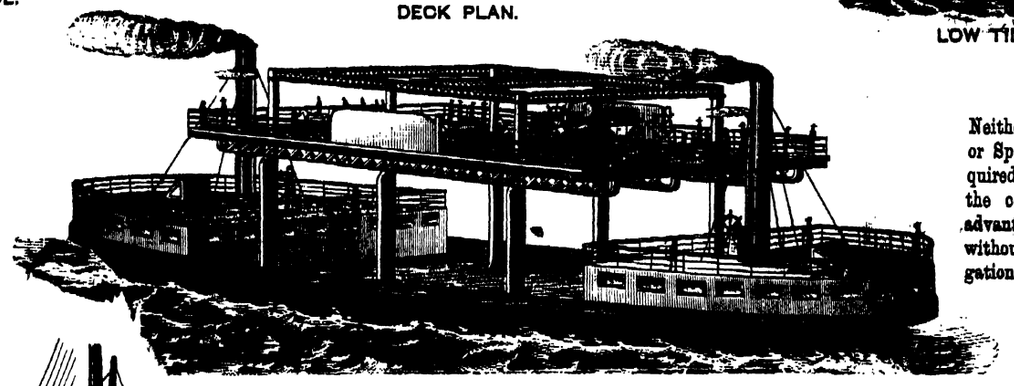


DECK PLAN.

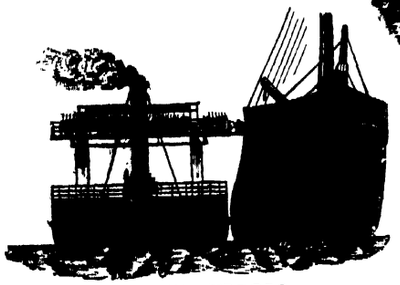


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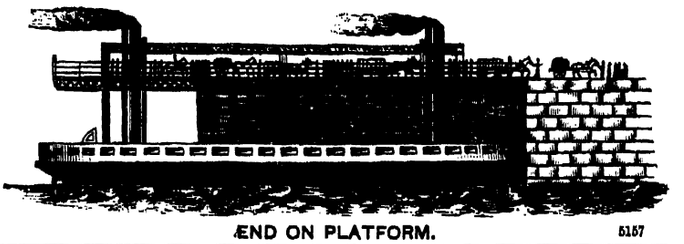


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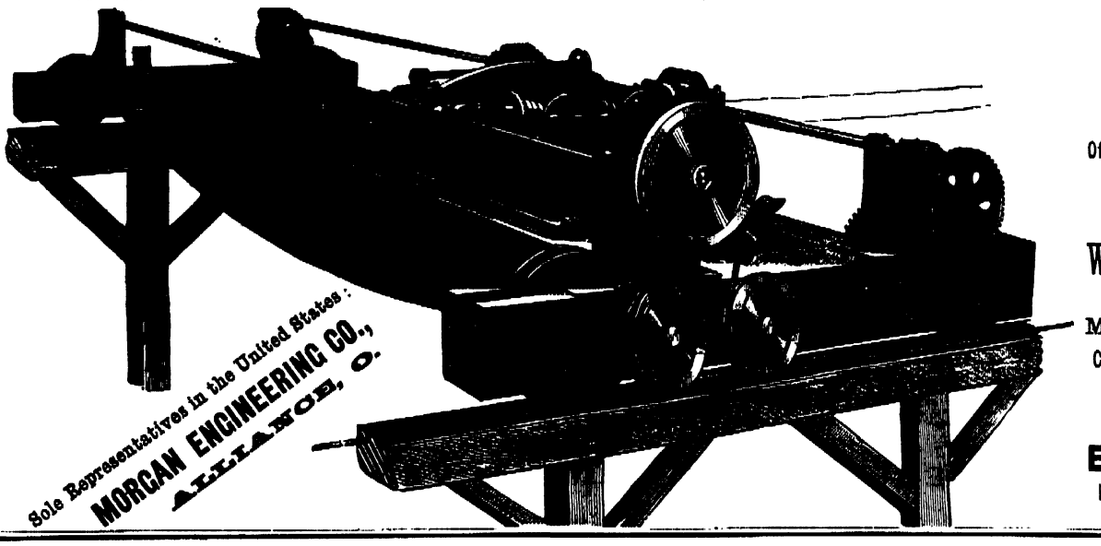
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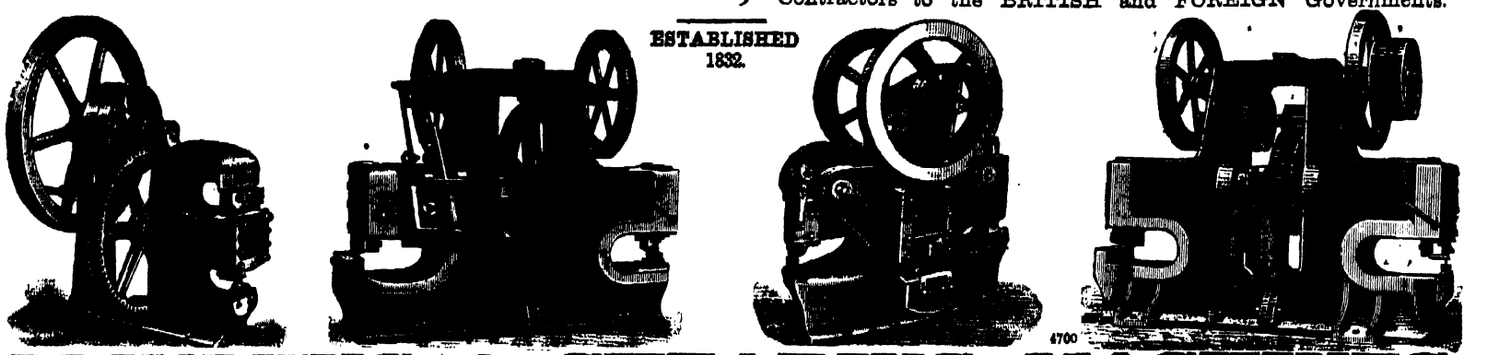
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No. 1.—In Ingots, Bearings, &c. Wears four or five times as long as gun metal. No. 2.—For Filling-in Ingots. For Stern, Main Bearings, Crank pin Brasses, Side Blocks, &c., of Marine and Land Engines Is used by the principal Steam Ship Companies and Engineers. Engineers prove it superior to all other White metals. 4066

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WALKERS' PATENT GUIBAL VENTILATING FANS,

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WALKER'S Patent, as adapted to Bessemer Blowing Engines, is now in successful operation at the following Steel Works, and is about to be applied to other Engines for similar purposes :—

Messrs. BOLCKOW, VAUGHAN and CO., Eston, Middlesbro'.
" The DOWLAIS IRON CO., Dowlais.
" CHARLES CAMMELL and CO., Cyclops Works, Sheffield.
" The DARLINGTON IRON and STEEL CO., Darlington.
" The WEARDALE IRON and STEEL CO., near Durham.

And to 150 other Engines for a variety of purposes throughout the country.

The advantages afforded by the application of the Patented Valves to Bessemer Engines, are a greater endurance than has yet been attained by valves worked automatically (eccentrics, &c., for the valves not being required), and an almost perfect expulsion of the whole of the compressed air from the cylinders. 4166

RANSOMES & RAPIER,

5, Westminster Chambers, LONDON, & Waterside Ironworks, IPSWICH,

MAKERS OF ALL KINDS OF RAILWAY PLANT,

INCLUDING

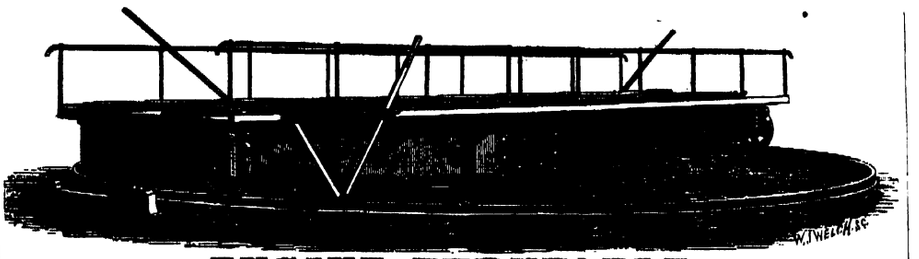
SWITCHES,

CROSSINGS,

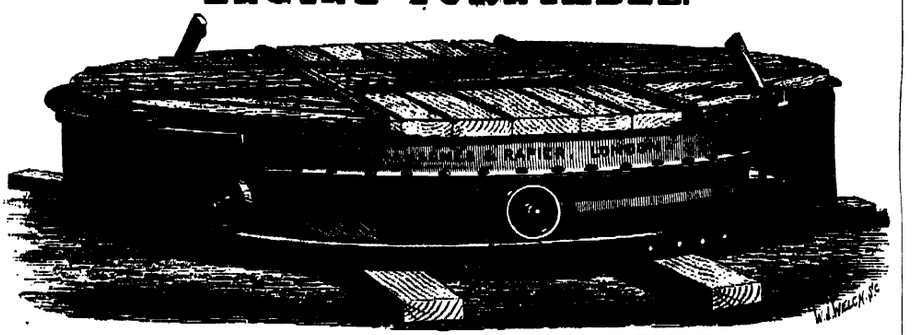
Engine Turntables,

CARRIAGE TURNTABLES,

TRAVERSERS.



ENGINE TURNTABLE.



CARRIAGE TURNTABLE.

INCLUDING

SIGNALS

HYDRANTS,

PUMPS,

TANKS,

WATER CRANES

ALSO ALL KINDS OF

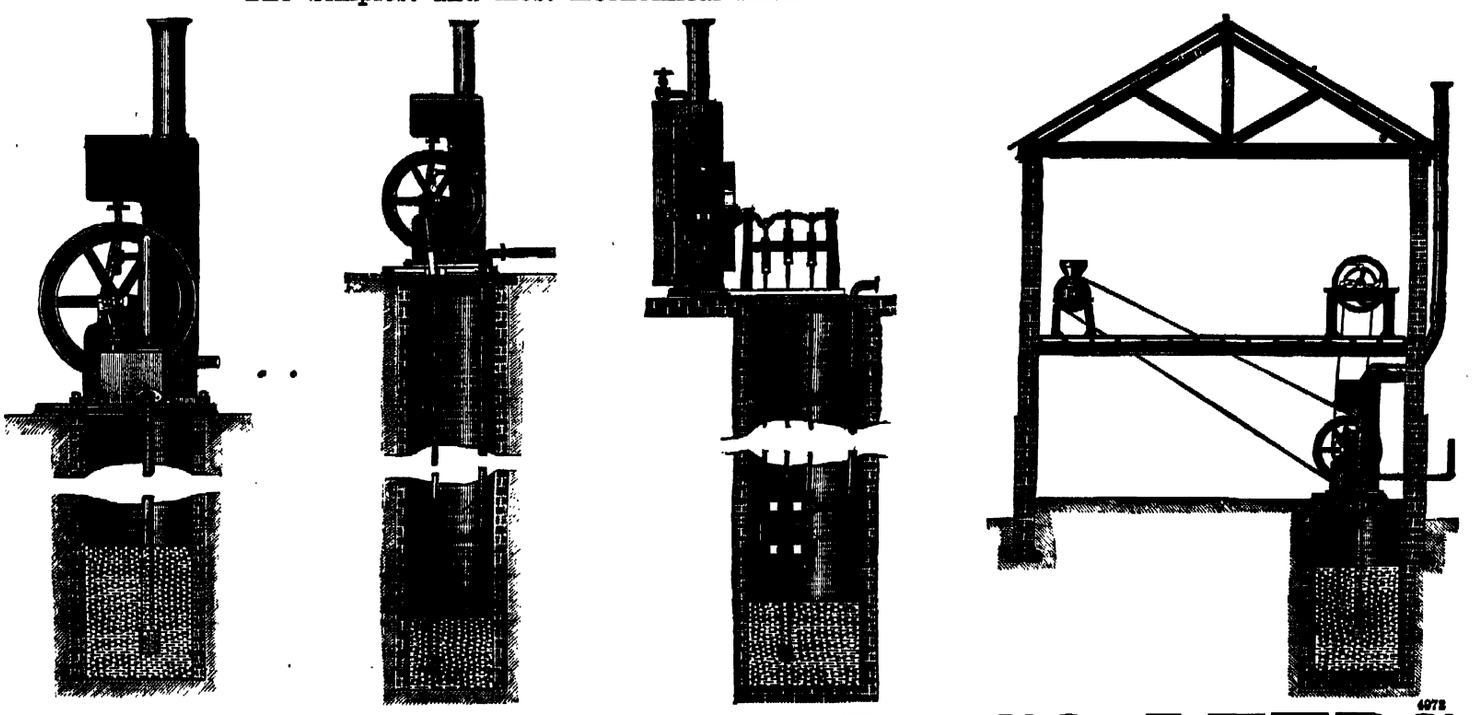
STEAM AND HAND CRANES.

Prices and Illustrations on application to RANSOMES & RAPIER, 5, Westminster Chambers, London. 5053

ROYAL SHOW AT SHREWSBURY.

THE DOMESTIC MOTOR.

The Simplest and most Economical small Motor. See STAND No. 203.



4975

HATHORN, DAVEY & CO., LEEDS

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breese, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

8ft.	long,	5ft. 0in.	diameter,	20-horse power.
10ft.	,,	5ft. 6in.	,,	30
12ft.	,,	6ft. 0in.	,,	40
13ft.	,,	6ft. 6in.	,,	50
14ft.	,,	7ft. 0in.	,,	60
15ft.	,,	7ft. 6in.	,,	70
16ft.	,,	8ft. 0in.	,,	80
17ft.	,,	8ft. 0in.	,,	90
18ft.	,,	8ft. 0in.	,,	100

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS.

BRASS & COPPER TUBES

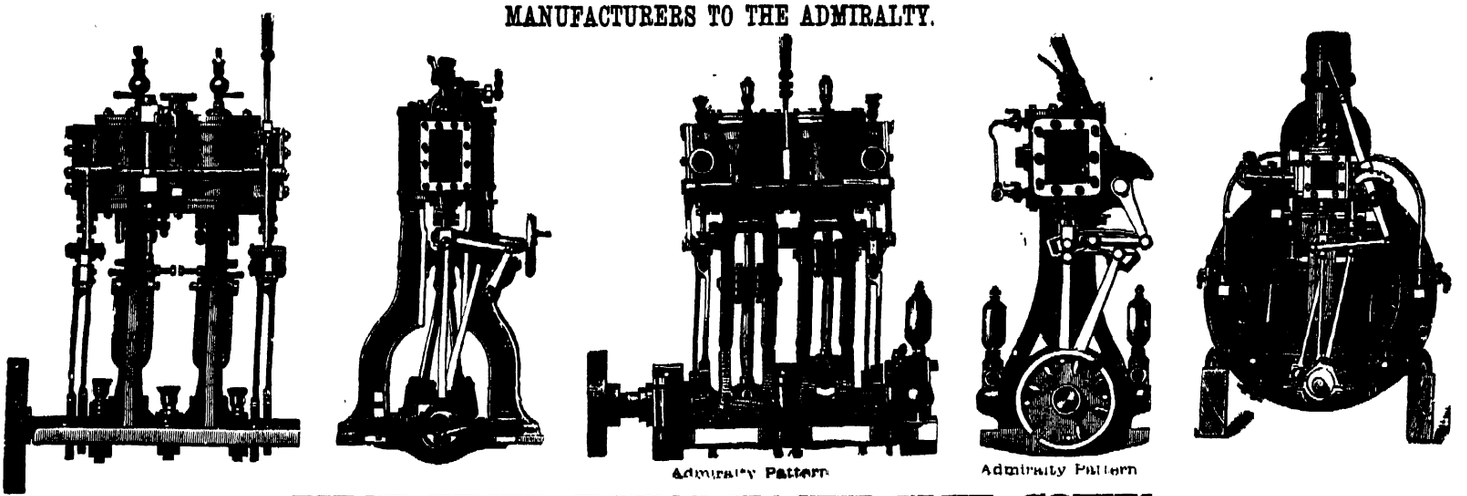
SEAMLESS & BRAZED, FOR BOILERS, SURFACE CONDENSERS &c 4957

BRASS & COPPER WIRE, SHEETS &c.

BIRMINGHAM BATTERY & METAL CO. BIRMINGHAM.

PLENTY & SON, EAGLE IRONWORKS, NEWBURY, BERKS.

MANUFACTURERS TO THE ADMIRALTY.



FIRST PRIZE, ROYAL YACHT CLUB, COWES

PATENT ENGINES AND BOILERS FOR SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &c. 4227

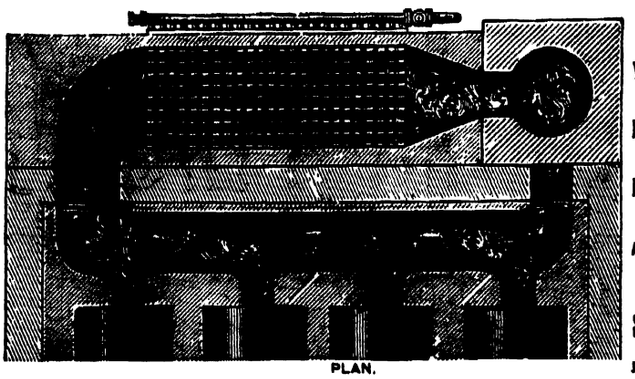
Simple, High-pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works.

Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(FOR UTILISING THE WASTE HEAT FROM STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION



PLAN.

SPECIAL ADVANTAGES.

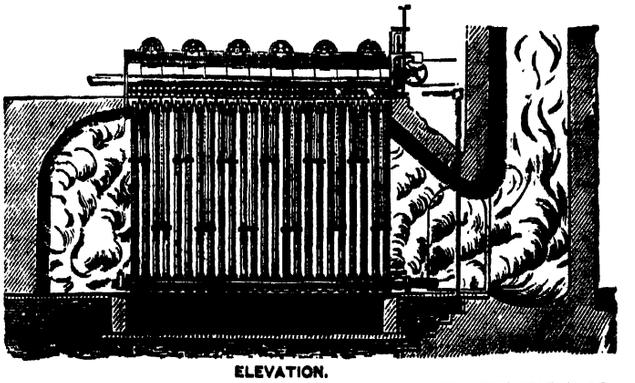
Vertical Pipe Castings. Guaranteed sound and perfectly true.

New Patent Spiral Scrapers The most effectual removers of soot.

Patent Reversing Gear. Never sticks or gets out of order.

ALREADY IN OPERATION TO HUNDREDS OF STEAM BOILERS.

Saves from 20 to 25



ELEVATION.

N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and abroad.

TESTIMONIALS, AND FURTHER PARTICULARS ON APPLICATION TO

ARTHUR LOWCOCK, Foundry, Shrewsbury England.

ROOFS and BUILDINGS in IRON and STEEL.



From Photo. of Engine Shed 600 ft. by 180 ft., recently erected by MOREWOOD & CO.

MOREWOOD & CO.
WOODFORD IRONWORKS,
SOHO, BIRMINGHAM.
LONDON OFFICES—158, LEADENHALL STREET, E.C.

CORRUGATED AND GALVANISED SHEETS,
LION WORKS, BIRMINGHAM

Manufacturers of every description of Roofs and Buildings in Iron and STEEL for Forges, Rolling Mills, Railway Stations, Goods Sheds, Yards, Docks, Stores, and General Purposes.
Special Curved Corrugated Iron Roofs without Framing for moderate Spans.

WROUGHT IRON WATER TANKS, any size.
ANNEALING AND GALVANIZING POTS.

Bridges, Gutters, and Tanks, Galvanised or Painted.
Wrought-Iron Lattice and Plate Girders. Railway, Road and Foot Bridges.
DESIGNS AND ESTIMATES ON APPLICATION. 4909

Paris, 1878.—GOLD MEDALS AWARDED.—Melbourne, 1881.

WM. JESSOP & SONS, LIMITED,

MANUFACTURERS OF

EVERY DESCRIPTION OF TOOL STEEL & STEEL CASTINGS,

Cast, Shear, German, Spring, Blister & Sheet Steel for all purposes.

Files of First Quality.—Steel Lagging Plates for Cylinders.—Steel Boiler & Ship Plates & Forgings of all kinds.

DEPOTS:—Manchester, Paris, Dusseldorf, St. Petersburg, New York, Boston, Philadelphia, Cincinnati, St. Louis Chicago, San Francisco, Baltimore, Providence, Montreal.

LONDON OFFICE: MESSRS. CORNES, CALVERT & CO., 30, WALBROOK, E.C.

DAVY BROTHERS, LIMITED,

MANUFACTURERS OF

STEAM HAMMERS

From 1 Cwt. to 50 Tons, for every kind of work,

Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.

BESSEMER STEEL WORKS PLANT,

FORGE AND ROLLING MILL MACHINERY,

Steam Engines for Mills, Ironworks, Collieries, &c.

SINGLE AND DOUBLE FLUED BOILERS. 5173

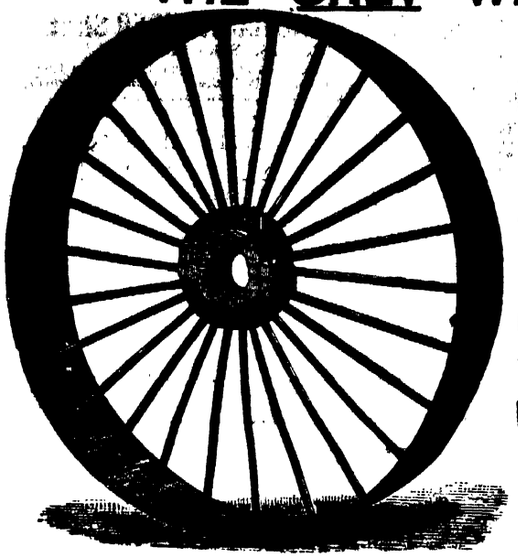
RODGERS' PATENT
WROUGHT IRON PULLEYS

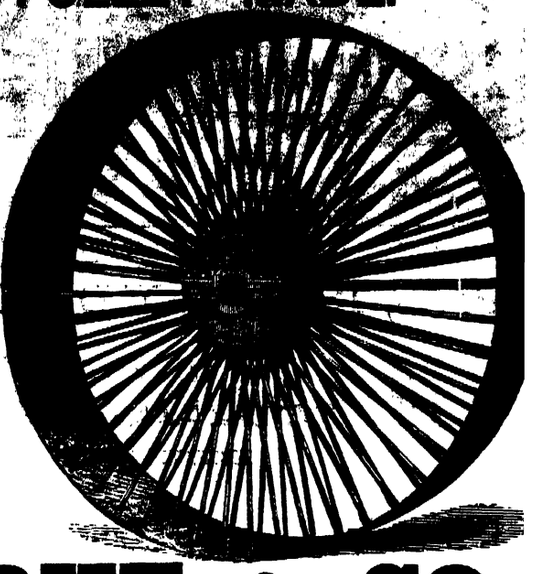
WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.

THE ONLY WROUGHT IRON PULLEY MADE.

SPLIT OR SOLID.

All Sizes up to 24 feet Diameter.





40,000
IN USE.

The Best Pulley in the World

USED SOLELY FOR
DRIVING THE ELECTRIC LIGHT
AT THE
HEALTH EXHIBITION,
SOUTH KENSINGTON.

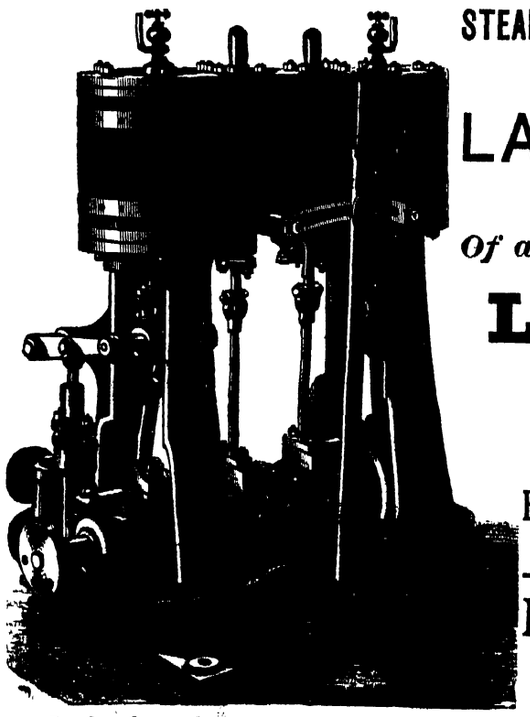
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Saxony—W. W. DERHAM, Leipzig.
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W. of England—Townsend & Young, Arch House, John St., Brist
Glasgow and District—ROBERTSON & Co., 9, Old Sneddon S
Paisley. 4925
South of Ireland—JAS. F. ROBERTS, 72, Francis Street, Dubli

MATTHEW PAUL & CO.,
MAKERS OF
STEAM AND HAND WINDLASSES,

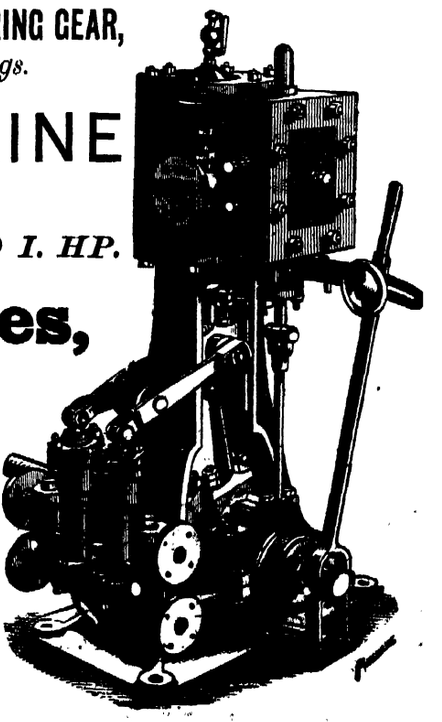


STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,
And every Description of Ship Fittings.

LAND AND MARINE ENGINES
Of all Sorts and Sizes up to 1,000 I. HP.

Launch Engines,
WITH
Patent Valve Motion.

Builders of LAUNCHES, BARGES, & YACHTS
UP TO 100 FEET LONG.



LEVENFORD WORKS,
DUMBARTON.

In the above the reversing is accomplished with single eccentric for each cylinder, and the numerous complications and working joints of link motion are dispensed with, while all the properties of same are retained, and the steam and exhaust openings at ends of stroke are the same always, whether in full gear or not.

FOR MINING, LEATHER

ENGINEERING, INDIA-RUBBER

AND GENERAL MECHANICAL PURPOSES GUTTA-PERCHA

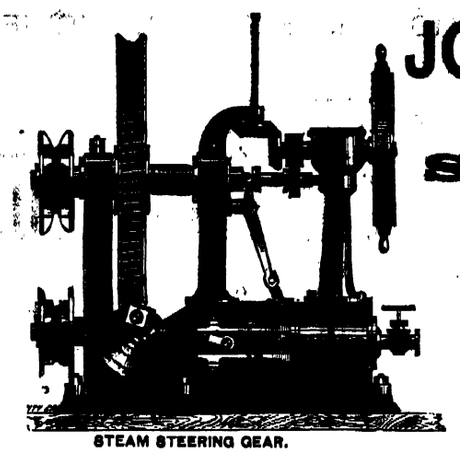
GEO. ANGUS & Co. NEWCASTLE-ON-TYNE 13, BILLITER STREET, LONDON. LIVERPOOL. And BUTE DOCKS, CARDIFF.

5101

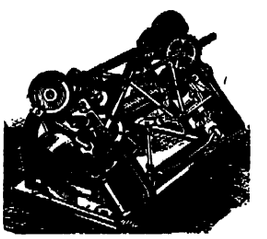
JOHN H. WILSON & CO.,

ENGINEERS AND BOILER MAKERS, &c.

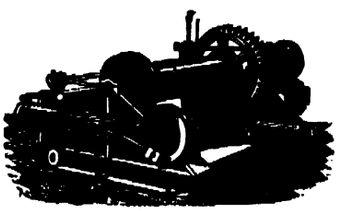
SANDHILLS, LIVERPOOL.



STEAM STEERING GEAR.



VERTICAL STEAM WINCH.



HORIZONTAL STEAM WINCH.

4662

MANUFACTURERS OF STEAM CRANES, OVERHEAD TRAVELLERS, STEAM PUMPS, &c.

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited,

BELL'S Asbestos Works, Southwark. S.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure.....115 lbs. | **Vacuum.....29 inches.**

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,

D. HENDERSON, Chief Engineer, S.S. "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,

Mr. J. BELL. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts, Admiralty, Whitehall, 30th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core.....square. | Elastic core.....round.

To Mr. JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 60 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

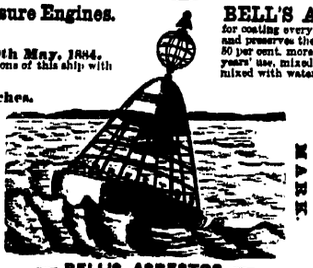
BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depôts and not through agents or factors.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION, for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates.. .. .. .. 186 deg.

" " Covering.. .. .. 94 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 28th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly, "W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

MR. JOHN BELL, Southwark, S.E. Gunnislake, Tavistock, 8th April, 1884.

Sir, I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our Travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals. We have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ½ in. to 3 in. wide, and any thickness from 1-16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.



FIG. 1.



FIG. 2

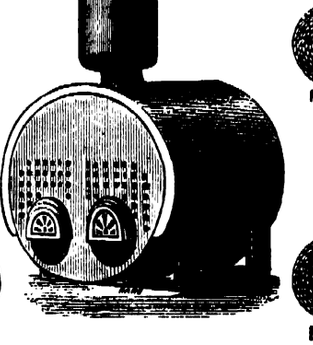




FIG. 4.



FIG. 3.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and ½ millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts, Admiralty, Whitehall, S.W., 17th May, 1884.

Sir,—I have to inform you that your tender for Asbestos Millboard has been accepted.

JOHN COLLETT,

MR. JOHN BELL. Director of Navy Contracts.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanized Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REGD.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

OR THE DEPOTS—

4043

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

READING IRON WORKS, LIMITED.

HORIZONTAL CONDENSING -	ENGINES	VERTICAL - - - - -	BOILERS
COMPOUND CONDENSING -	ENGINES	CORNISH OR SINGLE FLUE -	BOILERS
BOTH CLASSES NON-CONDENSING	ENGINES	LANCASHIRE OR DOUBLE FLUE	BOILERS
VERTICAL, to 12 Horse-Power -	ENGINES	MULTITUBULAR - - -	BOILERS
AUTOMATIC EXPANSION - -	ENGINES	SEMI-PORTABLE - - -	BOILERS
PORTABLE, HIGHEST CLASS -	ENGINES	And VERTICAL - - -	BOILERS
SEMI-PORTABLE - - -	ENGINES	In COMBINATION with VERTICAL	ENGINES
TRACTION - - - -	ENGINES		

FOR CATALOGUES AND INFORMATION APPLY TO 4781

THE READING IRON WORKS, LIMITED, READING, BERKS.

THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

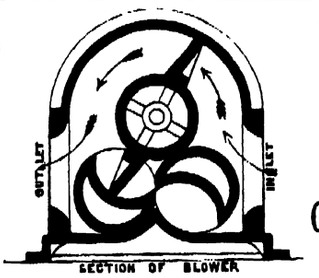
Baker's Patent Rotary Pressure Blower and Gas Exhauster

—:o:—

BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

—:o:—

HALL'S PATENT STONE BREAKER.

—:o:—

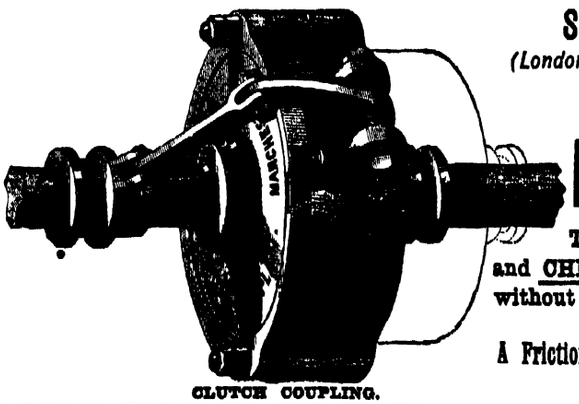
General Machinery of Every Description.

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4668

MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.

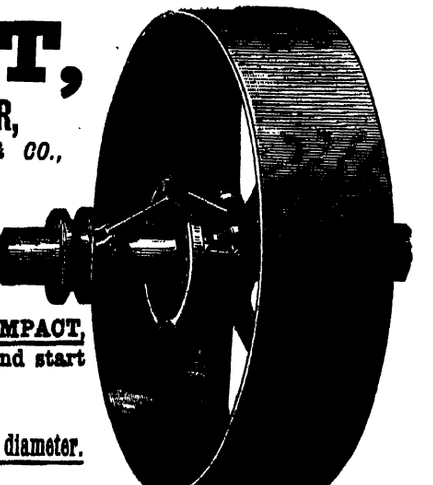

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As fitted in "Engineering," "Daily Telegraph," and "Daily Chronicle" Offices.

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Highest Award for Heating Apparatus,
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BUTTWELDED GAS, STEAM, and WATER TUBES.

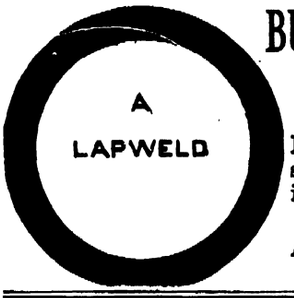
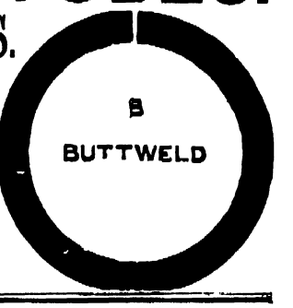


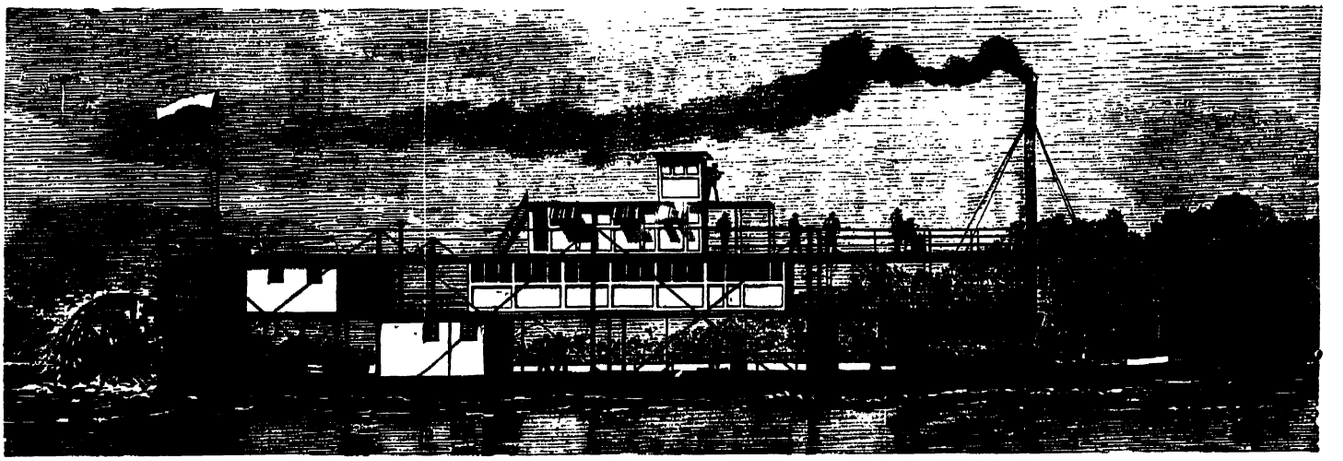
DIAGRAM SHOWING LAP AND BUTT WELDS.

These two Engravings, representing sections of Lapwelded Wrought Iron Tube (at A) and Buttwelded (at B) show conclusively the superior strength of Lapweld, which has nearly four times the surface in contact in the Weld over that given in Buttweld.



All Gas, Steam, or Water Tubes over Two-inch size are made Lapwelded by us. 4864

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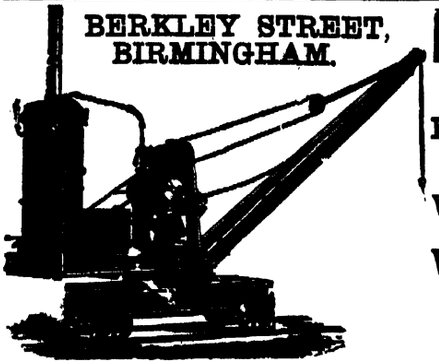
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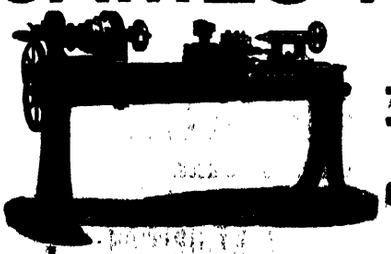
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PORTABLE, WHARF, DERRICK,
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Warehouse Cranes and Pile Drivers,
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Warehouse Lifts and Hoists,
CRABS, JACKS, PULLEY BLOCKS, SCREW COUPLINGS, PLATELAYERS' TOOLS, &c.

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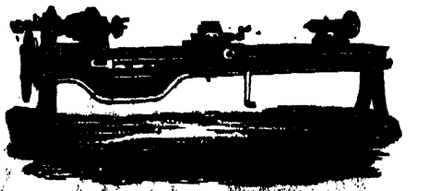


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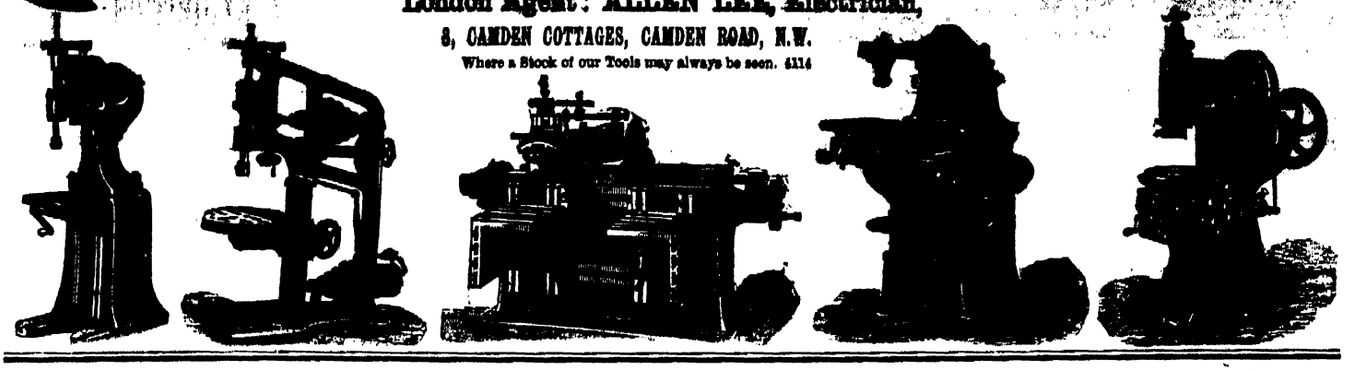


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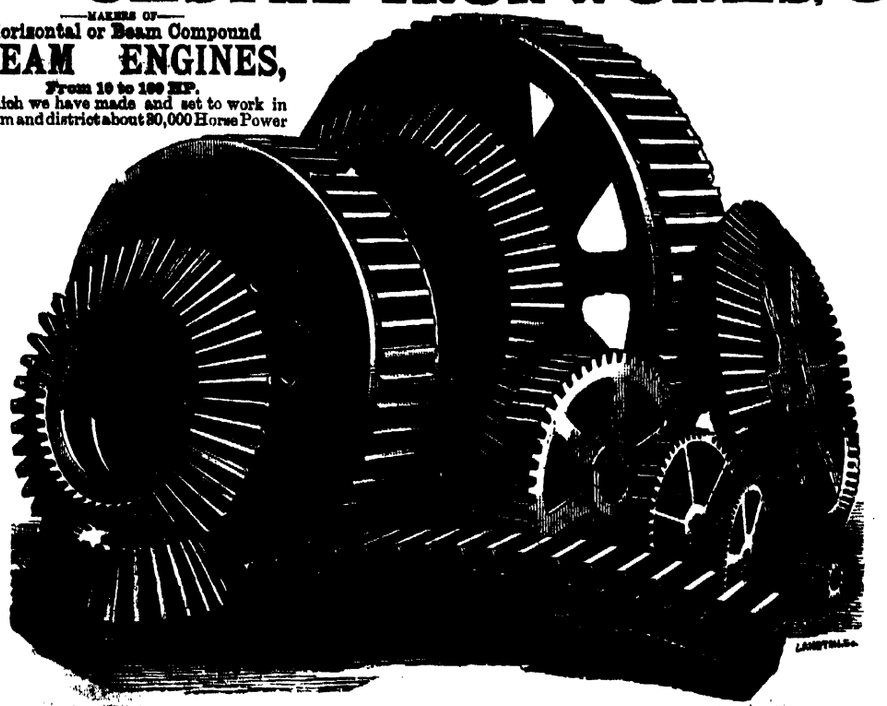
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STEAM ENGINES,
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Specially designed and adapted for heavy work, varying loads, and sudden shocks.

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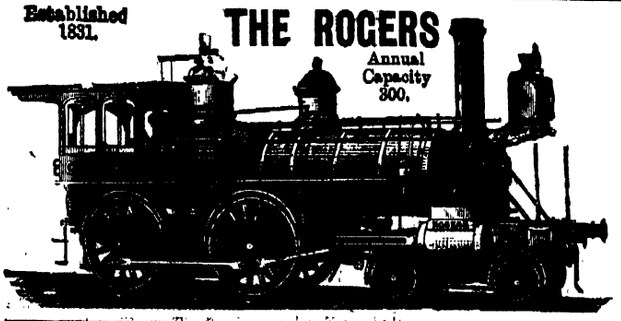
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And for every variety of service,
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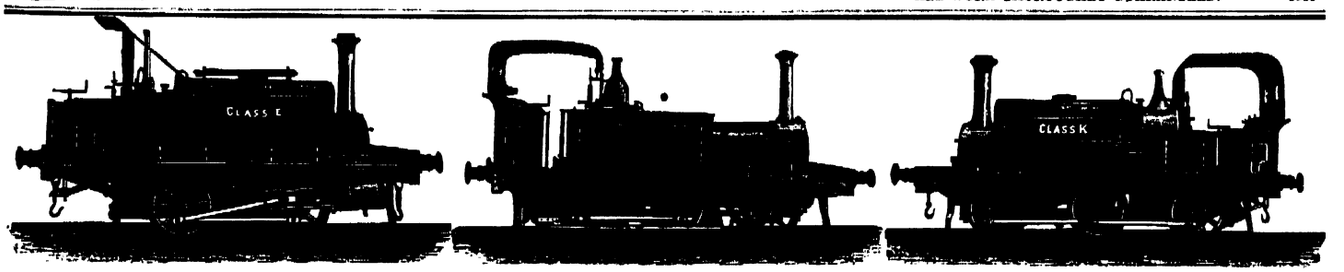
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Adapted to every variety of service, and built accurately to standard gauges and templates. Like parts of different engines of same class perfectly interchangeable.
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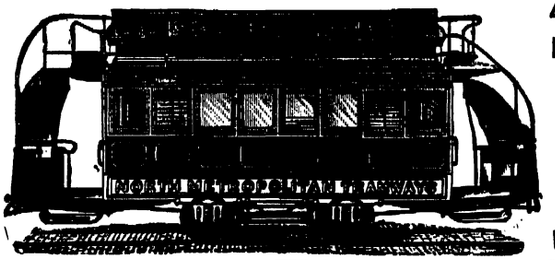
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MANNING, WARDLE & Co., having designs and models of such a great variety of Engines, are enabled to execute orders for Locomotive Engines adapted to most requirements in a very short time.

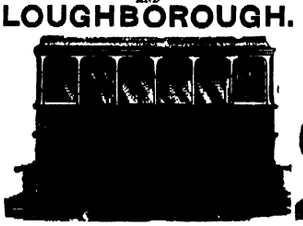
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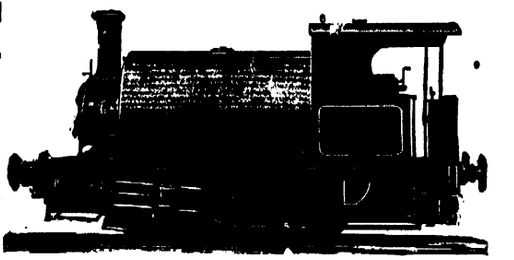
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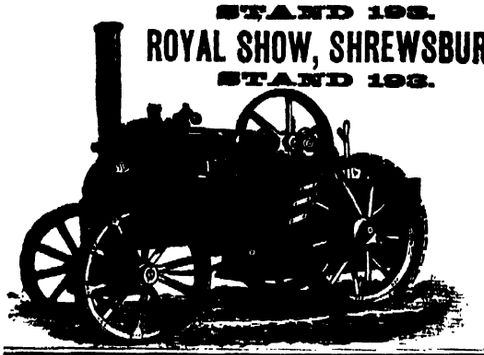
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Steam Cultivating Machinery — Traction Engines — Patent Compound Yorkshire Semi-Portable and Fixed Engines — Semi-Portable Engines — Horizontal High-Speed Stationary Engines — Hauling, Winding, and Pumping Engines — Patent Automatic Expansion Valve Gear and Governor, for ensuring Economy, Regularity, and Safety—Boilers of all types, adapted for every kind of fuel and country—Steel Portable Railway, for Sugar, Cotton, and Indigo Plantations, Contractors' Works, Military Depots, Workshops, Mines, Timber Yards, Agricultural Holdings, &c.—Locomotives of various gauges. 3061

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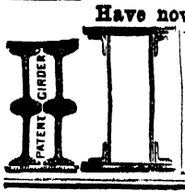
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Have now in their TOWN STOCK 5,000 TONS, and can guarantee prompt delivery at lowest Market Prices.

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6 × 6	8 × 8
6 × 3½	2½ × 2½
5 × 3½	2 × 2
4 × 3½	1½ × 1½
4 × 4	1 × 1

SECTION OF JOISTS.

3 × 3	= 10lbs.	4½ × 3	= 18lbs.	7 × 2½	= 14lbs.	9½ × 3½	= 24lbs.
3 × 1½	= 5 ,,	5 × 4½	= 20 ,,	7 × 3½	= 20 ,,	9½ × 4½	= 30 ,,
4 × 1½	= 7 ,,	6½ × 2	= 11 ,,	8 × 4	= 22 ,,	10 × 4½	= 32 ,,
4 × 3	= 12 ,,	6½ × 3½	= 16 ,,	8 × 5	= 29 ,,	10 × 5	= 36 ,,
4½ × 1½	= 8 ,,	6 × 5	= 29 ,,	8 × 6	= 34 ,,	10 × 6	= 56 ,,

12 × 5	= 42lbs.	17½ × 6½	= 82 ,,
12 × 6	= 56 ,,	17½ × 7½	= 100 ,,
14 × 6	= 60 ,,	18 × 6	= 62 ,,
16 × 6	= 62 ,,	10½ × 7½	= 100 ,,

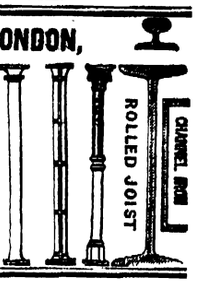
Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to ½". 5126

TEES.

5½ × 5½
4 × 4½
5 × 3
3 × 3
2½ × 2½
2 × 2
1½ × 1½
1 × 1

CHANNELS.

12 × 3
9½ × 3½
9½ × 3½
9 × 3½
5½ × 2½
4½ × 2½
2½ × 1½
1½ × ¼



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Established 1851.] ENGINEERS AND BOILER MAKERS, [Established 1851.

DUKINFIELD, NEAR MANCHESTER,

HIGH-PRESSURE, CONDENSING, & COMPOUND STEAM ENGINES.

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GENERAL HYDRAULIC ENGINEERS. 4793

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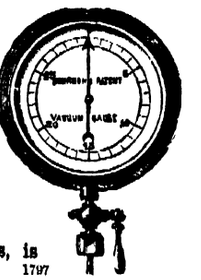
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NEGRETTI & ZAMBRA, OPTICIANS, HOLBORN VIADUCT,

TELEPHONE No. 6583.] SOLE AGENTS IN LONDON. [TELEPHONE No. 6583.

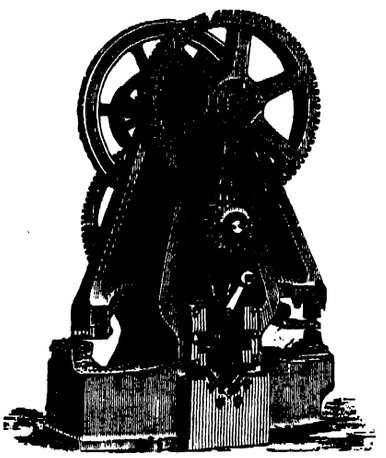
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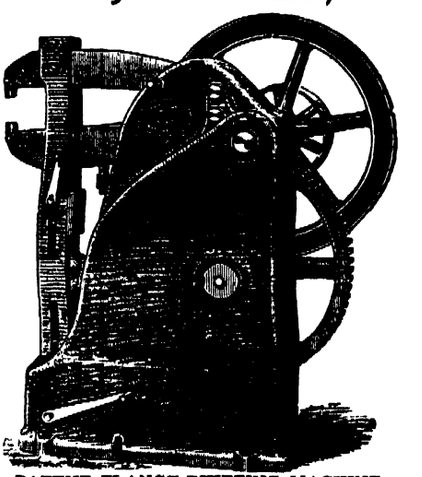
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CUTS ANGLE IRON 5×5×¾, any length cold.

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SHEAF WORKS, AND SPRING WORKS, SHEFFIELD.

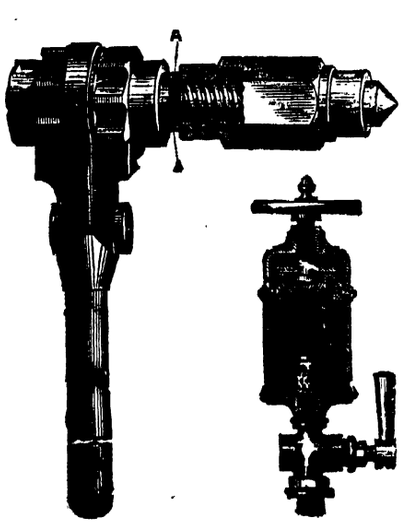
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PATENT DIFFERENTIAL RATCHET BRACE.—PATENT OPEN TOP SUET LUBRICATOR.



These BRACES, which have been several years before the public, and are MUCH APPRECIATED by them, NETTLEFOLDS have lately CONSIDERABLY IMPROVED by enclosing the SCREW in a SLEEVE (A) which always PROTECTS it from INJURY either from DIRT or BLOWS. This SLEEVE also acts as a GUIDE for the NUT, thus keeping it steady throughout the whole of its traverse, and consequently enabling the drilling to be effected with PERFECT ACCURACY.

The SUET LUBRICATOR has effected a saving of 70 per cent. in the cost of lubricating material used for Nettlefolds' Engines, and has now been fully tested in their works on 15 Cylinders working to 750-horse power.

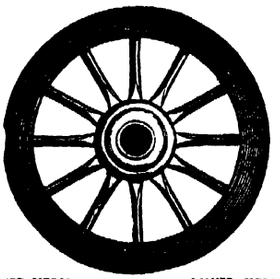
Messrs. HICKS, HARGREAVES & Co. write:—"We find the saving in *excess* of that stated in Messrs. Nettlefold & Chamberlain's Report—viz., 70 per cent., and the cylinders to which these Lubricators have been applied are in beautiful condition. We shall adopt them for all our engines."

By this Invention the steam is lubricated before passing to the valves, while the supply of grease is uniform and constant.

SOLD BY THE UNDERMENTIONED AGENTS:—

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LIVERPOOL	Sharp & Carline, 34, James Street.
MANCHESTER	Edmundsons & Co.
GLASGOW	W. McGeoch & Co., Schaffer & Budenberg.
EDINBURGH	Redpath, Brown & Co., Thos. Scott.
BRISTOL	Weston, J. D., & Son.
SHEFFIELD	Wilkes Brothers & Co., Tasker Sons & Co.
NEWCASTLE-ON-TYNE	Galloway & Co.
NOTTINGHAM	Manlove, Alliott, Fryer & Co.
BELFAST	Patterson, R., & Sons.
DERBY	Handyside & Co.
RUSSIA	Sumner, John M. & Co., Manchester.
AUSTRIA	Simon Henry, Manchester.
GERMANY	Schaffer & Budenberg Manchester. 765

OF WHOM PRICED LISTS AND FULL PARTICULARS MAY BE OBTAINED.



SILVER MEDAL SILVER MEDAL



WHEELS.

Made by Machinery, all sizes, for Carriages, Carts, Vans, Wagons, Cabs, Omnibuses, &c.

WHEELS.

Large Stock always on hand. Tyreing Repairs, and Special Orders executed at the shortest notice.

AXLES AND SPRINGS SUPPLIED.

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PRICES ON APPLICATION.

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PIMLICO WHEEL WORKS, 5113

BUCKINGHAM PALACE ROAD, LONDON.

JOHN BEATSON & SON,

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IRON and STEEL RAILS, of all sections, from 10 lbs. to 86 lbs. per yard—new perfect, new slightly defective, or second-hand; with Fish-plates, Bolts, and Nuts, Chairs, Spikes, and Points and Crossings to match, when required.
Steel and Iron Wire Ropes, Locomotive Engines, &c., &c.
Bars, Plates, Sheets, &c. Steel of all kinds. Pig Iron of all kinds. 5161
Delivered at all Railway Stations and Ports in Great Britain.

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A. EARNSHAW & CO.,

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MAKERS OF SUPERIOR

Slide and Screw-Cutting Lathes,

PLANING, SLOTTING, DRILLING, PUNCHING AND SHEARING MACHINES, &c. 4791

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We wish to call your attention to our newly-discovered

'Amorphous Phosphor Cake'

which is the best and cheapest method of making Phosphor Bronze without special skill or danger.

ALWAYS GOOD ALIKE!
ALWAYS ACTS ALIKE!

And is 50 per cent. less in cost for like results.

Sold in 7 lb. Cakes, 5/6 per lb.

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ORMEROD, CRIERSON & CO.,

St. George's Ironworks, Hulme, Manchester,

Have the largest assortment in the trade of

PATTERNS OF SPUR WHEELS, BEVEL WHEELS, AND MITRE WHEELS, WITH TEETH CUT BY MACHINERY.

Also Fly Wheels, Driving Pulleys, and Drums can be supplied Bored and Turned if required.
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THE PATENT SOLIDIFIED OIL

For Lubricating Ordinary and Steam-heated Journals, Engine and Steam-Hammer Slides, &c
And for use wherever Tallow or Suet is applicable as a Lubricant.

THE CHIEF FEATURES OF THIS LUBRICANT ARE—

1. ITS HIGH MELTING POINT—212° Fah. 2. THOUGH SOLID IT IS SOFT. 3. IT IS PERFECTLY NEUTRAL. 4. IT LASTS FOUR TIMES AS LONG AS TALLOW

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STERN AND RUDDER FRAMES,

FORGINGS

OF ALL KINDS

IN IRON AND STEEL.

Weight, 25 tons 10 cwt. ——————:=:——————

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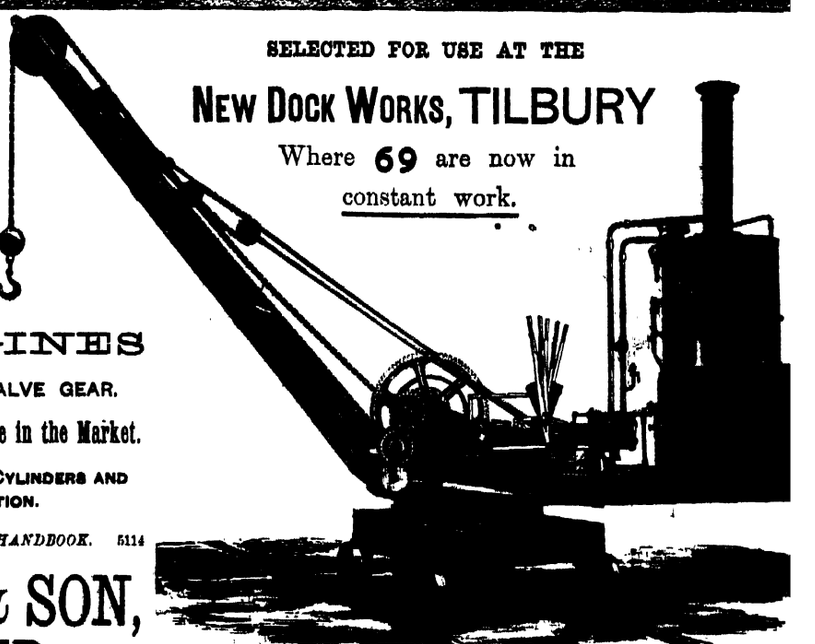
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—PUMPS,—
MILL ENGINES
FITTED WITH
COLLMANN'S PATENT VALVE GEAR.

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ALL OUR CRANES HAVE TWO CYLINDERS AND LINK REVERSING MOTION.

SEND FOR ILLUSTRATED HANDBOOK. 5114

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Where **69** are now in constant work.

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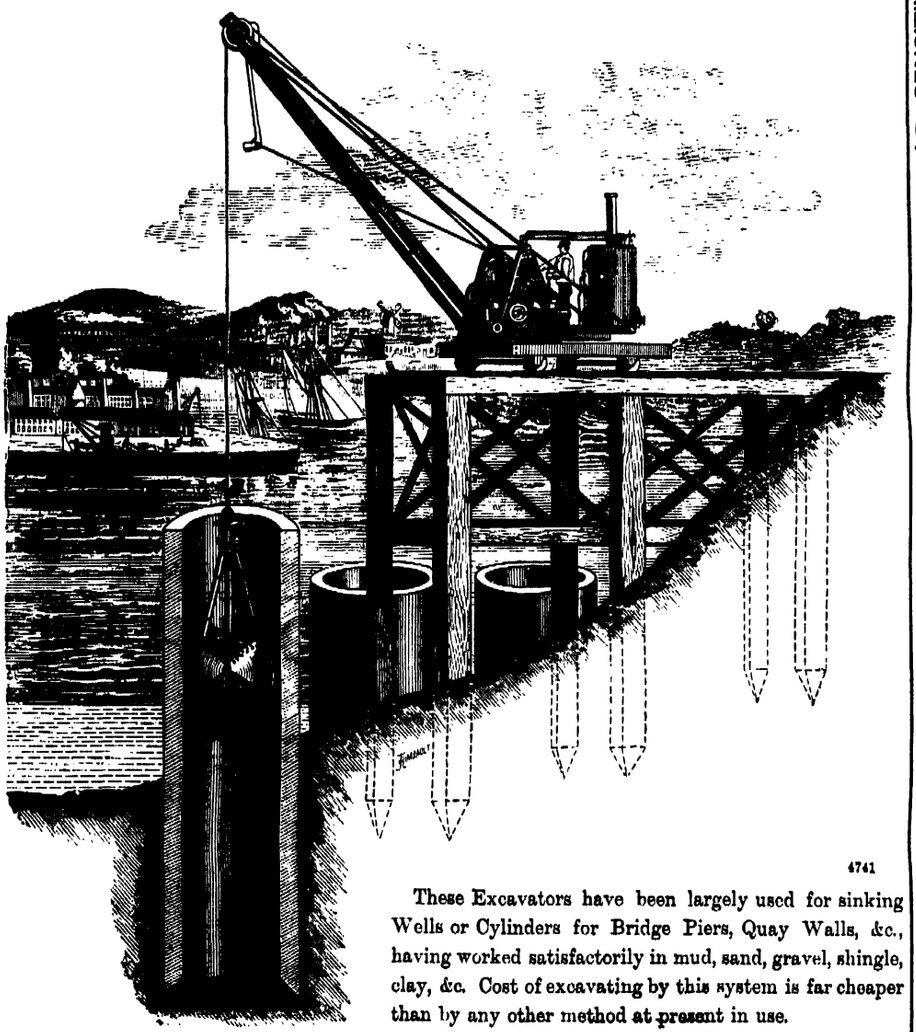
System of Dredging and Excavating,

9, VICTORIA CHAMBERS, WESTMINSTER, S.W.

EXCAVATORS

USED AT

London Docks,
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Cardiff,
Harwich,
Cork,
France,
St. Petersburg,
Benares,
Para,
Madagascar,
Poti,
Calcutta,
Singapore.

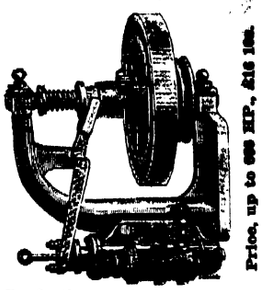


4741

These Excavators have been largely used for sinking Wells or Cylinders for Bridge Piers, Quay Walls, &c., having worked satisfactorily in mud, sand, gravel, shingle, clay, &c. Cost of excavating by this system is far cheaper than by any other method at present in use.

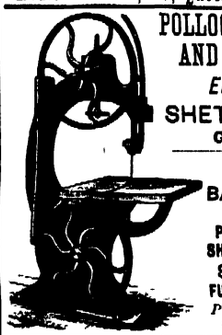
BLAIR'S IMPROVED MARINE
ENGINE GOVERNOR

SENSITIVE & RELIABLE.



Price, up to 600 HP., £16 10s.
Has been supplied to Number of Steamers.

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GEORGE BLAIR, 38, Queen St., Glasgow.



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SPECIALITIES:
BAND SAWING MACHINES.
PUNCHING AND SHEARING MACHINES
STEAM HAMMERS,
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Prices & Lithographs on application. 5176



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ALL ACCIDENTS DURING EMPLOYMENT.
GENERAL ACCIDENTS.
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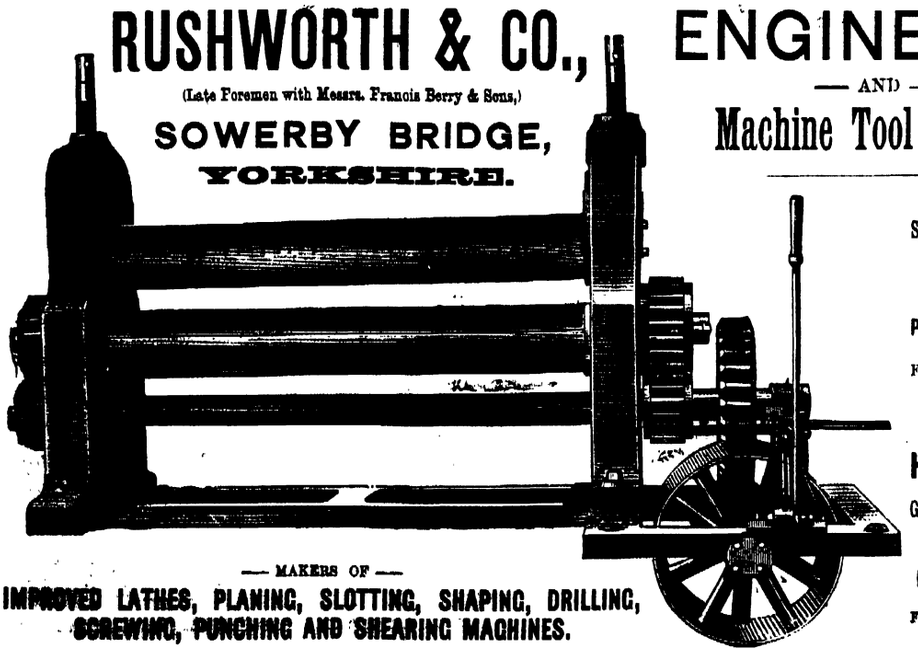
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ASSURANCE CORPORATION (Limited).
64 and 65, King William Street, London, E.C.
Capital £1,000,000. Fully subscribed £500,000.
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Persons insured about 800,000.
Names of workmen not required; premium charged on total wages at 2s. per cent. and upwards.
Protection granted during issue of Policy.
Reduced rates for GENERAL ACCIDENTS with bonus on all renewals.
Collective Fidelity Guarantee Policies for any number of persons.
Applications for Agencies invited.
S. STANLEY BROWN. 5227
General Manager.

JAMES GOODWIN AND COMPANY,
Ironfounders, Engineers, and Bridge Builders.
CONTRACTORS for RAILWAY PLANT, viz.: Cast Iron Chairs, Sleepers, Tanks, Water Cranes, Axle Boxes, Screw Piles for Bridges, Piers, and Wharfs, Blast Furnace Castings, Ingot Moulds, and every description of Plant for Collieries, Iron Works, &c. Also all kinds of Castings for Engineers and Tool Makers. Manufacturers of Iron and Steel Bridges, Iron Roofing and Buildings, and General Structural Work. (Bridge Works at Motherwell). 2347
Works: Ardrossan, Johnstone, and Motherwell.
Shipping Ports: Ardrossan, Glasgow, Greenock, Leith.

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— MAKERS OF —
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ENGINEERS,

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SPECIAL MULTIPLE PUNCHING & SHEARING MACHINES
FOR GAS HOLDER AND TANK MAKERS.

STEAM HAMMERS

Geared & Steam Riveting Machines, &c.

PLATE EDGE PLANING MACHINES,
For Boiler Makers and Ship Builders. 5163

WATER PURIFICATION

JOHN HENDERSON PORTER, PATENTEE,
1 & 2, TUDOR STREET, LONDON, E.C., furnishes the necessary Plant.

The PORTER-CLARK PROCESS

Removes the Carbonates of Lime, Magnesia, and Iron from Hard Waters, and thus, the **causes of Incrustation in Boilers and Pipes.** This Process is in use in Paper Mills, Breweries, Sugar Works, India-rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c. One Railway Company employs it for feed-water to the extent of **1,000,000 gallons** daily, and one of the London Water Companies at two of its Pumping Stations. It is also in use in County Asylums, Public and other Schools, and Private **Mansions.** The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich, are rendered soft and clear. 5226

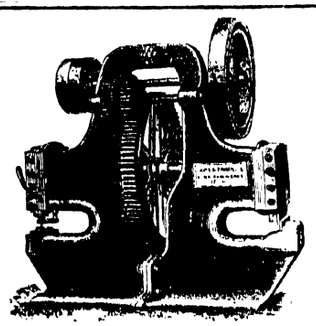
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New Patent Barring Engine.

AUTOMATIC MOTION FOR MOVING INTO GEAR, AND FALLS OUT OF GEAR AUTOMATICALLY WHEN MAIN ENGINE STARTS.

The SIMPLEST, SAFEST and BEST, and also the CHEAPEST Automatic Safety Apparatus for Turning Main Engines.

Sole Makers: HICK, HARGREAVES & CO., ENGINEERS, MILLWRIGHTS, AND BOILER MAKERS.
SOHO IRONWORKS, BOLTON. 5199

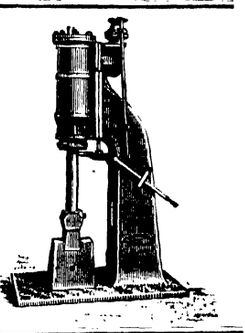


DAVIS AND PRIMROSE,

ETNA IRONWORKS, BANGOR ROAD, LEITH, N.B.

IMPROVED DOUBLE-ACTING STEAM HAMMERS

For Forges, Smithies, Stamping, &c.
AWARDED THE
FIRST PRIZE at SYDNEY EXHIBITION, 1880.
Sizes from 1¼ cwt. to 12½ cwt. usually in Stock. 4377
Punching and Shearing Machines, Shipbuilders' and Boiler Makers' Tools, &c.



P. R. JACKSON & COMPANY,

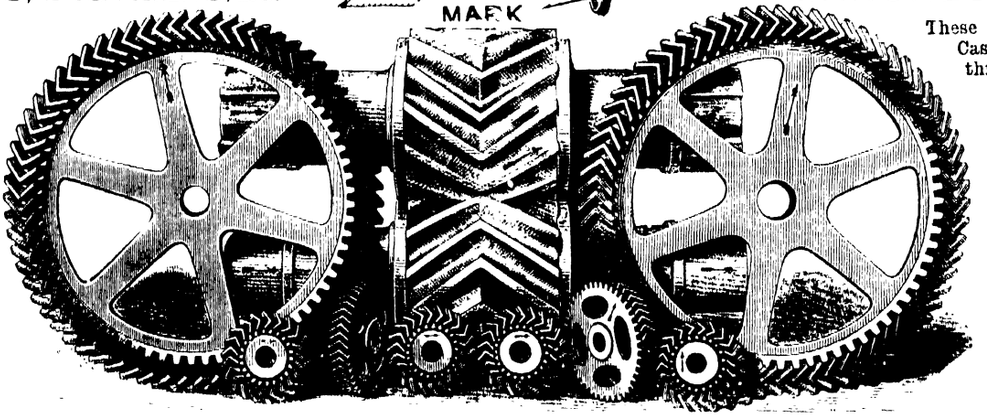
STEEL AND IRONFOUNDERS
MILLWRIGHTS, ENGINEERS, &c.

TRADE MARK

SALFORD ROLLING MILLS,
MANCHESTER.

MANUFACTURERS OF
JACKSON'S
Machine-Moulded
Spur, Bevel, AND Worm Wheel
CASTINGS.

PULLEYS
EITHER FOR
Straps or Ropes,
Spur or Bevel
Mortice Wheels
with Machine
cut Cogs.



These Steel or Iron Wheel Castings can be obtained through almost any Engineer, Millwright, or Machinery Merchant.

Care should be taken to specify

"P. R. Jackson & Co.'s MACHINE-MOULDED WHEELS."

And each Wheel should bear the above TRADE MARK.

Fly Spur Wheels Rope or Strap Pulleys to 30 ft. diameter, bored, turned and key-grooved by Machinery, and erected when required.

MAKERS OF RAMSBOTTOM'S PISTONS & PISTON PACKING RINGS, in Iron, Steel, or Brass. More than 28,000 of these Pistons are at work. 4330

WALKER'S PATENT
HYDRO-CARBON FURNACE AND APPARATUS.

This Furnace and Apparatus makes one ton of oil do the heating duty of three tons of coals for the generation of steam

For further particulars, apply to
ROBERT WALKER, C.E., Consulting Engineer,
"The Patent Hydro-Carbon Furnace and Apparatus Company, Limited," 5146
7, UNION COURT, OLD BROAD STREET, E.C.

COAL PRODUCTS

JAMESON'S COKING PROCESS

Applicable to any ordinary coke oven and all descriptions of coal.

Over 800 ovens are already at work or arranged for by owners of over 10,000 ovens

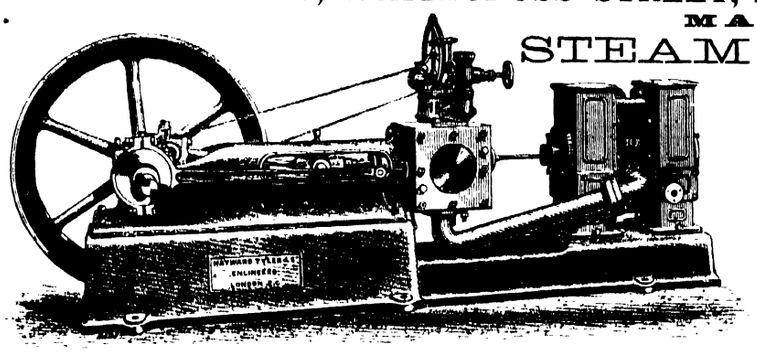
At a nominal cost this process saves the volatile products of coal and rich burning gas, and gives increased yield of coke of improved quality.

FOR PARTICULARS APPLY TO 4822
JAMESON'S PATENT COKING CO., Ltd.,
ST. NICHOLAS CHAMBERS, NEWCASTLE-ON-TYNE

HAYWARD TYLER & CO.,

84 & 85, WHITECROSS STREET, LONDON,

MAKERS OF
STEAM ENGINES

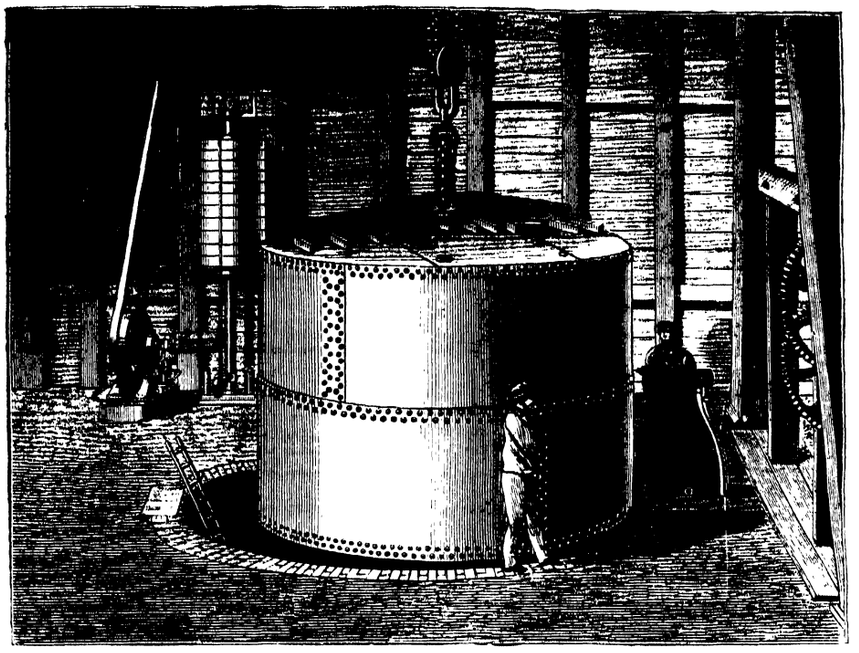


The BRAMAH ENGINES, High Pressure, 3 to 10 HP.
Ditto, Condensing
(for Chemical Works, &c., where low pressure steam is used).
The TUBE GIRDER ENGINES, High Pressure, 6 to 60 HP.
Ditto, Condensing.
The STANDARD HORIZONTAL ENGINES, High Press., 6 to 60 HP.
Ditto, Condensing.

4930

COMPOUND CONDENSING ENGINES, 30 to 300 HP., with Rider's Patent Automatic Expansion, controlled only by the Governor.

HYDRAULIC RIVETTERS



OF THE MOST RECENT TYPES.

Punching, Shearing, Bending, Forging, Hoisting,

AND OTHER HIGH-PRESSURE

HYDRAULIC MACHINERY

Please Note Change of Address:

ANDERSON & CALLWEY

Hydraulic Labour-Saving Machine Makers,

CREMORNE WORKS, 4985

CHELSEA, LONDON, S.W.

STOLLWERCK'S PATENT FEEDWATER PURIFYING APPARATUS,

APPLICABLE TO ALL KINDS OF STEAM BOILERS,

Increasing their POWER, preventing INCRUSTATION, and thus effecting GREAT ECONOMY in FUEL.

NO CHEMICALS USED. ENTIRELY SELF-ACTING.

NO EXPENSE IN WORKING. CANNOT GET OUT OF ORDER.

FOR FULL PARTICULARS, ADDRESS:

CONRAD KNAP, 11, QUEEN VICTORIA STREET, LONDON, E.C.

LICENSE TO MANUFACTURE GRANTED TO BOILERMAKERS. TERMS ON APPLICATION. 5087

THE

EMPIRE LUBRICATOR COMPANY

EMPIRE WORKS,

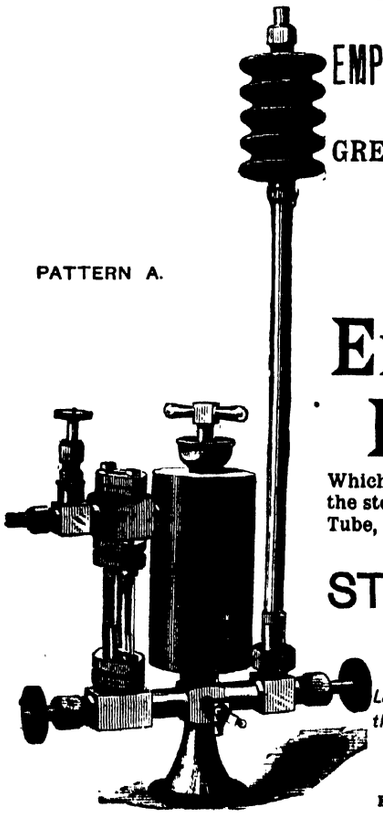
GREAT BRIDGEWATER ST.,

MANCHESTER.

MANUFACTURERS OF

GRANDISON'S

Empire Lubricator



PATTERN A.

Which shows each drop of oil passing into the steam through the medium of a Glass Tube, and is the BEST APPARATUS now known for Lubrication of

STEAM ENGINES,

LAND OR MARINE.

Lubricators sent on approval to any part of the kingdom, and references given to users in all parts of the inhabited world.

4763

FURTHER PARTICULARS ON APPLICATION.

RAGOSINE OIL

THE RUSSIAN NATURAL LUBRICATING OIL. Gold Medal, Paris, 1878.

Pure Hydro-carbon, free from acid. Body superior to Olive or Lard Oil | Never gums or clogs. Never freezes or thickens.

No. V 2s. 6d. PER CAL.

RAGOSINE & CO.,

7, IDOL LANE, LONDON, E.C.,

And Love Lane, Quayside, Newcastle on-Tyne.

Works—BALACHNA and CONSTANTINOW, RUSSIA.

Price Lists and full particulars on application 4779

No. VIII 2s. 0d. PER CAL.

HANSON'S SPECIALITIES

Steam Pumps, Steam Engines, Steam Winches, Steam Dryers, Steam Traps, Steam Reducing Valves, Steam Purifying Apparatus for Boilers, Water Engines and Hoists for Warehouses.

WILLIAM HANSON,

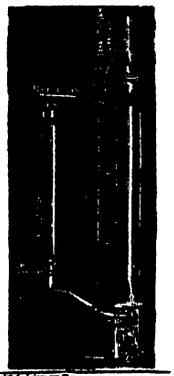
QUEBEC WORKS, BRADFORD.

LONDON OFFICE: 37, WALBROOK. 5227

(See Illustrated Advertisement June 13th, page 40.)

TAYLOR & CHALLEN,
ENGINEERS,
BIRMINGHAM.

SOLE MAKERS OF
WITHINSHAW'S PATENT
Feed Water
HEATER.

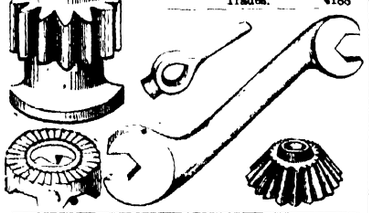


The most powerful invented.
Great Saving in Boilers, Coals, and Labour.
LARGE HEATING SURFACE
Solid Drawn Brass Tubes.
Free Expansion.
No Scurf adheres to the Tubes.
—o— 4837
List on application.



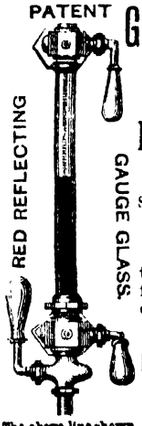
MATHER'S PAN MILL
For Red Lead, Putty, Crushing Lumps, &c.
What Users of Machine say:
Messrs. Gwynne & Co., London: "Are satisfied with it." Hayward Bros. & Co., London: "It saves time, &c." Mr. H. Mobbs, Northampton: "I am satisfied with it." Mr. W. Allchin, Northampton: "It is most useful." Messrs. Clayton & Shuttleworth, Lincoln: "We like it very much" Messrs. Tangye Bros., Birmingham: "Work is better than hand." Messrs Foster & Co., Lincoln: "We think it well worth the money." 5104
Price with handle £1 18s. As above sketch, £2 2s.
G. R. MATHER, WELLINGBOROUGH, ENGLAND.

W. R. PALMER,
LIMITED,
BACOT STREET FOUNDRY,
BIRMINGHAM.
Manufacturers of
MALLEABLE IRON CASTINGS.
Guaranteed true to Pattern, of best Qualities, and at Low Rates.
Castings for the Bicycle and Tricycle Trades. 4188



GOLD MEDAL, PARIS, 1878.

GAUGE GLASSES
AND
ENAMELS
For Iron, Cast-iron, Copper, &c.



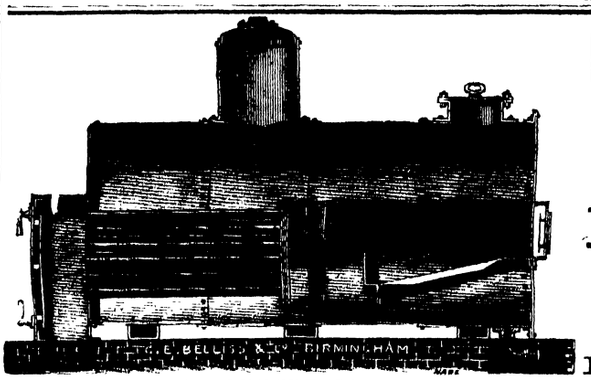
PATENT GUILBERT MARTIN
Patentee and Manufacturer of the
PATENT
RED REFLECTING GAUGE GLASS,
Showing through the water a Broad Red Line.
N.B.—All Glasses are of the finest quality, and manufactured expressly to resist extreme pressure.
DEPÔT:
1 & 2, FALCON STREET,
Aldersgate Street,
LONDON, E.C.
The above line shown in black is of a rich Red. 5002
REPRESENTED BY E. M. HAMBURGER.

Highest and only First-Class Award at the Calcutta International Exhibition, 1883-4.

TRAMWAYS DICK, KERR & CO., TRAMWAYS



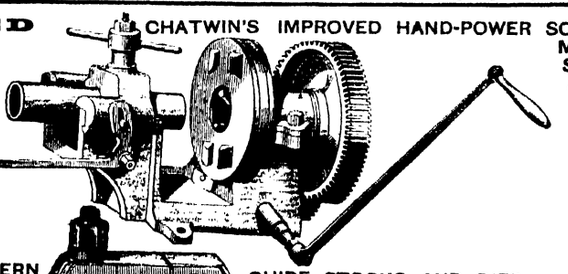
Over 150 miles of Line now laid in England on the above systems.
BUILDERS OF TRAMWAY LOCOMOTIVES AND TRAMWAY CARS. 501
Estimates, Specifications, and Drawings on application to HEAD OFFICE: 101, LEADENHALL STREET, LONDON, E.C.
WORKS: BRITANNIA ENGINEERING WORKS, KILMARNOCK.

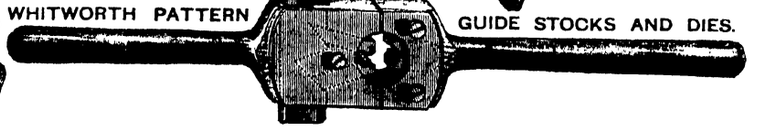


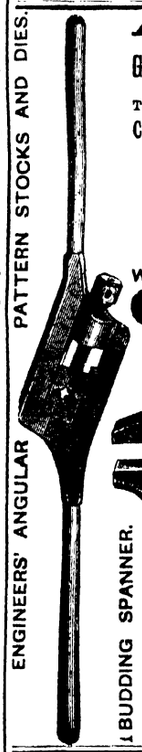
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ENGINEERS' ANGULAR BUDDING SPANNER.

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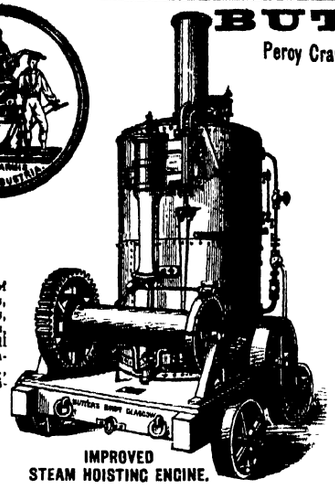
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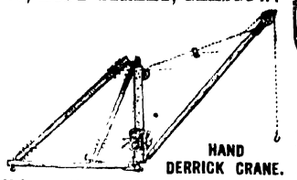
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IMPROVED STEAM HOISTING ENGINE.



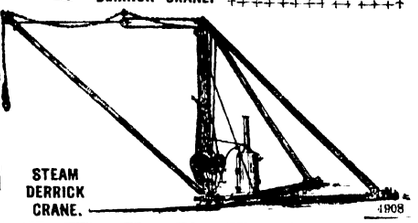
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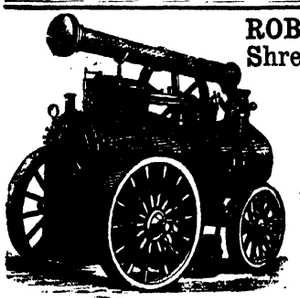


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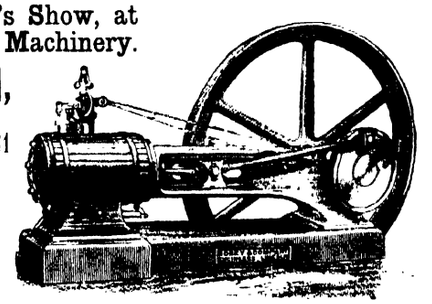


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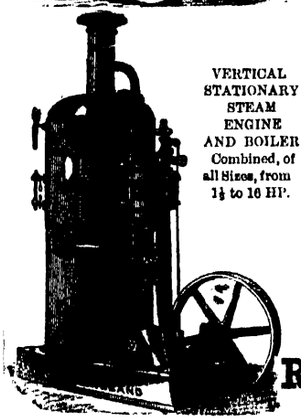
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PARIS, 1878, GOLD MEDAL.

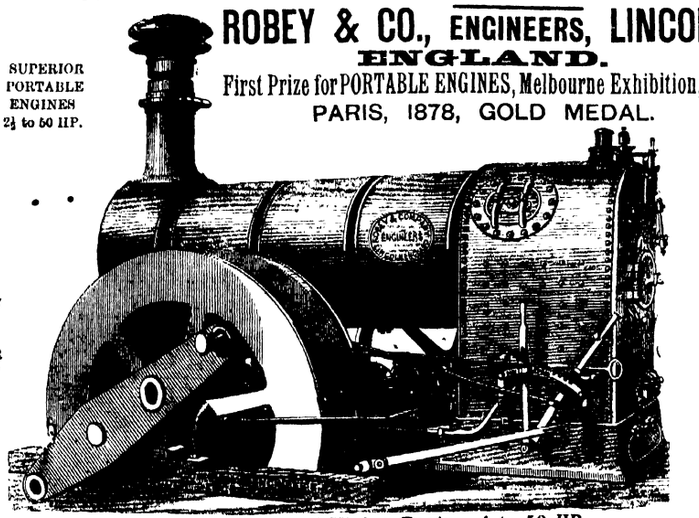


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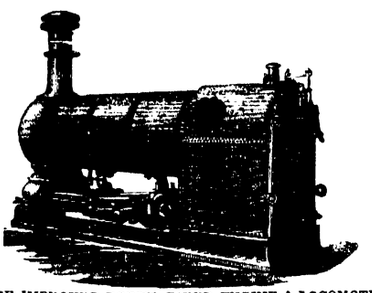
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VERTICAL STATIONARY STEAM ENGINE AND BOILER Combined, of all Sizes, from 1½ to 16 HP.



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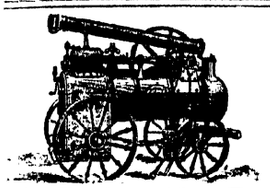


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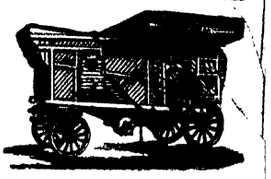
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Awarded Prize Medals at Paris, London, Vienna, Manchester, Leeds, Falmouth, and the Exhibitions in America.

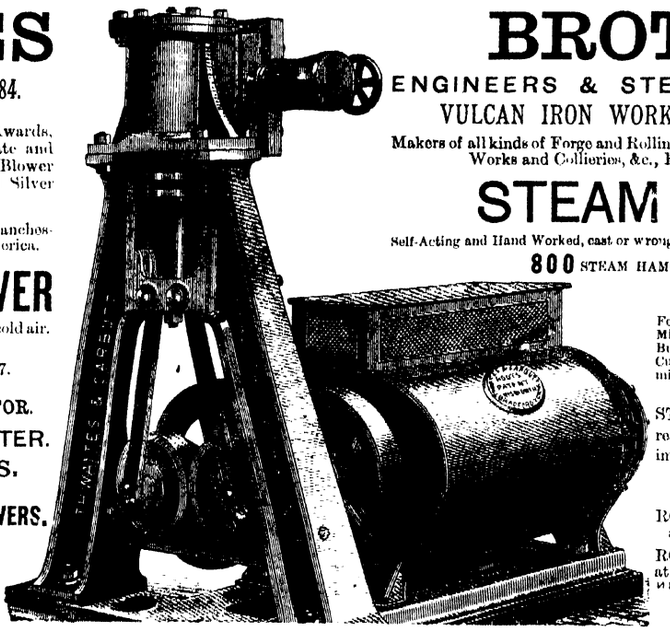
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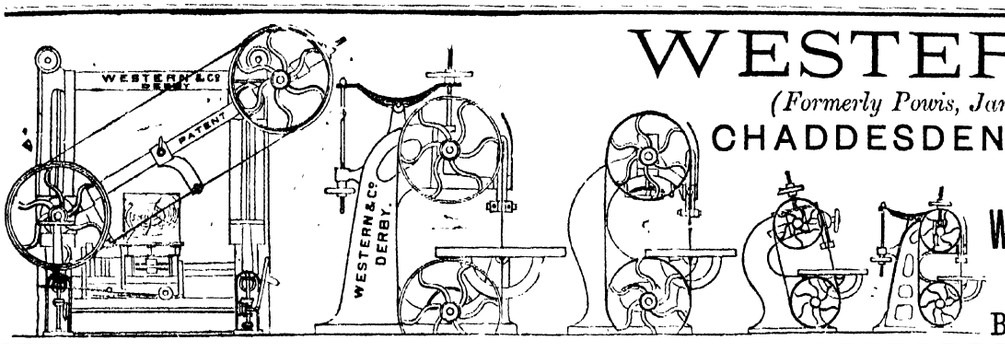
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Price Lists and Particulars on application. 4391



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The Bedford Press, 20 & 21, Bedfordbury, in the Parish of St. Martin-in-the-Fields, and Published by CHARLES GILBERT, at the Offices of ENGINEERING, 35 & 36, Covent Garden, both in the County of Middlesex.—Friday, July 11th, 1884.

Registered at the General Post Office as a Newspaper.

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.

VOL. XXXVIII.—No. 968.] *LONDON: FRIDAY, JULY 18, 1884.* [DOUBLE NUMBER WITH INDEX } PRICE...1s. (By Post .1s. 4d.

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With a Two-page Engraving of the BESSEMER BLOWING ENGINES for the Heft Steel Works, near Huttenberg, Carinthia.

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designed and constructed by

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Boyne Engine Works, Leeds. 2487

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Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough. 5206

See Illustrated Advertisement last week, page 43.

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Any other Engine.

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See Advertisement, page 51 3627

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The Patent Corliss Engine And PATENT CORLISS GEAR ENGINE, with special Improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N.B. These engines are made Horizontal or Beam, Condensing, Non Condensing, and Compound. Also makers of Rice Mills, and Paper Mills, and General Engineers. Machinery shipped or trucked direct from the premises. Makers of

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See Illustrated Advertisement last week, page 14

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Self-Starting Gas Engine.

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BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881.

GOLD MEDAL,

CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifiers,

WITH

STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels,

Emery Machines,

Spiral Springs.

The Crown Iron Works, GLASGOW.

The Crown Iron Works (Hollinwood), MANCHESTER.

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City Office and Show Rooms, 40, CANNON STREET, E.C.

10, Rue Laffitte, PARIS. 2588

University College, London.—

DEPARTMENT OF APPLIED SCIENCE AND TECHNOLOGY.

ENGINEERING & MECHANICAL TECHNOLOGY. —Professor ALEX. B. W KENNEDY, M. Inst. C.E., M. Inst. M.E.

CIVIL ENGINEERING.—Professor L. F. VERNON HARCOURT, M.A., M. Inst C.E

ARCHITECTURE. — Professor T. ROGER SMITH, F.R.I.B.A.

CHEMICAL TECHNOLOGY. — Professor CHAS. GRAHAM, D. Sc F.I.C.

Lectures and Practical Work in Engineering and Chemical Laboratories COMMENCE 3rd October.

Prospectuses may be obtained from the College, Gower Street, W.C. G 533

TALFOURD ELY, M.A., Secretary.

TENDERS.

INDIA OFFICE,
17th July, 1884.

BY ORDER OF THE SECRETARY OF STATE FOR INDIA IN COUNCIL.

INDIAN STATE RAILWAYS.

The Director General of Stores for India is prepared to receive

Tenders from such Persons

as may be willing to SUPPLY TWO VERTICAL COMPOUND CONDENSING STATIONARY ENGINES

The Conditions of Contract may be obtained, and the Drawings inspected on application to the Director General of Stores, India Office, Westminster, S.W., and Tenders are to be left at his Office at any time before Two o'clock p.m. on Tuesday, the 26th July, 1881, after which no Tender will be received.

A. ABERCROMBIE JOPP, G 549
Director General of Stores.

EAST INDIAN RAILWAY COMPANY.

The East Indian Railway Company is prepared to receive

Tenders for the Supply and

DELIVERY of:
BESSEMER STEEL RAILS, and
WROUGHT-IRON TIE BARS, KEYS and COTTERS,

as per Specifications and Drawing to be seen at these Offices

Tenders are to be delivered in sealed envelopes, addressed to the undersigned, marked "Tender for Bessemer Steel Rails," or, as the case may be, not later than One o'clock p.m., on Thursday, the 24th day of July instant

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
A. P. DUNSTAN,
Nicholas Lane, London, E.C. Secretary.
10th July, 1884 G 515

LANCASHIRE AND YORKSHIRE RAILWAY

The Directors are prepared to receive

Tenders for the whole of the

WORKS REQUIRED (except Ironwork) in connection with the alteration of levels, deviation of line, and new lines and new Exchange Station at Liverpool

Drawings and Specification can be seen, and Quantities and Forms of Tender obtained from the Engineer's Office, Hunts Bank, Manchester, on and after Monday, the 21st inst

Tenders addressed to the Directors, and endorsed "Tender for Alteration of Levels, Deviation of Line, and New Lines and New Exchange Station, at Liverpool," to be in the hands of the undersigned, not later than Ten o'clock on Monday morning, the 25th August proximo.

J. H. STAFFORD,
Hunts Bank, Manchester, Secretary
12th July, 1884 G 518

HULL CORPORATION.

SPYVEE STREET BRIDGE. CONTRACT No 2

TO ENGINEERS AND CONTRACTORS

The Corporation of Kingston-upon-Hull are prepared to receive

Tenders for the Ironwork

(comprising about 70 tons wrought iron and 10 tons cast iron) for a Bridge across the Sutton Drain at Spyvee Street.

The Plans may be seen at this Office, where also copies of the Specification and Form of Tender may be obtained, after Wednesday, the 16th inst, upon payment of Two Guineas, which will be returned to parties tendering in accordance with the Specification

Tenders endorsed "Tender for Spyvee Street Bridge, Contract No 2," are to be addressed to the Chairman of the Works Committee, and delivered under cover to C. S. Topp, Esq., Town Clerk, Hull, on or before Thursday, the 31st day of July, 1884

The Corporation do not bind themselves to accept the lowest or any Tender

By order,
Town Hall, J. FOX SHARP, G 513
Hull, 9th July, 1884 Borough Engineer

LANCASHIRE AND YORKSHIRE RAILWAY.

The Directors are prepared to receive

Tenders for the whole of the

CAST and WROUGHT IRONWORK required in connection with the alteration of levels, deviation of line, and new lines and Station at Liverpool, including the principles, girders, and columns of new roof, girders, floorplates, &c, required in subway and cab approach; girders, floor plates, and columns, &c, required for Bridges over Leeds Street and Waterloo Tunnel, and Viaduct between Leeds Street and Chadwick Street

Drawings and Specification can be seen, and Quantities and Forms of Tender obtained from the Engineer's Office, Hunts Bank, Manchester, on and after Monday, the 21st inst.

Tenders addressed to the Directors, and endorsed "Tender for Ironwork required, New Exchange Station, &c., Liverpool," to be in the hands of the undersigned, not later than Ten o'clock on Monday morning, the 25th August proximo.

J. H. STAFFORD,
Hunts Bank, Manchester, Secretary.
12th July, 1884. G 519

THE BRYMBO STEEL CO., Ltd., Wrexham, are open to receive

Tenders for Heavy Anvil

BLOCK CASTINGS. The largest to weigh 35 tons Particulars on application. G 523

SINGAPORE TRAMWAYS.

KER, BOLTON & CO., Glasgow, are prepared to receive

Tenders for the Supply, f.o.b.,

of the necessary IRON or STEEL SLEEPERS and relative FIXINGS required for the Singapore Tramways, according to Drawings and Specifications to be seen on and after 21st July, at the Office of JOHN STRAIN, C.E., 154, West George Street, Glasgow, from whom a Copy of the Specification and Form of Tender may be obtained on payment of One Guinea, which will not be returned.

Tenders addressed "Singapore Tramways" to be lodged, not later than Tuesday, 5th August, with KER, BOLTON & Co, who do not bind themselves to accept the lowest or any Tender. G 536

APPOINTMENTS OPEN.

The Royal Indian Engineering College, Cooper's Hill, Staines

APPOINTMENT OF PROFESSOR OF HYDRAULIC ENGINEERING AND MECHANISM.

This appointment becomes vacant in Sept., 1884.

The salary is £600 (first year £450 only), with bachelor quarters in the College (partly furnished), including the use of coals and gas

The new appointment will be made by the Secretary of State for India, on the recommendation of the President of the College

A statement of the duties may be obtained from the Secretary of the College, to whom also applications for the appointment, accompanied by testimonials, may be made before the 23rd July next. G 421

County or District Surveyorships in Ireland.

An OPEN COMPETITION for Two County or District Surveyorships in Ireland, will be held in Dublin, in August next, under the Acts 7 and 8 Vict., c. 106, and 25 and 26 Vict., c. 106

The Examination will extend over the four days commencing with 12th August, and the six days commencing with 26th August, and will be in the following branches of knowledge:—

PART I.	Maximum of Marks.
Mathematics—including Geometry, Trigonometry, Algebra, Differential and Integral Calculus, and Geometrical Optics	100
Mechanical Philosophy—including Statics and Dynamics, Hydrostatics and Hydraulics, Pneumatics, and Heat regarded as a source of Power	100
Experimental Science including Inorganic Chemistry, Heat, Electricity, and Magnetism	100
Geology and Mineralogy	40

No Candidate will be eligible who does not show some proficiency under one at least of the heads included in Part I

PART II	Maximum of Marks.
Strength and other Properties of Materials, and the Calculation of Strains	100
(A) Railway and Canal Engineering	140
(B) Marine Engineering—including Harbour, Dock, Sea, and Reclamation Works	140
(C) Hydraulic Engineering — including Water Supply, Sewage, and Irrigation	140
(D) County Works including Architecture, Roads, Drainage, and River Works	140
	1000

*** Each of the groups lettered A, B, C, D, to include Designs, Estimates, Specifications, and the mechanical contrivances connected with it, and Candidates will be required to show that they have been engaged in the practice of their profession on adequate work satisfactory opportunities of becoming acquainted with the practice of their profession in some one of the branches thus indicated

Limits of age, 26 and 40.

Persons wishing to compete for those appointments, or to be reported qualified to act as Deputies to County Surveyors, must make written application to the SECRETARY, Civil Service Commission, London, S.W.

No person will be admitted to compete from whom the Secretary, Civil Service Commission, has not received, on or before the 1st August, an application on a prescribed form, which may be obtained from him at once

Such enquiries as may be necessary will be made by the Civil Service Commissioners, with regard to the age of Candidates, and also as to their health and character

NOTE.—All the Candidates who reach the prescribed standard, and furnish the required proof of age, health, character, and professional training, will, if they so desire it, be certified. Two of them will be appointed County Surveyors, and the others will be eligible to act temporarily as Deputies, but will have no claim to be appointed County Surveyors

Dublin Castle, June 28th, 1884. G 472

Foreman Wanted in Dublin,

about the end of August, to take sole charge of the Engineering Department of our business, employing a small number of fitters, turners, and smiths. Must be a man of all round experience, a good manager of men, able to direct in every detail, a good estimator and draughtsman. The work is of a very general character Repairs of gas and steam engines, printing and wood working machinery; also the manufacture of some specialities in tools, working out inventions, &c. A liberal salary will be paid to a competent man

Apply at once, giving full particulars of previous experience, stating age, and salary expected (without which no replies will be attended to), to BOOTH BROTHERS, Dublin G 526

Wanted, Foreman to take

charge of Iron and Brass Foundry, none but first class men, accustomed to Locomotive and Tool work need apply.—BEYER, PEACOCK & CO., Limited, Gorton Foundry, Manchester G 540

Wanted, by the Kirkstall

FORGE CO., Leeds, FOREMAN over their patent rolled shafting department. Must be a thoroughly good all round mechanic G 530

Wanted, a neat and expe-

ditious DRAUGHTSMAN, who has had experience in railway rolling stock, &c. — State age, salary required, &c., to X. Y. Z., Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. G 529

Wanted, at once, a capable

and quick Mechanical DRAUGHTSMAN, experienced in good economical engine and general work. Apply by letter, stating age, experience and salary required, to T. D. DEWDNEY, 1 & 2, Fenchurch St., E.C. G 542

Wanted, Two efficient Loco-

MOTIVE DRAUGHTSMEN.—Address, stating experience and salary, SHARP, STEWART, & CO., Limited, Atlas Works, Manchester. G 538

Lists of Berths Vacant or

WANTED. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5262

SITUATIONS WANTED.

An Engineer (Medallist of

Institute), desires ENGAGEMENT; good chemist and electrician.—Address, P. J., at C. H. MAY and Co.'s General Advertising Offices, 78, Gracechurch Street. G 550

To India Rubber Manufac-

TURERS. A Gentleman of considerable experience in Mechanicals, and with a first-class connection amongst merchants, steamship owners, &c., will shortly be open to REPRESENT a good house. Address INDIA RUBBER, care of FERGIE & TURNER, Advertising Offices, 21, Queen Victoria Street, London, E.C. G 551

The Advertiser is open to un-

dertake AGENCIES in Manchester and District for the Sale of general Gas Apparatus, &c., and materials used by gas companies, or to represent one firm only, highest references.—Apply, by letter, to Y., MESSRS STREET BROTHERS, 5, Serle Street, Lincoln's Inn G 546

PARTNERSHIPS.

Partnership in the Colonies.—

An important Firm of Manufacturing Engineers doing a large trade, and employing several hundred hands, with modern works and plant, DESIRE a thoroughly experienced GENERAL ENGINEER to JOIN them, and take active management. He must invest £5,000 to £10,000, and be accustomed to the management of large bodies of mechanics.—Apply to No 746, WHEATLEY KIRK, PRICE AND GOULTY, 52, Queen Victoria Street, London, E.C. G 527

Partnership.—Experienced

Auctioneer, Valuer and Accountant (Sussex) wants a Young Gentleman of good business habits as JUNIOR PARTNER. Increasing connection.—H. C., HORNCASTLE'S, 61, Cheapside, E.C. G 544

WANTED, &c.

Wanted, Strong Second-hand

Treble Geared GAP or PIT LATHE; headstocks, 18 in. to 24 in.; bed to slide, so as to take in about 12 or 16 ft. diameter and 4 ft. wide; length of bed, 14 to 18 ft.—Address, ADAIR & CO., 17, Neptune Street, Liverpool. G 525

Wanted, a 5 ton Weighbridge

(Second hand). Address, F. G. H., 51, Graham Road, Wimbledon. G 528

Agents Wanted for the Sale

of TIN PUTTY POWDER for needle makers. Apply, stating references, to R 4828, care of RUDOLF MOSSE, Cologne. G 489

Agents Wanted, to push First-

class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool. 5233

Lists of Machinery Wanted or

on SALE See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5262

FOR SALE.

For Sale, Twelve Tramway

LOCOMOTIVES, 4 ft 8½ in. gauge, in good working order.—For particulars address THE ROUEN TRAMWAY COMPANY, Rouen, France G 548

For Sale, being superseded by

engines of higher power, a pair of High Pressure COMPOUND STEAM ENGINES. Cylinders, 26 in. diam., 3 ft. 6 in. stroke, with cold water pump for same.—Can be seen at work at the Manufactory of the LONDON PORTLAND CEMENT CO., Ltd., Northfleet, Kent, to whom enquiries may be addressed G 534

TO BONE AND SEED CRUSHERS AND MANURE MANUFACTURERS
VALUABLE LEASEHOLD MILLS.

To be Sold, the Largs Bone

and Seed Crushing Mills, three miles from the Port of Kirkcudbright, and one mile from Tarff Railway Station, occupying 4½ acres of land adjoining main road Worked by steam and water, the latter a 10 horse-power turbine wheel supplied by a stream running through the land, giving an almost constant water supply. The Bone Mill has been erected five years, and the Seed Mill two years. The Machinery is nearly new and in first rate condition The premises, which are held on about nine years' Lease, comprise all necessary apparatus and utensils for carrying on a large manure and seed crushing trade. There is a good trade attached, the mills being situated in an important agricultural district. Immediate possession.—For full particulars and cards to view, apply to Messrs. ROOSE, PRICE & CO., Chartered Accountants, 26, North John Street, Liverpool, or to Messrs. FIELD & WEIGHTMAN, Solicitors, Fenwick Street, Liverpool. G 520

To Engineers.—Business to

be SOLD as a GOING CONCERN (with foundry), established some years and doing a good business in repairs, situate in pleasant suburb, free from competition, new and suitable machinery. Price, including Plant, Lease, Goodwill, &c., £900.—Apply to Mr. BRADSHAW BROWN, Auctioneer and Valuer, 59, Fenchurch Street, E.C., and Estate Offices, Millwall, E. G 543

For Sale, Stencil Plates.—

Mahogany case, containing Ten sets of Alphabets (various), Five sets of Figures, and Fifty Plates as used upon engineers' drawings. Price, 30s.—Apply to G. BAKER, 22, Orpingley Rd., Hornsey Rd., London, N. G 541

For Immediate Sale, at low

prices for cash.

SECOND-HAND.

LANCASHIRE BOILER, 18 ft. 3 in. by 7 ft. diameter.
CORNISH BOILER, 12 ft. by 4 ft. diameter.
VERTICAL CROSS TUBE BOILER, 7 ft. 6 in. by 3 ft. 3 in. diameter.
TANK LOCOMOTIVE, 4 wheels coupled, cylinders 10 in. by 20 in.
A New 9 HP. CHAPLIN'S LOCOMOTIVE.
5 ft 6 in. FACE PLATE LATHE, by Whitworth.
RAIL STRAIGHTENING MACHINE, with engine attached, by Collier.
No. 6 ROOT'S BLOWERS, by Thwaites.
Two No. 4½ PATENT BLOWERS, by Ellis.
Two SCOTT WHEEL MOULDING MACHINES.
10 ton RAILWAY WEIGHING MACHINE.
STEAM WINCHES, from 5 in. to 7 in. cylinders.

For prices and full particulars of any of above apply to "PHILLIPS' MONTHLY MACHINERY REGISTER," Newport, Mon. 4804

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PLANT FOR SALE.—8, 5, 4, 3, 2, 1½, 1 ton, and 15 cwt. Hand Derrick Cranes; 5, 7, and 10 in Centrifugal Pumps, with foot valves and pipes to suit; Upright Boiler, 8 ft. by 3 ft. 9 in., with two cross tubes and mountings complete Piling Engines, single and double power Crab Winches, Overhead Travellers, &c., &c.—Apply to ROBERT A. KING, 130, Waterloo Street, Glasgow. G 524

Railway Plant and General

ENGINEERING WORKS (small), in Eastern Counties, FOR SALE as going concern. Contracts now in hand.—For full particulars address, G 537, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 537

A No. 1 Second-hand Sissons

and White's STEAM PILE DRIVER FOR SALE. —Apply, SISSONS & WHITE, Hedon Rd., Hull. G 532

Finnigan's Patent Horizontal

BAND SAWING MACHINE, to cut 54 in. diam., with 6 ft pulleys, complete with four saws. Used three years. £125. F.o.r at Preston.—IRVIN and SELLERS, Preston G 522

Patent Fuel.—For Sale, Com-

plete Patent FUEL WORKS PLANT of modern type, manufactured by Bolton, of Swansea, consisting of all necessary machinery and appliances, with or without steam engines and boilers, the whole in condition equal to new, having been in use only a few months. For particulars, apply to ELLIOTT'S METAL CO., Limited, Birmingham; and PEMBREY COPPER WORKS, South Wales. G 521

Hornbeam Plank, all thick-

nesses, dry; warranted English growth; very large stock; cogs cut to any pattern at moderate prices J. KEEN, 264, Waterloo Bridge Road, London, S.E. 5191

25 HP. Portable Steam

ENGINE, high class, new, FOR SALE on advantageous terms. A 14 HP PORTABLE STEAM ENGINE, excellent, second-hand, with two 6 ft. pan Mortar Mills and a 5 ft. by 2 ft. 6 in. Saw Table complete.—For price, or to view, apply to BARROWS and STEWART, Engineers, Banbury, Oxon. 503

Boilers! Boilers!! Boilers!!!

The Largest Stock in London of Cornish or Vertical Boilers for Sale or Hire from 2 to 30 horse power.—F. BONE, South London Boiler Works, Long Lane, Borough. Boilers repaired by practical men only. 5141

Boilers.—Two First-class Lan-

CASHIRE BOILERS, 32 ft. by 7 ft., two flues, with five cross tubes in each flue; with fittings. Guaranteed for 60 lbs. pressure.

Two excellent Galloway Patent Boilers, 26 ft. by 6 ft. 6 in., two flues into combustion chamber, with twenty-four tubes and two water sockets, and fittings. Guaranteed for 65 lbs. pressure.

One excellent Boiler, 30 ft. by 7 ft., two flues, with fittings. Guaranteed for 60 lbs. pressure.

One excellent Hadfield's Patent Boiler, 27 ft. by 7 ft. Guaranteed for 50 lbs. pressure.

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Locomotive Tank Engine

FOR SALE or HIRE (Second hand). Cylinders 12 in. diam.; 18 in. stroke; four wheels coupled; photograph on application. New Locomotives in progress.—THOS. PECKETT, Atlas Engine Works, near Bristol.

Tank Locomotives, 4 or 6

wheels coupled. Specification and workmanship equal to Manning Wardle Engines.—Apply to R. & W. HAWTHORN, Engineers, Newcastle-on-Tyne.

See Advertisement, page 42. 4964

Locomotive Tank Engines

always in stock or progress.—HUDSWELL, CLARKE and CO., Railway Foundry, Leeds, Sole Makers of RODGERS' PATENT WROUGHT IRON PULLEYS. See Illustrated Advertisement, page 36.

Locomotive Tank Engines for

Main Line Traffic, Short Line, Collieries, Contractors, Iron Works, Manufactories, &c., from a superior specification, equal to their first-class Railway Engines, and specially adapted to sharp curves and heavy gradients, may always be had at short notice from Messrs. BLACK, HAWTHORN, and Co, Locomotive, Marine, and Stationary Engine Works, Gateshead-on-Tyne 1524

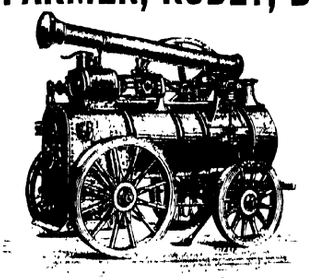
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50 HP. Beam Condensing, new, cylinder 24 by 48 in.
25 HP. ditto cylinder 18½ by 30, with Lancashire Boiler fitted complete; may be seen working.
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2 HP. Vertical Engine and Boiler combined, good condition. Cornish Boiler, 18½ ft. by 4½ ft., with fittings, tested to 90 lb. Cornish Boiler, 12 ft. by 4 ft., with fittings, tested to 100 lb. 5167

The above offered very cheap, to clear out stock.
SPENCER & Co., Melksham Foundry, Melksham, Wilts.

Awarded the SILVER MEDAL at the Worcestershire Agricultural Society's Meeting, 1883, and CERTIFICATE OF MERIT and MEDAL at the Calcutta Exhibition, 1884.

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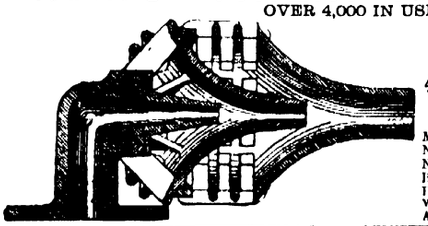
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Best and Cheapest Means of Preventing Unequal Expansion.

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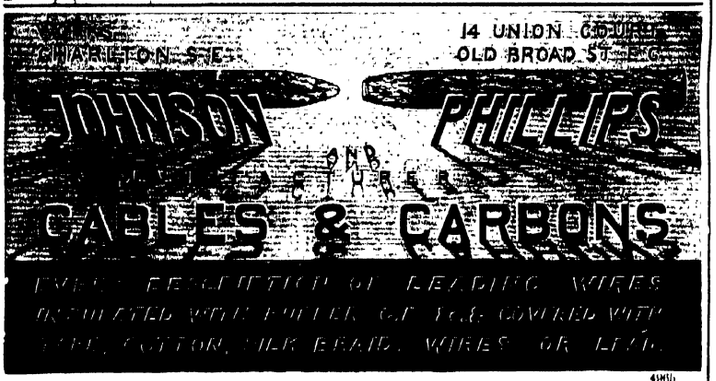
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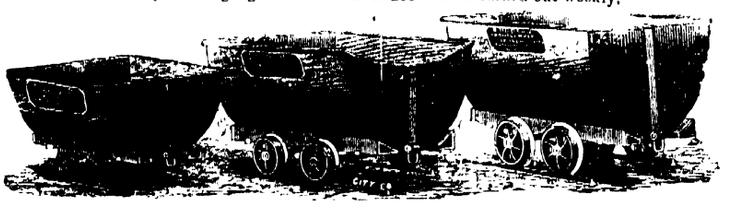
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BERRYMAN'S IMPROVED PATENT UNIVERSAL EXPANDING TUBULAR

FEED-WATER HEATER



THE WELL KNOWN

BERRYMAN HEATER

AND

INTERHEATER,

ARE NOW FITTED WITH OUR NEW

PATENT

SYPHON BOTTOM

AND OTHER IMPROVEMENTS,

SAVING

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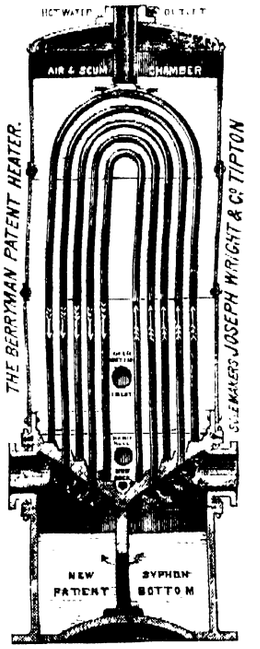
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SUITABLE FOR HIGH OR LOW PRESSURE AND COMPOUND ENGINES.



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CRANE CHAIN.



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CHAIN CABLES

THEY HAVE NEVER BEEN SURPASSED FOR STRENGTH, UNIFORMITY *OR* DURABILITY, *AND ARE MADE BY SPECIAL WORKMEN FROM IRON OF SPECIAL QUALITY, PREPARED EXPRESSLY FOR THIS COMPANY ONLY.*

THE STEEL COMPY. OF SCOTLAND,

LIMITED.

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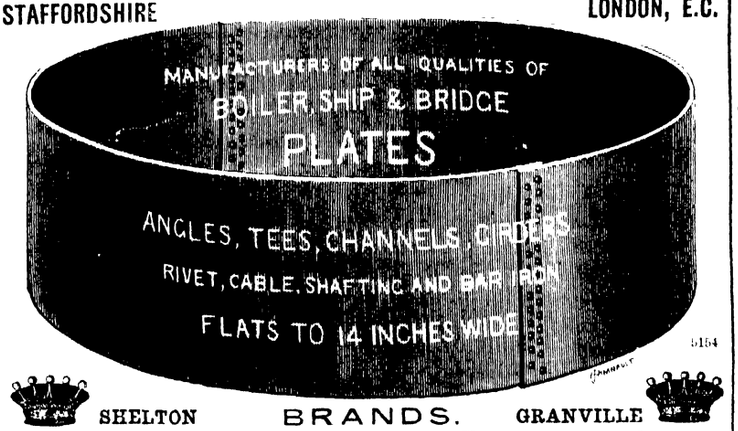
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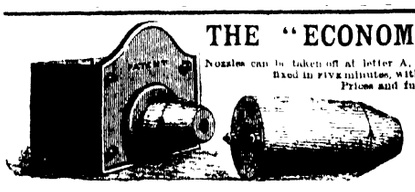
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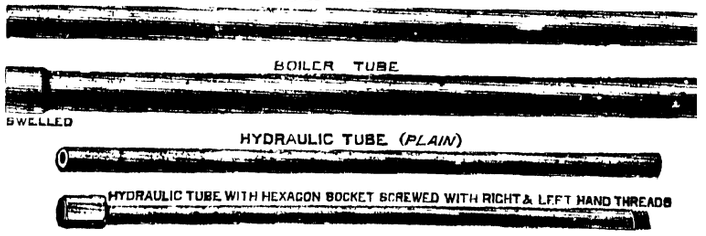
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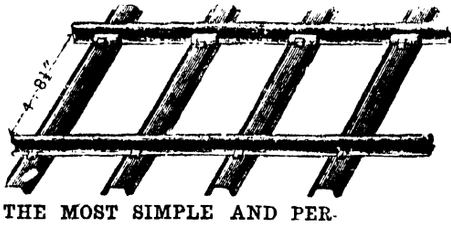


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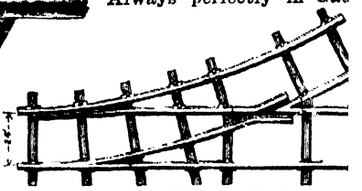
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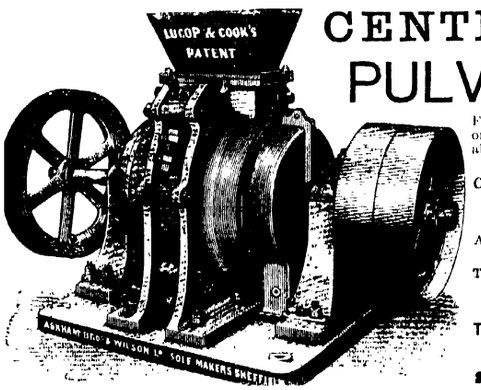
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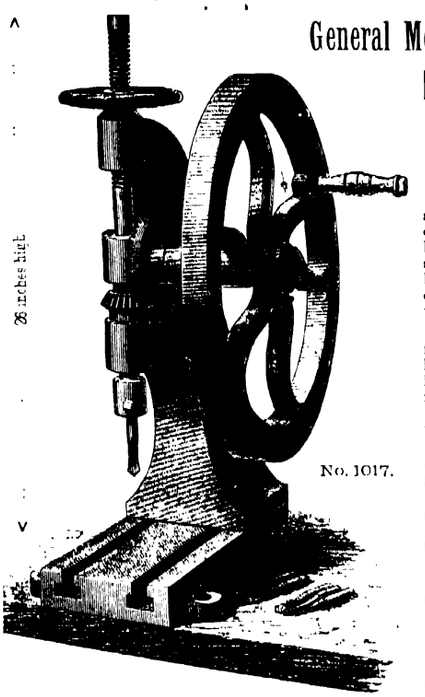
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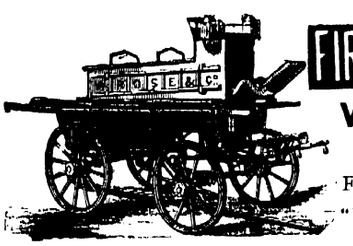
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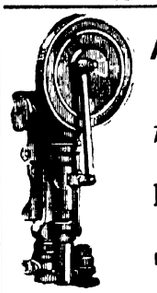


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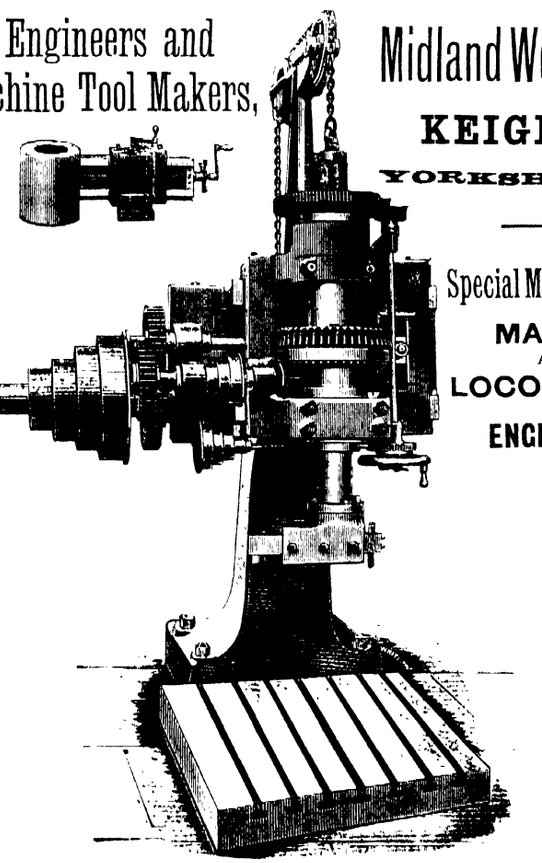
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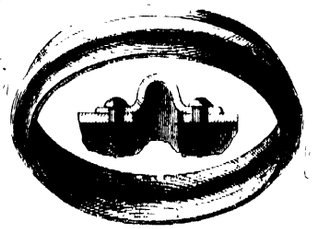
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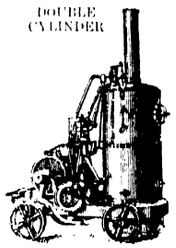
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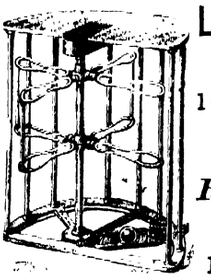
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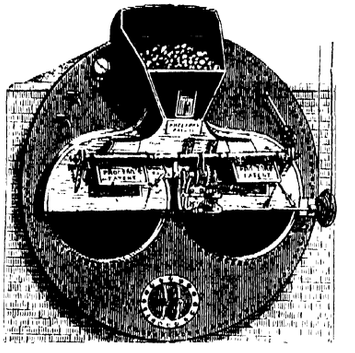
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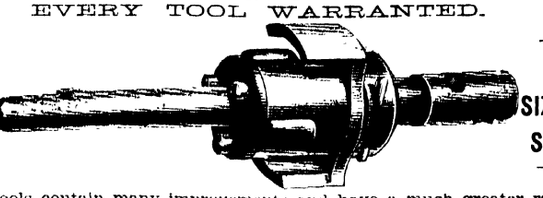
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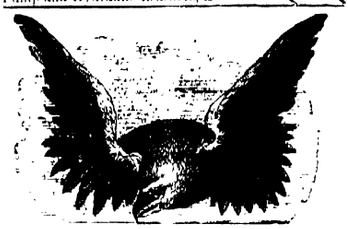
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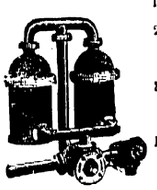
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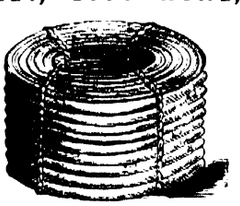
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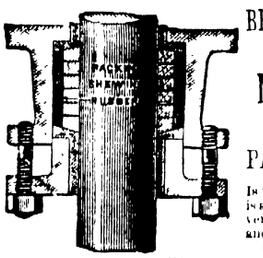
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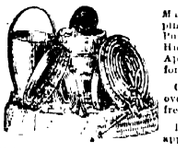
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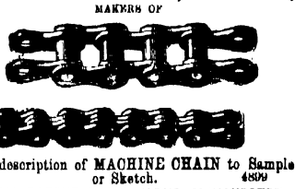
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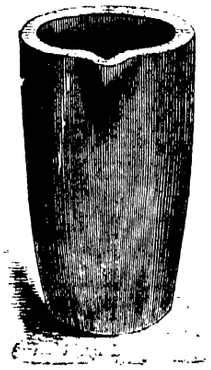


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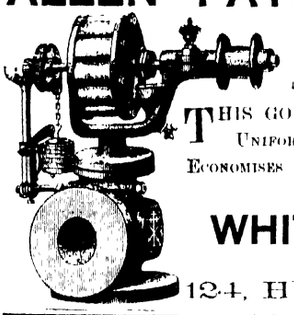
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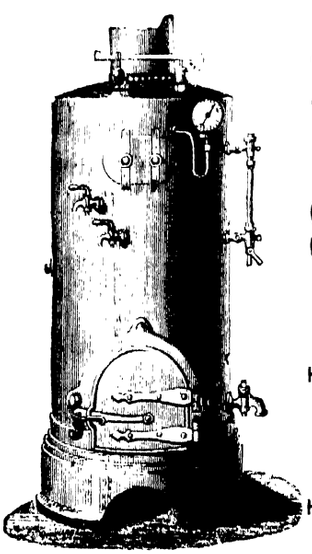
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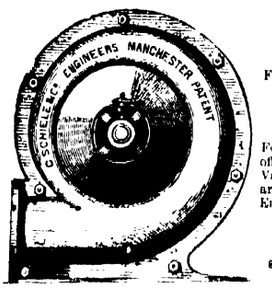
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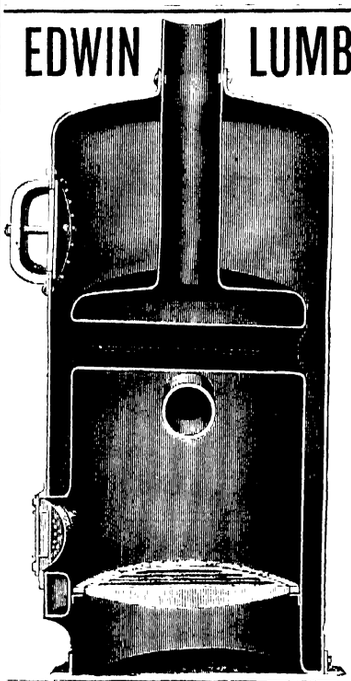
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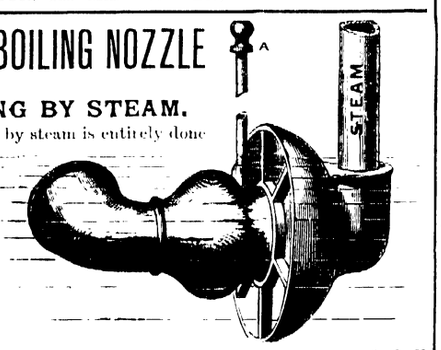
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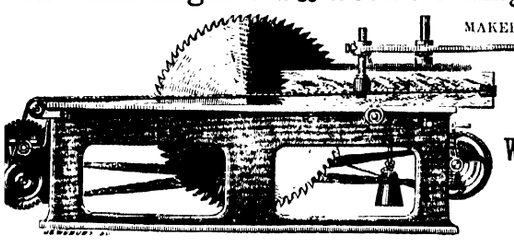
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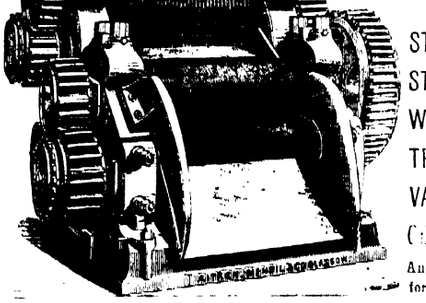
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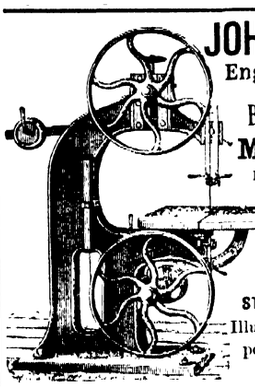
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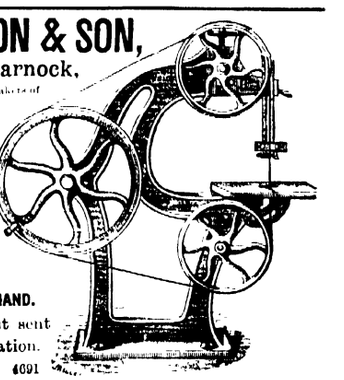
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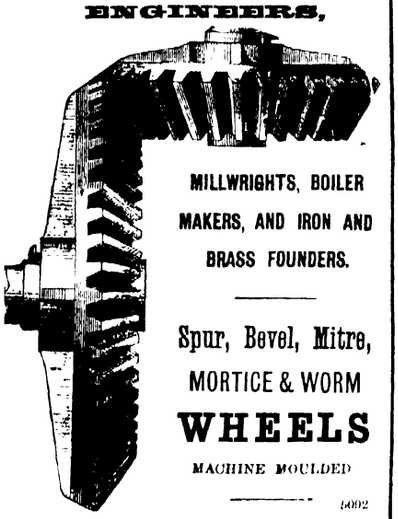
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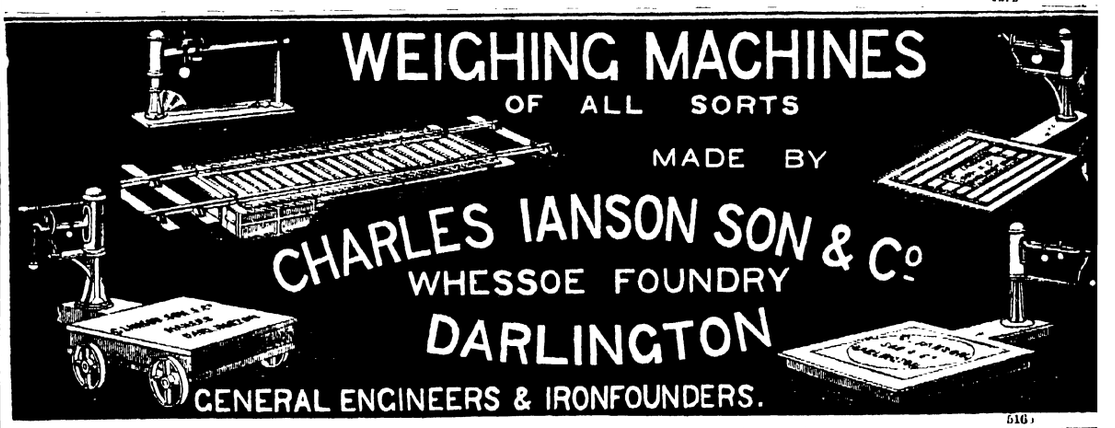
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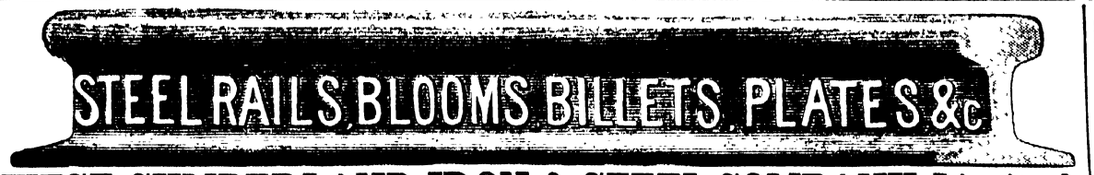
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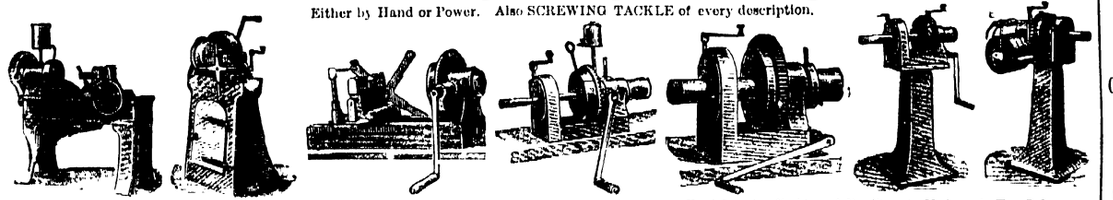
HÆMATITE PIG IRON, BESSEMER STEEL RAILS,

SIEMENS-MARTIN STEEL PLATES FOR SHIPS, BOILERS, BRIDGES, &c. 4807

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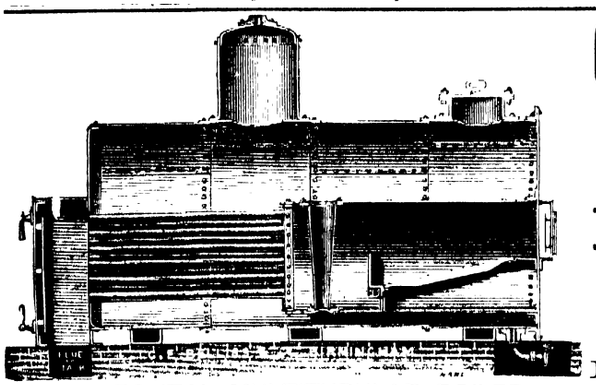
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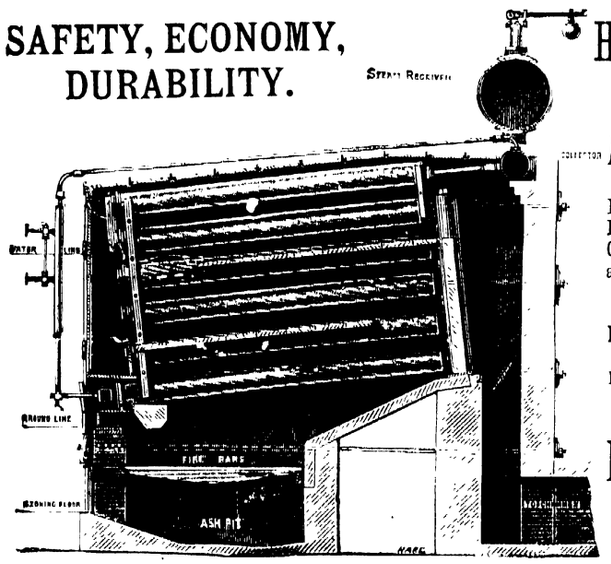
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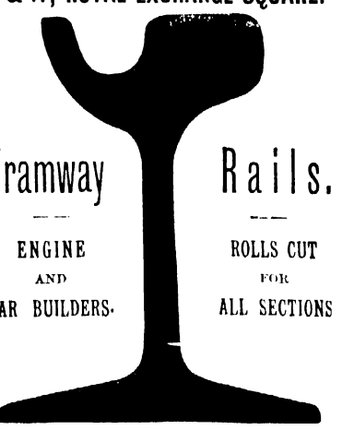
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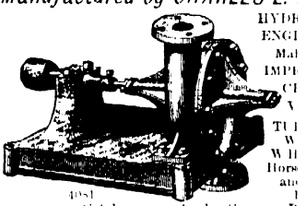
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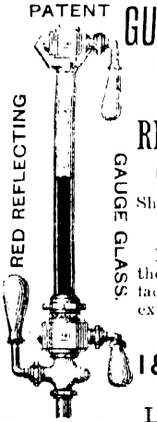
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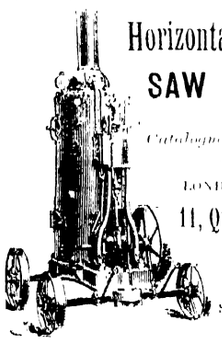
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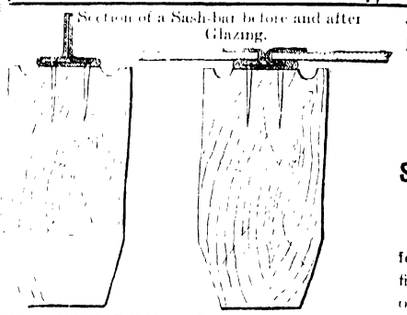
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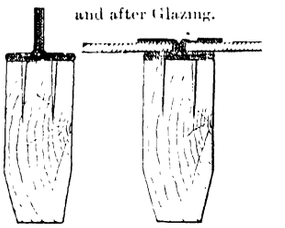
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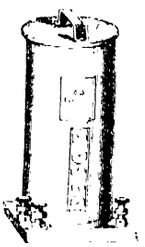
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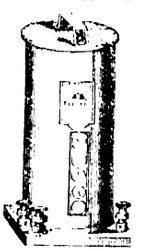
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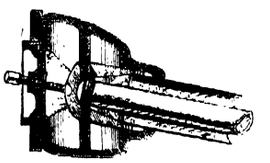
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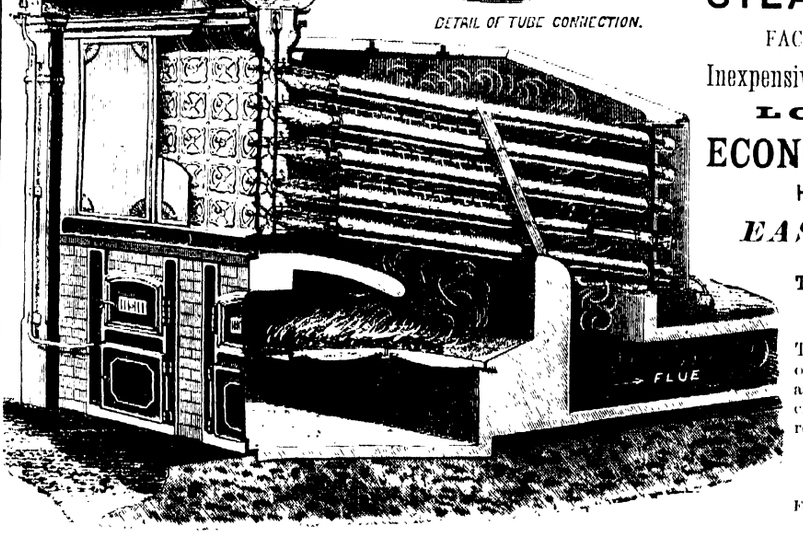
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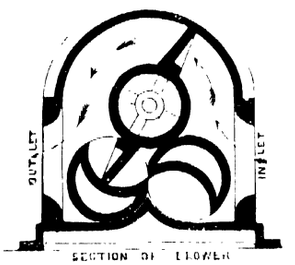
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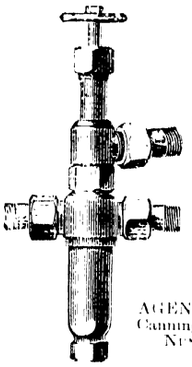
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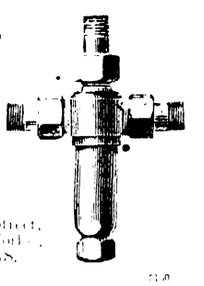
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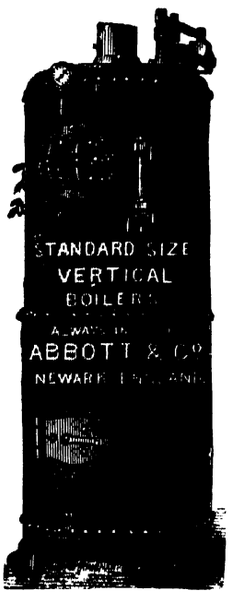
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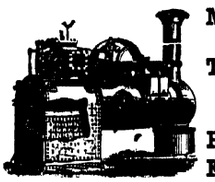
3912

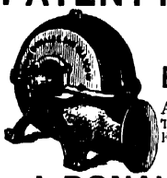
"The Lancaster"

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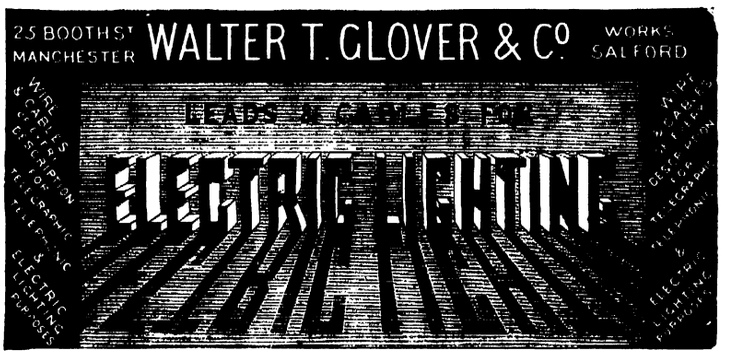
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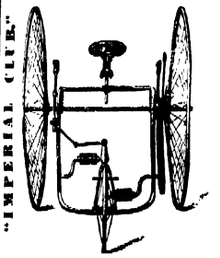
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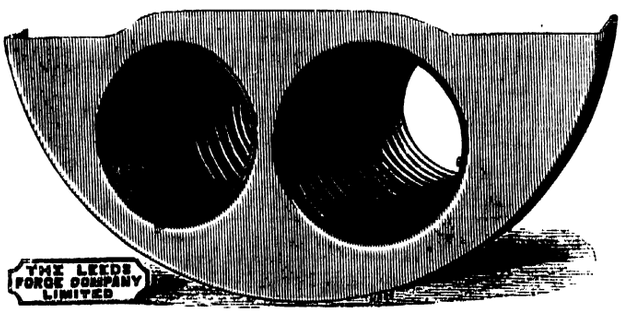
Important Fact as to Belting.

AT the Bath and West of England Show, held at Maidstone, from the 2nd to the 6th June, various belts were in use on the Machinery in motion there. On the 4th, about noon, the rain came on, and continued up to the close of the Show on the 6th. *During the whole of the rain, out in the open,* one of GANDY'S PATENT AMERICAN COTTON BELTS *continued to do its work satisfactorily,* driving a set of Messrs. TAYLOR & NEATE'S, of Rochester, 12 in. three throw Slurry Pumps. This was the only Belt that continued to work in the rain. All the Leather and Rubber Belts *had to be taken off, owing to their inability to drive in wet weather.* This fact alone speaks volumes. How long will it take to convince Englishmen (the Americans are already convinced) that the "GANDY" BELT is the CHAMPION Belt of the WORLD? 3140

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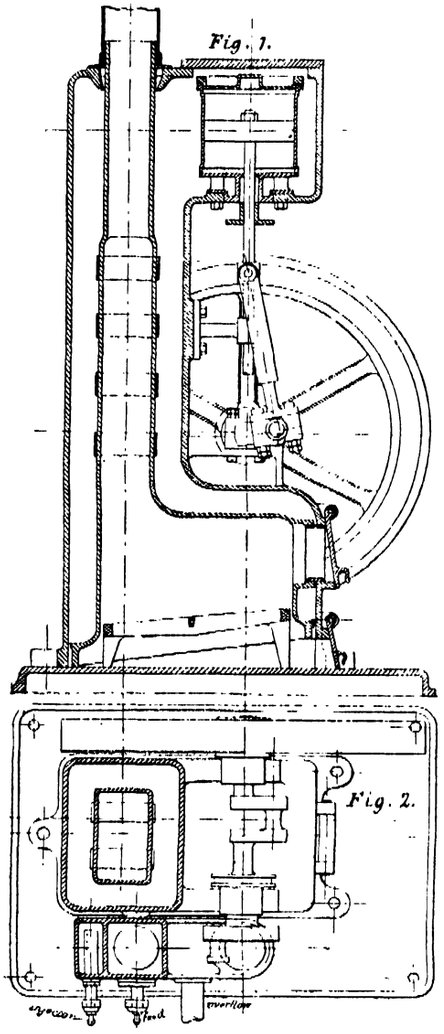
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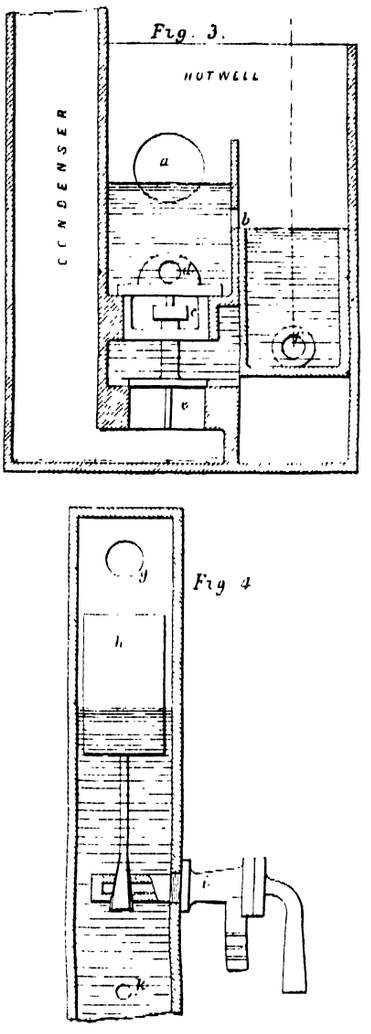
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THE SHREWSBURY SHOW.

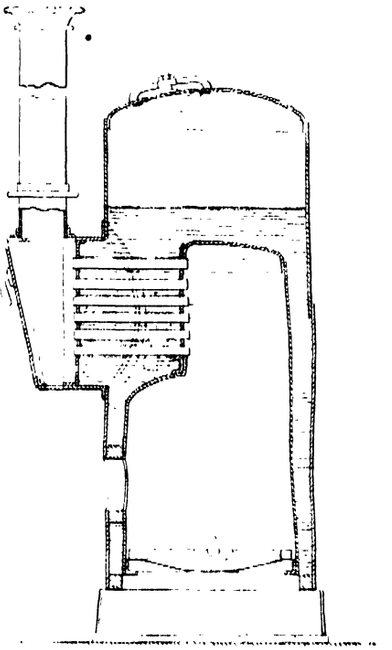
DURING the present week the Royal Agricultural Society have for the second time been holding their Show at Shrewsbury. The first occasion on which the Society visited this interesting town was in 1845, when agricultural engineering was in its infancy, and the value of mechanical appliances for the assistance of the farmer had scarcely even begun to be recognised. At the Show of 1845 the total number of implement entries was but 942, while at the current Show it is 5241, and this notwithstanding the rules which the Society has for the past few years rigidly (and most wisely) enforced as to the exclusion of duplicate exhibits. A comparison of the number of stands and exhibits in the implement yard at Shrewsbury with those at the shows of the previous fifteen years, is afforded by the figures given in the annexed Table.

The prizes offered by the Royal Agricultural Society for implements this year are divided into two sections, the first relating to sheaf-binding machinery and the second to ensilage. The first section is again divided into two classes, of which Class 1 includes sheaf-binding reapers using binding material other than wire, while Class 2 relates to separate sheaf-binders, the binding material employed in these being also other than wire. In the first of these classes two prizes, one of 100*l.* and one of 50*l.*, are offered, while in Class 2 there is a single prize of 25*l.* These prizes will not be competed for until later in the season, although the machines entered for competition are shown at Shrewsbury. In the second section—that relating to ensilage—a single prize of 25*l.* was offered for an efficient machine for cutting and elevating materials to be preserved in silos. A number of machines were entered for this competition, and the trials of them have been conducted during the past week. Of these trials and their results, as well as of the competing machines, we shall speak later on when dealing with this class of machinery. The Society also offered this year, as usual, their ten silver medals for new implements which the judges may consider of sufficient merit to deserve this recognition.



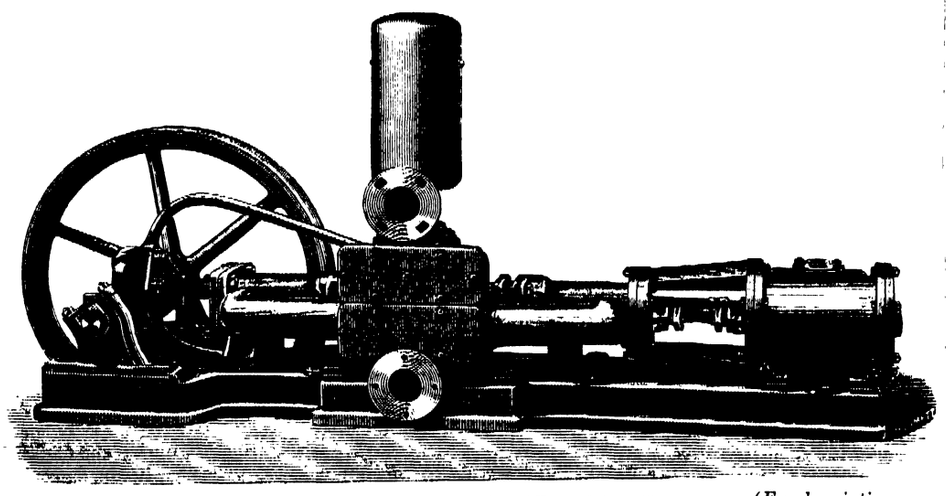


DOMESTIC MOTOR, CONSTRUCTED BY MESSRS. HATHORN, DAVEY, AND CO., LEEDS. (*For description, see page* 51.)



VERTICAL BOILER, CONSTRUCTED BY MESSRS. E. R. AND F. TURNER, IPSWICH. (*For description, see page* 51.)

Year.	Place of Meeting.	Number of Stands.	Number of Exhibits.
1869	Manchester	395	7,724
1870	Oxford	406	7,851
1871	Wolverhampton	363	7,650
1872	Cardiff	308	5,843
1873	Hull	329	5,634
1874	Bedford	361	5,931
1875	Taunton	284	4,214
1876	Birmingham	420	6,414
1877	Liverpool	428	6,930
1878	Bristol	435	6,837
1879	London	704	11,878
1880	Carlisle	288	4,196
1881	Derby	293	5,960
1882	Reading	391	6,102
1883	York	401	6,058
1884	Shrewsbury	367	5,241



DOUBLE-RAM STEAM PUMP, CONSTRUCTED BY MR. JOSEPH HATTON, COVENTRY. (*For description, see page* 54.)

PORTABLE AND FIXED ENGINES.

As far as steam engine design and construction is concerned, there is a great dearth of novelties at Shrewsbury, and our remarks under this heading will, with a few exceptions, have to relate solely to points of detail. In engines for steam cultivating purposes we find absolutely nothing new; while in traction engines and agricultural locomotives the most noticeable feature is the exhibition of further examples of spring-carried engines. As we stated when dealing with the York Show last year, the spring-carried traction engines may be divided into

two chief classes, viz.: first, those in which the desired end is attained by the use of elastic wheels; and, second, those in which springs are interposed between the axles and the main body of the engine. Of the first class there are three representatives at Shrewsbury, namely, the spring wheels of Messrs. Aveling and Porter and Messrs. J. and H. McLaren, both of which we have already described and illustrated,* and that of Messrs. C. Burrell and Sons, of Thetford, which now makes its appearance at a Royal Agricultural Society's Show for the first time. Messrs. Burrell's spring wheel was exhibited by them at the Maidstone Show of the Bath and West of England Society, a few weeks since, when we mentioned it briefly. In this wheel, of which we give a perspective view on page 52, the spokes are formed of steel, and have their width placed in the direction of the plane of the wheel, like the spokes of ordinary rigid wheels. Perpendicularly to the plane of the wheel, however, the spokes are cranked, so that those which spring from the inner side of the boss pass to the outer side of the tyre, and *vice versâ*, this cranking rendering the spokes elastic in a radial direction. At Shrewsbury Messrs. Burrell and Sons show these wheels applied to two engines, the smaller of these being one of their ordinary 8-horse agricultural locomotives with 6-ft. driving wheels, while the other is a road locomotive specially designed for heavy haulage, and having spring driving wheels 7 ft. in diameter by 18 in. wide. This latter engine is of the type which Messrs. Burrell first exhibited at the last Smithfield Show, and it is capable of taking a load of 40 tons up a gradient of 1 in 15. The boiler is made for a working pressure of 150 lb. per square inch, and the wearing surfaces of all moving parts are exceptionally large. Both the engines are fitted with Burrell's high-speed governor, of which we shall have something to say later on in connection with another engine at this stand.

In comparing the three kinds of spring wheels named above, there are certain differences of principle worth noticing. Messrs. Aveling and Porter's wheels possess, from their construction, a circumferential as well as a radial elasticity, that is to say, the pull exerted by the engine causes the driving axle at starting to revolve through a small angle within the tyre. The engine thus exerts what may be termed an elastic pull on its load, the elastic wheels serving the purpose of a draw spring. In Messrs. J. and H. McLaren's wheel the boss would also tend to rotate to a slight extent within the tyre, but the makers prevent this by providing each wheel with a rigid driving arm which projects from the boss and engages with the tyre, without, however, interfering with radial motion. Messrs. Burrell and Sons' wheel, on the other hand, is specially designed to prevent any circumferential motion of the tyre relatively to the boss, the breadth of the spokes being, as we have said, disposed parallel to the plane of the wheel. One effect of this is, however, that such spokes as happen to be horizontal in any given position of the wheel resist any radial movement of the boss in a vertical direction, and such movement can only take place by causing a certain amount of twisting in the spokes which lie horizontally. In this case the twisting moment acts with a leverage equal to the distance each spoke is cranked in a direction perpendicular to the plane of the wheel.

We know that an idea exists in some quarters that the use of spring wheels in some mysterious way adds to the resistance which a traction engine has to overcome, an engine so fitted being supposed to be always "running up hill." We need scarcely say that this is a fallacy, any power expended in compressing certain of the springs during one portion of a revolution being recovered during a subsequent portion of the revolution, when these springs are relieved of strain. Messrs. McLaren and Messrs. Aveling and Porter have now both tested their spring wheels sufficiently long to get trustworthy results concerning them, and both are able to give very satisfactory reports as to their action. Since we last noticed Messrs. Aveling and Porter's wheels, these have, we may mention, been severely tested on one of their military traction engines or "steam sappers," and with highly satisfactory results.

Of the second class of spring-carried traction engines, there are three examples exhibited at the Show, namely, those of Messrs. John Fowler and Co., of Leeds, Mr. Edwin Foden, of Sandbach, and the Durham and North Yorkshire Steam Cultivation Company (Limited), of Ripon. Of these methods of applying springs, that of Messrs. Fowler and Co. is similar in principle to that which they exhibited at York last year, and which we illustrated on page 35 of our thirty-sixth volume, but differs in certain details. In this arrangement the driving axle-boxes are free to move in vertical guides (like those of a locomotive), and the weight of the hind part of the engine is transmitted to them through springs. The axle-boxes are, moreover, connected by links to the bearings of the intermediate shaft, which is able to move in an approximately vertical direction. In the case of the engine exhibited at York last year, the motion of this intermediate shaft was controlled by links which connected it to the second-motion shaft, it thus moving in an arc of a circle, having this shaft for its centre. In the engine shown at Shrewsbury, on the other hand, the links connecting the intermediate shaft to the second-motion shaft have been replaced by shorter links pivotted on studs fixed to the framing. The intermediate shaft, when shifted vertically by the movement of the driving axle, is not maintained at an absolutely constant distance from the shaft to which it is geared, but the variation in this distance is so slight as not to interfere in any way with the proper action of the gearing, while the new arrangement possesses certain constructive advantages over that previously employed. We hope to illustrate Messrs. Fowler's engine, as exhibited at Shrewsbury, in an early number, and we shall then have more to say about it.

Mr. Foden's engine is practically identical in its construction with that which he exhibited at York last year, when we illustrated and described it fully (see page 53 of our thirty-sixth volume), and we need not therefore enter into detailed particulars of it here. The engine at Shrewsbury, however, has, we notice, been fitted with a Porter governor, and some other alterations of detail have been introduced.

In the engine of the Durham and North Yorkshire Steam Cultivation Company, Limited, the arrangement of springs adopted is the same in principle as that used in the engine exhibited by this firm at the Derby Show of 1881, and which we described at the time (*vide* page 58 of our thirty-second volume). As we then mentioned, the arrangement is one devised by Messrs. Nicholson and Hewison. In it the crankshaft, driving axle, and intermediate shafts have their bearings mounted on frame plates, which are free to move vertically relatively to the boiler, the weight of the latter and other parts of the engine being transmitted to the frames above named through springs. The frame plates carrying the shaft bearings are also extended forwards past the firebox so as to carry the steering shaft. The engine at Shrewsbury which we hope hereafter to be able to illustrate—is fitted with an arrangement for shifting the crankshaft pinions into or out of gear, which is one of the neatest devices of the kind which we have yet seen, and we hope in a future number to be able to give engravings which will explain its construction.

Of the remaining traction engines shown at Shrewsbury there is but little to be said. Messrs. Aveling and Porter exhibit, however, an engine with an exceedingly well-arranged crane at the leading end, capable of lifting three-ton loads with a double, or 1½ ton loads with a single chain. This has been specially designed for working a Priestman's dredging bucket, but it is also of a very useful type for a variety of other work. The lifting drum is driven by friction gear which enables the load to be lifted, stopped, or lowered without stopping the engine, the whole action of the lifting gear being controlled by a single lever. The crane is also provided with slewing gear.

Mr. F. Savage, of King's Lynn, in addition to an agricultural locomotive of his usual pattern with chain gear, shows for the first time a traction engine with wheel gearing only, while Messrs. Clayton and Shuttleworth exhibit a traction engine with a boiler barrel of most unusual length. Excellent engines of the standard patterns of their respective makers are also shown by Messrs. John Fowler and Co., Messrs. Aveling and Porter, Messrs. Marshall, Sons, and Co., and other firms; but they are all of types which we have already described, and do not therefore call for special notice here. We may mention, however, that Mr. James Braby, of Rudgwick, Sussex, again exhibits an example of a very light three-wheeled traction engine of the pattern which he showed at York last year, and which we described on page 55 of our thirty-sixth volume. The weight of the York engine was stated to be 23 cwt, that at Shrewsbury has its weight marked as 35 cwt., while the boiler has also been modified. There is a good deal of ingenious scheming about this engine, but we cannot help repeating the opinion which we expressed last year, namely, that it is not of a type fitted for the work for which it is intended, and it is in fact difficult to see how a farmer could utilise it. Before dismissing self-moving engines we may notice that one of the steam ploughing engines shown by Messrs. Fowler and Co. is fitted with two speeds on the ploughing gear, and we understand that this firm are now making all their ploughing engines in this way, the idea being to better utilise the power of engine when hauling a harrow or doing other light work.

As regards portables the most marked feature of the Show consists perhaps in the strong desire which a number of makers exhibit to facilitate the lifting of their engine chimneys. It will be remembered that at the York Show last year, Mr. James Coultas, of Grantham, brought out a very neat arrangement of chimney lifting gear, which we illustrated at the time (*vide* page 52 of our thirty-sixth volume), and which has since been largely applied. Mr. Coultas's device appears to have suggested to portable engine builders that a mechanical chimney lifter of some kind was the one thing required to render a portable engine perfect, for at Shrewsbury we find a number of arrangements for this purpose, while of other novelties of detail there are practically none. Mr. Coultas's original arrangement—which we may mention is, to our mind, the neatest yet proposed for dealing with the heavy chimneys of large-sized engines—is of course represented, while in addition devices for the same purpose are shown by Messrs. Clayton and Shuttleworth, Messrs. Ruston, Proctor, and Co., Messrs. Barford and Perkins, and Messrs. Hornsby and Sons. Messrs. Clayton and Shuttleworth's device consists simply in making the ring at the bottom of the movable part of the chimney a casting having a socket into which a lifting bar can be inserted. When the chimney is folded down on the boiler a lifting bar inserted in the socket just named extends upwards and forwards at an angle of 45 deg., a chain attached to its outer end affording the means of pulling that end down and so lifting the chimney. When the chimney is raised the bar projects downwards in front of the smokebox, but by withdrawing a pin which secures it in the socket it can be removed to give access to the tubes.

Messrs. Ruston, Proctor, and Co.'s arrangement is more complicated and is described as a combined chimney lifter and stay. It consists of a long bar which, when the chimney is down, lies housed beneath it along the top of the boiler, the hind end resting on a roller carried by the chimney rest. To lift the chimney the bar just mentioned is pulled out towards the rear, and its forward end is attached to a suitable connection near the top of the chimney. A rope having one end attached to the chimney rest is then rove through a pulley near the rear end of the lifting bar, and back through another pulley on the chimney rest, and by hauling on this rope the bar is thrust upwards and forwards, thus raising the chimney. When raised the bar is locked in position, and remains as a stay. For smaller-sized engines the use of the rope for hauling up the bar may be dispensed with.

Messrs. Barford and Perkins, of Peterborough, are the exhibitors of Smith's chimney lifter, which we illustrate on page 52, and which is applied to a number of engines at the Show. This arrangement has been specially designed for attachment to existing engines. As will be seen from our illustration, the device consists of two wrought-iron rings made in halves for clipping the chimney, these two rings being connected by a truss rod, while the lower of them carries a socket for the reception of a lever, this lever being a solid wrought-iron crowbar with a round point at one end and chisel point at the other. When inserted in the socket above mentioned the crowbar is fixed by a pin. The mode of using the lifter will be at once clear from our engraving, from which it will be seen that the weight of the solid bar helps to balance the chimney when the latter is down. The device can be readily applied to existing engines, and is likely to be largely used.

Messrs. Hornsby and Sons' device is also a simple

* Engravings of Messrs. Aveling and Porter's wheel will be found on page 181 of our last volume, while Messrs. J. and H. McLaren's wheel was illustrated on page 52 of our thirty-sixth volume.

one, and it is illustrated by us on page 53. In this case the lifting bar is made of a piece of wrought iron gas-piping cranked at one end and made to slide in two sockets fixed on the movable part of the chimney, as shown. When the chimney is down and the lifter not in use, the bar can be slid back, while when the chimney is raised the bar can be slid up and its cranked lower end turned aside out of the way of the smokebox door. As the lifting bar is not removable, it will always be available when wanted.

There can be no doubt that as long as hinged chimneys are used, devices such as we have been describing serve a good purpose and do away with the necessity of men climbing on the boiler, thus damaging the lagging, &c. It is, however, we think a question worth considering by portable engine makers, whether or not long hinged chimneys are frequently employed in cases where they are quite unnecessary. We believe, indeed, that the long hinged chimney is really a relic of the time when portable engine makers did not know how to properly apply exhaust nozzles—we are far from certain that *all* makers have acquired that knowledge now—and its use has been continued as a matter of habit. It is quite certain that as far as draught is concerned a better result could be obtained with a shorter chimney when the engine is at work, while for getting up steam the difference between the effect of the long and short chimney is by no means so great as is commonly supposed, particularly if the short chimney be properly proportioned and kept free of obstructions such as are caused by inserting the blast-pipe at the side—a very usual practice. As regards danger from sparks in a stack-yard, we may point out that plenty of thrashing has, during the past few years, been done by agricultural locomotives and traction engines with short chimneys, and we have never heard that their use has been found more dangerous than that of the ordinary portable. Altogether we believe that in the majority of cases portable engine builders would do well to discard the long hinged chimney and to adopt short, well-proportioned fixed chimneys with the blast nozzle properly placed.

With the exception of the chimney lifters there is really nothing to specially notice in the details of the portable engines collected at Shrewsbury. The engines shown at the stands of the leading firms prove, as they have done for some years past, that these makers can turn out work of the highest quality, while a steady progress is noticeable in small matters of design. Amongst the smaller makers also a decided progress is likewise noticeable, and if the Shrewsbury Show contains fewer examples of originality than usual; it also certainly contains fewer specimens of bad designing than any of its predecessors which we can remember. Before dismissing the portables, however, we may mention by the way that Messrs. Garrett and Sons, of Leiston, exhibit an unusually large compound engine constructed to indicate 100 horse-power.

The fixed and semi-fixed engines exhibited include more features deserving notice here than is the case with the portables. First of the novelties amongst the fixed engines is the "domestic motor" of Mr. Henry Davey, made by his firm, Messrs. Hathorn, Davey, and Co., of Leeds. This is an extremely handy little engine, working with steam at or slightly below atmospheric pressure, and intended for use when small powers, say ¼ to 2 horse power, are required. The three engines exhibited by Messrs. Hathorn, Davey, and Co., at Shrewsbury, are rated by the makers at ¼, ½, and 1 horse-power respectively, and are all of the same general design, this design being shown by our illustrations on page 49. Referring to Figs. 1 and 2 there given it will be seen that the arrangement consists of a cast-iron boiler containing a cast-iron firebox with uptake, this uptake, which is of rectangular section, being traversed by rows of wrought-iron tubes. The firebox and uptake are cast in one piece and are connected to the outer shell by cement joints caulked into the socket spaces left to receive them at top and bottom as shown, the joint at the firehole being made by a ring coated with red-lead and driven in. The upper part of the boiler is extended to contain the steam cylinder, which is made of gun-metal and fitted with a slide valve in the ordinary way. There is no valve chest, however, the cylinder with its valve being directly surrounded by the boiler steam, while a throttle valve placed on the exhaust affords the means of stopping and starting. Of course the cylinder is by this arrangement most effectively steam-jacketted. The piston is coupled by a connecting rod in the usual way to a crankshaft supported by bearings which are mounted on brackets cast in one with the boiler, as shown. The crankshaft is provided with an eccentric for actuating the slide valve in the usual way, while at one end it carries a flywheel and at the other a disc crank for driving the air-pump. When the engine is used for pumping purposes, the pump is mounted on the bed-plate and driven from a crank-pin in the flywheel.

By the side of the boiler is another casting forming the condenser, the feed chamber, and the hot-well. In the connection between the cylinder and the condenser is fitted the throttle valve we have already referred to. The condenser is provided with an ordinary jet injector (see Fig. 2, page 49), and a section of the lower part of it with the air-pump and hot-well is shown to a larger scale in the detail view, Fig. 4. The air-pump is single-acting and is fitted with a plunger *f*, not having any packing. When near the bottom of its stroke, however, it uncovers a small hole *b* which allows water from the hot-well to flow back into the plunger and over its edges, thus forming a water seal. At the high speed at which these engines are run a plunger wholly submerged would splash the water about too much, but the contrivance we have just described avoids this trouble, and serves the same purpose of making a water joint. In the engines exhibited at Shrewsbury the air-pumps are fitted with metal valves, the suction valve *e* (Fig. 4) having a stem which projects through a bar on the delivery valve, and is furnished with a collar at *c*. By this arrangement the two valves are linked together, and as the outside diameter of the suction valve is slightly less than that of the hole which the delivery valve covers, the two valves can, when the vacuum is destroyed, be easily lifted out together by taking hold of the ring *d*. The overflow from the hot-well is at *a*.

The boiler is fed from a closed feed chamber which is cast on the side of the condenser above the hot-well, and a section of which is shown by the detail view, Fig. 3, on page 49. This chamber is in free communication with the boiler by two passages, namely, a large one *g* leading into the steam space, and a small one *k* leading to the boiler below the water line. The water thus stands in the feed chamber at the same level as in the boiler. The feed water is brought to the feed chamber by a flexible pipe attached to the cock *i*, which has a nozzle projecting into the feed chamber as shown, the nozzle being fitted with a plug and float *h*. If the water level falls the float of course falls with it, thus lowering the plug and admitting more water to the boiler until the proper level is restored. In the case of the engines at Shrewsbury this arrangement worked admirably, the water level being maintained with great steadiness notwithstanding that there was a great fluctuation in the pressure in the mains from which the supply was drawn.

The boiler is provided with a loose cover or large valve at the top, and when starting the engine steam is got up until it blows through this valve and expels the air from the boiler. The engine being then turned round and the condenser blown through, a partial vacuum is formed on the injection being turned on, and the engine works just like an ordinary condensing engine. In practice the engine does best if the steam is kept just below blowing-off point or practically at atmospheric pressure, as there is then no tendency for air to leak in at the stuffing-boxes of the piston rod and valve spindle, even if these are but slackly packed. The engine will, however, work perfectly well with several inches of vacuum in the boiler, the amount of vacuum permissible of course depending upon the load. In the condenser the vacuum obtained is 25 in. to 26 in. At Shrewsbury we witnessed an experiment made to show the amount of vacuum required to overcome the friction of the engine and resistance of the air pump, this experiment showing that with a vacuum in the condenser only 5 in. of mercury lower than the pressure in the boiler, the engine ran at its normal speed. As under ordinary working conditions the difference between the boiler and condenser pressures is about 25 in. of mercury, there is a margin of 20 in. of mercury, or say 10 lb. per square inch above that required to overcome the friction of the engine available for producing motive power. Working as it does at atmospheric pressure, Mr. Davey's engine is of course absolutely safe, while as the boiler is self-feeding and the fire can be made up to last a considerable time, the engine requires the minimum of attention. The consumption of gas coke is stated by Mr. Davey to be about 6 lb. per indicated horse-power per hour, and the cost of working is thus exceedingly small. Altogether Mr. Davey has succeeded in producing a very useful and interesting type of motor and one for which we anticipate there will be a very extensive demand. We may add that in the engines shown at Shrewsbury all the bright work is nickel-plated and the workmanship is excellent.

The Coalbrookdale Company, Limited, exhibit a new type of engine intended especially for driving dynamos or other high-speed work. This engine is one patented by Messrs. Parker and Elwell, and we hope on a future occasion to illustrate it; meanwhile, however, we may say that it is a single-acting engine with a single cylinder and piston valve, the whole being very compactly arranged. At the same stand are shown a good collection of Parker and Neston's steam pumps of various patterns.

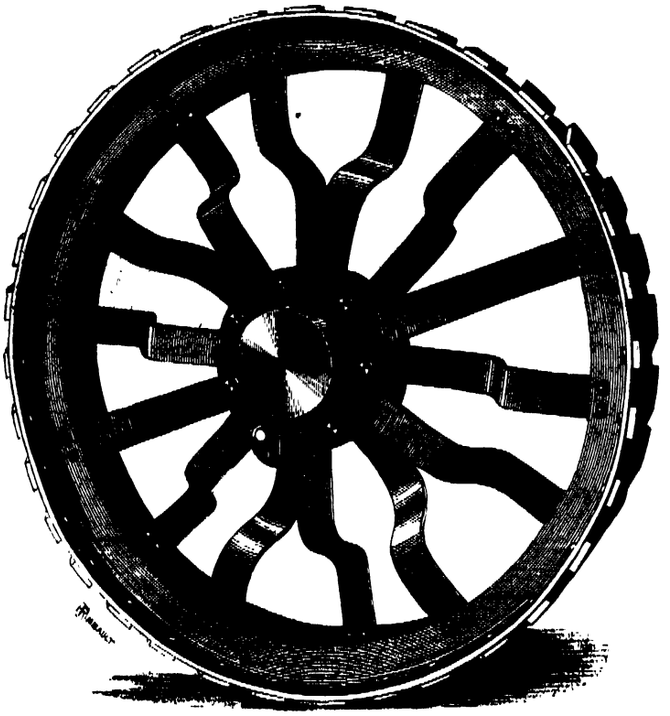
The fixed and semi fixed engines of many makers show a decidedly increasing tendency to abandon the old throttle valve system, and to substitute for it an arrangement of automatic expansion gear. Messrs. Marshall, Sons, and Co., of Gainsborough, have done this largely for some years past, and their regular pattern of automatic expansion gear, which they show fitted to a six-horse fixed engine and to one of their compound semi-fixed engines arranged beneath the boiler, is one of which we have several times had occasion to speak most favourably. Messrs. E. R. and F. Turner, of Ipswich, also, who have long applied one form of Hartnell's governor, varying the expansion to both portable and fixed engines, are now regularly applying a cheaper form of this governor to their neat little "Gippeswyk" engines, of which we have already published illustrations. These engines, it may be remembered, are designed so that what is practically the same pattern may be used for either a horizontal or vertical engine. In connection with some of these "Gippeswyk" engines, by the way, Messrs. Turner are using a type of vertical boiler, which we illustrate on page 49, and which has some excellent points. As will be seen from the view just referred to, the upper part of the firebox is flattened on one side to form a tube plate from which tubes extend horizontally through a short barrel attached to the side of the main shell, this short barrel terminating in a smokebox. The boiler is practically identical with that which Mr. Charles Brown, of Winterthur, has applied to many of his small locomotives;* but the barrel is rather shorter than Mr. Brown uses. The boiler is a very good one, involving no special difficulty either in construction or staying, while it can be readily cleaned. The only weak point in the design is the junction of the barrel and main shell, which is practically identical with the junction of an ordinary boiler with a steam dome nearly its own diameter. Mr. Brown gets over this difficulty by flanging out the vertical shell to meet the flanged end of the barrel, and double rivetting the joint, thus obtaining a good section of metal at the junction, and making a very satisfactory job. In Messrs. Turner's boilers attention also appears to have been paid to this point, which, however, is of course of less importance with small boilers worked at moderate pressures than it is in the case of Mr. Brown's engines, which are worked at 200 lb. per square inch.

To return, however, to the question of automatic expansion gear, Messrs. Ruston, Proctor, and Co., of Lincoln, and Messrs. Richard Hornsby and Sons, of Grantham, both exhibit engines fitted with expansion gear, controlled by the governor, the former firm showing a horizontal fixed engine and a compound "underneath" semi-fixed engine, both fitted with the gear which we illustrated on page 572 of our thirty-second volume, while the latter firm show an "underneath" compound fitted with the gear illustrated by us on page 294 of our thirty-fifth volume, the governor acting through an eccentric which prevents the thrust on the valve rod from disturbing the governor. We notice that in the type of engine last mentioned Messrs. Hornsby are now fitting the crankshaft with a central bearing, in this following the practice of Messrs. Fowler. The design of Messrs. Hornsby's engine is very neat and good.

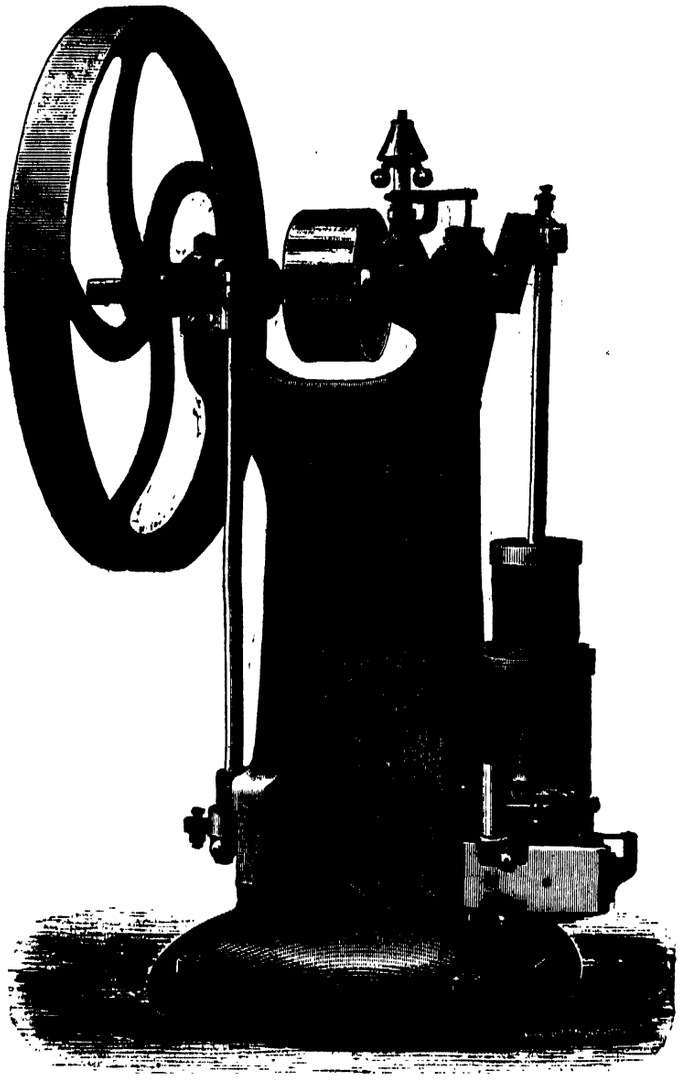
Messrs. John Fowler and Co., of Leeds, have several of these compound "underneath" semi-fixed engines in the Show ground, and one of these, which is employed in driving Messrs. Bradley and

* A two-page engraving of one of these engines appeared in our number of February 3, 1882.

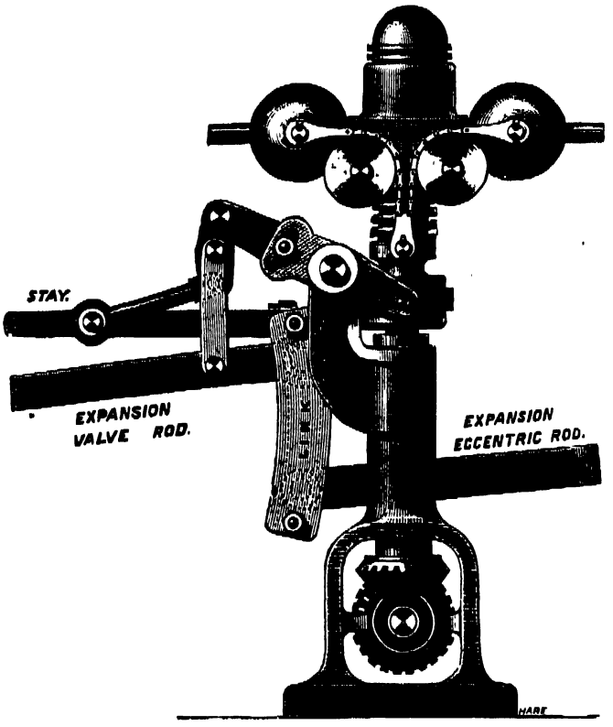
EXHIBITS AT THE SHREWSBURY SHOW.



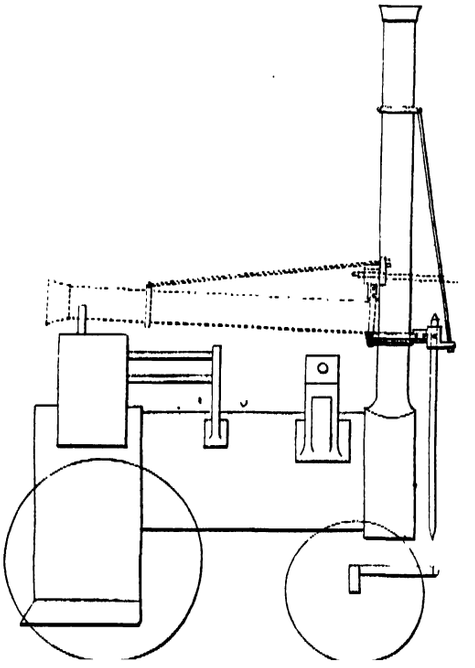
SPRING WHEEL FOR TRACTION ENGINES, CONSTRUCTED BY MESSRS. C. BURRELL AND SONS, THETFORD. (*For description, see page* 50.)



VERTICAL GAS ENGINE, CONSTRUCTED BY MESSRS. CROSSLEY BROTHERS, LIMITED, MANCHESTER. (*For description, see page* 54.)



GOVERNOR AND AUTOMATIC EXPANSION GEAR, CONSTRUCTED BY MESSRS. BURRELL AND SONS, THETFORD. (*For description, see the opposite page.*)

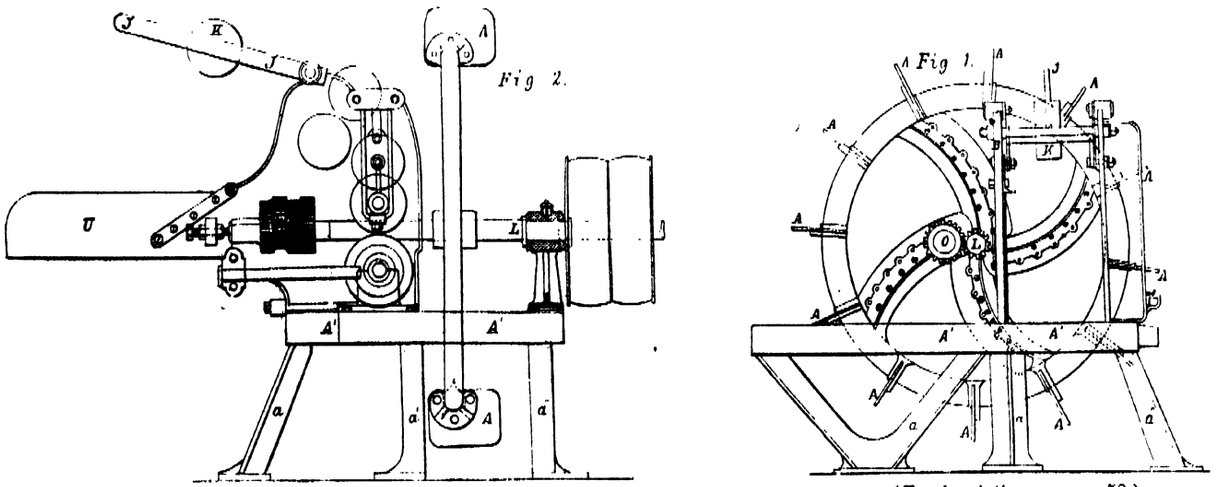


SMITH'S CHIMNEY LIFTER, CONSTRUCTED BY MESSRS. BARFORD AND PERKINS, PETERBOROUGH. (*For description, see page* 50.)

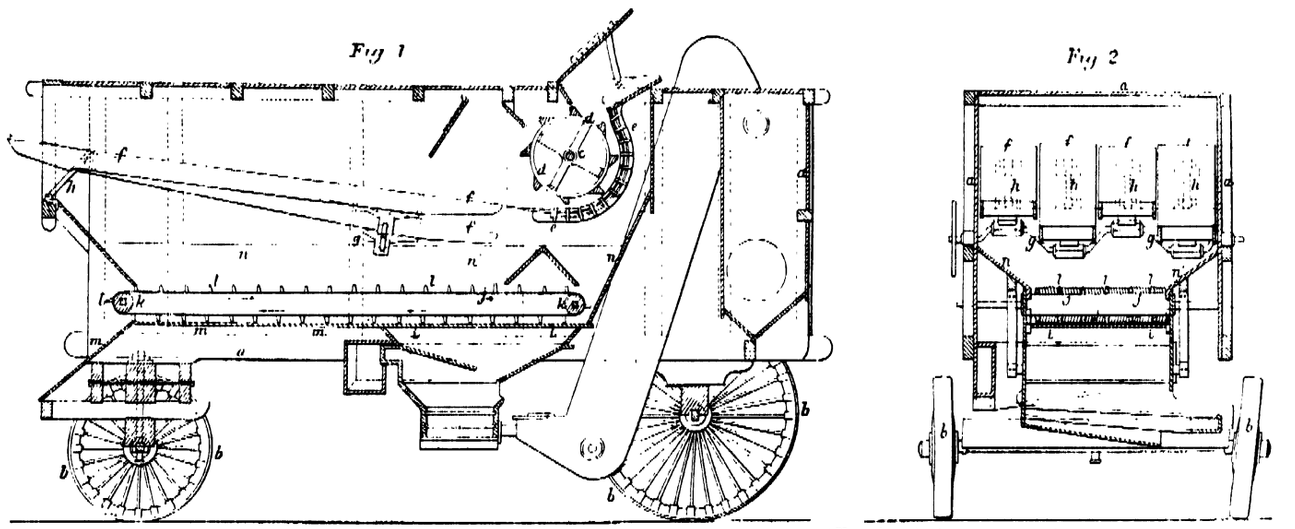
Craven's brickmaking machinery, is fitted with a new arrangement of automatic expansion gear patented by Mr. Hartnell. The governor employed in this case has a horizontal spindle and is provided with four balls which act against a spring as they are spread by centrifugal force. The main slide valve of the high-pressure cylinder has an expansion valve at the back of it, this valve having its cut-off edges at an angle with the direction of motion like the cut-off valves employed in the Rider—or rather the Bodmer—gear. The ports in the main slide are also at a corresponding angle. The governor is so coupled up to the valve spindle that a movement of the former partially rotates the latter, and, by means of a finger on the valve spindle, shifts the expansion slide at right angles to the direction of its motion as derived from the eccentric, thus practically, by the relative action of the oblique cut-off edges and the oblique ports, altering its effective length and varying the cut-off. The arrangement may in fact be described as the Rider gear with a special form of governor.

Another "underneath" compound which is provided with an automatic expansion gear fitted to the high-pressure cylinder is that shown by Messrs. Burrell and Sons, of Thetford. This is an exceed-

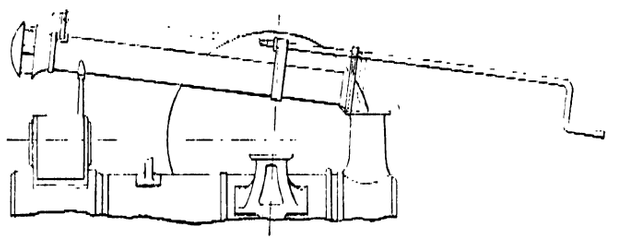
EXHIBITS AT THE SHREWSBURY SHOW.



ENSILAGE CUTTER AND ELEVATOR, CONSTRUCTED BY M. ALBARET, LIANCOURT-RANTIGNY, OISE. (*For description, see page* 58.)



THRASHING MACHINE, CONSTRUCTED BY MR. EDWIN FODEN, SANDBACH. (*For description, see page* 59.)



CHIMNEY LIFTER FOR PORTABLE ENGINES, BY MESSRS HORNSBY AND SONS, LIMITED, GRANTHAM. (*For description, see page* 51.)

ingly neat engine of the general design which we mentioned in our account of the last Smithfield Show, when it was exhibited for the first time, but without automatic expansion gear. The gear used on the engine now exhibited at Shrewsbury is shown by the engraving on the opposite page, and acts on an expansion slide at the back of the main valve. The governor used in connection with this gear is that which Messrs. Burrell exhibited on their engines at the York Show last year, and which we illustrated and described on pages 105 and 106 of our thirty-sixth volume. In the present instance this governor acts on the valve rod connecting the expansion valve spindle to the block of a vibrating link, of which the upper end is pivotted on a fixed stud, while the lower end is coupled to the rod of the expansion eccentric. The connection between the governor and the expansion valve rod is made through a kind of parallel motion arrangement which causes the upper end of the link coupled to the valve rod to move in the most desirable path. It will be noticed that the arrangement is such that the travel of the expansion valve is increased as the cut-off becomes earlier, and the arrangement, which is very neatly worked out, gives a large range of expansion.

Another arrangement of automatic expansion gear, which makes its appearance for the first time at Shrewsbury, is that applied by Messrs. Whitmore and Binyon, of Wickham Market, to a tandem compound non-condensing engine which they exhibit. This engine has steam-jacketted cylinders 6½ in. and 10½ in. in diameter respectively, with 12 in. stroke, and the high-pressure cylinder is fitted with an arrangement of automatic expansion gear designed by Mr. G. Low, of Ipswich. This arrangement consists of a cylindrical cut-off valve placed in the back of the main slide, and capable of being rotated in a direction at right angles to the motion of that slide, such motion being given by a partial rotation of the expansion valve spindle caused by cam-plates actuated by the governor. The cylindrical bored chamber in the main slide in which the cut-off valve works is provided with longitudinal ports communicating with the ordinary steam ports to which they are at right angles, and the cut-off valve, which is hollow, has also longitudinal ports communicating with those in the chamber. By the partial rotation of the cut-off valve the steam can thus be promptly cut off from the ordinary steam ports. To give the desired motion to the cut-off valve there are two cam-plates acting on a roller which runs between them, and these plates are mounted on the same axis as the governor, the action of the latter being to advance the plates more or less and so vary the two points in each revolution at which the cam-plates actuate the cut-off valve. The cut-off can be varied from about 2½ to 62½ per cent. of the stroke. The governor is approximately parabolic, the balls lifting a central weight. The arrangement appears to work well, and the engine to which it is applied is of good design generally.

We have already mentioned several compound semi-fixed engines arranged under the barrels of locomotive boilers, and we may here notice another which is exhibited by Messrs. Thomas Robinson and Son, of Rochdale, a firm which we believe now show an engine of this type for the first time. The engine has a central bearing on its crankshaft, each of the three crankshaft bearings being mounted on a wrought-iron frame of girder iron which is connected to the cylinders. The three girders are of course connected by transverse stays. The cylinders of this engine are not steam-jacketted, and the governor is of the old-fashioned type acting on a throttle valve.

Not far from the engine last mentioned Mr. William R. Mansell, of Wellington, exhibits some of his horizontal and vertical engines, the only special feature about which is that one of the verticals is fitted up for coiling wire, the end of the crankshaft carrying a large disc, in which can be fixed studs for receiving the wire coils. Close by, too, Mr. W. G. Bagnall, of Stafford, shows two examples of his

small narrow gauge locomotives together with samples of his portable railway, and some rolling stock for use on such lines. One of the engines and a carriage are respectively of the pattern which we recently illustrated and described (see pages 330 and 335 of our last volume), while the other exhibits include some very well-designed tip-wagons.

On the same side of the Show ground Mr. Joseph Hatton, of Coventry, exhibits a good collection of his "Challenge" steam pumps both vertical and horizontal, one of the latter being illustrated by the perspective view which we give on page 49. In the pump the two rams, which are cast in one piece, are directly connected to the steam piston, while between the two stuffing-boxes the rams are coupled to a bow connecting rod, this rod taking hold of a crankshaft running on bearings at the end of the bed-plate, as shown in our illustration. Of course this rod only has to transmit to the crankshaft the difference between the effective pressure on the steam piston and the resistance of the pump rams, and the strain imposed on it is consequently small. The crosshead through which it is connected to the rams is readily detachable. A special feature in these pumps is the arrangement of the valves, these being arranged in a central valve box so that the removal of a single cover gives access to the suction or delivery valves belonging to both rams. The valve seats as well as the valves are also renewable with little trouble. Besides the double-ram pump illustrated, Mr. Hatton shows some well-designed bucket pumps, and also a number of donkey pumps with single rams. These latter are fitted with Mr. Hatton's swivelling valve boxes, which are secured to the body of the pump by a single bolt, on slacking which the valve box can be turned round so as to suit the pump for being worked in either a vertical or horizontal position. The arrangement is neat and convenient.

Messrs. Robert Jenkins and Co., of Rotherham, are the exhibitors of some excellent examples of welded boilers, constructed chiefly for horticultural purposes, but including also a vertical steam boiler with the firebox welded up and the two cross tubes welded in. Messrs. Jenkins and Co. make a very large variety of boilers intended for use with hot-water apparatus, many of them exceedingly well designed, but this is not the place we can notice them in any detail.

AIR AND GAS ENGINES.

Turning now to motors other than steam engines, we find at the stand of Messrs. Gilbert Gilkes and Co., of Kendal, an example of the Buckett caloric engine, which was working much more quietly than it did at York last year, where it was so largely represented. Messrs. Gilkes and Co. also exhibit one of their well-known turbines. At the stand of Messrs. W. H. Bailey and Co., of Salford, are shown several of their air engines, both vertical and horizontal, one of the former being heated by gas instead of by a coke fire. The vertical engines shown are both arranged for pumping.

Gas engines are exhibited by Messrs. J. E. H. Andrew and Co., of Stockport; Messrs. T. B. Barker and Co., of Birmingham; and last, but by no means least, by Messrs. Crossley Brothers (Limited), of Manchester. Messrs. Andrew and Co., of course, show the Bisschop engine, which they have manufactured so largely, and which is now so well known, while Messrs. Barker and Co., exhibit their "Universal" engine, one of the chief features of this engine being the rotary ignition valve, which is a disc with radial slots mounted on the back cylinder cover, and having an intermittent motion given to it by a ratchet movement.

The stand of Messrs. Crossley Brothers, Limited, contains four engines, all admirable specimens of workmanship. One of these is a vertical engine—a new pattern of which we give a perspective view on page 52. As will be seen from this illustration the general design of this engine is exceedingly neat, while the small amount of floor space which it takes up will render it very convenient of application in many cases. In this engine the hollow standard forms the water tank containing the water for circulating in the cylinder jacket, the water storage thus afforded being sufficient when the engine is used intermittently. In the event of the engine being worked continuously, at near its full power, the water storage in the standard would, however, have to be supplemented by an additional tank, or the water would have to be partially renewed at intervals. A single cylinder six-horse gas engine of the ordinary type exhibited, is fitted with a new arrangement of base, this base forming an air chamber through which the air supply for the cylinder is taken in. The base is provided with longitudinal partitions, dividing it into chambers through which the air circulates successively, the arrangement being such as to baffle the transmission of sound, and prevent a noise in the event of a back explosion.

Perhaps, however, the most interesting engine in the stand is one of Messrs. Crossley Brothers' new twin-cylinder Otto engines, fitted with their self-starting arrangement. This engine is capable of indicating 28 horse-power, and it is arranged so that when working at full power, an impulse is given every revolution, instead of every alternate revolution as in the ordinary Otto engine. The two cylinders are placed side by side, and their pistons are both coupled to the same crank, so that they move together, while a single valve passes across their back ends and affects the gas and air distribution of both. The ignition arrangements are such that when the engine is working at its full power the explosion takes place in the two cylinders alternately, one cylinder taking in a charge while an explosion is taking place in the other. As the power required is reduced, the governor first reduces the number of explosions made per minute in one cylinder, eventually shutting off the gas supply from that cylinder altogether, and then reducing the number of explosions in the second cylinder, so that at very low powers the engine is driven by explosions in one cylinder only. The self-starting arrangement consists of a strong cylindrical chamber or accumulator placed by the side of the engine, and communicating with the adjacent cylinder by a connecting pipe and loaded valve, the arrangement being such that at each explosion, as soon as a certain pressure is reached, a small quantity of the gaseous products passes over into the accumulator, this going on until the pressure in the accumulator reaches that attained in the cylinder. When the engine has to be started, the gases under pressure stored in the accumulator are admitted to the cylinders by a hand-moved valve, and act on the pistons just as steam or compressed air would do. It is only necessary to give a single impulse in this way to start the engine. We may mention that the valve through which the gases pass to the accumulator is fitted with an arrangement of oil trap which renders it necessary that it should only be oil-tight and not gas-tight; this of course greatly facilitates the retention of the pressure in the accumulator for long periods. The accumulator has sufficient storage to enable the engine to be started a dozen times, or even more, with one charge, if care be taken in the manipulation of the admission valve.

TELPHERAGE.

Among the exhibits that figure this year in the Royal Agricultural Show for the first time, is the telpherage system of Professor Fleeming Jenkin. This is an overhead electric railway designed for transit of moderate weights, at slow speeds, in situations where the question of expense or the difficulty of construction, precludes the erection of an ordinary line. Since it was first described in our columns* the system has undergone much simplification, and the apparatus shown at Shrewsbury illustrates the latest design. It consists of a short length of line with a locomotive and train, as illustrated on pages 56 and 57, and a working model which shows the method of operation.

A telpher line differs from previous electric railways in that (*a*) each track has only a single rail; (*b*) the rail is overhead, and the loads are suspended from it; (*c*) two rails serve both for the up and down lines, and also for the positive and negative conductors for the current; and (*d*) each line is divided into short sections, which are alternately positive and negative. This latter is probably the most characteristic feature of the whole. The sections extend from one post to the next, and at each post there is a cross connection. Thus, supposing the positive current to enter the up-line at the first post, it traverses it as far as the second; then it crosses to the down-line by a wire, and follows it to the third post, when it returns to the up-line, and so on. The alternate sections are similarly connected together and to the negative terminal of the stationary dynamo machine which furnishes the current. If the railway be only a single track, on which the trains run in both directions, then all the odd sections must be connected by wires, and all the even sections. In such case the positive current flows through the first section, goes from the first to the third by a wire, traverses the third section, and goes to the fifth by a wire, and so on. The second, fourth, and sixth sections are similarly connected with each other in series. Whether there be one or two tracks the train works under exactly the same conditions; its length is equal to the length of a section, and thus it constantly rests part on one section and part on another. The train carries a conductor connected to the wheels of the leading and the trailing vehicle, and including in its circuit an electro motor. This conductor, therefore, forms a connection between the positive and negative leads, because its ends are connected to two adjacent sections which are always of opposite polarities, and each time that its extremities pass from one section to the next, the current in it is reversed. This, however, makes no difference to the motor, the direction of revolution of which is determined by the position of the brushes, and not by the direction of the current. The amount of current passing through the motor depends upon its resistance, and the inverse electromotive force which it sets up, and however many trains there may be on the line, each will only take its proper amount of current, just in the same way that incandescence lamps arranged parallel upon the same conductors, will burn without appreciable interference with each other.

The speed at which the trains are designed to run is about five miles an hour, and each wagon will carry from one to two hundredweights. The various vehicles are coupled by rigid connections which serve to push them when the locomotive is backing, and also prevent them overrunning each other on an incline. As the line is flexible it hangs in curves from post to post, and thus one-half of the train is always on a down grade and the other on an up grade, the two balancing each other and keeping the speed uniform. Of course the general direction of the line may be up or down hill, in which case other means, as will be explained later, are required to secure regularity of motion.

The first vehicle of the train is, as is usual, the locomotive, and as lightness is a matter of great importance in lines of this kind, it cannot well be made of sufficient weight to give the required adhesion by that means alone. It is therefore provided with gripping wheels which tightly clasp the rod or rope. These are shown in Figs. 2 and 5, the latter being to a larger scale. The motor itself is suspended, as are all the loads, below the line, and drives through a pair of spurwheels (Figs. 1 and 2) a small countershaft. This is geared by a pair of wheels and a pitch chain to the "nest gearing" above, which rotates at a much smaller speed than the motor. The principle of "nest gearing" has already been explained in detail in these columns,* but it may be briefly stated to be frictional gearing in which the strain of the nip or grip is taken by rolling surfaces, and is not transmitted through the bearings to cause useless friction. The arrangement is clearly shown in Fig. 5; the rod or line is nipped between two conical wheels, the acting surfaces of which form a very acute V. These wheels are each driven by a pair of frictional bevel wheels, of which one is on the horizontal shaft, and the other coaxial with the gripping wheel. As a matter of convenience the frictional surface is made in two bands, separated by an open space, but both bands form part of the same conical surface. The grip, both between the frictional driving surfaces, and between the gripping wheels and the line, is obtained by means of the coiled spring in the interior of the horizontal axis. This can be set up by a screw, and draws the two large bevel wheels towards each other, and towards the gripping wheels. These latter are carried by swinging bearings which permit them to advance towards the line, and at the same time to conform exactly to the position of the driving wheels. The gripping wheels serve another purpose besides securing adhesion. They act as the contact makers to lead the current from the line to the motor, and their firm tread keeps both themselves and the line bright, securing excellent contact without the use of brushes.

It will be noticed that the line is shown of a different section in Figs. 2 and 5. In the former case there is represented the short portion of insulated line which occurs at each post to separate the positive and negative conductors, and in the latter a part of the rod through which the current travels.

* See ENGINEERING, vol. xxxv., page 318, and vol. xxxvi., page 481.

* See ENGINEERING, vol. xxxvi., pages 307, 379.

The rod, which for ordinary lines is ⅜ in. or ½ in. in diameter, is welded at the end of each section to an angle piece (Figs. 6, 7, and 8) by which it is bolted to the post. Insulation is secured by porcelain washers (Fig. 9) between the angle piece and the timber, and under the nut. By this arrangement no transverse strain is thrown upon the porcelain insulator, which is formed with a sharp edge, designed to be washed clean by the rain, after the manner of telegraph insulators. Between the two adjacent sections a short length of stiff insulated rail is erected (Figs. 7 and 8) to prevent the formation of arcs. There is no danger of a train sticking at these points, as the momentum is sufficient to carry it more than half a span. The posts are of X form, with the base wider than the distance between the up and down lines, so that the load has no tendency to work them out of the soil.

All the vehicles are designed to run round very sharp curves. As the spans are, of necessity, straight, all the curvature occurs in the short lengths of rail which separates the sections, and consequently has often to be very rapid. The wagons run on two grooved wheels, both of which are free to swivel round a vertical axis, while the bar, which carries the wagon body, can swing fore and aft. In the locomotive the weight is divided between the gripping wheels, the small wheel between them (Fig. 5), and the leading wheel (Fig. 1). This latter is free to swivel, and serves to keep the plane of the gripping wheels parallel to the rail, whether the locomotives be going up hill or down. It does not act as a guiding wheel, as the arm by which it is held is pivotted to the frame of the gripping wheels. These latter always set themselves so that the line joining these centres is square with the rail, and need no further guide.

From the foregoing description the method of working will be readily understood. A train is made up of a locomotive and a number of trucks spaced rather wide apart, so that the total length is equal to a span. The current from (say) a positive section of the line enters the gripping wheels, passes down to and through the motor, putting it into action, and then through the conductor along the train to the trailing wheels, which are on a negative section. As soon as the locomotive enters the next section the flow of the current is reversed, but everything else remains the same, and the train proceeds automatically without driver or attendants. At the station it can be stopped by breaking the circuit to one of the sections, or by diverting it into a siding by means of a switch, and be again as easily started. Or it may be reversed by altering the positions of the brushes on the motors and be sent back again. To prevent the train running away on inclines a very neat form of automatic brake has been added to the motor. Upon an extension of the spindle there are fixed two strong U springs, carrying at their outer extremities brake shoes. These shoes run in the inside of a fixed ring, and at normal speeds are clear of it. Should the speed increase beyond a certain amount the centrifugal force overpowers the spring and the shoes come into contact with the ring, grinding around its inner circumference. Their pressure is, of course, not great, but as the motor runs from 1500 to 2000 revolutions per minute, the product of the speed into the pressure is very considerable, and the train runs at nearly uniform speed up and down hill. An automatic block system has been devised whereby the train as it leaves a certain section breaks the circuit of that section, making it again by means of an electro-magnetic apparatus, when it has proceeded a certain distance. But when it is considered that the trains carry no passengers, and proceed at a very slow speed, it is doubtful whether it be worth while to introduce any unnecessary complication, at least at present. The system itself is exceedingly simple, there are no contacts to become oxidised, no delicate apparatus to go wrong, and no parts that are beyond the comprehension of an ordinary mechanic, and as it is probable that the first applications will be on a moderate scale, it would be unwise to introduce refinements that will not be required, but which will necesitate a good deal of skilled oversight.

The Telpherage Company, Limited, has had an experimental line at Weston, Herts, for some time, and has sent one to South America, where it is to be employed in the conveyance of minerals. This, indeed, appears for the present to offer the likeliest field for the system, which is peculiarly adapted to undeveloped countries. Professor Jenkin has hopes that in time telpher lines may become common in this country as feeders for railways for the conveyance of farm produce, for coal mines, brickfields, and the like, and is working steadily towards this end.

SILOS AND ENSILAGE CUTTERS.

The Shrewsbury meeting has afforded great facilities to farmers and others interested in the preservation of fodder, of judging the practical value of ensilage, and the best means to be adopted for storing green crops in such a way as to preserve them for winter use. Long established and largely used in many countries, it is only of very recent years that attention has been forcibly called to this process by which the gathering and saving of crops are rendered independent of wet seasons. The various methods of hay curing and drying in favour some years since, are rendered unnecessary by the simpler one of packing the green crops in a suitable receptacle, and keeping them till required. Ensilage, only experimentally tried in this country, has nevertheless a literature of its own, scattered through many pamphlets, and the pages of the leading agricultural and other journals, and its general principles and advantages are almost too well known to bear recapitulation here. Still, at the Royal Agricultural Society's Show this year, so far as striking novelties are concerned, is an ensilage show, and as we propose to do justice as far as possible to the exhibits bearing on the process, a few words of introduction will be admissible. Not to go further back, the storing of green crops has been practised in Germany for over forty years, and in 1852 the question was studied by the light of that experience by M. Goffart in France. In the United States and Canada the hints conveyed by this Continental practice were not lost, and of late years ensilage has been practised there largely and successfully. It was not, however, till October, 1882, that public attention was fully called to the subject in this country by an article in the *Times*, describing the silos and ensilage on the estate of the Viscomte de Chezelles at Liancourt, in France. The writer of this article, Mr. Kaines-Jackson, has since closely identified himself with the system, and he has rendered excellent service to agriculturists at the present Show. The Viscomte de Chezelles' silo is a large covered building over 200 ft. long and 20 ft. wide, with the floor sunk to a depth of 12 ft., so as to form a huge tank, large enough to contain the green forage crops from 170 acres. As the crops are cut they are passed through suitable cutting machines and charged into the pit. From time to time the mass is trodden down by bullocks to level it and make it more compact, and when filled, about 18 in. of sand or earth are laid on top to preserve it from the weather and provide a weight that will compress the forage and follow it up as it contracts into smaller bulk. In the United States the question of ensilage was eagerly taken up, and the experiments made were very numerous and on a large scale, much ingenuity being expended in the construction of cheap and suitable structures for the purpose. Mr. T. Christy, who has done much good work in stimulating farmers to follow this old and well-tried practice, gives in his pamphlet on ensilage a number of examples of American silos, from the simple clamps in which the fodder, like beets or potatoes, is simply stored in trenches and covered with earth, to the extensive and more costly arrangements involving sunk pits and covered sheds. The cost of an efficient building for this purpose in America is stated to be about one dollar a ton.

It is a matter of considerable surprise that although this method of preserving forage has been known and widely practised on the Continent for so long a time, no trials of it have been made until recently in this country. There are so many powerful inducements to the farmer in this uncertain climate to seize on anything that offers him a chance of becoming partially independent of it, and there are many societies connected with agricultural interests, that one cannot but wonder, it should have been left to the *Times* and the *Field* newspapers to have aroused attention and curiosity in the matter. The first official trials, so far as this country is concerned, were made in Ireland, and the result was embodied in a report, by Professor Carroll, on some experiments that had been carried out at the Albert Institution, Glasnevin. At the request of Lord Spencer, the trials were carried out during the summer of 1882, various crops being treated in different ways as follows:

1. Lucerne and straw cut in a chaff machine, put in a silo 5 ft. deep, and made practically air and water-tight. 2. Comfrey and lucerne, mixed with a little oat straw, and similarly stored. 3. Italian rye grass, not cut by the chaff machine, but tightly packed in the silo. 4. This was also Italian rye grass not cut, and stored in a pit that was unlined or otherwise protected, except that it was of course covered in with earth. 5. Italian rye grass packed tightly on the ground and covered over with earth. These were also stored towards the end of July, and the different pits were opened on October 9, when it was found that Nos. 1, 3, and 4 were in excellent condition, and made good forage. The other experiments had failed. In connection with these experiments, which must always possess a high interest, some analyses were made by Dr. Cameron, and which are annexed with an analysis of the fresh grass, from which the ensilage was prepared:

	Grass.	(A).	(B).
Water	68.200	66.50	68.10
Albumenoids (nitrogenous substances)	2.830	2.76	2.60
Non substances, soluble in acids and alkaline solutions ...	13.116	15.20	14.82
Insoluble in acid ...	11.728	11.37	10.13
Fats	.764	.77	.75
Mineral matter (ash)	3.052	3.40	3.60
	100.000	100.0	100.00

Referring to these analyses Dr. Cameron points out that the albumenoids are less in the ensilage than in the fresh grass; that the quantity of water varies but very slightly, and that the soluble non-nitrogenous matters and ash are greater in the ensilage than in the grass.

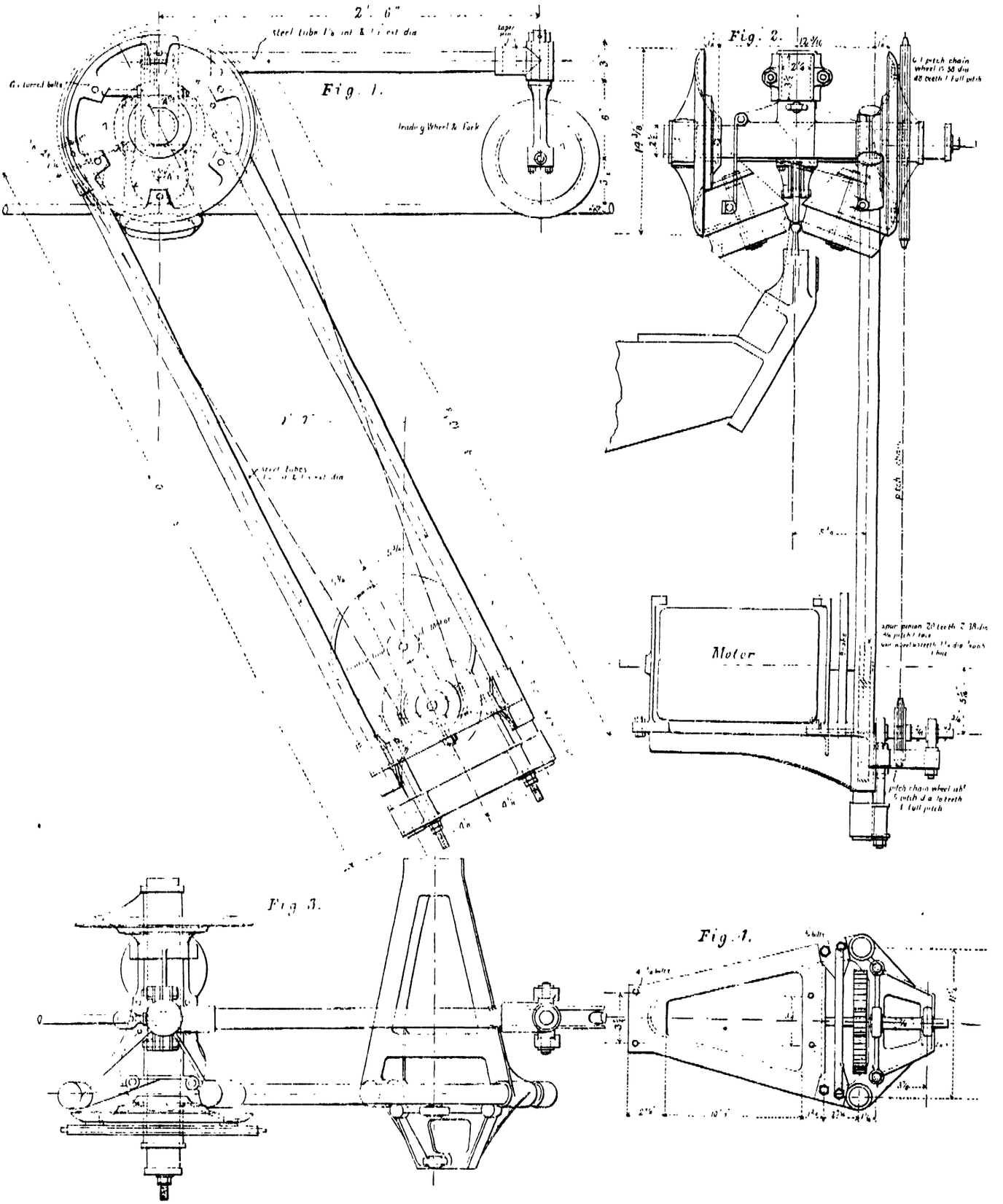
While these official trials were being carried out similar ones were in progress by a number of private individuals in different parts of the country. Mr. Gibson, of Saffron Walden, filled a silo built of concrete with about 80 tons of green rye, passed through the chaff-cutter; he took no precautions to load the top of the charge in order to compress it, the result being that when opened some months later the forage was found to have deteriorated at the top, but underneath it was in perfect order. The analysis of this ensilage gave 72 per cent. of water, 2 of albuminous substances, and 12.8 of mucilage and digestible fibre. Lord Walsingham conducted at Merton some very valuable and interesting trials. Some existing farm sheds were converted into three silos, and very common rough grass crops were chosen for the experiments. The crops when cut were reduced to chaff, and charged into the magazines, being well trodden and rammed down, a little salt being added. After the silos were filled they were covered with planking and coarse bran. This was removed about three weeks after, when the forage had sunk down to about one-third of its original depth, and the silos were again filled. The cost of thus treating the crops was 12s. 9d. an acre as compared with 26s. for making into hay. Five months later, when the silos were opened, the contents were found entirely satisfactory, and served as fodder throughout the winter.

The natural result of the foregoing, and many other trials, made in this country in 1882 and last year, has been to arouse new hopes and prospects for British agriculture, and to encourage the reasonable expectation that the forage harvests may be rendered independent of the weather. There are indeed many other advantages that should be secured by this method. Crops can be raised and cleared off the ground rapidly to make room for a succession, grain, laid or irretrievably damaged for ordinary harvesting, can be siloed and so utilised for fodder as if it had been the best of crop. The *Field*, on the 22nd of March last, called attention to the special value of ensilage on sewage farms where a rapid succession of coarse crops is grown, which must be cleared off the ground promptly, to be out of the way of the sewage discharge that is of necessity to be distributed. From this cause it even happens that such crops, besides being damaged by rain, are sometimes rendered useless by sewage drenching after they are cut. On these farms the storage of green crops must evidently be of the greatest possible advantage, and since Mr. Lascelles's recent experiments at Croydon have proved that grass from sewage farms can be turned into good ensilage, a much more hopeful view can be fairly sewage disposal of sewage by irrigation.

TELPHER LOCOMOTIVE AT THE SHREWSBURY SHOW.

CONSTRUCTED BY MESSRS. EASTON AND ANDERSON, ENGINEERS, LONDON, FROM THE DESIGNS OF PROFESSOR FLEEMING JENKIN.

(*continued from page* 54.)

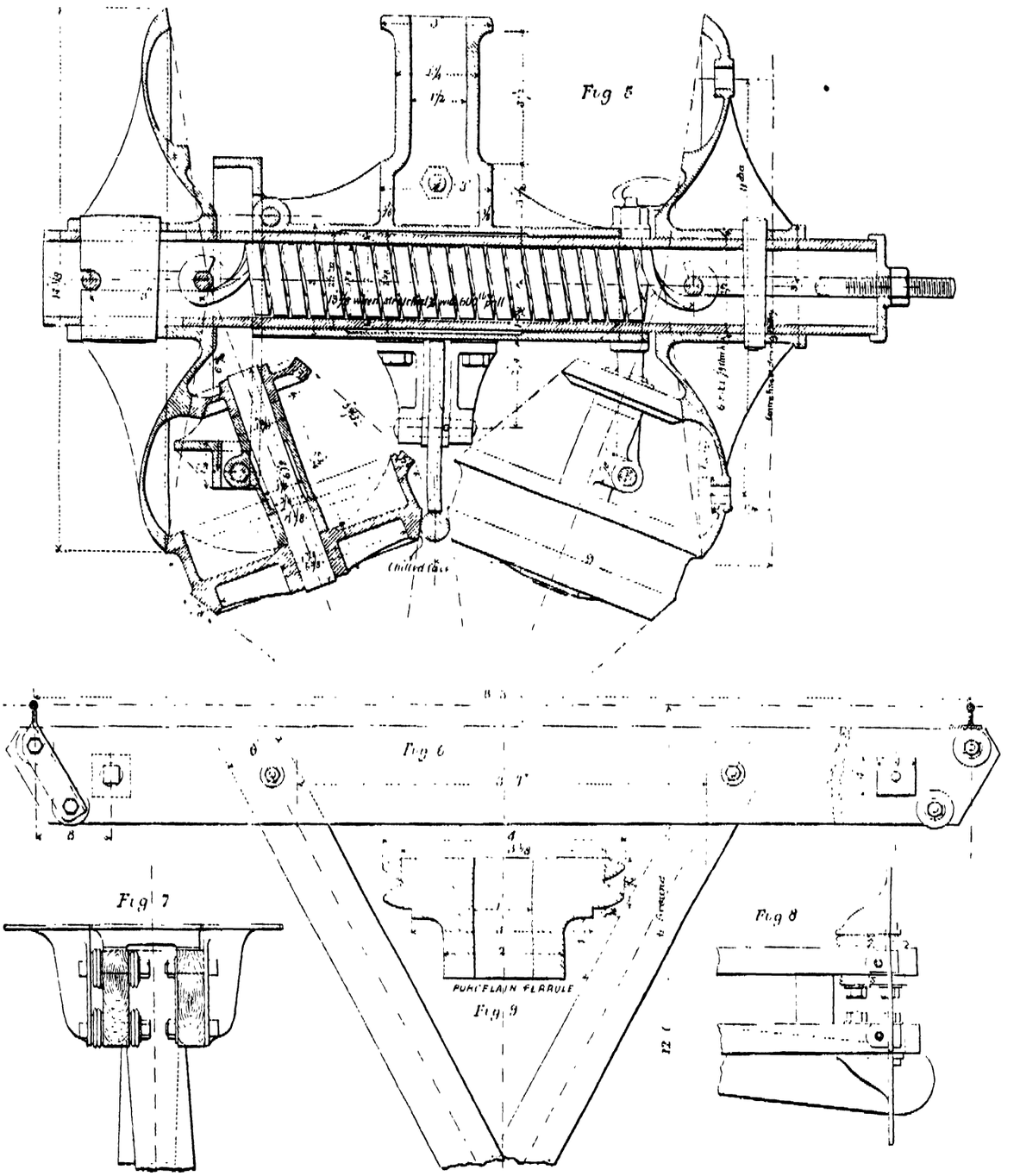


If the Royal Agricultural Society has done little officially to encourage this development of agriculture, its meeting at Shrewsbury has, at all events, afforded an opportunity to exhibitors and visitors of examining the various systems proposed of storing and treating the crops. As with all new subjects, which, taking the public mind, find practical shape for the first time in the show-ground, the first results are more or less crude and ill-adapted to the ends in view. It is true that the practice of ensilage appears to be so easily carried out that it requires only few and simple appliances, but such appliances are of course capable of development and improvement, with an increased and more intimate acquaintance with the new system.

Messrs. J. and F. Howard, of Bedford, show a large model of an iron silo, which according to them does away with the disadvantages of the more generally used systems. It consists of a cylindrical reservoir, without a bottom, placed on the ground, but provided with a cover fitted with a water seal. This is made by forming a trough round the top of the tank, and into which the rim of the iron cover, which encloses the tank, is dipped; the trough being filled with water makes an air-tight joint. To the cover is secured the end of a vertical boss, which passes down the outside of the tank and carries a

TELPHER LINE AND DETAILS OF TELPHER LOCOMOTIVE AT THE SHREWSBURY SHOW.

(*For Description, see Page* 54.)



bevel wheel at the bottom, where a bearing is provided by a bracket bolted to the side of the tank. A pinion worked by a hand lever, gears into the bevel wheel, and when it is desired to open the silo the rod is raised so as to clear the rim of the cover and the water-seal trough, after which a few turns of the bevel wheel throws the cover over the edge of the tank and gives access to the contents. The dimensions of the silos made by Messrs. Howard upon this system, are 12 ft. in diameter and 12 ft. high, the capacity being about 35 tons. The exhibitors maintain that fodder preserved in this manner is at least equal in quality to that kept by any system involving the use of top weights to compress the contents, so that more or less of complication and labour are saved, and to illustrate their assertion, they show two series of large glass jars, in one of which the grass, &c., has been packed in the same manner as it would be in their silos, while the second series contains similar forage, weighted on top. Although these examples may seem to endorse this view they are on altogether too small a scale to form a practical proof of the method.

Messrs. W. F. Reynolds and Co., Acorn Works, Edward-street, Blackfriars, show three examples of portable silos, holding respectively 20, 30, and 50 tons. They are simple circular tanks of wood, framed roughly and strongly together, and are provided with a waterproof canvas roof. These silos are fitted with Reynolds's appliance for compressing the ensilage. It consists of a wooden platform which rests on top of the charge after the tank is filled. Chains secured at the bottom of the tank pass up its sides and over the platform, where they are taken into suitable shackles and connected to screwed couplings, by turning which a sufficient pressure can be exerted on the platform, and the contents compressed. In the silos exhibited two pairs of such chains are sufficient to produce the desired effect. The same exhibitors also show a model illustrating the same arrangement applied to a sunk silo. One of the wooden tanks forming this exhibit is fitted with a large window glazed with thin glass, through which the compressed ensilage and the compressing floor can be seen, demonstrating the absence of any important lateral pressure against the sides of the reservoir. Until recently, built-up silos have been constructed with thick side walls to resist this imaginary pressure. The tendency appears to be rather the other way, and shrinking of the mass relieves the sides of the enclosing chamber.

Mr. J. H. Stocks, of the Whitecliffes, Cleckheaton, exhibits a so-called portable silo and press having a capacity of 53 tons. This is a rectangular wooden framed structure, also provided with a pressing floor, as in those just mentioned. Pressure on this floor is not exerted however by chains, but by means of heavy iron rods, which rise vertically from the floor where they are firmly secured, and passing through the pressing floor, terminate in a screw thread, on which works a deep nut and long lever. Between the bottom of the nut and the bearers, to which the pressing floor is framed, each rod passes through a powerful volute spring, and when the silo is charged and the nut screwed down so as to compress the springs, the latter exert a pressure on the ensilage, which relaxes as shrinking takes place, when the nuts have again to be run down to restore the pressure. Lastly, we have to mention the silo made and shown by Messrs. W. H. Lascelles and Co., 121, Bunhill Row, London. This is a

structure built up of open wooden framing, the panels being filled in with slabs of concrete, and the structure, thus enclosed, covered with a roof, which can be partially run back for charging. Arrangements are made for the easy removal of some of the side slabs, when it is desired to use the ensilage. We think that this form of silo, several of which have been already constructed by the exhibitors, possesses great advantages over any of the other forms proposed or in use, at least when a sunk reservoir is not employed. The system is extremely strong, durable, and cheap; it is very readily put together, and, in the event of any of the slabs being broken, they can be quickly and easily replaced. It is worth mentioning that Messrs. Lascelles advocated this form of construction some time since in the *Field* newspaper, where they published illustrations of the mode of construction. What lends a special interest to the Lascelles silo is the fact of its being charged upon the French system, followed with absolute success by the Vicomte de Chezelles, and others. We have already mentioned that Mr. Kaines-Jackson has been intimately and actively associated with the question of ensilage since he first described the Dutch and French methods. Messrs. Lascelles erected their silo on the ground at Shrewsbury early in June, and on the 14th of that month Mr. Jackson charged it with mixed green crops from the adjoining fields. After it had been filled and trodden down as compactly as possible, the charge was covered to a depth of 18 in. with sand, and the silo was closed until last Monday. On being opened it was found that the contents had, under the influence of the top weight, contracted by about 3 ft. in depth, while the samples that were cut left nothing to be desired as regards the perfect manner in which the forage had been preserved. The load of sand, exerting a constant and equal pressure, had produced a uniformity in the ensilage, which certainly tends to promote its preservation in good condition, and which can hardly be secured by the use of mechanical appliances. The latter, moreover, are open to this objection, that they do not follow up the sinking mass, and therefore require constant attention. Boards laid on the top of the charge and loaded with stones, a practice followed in America and elsewhere, have the advantage of sinking with the charge, but they do not exclude the air, which the thick mattress of sand does very effectively. The farming interests have certainly been greatly served by Mr. Kaines Jackson, who has thus afforded the best possible proof of the efficiency and simplicity of the French method, a method which, moreover, has all the advantage of economy to recommend it. It may be urged that the top of the charge is rendered useless on account of the admixture with the sand lying upon it; but this is an objection of little moment, since no sand penetrates beyond a very insignificant depth, and the thin skin thus affected, if shaken out in the open air, is very quickly freed from what sand may adhere to it. This exhibit cannot fail to be of high practical value to farmers, who, thoroughly alive now to the value of ensilage, have been thus afforded a practical demonstration of how to carry out the system cheaply and efficiently.

We have stated at the beginning of our notice of this Show, that a prize was to be awarded to the machine which on trial showed itself to be best adapted for cutting and elevating the green crops for charging silos. These trials, for which there were several entries, were watched with considerable interest. Although the work to be done resembles chaff cutting, and the machines for doing it must be closely allied to chaff-cutters in their general principles, there are some considerable difficulties in dealing with a green crop; the material is heavy to cut, very bulky, it clogs and binds around the feed rolls and the cutter wheels, it lies close and dense in the hopper after leaving the knives, and has a tendency to collect when it gets a chance, clogging up passages and hindering or stopping the work. Moreover, with few exceptions, makers have little experience of the requirements and difficulties, so that the very natural result followed, that the result of the trial did not come up to the expectations of the judges and the public. As a consequence of this, the following notice was posted in the yard on Tuesday last:

"We have carefully tried the whole of the machines entered in this competition. We have not found any single machine that completely meets the conditions under which the prize was offered, viz., for an efficient machine for cutting and elevating materials to be preserved in silos. We consider, however, that Messrs. Richmond and Chandler's machine, No. 1630, is deserving of high commendation for the efficiency of its arrangement for cutting the materials." A very universal feeling of dissatisfaction—to use no stronger word—followed this announcement; and we consider that the decision not to make the award is much to be regretted, and must tend, under the peculiar circumstances, to discourage manufacturers from entering similar competitions in future.

Nine exhibitors of machinery for cutting and raising ensilage entered the competition; and while some of the apparatus presented few features of interest, others possess special and noticeable points in their design. The machine of Messrs. Richmond and Chandler, of Manchester, which deservedly received the special approval of the judges, is well designed for the purpose intended. The endless band in the bottom of the feeding trough conveys the material to be cut to the feed rollers, which are made up of a number of toothed steel discs, strung together on shafts with distance-pieces between. The top roller is free to rise and fall within certain limits, being held down to its work by spiral springs, which yield and allow the roller to rise if any exceptional pressure is set up. The makers' special form of mouthpiece is added, which effectually prevents choking. The upper part of the mouthpiece, which comes over in front of the rolls, instead of being solid is cast open, so that if the material being cut works up between the roller and the comb, or concave in front, it falls over upon the cutter wheel through the opening above referred to, or under the worst conditions, reversing the motion of the rolls will free the mouthpiece immediately. The length of feed is regulated according to Messrs. Richmond and Chandler's usual chaff-cutter system, by means of two bevel pinions on the main shaft gearing into one of two concentric bevel wheels on the motion shaft. This means of adjustment is controlled by a lever placed close beside the workman, occupied on the footplate in feeding. The same lever, of course, starts and stops the machine, and should the man's hand be drawn by accident between the feed rolls, the machine would be stopped by his falling against the lever. An additional means of security is afforded by the introduction of a foot lever, by which the machine can be stopped. The cutter wheel presents nothing calling for remark. It revolves in a large box or hopper, into which the cut grass falls; the bottom of this box is formed of an endless travelling band, which conveys the cut material forward into the hopper of a separate elevator, by the travel of which the ensilage is raised into the silo. We propose, shortly, to publish illustrations of this machine, which, besides having all the excellent finish which characterises Messrs. Richmond and Chandler's work, is designed with good judgment to avoid any choking up of the material, and with a proper regard to the safety of the workman.

Close by the stand of Messrs. Richmond and Chandler is that of Messrs. John Crowley and Co., of Meadow Hall Iron Works, near Sheffield, who entered the competition with an ensilage cutter. This presents the general features of the chaff-cutters made by this firm, with some modifications, and, of course, increased size to meet the special requirements of ensilage. A wooden safety roller is fitted over the trough at the back of the feed rollers, so that if the attendant's hand is drawn in he will be arrested by the roller and thrown forward against the stopping and reversing lever. The cutter wheel, which is provided with four knives, is also fitted near the rim with several curved blades or fans, the object of which is to project the cut material against the discharge leading to the elevator hopper. The cutter wheel works in a box, and is completely enclosed by a metal hood. We believe that this machine did very fair work, but the trial suggested some modifications, which will doubtless appear in the machines the next time they are exhibited.

The ensilage cutter exhibited by Messrs. Carson and Toone, of Warminster, is simply a large chaff-cutter intended to deliver about 2 tons of cut material per hour. It will cut four lengths from $\frac{3}{8}$ in. to 1 in., and is adapted to deliver either into bags through a suitable shoot and hood, and upon an elevator, the one shown having a lift of 12 ft. For convenience of travelling this elevator can be folded back, and it can be raised or lowered during work.

Messrs. R. A. Lister and Co., of Victoria Iron Works, Darnley, exhibit a somewhat similar machine, an apparatus that may be used either for cutting ensilage or chaff. We show the general appearance of this machine on page 68, from which it will be seen that the elevator attached to the machine allows of a very considerable lift. The maker has paid considerable attention in designing this elevator. It can be folded for travelling, and although very light and stiff, is strongly made; compensation bearings are placed at the upper end to keep the travelling band stretched. We may mention, in passing, that this maker has a very good collection of grist mills, which display a great deal of ingenuity in the design of their details.

At the invitation of the Secretary of the Royal Agricultural Society, M.M. Albaret, of Liancourt-Rantigny, in the department of the Oise, exhibit a machine of the same class, but having several special characteristics. M. Albaret, one of the leading makers of agricultural machinery in France, has a number of these ensilage cutters in use, and has already gained sufficient experience with their working to have developed a standard machine adapted to French agricultural requirements. But as it is chiefly maize which is cut and stored in the silos, the machine exhibited is not so well adapted for cutting up clover, oats, and other light material, and at the trial, although excellent work was done, it is certain that the cutter worked under considerable disadvantages. It was in fact doing a duty for which it was not designed. The diagrams on page 53 illustrate the general arrangement of the apparatus, which we shall illustrate in detail on another occasion.

The cast-iron table A^1 rests on three feet a a^1 and supports the cutter wheel shaft, on which is placed the driving pulleys and a series of distributing rollers R S V T. The forage to be cut is conveyed on an endless band within the feeding box U, to the compression rollers in front of the cutter wheel. These rollers are heavy and large, 10 in. in diameter, and are provided with projections to feed the forage to the knife. The lower roller runs in fixed bearings, but the bearings of the top roller are free to slide in the grooves made in the side of the box frame. The pressure exerted by the top roller on the forage is regulated by means of a lever provided with a shifting weight, and the top roller is driven from the bottom one by a pitched chain passing over wheels on the roller spindles. The feed is regulated to four lengths of $\frac{1}{8}$ in., $\frac{1}{4}$ in., $\frac{3}{8}$ in., or $1\frac{1}{2}$ in. by means of the four controlling wheels R S X T. The cutter wheel is of the form shown, and around its periphery are twelve blades a a. This wheel is inclosed in a box, to which an elevating spout is attached, and the chaff when cut, is subjected to the powerful action of the fan, which forces it up the elevator spout to the silo, cart, or other point of delivery. The casing surrounding the cutter wheel is provided with several openings: one to admit air, a second for giving access to the knives, and a third for clearing out the box. The ordinary working speed of this machine is 400 revolutions per minute, but driven at 500 revolutions it can cut 10 tons into $\frac{3}{4}$ in. lengths per day. We may mention that Mr. Albaret is represented in this country, so far as regards this ensilage cutter, by Mr. Thos. Christy, of 155, Fenchurch-street, whose name is so well known in connection with the ensilage movement.

We may dismiss with a brief notice the machines shown by Mr. Robert Maynard, of Whittlesford Works, near Cambridge, that of Messrs. Burlingham, Innes, and Paternoster, of Hitchin, and that of Messrs E. H. Bentall, and Co., Heybridge, Essex. The first is with slight modifications, the well-known machine made by Mr. Maynard for dealing with large quantities of cut material, and the other two are chaff-cutters on a large scale

The ensilage cutter possessing the greatest originality of design, and which, at the same time, not only did its work during the trial thoroughly well, but was by common accord of the other competitors, fully deserving the prize withheld by the judges, is exhibited by a young and rising firm, Messrs. F. and J. S. Bust, of Winterton Brigg, Lincolnshire. The success which attended this implement is probably due to the fact that the makers have passed beyond the experimental stage, and have several of their cutters and elevators at work for charging silos which they have constructed. We shall on an early occasion illustrate this machine, but in the meantime we may give a general idea of its principal features. The feed trough is very short, and

is fitted with a wooden safety roller in the same way as Crowley's, except that its spindle rests in inclined slots made in the sides of the feed box, and is held down by spiral springs so as to yield a little if the attendant's hand is drawn forward. In such an event the man would be thrown forward against a curved lever projecting at right angles from the side of the feed box. This lever is connected to a vertical lever on the starting, stopping, and reversing shaft, and terminates at the inner end against the box by a triangular plate in which are mounted two small rollers running upon a steel plate fastened to the box and provided with stops, the position of which corresponds to the different movements of the machine. The lever when moved to and fro, travels on one of the rollers just mentioned, the other being raised clear of the plate by the act over the level. The reversing motion is on the main shaft, and the countershaft drives change wheels by which the length of the cut is regulated. These change wheels drive, through gearing, the feed rolls, which are heavy and fluted, longitudinally. A rising and falling motion is given to the top roll, controlled by a weighted lever underneath the machine. The cutting edge which comes in contact with the knives on the wheel is formed on a steel bar, the inner side of which makes a close fit with the lower feeding roll in such a way that the grass, &c., cannot get between the mouth and the roll and so choke the machine. Packing pieces for fitting under the bearings of the lower or fixed roll are provided for taking up the wear and always maintaining the close fit with the mouthpiece. By this arrangement the level of delivery between the rolls is above that of the cutting edge, and the revolving knives coming in contact with the material fed forward by the rolls, depress it on to the knife edge, and effect the cutting. On the arms of the cutter wheel are fixed a series of projecting and radial fans, straight for the greater part of their length, but slightly bent towards the periphery of the wheel with the object of checking the centrifugal action of the cutter and of preventing the grass from being projected against the hood inclosing the wheel. The material is discharged through a straight mouthpiece the top of which is tangential with the upper face of the hood, and from this discharge the cut material passes into the hopper of the elevator and thence to the silo. There can be no doubt that this very efficient machine thoroughly established its character at the Show, and from its excellent performance attracted a large amount of well-deserved attention.

MISCELLANEOUS EXHIBITS.

There are an unusually large number of miscellaneous exhibits of implements and other objects at the Shrewsbury Show, which, if not possessing novelty, command at least more or less interest. Want of space will not permit of our doing justice to more than a small proportion of these; the others we must dismiss with the general remark that exhibitors have certainly succeeded in raising this meeting of the Royal Agricultural Society above the level of monotony which has characterised it of late years.

We took occasion in our notice of the York Show to illustrate and describe the thrashing machine exhibited by Mr. Edwin Foden, of Sandbach, Cheshire, and which then attracted considerable attention from its novelty. This year Mr. Foden shows another thrashing machine, containing various details developed since last year. In this machine there is combined with a fixed caving riddle an endless band passing around rollers, and provided with fingers or scrapers which drag the short straws over the fixed riddle, and cause the corn to fall through the holes or interstices. The machine is shown in side and end view in Figs. 1 and 2 on page 53. The shakers are actuated by one set of four-throw cranks, having the first and third throw, vertical and opposite to the second and fourth. The opposite end of each shaker is supported on an arm *h h*, working on a fixed centre, and inclined at an angle, so that this end of the shakers has a rising and falling, as well as a to-and-fro motion imparted to it, and a most effectual shaking of the grain is thus attained. The caving riddle *i i* is fixed, and the tray and movable caving riddle, with its crankshaft and hangers is dispensed with, and in place of the tray there is employed the endless travelling band *j j*, passing round the two rollers *k k*', and fitted with fingers or scrapers *l l*. As the band travels along, these fingers or scrapers carry all the short straws, corn, &c., towards the back end, and deliver them upon the fixed caving riddle *i i*, and then in the return strokes they drag the short straws over the riddle, along the board *m m*, and eject the cavings from the machine. The corn is at the same time caused to fall through the holes of the riddle. The sloping boards *n n* from the drum and the sides of the machine are carried down to meet the riddle and the band *j j*, so that nothing can escape but what passes through the riddle. The short straws and corn fall down from the drum *d d* and shakers *f f* on to the travelling band along the sloping boards *n n*.

Messrs. Nalder and Nalder, of the Challow Iron Works, Wantage, exhibit no novelties in thrashing machines this year, but confine themselves like nearly all the other makers to small modifications and improvements. In the machines shown by this firm the first dresser has a divided blast, the blast passing under top and bottom sieves, which can be put on or taken off the latter at pleasure; suitable tailboards are introduced to prevent waste in each sieve. The second dresser is arranged so that all chaff, dust, &c., is blown out, as well as any corn, capes, &c., that have riddled over, is sent back again over the caving riddle, and as there is a seed sieve in the second dresser, the seeds are put into one of the four bags at the end of the machine.

Messrs. Ransomes, Sims, and Jefferies, who have greatly improved the general appearance of their exhibit by collecting it in one spot instead of dividing the smaller implements from the engines and thrashing machines, show some very finely-finished examples of the latter class, especially designed for dealing with light crops in hilly districts. Although essentially a light machine, it combines efficiency and strength, and the quality of the work it does is equal to that of the same firm's heaviest finishing machines. The other exhibits include the usual fine collection of haymakers, ploughs, and horse rakes, the latter with some improvements, especially in the fastening of the teeth. A very nicely designed and simple lawn mower is quite a novelty. It is designed for trimming the edges of lawns, and consists of a fluted and coned roller mounted suitably in long handles for propelling it; within the cone is placed the gear, which as the machine is advanced, imparts a very rapid revolving motion to four small blades mounted at right angles to each other, and working against a fixed shear blade. This little implement is very handy and efficient, and all its details has been carefully worked out.

It is almost superfluous to say that the leading makers of implements are fully represented Messrs. Howard, of Bedford; Messrs. Richard Hornsby and Sons; Messrs. Marshall, Sons, and Co., and many others, have their usual excellent collections of implements. The last named firm show one of Howard's well-known straw binders as a thrashing machine attachment, but mounted on a separate carriage, and not fastened to the thrashing machine. As the straw passes from the shakers it falls into a hopper on the binder carriage, and is fed forward to the binding table between two large wooden rollers.

Messrs. Jeffrey and Blackstone, Rutland Ironworks, Stamford, make an excellent show of their standard implements. Amongst others may be noted a haymaker and clover turner with quick back action. Mr. Thomas Corbett, of the Perseverance Ironworks, Shrewsbury, has naturally an unusually large display of corn-dressing machines, ploughs, harrows, and other implements. Messrs. Richmond and Chandler, of Manchester, of course exhibit a large number of their chaff-cutters, mills, food preparers, &c. The safety mouth-piece to prevent choking has already been described in noticing their ensilage cutter; it appears to be sufficiently effective to set the efforts of the average farmer's labourer at defiance to choke it or stop its action,—than which higher commendation cannot be bestowed. The same firm show a very neat crushing mill for horse feeders, in which the maize or other grain is fed from the hopper between two large diameter rolls, which are cut at wide intervals with spiral and sharp-edged grooves, these grooves being in opposite directions on the two rolls. The grain in passing between the smooth portion of the rolls is crushed, and when it comes in contact with the grooves it is held in one and sheared by the sharp edge of the other passing over it. Messrs. E. H. Benthall and Co., of Maldon, show, amongst a number of other implements, a litter cutting machine, adjusted to cut to lengths varying from $\frac{1}{16}$ in. to 6 in. The cutting is effected by a broad knife set spirally over a circular frame, and turning in front of the feed rollers, which are actuated from the knife shaft by a connecting rod working in a slotted disc, and moving a pawl and ratchet wheel which gives motion to the feed rollers. By shifting the connecting rod head in the slot, a range of feed motion is obtained, this range being widened by a pair of spur wheels of an equal diameter, and which can be shifted from one spindle to the other, completing the variations. Messrs. R. A. Lister and Co., of Dursley, who have been already mentioned, show a number of grit mills with vertical stones, one fixed and the other revolving. The fixed stone is provided with a large central hole through which the grain is fed, and the pressure between the stones is regulated by means of adjusting bolts and spiral springs, a distance-piece of hardened steel being introduced against the end of the stone spindle to receive the wear. The shoe into which the grain falls from the hopper is kept in motion by a flattened vertical spindle bearing revolving against a projection in front of the shoe. A small hinged door is placed beneath the mouth of the hopper, and rests against the shoe in such a way that by lifting the latter the door is closed and the supply from the hopper shut off. Messrs. W. N. Nicholson and Son, of Newark-on-Trent, show a very excellent grist mill, which we shall illustrate shortly; in this the grain is delivered between a fixed concave, placed horizontally, and a fluted wheel turning on a vertical spindle, but which is free to move on the centre that supports it, to allow any obstruction to pass. The same firm exhibit some very fine bone mills, which we also propose to illustrate, and in which the work is very carefully designed and well finished.

A very useful form of excavator and dredger is shown by Messrs. Priestman Brothers, of Hull. About a year and a half ago (*vide* page 152 of our thirty-fifth volume) we illustrated a floating dredger devised by Messrs. Priestman for clearing canals and water courses, and that now exhibited is a modification of this arrangement, but mounted on road wheels so that it can be worked from the bank. The machine may also be placed on a punt if it should be desired.

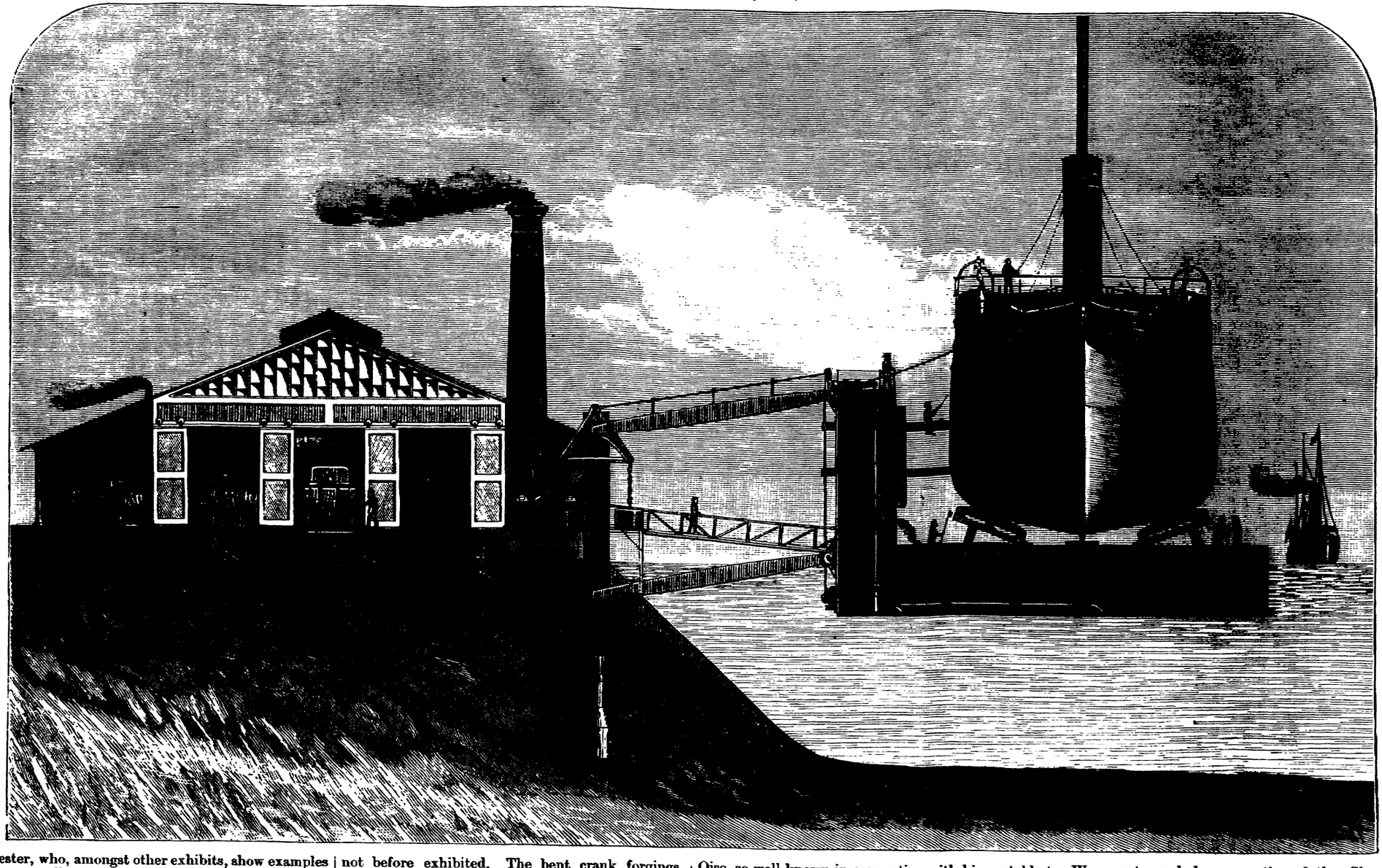
On page 68 of the present number we illustrate an ingenious arrangement exhibited by Mr. C. G. Roberts, of Haselmere, Surrey, for separating the impure water passing off from roofs during the first part of the shower, from the clear water which follows later on. In the view given by A is a removable strainer with perforated plate to prevent rubbish passing into the separator, while B is the outlet for the water to pass to the separator, and C is the separator itself balanced on pivot. D is a small compartment into which the rain water first falls, and E is a small hole fitted with a washer proportioned to the size of the roof. F is a larger hole to take the overflow from D during moderate rain, and G is the discharge pipe. In a storm the water fills the compartment D and flows over the top of this pipe. At H are small holes at back of G between the compartments. When the rainfall exceeds the discharging capacity of the hole E, the water rises in the compartment D, and passing through holes H slowly fills the compartment J. When the weight of water in J overbalances the separator, it is canted (as shown in engraving) and the water (by that time pure) is directed by the discharge pipe G into the storage pipe K. L is a small hole at the bottom of the compartment J. M M is an auxiliary pipe for keeping the compartment J full after the separator is canted when the rain is leaving off, so that the last drop of rain may be stored. By raising the slide N a third and fourth hole can be opened at H; this will cause the compartment J to fill more rapidly. The whole of the water passes through the discharge pipe G which conveys it into the waste pipe O so long as it remains uncanted. The length of time it remains in this position, running the water to waste, is regulated by the slide N to suit the smokiness of the locality.

A stand well worth notice is that of Messrs. Bohler, Brothers, and Co., of Sheffield, who exhibit a number of samples of various kinds of Styrian steel, as well as scythes, &c., made from it. The steel is of admirable quality, and the scythes made of it have their edges finished by hammering instead of by grinding. An admirable collection of screwing tackle, large taps, &c., is shown by Messrs. John Cowley and Son, of Hyde, near Man-

LIFTING DOCK FOR CARDIFF.

MESSRS. CLARK AND STANDFIELD, ENGINEERS, LONDON.

(*For Description, see Page 69.*)



chester, who, amongst other exhibits, show examples of an excellent tube cutting and screwing machine (Maiden and Cowley's patent), having some novel details. The Kirkstall Forge Company also have an excellent collection of their cold rolled shafting and fittings suitable for it, including some long cast-iron pivotted bearings of a pattern which they have not before exhibited. The bent crank forgings, &c., constructed by the Clarke's Crank Company, Limited, of Lincoln, we have frequently had occasion to notice favourably, and the exhibits of this firm at Shrewsbury fully maintain their high reputation.

M. Decauville Aine, of Petit Bourg, Seine and Oise, so well known in connection with his portable railways and the plant for working them, has an excellent collection of his specialities on the ground, including amongst them a new form of stone tipping wagon and a new wagon for carrying sugar cane, capable of dealing with larger loads and larger canes than the wagons ordinarily made for this purpose.

We must conclude our notice of the Shrewsbury Show here, not because of any deficiency of subjects to extend it to an indefinite length, but because we have reached the limit of our space, and we regret that we must leave unmentioned many whose names and exhibits deserve consideration.

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ENGINEERING.

FRIDAY, JULY 18, 1884.

THE COMPTROLLER OF PATENTS' REPORT.

WE have before us the first report of the Comptroller-General of Patents, Designs, and Trade Marks, which, owing to the date prescribed for its presentation to Parliament, is, in the present instance, necessarily limited to a fragmentary portion of the year 1884, namely, the first four months.

With the view of providing for the due administration of the new Act, a joint committee was appointed last autumn by the Board of Trade and the Treasury, to advise as to the reconstruction of the staff of the office of the Commissioners of Patents, and as to the formation of a properly qualified staff of examiners.

The Comptroller states in his report that the recommendations of the Committee having been "*generally approved*," a staff, including the majority of the officers of the Commissioners of Patents' staff, was appointed by the Board of Trade, with the approval of the Treasury, as provided by the 82nd and 83rd sections of the Act, in readiness to undertake the work of the new office upon the 1st of January last.

This staff includes the Comptroller-General, a Deputy Comptroller-General, a Registrar of Designs and Trade Marks, a Superintendent of Indexing and Abridgments, a Superintendent of Examining, an Assistant-Superintendent of Examining, a Librarian, a Superintendent of Store Branch, a Clerk-in-charge of Register, two Examiners, and 22 Assistant-Examiners, besides a large number of clerks and other officials.

When the Comptroller states that the recommendations of the Committee were "generally approved," it is not easy to understand what he means. If it be his intention to convey, that the views of the authorities as to the qualifications of those to be entrusted with the administration of the new Act, met with general approval on the part of that section of the public qualified to express any opinion on the subject, we can only regret that he did not more closely observe the very noticeable indications that from time to time appeared to the contrary.

That those who have been so fortunate as to secure appointments under the Act, have endeavoured to justify their selection, we are fully disposed to believe; nay, we will go further, and will admit that some of the appointments have been fortunate. But there is a radical defect in the machinery, which, to say the least, it will take much time to cure. We allude to the absence of the scientific training, practical knowledge of the manufacturing arts, and experience in the actual working of Patent Law, which one would desire to see possessed by those having to perform such special and onerous duties as must necessarily, from time to time, devolve upon officers intrusted with the complex business of the Patent Office.

The number of applications for patents received under the new Act during the first four months of the present year far exceeded the number estimated, having reached 7060, against 5993 in the whole of 1883, and 6241 in the year 1882, the highest number under the Act of 1852. The numbers of applications in the past months were: January, 2499; February, 1673; March, 1576; April, 1312. The highest number applied for on any one day was 266 on the 1st of January, and the lowest 40 upon the 2nd of April. Of the total number of applications 5093, or 72 per cent., were made by agents, and 1967, or 28 per cent., were made direct.

This shows we were correct when we stated that professional assistance would usually be essential to the intending patentee under the new law, notwithstanding the great pretence made of enabling inventors to do their own business. The man who is his own patent agent may, in many cases, be not inaptly compared to him who is his own lawyer. Under the new law, with officials some of whom are practically serving an apprenticeship to their duties, inexperience is not able to cope with the constant difficulties. It is not a mere question of passing defective specifications, but there is no knowing to what extent an applicant may be called upon to make alterations, the full effect of which only an experienced practitioner would be likely to appreciate.

The Comptroller says the short period during which the new Act has been in operation renders it difficult to determine how far its provisions have met the wants of inventors, but that the absence of any serious complaints may be taken as an indication that in some degree, at least, it has done so. He adds that it is true some dissatisfaction was shown shortly after the Act came into force, with the requirement of a half-crown stamp upon the declarations on application, when made before Commissioners entitled to take such declarations; but the provision made by the Board of Trade for the discontinuance of such requirement, removed that cause of complaint. In other respects, he asserts, applicants appear to have fairly comprehended the new method of procedure. From some of the cases that have come before us from time to time we should have been disposed to think otherwise. Then as to causes of dissatisfaction. We cannot help thinking the Comptroller has adopted a somewhat too sanguine view.

There is a question of great importance as to which much dissatisfaction exists; we allude to the action of the Comptroller as respects what may be properly considered one invention. We have before now pointed out that he declines to allow, under a single patent, a claim to a combination of parts, and also a separate claim to one of those parts that happens to be susceptible of advantageous employment apart from the rest of the combination. Now, one very serious inconvenience that results in practice is, that where a provisional specification only has been filed, the applicant for a patent is in some cases actually called upon by the Comptroller at that early stage, to state what he proposes to claim, presumably in order that an examiner may form an opinion as to whether he ought, or not, to report that the specification contains more than one invention.

When the Government Patent Bill was introduced into the House of Commons, it contained a proviso requiring the applicant for a patent to insert in his provisional specification a distinct statement of the invention claimed, but objections to this course were so strongly urged, and so well founded, that the idea was abandoned. Why then should an applicant for a patent be now required to commit himself on a separate sheet of paper, or even by word of mouth, to that which the Legislature deliberately abstained from enacting as a requirement? A statement of the applicant's intention as respects claims, whether in writing or not, either is, or is not, intended to be used against him when the examiner ultimately compares the complete specification with the provisional specification. If not intended to be so used, there can be no possible ground for requiring the statement. If it be intended for the use just indicated, then the practice is in our opinion *ultra vires*. Not only so, but it is calculated to most seriously embarrass the applicant for a patent when he comes to prepare his complete specification and claims, because his investigations as to features of novelty, or his experiments, or both, may have induced him by that time to greatly modify his views as to what his claims should be. Indeed, if the applicant has to be committed to a statement of claims before acceptance even of his provisional specification, it is difficult to perceive the advantages to be derived from provisional protection, because, although the Government fee payable on depositing an application with provisional specification is only 1*l.*, as against 4*l.* when a complete specification is lodged; yet, on the other hand, it is to be noted that such protection as is accorded on a provisional specification, does not give the grantee any right to stop others from using his invention during the time that it remains under provisional protection only.

We trust that in future the office will be guided to a much larger extent by precedent. We do not desire by any means to find fault on trivial grounds. But we conceive that if officials—through want of experience or through disregard of precedent—should continue in the course upon which they have embarked, the result cannot fail to be unfortunate, and our criticisms are written in the hope that good counsel, guided by experience, will prevail ere it be too late. And having had occasion to take exception to certain things that have been done, it is now our pleasurable duty to record the fact that commendable moderation has been displayed in the administration of a provision of the law that might have been worked very arbitrarily, and so as to be productive of grave inconvenience and injustice. We refer to sub-Section 3 of Section 5 of the Act, which provides that a provisional specification shall be accompanied by drawings if required. The practice in this respect has been not to call for drawings to an unreasonable extent, and what is still more satisfactory is the circumstance, that even where a drawing has been deemed needful to a clear understanding of the nature of the invention by the examiner, the applicant has not usually been put to the serious inconvenience, expense, and delay incident to providing drawings in duplicate and according to regulation, but the office has been satisfied with the production of a drawing or sketch for inspection, to enable the sufficiency of the provisional specification to be verified. In this particular a proper spirit of moderation has been displayed, and we are not without hope that the same enlightened view will ere long be adopted in regard to matters that are at present not carried out in so satisfactory a manner.

It appears that of the total number of 7060 applications, 6371 were accompanied by provisional specifications, and 689 by complete specifications. During the four months 199 complete specifications were also deposited in connection with provisional

specifications. During the four months (January to April, 1884, inclusive) the Comptroller has accepted 5256 provisional specifications and 612 complete specifications. Only four applications were refused. Allusion is made in the report to the operation of the new provision, of affording notice to applicants of applications, which are made bearing the same or a similar title, and which appear to the examiner, from a comparison of the specifications, to comprise the same invention. During the four months to which the report refers, the examiners reported no less than 224 cases of apparent similarity, and the Comptroller consequently notified the fact to the 448 applicants affected. He observes, however, that in many instances, when the comparison is made upon provisional specifications, the general terms which are permitted by law to be used in drawing up those documents, render it exceedingly difficult for the examiner to pronounce an accurate opinion, and, consequently, many notices of apparent similarity may unavoidably be given under the provison of Sub-section 5 of Section 7.

A representation upon this subject was recently addressed to the Board of Trade, the applicant pointing out that in his case, where the inventions were not the same, although the examiner had reported that they appeared to be so, his patent interest might be injuriously affected by the official record of apparent similarity. No record of such notice having been given, however, will appear upon the register of patents, which is the official record of title, but is only entered in the preliminary application book, and steps will be taken, so soon as the Comproller is informed of the fact, to insure an entry in such book to the effect that no similarity was found to exist, notwithstanding that a notice to that effect was issued by the Patent Office; the official title will thus be clear.

No oppositions were lodged at the Patent Office during the first four months of the present year against the grant of a patent to the owners of any of the 612 applications with complete specifications, accepted within that period by the Comptroller. The total number of patents sealed under the new law, during the four months was 91.

One application for an extension of time for paying fees under Section 17 was allowed by the Comptroller in the month of February, and one in the month of April. Fifteen applications for amendment of specifications before the sealing of the patent, and 15 applications for amendment after the sealing of the patent, were made during the four months. Eleven notices of opposition to amendments were also received, but up to the 30th of April no cases had reached the stage for hearing by the Comptroller.

The Illustrated Journal of Patented Inventions, which is to contain a description of inventions for which patents have been granted, is in course of preparation. The materials required for its production, consisting of a special drawing and short description of the invention, have in most cases been furnished by applicants. A few applicants, however, have refused to furnish the drawings; and upon a recent representation of the Council of the Institute of Patent Agents, the Board of Trade have authorised the Comptroller to dispense with the requirement of the short description prescribed by Rule 31. Such description will, in future, be supplied by the Examiners' Branch from the official abridgments, but the Board of Trade do not think it desirable for the Patent Office to undertake to select the drawing required by Rule 31

When it is remembered that, according to the memorandum endorsed on the Patents for Inventions Bill, the applicant was to be required to use only three documents, one of the objects of the Bill, according to the memorandum, being "to simplify procedure and lessen its cost," it is a very noticeable fact that, notwithstanding the strong remonstrances from time to time made, the applicant for a patent should be required to deposit not only a specification and copy, but also drawings in duplicate and an extra drawing for the illustrated journal. In other words, although the memorandum stated that the applicant would only have to use three documents, yet, in practice, if the applicant applies for a patent by provisional specification and subsequently proceeds with his application, he must use no less than six documents, namely, an application, a statement of address, a provisional specification, a copy provisional specification, a complete specification, and a copy complete specification, and in addition to all these, in the case of a mechanical invention, there must be a drawing, a duplicate drawing, and a drawing for the Illustrated Journal. We leave the public to judge whether, under the new law, inventors have gained anything in the way of simplification of procedure, especially when the additional trouble of passing a case, arising from the new examination system, is taken into consideration.

A question of serious importance arises on the requirement of a special drawing for the Illustrated Journal. According to the rules that drawing must be illustrative of the feature or features of novelty constituting the invention. Until recently, as we have seen, the applicant was required also to furnish a concise explanatory statement, and it has been considered by some authorities whose opinions are entitled to great respect, that such a statement might be used as against a patentee, in a court of law, for the purpose of inducing such court to place some particular construction upon his specification. Seeing, however, that a complete specification is needful in order to enable an invention to be understood, and seeing that the claims must be taken in connection with the rest of the specification, we conceive that the strongest possible grounds exist for assuming that neither the concise explanatory statement, nor the drawing for the Illustrated Journal, could properly be made use of in the manner referred to. If an applicant could define his invention satisfactorily in a concise explanatory statement there would be no need for a complete specification. The object of such statements or abstracts is to facilitate cursory investigations as to what has been proposed to be done, but they are not intended to supersede specifications. On the contrary a careful searcher would, at most, use the abstracts simply as an extended index. However, if a danger ever existed of a concise explanatory statement for the Illustrated Journal being used as against the patentee in a court of law, then there may be a possibility that the drawing supplied for the Illustrated Journal, might be used in a similar way. The circumstance that the Patent Office is not prepared to take the responsibility of preparing the drawing, cannot, at any rate, be encouraging to inventors.

Want of space precludes our offering other observations on the present occasion, but we may mention that the Comptroller's report deals with the operation of other portions of the Act, including those relating to the registration of designs and trade marks. We may have more to say on the matter on a future occasion.

THE MAINTENANCE OF BRAKES.

THE interesting report on the working and cost of maintaining the Westinghouse automatic brake on the North-Eastern Railway which has been forwarded us by Mr. T. E. Harrison, the chief engineer of that railway, and which appears in the present number, will be welcomed by many of our readers, both here and abroad, as furnishing just that practical information on an important matter which is so seldom to be got from a railway company.

The North-Eastern, having had practically the whole of their carriage stock, amounting to about 2700 vehicles, fitted with the Westinghouse brake for a considerable time, are in a position to give the best information, and the result is, as the report says, that "the figures show conclusively that there is great economy in the maintenance of the Westinghouse brake." This is the case, notwithstanding the fact that the two years dealt with, were exceptionally unfavourable for the brake, as Mr. Harrison points out. This was due to the large number of rubber hose connections which were renewed in that period, the whole having been changed. Originally, the position of the hose couplings was below the screw couplings, and when it was decided to change them to the present position, the old hose was pulled off and remounted, an operation resulting in more or less damage to the hose, which it was eventually decided should all be replaced by new hose. The cost of doing this is included in the report, and, as Mr. Harrison says, is above the average to the extent of one-half. Exclusive of the hose pipes, the total cost of renewals and repairs for both the parts proper to the Westinghouse brake, and also for the brake rigging, taken over two years, averages less than eightpence per carriage per annum! To this surprisingly small sum must be added the wages of men testing and overhauling, and the salaries of inspectors, which amount to 4s. per vehicle more, and then taking 2s. 4d., the proportion mentioned above as the average cost of renewing hose pipes, we find the total expenditure may fairly be put down as only 7s. per carriage per annum! This sum includes everything but brake blocks, which may be taken as being the same for all brakes, provided the same amount of work is performed, and which are found to average 6s. 6d. per vehicle in addition.

There are some who may be surprised at the results of the working of the triple valve, upon which Mr. Harrison lays great stress. When making his first report on this subject to his directors in 1879, Mr. Harrison, alluding to the triple valve, said it had been made a singular bugbear, but that he considered it essential, and a "model of ingenuity and simplicity." How just was his view has been proved by experience in a remarkable way, for it is found that triple valves requiring repairs amount to only about one per cent. per annum; and that out of over 3000 in use, only five triple valves are reported as having caused delay in 1883. The report says further that the Westinghouse brake is found especially useful for working steep inclines, of which there are many on the North-Eastern Railway, in some the gradients being as steep as 1 in 37, and on the main line to Whitby there are five miles of less than 1 in 50, with curves of 15 chains radius. The brake retains a uniform pressure, which takes the train down this incline at a speed of from 20 to 25 miles per hour under complete control. The "leak off" brake used on the Great Western and Midland Railways would be useless on such an incline, and, in fact, could never be trusted upon it.

We remember it used to be argued that, however suitable the Westinghouse brake might be for express trains, it was not so for omnibus trains, but the Great Eastern and London and Brighton Companies, having the largest suburban traffic, find they could not do the work without it, and this is Mr. Harrison's experience also. In fact, it seems that, whether for fast trains or slow, as an emergency brake, or for stopping at stations, for descending heavy gradients, for reliability, as well as for economy of maintenance, the Westinghouse brake is found by the North-Eastern Railway Company to be all that can be desired.

We have consistently advocated the same opinions, and it is gratifying to find our views confirmed by practical experience, and so courageously put forward by a gentleman of Mr. Harrison's authority and eminence. The report concludes by saying that there "does not appear to be any one point in the principle and arrangement of the Westinghouse brake, as now in use, requiring alteration, and it entirely complies with all the requirements of the Board of Trade." A good many other people must be of the same opinion, since the same return shows that during the three years and nine months ending April, 1884, there have been ordered from all parts of the world an increase of 50,000 sets of Westinghouse automatic brakes for carriages and wagons, and over 8000 sets for engines, making a total record of orders for 63,065 sets for carriages and 11,553 for engines on the automatic system alone. Such figures are remarkably significant.

THE INTERNATIONAL HEALTH EXHIBITION LITERATURE.

IF the official literature, issued in connection with the present Exhibition, does not prove so attractive to the general public as that which was the outcome of last year's Fisheries, the fault will not rest with the authors, but with the subject; or perhaps rather with the failure of the public to take an interest in a subject which should be of paramount importance to every member of the community, but which is almost invariably neglected, even by those on whose shoulders the responsibility should sit heaviest. It is a curious psychological problem why a man will lavish endless thought and energy on his business in the effort to procure ease and luxury, and yet will not exert himself to devote an hour or two to the investigation of the drainage or water supply of his house, although he may be troubled with an uneasy consciousness that they are in an unwholesome state and are sapping the health not only of himself but of his family. But it is no part of the physiologist's duty to solve this problem, all he can do is to put the issues before the householder as plainly and forcibly as possible, and probably this has never

before been done in so effectual a manner as by the handbooks issued by the Health Exhibition.

Perhaps, however, the first part of the official literature that calls for notice at our hands is the catalogue, of which the second edition has recently been issued. Few people who pay their shillings for this useful compendium realise the labour and thought that is required to complete such a work. There are over 1500 exhibitors in the British section alone, and from every one of these particulars of the articles exhibited had to be obtained, and the information having been checked in order to verify its accuracy, it had then to be condensed within suitable proportions. This was no light matter, as each individual is apt to look on his own display as the most important, and to expect half a page or so of the catalogue to be put at his disposal wherein he may set forth the absolute superiority of his pickles, jams, or drain pipes (as the case may be) over those of his neighbour. The editor of an official catalogue should be endowed with such qualities of industry, shrewdness, and Good temper as would go to form an ideal Prime Minister or a successful diplomatist. A coloured plan of the Exhibition forms a frontispiece to the catalogue. This is followed by the usual official information, memoranda, and lists of names of the presidents, members of council, and those serving on committees. An introductory preface gives a history of the Exhibition from its first inception; following which is the list of those who have contributed objects of practical use or ornamentation to the enterprise. A rather poor engraving of the Royal Pavilion, which has been so beautifully decorated by Gillow and Co., is in this part of the book. A few pages devoted to the electric light, to the Art Schools exhibit, and to Old London, then follow; Mr. G. H. Birch having written an excellent description of the civic contribution. The London Water Companies' exhibit, the aquarium, and the collective exhibition of costume are also described. The lists of British exhibitors relating to the sections, have appended to them prefaces appropriate to the various subjects. The foreign exhibits are duly catalogued, and at the end of the book an index of exhibitors will be found. The work represents, as we have said, a vast amount of labour, Mr. Trendell, the literary superintendent, and his too limited staff, working for a considerable time from early morning up to 11 and 12 o'clock at night. A few words should also here be said of the official guide which is published by Messrs. Clowes and Sons. It is a small but efficient hand-book carefully arranged, easy of reference, and full of information. It is written, as all guide books should be, in a pleasant, easy style, with no effort for grand description or flippant witticisms, which are such annoying features in some other publications of this nature.

"Legal Obligations in Relation to the Dwellings of the Poor,"* by Mr. H. Duff, M.A., B.C.L., is the first of the Health Exhibition handbooks. To this a preface has been written by Mr. Arthur Cohen, M.P., Q.C. Mr. Duff's little volume puts forward in a very clear and concise manner, with language unobscured by legal phraseology, the scope of the principal Acts bearing on his subject, viz.:

1. The Acts regarding the removal and prevention of nuisances, the Public Health and Sanitary Acts.
2. The Labourers' and Artisans' Lodging Houses Acts.
3. The Artisans' Dwellings (Torrens's) Acts.
4. The Artisans' and Labourers' Dwellings Improvement (Sir Richard Cross's) Acts.

The dwellings of the poor is a subject that has rightly excited a good deal of popular indignation of late, but those who have been crying so loudly for further legislative powers would do well to study the little book under consideration, and see how adequate the existing law is to suppress overcrowding and insanitary conditions generally. Mr. Duff tells us that the whole of England, except the City of London and its liberties, is divided into either urban or rural sanitary districts, which are controlled by an elective local authority, which again is responsible to the Local Government Board. The metropolis is administered by the Metropolitan Board of Works.

The local or sanitary authorities in urban districts are;

1. In boroughs, the mayor, aldermen, and burgesses acting by council.
2. In a local government district, the local board.
3. In an improvement district, the improvement commissioners.

In rural districts the local sanitary authorities are the guardians of the union. In the City of London the authority is the Commissioners of Sewers; and in the rest of the metropolis the several vestries and districts boards. The authorities of every district, as well as of the City and the metropolis, are bound to employ a medical officer of health, and an inspector of nuisances, who are appointed by, and are the servants of, the local authorities. It is the duty of these officials to detect and report upon all nuisances or insanitary conditions, existing within their jurisdiction. It will be easy enough for any one acquainted with ordinary English customs to detect the weak spot in this system. Vestries, local boards, and improvement commissioners, are too often recruited from those who have a personal end to serve in giving their services, and very frequently a medical officer of health or inspector of nuisances knows that doing his duty would be equivalent to asking for his own discharge. The way in which the proper functions of the local authorities and their officers are most shamefully neglected, is witnessed by the facts disclosed during the agitation of the last few months. A remedy suggested for the present unhappy state of affairs, is that the medical officers of health and inspectors of nuisances should be controlled by some central authority, regulating the pay and alone having power of appointment and dismissal. But even if the local officials fail in their duties, Mr. Duff tells us there is no reason why a nuisance should go unabated. Any person aggrieved may give information to the local authorities, who are then bound to act, or he may carry the complaint direct to a justice of the peace. Such is the law, and so far as it goes nothing could be simpler or more effective; in practice an individual would too often find that energy, patience, and a very long purse would be required to obtain redress.

"Our Duty in Regard to Health,"* by Dr. G. V. Poore, M.D., F.R.C.P., is the second of these handbooks. The author of this work treats the subject from exactly the opposite standpoint to that taken by Mr. Duff. The latter teaches us how far we are entitled to help from the State in sanitary matters, Dr. Poore tells us how to help ourselves. The health of the individual, says the author, is mainly in his own keeping. It is the first duty of every one to keep healthy, as otherwise no man can fully perform his duty to his neighbour and himself. Infectious disease may infect those we love best, and even be transmitted to generations yet unborn, whilst the watching, anxiety, and fatigue which sickness entails, have undermined many a constitution. In these days a man is in danger of forgetting that his first duty is to keep himself well, for the carelessness and apathy of individuals has necessitated the formation of boards and sanitary authorities, and we are too willing to give our individual responsibility into the keeping of a board and allow rates to take the place of morals. Sometimes it would seem as if the individual thought he had a moral right to be kept healthy rather than to try to keep himself healthy. Dr. Poore then speaks of the evils of overcrowding. The great difficulty of dealing with this problem is that so many people make a profit out of it. First, the owner of the property, whose ground-rents are proportionate to the number of houses. Secondly, the speculative builder. Thirdly, the tradespeople who supply the builder with materials. Fourthly, the water companies, whose profits depend on having a large number of customers on a small area. Fifthly, the gas companies. Sixthly, the railway companies; and seventhly, tradesmen generally. Thus overcrowding is a source of profit to nearly every one, and until we have "Boards" composed of men who rise superior to all considerations of immediate profit, there is but little chance of the owner and builder being made to do their duty. When a district has become overcrowded so that direct filth disposal is impossible, then comes the gigantic sewerage scheme, which makes it possible to pack houses even closer than before. In rural and semi-rural districts great schemes of sewerage and the like, which are never an unmixed good and often an unmixed evil, should never be necessary, and would not exist if Dr. Poore's golden rule, that all refuse matter should be restored without delay to our mother earth, were carried out. A piece of ground 50 ft. by 30 ft. should be enough to absorb all the refuse matter from a household of ten persons, and allow a splendid succession of crops to be taken from it. It will be easily seen from the above that Dr. Poore is by no means one of those disposed to calmly accept our present metropolitan drainage scheme as the perfect system it was the fashion to consider it up to within a short time ago. He points to what has been done at Glasgow, Manchester, Warrington, Carlsruhe, and Mannheim with the dry methods, and dwells on the many evils of the water-closet and sewerage system. The little volume is one that may be read not only with profit but with interest by every one.

Mr. Blyth's contribution, "Diet in Relation to Health and Work,"* is the next of these handbooks that we shall notice, although it does not immediately follow in the publisher's list. The little volume is written in a readable, pleasant style, and a good deal of information on various subjects may be got from it; but any one is likely to be disappointed who seeks to obtain guidance as to the best course of diet to adopt under given conditions of work, and wishes to satisfy himself that such course is founded on true principles or authenticated by sufficiently exhaustive experiment. This lack of definite information is no fault of the author's, whose work and reputation is sufficient guarantee that he is acquainted with all that is generally known on the subject he writes upon. But all that is known is not sufficient to build an unassailable theory of dietetics upon. Medical men, who are the principal writers on physiological matters, are often too apt to be carried away by their professional instinct for diagnosis, and to build heavy superstructures of theory on somewhat scanty and imperfect foundations of fact. Until some means are placed at our disposal for accounting for the way in which the food we eat performs its functions in the economy of our existence, it would seem to be well that the theoretical conclusions of the doctors should be more liberally supported by the of practical experiment. The important part that chemical analysis must play in all scientific research as to the action of food, must be apparent, and yet how thoroughly such help fails us in any complete investigation as to the nutrient value of different articles of diet. The products of digestion, obtained from foods entirely dissimilar, will be identical according to the best analysis that can be obtained, and yet in one case the food might be of the most unwholesome description to the patient, whilst in another it would prove a healthy and nourishing diet. As a matter of fact the unconscious part of us which silently carries on the internal functions of our existence, is capable of performing an analysis infinitely more subtle than our intellect can devise, or the most highly-trained senses and delicate laboratory appliances can compass. Under these circumstances it is to be regretted that physiologists do not strive oftener to fortify their theoretical deductions by observed results.

Mr. Blyth commences his subject by an example of molecular life. There are little masses of jelly to be found in ponds which possess the power of digesting without a stomach, of breathing without lungs, of feeling without nerves, of moving without muscles, and of multiplying without marriage. Amongst these is the amœba, an *undifferentiated protoplasm*, which takes its food by flowing round the substance and embedding it in the jelly of its body. After a time those portions which it cannot asimilate are ejected. The amœba breathes by absorbing oxygen from the dissolved air in water and excreting carbonic acid. Man, says Mr. Blyth, is but a collection of just such minute masses of protoplasm, the nearest approach to the amœba being seen in the white corpuscles of the blood, while the furthest is perhaps seen in the corpuscles of the bone. From the "undifferentiated protoplasm" our author takes us to a short chapter on the sugar contained in the liver, following which is another chapter on "The Work to be

* "Legal Obligations in Relation to the Dwellings of the Poor," by Harry Duff, Barrister-at-Law, with a preface by Arthur Cohen, Q.C., M.P. London: William Clowes and Sons, Limited.

* "Our Duty in Regard to Health," by G. V. Poore, M.D., F.R.C.P. London: William Clowes and Sons, Limited.

* "Diet in Relation to Health and Work," by Alexander Wynter Blyth, M.R.C.S., F.C.S., &c. London: William Clowes and Sons, Limited.

Done." In cold weather metabolism, or "tissue change" is most active, and in this way the heat of the body is maintained. The foods that give heat are fats and carbohydrates, but Liebig's theory that meaty or nitrogenous substances go to build up the muscles is discredited by the author. Every one, he says, knows that a highly nitrogenous diet is necessary for hard labour, and that the labourer if he can get it eats plentifully of meat, and that the diets of those training for athletic feats also include much meat.

This is very true, but at the same time it might be remembered that the strongest race of men probably in the world, are vegetable feeders, whilst engineer contractors are just now loud in their praise of the endurance of the Italian labourers, who may said hardly to know the taste of meat; again, in one of the best races ever rowed on the Thames, one of the crews trained entirely on vegetable food. The fact is that not only the labourer will eat plentifully of meat if he can get it, but all other classes do the same. The City man, who starts with bacon and eggs or a chop for breakfast, eats a steak at lunch, and finishes up with a dinner of three courses, will take a cab or an omnibus rather than walk a mile. A meat diet is more palatable and more stimulating than vegetable food, but that harder work can be done on it has yet to be proved. Some details from Professor Frankland's experiments, in order to determine the potential energy of food, are quoted. These, of course, are not given as affording absolute data on which to regulate food supply; for instance, an ounce of lean beef is credited with a potential energy of 55 foot-tons, whilst an ounce of ground oatmeal equals 152 foot-tons, and butter gives an equivalent of 281 foot-tons per ounce. As the author points out, on purely chemical grounds, a charcoal biscuit should have a higher value ascribed to it than an ordinary biscuit of the same weight.

The second division of the work is devoted to "Food Equivalents," The composition of the human body is given, and a short chapter on the functions of water follows. Carbohydrates and fats are treated in two brief chapters, the fact that the former principles of food are transformed into fat being dwelt upon briefly. The chapter on nitrogenous substances, another on luxuries, and a third on mineral matter, lead up to the digestibility of food. A table, compiled from different authorities, is given of the order in which various substances stand with regard to digestibility. Sugar naturally heads the list, following which we have rice (96.00), wheaten bread (95.00), roast meat (94.80), and amongst other foods potatoes (90.60), rye bread (88.90), carrots and cabbage (76.00), peas, beans, &c. (52.40), and finally gelatine (50.00), one-half only of the latter substance being digested, the other passing away as refuse. It does not of course follow that the nutrient substance is governed by the relative proportion that can be digested. In the chapter on meat, analyses of various kinds of flesh are given, and the well-known experiments of Dr. Beaumont on the Canadian who had a fistulous wound leading to his stomach, are quoted. The fact that raw meat is sooner assimilated than that which is cooked, is also pointed out. Fish is treated of in the following chapter, the estimated quantities of albuminous matter, fat, and salts in a pennyworth of fish and beef respectively, being given, the balance being in favour of fish. Tinned meat is also shown to be, by analysis, a more nourishing diet than butcher's meat, taking money value as the standard. Milk, Mr. Blyth reminds us, contains all the constituents of a perfect diet, but it is not a suitable diet for adults, excepting as an adjunct to other foods, however necessary it may be for children.

In the divison of the work devoted to "the chief sources of the carbohydrates" compound parts of whole meal and white flour are given. The former is naturally richer in nitrogenous substances and proportionately poorer in carbohydrates, the proportions being in percentages:

	Whole Meal.	Flour.
Nitrogenous substances ...	21.80	12.00
Carbohydrates	60.90	70.80
Mineral matters	1.60	0.70

In the whole-meal bread, however, about ten per cent. passes away unassimilated against five per cent. of white bread. The stimulation of the intestines by the rough outer portions of the wheatberry, which are retained in the whole meal, has a most beneficial effect in the case of a great number of people, where sufficient exercise is not taken to promote the action of the bowels in the natural way. The food values of other cereals, as indicated by analysis, are given in succeeding chapters; succulent vegetables and fruits are treated of, and a chapter on alkaloid-holding drinks—tea, coffee, and chocolate—follows.

The final chapter is devoted to the principles of diet. Mr. Blyth looks forward to the time when by successive researches the science of diet will have banished all drugs, and maladies will be treated by cutting off certain foods and surfeiting with others.

The standard diet for ordinary labour without reckoning water is laid down as follows:

	oz.	grains.
Albuminoids ...	4.2	= 290 nitrogen.
Fat	1.6	} 4184.4 carbon.
Carbohydrates ...	18.7	} = 459.3 mineral sub-
Salts...	1.05	} stances.

In this chapter the food taken by the pedestrian Weston during one of his walking feats is given. It was equal to 545 grains of nitrogen and 7879 grains of carbon daily, or about twice the amount that would be presumably required in ordinary work. The details would be more valuable if any comparison could be made with the work done under other conditions of diet. The vegetable diet of the Trappist monks is described and some facts are given as to the state of ten prisoners after two months' vegetable diet. The details, however, are of comparatively little value, as they afford no means of comparison as to the conditions that would have been obtained under any other system of dietary.

STEAM TRACTION WORK IN GLASGOW.

THE inquiry instituted by the public authorities of Glasgow regarding the question of cross-river communication west of Broomielaw Bridge, has brought forth a mass of exceedingly valuable and interesting information on the subject of steam traction traffic. It was in Glasgow, if we mistake not, so far as this country is concerned, that the road steamers of the late Mr. R. W. Thomson, of Edinburgh, were first turned to successful account in drawing heavy loads, such as screw *shafting* and other forgings, boilers, engine castings, &c., for large steamers in course of being fitted in the harbour; and to work done resulted in a great economy to engineering and other firms. What used to be one of the most extraordinary sights on the Glasgow streets and bridges, was a heavy boiler or other piece of machinery, in process of being dragged on a bogie wagon to its destination by from three to five or eight hundred workmen, many of them skilled hands—an operation which frequently took a number of hours, and which was almost certain to interfere very greatly with the ordinary street traffic. But very soon after the road steamers were introduced, that state of matters gave place to the one which now prevails.

It is some fifteen years ago, or thereabouts, since the first of the road steamers found its way to Glasgow, and since then the number of such engines has been considerably augmented. Their management is entirely in the hands of the Road Steam Engines Company, the executive manager of the company being Mr. W. Marshall, and the traffic in which the company is engaged has now become so thoroughly organised, and is so well regulated, that a train of two or three steamers, with the heavy "tailpiece" in tow, is one of the commonest sights upon the streets in the vicinity of the harbour—so common, indeed, is it that it affords scarcely any interest to the passers-by. Within the last few years the traffic in question has increased to such an extent, that the quantity of heavy machinery conveyed by traction engines from the engine works, forges, and foundries of the city and district to the harbour cranes and shipbuilding yards, has reached to between 2000 and 3000 loads, of a total weight of about 40,000 tons, per annum. Such an amount of work, taking into account return journeys and journeys empty in connection with the work, involves single engine journeys amounting to about 6000 tons in the course of a year; and the single journeys between the north and south sides of the city, by way of the bridges, have amounted to upwards of 2500 in the course of the same period. The cross-river traffic by way of the bridges, would doubtless be very considerably increased if the bridges were open for the conveyance of heavy traffic without limit, since the necessities of harbour work often render it necessary that new vessels should be berthed on the side of the river which is opposite to that on which the works are situated which supply the machinery. But the Bridge Trustees have placed restrictions on the weights that may cross the bridges. Their regulations do not admit of any traction engines—even without loads—crossing by way of Broomielaw Bridge; while, as regards the Victoria and Albert Bridges, the trustees limit the weight of the whole train—engines, carriages, and load—to a maximum of 60 tons; so that, as not less than 25 tons ought to be allowed for the weight of the engine and carriage, such an arrangement restricts the weight of the load itself to 35 tons.

While that arrangement may of itself be regarded as a very prudent one, it affects the interests of shipbuilders, marine engineers, and shipowners very detrimentally. For example, it is not an unfrequent thing to find the cranes on the southside of the harbour very slack for want of work while those on the north side have too much to do; and occasioally several large vessels have had to wait their turn with considerable delay. Sometimes the effect is in the contrary way, as the north side cranes may be slack while those on the south side are busy. Not long since an engineering firm, whose works are on the south side of the harbour, desired to get boilers weighing 40 tons each removed to one of the north side cranes, so as to avoid having to wait for several weeks for a turn at the 70-ton crane at Plantation Quay, on their own side of the river. Owing, however, to the restrictions as to weight, the boilers could not be allowed on any of the bridges, and therefore the vessel had to wait some weeks before she could get in her machinery at the Plantation crane. More recently, the Dominion Line Steamer Vancouver, a vessel of some 6000 tons, could not get a turn with the desired promptness at one of the north side cranes to receive her machinery from the adjacent works of the engineers in Finnieston-street (Messrs. John and James Thomson), and the consequence was that she had to be berthed at the Plantation crane on the south side, thereby involving greater expense and delay in taking her heavy machinery over from the works, a distance of well nigh two miles, if not even more, as against some 300 or 400 yards. When less than half of the machinery had been conveyed across the river to the destination mentioned, it was found that the weights of the remainder were in excess of what the Bridge Trustees would allow to cross by way of the bridges, and the completion of the vessel was therefore delayed until a berth could be obtained at one of the north side cranes, to which the vessel had to be transferred. The weights in question ranged from fully 36 tons to upwards of 50 tons. When Mr. Marshall was giving evidence on this subject before the sub-committee of the Statute Labour Trust of the Town Council, he was asked by Lord Provost M'Onie—himself an engineer—if he thought he would get a bridge that would allow of the passage of the increased weights that he was looking forward to. He replied that he thought he saw indications that such would be the case, and he went on to remark that, as the weights of modern marine machinery often approach in single loads to double the limit (35 tons) fixed by the Bridge Trustees for the present bridges, and as the weights of the hauling engines may, in some cases, approach to another 35 tons, it is at once seen that to accommodate the heavy traffic of the Clyde engineers, there should be bridge accommodation equal to a strain of considerably over 100 tons; and 150 tons would not be too large a margin to count upon, in view of the increase that has taken place in recent years in the weights of individual loads. Ten years ago 40 tons was a very extreme weight, and few loads went beyond it. In the three years 1873-74-75, the loads that were taken to the harbour cranes above 40 tons in weight were only a little over fifty in number, and none of them were over 50 tons in weight. In the three years, 1881-82-83, the number of loads exceeding 40 tons was upwards of 250, of which a large number weighed upwards of 50 tons each, while not a few were over 60 tons in weight. One firm (Messrs. John Elder and Co.) during the three years ending June, 1883, put into vessels no fewer than 120 loads each weighing over 40 tons, of which 45 were upwards of 50 tons each, and 20 over 60 tons weight in the single pieces. Such data at once prove that

the call for better bridge accommodation is not only well founded, but that it is one that cannot remain any longer unheeded.

As to the best means of giving the cross-river accommodation required, Mr. Marshall urged that a swing bridge near to Finnieston-street is the only plan that appears likely to serve the purpose, from the point of view which he represented at the inquiry. He gave very strong reasons against high-level bridge and tunnel or subway schemes, such as had been or might be proposed. For the class of traffic with which he dealt, and with loads up to 70 tons, no severe gradients, up or down, are possible without great additional cost for haulage and great risk in case of accident. He also showed very clearly that a floating ferry-boat or stage, with rising or falling platform, would be unsuitable. One of the plans that had been proposed contemplated a platform 68 ft. long, while a train of road steamers with a heavy load occasionally reaches to a length of nearly 100 ft. Various other reasons, in Mr. Marshall's opinion, placed such a proposal entirely out of the question.

THE HEALTH EXHIBITION.

EDUCATIONAL EXHIBITS.—No. II.

ANOTHER part of the room of the Technical Institute allotted to the Christian Brothers, is devoted to their Agricultural School of Beauvais. From the recently published Report of the Royal Commissioners on Technical Education, we had learnt that this school is furnished with the requirements necessary for a good theoretical and practical course of instruction in all the branches immediately connected with agriculture. There are lecture-rooms and museums, physical and chemical laboratories, and a farm extending over 325 acres. The students are required not only to work on their model farm, but to visit the best farms in the vicinity, to attend, with specialists, certain markets and sales of live stock, as well as to accompany the Brothers in frequently appointed field-days for the practical study of botany, geology, and entomology.

The exhibits from this school show the extent and thorough practical character of the instruction given. They comprise a very large classified collection of seeds and grains from the farm, herbaria of plants peculiar to certain soils, a folio volume containing the results of experiments made in the school laboratories and on the farm, theses on agricultural subjects, and numerous accounts of excursions and work done on field-days.

The technical schools conducted by the Christian Brothers are represented by specimens of work done in the New York Catholic Protectory, the La Salle School at Lyons, and the Schools of St. Nicholas at Paris.

The youths at the Protectory show no mean skill in such handicrafts as chair-making, silk-weaving, printing, and electrotyping. The school of La Salle deserves great praise for the efficiency of the training given in its workshops. It is interesting to know that this is an establishment in which the most successful students of the Brothers' elementary schools in Lyons, are admitted and put through a comprehensive technological course, and that free of expense. Besides numerous specimens of silk-weaving, which is an important local industry, this school exhibits collections of patterns and designs and a beautiful piece of weaving containing the arms of the City of London. Not less valuable than these are the albums which contain the working drawings of all the silk-weaving machinery in the establishment. To be able to make these sketches, as we have seen them, argues a good course of drawing and a very fair degree of proficiency. Doubtless the boys who have been trained in such a school, experience but little difficulty in obtaining eligible situations.

The schools of St. Nicholas seem to have a wider scope and a larger number of well-equipped workshops. We find among their many exhibits articles of excellent workmanship. These are microscopes, terrestrial telescopes, levels with all the adjustments, musical instruments, finely gilt candelabra, a large screw-cutting lathe, cabinets of carved oak, bronze statuettes, solid leather portmanteaus, and numerous specimens of engraving on wood and stone, printing and book-binding. The senior students of this school are also practically trained in the principles of electric lighting, advantage being taken for this purpose of the presence of a Gramme machine and a number of incandescence lamps which light up the physical and chemical laboratories, the corridors, and workshops.

A great attraction in this exhibition of the Brothers is the very large number of school museums sent from various places in France, the United States, and Canada. For the most part they contain objects of local interest which were collected by the boys and duly classified by the Brothers. We had thought that the school museum was a recent addition to the machinery of education, and were consequently surprised to read in a recently published work on education, that the founder of the Christian Brothers, J. B. De La Salle, more than two hundred years ago required them to use these and other similar means of fixing the attention of the junior boys of the school.

Of the thirteen museums which we examined, four deserve special, mention, viz. :

1. That of Annecy, which contains specimens of the geology and flora of Savoy, and of the local industries, as well as analyses of the principal mineral waters and soils of the vicinity.

2. That of Beauvais, which contains upwards of 1500 articles illustrating various handicrafts.

3. That of Marseilles, showing the local industries, chiefly the oils. And

4. A number of separate classified collections showing the successive stages in the manufacture of needles, combs, and the like, the making of clocks and flutes, and the various processes of mirror making, wood gilding, printing, engraving, &c.

We also saw, in our examination tour, a series of excellent charts made by the Brothers of Dijon to illustrate their courses on vegetable physiology, arboriculture, and viticulture.

We did not stay to carefully inspect the class-work sent from some 200 schools of the Brothers. We noticed, however, in passing, that the senior students are accustomed to make short-hand notes of their lectures. We found numerous specimens in the Pitman system from the United States (Providence and Brooklyn), and others in the Duployé system from Paris, Nantes, and Moulins.

The last table which we examined contained the text-books written and published by the Brotherhood. We found manuals for elementary and also for advanced classes of trigonometry, descriptive geometry, surveying, theoretical mechanics, physiography, as well as methods for learning modern languages and books on school government, literature, logic, book-keeping, and commercial law. Some of these are used in France, others in Belgium, whilst the English text-books come from Canada and the United States.

We solicited and obtained from the Brother in charge of the room permission to take two of the books with us for close examination. One of these was a treatise on trigonometry, the other a manual on theoretical mechanics. We fingered these books at our leisure and our impression is that for completeness, systematic arrangement, and clearness of exposition, they are equal to any science books used in our own schools. Nor are we surprised at this; for among the 12,000 Brothers that form this society which seems to be well imbued with the progressive spirit of the times, their splendid exhibition proves that there are many able men and eminent teachers in all the branches of a scientific and technical education. But little was known in England of the Brothers before this Exhibition, save that they had a college at Clapham which figures well at the London University examinations. Their work at South Kensington has now brought them most favourably before the British public, and we have little doubt that their rich and varied collection (an international exhibition in itself) will exercise a beneficial influence upon the elementary and intermediate education of this country.

CHEMICAL INDUSTRIES ON THE TYNE.

THE visit of the Society of Chemical Industry to Tyneside draws especial attention to an industry that is there ancient, and that of late has passed through considerable change, and seems to have further changes before it. In the older period of the chemical trade on the Tyne, there was the use of salt locally made down the side of the river, from sea-water and from brine springs. Later the dependence has been on salt brought from Cheshire; and now there is added a slight supply from South Durham, which is expected by some authorities to be very greatly increased. And as changes have taken place in the source of the supplies of the raw material, variation has also been known in the mode of production, and competition has arisen, and is arising, with other districts and countries that are differently situated in regard to material, fuel, &c. Alkali manufacture on the Tyne dates back ninety years—the oldest of the works having been commenced by Mr. W. Losh and others at Walker, about the year 1796. In one of the most authoritative notices of the alkali trade of the Tyne—that submitted to the British Association at their Newcastle meeting—it is stated that "Mr. Losh resided in Paris in 1791, where he obtained a knowledge of chemistry, and soon after his return home a company was formed to manufacture soda at Walker. The original partners were Lords Dundas and Dundonald, Messrs. Arbone and John Surtees, and John and William Losh. They obtained their salt from a brine spring found in a coal-pit at Walker, and the heavy duty upon salt at that date—which was 36*l.* per ton—was avoided by evaporating together a concentrated solution of the brine spring and sulphuric acid; thus obtaining sulphate of soda instead of salt." The alkali trade grew on both the north and south sides of the Tyne, and it is one of the curiosities of the trade to find that now, with the exception of one works, it has entirely settled on the southern bank. But there have been other and greater changes in the trade and in its locality, and there has been and is now felt a greater competition than that between Northumberland and Durham as competitors.

In the chemical trades of the Tyne, the landmarks of the changes of material are the introduction of Cheshire salt, in the year 1825, and of the salt from South Durham, above a year ago; but the changes in the method of use have been many. Sulphuric acid chambers date on the Tyne back to about seventy years ago; fifty-three years ago the French method of alkali production was introduced; forty-four years ago pyrites were introduced; and gradually the trade has drifted into the main channels it now knows, those of the production of soda ash, of soda crystals, and of bleaching powder. Taking these in the order named, and giving the most reliable estimates, we find that in the year 1862 the production of soda ash on the Tyne was over 43,000 tons, and at the present time it is believed to be about 90,000 tons. Of soda crystals, the production in the earlier year was 51,000 tons, and now it has increased to about 140,000 tons, though the possible production is more, the output being at present restricted by arrangement. Of bleaching powder, in the year 1862, the production was 11,000 tons, and now it is estimated at about 30,000 tons. In addition caustic soda and other articles are produced, but not in quantities that are large. Unquestionably the prices that have ruled, and the circumstance to which we refer below, have contributed to the change in the position and prospects of the trade. In 1862, for instance, soda crystals sold on the Tyne at 4*l.* 15*s.* per ton, now the price is 3*l.* Bleaching powder at the earlier date was 9*l.* per ton; it fell by the end of 1882 to under 4*l.*, and thence, by the result of a combination, more than doubled its price, and is still sold at about 6*l.* 15*s.* Concurrently with these changes in the source of the chief raw material, and in the price, there has been an increased use of machinery, and now the furnaces of Jones—in use at the Newcastle Chemical Works and of Mactear—employed by Messrs. C. Tennant and Co. have largely abolished the use of hand decomposing furnaces; indeed, it is understood that Mactear's furnaces are exclusively used at the latter works. And on the Tyne, in the chemical, as in other trades, the tendency has been to the crushing out of the smaller works and to the drifting of the industry into larger establishments, such as those at Gateshead, at Hebburn, and at Jarrow.

Unquestionably the future of the chemical trade of the Tyne is one that has its dark cloud. The industry has depended in some degree upon the manufacture of alkali by the Leblanc process, and so far as soda ash is concerned, the introduction of the ammonia process into the Cheshire district has enabled the makers there to compete with much success with those on the Tyne who have not the brine supply. For some years the manufacturers in the latter district have had this in their thoughts, and at a comparatively recent meeting of the London section of the Chemical Society, it was stated as a proof of the unsatisfactory condition of the soda industry that "of twenty-five alkali works which were in operation in the neighbourhood of Newcastle-on-Tyne a few years ago, only thirteen are in

operation now, and of the other twelve not fewer than eight have been actually dismantled." This was due to the rapid growth of the ammonia process at home and abroad. There have been several suggestions and attempts to meet that competition —more economical working, the use of machinery, and a greater dependence on bleaching powder, as well as the regulation of the extent of the production of the latter, so as to force up the price. In addition, the utilisation of the salt deposits of South Durham have been looked to for aid. In some degree all of these have been tried. We have referred to the increased use of machinery—it has also contributed to a considerable saving in fuel. For a year the "regulation" of the production of bleaching powder has been in progress, with that remarkable effect on prices that has been related, and for a shorter time a more local attempt to similarly regulate the production of soda crystals, has been carried out on the Tyne. In the latter case, prices have not risen above the range that has prevailed of late years; but in combination with the restriction of the production of bleaching powder, it is believed to have led to internal economy in the works and to lessened waste of products and lessened decomposition of salt. Finally the South Durham salt deposits have been "tapped" near Port Clarence, and some 400 tons of salt are weekly sent thence to the Tyne, whilst two other attempts to utilise the deposit are being made now. On the other hand the ammonia process is to be introduced into South Durham, and thus the battle will be fought out on that ground also.

The chemical trades of the Tyne, then, have before them a competition that will be keener in the future probably than in the past; but as these trades are in a measure in their infancy the possibilities in favour of the district that has ancient practice, generations of skill, cheap fuel, and great works are many, though as yet indefinite. With the incoming year there will be a supply of sulphur that is to be much cheaper, but there may be the production of soda ash in the north-east by the ammonia process. Salt should be more largely procurable in that district, and with larger production lessened cost ought to follow. But probably cheaper working, the lessened cost of fuel, and the profitable use of products that are now wasted, will form the chief of the resources that are to be looked to for the benefit of the Tyne chemical trade.

NOTES.

Electric Conductivity of Solutions.

According to the recent researches of M. Bouty, the neutral salts in very extended solutions of water, form a group apart as regards their electric conductivity. For example, ethylic alcohol, glycerine, erythrite and phenol, glucose and candied sugar, ordinary ether and dichlorhydrine, ethylic aldehyde and acetone, as well as albumen, all conduct very badly. M. Bouty has also come to the conclusion, from his experiments, that an anhydrous alkali or acid is not a conductor, but that a hydrated acid or alkali conducts like a salt.

The Hudson's Bay Route.

A report on the opening and closing of navigation at York Factory on the west coast of Hudson's Bay, with observations extending from 1828 to 1880, has been communicated by Mr. W. Woods to the Hudson's Bay Company. The latest recorded date of open water in spring is June 1, the earliest closing of navigation November 3. The earliest recorded date of opening was May 4, the latest date of closing December 9. There is, therefore, some six months of open water on the average in the bay itself, but the communication between the bay and the Atlantic can only take place through Hudson's Straits, and this passage is only clear in July, August, and September, with probably a part of October. Further information on this head is much needed, and it is satisfactory to learn that Hudson's Bay is shortly to be properly surveyed, for the question of its navigability is a most important one to the settlers of Manitoba and the Saskatchewan, since they can ship their exports for Europe by this shorter route, instead of by the Red River and the St. Lawrence.

The Silver Voltameter.

At the last meeting of the Physical Society for the present session, Lord Rayleigh, president-elect of the British Association, exhibited the platinum-bowl voltameter which he has designed for measuring the strength of an electric current. This is the best means yet found for estimating the current in absolute measure. The platinum bowl is the cathode in his apparatus; the anode being a sheet of silver wrapped up in clean filter-paper sealed round it. The filter paper is a sheath for the anode to catch any grains of silver which may be loosened from it in the act of decomposition, and prevents them from falling on the bottom of the bowl or cathode. The bowl is filled with a solution of silver salt, the pure nitrate or pure chlorate being preferred. Silver acetate ought not to be used, as it does not give such good results. The anode is dipped in the solution till the sheet is quite immersed; and the current turned on. One ampère deposits 4 grammes of silver in an hour, therefore a quarter to half an hour is sufficient to give one to two grammes, a quantity which can be weighed with sufficient accuracy in a chemical balance. Any current from ¼ to 5 ampères can be successfully measured in this way.

Rainfall Records at Glasgow Observatory.

On the authority of Professor Grant, F.R.S., some interesting rainfall records at Glasgow Observatory have been made available for public use. Their publication was suggested by the heavy rainfall at Glasgow during the twenty-four hours ending at ten o'clock on the morning of the 11th inst., which is said to have been the most excessive that has occurred during the past twenty-two years. The downpour was heralded by a smart shower which commenced about 1 P.M. on the preceding day (Thursday), and lasted but a few minutes, when fair weather was again enjoyed for about an hour. A little after 2 P.M. there was registered by the self-recording instrument of the observatory, a drenching shower, which, although happily short-lived, was remarkable for the rapidity with which it fell. At 4.15 P.M., the sky, which was destitute of sunshine for several hours previously, again sent down rain in perfect torrents. During the evening 1 in. of rain fell in five hours. During the twenty-fours referred to, the rainfall amounted to 2.12 in., and during none of the twenty-two years preceding 1884 did the rainfall at Glasgow Observatory ever exceed 1.77 in. in the same period of time. That was in the month of July, 1866.

The Accident on the Manchester, Sheffield, and Lincolnshire Railway.

On Wednesday afternoon a fearful railway accident took place on the Manchester, Sheffield, and Lincolnshire Railway to the train leaving Manchester at 12.30, and due at King's Cross at 5.20 P.M. The train consisted of an engine and tender, a horsebox, nine carriages, and two brake vans. Half way between Hazlehead and Penistone, opposite the Bullhead Colliery, the crank axle of the engine broke, when the train was on a sharp curve. The engine and horsebox broke away from the rest of the train and ran on for 400 yards, but the carriages were not so fortunate. The first and second left the rails and fell down the embankment; the third and fourth went over the bridge into the road, all the passengers being either killed or fearfully hurt, and the remaining carriages were overturned. Twenty-two persons were killed and thirty injured, some of them very seriously. As far as can be learnt at present there is every reason to believe that this awful loss of life might have been averted had the train been fitted with quickly acting automatic brakes instead of the simple Smith's vacuum brake, which the Manchester, Sheffield, and Lincolnshire and Great Northern Companies still insist upon using. The engine and one vehicle parted from the train, and of course from this moment the train was helpless, even if the brake pipes had not been injured before the train separated. Amongst the innocents slaughtered by the Government recently was the Railway Bill, part of which provided that brakes complying with the wishes of the Board of Trade, should be fitted in a certain time. Whether it will really be necessary to wait for an Act of Parliament before proper safeguards are adopted we cannot say; judging from the past only, we should say that nothing short of this would overcome the obstinacy of certain railway companies, but we would fain believe that both the Manchester, Sheffield, and Lincolnshire, and other companies will take this last of many warnings to heart without further pressure.

The Society of Arts Albert Medal.

The Albert Medal, which was awarded by the Council of the Society of Arts to Mr. James B. Eads, the American engineer, was last Wednesday presented to him at Marlborough House by His Royal Highness the Prince of Wales, President of the Society, in the presence of the Council. This medal was founded in 1862 in memory of H.R.H. the Prince Consort, and is awarded annually for distinguished merit in promoting arts, manufactures, or commerce. This is the twenty-first which has been awarded. Among the distinguished recipients of the medals are Sir Rowland Hill, K.C.B., F.R.S.; His Imperial Majesty, Napoleon III.; Professor Faraday, D.C.L., F.R.S.; Sir Joseph Whitworth, L.L.D., F.R.S.; Baron Justus von Liebig; Count Ferdinand de Lesseps; Sir Henry Bessemer, F.R.S.; Sir C. W. Siemens, D.C.L., F.R.S.; M. Michael Chevalier; Sir J. B. Airy, K.C.B., F.R.S., Astronomer Royal; M. Jean Baptiste Duma; Professor James Prescott Joule, L.L.D., D.C.L., F.R.S.; Sir William Thompson, L.L.D., D.C.L., F.R.S., and Professor Auguste Wilhelm Hoffmann, M.D., L.L.D., F.R.S., University of Berlin. Mr. Eads is the first American who has received this distinguished honour. It is the more complimentary to him from the fact that his name was suggested by the Council of the Institute of Civil Engineers, and the award was unanimous in the council of the society. In replying to the complimentary remarks of his Royal Highness, Mr. Eads said that he recognised the award as a token of goodwill on the part of the Society towards his countrymen, rather than for any merit of his own; and the fact would be received by them as another of the many evidences of sincere solicitude for the happiness and prosperity of the United States, and which had been so often shown by Her Most Gracious Majesty the Queen, her Government, and her people, and which, he believed, had assured his fellow-citizens that their kin across the sea were their truest friends, and that the homely adage, "blood is thicker than water," had lost none of its force because they were separated by an ocean from the land of their ancestors.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Dore and Chinley Railway—What Navvies may expect.—In the construction of the Dore and Chinley Railway one of the principal depôts will be that of Hathersage. Dr. P. S. Fentem in his report delivered to the Urban Sanitary Authority, draws attention to the fact that the making of the railway is now being undertaken, and the water for the supply of the navvies will be obtained from a brook at Hathersage. He reported that he found the supply pipe had been removed from its original site, and it was now adorned at the nozzle with what looked very much like an old perforated tin lantern with the top knocked off, so as to slip on the nozzle. It was so surrounded with nasty gelatinous matter that at first sight it was difficult to say what it was. Floating on the surface of the water were masses of the same vegetable jelly-like material, which, on examination, he found to be alive with small animalculæ.

The Yorkshire College and Engineering.—At the annual meeting of the governors of the Yorkshire College, held during the week under the presidency of Sir Edward Baines, the latter gentleman referred to the scheme for the equipment of a laboratory in connection with the engineering department. In speaking on this he said that this important branch of industry, which was now carried on in Leeds to a larger extent than in any other Yorkshire town, required that this department should be reorganised. To secure a proper equipment of a mechanical laboratory the employers of Leeds had given 1000*l.*, and the sum now contributed reached 2200*l.* In addition to this, Sir John Hawkshaw had given 1000*l.* towards founding a chair of engineering. Mr. Barr, of Glasgow, has been appointed professor, and the suggestions he had already made indicated that he was capable of carrying on the department with a high degree of efficiency. Sir Edward also spoke of the large liberality of the Clothworkers' Company, London, in connection with the existing school of dyeing and textile industries, and the extension about to be made. The new buildings of the College are expected to be ready for occupation at the beginning of October.

Chesterfield and the Institute of Engineers.—At the last monthly meeting of the members of the Chesterfield Town Council, reference was made to the proposed removal of the Institute of Engineers from the Chesterfield Memorial Hall. The Council are of course averse to the taking to Sheffield of the head-quarters of this Institute, and at their meeting thanked their acting representative for his efforts in attempting to prevent the completion of such a measure.

NOTES FROM THE SOUTH-WEST.

Newport.—The house coal market continues easy. The iron ore trade remains dull; it is, however, thought possible that the quarantine which is imposed at Spanish ports may have the effect of improving prices. The quantity of iron exported last week was 4990 tons, forwarded to the following destinations: Halifax, 1600 tons; Montreal, 1978 tons; and Galatz, 1412 tons. Last

week's coal clearances amounted to 44,454 tons. From Bilbao there arrived 10,474 tons of iron ore.

Dowlais.—There is no hope of any start at Dowlais in consequence of a continuance of drought. No such weather has been experienced in the neighbourhood for many years.

New Railway.—A new railway from Corfe Mullen to Poole Junction has been commenced this week. When completed it will enable trains to be run from Bristol, Bath, and other places north *vid* Blandford to Poole and Bournemouth, without touching Winborne.

Cyfarthfa.—Men have been busily engaged stacking Bessemer pig for the starting of the steel works, an event which is drawing near.

Great Western Railway.—The Great Western Railway (No. 2) Bill came before Lord Redesdale on Thursday as unopposed. The object of the Bill is to authorise the company to make short railways from the Cirencester Branch to the Swindon and Cheltenham Railway, in the parishes of Liddington and Cirencester; to stop up a portion of a road at Carmarthen; to acquire additional lands at Basingstoke, Standish, and Carmarthen; to make agreements with the Swindon and Cheltenham Railway, and with the Corporation of Carmarthen, and with the Llanelly and Bury Commissioners. The proceedings were purely formal, and the Bill was ordered to be reported to the House.

Taff Vale Railway.—The new Pontypridd and Caerphilly Railway, which has just been opened for mineral traffic, supplies a fresh element in the history of the Taff Vale Railway Company. The Taff Vale engines for the first time conveyed mineral traffic to within a short distance of the Alexandra Docks, Newport, and in a few months, when a short line on the Tredegar estate is completed, they will convey coal direct from the Aberdare Valley to the Alexandra Docks. Up to this time coal from the Aberdare Valley has been conveyed round Quaker's Yard by the Rhymney Railway on the Brecon and Merthy and Newport Railway and thence to Newport.

The Forest of Dean.—The iron trade of the Forest of Dean continues in a depressed condition. On Saturday notices were posted at James's Iron Mine, the property of Messrs. Crawshay Brothers, giving notice to terminate all contracts on Saturday next. It is understood that the proprietors have been reluctantly compelled to take this step in consequence of the general slackness of trade. The same cause has forced upon the proprietors of the Cinderford Iron Works the necessity of giving notice of a reduction of 10 per cent. in wages. The tin-plate works of the district maintain a fair amount of activity. The Forest of Dean coal trade remains in much the same state as hitherto.

Doubling the Great Western Railway.—The Great Western Railway Company has at last completed the doubling of its line between Bristol and Weymouth, the last section between Maiden Newton and Dorchester, about eight miles in extent, having just been finished. The work has been of a costly nature, as three new stone bridges have had to be provided in place of wooden structures.

Cardiff.—The steam coal trade has continued active. Contracts for the Peninsular and Oriental Company have been divided among several local merchants. The fuel trade retains a healthy tone. The house coal trade is quiet and prices are slightly easier. The iron ore market continues weak. Last week's clearances comprised 181,243 tons of coal, 2539 tons of iron, and 4700 tons of patent fuel. From Bilbao there were received 4424 tons of iron ore, and 2863 tons came to hand from other sources.

Newport Abercarn Black Vein Steam Coal Company.—The twelfth general meeting of the shareholders of this company was held on Friday in London. The Right Hon. H. C. Raikes, M.P., presided. A dividend of 7 per cent. was declared, making with an interim dividend paid in January, 10 per cent. for the past financial year.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was rather a thin attendance on 'Change. The tone was quiet and No. 3 Cleveland pig was quoted 36s. 9d. to 37s. per ton. No. 4 was slow of sale at about 35s. The amount of business transacted was trifling. At present the outlook in the iron and kindred trades is the reverse of encouraging. The competition of local makers in the Scotch, Welsh, and inland markets is keenly felt. The shipments from Middlesbrough are about the same as last month up to date, but they compare unfavourably with July last year. There is no change in the manufactured iron trade except that one or two firms on Teeside have fortunately secured a few orders recently. A report in Monday's *Times* money article stating that there had been a rumour on the London Stock Exchange, to the effect that the North-Eastern Railway Company had made a bad debt to the extent of 200,000*l.* with a Middlesbrough firm, was freely discussed. Everybody in the iron and steel trades expressed their surprise that such a rumour should have had the slightest credence for a moment. Shipbuilders and engineers are anxiously inquiring for works. There is a slow demand for steel and the few firms that are at all busy have productive power to meet any expansion likely to take place within the next few months.

North-Eastern Inspection Association.—To-morrow (Thursday) the first general meeting of the members of this Association will be held in Newcastle, and seeing that the dread of cholera has induced so much discussion on sanitary affairs more than ordinary interest attaches to the gathering in question. The Council of this Association in urging the importance and necessity of having houses inspected by their engineers conclude as follows: "When this truth is realised in this district our success will be assured, not only financially but practically in the great works of delivering the people from the results of the ignorance which prevails and which ought to be made criminal on the part of those responsible for the grave errors in the sanitation that abounds everywhere."

The Coal and Coke Trades.—There is no change in the fuel trades.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The pig-iron market was quiet last Thursday, and only a small amount of business was done. Prices closed much the same as on the previous day. Business was done during the forenoon at 41s. 4½d. cash, and 41s. 5½d. one month, the close being, sellers at 41s. 4d. cash and 41s. 6d. one month, and buyers offering ½d. per ton less. In the afternoon the cash price was 41s. 3d. to 41s. 3½d, and 41s. 5d. to 41s. 5½d. one month, the market closing with the lower quotations, and sellers wanting ½d. per ton more. Friday's market was steady, with transactions done during the forenoon at 41s. 3½d. to 41s. 4d. cash, also at 41s. 5d. up to 41s. 6d. one month, the close being, sellers at 41s. 4d. cash and 41s. 6d. one month, and buyers offering ½d. per ton lower. Business was done in the afternoon at 41s. 4d. and 41s. 3½d. cash, also at 41s. 6d. and 41s. 5½d. one month, with buyers at the close at the lower quotations and sellers wanting ½d. more per ton. The market was somewhat quieter on Monday; and prices at the close were ½d. under the final quotations of last week. Business was done in the morning at 41s. 3d. and 41s. 2½d. cash, also at 41s. 5½d. and 41s. 5d. one month, the close being sellers at 41s. 3d. and 41s. 5d. cash and one month respectively, and buyers at 41s. 2½d. cash. In the afternoon the quotations were 41s. 3d. and 41s. 3½d. cash, and 41s. 5d. one month, the market closing with sellers at 41s. 3½d. cash and 41s. 5½d. one month, and buyers offering ½d. per ton lower. The warrant market was dull yesterday, but the closing prices showed no change. Transactions were reported on forenoon 'Change at 41s. 2½d. and 41s. 3d. cash, also at 41s. 5d. one month, the closing quotations for sellers being 41s. 3d. cash and 41s. 5d. one month, and buyers offering ½d. per ton less. Business was done in the afternoon at 41s. 3d. cash and 41s. 5d. one month, and at the close there were buyers at those prices, with sellers at ½d. more per ton. To-day's market was a little firmer, up to 41s. 4d. cash and 41s. 6d. one month being obtained during the forenoon, and sellers were asking those prices in the afternoon at the close, with buyers at ½d. per ton less. Extremely little business has been during the past week, and the market has been almost entirely devoid of interest. It still remains in the hands of the dealers, as the outside public do not see any inducements to go into speculation in pig iron. The state of trade remains practically unaltered, and reports from America, Canada, and the Continent show that for a time no improvement need be looked for. There is no official announcement on the subject, but it is understood that from the 13th of the present month the duty on pig iron imported into Russia will be increased from 6 kopecks per pood of 36 lb., which has been the rate hitherto, to 9 kopecks for the rest of the year, then to 12 kopecks [illegible] in the third year to 15 kopecks per pood. The proposal has naturally met with a great deal of opposition from ironfounders and other large consumers of imported pig iron, many of them declaring that it will be impossible for them to continue their business, as they could not afford to purchase foreign iron loaded with such a high duty. There are still 96 blast furnaces in actual operation, as against 114 at this time last year. One has been put on ordinary iron that has hitherto been making hematite pig iron. Last week's shipments of pig iron from all Scottish ports amounted to 10,199 tons, as against 14,612 tons in the preceding week, and 12,436 tons in the corresponding week of last year. They included 1300 to the United States, 462 tons to Canada, 195 tons to India, 195 tons to France, 290 tons to Italy, 1281 tons to Germany, 500 tons to Russia, 693 tons to Holland, 405 tons to Spain and Portugal, and lesser quantities to other countries. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores yesterday stood at 588,101 tons, as against 588,666 tons yesterday week, showing a decrease for the week of 565 tons.

Mining Institute of Scotland.—A meeting of this institute was held last Thursday night at Hamilton, Mr. James M'Creath, president, in the chair. Mr. James Walker, Glasgow, read a paper on "Blasting Explosives," in which he demonstrated the superiority of compressed over loose powder, a fact that was generally acknowledged in the course of the discussion by those who had used both. Mr. Gilchrist, Earnock Colliery, mentioned that his employer, Mr. John Watson, of Earnock, after inspecting the Fleuss life-saving apparatus in London, was willing to subscribe liberally in support of a movement having for its object the introduction into the district of the apparatus and the testing of its use in the case of mining accidents. Mr. Gilchrist gave expression to the opinion that had the apparatus been available at Niddrie Colliery on the occasion of the recent disaster, it have been the means of averting the loss of life that was entailed. A general opinion prevailed that the institute ought to take the initiative in the movement, leaving the coalmasters to supply the funds, but the appointment of a committee to take the necessary steps was left over till next meeting.

The Dundee Shipbuilding Trade.—This branch of trade is almost at a complete standstill at Dundee, and in one yard in which there is a vessel in course of completion for the Kirkcaldy and London trade, the firm intend to lay down the keel of another vessel merely for the purpose of keeping a few of their old hands in employment. Upwards of 400 of the men recently employed in the local shipyards are now engaged at the Tay Bridge Works. When the former bridge was building the local shipbuilding trade was also in a very dull state, and large squads of the men found employment at the Tay Bridge.

Shipbuilding at Port-Glasgow.—It is gratifying to be able to state that the shipbuilding at Port-Glasgow, which seemed to be so dull a few weeks ago, now shows some signs of improvement. Rumours were prevalent a short time since that more than one of the shipyards in the Port" were about to be closed, but happily, through the securing of several new contracts, this unfortunate condition of things has been averted. Messrs. D. J. Dunlop and Co. have contracted for a steamer of about 1200 tons for the Glasgow and Liverpool trade; Messrs. Murdoch and Murray have booked orders for two new steamers; and Messrs. William Hamilton and Co. have likewise booked an order recently. Messrs. Russell and Co. are well employed both at their Port-Glasgow and at their Greenock yards.

The Local Trades and the Glasgow Fair Holidays.—The local trades of shipbuilding and marine engineering are in such a depressed condition that some of the firms have already set their men free for the Glasgow fair holidays. Usually the holidays at this time of the year last for a week or ten days, but in several instances, they are on this occasion to extend for about three weeks, work not being resumed till Monday, the 4th of August.

The Tay Bridge.—A meeting of the Dundee Town Council was held last Friday Provost Moncur in the chair—when it was resolved to grant a conveyance of ground at the Magdalen Green Point to the North British Railway Company, to enable them to proceed with the erection of the piers of the Tay Bridge. This was done without any demand for compensation, on the ground that the bridge would be of great public utility and benefit to Dundee. Some members thought that the work of erecting the new bridge was proceeding very slowly, and that, at the present rate of progress, the structure would not be completed in five years. It was agreed to write to the North British Railway Company, urging them to proceed with greater activity in the erection of the bridge.

Dumbarton Harbour Board.—At the last meeting of the Dumbarton Harbour Board, it was resolved to ask four shipbuilding firms to give in tenders for a steam hopper dredger, to be capable of dredging 350 tons of mud, soft clay, or sand and gravel per hour, in depth of water varying from 6½ ft. to 30 ft., and to have a speed of nine knots per hour at sea. It is expected that the [illegible] will cost at least 20,000*l.*

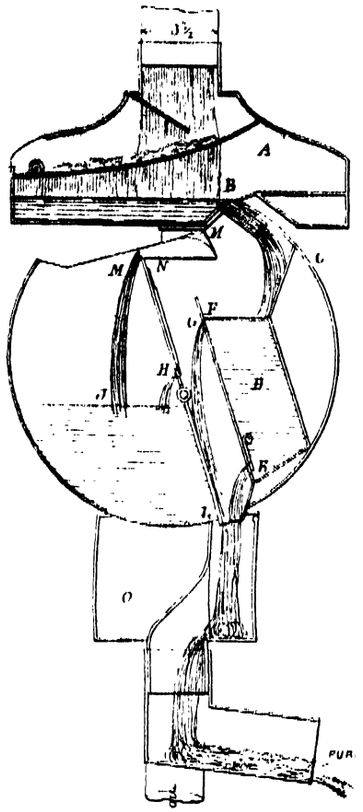
LARGE STEEL SHAFTS.—The Nashua Iron and Steel Company, of New Hampshire, recently manufactured and shipped four large steel shafts to Roach's shipyard, at Chester, Pennsylvania, designed for some new United States steel cruisers. They weighed over 70,000 lb. in the aggregate.

STEAM PLOUGHING IN THE WEST.—Recently at Fargo, Dakota, a traction engine drew eight ploughs, turning a sod 4 in. thick as even and well as could be done by horse power, and at a rate of over 25 acres per day. The cost of steam ploughing is rated at about 1 dol. per acre as against 3 dols. per acre by horse power.

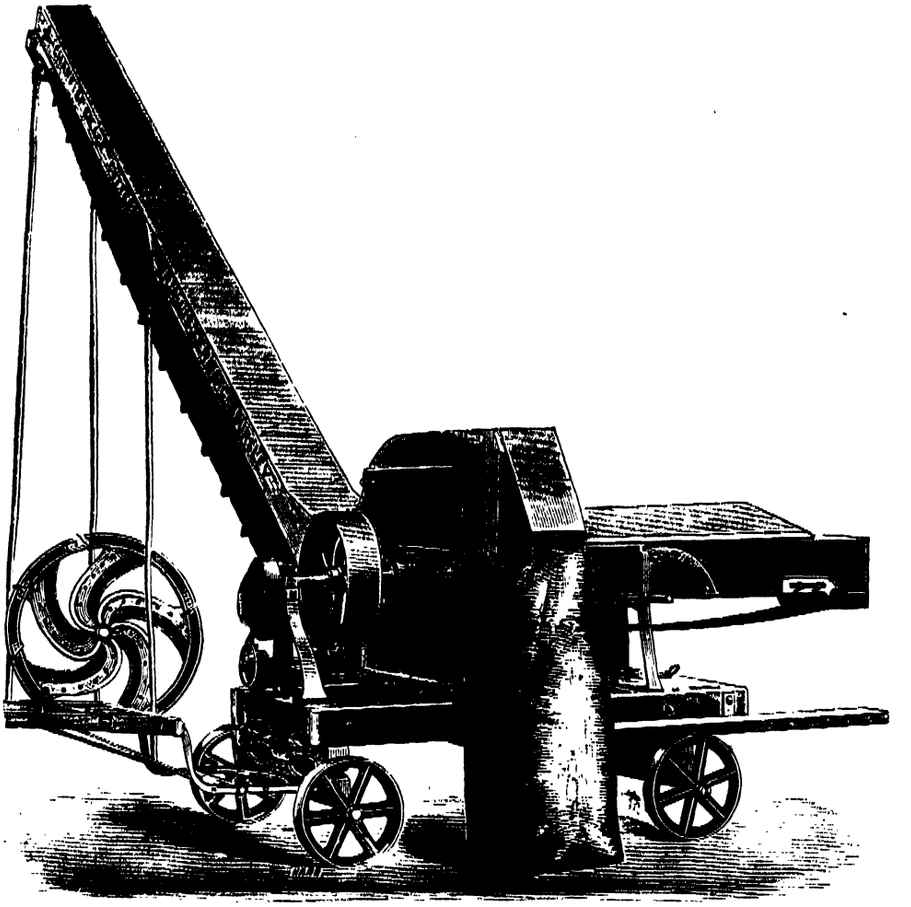
WATER SUPPLY CONFERENCE.—The Conference on Water Supply by the Society of Arts, will be held at the Health Exhibition on the 24th and 25th inst. The Conference will meet each day at 11 a.m., and will sit till 1.30, then adjourn till 2, and sit again till 5 p.m. The proceedings will be opened on Thursday, at 11, by the Chairman. The papers and discussions will be arranged under the following heads:—1. Sources of Supply. 2. Quality of Water; Filtration and Softening. 3. Methods of Distribution; modes of giving pressure; house fittings; discovery and prevention of waste, &c., &c. The proceedings will be continued on Friday, and if necessary on Saturday. The readers of papers will be restricted to twenty-five minutes. Speakers will be restricted to ten minutes. The papers to be read will, in most instances, be printed, and distributed in the room.

AUSTRALIAN TIMBER.—A Board appointed to inquire into and experiment on the best kind of timber grown in the Australian colonies, and adapted for the construction of railway vehicles, has sent in its report. Among the woods which the commissioners mention as suitable are blackwood, mountain ash, bluegum, and Gippsland mahogany. Under test the blackwood presented results which were superior to any other timber. The mountain ash was second to the blackwood for railway purposes. It should be felled, the commissioners think, during the winter months, when it had attained maturity, and is between 4 ft. and 5 ft. in diameter, and it might remain felled for six months before being broken down into planks for seasoning. Bluegum should be treated in the same manner. Going somewhat beyond its reference, the Board deals with the question of timber licenses, and recommends that getters be compelled to pay for the timber felled, and to confine their operations to a given area, or otherwise that selected lots of trees be sold by tender. It is also strongly recommended that a forest board should be called into existence.

EXHIBITS AT THE SHREWSBURY SHOW.



ROBERTS'S RAIN WATER SEPARATOR. (*For description*



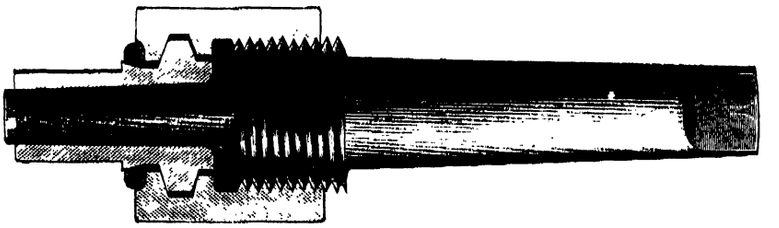
COMBINED CHAFF AND ENSILAGE CUTTER, CONSTRUCTED BY MESSRS. R. A. LISTER AND CO., DURSLEY. (*For description, see page* 58.)

NOTES FROM THE UNITED STATES.

July 4, 1884.

THE six months just closed have been far less satisfactory to the American iron trade than the first six months of 1883. The volume of business transacted has been very little less, but the margins of profit have been very much narrower in all departments. Although steel rails have dropped to 30 dols. per ton, very little business is being done; and it is not likely that there will be any heavy orders placed before about September 1st. Inquiries are being made, but railroad builders are not willing to place orders at any concessions that are named, because of the fact that there is no particular urgency for stocks. There is some talk of a combination among the steel rail makers to restrict the production, but nothing definite has been done, and at present it does not seem possible that any such arrangement can be carried out, as there are one or two companies who would prefer to remain out of it, and make and sell rails on the best terms obtainable. A good many orders are coming in for small lots, running from 100 to 500 tons each; business for the past two weeks will aggregate perhaps 35,000 tons, at from 30 dols. to 32 dols. Light sections have been selling at from 35 dols. to 38 dols. Agents are trying to secure orders for fall delivery, but have not met with much success. Bar iron is selling at from 1.75 cents to 2 cents per pound. Most of the mills are shutting down for a short rest, and for repairs and stock taking, and some of them will remain idle six weeks. Nails are quoted nominally at 2.40 dols. to 2.50 dols here, and 2.15 dols. to 2.25 dols. in Western Pennsylvania. Pig iron is selling at from 16 dols. to 18 dols. for forge, and from 18 dols. to 20 dols. for foundry, according to quality; special makes command as high as 21 dols. in some cases. Very little Bessemer pig is selling; quotations are nominally 19 dols. to 20 dols. Spiegeleisen is quoted at 28 dols. for 20 per cent., but there are no buyers. Plate iron is selling at 2 cents. The structural mills are looking for the placing of orders for from 10,000 to 12,000 tons of construction iron, principally for use in New York and Brooklyn. The iron trade is very dull, as is usual at this season; but leading manufacturers say that the prospects for the fall trade are favourable. The presidential campaign is having a bad effect upon business, and a good many large enterprises have been deferred until next season. Encouraging crop reports continue to be received. Congress will adjourn in a few days, and the business interests have reason to be thankful that no hurtful legislation has been enacted. Tariff agitations will be revived next winter, with a view to a moderate reduction of duties, possibly 10 per cent. Several strikes are in progress in the coal region, but none of them are serious.

BARLOW'S EXPANDING MANDREL.





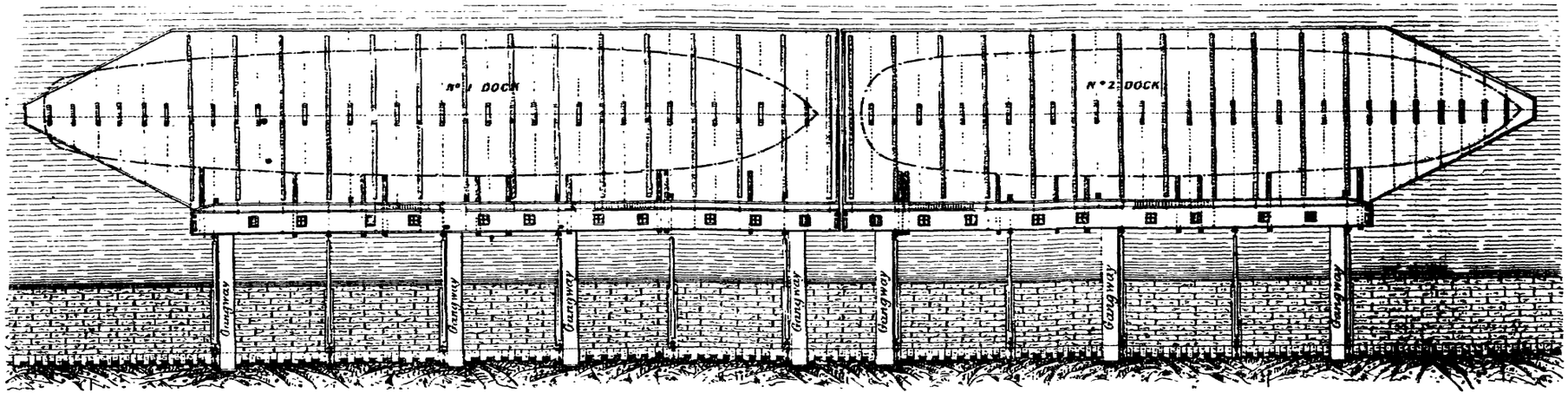
THE annexed engravings represent a new form of expanding mandrel manufactured by Mr. H. B. Barlow, Cornbrook Works, Manchester. The mandrel consists, as will be seen, of three parts. The body and taper spindle are forged of one piece of steel, and the steel nut has a recess turned in it into which the collar or enlarged portion of the die rests. The die is split into three pieces after it has been bored, reamed, and turned to the desired diameter. In order to prevent dirt and chips entering between the die and the spindle, a spiral spring surrounds the die, and holds it in contact with the spindle. To secure the article of work to be operated upon on the mandrel, the split die is expanded by screwing up the nut which draws the die along the taper spindle. The grip or holding power of this mandrel is thorough, as the parallel die fills the hole in the article. The necessity for knife-edge tools, which are costly and not durable, is to a great extent obviated, as the work can be set in such position that it can be turned or faced on the boss and all over the surface without change of tools. The range of the new mandrel can be readily increased by using split bushes on the die which can be changed from one size to another in a moment. By cutting a thread on the die or on a split bush, large nuts can be squared on their faces true with the thread and in less time than usual. These mandrels are used for all classes of heavy and medium-sized work of iron and brass, and they are now being got up to suit the requirements of watch tool makers. A number of them have been working, among other places, for the past two years at the Royal Arsenal, Woolwich; Messrs. W. Muir and Co., Manchester; and Messrs. Kitson and Co., locomotive builders, Leeds.

MR. ROBERT LUTHY.—We have to record the sudden death of Mr. Robert Luthy, who, for the last nineteen years, has been chief draughtsman and manager in the hydraulic department of the works of Messrs. Hicks, Hargreaves, and Co., of Bolton. He was forty-four years of age, and a member of the Institution of Mechanical Engineers. On several different occasions he has visited America and the Continent for his firm, and on the night of his death, July 2, had just returned from Queensland, where he had been in connection with cold air machinery for meat preserving. The deceased was a native of Switzerland and was well known as the inventor of several improvements in hydraulic machinery.

SANITARY INSTITUTE OF GREAT BRITAIN.—At the anniversary meeting held at the Royal Institution, Albemarle-street, on Thursday, July 10th, the Right Honourable Earl Fortescue, vice-president of the Institute, in the chair, an address was delivered by Dr. H. C. Bartlett, entitled "Some of the Present Aspects of Practical Sanitation," and the medals and certificates were presented to the successful exhibitors at the exhibition held at Glasgow in September, 1883. At the close of the address the chairman proposed a vote of thanks to Dr. Bartlett, which was seconded by R. B. Grantham, M. Inst. C.E., and a vote of thanks to the Right Honourable Earl Fortescue for presiding was moved by Dr. A. Carpenter, and seconded by Professor F. de Chaumont, M.D., F.R.S.

LIFTING DOCK FOR CARDIFF.

MESSRS. CLARK AND STANDFIELD, ENGINEERS, LONDON.



We illustrate on the present page and on page 60 a novel form of dock now being constructed by Messrs. Clark and Standfield at their new works at Grays, Essex. This dock is for the Dumfries Dry Dock Shipbuilding and Engineering Company of Cardiff, and will be placed just outside the entrance to the Roath Basin and the Bute Docks at that port; those who know the locality will see that this position alongside the fairway of the channel is exceptionably favourable for a dry dock.

The dock is in two parts, as shown in the plan on this page, each of which can be worked independently, the larger part being capable of docking a vessel of 2500 tons, and the smaller a vessel of 2000 tons: the two united are capable of docking a vessel of 4500 tons dead weight, and 500 ft. or more in length.

In end elevation the dock has the general appearance of a very large landing stage, and could well be used as such when found convenient to do so. It resembles the letter L, the upright side of which is attached by eleven pairs of parallel motion booms to vertical girders built into the sea-wall; the lower ends are embedded in concrete: and at the ground-level these girders are secured by a horizontal anchorage. This connection insures that the dock shall be horizontal throughout the whole range of the tide, which is here about 42 ft.

Ample accommodation is provided for communicating with the shore by means of seven principal gangways, passing through passages in the side of the dock to the pontoon; these are hinged at their upper ends on the shore and are furnished with rollers at their lower ends on the dock, so that they accommodate themselves to its rise and fall. There are also gangways on some of the upper booms, giving additional access to the upper deck.

The dock having been lowered by allowing water to enter the bottom or pontoon, a vessel is brought over the keel blocks and rapidly centred by the mechanical centring shores shown as passing through the side of the dock: the pumps are then set to work till the vessel has a good bearing on the keel blocks, when additional blocks are brought up to thoroughly support the bilges, so that the vessel is firmly secured. Pumping is then resumed, and the water ejected from the pontoon until the vessel is raised completely out of the water, when the operation of lifting is completed.

The pumps are of sufficient capacity to enable the largest vessel to be docked within an hour, and not more than half an hour would be occupied by lowering her into the water. The advantage of this unusual rapidity will be very great, as it will enable a vessel to be docked, sighted, and again floated, and be taken to her loading berth in the wet docks within one tide.

The dock is divided both longitudinally and transversely into a large number of water-tight compartments, each of which may be pumped or shut off independently. The sluice valves are arranged and grouped in such a manner that they afford the most perfect control; they are provided with gear for automatically opening and shutting them, and also with manual gear which can be worked either independently of the automatic gear or in conjunction with it.

The automatic gear is arranged as follows: On the upper end of the vertical columns or girders an A shaped frame is pivotted in gudgeons at its upper end, and at a certain distance below that point the shore end of the upper boom is connected to it by a steel pin, so that the A frame can rotate freely on the gudgeons through a certain angle in either direction. From each leg of the A frame is suspended a heavy weight. To the apex of the frame above the gudgeons, is attached the rod connecting with the valve lifting gear on the dock.

Taking the dock in the position shown in the engraving, and supposing it be required to lower it, the whole of the interior valves are opened ready to admit water to the various compartments. the outer sluice valves are then raised and the dock commences to lower. Should the outer side of the pontoon fill slightly faster than the shore side, and so have a tendency to list the dock in that direction, a pull is exerted upon the upper boom, causing the A frame to be turned on its gudgeons, and the right-hand weight to be lifted. A very slight traverse of the A frame causes the rod above to actuate the valve gear, so that the valves admitting water on the outer side of the pontoon are closed, whilst those on the shore side of the pontoon remain open. The dock is thus almost immediately brought back to a dead level, and the valves which have been previously closed are again automatically opened. A similar operation by the same gear controls the dock in the event of a tendency to list towards the shore.

There will be two centrifugal pumps in each part of the dock; they will be driven by powerful horizontal engines placed in the upper chambers of the vertical side of the dock. Whatever may be the level of the dock, steam is always in connection with the engines from the workshop boilers on shore, thus economising weight and space in the dock.

The dock will be furnished with several vertical spring booms, as shown, along the side, and against these the vessel might be brought up without any shock when coming alongside. The side shores shown as passing through the side of the dock, are worked by hand from the top deck, by means of a worm and wheel gear. The extreme shores are used for bringing the vessel centrally over the keel blocks while she is still afloat, and the remainder are brought into position during the operation of lifting.

The bilge blocks consist of a very strong timber framework, and allow of a certain amount of spring, so as to give the vessel a secure seating, as shown. These are worked from the top deck by means of similar gear to that employed for the side shores, and they can readily adjust themselves to accommodate vessels of any shape.

Rails are laid along the whole length of the top deck, so that a steam crane can travel from end to end. Four gangway ladders provide communication from the pontoon to the top deck, and also to the three painting stages which run from end to end. Every part of the dock will be able to be got at for cleaning and painting whenever required, as one part can readily be docked on the other part. Provision is also made for flushing the interior in the event of sediment being deposited from the water.

As this dock will not be placed inside one of the wet docks. it will possess the great advantage of being able to accommodate vessels going to or from any of these docks, as well as outsiders. It is obvious that it could be readily lengthened at any time to meet an increase of ship-repairing work.

In conclusion, we may mention that the special features of this dock which render it remarkably rapid and efficient are the subject of a patent of Mr. John Staudfield, and, as we have already stated, the dock is being built by his firm, who have long made this class of work a speciality, and whose floating docks we have at various times illustrated in our pages.

BESSEMER BLOWING ENGINES.

We give this week on our two-page engraving general views of a pair of Bessemer blowing engines, designed for the steel works at Heft, in Carinthia, by Professor A. Riedler, of Münich. Since we intend shortly to publish complete detail drawings of these very interesting engines, we shall postpone any description of them until a future date.

COST OF WORKING ENGLISH STEAM TRAMWAYS.

Any reliable statistics which can be obtained on this subject are just now of special value in view of the approaching introduction of steam on the metropolitan tramways. As mentioned by us a few weeks ago, Messrs. Merryweather and Sons, of Greenwich, are constructing fifteen engines (similar to those working so satisfactorily at Dewsbury and Stockton) for use on the North London Tramway Company's lines running through the Seven Sisters'-road to Edmonton and Tottenham.

We have just received the following particulars of the working cost for the past twelve months of the engines referred to in use on the Dewsbury tramways, where they have been running for the past 4½ years. The line is equipped with nine Merryweather engines:

	Cost per Mile run. d.
Coke	0.72
Oil and waste	0.11
Water	0.02
Firewood, &c., for lighting	0.02
Locomotive repairs	0.59
,, drivers	0.83
Coke, watering, and relief man ...	0.11
Cleaners	0.17
Total cost of working per mile ...	2.57

We believe that these figures are the best yet shown by any makers of steam tramway locomotives. It will be noticed that the renewals and repairs only amount (after over four years' work) to 5 per cent. per annum on the cost of the engines. It may be interesting also to note that the weight of coke consumed throughout the year has averaged 6.54 lb. per mile run, the number of miles travelled being 141,065.

THE HISTORY OF PHOTOMETRY.*

PHOTOMETRY is a subject which has developed with the electric light. Formerly it did not appear to offer any great difficulties, and it has consequently been treated somewhat superficially in our text-books of science. For the electrician, photometry has a twofold importance; the function of the photometer is, firstly, to show what quantity of light a certain lamp supplies, so that its economy may be judged; and, secondly, to demonstrate the relations between the light produced and the other forces at work in a given system of machines and lamps. It was only when this latter point became better understood that photometers began to engage the attention of the electrician.

The first photometric tests referred to in text-books of science generally, are those of Fizeau and Foucault, of 1843. It must, however, be borne in mind, that what these eminent French scientists originally measured, is not that which really interests us at present in such experiments; the decomposition of an iodine and silver combination, by means of light from various sources, indicated the chemical intensity of the rays, but not the optical intensity. The surprisingly low chemical intensity of the limelight caused MM. Fizeau and Foucault to repeat their experiments, in order to determine the optical energy; and the agreement of the new and old figures suggested to them that, for white light, the two determinations might practically be replaced by the one which is more convenient, that is the chemical test. It is evident, however, and needs no further support in these days, when we photograph the invisible ultra violet spectrum, that chemical tests cannot be relied upon, and that photometers like Becquerel's electro-chemical actinometer, or Siemens' selenphotometer, cannot measure the illuminative power of a source of light, however perfect and ingenious they may be in other respects. We have still to depend upon the physiological action of the light rays upon the retina of our eye, untrustworthy as this may be, since different observers are not equally sensitive to the same degree, and even the same observer is not so at all times.

The photometrical researches of Th. W. Casselmann, of Marburg, are of interest for the electrician, because they included the electric light, because they were prior to those of Fizeau and Foucault, and because in them there was first introduced Bunsen's photometer, in favour of which Casselmann decided against Ritchie and Rumford.

No accurate tests appear to have taken place after that before 1855, when MM. Lacassagne and Thiers tried their electric lamps at Lyons. M. Edmond Becquerel reported on those trials to the Société d'Encouragement of Paris, and this report led to a contest between the interested parties, as Becquerel estimated the intensity at 350 candles, whilst the manufacturers claimed 600 and more. This contest was of importance, because the real point was the question of expense. Scarcely any tests of real scientific value were, however, undertaken before the Alliance magneto-electric machines in France, and those of Mr. Holmes and others in England, attracted attention. Then difficulties cropped up everywhere, and the main problem has not been solved up to the present day. Neither the French bec-carcel, nor the English standard candle, nor the German candle, can be considered as normal, as they are all variable; this is strikingly evidenced by the fact that the ratios between the different standards, as stated in hand-books, do not agree. Many proposals have been made; MM. Rudorff, and Methuen suggested that the middle part of a flame, as more steady than the flickering top and the lower zones, ought to be observed; Mr. Vernon Harcourt and others proposed to burn mixtures of air and normal gases, and the former gentleman exhibited a neat normal lamp of about three-candle power, at the Southport meeting of the British Association. But these devices were mostly too delicate and complicated, and Mr. Louis Schwendler, one of the many electricians whose deaths we have lately had to lament, perhaps made the most practical suggestion in once more drawing attention to Mr. J. W. Draper's idea of using a fine platinum wire, heated by a constant current. Schwendler's units are sheet platinum horseshoes of .017 millimetre thick; but these again are open to objections, as we shall find. If we return to our historical abstract, we find M. Tresca, in 1876, experimenting with a Foucault photometer, a modification of Rumford's instrument, which is largely employed in France, and comprises a milk glass disc, whose two halves are illuminated by the lamp to be examined and the standard candle respectively. Tresca experienced difficulty from the different colours of the lights, and interposed tinted glasses before them. Very instructive were the tests at the South Foreland lighthouses, conducted by Messrs. Tyndall and Douglass, and fully described in the Trinity House Report, 1876-77. The electric lights were compared to a powerful colza-oil lamp, kept as nearly as possible constant at 722 standard candles; this comparison was effected by a Bunsen photometer, the colza lamp being again controlled with the help of a Sugg photometer. As the arc itself emits very little light while the greater part comes from the negative carbon, and a smaller amount from the positive, the necessity arose of taking, even with the two carbons vertically above one another, observations in various horizontal planes; M. Allard has further pointed out that even the various points of the vertical plane of the normal candle do not receive equal quantities of light. The report on his very extensive tests at the French lighthouses to the French Ministry ("Mémoire sur les Phares Electriques"), Paris, 1881, forms a very valuable contribution to the literature on photometry. M. Fontaine's observations on the Gramme machines and Serrin lamps, described in his "Eclairage à Electrique," 2nd edition, 1879, also deserve mention for their completeness. Both MM. Allard and Fontaine used Foucault's photometer, and suggested ways to arrive at mean values with very unsteady lamps; these proposals are, however, hardly of practical weight, nor could M. Allard's idea of verifying his figures, with the help of a Crookes' radiometer, contribute much to their corroboration, as this comes scarcely within the functions of a radiometer. Foucault's photometer was likewise employed when MM. Sautter, Lemmonier, and Co., of Paris, were testing their photo-electric apparatus, for military operations, the lamps being supplied with Colonel Mangin's aplanatic reflector; green glasses were also, in this case, interposed to equalise the colours.

A similar arrangement was adopted at Rouen in 1881, when, on behalf of the Société Industrielle, the systems of Jablochkoff, Gramme, and Siemens were subjected to a series of comparative tests. Here, again, a Foucault photometer was used, together with the ordinary bec-carcel, and the silvered-glass mirror to make the rays parallel. The loss from reflection was averaged at 30 per cent.; the observations were made at various distances, and a determination was made of the radius of that horizontal plane, which received the same quantity of light as a normal candle could supply at a distance of about 4 m. This was a step in the right direction; the report, "Rapport general sur l'Eclairage Electrique des Quais de Rouen," 1881, shows curves drawn to indicate by their ordinates, the light falling upon the horizontal plane.

The municipality of Paris has for some years instituted annual tests of the Jablochkoff candles in the Avenue de l'Opera, which tests finally induced them to abandon those apparatus. The Jablochkoff candles shed their maximum illumination, of course, in the plane perpendicular to the line drawn through both candles; the minimum in this line was found to be 0.57 of the maximum; the mean intensity, however—not the mean between maximum and minimum—was equal to .9 of the maximum, as the intensity curve proved to be of the shape of a figure 8, and not an ellipsis. It also transpired that the air was less transparent to the red light of the Jablochkoff candles than to the gas rays.

The well-known experiments at Chatham of 1879 and 1880 ought to have been mentioned before this. The apparatus comprised a Rumford photometer and an Argand burner of 40 candle-power, with a Sugg's regulator. Photographs were taken at the same moment of the front and sides of the carbons, and the illuminated areas calculated from these photographs. The average illumination of a point was further derived from these calculations, under the questionable assumption that the light was evenly distributed over the whole plane.

We have already spoken of the difficulty which was met with in comparing lights of different colours. The method of action of the ether vibrations, which excite our optic nerves and create the sensation of sight, is unknown to us; but we know that this function depends upon the wave lengths of the rays. M. Purkinje has shown that two coloured planes which appear equally light at a certain distance, seem to lose their light in a different ratio if further removed from the eye. Two lights of different colour are therefore incommensurable. Mr. Dietrich has recently, with more perfect apparatus, repeated the tests by means of which Fraunhofer attempted to determine the illuminative power of the various parts of the spectrum, whose lines he so assiduously studied and noted, without in the least conceiving their character and importance. Fraunhofer had only an oil-lamp at his disposal, and, just as we should expect, he was wrong by about 9 per cent. with reference to the rays from the line D in the yellow, as here the two lights were most homogeneous, but wrong by 60 per cent. when analysing the rays from lines B, G, and H. Spectrophotometric observations, such as first proposed by Vierordt, Glan, and others, may be perfected to a high degree of comparative accuracy; if we arrange the two spectra to be compared, above one another, and divide both by vertical lines into bands of one and the same tint, we may indeed achieve very exact measurements. But this can only be executed in the laboratory, and not in ordinary practice, while, after all, it yields only comparative values for the various colours.

Tinted glasses have often been employed to produce rays of equal colour; but such interposition means loss. Captain Abney conceived the interesting idea of watching lights through a photographically prepared glass plate with a scale of darker and darker bands, through the darkest of which even the sun was not visible. But in the dark the eye gets slowly capable of distinguishing details which were at first quite indiscernible. Further researches, therefore, convinced Captain Abney that the ratio between red and blue in the same electric lamp, varied very considerably as the speed of the generator increased, so that the red rays, which originally were half as strong as the blue ones, finally possessed only one-fourth of the intensity of the blue one, both, of course, increasing in intensity with the quicker revolutions. Professors Ayrton and Perry followed Captain Abney in making two series of tests, choosing, however, red and green lights, instead of red and blue. The difficulty remains, however, how really to compare and reduce to unit measurements those two rows of figures. M. Crova (Comptes Rend. xciii. p. 512) went one step further in this direction. He watched the two half-discs of a Foucault photometer by means of two Nicol prisms, with their main sections vertical to one another, and between the pivots he put a quartz plate of 9 millimetres thickness. If the two lamps are placed in their proper positions both discs appear of a greenish-white tint, and may then easily be adjusted until equal illumination is attained. The theory of this apparatus is too complicated to be discussed here; the main point is that the quartz is designed to produce two broad interference bands towards the ends of the spectra; in the middle parts the intensity of the rays varies, but there must be one line at which the rays pass through the pivots without becoming weakened. This maximum of illumination is now, by adjusting the second pivot, to be fixed at those rays whose comparison would yield the same result as that of the total intensities. The apparatus is ingenious, but in seeking for the districts of equal illumination in the two spectra, it presumes that the spectro-photometer received equal amounts of light from both sources, which anticipates the solution of the problem.

The newer photometers of both M. Cornu and Professors Ayrton and Perry permit measurements of strong electric lamps being taken in small rooms without the awkward necessity of removing powerful lamps to great distances to bring them into comparison with the standard candle. M. Cornu intercalates between the rays of both lights an achromatic lens whose active aperture may be widened or lessened with a micrometer screw, and thus varies the quantity of light falling upon the photometer. Apparatus of this kind have often been thought of; the star photometers of Steinheil and Herschel are based upon the same principle. Messrs. Ayrton and Perry, in their dispersion photometer, use a concave lens to decrease the intensity of the rays. No loss of light was supposed to occur through absorption in this concave lens if it were only thin enough; Mr. Voller, of Hamburg, has, however, taken exception to this assumption, and pronounced the possibility of losses of 10 per cent., and Messrs. Ayrton and Perry seem after to have silently admitted this source of error by introducing a plane parallel glass plate between the screen and the standard candle to weaken the intensity of the light standard. The losses through absorption in the air, Professors Ayrton and Perry observed to be strongest for green light. MM. Bouguer and Allard have further investigated the phenomena of absorption in air; the coefficients vary greatly with the conditions of the air, but they are sufficiently determined to show that in tests where the strong lamp is 50 metres distant from the screen, a loss of about 4 per cent. has to be taken into consideration.

We have finally to speak of the labours of the third section of the Congress at Paris in 1881. The candle found practically no advocate, although Dr. Werner Siemens declared that a good candle need not vary by more than 5 per cent. MM. Tochikoleff and Bède stood up for Schwendler's platinum unit, but M. Crova objected, because platinum had no constant molecular structure, and consequently no constant emissive power; small differences of temperature would further lead to inexact figures. M. Violle recommended the use, as a unit, of the quantity of light radiated by one square centimetre of platinum at melting point. MM. Werner Siemens and Cornu assented, but preferred silver. Sir William Siemens proposed an iridium wire under the influence of the unit of current. MM. Neujean and Flamache caused slight surprise by praising the magnesium and lime lights. For want of anything better, the old bec-carcel was finally left in office, although M. J. Dumas pronounced it too weak. The discussions on photometers were less warm. M. Bergè made the curious proposal to remove the lamp until a white screen would no longer be visible through a solution of the sulphate of copper ammonia. The great problem of what to do with reference to the various colours also remained unsettled. M. Allard suggested the creation of a blinking effect, as then all colours would dissolve into one uniform grey, and Dr. Gladstone proposed the employment of long distances across which the differences of colours would disappear. The proposal of M. Rousseau that for each lamp the equation of the intensity curve $J=f(a)$ should be calculated was warmly supported and accepted.*

* Abstract of the Report of the Scientific Commission at the Munich Electrical Exhibition.

* Since the date of this report the Paris Congress has decided that a surface of one square centimetre of melted plating shall be the standard of light.

THE INSTITUTION OF CIVIL ENGINEERS.

THE Council of this Society have made the following awards to the authors of some of the papers read and discussed at the ordinary meetings during the past session, as set against their respective names:

A Watt Medal and a Telford Premium to Sydney Walker Barnaby, for "Hydraulic Propulsion."

Telford Medals and Telford Premiums to Samuel Bagster Boulton, "The Antiseptic Treatment of Timber;" and to William Foster, "Experiments on the Composition and Destructive Distillation of Coal."

Also Telford Premiums to William Tregarthen Douglass, "The New Eddystone Lighthouse;" to James Atkinson Longridge,† "Wire-Gun Construction;" and to William Hackney,‡ "The Adoption of Standard Forms of Test-Pieces for Bars and Plates."

The Manby Premium has been bestowed upon George Henry Stayton, for "Wood Pavement in the Metropolis."

For papers printed in the proceedings without being discussed:

Telford Medals and Premiums have been awarded to Thomas Andrews, for "Galvanic Action between Wrought Iron, Cast Metals, and various Steels, during Long Exposure in Sea-Water," and to Francis Collingwood, "On Repairing the Cables of the Allegheny Suspension Bridge at Pittsburgh, Pa., U.S.A;" while Telford Premiums have been given to James Henry Apjohn, "The Area of Sluice-opening necessary for the Supply Sluice of a Tidal Canal;" to Thomas Gillott "On the Basic, Open Hearth, Steel Process;" to James William Wyatt, "On the Art of Paper Making by the Machine,

† Has previously received a Telford Medal and also a Watt Medal.

‡ Has previously received a Telford Medal.

as exemplified in the Manufacture of High Class Writings and Printings;" and to William Santo Crimp on "The Wandle Valley Main Drainage."

In addition to the ordinary meetings, there are supplemental meetings for the reading and discussion of papers exclusively by students of the Institution. Some of these communications have been awarded as follows:

The Miller scholarship of 40*l.* annually for three years to Alfred Richard Sennett, for his paper "On the Electric Light."

And Miller Prizes to Peter Chalmers Cowan, "The New York, West Shore, and Buffalo Railway, and the Methods used in its Construction;" to Walter Osmond Rooper, "Emery Wheels and Emery Wheel Machinery;" to Richard Moreland (*tertius*), "Constructional Ironwork for Buildings;" and to Edward Woodrowe Cowan and James Fawcus, "A Light Draught Launch."

THE WESTINGHOUSE AUTOMATIC BRAKE.

TO THE EDITOR OF ENGINEERING.

SIR,—I enclose you a memorandum on the Westinghouse brake, which may be interesting to some of your readers. It is simply a statement of facts coming within my own professional experience, and is not to be taken as an official document of the North-Eastern Railway Company.

I remain, your obedient servant,
London, July 10, 1884. T. E. HARRISON.

July 10, 1884

Notes on the Westinghouse Brake and on some Regulations in working it.

A van has been specially fitted up for instructing the enginemen and firemen in the use of the Westinghouse brake under all circumstances. The van contains all the apparatus necessary for a train of eleven carriages, and pressure indicators are attached to show the varying pressure in the reservoirs, cylinders, and pipes. An intelligent engine driver takes the van to the different stations where men are located, and they are instructed in the use of the brake, the men taking a great interest in it, and when fully understanding its working they are passed, and their names entered in a book. A great improvement in the working of the trains was observed after the men had been instructed.

Hose Couplings Bursting.—The number of failures of the hose couplings is chiefly to be attributed to their position on the carriages having been changed, necessitating the hose being removed from the iron ends by the following process: The hose is soaked for from 15 to 30 minutes in nearly boiling water, and then each end of the hose is put into a machine with movable heads, worked by levers and forcibly pulled off the iron nipples, and invariably more or less damaged. The hose couplings so damaged have now been nearly all removed, and replaced by new ones.

Triple Valves.—All triple valves are examined and cleaned every three months, and it is probable that this examination will turn out to be more frequent than is necessary; the time occupied for the examination and cleaning of each triple valve is seven minutes. A little water is sometimes, but not often, found in engine triple valves, and in those on vehicles worked next to the engine. So far triple valves requiring repairs amount to about 1 per cent. per annum.

Brake Cylinders.—Brake cylinders on engines and carriages are at present examined every three months, a little paraffin oil is put in and the pistons are turned round, so that the leather washers may be lubricated and wear evenly. This process takes 20 minutes. The leather washers in the cylinders seldom require renewing, except in some cases on engines where they come in contact with heat.

Main Reservoirs on Engines.—Water accumulates in these reservoirs at the rate of from one to two gallons per week, depending on the state of the atmosphere. The time occupied in clearing off this water by a plug is five minutes. If these main reservoirs be kept moderately free from water, there is very little accumulation of water in the reservoirs in the carriages or bottom caps of triple valves. The larger the main reservoirs the better, and they ought not to be less that 9 to 10 cubic feet capacity.

Dirt.—It is most desirable that dirt should be kept out of the working parts of the brake as much as possible, and this depends chiefly on the lubricant used in the air pump, and if a little pure paraffin oil is used once in two days, very little accumulation of dirt and consequent clogging of the different parts of the brake will take place.

Governors.—The automatic governors now in use on all engines on the North-Eastern Railway, though little used on other lines, have been proved to be of great importance in keeping up a uniform pressure; they require cleaning every two or three months, the time occupied being about one hour

Donkey Pumps.—The lower or air part of these pumps, and the air valves and case, require cleaning every three months, the time occupied being about half an hour, the pump itself requires a complete examination and cleaning once every nine months, taking two men's time one and a half days.

Driver's Valves.—These valves require cleaning every two or three months, and take about an hour. All the cost of labour in connection with the examinations and cleaning above referred to is included in the accompanying Table.

Brake Blocks.—The wear of brake blocks is common to all continuous brakes, and depends on the number of stoppages made by the brake. In the year 1883 the stoppages at stations on the North-Eastern Railway were 2,863,756, and on the Brighton Railway it has been found that the additional stoppages from signal and other causes amount to 50 per cent. The cost of brake blocks from one year is:

WESTINGHOUSE BRAKE.

Repairing and Maintenance of Brakes and Machinery for the two Years 1832 *and* 1883, *the Number of Vehicles being* 2029 *Carriages*, 637 *Guards' Vans, Horse Boxes, &c.; in all* 2666.

DESCRIPTION OF PARTS.	Quantity.	Cost of Materials, Less Old Materials. £ s. d.	Labour in Fitting and Repairs. £ s. d.	Total Cost of Repairs for Two Years. £ s. d.	Average Cost per Vehicle for Two Years. s. d.	Average Cost per Vehicle for One Year. s. d.
Cylinder and Parts:						
Cylinder	4	16 0 0				
Pistons	1	2 0 0				
Covers	9	3 12 0				
Springs	7	2 2 0	6 0 8			
Washers	65	6 10 0				
Air gauge	2	2 0 0				
		32 4 0	6 0 8	38 4 8	0 3.44	0 1.72
Reservoir and union	1	1 15 0	0 3 0	1 18 0	0 0.17	0 0.085
Triple valve	86	80 0 0	2 3 0	82 3 0	0 7.39	0 3.695
Release valves	14	6 6 0	0 7 0	6 13 0	0 0.60	0 0.3
Cocks	51	12 10 0	1 12 9	14 2 9	0 1.27	0 0.635
Crosshead	1	0 2 6	0 0 3	0 2 9	0 .01	0 0.005
Miscellaneous Parts:						
Truss rods, piping, &c.		20 3 11	3 10 0	23 13 11	0 2.13	0 1.065
Oil (lubricating)		9 6 4		9 6 4	0 0.83	0 0.415
Total brake parts	241	162 7 9	13 16 8	176 4 5	1 3.84	0 7.92
Hose pipes and mounting*	5332	1194 14 0	66 13 0	1266 7 0	9 6	4 9
Reversing pistons			279 12 0	279 12 0	2 1.15	1 0.575
Wages, men, testing			200 0 0	200 0 0	1 6	0 9
Salaries, inspectors, &c.			596 4 0	596 4 0	4 5.07	2 2.835
		1362 1 9	1156 5 8	2518 7 5	18 10.7	9 5.35

* As it was thought desirable to change all the hose pipes that had been damaged when altering their position, the number here charged is above the average, to the extent of from one-third to one-half. The above figures show conclusively that there is great economy in the maintenance of the Westinghouse brake.

	£
Material	559
Labour	315
	874 6s.

or 6½d. per vehicle.

The cost of repairs and maintenance of the pump, triple valves, reservoirs, and everything connected with the Westinghouse brake, for each engine with its tender for one year, taken on the average of two years, amounts to 3*l.* 5s. 9d.. The brake blocks for each engine with its tender for one year cost 1*l.* 18s. 10d.

An analysis of the returns of delays made to the Board of Trade by the North-Eastern Railway Company gives the following results for the year 1883:

	Number of Cases.	
Negligence of men and neglect of regulations	21	
Breakage of parts of brake gear, such as cocks, pipes, swan necks	33	
Leakage from various causes	7	
Triple valves, parts of it being out of order:		
North-Eastern carriages	4	
North British carriage	1	
	5	
Total number of cases		66=1.27 per wk.
Cases of hose pipe bursting		92=1.77 ,,
Total		158=3.04 ,,

Attention is directed to the few cases of delay from the triple valve being out of order. It may here be remarked that the above delays are not attended with danger; though called "failures," they are in most cases the best proof of the reliability of the automatic brake acting as a "tell-tale" to call attention to any slight derangement, and they will certainly be gradually and greatly diminished in number, particularly in the bursting of the hose pipes.

The whole result is a delay to ONE train every other week day, of three to five minutes out of all the trains working on the North-Eastern system, not as great a delay as occurs every hour under the working of the block system. The returns of failures made by different companies for the half-year end 31st of December, 1883, vary a great deal, in one case being relatively more than six failures to one on the North-Eastern.

Efficiency of the Westinghouse Brake.—It must not be forgotten that the great object of the introduction of continuous brakes was not for the mere stopping of trains at stations, but that it might be used as an emergency brake to prevent accidents, and every day's experience shows more clearly the efficiency of this brake for this purpose and in diminishing the extent of damage when accidents do occur, and it is generally liked by all engine drivers who have used it. It has been found especially useful for working steep inclines, of which there are many on the North-Eastern system, in some the gradients being as steep as 1 in 37.

The incline on the main line to Whitby, five miles long, with curves of fifteen chains radius, and the gradient less than 1 in 50, was formerly worked with a train of carriages fitted with Fay's brake.

The Westinghouse brake now works the trains over this incline at a speed of from twenty to twenty-five miles an hour under complete control, the brake being applied throughout the running in descending the incline at a uniform pressure. The "leak off" brake would be useless on such an incline. There does not appear to be any one point in the principle and arrangement of the Westinghouse brake, as now in use, requiring alteration, and it entirely complies with all the requirements of the Board of Trade.

Automatic Brakes.—The automatic brakes of all kinds in England, December 30, 1883, exceed the number of non-automatic brakes by more than 50 per cent., and of the automatic brakes of all kinds in use more than 60 per cent. are Westinghouse brakes.

A comparison is given below of the number of Westinghouse brakes in use and actually ordered on the 30th of April, 1884, and on the 20th of July, 1880, the increase being remarkable.

Westinghouse Automatic Brakes, April 30, 1884.

	Engines.	Carriages and Wagons.
England	1,647	13,129
France	1,520	10,642
Continental railways and the colonies	1,219	5,571
	4,386	29,342
United States	7,167	33,723*
Total	11,553	63,065
Return, April 20, 1880	3,277	13,502
Increase in three years and nine months	8,276	49,563

According to the last Board of Trade Returns, there is not a single vacuum brake in use on any of the Scotch lines of railway.

The Westinghouse brake is becoming generally the adopted brake for the Continental railways.

* Includes 11,251 wagons.

THE PATENT LAW.

TO THE EDITOR OF ENGINEERING.

SIR,—Inventors and the public are indebted to you for the efforts you have made in your journal in foreshadowing the many and gross defects in the new British Patent Law put forward with Mr. Chamberlain's name attached.

After a long experience in patents, and on carefully considering this new law, my opinion is that poor inventors are being led by it into a pit of legal jobbery and ruin, but that it is well adapted to wealthy manufacturers. It will yet be held up as a mark of disgrace to the present Gladstone Government, a thing to be deplored, as it is far from the liberal and just sentiments of either a Gladstone or a Bright.

I would humbly and seriously caution inventors carefully to consider before they step into the Office of the new British Patent Law with anything good. Under advice one person has already gone to America and made sure of his patent there, and is now supported by men of means, against any who would attempt to ruin him by aid of the publicity and opposition allowed by the new law. Opposition in the United States of America and British 1852 law was only possible after a patent is granted, and then means heavy costs and damages for the opponents to pay in case they lose. But under this new law it simply means annihilation to the poor inventor who has something good, and loss to the nation. Talk about saving and retrenchment! Mr. Chamberlain seems to have been hoodwinked by officials and place-hunters, who have adroitly framed this law to get swarms of expensively-paid officials about the Patent Office. This new law may do for a Birmingham double-shanked button, but how about finely-balanced points of the practicability or non-practicability of a process, say, for instance, Young's nationally valuable invention of producing paraffin oil simply by distilling coal at a lower heat than had been generally done? Could all the technically educated lads in the nation, much less the Patent Office, settle a point like this? Never; and yet these points of a patent are to be

brushed off with special contempt by a lot of paper officials, and the money swept out of the poor inventors' pockets.

Now, Mr. Chamberlain promised in public that he would give the nation and the inventor a patent as cheap as in other countries, and quoted an American and British patent side by side, and said one British patent at 175*l.* covered nearly four United States patents at 7*l.* 10*s.* each. Now what has he done? The old British patent costs 175*l.* for fourteen years, and the new British patent 154*l.* for fourteen years, and now he allows only one modification, necessitating four British patents costing 616*l.* for fourteen years, whereas you can get four American patents for 30*l.* for seventeen years, and American patents are now worth double the value of a British patent.

By the new law an inventor has to give seven days' notice that he is going to pay his tax, instead of the Patent Office mailing him that it is due; this resembles a tenant giving notice to his landlord that he will pay his rent a week after, instead of the landlord giving notice to the tenant.

There is another grave consideration which Mr. Chamberlain seems to have swept to the winds, that is, the matter of international patents. At the Paris Exhibition a large body of men, valuable to their several nationalities, spent a large amount of time in preliminary steps to a united national understanding on the uniformity of international patent law. If this could be achieved it would be one hoop round the more harmonious working of nations than at present exists, but this new jerry built patent law casts all these things aside with contempt, for the more ambitious scramble to pass more laws in a given time than any other Parliament.

Birmingham, July 12, 1884. J. R.

REVERSING ECCENTRICS.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to the above subject, I beg to say that some months ago, when making a small engine of a novel construction, I was desirous that the reversing gear should also if possible be novel, and under this impression I tried the differential motion in this way. I fixed my eccentric and a mitre or bevel wheel on the some boss or tube, and placed them loose on the crankshaft, the starting or reversing lever with a boss was then slipped on the shaft having a loose bevel pinion or mitre running on a projecting end opposite, and gearing with the first, then another wheel same as the first was slipped on to gear with the pinion, but this was keyed to the shaft, and the arrangement was complete, and it answered the purpose; although it may be as old as the wedge, a model of which I made in wood. In 1858 and in 1859 I saw one in actual work on a locomotive at Monmouth.

Egham, July 14, 1884. GEO. HUNTER.

MILL ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—In your publication of last week, I observe a second letter from Mr. George Dixon, who, this time, I am glad to see has favoured me with his whereabouts.

Mr. Dixon in his recent letter refers his readers to two engine samples (I presume) of his own designing erected near home, signalling one at Fernhill, Bury, as having a separate boiler and working economically, adding, "the particulars of its performances, Mr. Ashworth can obtain on inquiry." What I solicited was a test from some practical and impartial party; however, Mr. Dixon seems to have inaugurated another course, by suggesting my applying on the premises, which is at variance with my request.

In Mr. Dixon's concluding sentence, he advances, "The best form of valve gear to adopt with any particular engine must depend upon the size, speed, and type of engine, and cannot be decided off-hand as your correspondent seems to think."

In conclusion, if Mr. Dixon has these particulars at hand it would probably be instructive, if he could (without much trouble to himself) place them in your columns, so that the less learned may have the opportunity of improving themselves.

Believe me, yours truly,

Astley Bridge, July 12, 1884. JOHN ASHWORTH.

SIR JOSEPH WHITWORTH'S NINE-INCH GUN.

TO THE EDITOR OF ENGINEERING.

SIR,—Allow me to correct an error which has crept into the P.S. of my article on "Modern Ordnance," which appeared in your issue of June 27. The gun there referred to is called a "9 in. *shot* gun." It ought to be "9 in. *steel* gun." It is not unimportant to correct this, because in the report which appeared in the *Standard* of December 27, 1883, it was distinctly stated that "the projectile was a *shot* and not a *shell*, and that a *shot* was necessary owing to the great thickness of the iron armour."

Without discussing this asserted necessity, I beg to inform your readers that the projectile in question was not a shot but a *steel shell*, and in addition to the 18 in. of iron, it passed through 37 in. of wet sand hard rammed in an iron cylinder, then 1½ in. of steel plate faced with 7 in. of oak and angle irons, and finally penetrated 16 ft. into the ground.

Fired with 10 deg. elevation it attained a range of 7870 yards. I believe no Woolwich or Elswick 9 in. gun has equalled this performance.

Yours truly,

JAS. A. LONGRIDGE.

15, Great George-street, Westminster, July 14, 1884.

HEALTH AND GASEOUS ILLUMINATION.

TO THE EDITOR OF ENGINEERING.

SIR,—May I supplement the communication from Mr. B. W. Thwaites, published in your last issue, regarding the efficiency of his ventilating gas burners, with the results of my experience with Siemens' regenerative burners. I have made many applications of them in this country, and with great success, both as regards ventilation and illumination. The Siemens burner is so well known that it is superfluous to give a description of it, but I may mention that in rooms where I have erected them, the atmosphere is now as fresh as in the open air, while formerly, with ordinary burners, it was insupportable.

Yours faithfully,

Rotterdam, July 14, 1884. M. SIEMONS, C.E.

SAND BLAST PROCESS.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to the failure of our application for a prolongation of the orignal sand blast patents, as reported in the *Times* of the 9th inst., we beg to state, for the information of your readers, that this decision has no reference to the process of sharpening files, which is protected by two later patents of 1877 and 1879.

Yours truly,

J. E. MATHEWSON, Secretary.

Tilghman's Patent Sand Blast Company, Limited,
Sheffield, July 14, 1884.

TRADE WITH RUSSIA.

TO THE EDITOR OF ENGINEERING.

SIR,—It may be of interest to some of your readers to learn the obstacles which are put in the way of foreign trade by the Russian authorities.

We recently had occasion to address a few circulars to the local authorities in the various Russian towns. They were stopped on the frontier, and have been returned to us. This appears to us to be carrying *protection* to a hitherto unheard of length.

We are, Sir, yours truly,

MERRYWEATHER AND SONS.

Greenwich-road, London, July 8, 1884.

INDIAN PUBLIC WORKS DEPARTMENT.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent "A Civilian Engineer, not a Cooper's Hill Man" in his letter in your issue of the 4th inst., complains that I have in my criticism of his previous letter, "deliberately contorted" some of his assertions. I annex his own words and my rendering of them side by side, and leave it to your readers to judge if his words have been contorted:

"Now when it came to reducing the Public Works Department on account of the low financial condition of the country it was never to be expected that this reduction would fall on commissioned officers of the army. To do so would have needed a special Act of Parliament."

"That it would have needed a special Act of Parliament to have removed military men from the Public Works Department in 1879."

It is mere bunkum to talk of Acts of Parliament when every one knows that the Crown can at any time remove any officer from the land or sea forces of the realm without assigning a reason.

I will not take up your space by arguing with "A Civilian, &c.," but will point out one more misstatement, which might be called a "deliberate" attempt to mislead your readers. He states in his last letter (using his own words to prevent mistakes) "there are still a number of staff corps men employed as civil engineers, who are far too good men to be sent back to ordinary regimental duty, they are men who owe their position to their own abilities *and work for ordinary civilian pay without any allowances*" (the italics are mine). Now, Sir, there are exactly twenty-four commissioned military officers, other than Royal Engineers, in the engineering branch of the Indian Public Works Department, whose distribution and rates of pay are as follows:

One lieutenant-colonel is a superintending engineer, Class II., and draws 1627 rupees a month, civil rate being 1350 rupees. One major is a superintending engineer, Class III., and draws 1340 rupees, the civil rate being 1100 rupees. Two lieutenant-colonels and nine majors are executive engineers, 1st grade, and draw 1427 rupees and 1240 rupees respectively, civil rate being 950 rupees. One lieutenant-colonel, two majors, and two captains, are executive engineers, 2nd grade, and draw 1327 rupees, 1140 rupees, and 874 rupees respectively, civil rate being 800 rupees. Two majors and three captains are executive engineers, 3rd grade, and draw 1040 rupees and 774 rupees respectively, civil rate being 650 rupees. One major is an executive engineer, 4th grade, and draws 940 rupees, civil rate being 550 rupees.

Six of the above officers are employed in the Military Works Department. I may add that the greater portion of the Royal Engineer officers who joined the department before 1871, draw their pay on the same principle of full military pay plus a staff allowance, instead of the consolidated pay plus military pay proper shown in the published classified lists, the former being much a higher rate as a rule.

CIVIL ENGINEER.

TRIAL TRIPS AND LAUNCHES.

THE s.s. Cutch went for her trial trip at Withernsea, at the mouth of the Humber on Tuesday, the 1st inst. She made several runs on the measured mile, and a mean speed of over 12 knots was obtained, the boiler pressure being 100 lb., vacuum 25½ in., revolutions 92 (mean). The Cutch is a handsome vessel built to the order of Jumabhoy Laljee, of Bombay, for the pilgrim trade. She is 180 ft. long, 23 ft. beam, and 11 ft. 6 in. deep, and is fitted with engines having cylinders 25 in. and 48 in. in diameter by 30 in. stroke. The construction of both hull and machinery has been supervised throughout by Messrs. Flannery and Baggallay.

On June 28 a large steamer was launched from Messrs. Hill's Albion Dockyard, Bristol. Her length is 211 ft., breadth 28 ft. 6 in., depth 22 ft. She has two iron decks, and all the deck fittings are of iron or teak. She was built for the Cardiff Steamship Company. Just before leaving the ways she was christened the Scheldt.

The new and very splendid 460-ton steam yacht, Lady Aline, lately built by Messrs. Ramage and Ferguson, Leith, for Mr. W. B. Walker, of the Royal Thames Yacht Club, had her official trial trip on the Firth of Forth on Thursday the 3rd inst. She measures 159 ft. by 23 ft. by 14 ft., is classed 100 A 1 at Lloyd's, and is fitted with engines of 75 horse-power nominal, having cylinders of 20 in. and 38 in. in diameter respectively, with 24 in. stroke, and a steel boiler to work up to 90 lb. pressure. With the engine working with steam at 85 lb. pressure and making 110 revolutions per minute, the vessel attained a speed of upwards of 11½ knots per hour.

On Friday, 9th July, Messrs. A. M'Millan and Son, Dumbarton, launched the Regina Margherita, a very fine iron screw steamer of 3700 tons gross register, measuring 415 ft. by 42 ft. by 29½ ft. There are four decks, two of which are iron-plated throughout under the wood sheathing, the other two being of teak. On two of the decks, extending from amidships aft, there will be accommodation for 178 passengers. The dining saloon, situated under the promenade deck and abaft the machinery space, measures 74 ft. by 24 ft. On the third and fourth decks iron berths are being fitted to accommodate 1200 emigrants. The electric light will be laid on throughout the whole of the vessel, and it is intended to have the side and masthead lamps lighted by the same means. Mr. David Rowan, Glasgow, is supplying the engines, which are expected to indicate about 5000 horse-power. The cylinders are three in number, one of 54 in. and two 76½ in. in diameter, with piston stroke of 60 in. Steam of 90 lb. working pressure will be supplied by four double-ended steel boilers fitted with twenty-four steel corrugated furnaces (Fox's patent). The vessel has been built to the order of Signors Rocco, Piaggio, and Figlio, of Genoa, and she is to be employed in their important trade between that port and the River Plate.

On the same day, Messrs. Murdoch and Murray, Port-Glasgow, launched an iron sailing schooner, of 247 tons gross register, and measuring 130 ft. by 31 ft. by 8 ft. She was named the Rosales, and is the second of three vessels in hand to the order of the Argentine Lloyd's for the coasting trade on the River Plate and Buenos Ayres.

With the same tide Messrs. A. Stephen and Sons, Linthouse, launched the Tampico, a steel three-masted schooner of about 300 tons, built to the order of Messrs. Jencquel Frères, of Bordeaux. She is intended for the Mexican trade.

An awning-decked steel paddle steamer, named the San Martin, and measuring 240 ft. by 34 ft., was launched on Thursday, July 10, by Messrs. Napier, Shanks, and Bell, Yoker, near Glasgow. She has been built to the order of the Lloyd's Argentine Company of South America, and has been specially designed for the navigation of the La Plata and its tributaries. The machinery is being supplied by Mr. David Rowan, Glasgow.

Messrs. Burrell and Son, Dumbarton, on the same day, launched the Bormida, an iron screw steamer of 3150 tons, gross register, and measuring 320 ft. by 37 ft. by 27 ft. 6 in. She has been built to the order of the Societa Italiana de Trasporti Marittimi Raggio, of Genoa, under the superintendence of Mr. Andrew M'Gechan, and is to be supplied with engines of 1300 horse-power by Messrs. Duncan, Stewart, and Co., Glasgow.

On the following day the screw steamer Kii Maru, a vessel of about 1400 tons gross register, built and engined by the London and Glasgow Shipbuilding and Engineering Company (Limited) to the order of the Kiodo Mayu Kaisha, of Tokio, Japan, had her official trial trip on the Clyde. Over a continuous run of six hours' duration a speed of 12 knots per hour was attained.

The screw steamer Washisti, built for the Bombay passenger service by Messrs Dobson and Charles, Grangemouth, and engined by Messrs. Dunsmuir and Jackson, Govan, had her official trial trip on the Firth of Forth on Friday, July 11. During a run of several hours a speed of 11½ knots was attained.

Messrs. W. Simons and Co., Renfrew, on the 12th inst. launched the Beta, a screw steamer of novel design, which has been built to the order of the Corporation of Liverpool, under the direction of Mr. Dunscombe, their engineer. She is intended for carrying 400 tons of the city refuse ten miles out to sea, where it is to be instantly deposited through the vessel's bottom in 60 fathoms of water. The bottom doors are simultaneously opened and closed by steam appliances, and the vessel is so fitted that water ballast, amounting to about 60 tons, takes the place of the discharged cargo. All the machinery and other fittings are very complete. The Beta is the second steamer of the same sort constructed by Messrs. Simons and Co. for the Liverpool Corporation, her predecessor being the Alpha.

The new paddle steamer, Duchess of Connaught, built to the order of the London and South-Western and the London, Brighton, and South Coast Railway Companies by Messrs. Aitkin and Mansel, Whiteinch, and engined by Messrs. John and James Thomson, Glasgow, had her official trial trip on Saturday, 12th July. Like her consort, the Duchess of Edinburgh, which left the Clyde two or three weeks ago, she is intended for the service between Portsmouth and the Isle of Wight. On the measured mile at Wemyss Bay she attained a speed of about 15 knots per hour. She was designed by Mr. W. Stroudley, superintendent engineer to the London and Brighton Railway Company.

On the same day, the screw steamer Sutsuma Maru, a vessel of 1850 tons gross register, and measuring 265 ft. by 35½ ft., built by Messrs. Napier, Shanks, and Bell, Yoker, for the Union Steam Navigation Company, of Tokio, Japan, and engined by Messrs. Jas. Howden and Co., Glasgow, had her official trial trip on the Clyde. The engines, which are of the direct-acting compound type, have cylinders of 36 in. and 68 in. in diameter, respectively, with piston stroke of 44 in. The mean speed attained was equal to 13¾ knots per hour, or about two knots in excess of the contract speed.

Messrs. Burrell and Son, Dumbarton, on the 12th inst., launched an iron screw steamer named the Wellington, of Launceston, and measuring 130 ft. by 21½ ft. by 8 ft. She has been built to the order of Messrs. John Terry and Co., London, and is being supplied with engines by Messrs. Ross and Duncan, Glasgow.

FOREIGN AND COLONIAL NOTES.

A Dull Railway Journey.—The Main Central Railway of Queensland is now open as far as Pine Hill, a distance of 252 miles from Rockhampton. There are two or three short stretches, such as, for instance, when crossing the Gogango or Drummond Range, where a traveller would find it worth while to look out of the carriage window, but for the rest of the journey there are dreary miles of dismal-looking brigalow scrub. The weary monotony is only broken by the train pulling up at a wayside station, which may be surrounded by half a dozen other buildings, or perhaps stands alone in its solitude.

Belgian Coal Exports.—The exports of coal from Belgium in the first four months of this year amounted to 1,481,685 tons, as compared with 1,277,898 tons in the corresponding period of 1883. France figured for 1,403,823 tons, the Low Countries for 36,062 tons, and other countries for 40,900 tons.

New Zealand Coal.—The Springfield Colliery Company has finished its boring operations with a diamond drill. The company has put down two bores at some distance from the present shaft, one to a depth of 300 ft., the other about 650 ft. The company passed through four workable seams of coal, varying from 3 ft. to 5½ ft. in thickness, the lowest at 545 ft. The coal, though not bituminous, is superior to that now worked. The Shag Point Company has arranged to test its ground with the same diamond drill.

Queensland Railways.—The South Brisbane Branch Railway, and a branch from Warwick to Killarney, were opened on June 2. The Brisbane Valley Branch was opened on June 16.

Victorian Railways.—The Victorian Minister of Railways is now receiving deputations, almost weekly, urging local claims for railway construction, in view of a Bill promised for next session. The most important of the deputations has been one urging the making of a line through South Gippsland to Port Alberton, which would, among other advantages, open up a direct reciprocal trade with Sydney. Mr. Gillies promised that the proposal should be thoroughly explained and all that could be urged for it laid before the Victorian Cabinet.

New Zealand Railway Progress.—The project of the construction of a railway to connect Auckland with the lake district of the north island of New Zealand, which has been subject to many disappointments, is now in a fair way of consummation. By Christmas the line will be constructed from Morrinsville, where it joins the Government railway, to the extremity of the Patetere block. From there to Ohinemutu the railway will be made under a Railways Construction Act, under which the Government gives blocks of land in aid. The agreements could not hitherto be completed, as the Government had not acquired the necessary lands from the natives. There is now, however, a fair prospect that this will be done within a short time, so that the construction of the line may be pushed on to Rotorua. The railway will open up an enormous extent of fertile country, and will greatly increase tourist traffic to the springs of Rotorua and the remarkable terraces of Rotomahana.

Defences of Auckland (N.Z.).—Major Cautley, who has been in Auckland for several weeks past inspecting the harbour and superintending surveys which have been made in connection with a plan for the defence of Auckland, has returned to Wellington. The surveys are not yet complete, but the results of the unfinished portion of the work will be forwarded to Major Cantley at Wellington. His Excellency the Governor, who has given the question of the defence of New Zealand much attention, is of opinion that the defensive works required for Auckland will not be costly, and has a high opinion of its natural advantages. It is likely that the chief defensive point for Auckland will be Mount Victoria. The survey operations have been devoted to ascertaining the distance from that point of the various channels by which vessels could enter the harbour.

Railways in New South Wales.—An extension of the Great Northern Railway of New South Wales, from Armidale to Glen Innes, has been completed and opened for traffic. Ten locomotives have arrived from England, for use on the New South Wales Government railways.

German Steam Navigation.—The German Federal Council has voted the payment of an annual subsidy of 200,000*l.* for the establishment and maintenance of an efficient line of mail steamers between Germany and Australian and Eastern ports. The North German Lloyd's Steamship Company intend to undertake the proposed subsidised service.

Steel in France.—The consumption of steel in various forms has enormously increased in France during the last ten years. In 1873 this consumption amounted to 133,000 tons; in 1882, it had grown to 486,000 tons.

The Corinth Canal.—The outlay of capital made upon the Isthmus of Corinth Canal works to the close of 1883 was 185,960*l.* The outlay made in 1883 was 92,105*l.* In this sum works properly so called figured for 57,254*l.*, and 15,622*l.* was expended upon the construction of two large dredging machines. The balance was represented by interest on shares and expenses of management in France and Greece. The available resources of the company, including its uncalled capital, were estimated at the commencement of 1884 at 970,453*l.* It is officially anticipated that the canal will be completed in the course of 1886.

Rails in France.—The consumption of rails in France in 1882 was 377,000 tons, of which 350,000 tons were steel rails. The corresponding consumption of rails in France in 1873 was 220,000 tons, of which 85,000 tons were steel rails.

The Province of Liége.—The production of coal in the province of Liége last year was 4,195,000 tons. The corresponding production in 1882 was 3,994,000 tons.

French Mechanical Industry.—The Fives Lille Company has obtained an order for some compressed air caissons intended to be used in connection with some submarine works about to be carried out in the Island of Réunion. The Denain and Anzin Forges Company is stated to have received an important order for iron sleepers.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF SPECIFICATIONS PUBLISHED DURING THE WEEK ENDING JULY 12, 1884.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

Copies of Specifications may be obtained at 38, Cursitor-street, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, and addressed to MR. H. READER LACK.

OF APPLICATIONS FOR PATENTS.

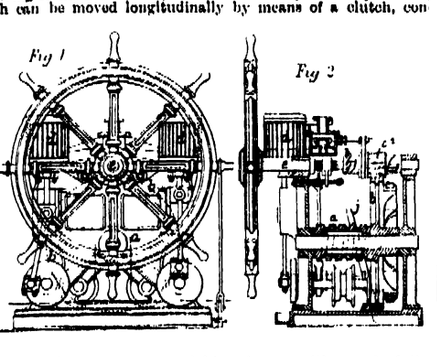
	1884	1883	1853
July 8th	56		10
9th	56	13	11
10th	47		
11th	48	11	
12th	30	20	
13th	..	32	8
14th			12
Total for week ..	274		57
Total from January 1st to July 14th (inclusive)	10,145	3483	1680

1882.

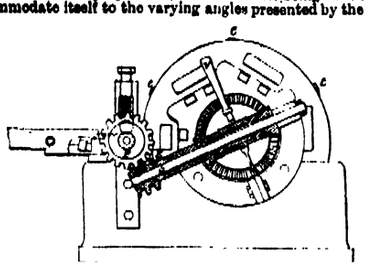
4179. Ventilators for Railway Carriages, &c. R. H. Brandon, Paris. (*Prince P. J. D'Aragon, Paris*) [6*d.* 18 *Figs.*]—The first and second claims are now disclaimed Thoy are: 1. The use of water, or other suitable liquid, introduced into a box or case for purifying and renewing the air inside railway carriages and other vehicles substantially as herein described, and shown by a pipe issuing into the box or case and dipping into the water or placed above the same. 2. The use of wheels with straight or helical wings placed so as to increase the volume of air to be introduced into the carriages as hereinbefore described. The third and only remaining claim is retained, and is for: The herein-before described ventilating apparatus made of any suitable shape material, or size according to the shape for which it is intended. (*Leave to amend granted.* June 20, 1884).

1883.

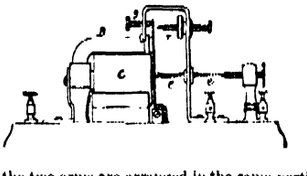
5389. Steering Gear for Ships: W. H. Harfield and G. T. Burden, Newcastle-upon-Tyne. [6*d.* 20 *Figs.*]—Referring to the illustration, on the shaft *s* is placed a pinion e^2, which can be moved longitudinally by means of a clutch, consisting of an incline *g* and a straight surface on either end of the pinion. The incline bear against corresponding inclines *h* on the shaft. If the steering wheel be turned in either direction the pinion will thus be shifted longitudinally in one or the other direction along the shaft, the extent of the sliding motion being limited by the straight surfaces. The pinion e^2 is coupled to the steam valves governing the admission to two cylinders *d*, and is always in gear with a spurwheel *b* on the shaft carrying the chain barrel *a*, the steam being thus shut off as soon as the rotation of the steering wheel is stopped. The engines can be disconnected by means of the lever *j*. A screw and nut or pin and slotted sleeve may be substituted for the sliding clutch arrangement. (November 15, 1883).



5401. Cutting Nails and Sprigs: G. Williamson, Leeds. [6*d.* 5 *Figs.*]—A series of cutters carried by a wheel or disc pass before a rest cutter in such manner that a nail or sprig is cut from a strip of metal fed thereto. Referring to the illustration, the striking cutters C are carried by a wheel or disc mounted in stationary bearings and rotate before a cutter carried in the rest E. The cutters may have their edges alternately parallel to the axis of the wheel or inclined thereto. The rest E is caused to vibrate horizontally by a cam, the rest cutter being thus caused to accommodate itself to the varying angles presented by the striking cutters. Two small boxes or rests are situated on either side of the rest and carry the head props which as the rest vibrates are alternately brought under the strip and support the head of the sprig. The feed rollers are operated by means of a worm O secured to the worm spindle Q, and gearing with a wormwheel P. The spindle Q is arranged on one side of the machine and is operated by the bevel gearing as shown. The illustration shows a frictional clutch arrangement operated by the lever V for reversing the feed arrangement for throwing the metal strip out of the machine when it has become too short. (November 15, 1883).



5535. Telegraphic Relays and Repeaters: J. H. Johnson, London. (*J. A. Maloney and G. W. Cooper, Washington, U.S.A.*) [6*d.* 5 *Figs.*]—The core of the electro-magnet of a telegraphic relay is formed of a bundle of soft iron wires, one arm being covered with a coil or helix, and being in close proximity to the other arm. An armature is arranged to vibrate in front of both poles. Referring to the illustration, one arm of the magnet is covered by the helix *c*, and the other arm B is left bare; the two arms are arranged in the same vertical plane. The helix *c* is so wound that the greatest number of coils is at the front, and they thence gradually decrease towards the neutral point. A soft iron lever vibrates before the poles, its axis of vibration being below the level of the lower pole, and at right angles to the vertical plane in which the arms lie. *e* is the ordinary adjustable retractile spring, and *f* and *g* the screws for adjusting the range of movement of the armature, the local circuit being closed through the screw *g*. (November 27, 1883).



5617. Driving Wheels of Road Locomotives: T. L. ·,veling, Rochester, Kent. [6*d.* 3 *Figs.*]—The wheels are constructed with inner rings or tyres suspended within an outer ring or tyre by coiled springs, which are always in compression, and with the outer ring or tyre formed with internal flanges to come on opposite sides of the inner ring or tyre to prevent side-way movement of the central portion of the wheel. This was fully illustrated and described in our issue of February 29, 1884. (December 3, 1883).

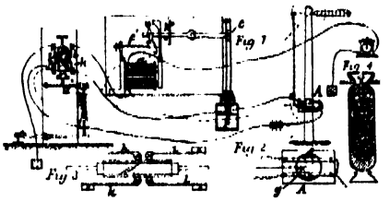
5619. Telegraph and Telephone Wires: A. J. Boult, London. (*G. Gray, Boston, U.S.A.*) [4*d.* 4 ··· The conductor is formed with a series of spiral grooves, care being taken to compress the solid central part leaving the ribs uncompressed, the object being to increase the conductivity of the central portion, and so lessen induction. (December 3, 1883).

5650. Wood-Paving: R. Hall and C. C. Woodcock, Leicester. [4*d.* 3 *Figs.*]—The wooden blocks are grooved, and the ends so shaped that when placed end to end they form a slot. The blocks are placed end to end, and strips or pieces of wood are placed between each row forming the counterpart of the slots in and between the blocks. The blocks thus laid form comparatively small wood squares with a considerable gap between them, the gaps being filled in with concrete or like material. (December 5, 1883).

5658. Sheet or other Piling for Making or Protecting Foundations below Water Level &c.: W. P. Thompson, Liverpool. (*F. Paponot, Paris*). [6*d.* 18 *Figs.*] —The sheet piling of U, T, or other suitable shape is joined together by flanges, the object being to present a shape capable of standing strong pressure in the vertical and also in the horizontal direction. (December 6, 1883).

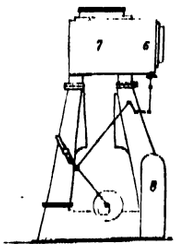
Berlin. (*Dreyse and Collenbusch, Sömmerda, Germany*). [6*d.* 6 *Figs.*]—Referring to the illustrations, the switch A (Fig. 1) is connected with the lever operating the ordinary optic signal board or disc, and consists of an insulating disc adapted to be operated by the signal lever and provided with the metallic segments *d g* (Fig. 2) serving respectively to connect two pairs of springs, one corresponding to "line blocked" and the other to "line clear." The commutator B (Fig. 1), shown in detail in Fig. 3, comprises four insulated metal springs *h*, *i*, *k*, *l*, provided with rollers pressed against four metals trips on an insulating prism resting with its low end on a lever *u* operated by the passing train. When the signal is set at line blocked, the current from the battery passes by the strip *d* of the commutator A, to the spring *k*, commutator B, spring *l*, magnet a^1, and through a galvanoscope to earth, the other pole of the battery being connected to earth through the springs *h i*. If a train now raises the lever and prism, the current passes across the diagonal strip of the commutator B, and the current through the electro-magnet a^1 is reversed; the spring f^1 then withdraws

the armature, disengaging the latch k^1, and permitting the weight o^1 to fall and ignite the cartridge p. The introduction of a new cartridge, and resetting of the apparatus, is effected by hand. When the signal is at line blocked, the current passes by the plate g of the commutator A through the magnet a^1 and to the other pole of the battery. The cartridge (Fig. 4) comprises a strong case and



contains at each end a wedge so that the cartridge can be bound or chocked outside the wedge. The wedge at the upper end is bored out in the centre for the purpose of receiving a pin which when struck by a bolt placed immediately above acts on the priming composition firmly secured to the lower end of the upper wedge. A cap closes the top of the cartridge. A similar arrangement for disengaging a weight for firing torpedoes and cartridges is illustrated. (December 7, 1883).

5669. Marine Engines: R. Wyllie, West Hartlepool. [6d. 5 *Figs.*]—In triple expansion engines the low-pressure cylinder is placed between the high-pressure and intermediate cylinders, and the exhaust, being led down the back column, enters the condenser at about the middle of its length. A single eccentric is used for each valve, the actions for reversing and for varying the cut-off being obtained by altering the oblique position of the

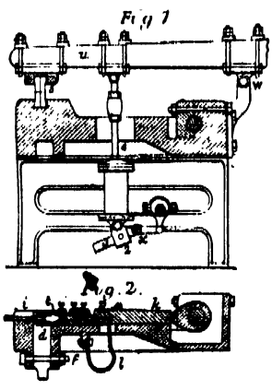


link or guide piece. The rod of the eccentric is arranged to act as a lever with a fulcrum reciprocating upon the guide piece. A stud fixed on the eccentric rod, and moving in an approximately elliptic path, has jointed to it a rod transmitting motion to the valve through a lever or rocking shaft. The illustration shows one cylinder 7 with its valve casing 6 arranged above the condenser 8. (December 7, 1883).

for Thrashing Machines:

bourn, Cambridge. [6d. 4 *Figs.*]—This relates to apparatus of the kind in which a set of yielding prongs or tines combined or alternated with a set of rigid prongs or tines are arranged above the distributing cylinder for the purpose of preventing the corn being fed in excessive quantities to the drum. The rigid tines are made adjustable, and the position and motion of the yielding tines can be varied. This relates also to a curved prong rising through the feed board and receiving rocking motion in the direction of the distributing cylinder for the purpose of assisting to convey the corn thereto; to a balanced guard for the drum feeder; to the bow form of the tines; and to providing the oscillating tines with cutters. (December 11, 1883).

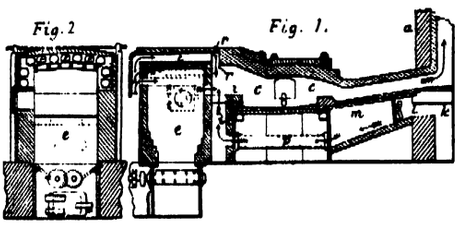
5719. Forging Bolts, Screws, &c.: W. Horsfall Turner. [6d. 5 *Figs.*]—The framework of the machine is similar to that described in Specification 2882 of 1869. Referring to Fig. 1, the gripping dies d are operated by a lever fulcrumed at f, and acted upon by a slide bar operated by a cam on the main shaft. The bar is received in a depression i in the main frame and the slide bar k forced forward to bring the plunger s against the bar. A pawl p on an outer sliding bar drawn towards the dies d by springs engages with a rack on the bar k. This outer slide bar carries a box-like tool t which surrounds the heated end portion of the bar which projects beyond the gripping dies, and at the part adjacent to the dies is recessed out so as to receive sufficient iron to form the square neck; the pawl p being released by a treadle before the plunger s can act, the plunger s forces up the hot iron



and fills the dies d and the tool t, thus forming enlargements for the head and neck. The treadle being now released the pawl p falls in gear with the rack, and the outer slide bar and the bar k are drawn back by the spring l. The gripping dies are at the same time released. The formed head is then placed between the dies 5 (Fig. 1) of a hammer to finish the square part of the neck, and is afterwards operated upon by a second pair of gripping dies for receiving a further pressure to finish the head. The hammer u is fulcrumed at w, and operated by a vibrating shaft x operated by an eccentric on the shaft. An air cushion cylinder is connected by a slide 2 with an arm 3 projecting from the shaft x, the position of the slide varying the length and weight of the blows. The slide used for finishing the head is operated by a cam or eccentric, and the tool or box is countersunk the shape of the head. The bolt may then be cut to length by shears operated by the slide that closes the gripping dies. (December 12, 1883).

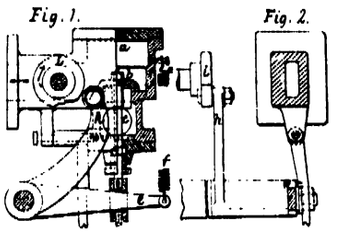
5720. Puddling and other Furnaces: J. Lones, C.

6 *Figs.*]—The air supplied to the furnace is highly heated by the waste heat of the furnace. Referring to the illustrations, a regenerative chamber k is constructed in the stack a, and at about the same level as the puddling chamber c. It communicates by a passage l with the air collecting regenerative flue m, and by means of horizontal pipes p, with the hollow bridge i, the air passing through the chambers k and m, and pipes p being heated thereby.



A portion of the heated air is delivered to the top of the puddling chamber immediately over the hollow bridge by means of vertical flues connecting the cross flue r and the hollow bridge i, the under side of the cross flue being provided with openings. Heated air may be supplied to the flue r by horizontal pipes in the crown of the gas producer e. During the boiling stage of the puddling process the dampers in the main flue and chamber m are closed, the chamber m being heated. In the first stage and the third or balling stage, these dampers are opened, the air passing through the chambers being heated. A steam boiler may be arranged within the chamber k. (December 12, 1883).

5721. Gas Motor Engines: E. C. Mills, Manchester. [6d. 10 *Figs.*]—This relates to gas engines of the type described in Specification 5052 of 1879. The illustrations show the arrangement for admitting the charge to the cylinder. The valve b is seated within the valve chamber a and is fixed to a spindle c passing through a gland and provided with a slotted head acted upon by a lever e which tends, by means of a spring f, to open the valve. The spring is prevented from opening the valve except at the desired time by means of a lever h bearing on the cam i. The lever e is locked by a lever connected to the governors, and the valve cannot be opened until the lever is released on the speed



becoming too slow. To stop the supply from the pump to the reservoir, a release valve, on which are seated a number of small valves which act as outlet valves from the pump and open against cushions, is employed. The charge is ignited by a platinum thimble projecting into the ignition chamber which communicates with the explosion chamber. A nozzle projecting into the thimble is fed with the compressed mixture, the admission being controlled by a cam on the main shaft. The charging mixture is stored in a chamber having a self-varying capacity, the gases from the pump having access to a chamber having on one side a flexible diaphragm which yields to admit the charge. The back of the diaphragm is exposed to gases at a pressure corresponding to that required in the explosion chamber when charged. (December 13, 1883).

5728. Seats and Sleeping Berths of Railway Carriages: J. and F. M. W. Livesey, London. [6d. 7 *Figs.*]—This relates to the arrangement and construction of the seats and sleeping berths of railway carriages in such a manner as to give improved accommodation, and to facilitate the operations required for adapting the compartments of a carriage for sitting or sleeping. (December 13, 1883).

5756. Production of Aluminium: G. B. de Overbeck, London. (*H. Nieuwerth, Hanover*). [2d.]—This consists in the decomposition by means of an electric current of a salt of this metal with an organic acid, or of a mixture of salts from which the above salts are generated, or of sodium or other chloride and sulphate of alumina. (December 15, 1883).

5766. Hansom and other Cabriolets: C. A. Floyd, Eastbourne. [6d. 1 *Fig.*]—The curved roof is constructed in two parts, the one fitted to slide concentrically within the other so that it can by a single movement be projected forward and downward to form a hood giving shelter to the passenger. (December 17, 1883

5808. Printing with Metal Engravings Direct from the Cylinders of Rotary Web Printing Machines: T. Shields, Bradford. [4d.]—The "riser" of the block is set up in the forme in its required position, and is surrounded by the descriptive matter in type. When the forme is completed an impression is taken therefrom in papier-maché and the metal plate is then cast from the papier-maché mould. The plate of the block is heated in a sand bath or superheated steam chest, wrapped in blanketing, and curved to the required shape in moulds and is secured by screws into the concave bed of the metal plate. (December 19, 1883).

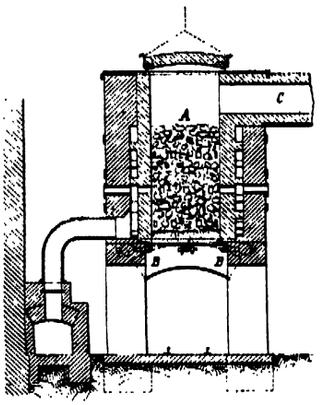
5815. Controlling the Supply of Steam, Gas, or other Fluids: F. A. Pocock and E. George, London, and R. Cook, Sheffield. [4d.]—The object is to apply electricity for automatically governing or controlling the supply of steam to the cylinders of engines, &c. In one arrangement for marine engines the level of water in a tube is caused to vary the resistance in the circuit of a solenoid acting on a lever controlling the valve as described in Pollard's Specification 1217 of 1867. As applied to engine driving electrical generators, the solenoid is arranged in the circuit of generator and controls the engine according to the resistance in the circuit. The solenoid is also arranged to close the circuit of a second generator by means of mercury cups when the first generator has reached the limit of its power. Other arrangements are described. (December 19, 1883).

5835. Compounds for Insulating, Protecting, &c.: A. Muirhead, London. [4d.]—Gutta-percha is dissolved out of raw gum by means of melted paraffine wax or other hydrocarbon. The mixture produced is then treated with hot water or steam to remove mechanical impurities, or with bi-sulphide of carbon. A small quantity of sulphur or finely-powdered silicated compound may be added to the paraffine wax. The gutta-percha obtained as above may be incorporated by hot mixing rollers with the elastic spongy mass obtained by mixing paraffine oil or other hydro-carbon with bisulphide of carbon and a vegetable oil, the compound produced being washed in paraffine oil, the excess of which is pressed out. (December 22, 1883).

5841. Desiccating Wood: C. D. Abel, (*J. A. Koch, Galveston, Texas, U.S.A., and W. Herre,* [2d.]—The timber is placed in a receptacle and surrounded with a hygroscopic substance, such as chloride of sodium, which may be mixed with antiseptic substances. (December 22, 1883).

5847. Recovering and Obtaining Tin from Tinned Metallic Surfaces: A. P. Price, London. [2d.]—The tinned surface is placed in a solution of a caustic alkali, and an electric current is passed through the bath, the surface forming an electrode. (December 22, 1883).

5886. Treating Zinc Ores: F. C. Glaser, Berlin. (*G. v. Kramsta'sche Erben and R. Wiester, Kattowitz, Prussia*). [6d. 2 *Figs.*]—The zinc ores are mixed with the necessary quantity of reducing material, arranged in a cupola-like shaft furnace and subjected to a temperature raised to a white glowing heat until the escape of zinc vapours ceases. The illustration shows the construction of the furnace, consisting of a shaft A closed by



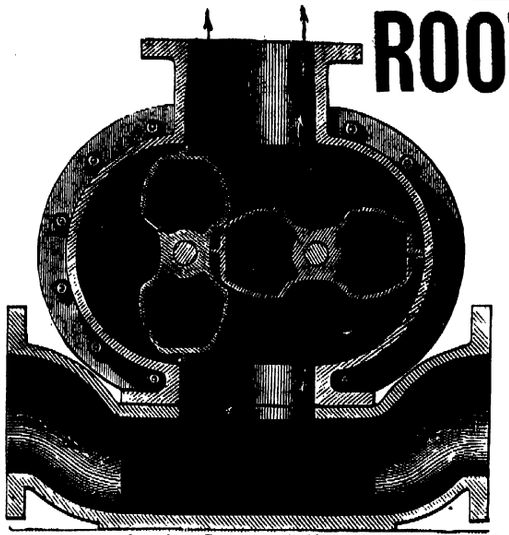
floor plates B provided with counterweights and turning on axes. A layer of sand protects the plates from injury. The zinc fumes are carried off through the passage C. Cold or heated air is introduced through nozzles or tuyeres in the side walls. The zinc oxide is collected in the usual manner in a chamber, the floor of which is provided with openings by which the oxide can be removed. (December 28, 1883).

5894 Vessels or Apparatus Exposed to Corrosive Action: J. Imray, London. (*H. Eyells, Berlin*). [2d.]—The vessels are constructed of a hard alloy of lead, such as type metal, having lead fused on the exposed surfaces. (December 28, 1883).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

THE PARKES MUSEUM.—At the annual meeting held July 9, Captain Douglas Galton in the chair, a letter was read from the Duke of Westminster, regretting his inability to attend the meeting, and a report was read by the Chairman of Council showing the valuable work that had been carried out by the museum during the past year. Twenty-one lectures have been arranged for by the Council and delivered in the museum by some of the best authorities on hygiene and sanitary science. These lectures have contained much valuable information, and have dealt with a majority of the subjects included in the scope of the museum in a most useful and interesting manner. The museum has been largely used by lecturers on public health, and other skilled teachers, for practical demonstrations to various classes of students, &c., who for this purpose have been admitted to the museum without entrance fee. In this way the special advantages offered by the museum have been utilised for the purpose of instructing a large number of students and others who, by the nature of their several callings, may be expected in various ways to exercise an important influence in the promotion of health, in connection with the construction of dwellings and otherwise; and the Council are glad to report that the facilities thus offered have been fully appreciated, both teachers and students having expressed a desire that further opportunities of the same sort might be afforded them. The members numbered 99 on June 30, 1883, just after the opening of the museum. They now number 260. During the year the museum has been visited by 6870 people. The lamented president, His Royal Highness Prince Leopold, Duke of Albany, in his inaugural address of May 26, 1883, said that the sole object of the museum was to disseminate, and to help others in disseminating, the laws of health. The sphere of work thus foreshadowed by the late Duke of Albany has, as will be evident to those who peruse this report, become an accomplished fact in every particular. The Council cannot believe that the very moderate amount of money which is necessary for the permanent establishment of the museum, will be withheld; or that the public will allow an establishment, the welfare of which the late Duke of Albany had so much at heart, to languish for want of funds. The utility of the museum has increased month by month. The museum has clearly met a great public want, and the Council would again strongly urge upon the members, and upon all who are interested in sanitation, to use their personal influence, so to increase the number of members and life members that the future of so valuable an institution may no longer be a matter of doubt.



ROOT'S PATENT ROTARY PUMP

HAS HIGH EFFICIENCY
and GREAT SIMPLICITY.
NO PUMP VALVES.

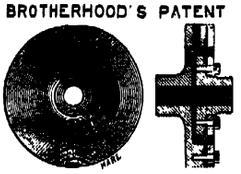
THE BEST PUMP FOR
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BROTHERHOOD'S PATENT

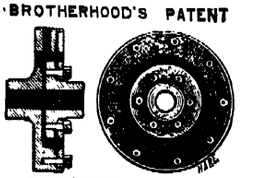


FLEXIBLE COUPLING

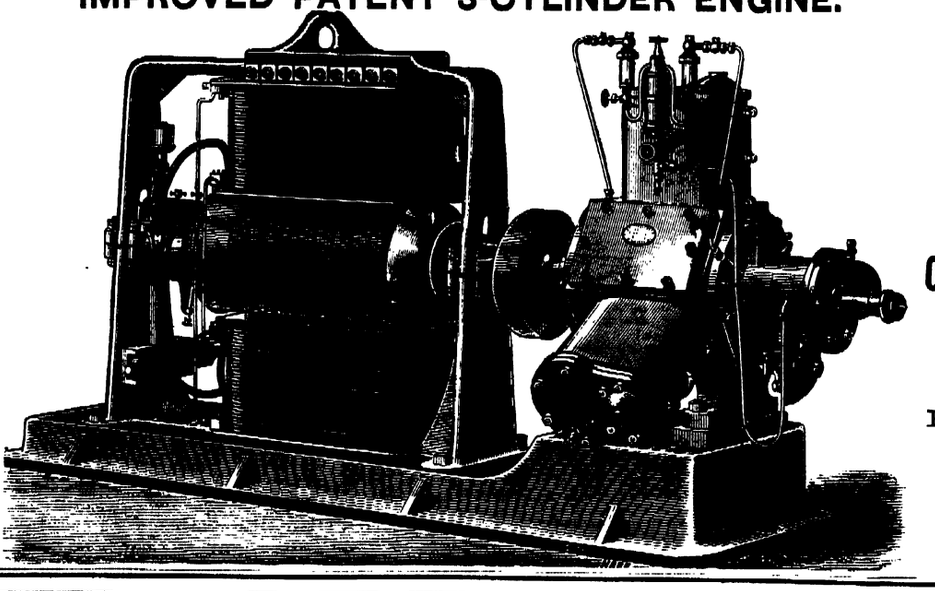
PETER BROTHERHOOD,

MECHANICAL ENGINEER,
BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.
IMPROVED PATENT 3-CYLINDER ENGINE.

BROTHERHOOD'S PATENT



FLEXIBLE COUPLING



THE MOST
ECONOMICAL
AND
EFFECTIVE
FOR
SHIP LIGHTING
As in General Use in the British, French, Italian, Danish, &c., &c., Navies.

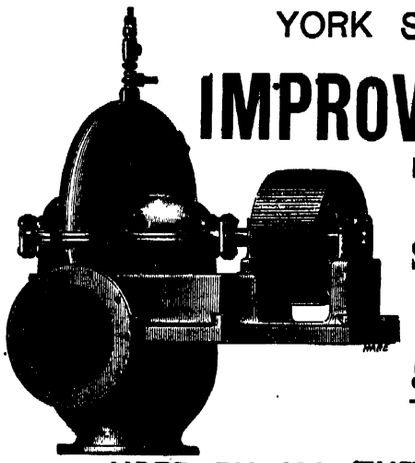
FOR DRIVING
FANS,
CENTRIFUGAL PUMPS,
AND OTHER
HIGH-SPEED
MACHINERY.

5204

W. H. ALLEN & CO.,

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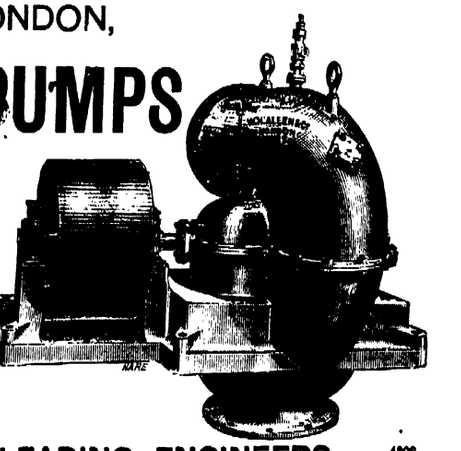


For all conditions of WATER RAISING
of the most economical form.

Small or Large Volumes up to 300 Tons per minute, in ONE PUMP.

500 of these PUMPS

Have within the last three years been made and erected in all parts of the world.



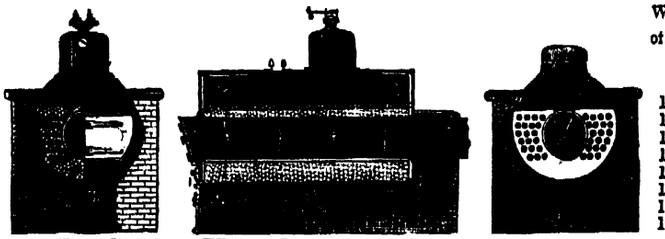
USED BY ALL THE PRINCIPAL GOVERNMENTS AND LEADING ENGINEERS. 4806

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
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9. Will Burn either Tan, Breese, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

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12ft.	,,	6ft. 0in.	,,	40	,,
13ft.	,,	6ft. 6in.	,,	50	,,
14ft.	,,	7ft. 0in.	,,	60	,,
15ft.	,,	7ft. 6in.	,,	70	,,
16ft.	,,	8ft. 0in.	,,	80	,,
17ft.	,,	8ft. 0in.	,,	90	,,
18ft.	,,	8ft. 0in.	,,	100	,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

DICK, KERR & CO., Engineers and Contractors, (Five Medals awarded, Calcutta International Exhibition, 1883-4.)



SOLE MANUFACTURERS OF

KERR'S PATENT

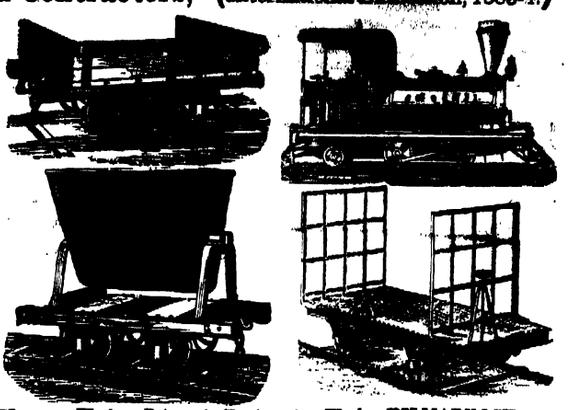
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SUITABLE FOR MINES AND PLANTATIONS.

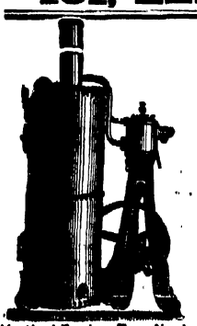
WAGONS & LOCOMOTIVES

FOR ALL CLASSES OF WORK.

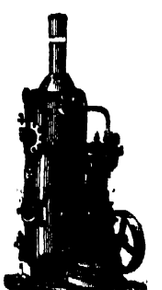
Catalogues and Prices on application. 5024



101, LEADENHALL ST., LONDON, E.C. Works: Britannia Engineering Works, KILMARNOCK.



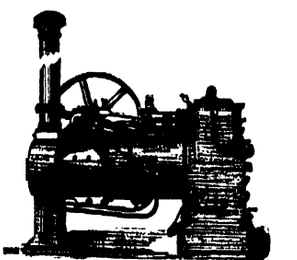
Vertical Engine, Type No. 1, with Vertical Cross Tube Boiler, 2½ to 12 HP.



Vertical Engine, Type No. 2, with Vertical Multitubular Boiler, 1 to 3 Horse Power.



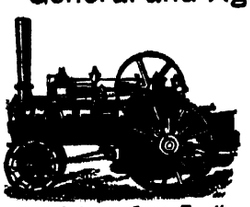
Traction Engine with Finishing Thrashing Machine and Straw Elevator on the Road.



Semi-Portable Steam Engine made with Single or Double Cylinders, 2½ to 35 Horse Power.

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General and Agricultural Engineers, Ironfounders, Boilermakers, &c.



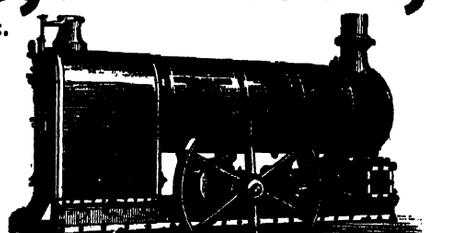
Improved Narrow Gauge Traction Engine, or Agricultural Locomotive.



Patent Portable Steam Engine, made with Single or Double Cylinders, and from 2½ to 35-HP.



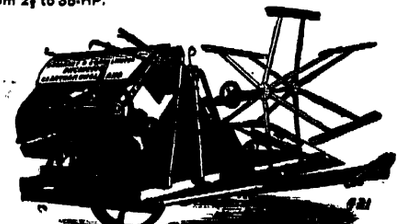
Patent Thrashing, Shaking, and Finishing Dressing Machine.



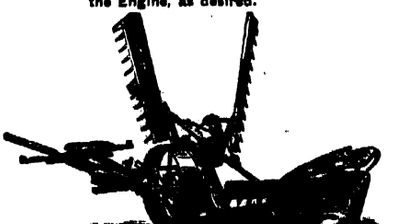
Patent Undertype Compound Engine, 6 to 50 Horse Power with Boiler above (as shewn) or separate from the Engine, as desired.



Fixed Horizontal Steam Engine, 10 to 60 Horse Power, with New Patent Automatic Expansion Gear.



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WIRE MACHINERY

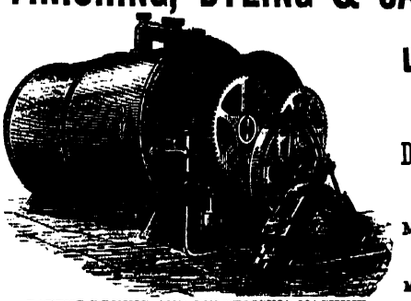
Consisting of Continuous and other Rolling Mills, Wire Pointing Machines, Wire Looms, Wire Testing Machines, Wire Blocks, &c.



COPPER TUBE ROUGHING LATHE.

BRASS & COPPER TUBE MILLS.

Wrought Iron TUBE MACHINERY.



PATENT DRYING AND PULVERISING MACHINE.

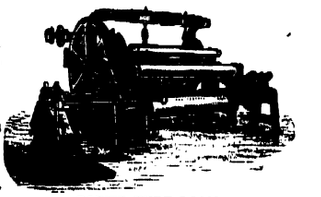
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Two and Four Yards wide.

"PATENT" Drying & Pulverising MACHINE

For Excrementitious Matter & other Materials and Compounds.

MACHINERY IN GENERAL.



POWER WIRE LOOM. 4859

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Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure.....110 lbs. Vacuum.....25 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,

D. HENDERSON, Chief Engineer, S.S. "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,

MR. J. BELL. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts, Admiralty, Whitehall, 20th June, 1884.

SIR,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core.....square. | Elastic core.....round.

To Mr. JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 20 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "bona" orders should be sent direct to the undermentioned depôts and not through agents or factors.

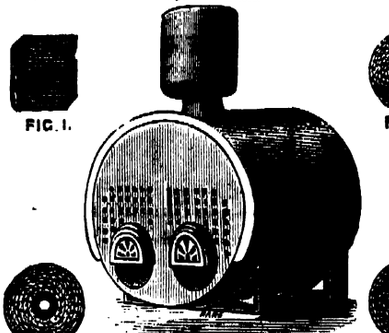


FIG. 1.

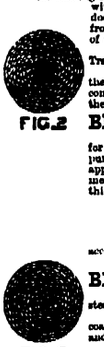


FIG. 2

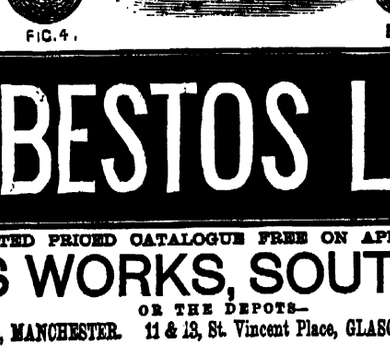


FIG. 4.



FIG. 3.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates.. .. .. .. 186 deg.

" Covering.. .. .. .. 94 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 26th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly,

"W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

Mr. JOHN BELL, Southwark, S.E. Gunnislake, Tavistock, 8th April, 1884.

SIR,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be beat by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ¼ in. to 3 in. wide, and any thickness from 1-16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at any price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and ¼ millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts, Admiralty, Whitehall, S.W., 17th May, 1884.

SIR,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,

MR. JOHN BELL. Director of Navy Contracts.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REGD.

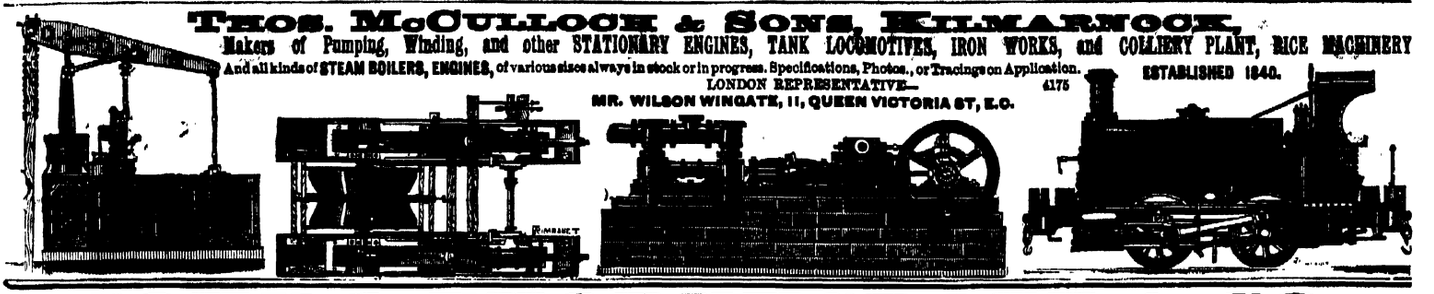
ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

4942

OR THE DEPOTS—

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.



THOS. McCULLOCH & SONS, KILMARNOCK,

Makers of Pumping, Winding, and other STATIONARY ENGINES, TANK LOCOMOTIVES, IRON WORKS, and COLLIERY PLANT, RICE MACHINERY

And all kinds of STEAM BOILERS, ENGINES, of various sizes always in stock or in progress. Specifications, Photos., or Tracings on Application. 4175

LONDON REPRESENTATIVE—
MR. WILSON WINGATE, 11, QUEEN VICTORIA ST, E.C.

ESTABLISHED 1840.

JOHN I. THORNYCROFT & CO.,

STEAM YACHT AND LAUNCH BUILDERS,

CHURCH WHARF, CHISWICK, LONDON, W.

YACHTS AND LAUNCHES FOR SEA OR RIVER SERVICE, from 25 to 100 feet in length, and Speeds from 10 to 25 Miles per Hour.

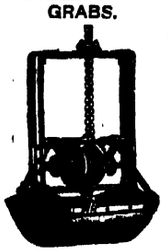
Thornycroft's Patent Screw Propellers made for all sizes of Vessels. Efficiency superior to any hitherto brought out.

TORPEDO BOAT FOR THE DANISH GOVERNMENT.—Speed 20 knots on a run of three hours, carrying 12½ tons.



5809

SINGLE CHAIN GRABS.



SUPPLIED TO ORDER WHEN PREFERRED.

WORKS:
Holderness Foundry, HULL.

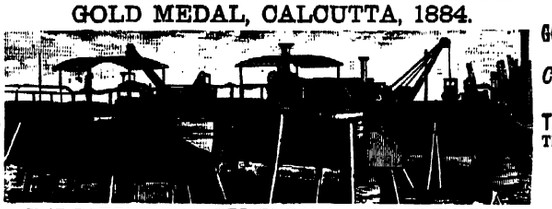
PRIESTMAN BROTHERS.

CONTRACTORS FOR BARGES TO H.M. GOVERNMENT & THE INDIAN BOARD.

GOLD MEDAL, CALCUTTA, 1884.

AWARDS
DIPLOMA of HONOUR AMSTERDAM,
Paris, Melbourne, Adelaide.

Contractors for Dredgers to
THE ENGLISH GOVERNMENT
THE CROWN AGENTS FOR THE COLONIES
The German Government
" French Government
" Italian Government
" Cape Government
" Danish Government
" Chinese Government
" Chilian Government



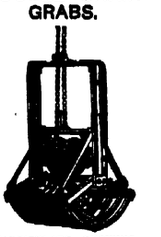
THE PATENT DREDGER EXCAVATOR & ELEVATOR.

LONDON OFFICE:
52, QUEEN VICTORIA STREET.

AWARDS
GOLD MEDAL FISHERIES LONDON,
Sydney, New Zealand, Tynemouth.

Contractors for Dredgers to
THE INDIAN BOARD
THE MERSEY DOCK & HARBOUR BOARD
The South Australian Government
" New Zealand Government
" Spanish Government
" Victorian Government
" New South Wales Government
" Dutch Government
" Queensland Government

DOUBLE CHAIN GRABS.

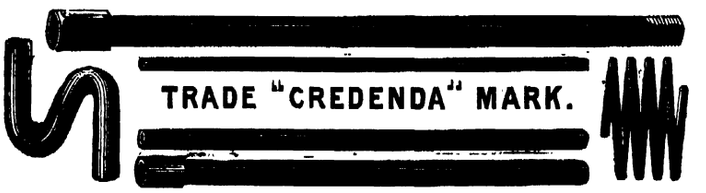


PARTICULARS, SHOWING GREAT ADVANTAGES, ON APPLICATION. 5057

—:- PATENT -:—

COLD-DRAWN SEAMLESS

THE CREDENDA COLD-DRAWN SEAMLESS STEEL TUBE COMPANY, BIRMINGHAM.



BIRMINGHAM WORKS & OFFICES:
LEDSAM STREET,
MONUMENT LANE STATION.

LONDON OFFICE:
4, WATER LANE,
GT. TOWER STREET, E.C.

4990

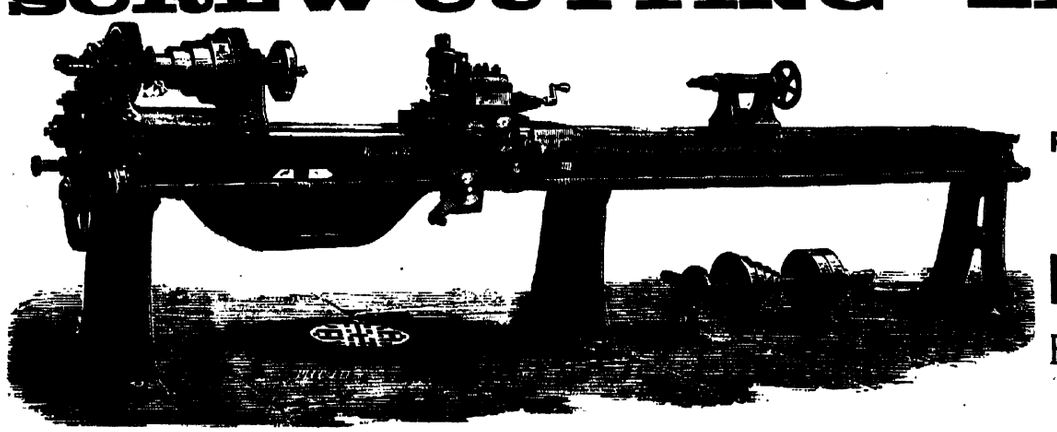
FOR BOILERS AND STAYS,
HYDRAULIC PRESSES,
AIR RESERVOIRS,

STEEL TUBES.

BORING RODS, COUPLINGS,
BUSHES, SPINDLES, COLLARS,
BICYCLES & OTHER USES.

SCREW-CUTTING LATHES,

6 in. to 24 in. Centres.



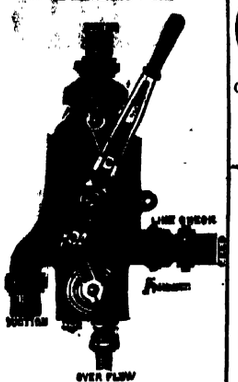
PRICED CATALOGUES ON APPLICATION.

LOUDON BROTHERS,

Bothwell St., GLASGOW. } AND { U. Thames St., LONDON.

4729

CLASS A.



LOCO. PATTERN, SINGLE LEVER.

THE HANCOCK

INSPIRATOR

ONLY GOLD MEDAL Paris, 1878. FIRST AWARD, Sydney, 1879.

60,000 IN USE.

THE DONKEY PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND REliably.

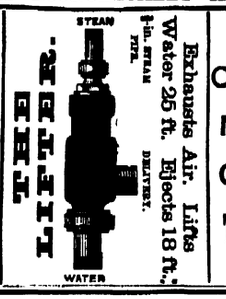
No Adjustment.

Draws Water at 140°.

All Sizes lift water 25 ft.

Delivers to Boiler up to 212°.

ESTIMATES FOR FIXING COMPLETE with Guarantee to start in good working order, and all information on application to—



Feeds through Heaters.

Can be used as a Pump only.

No Valves or Wearing Parts.

Can be examined instantly.

THE HANCOCK INSPIRATOR CO., 108, Upper Thames St., London, E.C.

CLASS C.



Cheap Class of Machine.

STATIONARY PATTERN.

5115

Henry Bessemer and Co., Limited,

Manufacturers of Cast Steel,

SHEFFIELD.

FORGINGS

In Steel of any size.—Quotations given either for uses or finished complete.

STEEL CASTINGS

Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0.30 per cent. carbon, and to bear a tensile strain of 34 tons to the square inch.

TYRES AND AXLES.



SOFT CAST STEEL

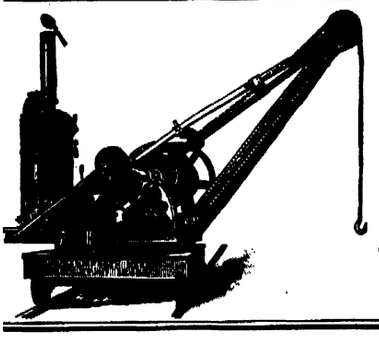
In bars and rods, for general use in Engineering Works.

BLOOMS, BILLETS, & SLABS

Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,

Of superior quality. 5137



EXORS. OF WM. BALMFORTH,

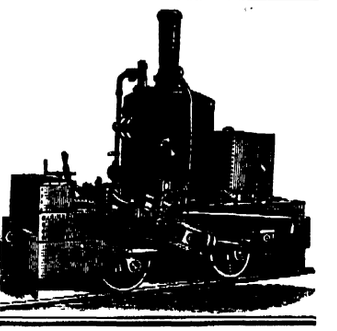
RODLEY, NEAR LEEDS,

MANUFACTURERS OF

LOCO. STEAM CRANES, CONTRACTORS' LOCOS., TRAVELLERS, HOISTS, AND ALL KINDS OF LIFTING MACHINERY.

4097

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes.





THE COALBROOKDALE COMPANY, LIMITED

MAKERS OF

STEAM ENGINES,

HORIZONTAL AND VERTICAL, AND

OTHER MACHINERY.

MAKERS OF

STEAM PUMPS.

PARKER & WESTON'S PATENT

PUMPING ENGINES for Mines, Sewage and Water Works,

BOILER FEEDERS and SLIP PUMPS.

AGENCIES { LIVERPOOL - 19, SWEETING STREET. MANCHESTER, 29, PRINCESS STREET. 5130

WORKS & OFFICES: COALBROOKDALE, SHROPSHIRE.

THE MERSEY FORGE, LIMITED



CRANK SHAFT FOR No. 206.
Forged Weight, 24 tons 11 cwt. ; Finished Weight, 15 tons 8 cwt. 2 lbs.

LIVERPOOL,

MANUFACTURERS OF

Marine and other Crank Shafts,

STERN AND RUDDER FRAMES,

FORGINGS OF ALL KINDS

IN IRON AND STEEL.

WORKS: GRAFTON STREET.

Town Office : 5, Harrington Street. 4033

BRICKMAKING MACHINERY.

THOMAS C. FAWCETT, OLD VICTORIA FOUNDRY, MANOR ROAD, & BURMANTOFTS FOUNDRY, CROMWELL ST., LEEDS,



Maker of Patent Semi-dry & Plastic Brickmaking Machines,

Steam Presses, Pugmills, Solid and Perforated Bottomed Clay Pans, Clay Rollers, Clay Mixers, and Sieves,

BOILERS, ENGINES, MARINE AND STATIONARY

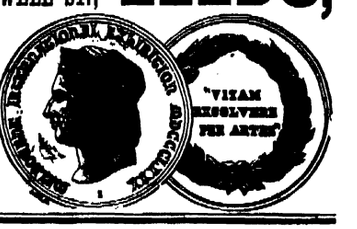
SHAFTING AND MILLWRIGHT WORK,

DRUMS AND PULLEYS OF ALL SIZES,

SPUR, BEVIL, MITRE,

And other Wheels by Patent Moulding Machine.

ILLUSTRATED CATALOGUES FREE. 4033



POINTS & CROSSINGS

FROM EVERY SECTION OF RAIL.

Portable Railways and General Railway Plant.

HARTLEY & ARNOUX BROS.

STOKE-ON-TRENT.

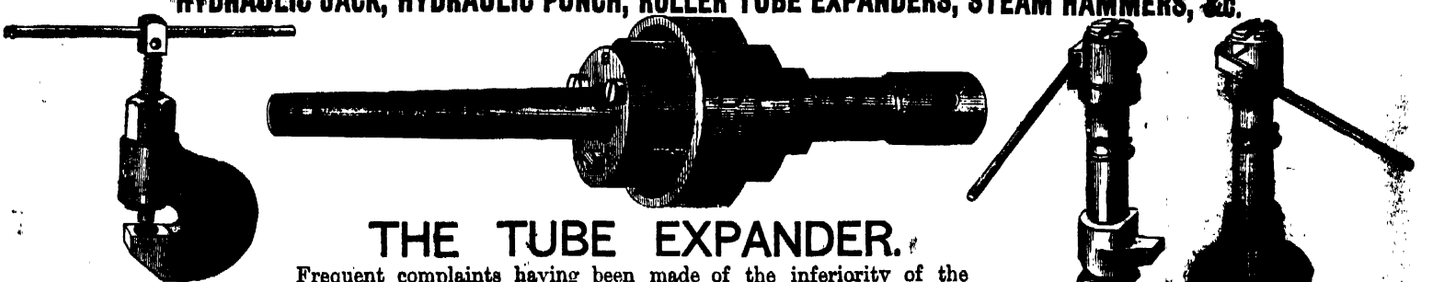
4033

RICHARD DUDGEON,

114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF THE

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, STEAM HAMMERS, &c.



THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "**DUDGEON'S ROLLER TUBE EXPANDERS**" R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only bear the stamp for the American Patent (still in force), as under :—

R. DUDGEON, N.Y.
PATD. FEB. 5TH 1867.

On the Guide-ring of each Tool,

WITHOUT WHICH NONE ARE GENUINE.

These can always be obtained at R. Dudgeon's English Depôt, 114, Fenchurch Street. If more convenient to get them through Merchants care should be taken to specify "*Dudgeon's own make*" on the *Order*, but as R. Dudgeon observes with regret that *imitations* bearing his *stamp counterfeited* are being sold as his, he would respectfully recommend both Merchants and Users requiring Expanders of his make to apply direct. In urging this he merely seeks to secure the identity of what is made by himself, by which he is content to stand or fall.

R. DUDGEON takes this opportunity of returning thanks for past favors, either by orders or recommendation, and it being his intention strictly to maintain the Quality and Workmanship so essential for perfect Results in the Expander, begs to solicit a continuance of the same.

CATALOGUES AND PRICE LISTS ON APPLICATION TO R. DUDGEON, 114, FENCHURCH STREET, LONDON, E.C.

13 PRIZE MEDALS.] **THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED,** [13 PRIZE MEDALS.

4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1884, 1



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 4794

100 TO 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

New Patent TWIN-ENGINES, Impulse every Revolution.

THE "OTTO." GOLD MEDAL at Crystal Palace, & HIGHEST AWARD at Paris Electrical Exhibitions.



New Patent SELF-STARTER. Best, Safest, and Simplest made, may now be applied.

CROSSLEY'S NEW VERTICAL ENGINE, Requiring little floor space.

½ TO 100 HP. IND. MANY IMPROVEMENTS. OVER 14,000 IN USE.

LONDON: 24, POULTRY, E.C. GAS ENGINE GLASGOW: 58, UNION STREET 4775

CHEAP GAS FOR MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·3 lb. per ind. H. P. per hour.

The DOWSON ECONOMIC GAS COMPANY, Ltd., 3, Gt. Queen St., Westminster, S.W. 4883

PULLEYS, FOR TRANSMISSION OF POWER BY BELTS, CAST OF SELECTED IRON, FROM CAREFULLY DESIGNED PATTERNS, EITHER WHOLE, IN HALVES PLAIN OR SHROUDED TURNED, BORED BALANCED & FINISHED

TURNED SHAFTING.

SHAFT-FITTINGS, PATENT ADJUSTABLE, SELF-ADJUSTING, SELF-LUBRICATING, & OTHER BEARINGS PEDESTALS, HANGERS, WALL-BOXES, BRACKETS

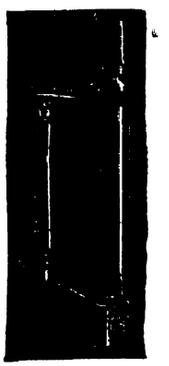
TAYLOR & CHALLEN

ENGINEERS + MACHINISTS + FOUNDERS + SMITHS



COUPLINGS DERWENT FOUNDRY + BIRMINGHAM + CONSTITUTION HILL COLLARS

SOLE MAKERS OF WITHINSHAW'S NEW PATENT **FEED-WATER HEATER** AND **Purifier.**



Great Saving in **BOILERS** AND **COAL.**

MAKERS OF Winding, Forge Mill & Pumping Engines.

Price Lists on application.

This Advertisement appears once a Month. 6181



Anglo-American Oil Press for 16 12 in. Cakes.

ROSE, DOWNS & THOMPSON,

OLD FOUNDRY, HULL.

Established 1777.

Makers of the ANGLO-AMERICAN

OIL-MILL MACHINERY,

For crushing Linseed, Cotton Seed, Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent. in labour and power, and 2 to 4 per cent. in Oil. (See *Engineer*, May 6, 1881, and Nov. 23, 1883.)

PRESSES FOR ALL KINDS of OIL SEEDS.

Elevators and Creepers for Grain Warehouses, Accumulators and Hydraulic Dock Machinery, Stationary Engines, Boilers, Trawling Engines, and Capstans for Fishing Boats.

SOLE MAKERS OF

HODGE'S & THOMPSON'S PATENT

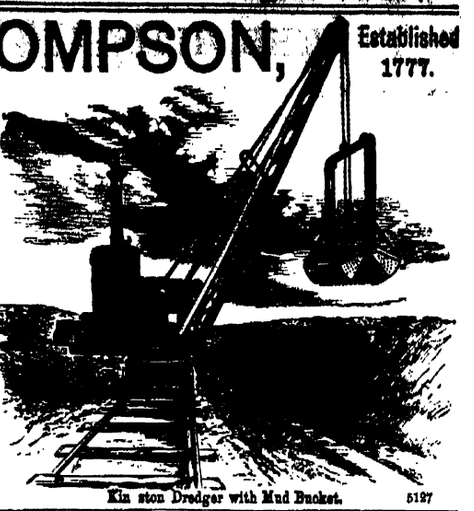
KINGSTON EXCAVATOR.

Grabs and Buckets for Mud, Sand, Shingle, Silt, Clay, Rock, Débris, Boulders, Coke, Ore, &c., supplied on Pontoons for Harbour and Dock Dredging.

NO HEAVY BALANCE WEIGHTS.

NO SPECIAL CHAINS.

PERFECT AND RAPID WORK.



Kingston Dredger with Mud Bucket.

London Office (Dredging Machinery): 36, KING WILLIAM STREET, E.C. 5127

Awarded a First-Class CERTIFICATE OF MERIT at Manchester, and a First-Class DIPLOMA OF MERIT at Tynemouth.

PATENT DIAGONAL ROCKING FIRE-BARS

—(Can be Fixed in a Few Hours.)— ARE ECONOMICAL, DURABLE, SMOKE-CONSUMING. —(No Attachment to Boiler necessary.)—

Numerous Official Tests show an average economy of over 10 per cent. *These Patent Bars last Years where ordinary Bars last only Months.*

Recently supplied to the order of the eminent builders of the engines and boilers of the most powerful Ironclad afloat for use in the whole of the furnaces, to work with "Forced Draught," MAKING THE THIRD Ironclad fitted. Used by the most eminent Engine and Boilermakers (Marine and Land), Railways, Home and Foreign Governments, &c. 5119

Agents having connections among Steam Users Required in Principal Towns. — Particulars of the Manager at the Offices, 259, Gresham House, E.C.

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The Best and Most Durable Metal for Bearings and Bushes of every Description: Hydraulic Pumps, Pinions, Valves, &c. &c Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c.

SOLE MANUFACTURERS UNDER SEVERAL PATENTS— 1475

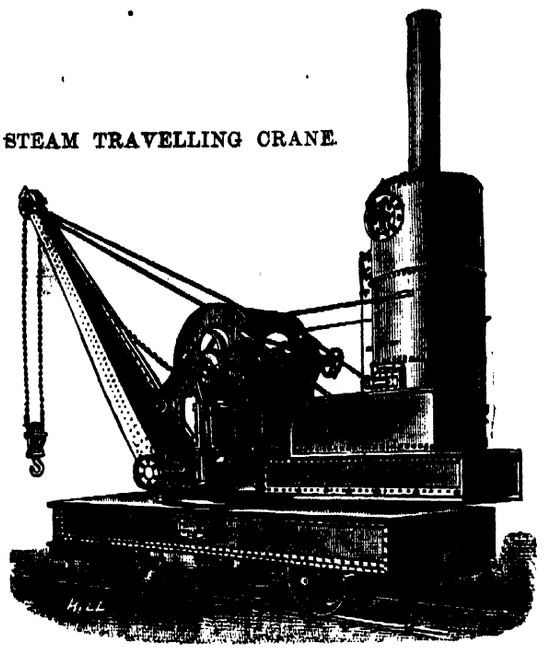
The PHOSPHOR BRONZE COMPANY, Limited, Sumner & Emerson Streets, Southwark, London, S.E.

COWANS, SHELDON & CO., LTD.,

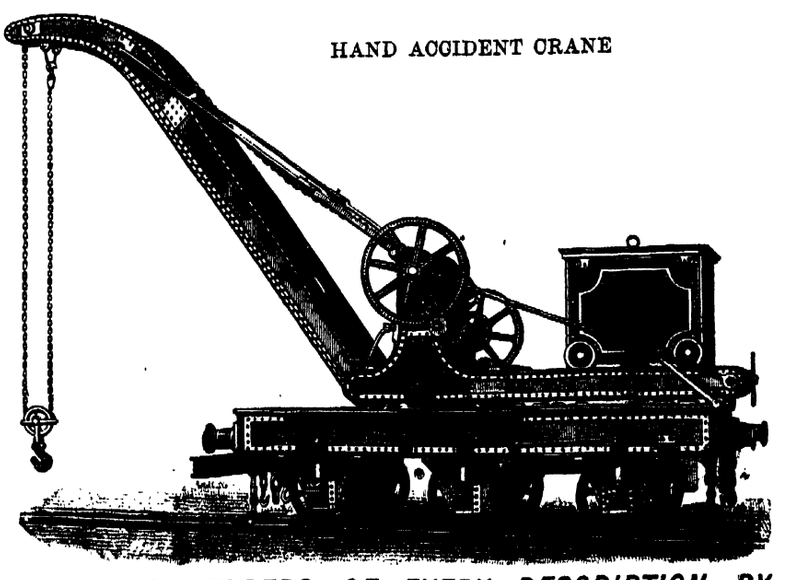
ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.

STEAM TRAVELLING CRANE.



HAND ACCIDENT CRANE



TURNTABLES, CRANES, MASTING SHEERS, AND TRAVERSERS OF EVERY DESCRIPTION BY STEAM, HAND, OR HYDRAULIC POWER. 5007

CHARLES CHURCHILL & CO.,

AMERICAN MACHINERY AND TOOL IMPORTERS,

21, CROSS STREET, FINSBURY, LONDON, E.C.

ESTABLISHED IN 1862.



C. C. & Co. have just removed to much larger premises with ample show rooms and warehouse, and will carry a greatly increased stock of all the best American tools.

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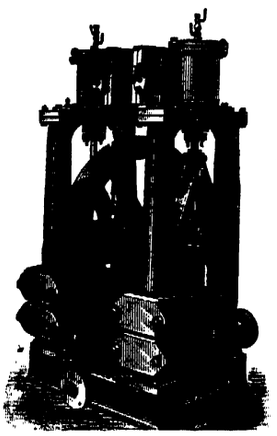
THE ONLY GENUINE AMERICAN MORSE TWIST DRILL,

WITH CENTRE GRINDING LINE, STOCKS AND DIES, REAMERS AND MILLING CUTTERS,

Stephens' Patent Vices, Horton Chucks, Cushman Chucks, Westcott Chucks, Sweetland Chucks, Stanley Rule & Level Co.'s Planes, &c., &c., Gould's Manufacturing Co.'s Pumps, and a great variety of New American Tools.

New Catalogue for 1883 just issued, 215 pages Quarto, sent on receipt of One Shilling in Stamps.

(THE LARGEST CATALOGUE OF AMERICAN TOOLS EVER PUBLISHED IN GREAT BRITAIN.) 4124



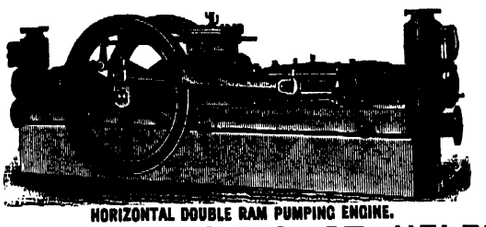
DOUBLE RAM PILLAR PUMPING ENGINE.

W. NEILL & SON,

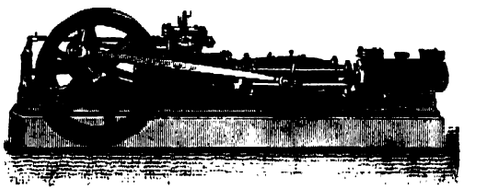
ENGINEERS. IRON & BRASS FOUNDERS, BOILER MAKERS. &c.

MANUFACTURERS OF

PUMPING ENGINES, BLOWING ENGINES, STEAM ENGINES, AIR COMPRESSORS, and VACUUM PUMPS.



HORIZONTAL DOUBLE RAM PUMPING ENGINE.



BLOWING ENGINE AND AIR COMPRESSOR. 4253

BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.

S. OWENS & CO.

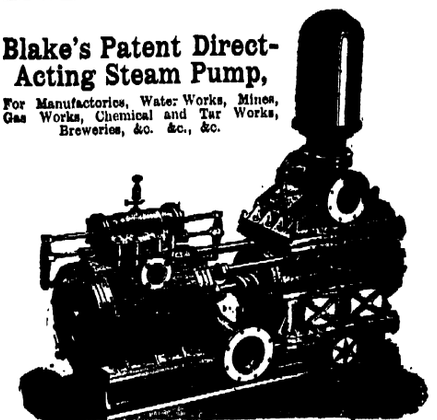
HYDRAULIC AND GENERAL ENGINEERS, WHITEFRIARS STREET, LONDON,

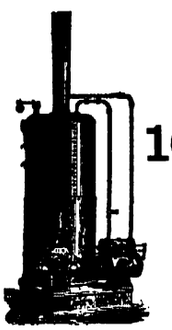
SOLE LICENSEES AND MANUFACTURERS FOR GREAT BRITAIN OF

BLAKE'S Patent DIRECT-ACTING STEAM PUMP.

Blake's Patent Direct-Acting Steam Pump,

For Manufactories, Water Works, Mines, Gas Works, Chemical and Tar Works, Breweries, &c. &c., &c.

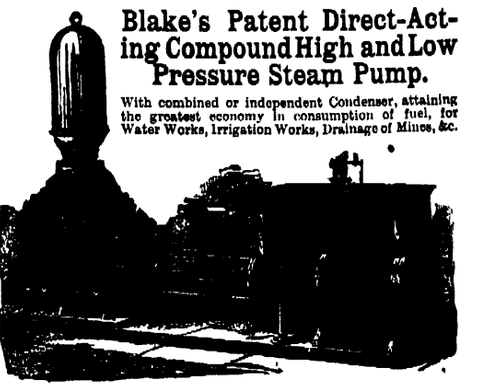


More than  16,000 in Use.

Blake's Patent Direct-Acting Steam Pump and Vertical Boiler Combined.

Blake's Patent Direct-Acting Compound High and Low Pressure Steam Pump.

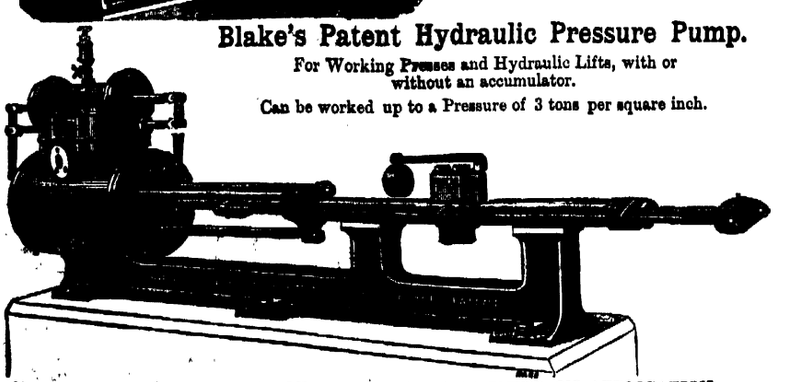
With combined or independent Condenser, attaining the greatest economy in consumption of fuel, for Water Works, Irrigation Works, Drainage of Mines, &c.



Blake's Patent Hydraulic Pressure Pump.

For Working Presses and Hydraulic Lifts, with or without an accumulator.

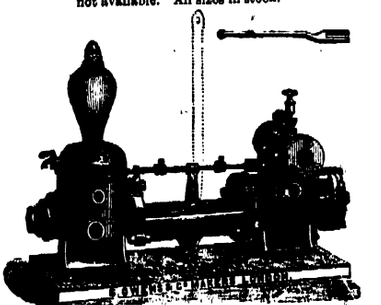
Can be worked up to a Pressure of 3 tons per square inch.



SPECIAL DESIGNS AND ESTIMATES FURNISHED ON APPLICATION.

Blake's Patent Boiler Feeder.

Fitted with hand power lever, for use when steam is not available. All sizes in stock.



DESCRIPTIVE PAMPHLET AND PRICE LIST FREE. 8008

The Edison and Swan United Electric Light Company,
LIMITED.

Contractors to the Admiralty, H.M. Office of Works, Houses of Parliament, War Office, Science and Art Department, South Kensington, &c.; to the principal Shipping Companies, and Criterion Theatre, Holborn Restaurant, Gatti's Restaurant, &c., &c.

EDISON & SWAN INCANDESCENT LAMPS from 2½ to 100 C.P.

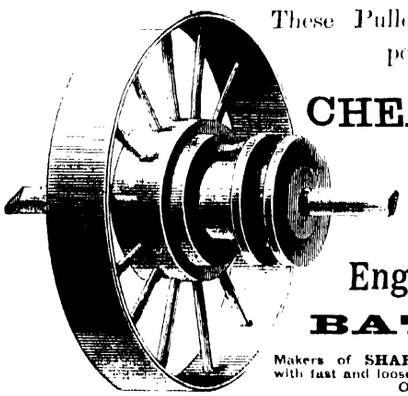
ELECTRIC METERS, SWITCHES, ELECTROLIERS, &c.

DYNAMOS: The Company are prepared to Supply the NEW and IMPROVED Type of EDISON Dynamos.

PRICES AND PARTICULARS MAY BE HAD UPON APPLICATION TO 4034

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TURNED WROUGHT IRON PULLEYS.



These Pulleys are **TURNED IN A LATHE,** and not polished on a Grindstone like those generally sold.

CHEAP, STRONG, AND TRUE.

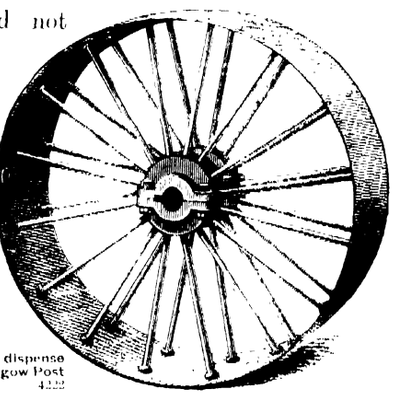
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Engineers, Ironfounders & Millwrights,

BATLEY, YORKSHIRE,

Makers of **SHAFTING** and **FRICTION PULLEYS** for Electric Lighting Machinery, which dispense with fast and loose Pulleys: one Pulley answers for both. In use at L. & S.W. Railway, Nine Elms; Glasgow Post Office; King's Cross Station; and all principal Factories home and abroad. 4222

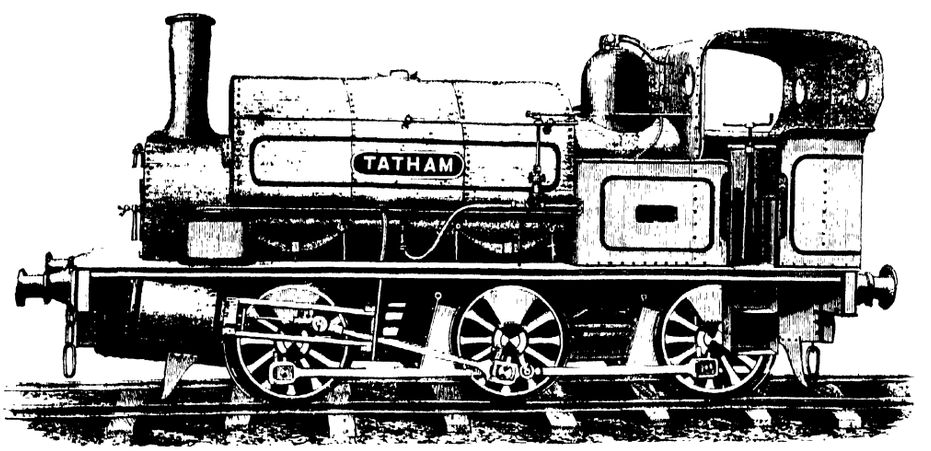


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RAILWAY FOUNDRY, LEEDS.

PRICES and SPECIFICATIONS on Application.



FOR CASH or DEFERRED PAYMENTS.

LOCOMOTIVE TANK ENGINES

OF ALL SIZES AND TO SUIT ANY GAUGE OF RAILWAY, 4025

For Main Line or Branch Railways, Contractors, Ironworks, Collieries, &c.

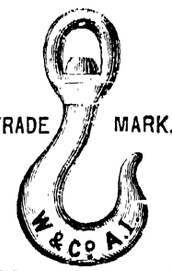


THE CLYDE RIVET WORKS CO., GLASGOW,
ADMIRALTY CONTRACTORS.

Ship, Boiler, Girder Rivets, Railway Spikes, Screws, Screw Bolts, Nuts.
BEST MATERIALS AND WORKMANSHIP. MODERATE PRICES.
PROMPT DELIVERIES OF ALL HOME AND EXPORT ORDER 5071

WHITEHOUSE & CO.,
TIPTON HALL CHAIN WORKS,
TIPTON, STAFFORDSHIRE.
MAKERS OF THE CELEBRATED

CRANE AND INCLINE CHAINS.



ORDERS DESPATCHED ON RECEIPT OF TELEGRAM.

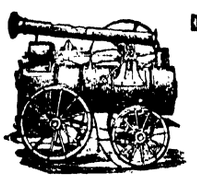
ALL HIGH-CLASS CHAINS made by EXPERIENCED WORKMEN, from SPECIALLY-PREPARED IRON, under the most careful PERSONAL SUPERVISION, thus ensuring the GREATEST POSSIBLE STRENGTH, UNIFORMITY, and DURABILITY.

SEND FOR PRICES. 5211

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MANCHESTER: C. J. BROWN, 7, Exchange Arcade.
LIVERPOOL: HOLT & ADDLINGTON, 24, Fenwick Street.

MACHINE-MOULDED WHEELS,
ALSO
SHAFTING PULLEYS, PLUMMER BLOCKS,
WROUGHT IRON COLLARS, &c.
ELIZA TINSLEY, *Engineer and Ironfounder,*
GREAT BRIDGE, STAFFORDSHIRE. 4717

CLAYTON & SHUTTLEWORTH,
Stamp End Works, Lincoln; and 78, Lombard Street, London.



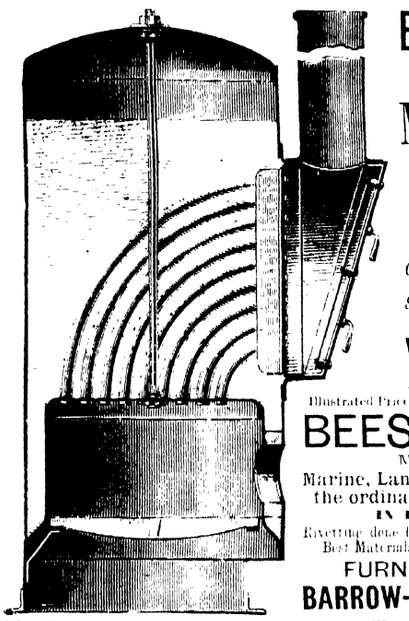
The Royal Agricultural Society of England have awarded every FIRST PRIZE to CLAYTON AND SHUTTLEWORTH for PORTABLE and other STEAM ENGINES since 1868, and PRIZES at every MEETING at which they have competed since 1849.

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For Coals, Wood, Straw, and every kind of Fuel.
Thrashing Machines. (Over 19,500 Sold).
Straw, Corn & Hay Elevators. Chaff Cutters for Steam Power.
Grinding Mills. Saw Benches. Traction Engines, &c.

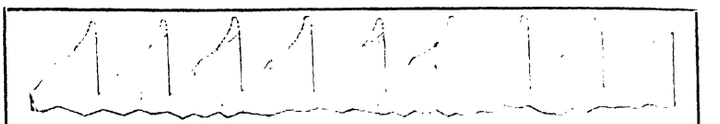
GOLD MEDAL and First Class Certificate at the Calcutta International Exhibition, 1883-4.
THE ONLY GOLD MEDAL awarded for PORTABLE STEAM ENGINES.

Gold Medals and other Prizes have been awarded to CLAYTON AND SHUTTLEWORTH at all the important International and Colonial Exhibitions, including:
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Catalogues in English and in all European Languages free on application. 5108



BEESLEY'S
PATENT VERTICAL
Multitubular Boiler,
WITH QUADRANT FLUE TUBES.
ADVANTAGES:
Compactness, Durability, Economical, Accessible, Cheap in First Cost, Suitable for all uses, and adapted for Export.
VARIOUS SIZED BOILERS
IN STOCK AND PROGRESS
Illustrated Price Lists Post free upon application to Patentee
BEESLEY & SONS,
MANUFACTURERS OF
Marine, Lancashire, Cornish, Rastrick, and the ordinary Cross Tube Vertical Boilers,
IN IRON OR MILD STEEL.
Riveting done by Machinery. First class Workmanship and Best Materials used. Low Quotations given. Address:
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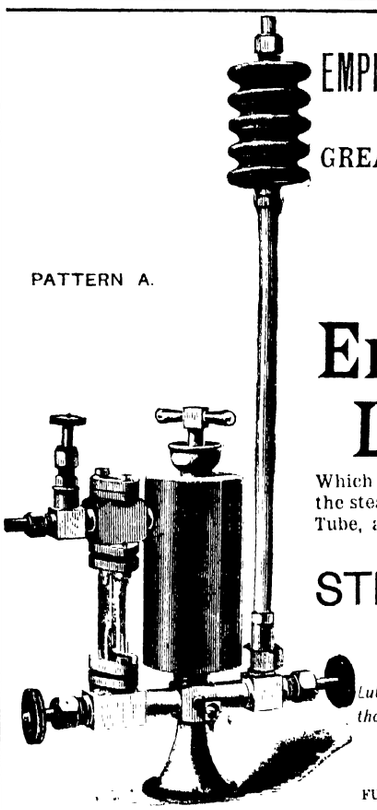
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EMPIRE LUBRICATOR COMPANY
EMPIRE WORKS,
GREAT BRIDGEWATER ST.,
MANCHESTER.
MANUFACTURERS OF
GRANDISON'S
Empire Lubricator


PATTERN A.

Which shows each drop of oil passing into the steam through the medium of a Glass Tube, and is the BEST APPARATUS now known for Lubrication of
STEAM ENGINES,
LAND OR MARINE.

Lubricators sent on approval to any part of the kingdom, and references given to users in all parts of the inhabited world.

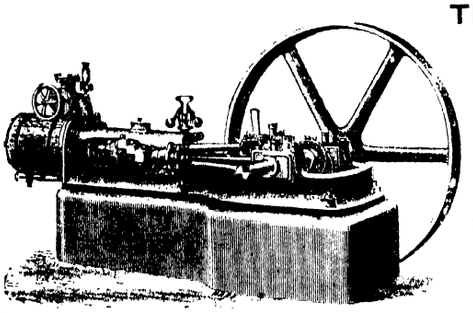
4763
FURTHER PARTICULARS ON APPLICATION.

MARSHALL, SONS, & CO., LIMITED,

[TELEPHONE No. 6648.

BRITANNIA IRONWORKS, GAINSBOROUGH, AND MARSHALLS' BUILDINGS, 79, FARRINGDON ROAD, LONDON, E.C.

MANUFACTURERS OF PORTABLE, SEMI-PORTABLE, HORIZONTAL, FIXED, VERTICAL, AND TRACTION ENGINES, THRASHING, CORN GRINDING, SAWING AND TEA PREPARING MACHINERY.



HORIZONTAL ENGINES WITH INSIDE CRANKS

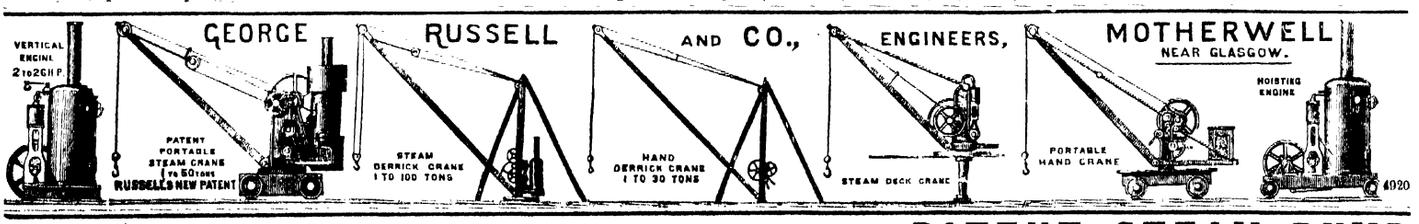
3 TO 10 HORSE POWER INCLUSIVE.

These Engines are self contained and very readily fixed, they are of great strength and extra capacity, and are fitted either with Equilibrium Throttle Valves and Quick Speed Governors, or our Patent Automatic Expansion Valve Gear, at option of Purchasers.

CALCUTTA EXHIBITION, 1884 FIVE GOLD AND THREE SILVER MEDALS.
AMSTERDAM EXHIBITION, 1883 THE DIPLOMA OF HONOUR.
ELECTRICAL EXHIBITION, CRYSTAL PALACE, 1882 GOLD MEDAL.
MELBOURNE, 1881 HIGHEST AWARD FOR ALL EXHIBITS. FIVE GOLD MEDALS.
SYDNEY EXHIBITION, 1880 TWO SPECIAL AND FOUR FIRST PRIZES.
PARIS EXHIBITION, 1878 TWO GOLD MEDALS AND OTHER PRIZES.

Catalogues in English, French, German, Spanish, or Russian free on application. 2559

GEORGE RUSSELL AND CO., ENGINEERS, MOTHERWELL NEAR GLASGOW.



4020



REPRESENTATIVES:
Wasteneys Smith, Newcastle. Simpson, Bruce & Co., L'pool. Gilbert, Bogle & Co., Glasgow. And at many other English and Foreign Ports.

The Pulsometer.

PATENT STEAM PUMP is specially desirable for use on board ship, and is now fitted on over 250 vessels. It is noiseless, has no moving parts except the simple valves, and will start at once, no matter how long it has been standing.

: REPORTS FROM USERS :

From Messrs. LAIRD BROS.
"We have much pleasure in testifying to the efficiency of the Pulsometers we have fitted."

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"We have now used the Pulsometer in six steamers for pumping water ballast, and have been much pleased with its action."

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"I find them thoroughly efficient pumps, doing a maximum amount of work with a minimum of noise and attention."

From Messrs. R. NAPIER & SONS.
"Always worked well and given complete satisfaction."

From Messrs. JAMES JACK & CO.
"In each case they continue to give the greatest satisfaction."

From Messrs. LEES, ANDERSON & CO.
"The two No. 7 Pulsometers we fitted on board steamers gave us and the owners entire satisfaction."

From THOS. F. IRWIN, Esq.
"They do their work most efficiently and economically, even to pumping hot water out of bilges run from the boiler."

PULSOMETER ENGINEERING CO., Ltd., Nine Elms Iron Works, LONDON, S.W.

Steam, Fire and Boiler Feeding Pumps. —:— Independent Air and Circulating Pumps. —:— Sanitary Pumps. 4889

PATENT ROLLED

SHAFTING

IN IRON AND STEEL

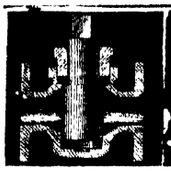
By Royal Letters Patent.

and

BUTLER'S PATENT FRICTIONAL COUPLINGS.



The Kirkstall Forge Co., Leeds, SOLE MAKERS. 4901

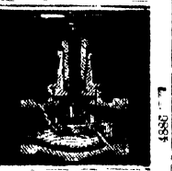


ASBESTOS PACKED COCKS
AUTOMATIC WATER GAUGES
[illegible] LUBRICATORS
[illegible] & PUMPS
[illegible] BRAKE VALVES
[illegible] ANTIFRICTION METAL

DEWRANCE & Co.

158 GREAT DOVER STREET LONDON S.E.

RENEWABLE STOP VALVES
PRESSURE REDUCING VALVES
SAFETY & RELIEF VALVES
LOW WATER ALARMS
BOURDON PRESSURE GAUGES
DEWRANCE'S BRONZE



4888

B. & S. MASSEY, MANCHESTER.

PATENTEES AND MAKERS OF

DOUBLE & SINGLE-ACTING STEAM HAMMERS.

BIRMINGHAM DEPOT: 2, CORPORATION STREET, BIRMINGHAM

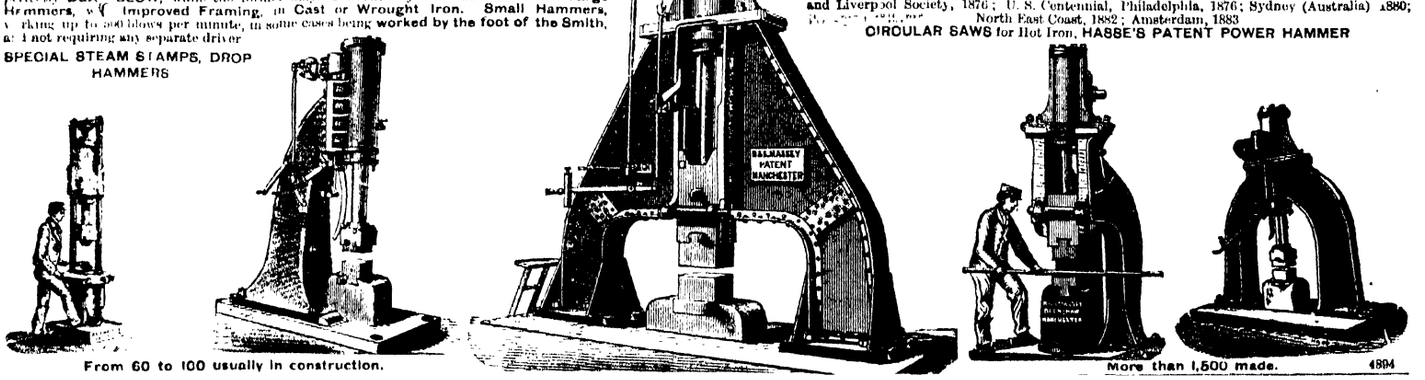
Received the ONLY Medal for Steam Hammers at the Paris Exhibition of 1878.

Also PRIZE MEDALS at Paris, 1867; Havre, 1868; Highland Society, 1870; Liverpool, 1871; Moscow, 1872; Vienna, 1873; Scientific Industry Society, 1875; Leeds, 1875; Paris, 1875; Manchester and Liverpool Society, 1876; U. S. Centennial, Philadelphia, 1876; Sydney (Australia) 1880; [illegible] North East Coast, 1882; Amsterdam, 1883

Of all sizes, from half-cwt to 20 Tons, with Self-acting or Hand Motions, in either case giving perfectly DEAD BLOW, while the former may be worked by hand when desired. Large Hammers, with Improved Framing, in Cast or Wrought Iron. Small Hammers, working up to 500 blows per minute, in some cases being worked by the foot of the Smith, and not requiring any separate driver.

CIRCULAR SAWS for Hot Iron, HASSE'S PATENT POWER HAMMER

SPECIAL STEAM STAMPS, DROP HAMMERS



From 60 to 100 usually in construction.

More than 1,500 made.

4894

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[Registered at the General Post Office as a Newspaper.

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.

VOL. XXXVIII.—No. 969.] *LONDON: FRIDAY, JULY 25, 1884* [PRICE.. 6d. By Post 6½d.

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With a Two-page Engraving of the TWIN-SCREW TRIPLE-EXPANSION ENGINES of the s.s. "ARABIAN."	

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4714

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See Advertisement, page 7.

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Railway Plant & General Engineers,

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The Patent Corliss Engine And PATENT CORLISS GEAR ENGINE, with special Improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N.B. These engines are made Horizontal or Beam, Condensing, Non-Condensing, and Compound. Also makers of Rice Mills, and Paper Mills, and General Engineers. Machinery shipped or trucked direct from the premises. Makers of

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5054

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See Illustrated Advertisement, page 24

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ALPHA STEAM CRANE and ENGINE WORKS, MOTHERWELL, near GLASGOW

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Steam Hammers.—

Massey's Patent Hammers

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The "Differential" Pumping ENGINE—DAVEY'S PATENT for Draining Mines, Water Supply of Towns; Irrigation; Supplying Docks; Pumping Sewage; and General Pumping Purposes.

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See their Illustrated Advertisement, page 43.

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Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough. 5206

See Illustrated Advertisement, page 43.

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Hadfield's Steel Foundry Co., SHEFFIELD. GOLD Medals, Paris and Melbourne, '78 & '80. For Engineers, Railways, Tramways, Mines, Hydraulic Work, Dredgers, &c., &c. Specially sound, dense, and of unequalled strength, toughness and durability. Our Unhammered Steel Castings, as recently tested by H.M. Govt., stand 40 to 65 tons per sq. inch (varying according to the hardness and purpose required) and up to 20 per cent. elongation. Can be thoroughly relied upon for regularity and uniformity of temper. See Advertisement page 19 4593

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Steel Hydraulic Cylinders.— HENRY BESSEMER & CO., Limited, SHEFFIELD.

See Advertisement last week, page 31 3057

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Hydraulic Rivetting Machines

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Sole Makers of

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Self Starting

Gas Engine.

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GOLD MEDAL,

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Strong's Patent Feed-water Heaters and Purifiers,

WITH

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Emery Wheels,

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10, Rue Laffitte, PARIS. 2588

TENDERS.

LONDON, BRIGHTON, AND SOUTH COAST RAILWAY.

TO ENGINEERS AND CONTRACTORS.

The Directors will be glad to receive

Tenders for the Erection and MAINTENANCE of a STEEL GIRDER BRIDGE over the Company's Lines at Eastbourne, in the County of Sussex.

Plans and Specification may be seen, and all information obtained at the Chief Engineer's Office, London Bridge Terminus, on and after the 21st inst., and Tenders addressed to the undersigned, and endorsed "Tender for Bridge at Eastbourne," are to be delivered at the Secretary's Office, by not later than 9.30 a.m., on Tuesday, the 5th August next

The Directors do not bind themselves to accept the lowest or any Tender.

A. SARLE,
London Bridge Terminus, Secretary
18th July, 1884 G 557

LONDON, BRIGHTON, AND SOUTH COAST RAILWAY.

TO CONTRACTORS AND OTHERS

LITTLEHAMPTON DIRECT RAILWAYS

The Directors will be glad to receive

Tenders for the Construction and MAINTENANCE of TWO SHORT LENGTHS of RAILWAY (total one mile) in the Parish of Leominster, in the County of Sussex

Plans and Specification may be seen, and all information obtained at the Chief Engineer's Office, London Bridge Terminus, on and after the 21st inst., and Tenders in the prescribed form only, and addressed to the undersigned, are to be delivered at the Secretary's Office, by not later than 9.30 a.m., on Tuesday the 5th August next

The Directors do not bind themselves to accept the lowest or any Tender

A. SARLE,
London Bridge Terminus, Secretary
30th July, 1884 G 556

LONDON, BRIGHTON, AND SOUTH COAST RAILWAY

TO ENGINEERS AND CONTRACTORS

RE-CONSTRUCTION & WIDENING OF BRIDGES.

The Directors will be glad to receive

Tenders for the Steel Girders REQUIRED for the RE-CONSTRUCTION of TWO ROAD BRIDGES at Denmark Hill, London, S.E., and the WIDENING of a BRIDGE under the Main Line, near South Croydon Station, in the County of Surrey.

Plans and Specifications may be seen, and all information obtained at the Chief Engineer's Office, London Bridge Terminus, on and after 21st inst., and Tenders addressed to the undersigned, and endorsed "Tender for Girders," are to be delivered at the Secretary's Office, by not later than 9.30 a.m., on Tuesday, the 5th August next

The Directors do not bind themselves to accept the lowest or any Tender

A. SARLE,
London Bridge Terminus, Secretary
18th July, 1884 G 554

LONDON, BRIGHTON, AND SOUTH COAST RAILWAY

TO BUILDERS AND CONTRACTORS.

The Directors will be glad to receive

Tenders for the Erection and MAINTENANCE of NEW STATION OFFICES, PLATFORM ROOFS, &c., at Horley Station, in the County of Surrey.

Plans and Specifications may be seen, and all information obtained at the Office of the Engineer, London Bridge Terminus, on and after the 21st inst., and Tenders in the prescribed form only, and addressed to the undersigned, are to be delivered at the Secretary's Office, not later than 9.30 a.m., on Tuesday, the 5th August next

The Directors do not bind themselves to accept the lowest or any Tender.

A. SARLE,
London Bridge Terminus, Secretary
18th July, 1884. G 555

SINGAPORE TRAMWAYS

KER, BOLTON & CO., Glasgow, are prepared to receive

Tenders for the Supply, f.o.b., of the necessary IRON or STEEL SLEEPERS and relative FIXINGS required for the Singapore Tramways, according to Drawings and Specifications to be seen on and after 21st July, at the Office of JOHN STRAIN, C.E., 1-4, West George Street, Glasgow, from whom a Copy of the Specification and Form of Tender may be obtained on payment of One Guinea, which will not be returned

Tenders addressed "Singapore Tramways" to be lodged, not later than Tuesday, 5th August, with KER, BOLTON & CO., who do not bind themselves to accept the lowest or any Tender G 536

TO CONTRACTORS

RIBBLE NAVIGATION AND PRESTON DOCK ACT, 1883

To be Let, the Construction of a DOCK of 10 acres, Tidal Basin, Locks, Diversion of River, and other Works, for the Mayor, Aldermen, and Burgesses of the Borough of Preston

Plans, Specification, and Detailed Drawings, may be seen, and Quantities and Forms of Tender obtained at the Office of EDWARD GARLICK, Esq., C.E., 33, Winckley Square, Preston, from the 28th inst to the 20th day of August next, by noon on which day, Sealed Tenders, addressed to "The Chairman of the Ribble Committee," and endorsed "Tender for Dock and other Works," must be deposited at the Town Hall, Preston.

A charge of Ten Guineas will be made to Contractors for a Copy of the Quantities, which will be returned on receipt of a *bonâ fide* Tender

The Corporation do not bind themselves to accept the lowest or any Tender. G 552

Town Hall, Preston, HENRY HAMER,
17th July, 1884. Town Clerk.

LANCASHIRE AND YORKSHIRE RAILWAY.

The Directors are prepared to receive

Tenders for the whole of the WORKS REQUIRED (except ironwork) in connection with the alteration of levels, deviation of line, and new lines and new Exchange Station at Liverpool.

Drawings and Specification can be seen, and Quantities and Forms of Tender obtained from the *Engineer's Office, Hunts Bank, Manchester, on and* after Monday, the 21st inst

Tenders addressed to the Directors, and endorsed "Tender for Alteration of Levels, Deviation of Line, and New Lines and New Exchange Station, at Liverpool," to be in the hands of the undersigned, not later than Ten o'clock on Monday morning, the 25th August proximo.

J. H. STAFFORD,
Hunts Bank, Manchester, Secretary
12th July, 1884 G 518

LANCASHIRE AND YORKSHIRE RAILWAY.

The Directors are prepared to receive

Tenders for the whole of the CAST and WROUGHT IRONWORK required in connection with the alteration of levels, deviation of line, and new lines and Station at Liverpool, including the principles, girders and columns of new roof, girders, floorplates, &c., required in subway and cab approach; girders, floor plates, and columns, &c., required for Bridges over Leeds Street and Waterloo Tunnel, and Viaduct between Leeds Street and Chadwick Street

Drawings and Specification can be seen, and Quantities and Forms of Tender obtained from the Engineer's Office, Hunts Bank, Manchester, on and after Monday, the 21st inst.

Tenders addressed to the Directors, and endorsed "Tender for Ironwork required, New Exchange Station, &c., Liverpool," to be in the hands of the undersigned, not later than Ten o'clock on Monday morning, the 25th August proximo

J. H. STAFFORD,
Hunts Bank, Manchester, Secretary
12th July, 1884 G 519

HAMMERSMITH AND CITY RAILWAY

The Joint Committee are prepared to receive

Tenders for the Construction of a NEW BOOKING OFFICE, and for the EXTENSION OF PLATFORMS, at the Latimer Road Station

Plans and Specification may be seen, and Forms of Tender and Bills of Quantities obtained, at the Office of the Engineer, at this Station, on and after Monday, the 28th instant.

Tenders addressed to the Secretary of the Joint Committee, at the Paddington Station, will be received on or before Tuesday, the 12th of August next

The Committee do not bind themselves to accept the lowest or any Tender

Paddington Station, London,
24th July, 1884 G 500

SOUTH INDIAN RAILWAY COMPANY.

The South Indian Railway Company is prepared to receive

Tenders for the Supply of 900 IRON HIGH SIDED GOODS WAGONS and 6" TONS WROUGHT IRON GIRDERS 147 TONS ROLLED BEAMS FOR FLOORING

Specifications and Forms of Tender may be obtained on and after the 28th inst., at the Company's Offices.

Tenders addressed to the Chairman and Directors of the South Indian Railway Company, and marked "Tender for Iron High Sided Goods Wagons," or "Wrought Iron Girders and Rolled Beams," as the case may be, must be left with the undersigned not later than Twelve o'clock noon of Tuesday, the 5th day of August, 1884

The Company is not bound to accept the lowest or any Tender

A charge of Ten Shillings (which will not be returned) will be made for Copies of the respective Specifications

Company's Offices, By order,
55, Gracechurch St., HENRY W. NOTMAN,
London, 24th July, 1884 Managing Director

IN THE HIGH COURT OF JUSTICE, CHANCERY DIVISION

To be Sold, by Private Tender, in ONE LOT, as a going concern, pursuant to an Order of the Honourable Mr. Justice Pearson, made in the matter of the Companies' Acts, 1862 and 1867, and in the matter of the JABLOCHKOFF ELECTRIC LIGHT AND POWER COMPANY, Limited, THE STOCK IN-TRADE, PATENTS, AND GOODWILL of the above Company, together with the Furniture, Fixtures, and Fittings, also the Leasehold Premises, situate and being No. 33, Albert Embankment, Westminster, also the Leasehold Premises, situate and being Canterbury Dock Wharf, 65, Belvedere Road, Lambeth, Surrey. Also the Beneficial Interest of the Company in two agreements, one relating to the hiring of Railway Arches, Nos. 97 and 98, in the rear of No. 33, Albert Embankment, and the other relative to the Company's suite of Offices, 1, Great Winchester Street, Old Broad Street, and the furniture and fittings appertaining thereto.

Tenders are to be sent to the Liquidator, Mr. WILLIAM AUGUSTINE SPAIN, at his Offices, 76, Coleman Street, in the City of London, not later than Four o'clock in the afternoon of 6th August, 1884, and Saturday, the 9th day of August, 1884, at Twelve of the clock at noon, at the Chambers of the said Mr. Justice Pearson, Royal Courts of Justice, Strand, in the County of Middlesex, is fixed for the consideration of such Tenders, and for the acceptance or non-acceptance of any of the same being decided upon and certified by the Chief Clerk, but the Liquidator, under the direction of the Judge, may decline to accept any Tender

Full particulars of the leases, furniture, fixtures, and patents, and Conditions of Sale, with Form of Tender annexed, may be obtained on application to the Liquidator, at his Office aforesaid, and at the Works and Offices of the Company, and of Messrs. MILLS, DOWSON & Co., 28, Bedford Row, and of Mr. FREDERICK KENT, 111, Cheapside, Solicitor to the said Liquidator.

Dated this 16th day of July, 1884.

E. W. WALKER,
FREDERICK KENT, Chief Clerk.
111, Cheapside, E.C.,
Solicitor for the Liquidator. G 562

Wanted, Tenders for Pair of WINDING ENGINES, 30 in., 33 in., or 36 in. cylinders, with drums, complete.—For further particulars apply in writing to SAMUEL SPRUCE, Esq., Mining Engineer, Tamworth, to whom Tenders must be delivered on or before 21st August, endorsed "Tenders for Engines." G 567

APPOINTMENTS OPEN.

Civil Service Commission —Examination for ASSISTANT EXAMINERSHIPS in the Patent Office (21-25) 29th August. Salary £250 to £400 The date specified is the latest at which applications can be received. They must be made on forms to be obtained with particulars from the SECRETARY, Civil Service Commission, London, S.W. G 578

Wanted, at once, a General FOREMAN, experienced in making and repairing Engines and other kinds of agricultural implements. Must be used to the Template system and turning out work expeditiously, able to make neat drawings, and get out estimates.—Address W. S., Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C.

Wanted, Foreman to take charge of Iron and Brass Foundry; none but first-class men, accustomed to Locomotive and Tool work need apply.—BEYER, PEACOCK & Co., Limited, Gorton Foundry, Manchester G 540

Wanted, in a British Colony, FOREMAN LOCO BOILERMAKER, must be thoroughly acquainted with the working of Tweddell's system of Hydraulic Machine Tools.—Apply letter only, stating salary required, and past exp to W. B., Offices of ENGINEERING, Bedford St., W.C G 581

Wanted Immediately, for a large Iron and Steel Works, an experienced DRAUGHTSMAN; must be well up in Blast Furnace and Bessemer Steel Plant.—Apply, stating age, salary expected, and giving references, to G 579, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 579

Wanted, a Skilful, Practical DRAUGHTSMAN, for hydraulic and gun work. Must have had experience in the construction of modern gun carriages. A really first-class man will receive a high salary and steady work.—Address, with full particulars, NOVELTY, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C G 561

Wanted, at once, a capable and quick Mechanical DRAUGHTSMAN, experienced in good economical engine and general work Apply by letter, stating age, experience and salary required, to J. & E. HALL, Dartford. G 575

Lists of Berths Vacant or WANTED See "ENGINEERING REVIEW," weekly 1d E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents 5262

SITUATIONS WANTED.

Grad. I. M. E. and Wh. Sc., (25) WISHES to ASSIST, confidentially or otherwise, manager or principal, home or abroad, to gain experience rather than salary. Good Draughtsman First-class references X, 19, Camden Street, N.W G 553

Draughtsman Disengaged, seventeen years' experience in compound engines, boilers, constructional ironwork, quantities, estimates, &c; good mathematician; university education, thorough French; moderate salary Address, C. E., 20, Montpelier Road, Kentish Town G 586

Cost Clerk (27) requires Situa- TION in or near Glasgow, or would travel for first-class firm; references to present and past employers.—Replies to G 580, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C G 580

To India Rubber Manufac- TURERS.—A Gentleman of considerable experience in Mechanicals, and with a first-class connection amongst merchants, steamship owners, &c., will shortly be open to REPRESENT a good house.—Address INDIA RUBBER, care of FRIGGENS, TURNER, Advertising Offices, 21, Queen Victoria Street, London, E.C. G 574

PARTNERSHIPS.

Partnership, sleeping or active, —WANTED immediately Two to Three Thousand Pounds, in an old established wholesale business having a large connection, to undertake the manufacture of a secured speciality in unlimited demand, especially among users of steam power, an unusual opportunity as profits are very good, at a minimum risk.—Address A. C. S 17, Messrs. DEACONS, Leadenhall Street G 584

Partnership.—Wanted, a Gentleman to take the share of an out-going partner in an established firm of agricultural steam ploughing, threshing, and hauling machinery proprietors The fullest investigation permitted, and references given and required Knowledge of the business not actually necessary.—Principals or their solicitors only need apply to A. J., at HORNCASTLES, Cheapside, E.C. G 585

To Engineers.—Partner WANTED, having a sound commercial and financial knowledge, to join Advertiser, who in addition to his general trade, has a good speciality with an extensive connection and well appointed Works Apply, in first instance, to B. K. L., Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C G 569

WANTED, &c.

Wanted, at once, a Second- HAND RADIAL DRILLING MACHINE, about 4 ft. 6 in. arm.—Send price and full particulars to KETTON & HOLLIS, Engineers, Curtis Street, Nottingham.

Wanted, Steam Pump and BOILERS, second-hand, in first-class condition, capable of pumping about 20,000 gallons per hour, complete with suction and delivery hose.—Apply, with full particulars, stating lowest price, to D. HALD & CO., 24, Gt. Winchester Street, London, E.C. G 583

Agents Wanted, to push First- class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool. 5233

Lists of Machinery Wanted or ON SALE. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5262

FOR SALE.

For Sale, 12 in. Leather and COTTON BELTING, of best description.—For orders to view, apply to W. BULL, Southboro', Tunbridge Wells G 576

For Sale, the Cheapest and Best IRON STOP and SLUICE VALVES made. Illustrated Price Lists on application.—ALLEY & MACLELLAN, Sentinel Works, Glasgow. 1161

For Sale, Largest Stock in England, Engineers' Machine Tools, Steam Hammers, Steam Engines, Wood-working Machinery, all sizes, best materials and workmanship, low prices; send for stock list.—SCOTT BROTHERS, Halifax.

For Sale, Twelve Tramway LOCOMOTIVES, 4 ft. 8½ in. gauge, in good working order. For particulars address THE ROUEN TRAMWAY CO., [illegible], France. G 548

For Sale, a Complete Collection of "ENGINEERING," since July, 1868, and of "THE ENGINEER" since the same date.—Offers to be addressed to M. [illegible] HERMANT, 123, Rue Lafayette, Paris. G 560

For Sale, being superseded by engines of higher power, a pair of High Pressure Condensing STEAM ENGINES. Cylinders, 26 in. diam., 3 ft. 6 in. stroke, with cold water pump for same.—Can be seen at work at the Manufactory of the LONDON PORTLAND CEMENT CO., Ltd., Northfleet, Kent, to whom enquiries may be addressed. G 534

TO CONTRACTORS, HARBOUR BOARDS, &c.

For Sale, at Wicklow Harbour Works, an 8 ton Russell Self-Propelling Steam Derrick Crane, with 60 ft. jib; 10-ton Cameron ditto, with 72 ft. jib; Priestman Steam Travelling Crane, for "B" size grab; two specially strong Priestman Grabs; Punching and Shearing Machine; Chaplins' Locomotive, several large Iron Skips; several tons 6 in. by 6 in. Angle and Tee-Iron; 40 tons Steel Rails; large quantity sound sawn Pitch Pine; three good Barges, one specially good rectangular Barge, on which Priestman Crane works.—Apply to JOHN JACKSON, Harbour Works, Wicklow Ireland; or 9, Victoria Chambers, Westminster. 5122

For Immediate Sale, at low prices for cash.

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In the matter of Letters Patent granted to JOHN TURNER, of Manchester, in the County of Lancaster, and JAMES ROBERTSHAW, of the same place, for an Invention of "Improvements in sanitary receptacles and appliances," dated 31st March, 1881, No. 1429.

Notice is Hereby Given that the said John Turner and the said James Robertshaw, have, under Sections 18 to 21 of the Patents, &c., Act, 1883, and Rules 48 to 56 of the Rules made thereunder, applied for leave to amend the Specification filed in pursuance of the said Letters Patent.

A copy of the said Specification, as proposed to be amended, can be seen at the Patent Office, and full details of the proposed amendment were advertised in the Official Journal of the Patent Office, published on the 1st day of July, 1884, page 16.

Any persons intending to oppose such application must leave particulars in writing of their objections to such amendment at the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W.C., within one calendar month from this date.

Dated this 30th day of June 1884. G 565
H. READER LACK,
Comptroller General.

In the matter of Letters Patent granted to JOHN TURNER, of Bury, in the County of Lancaster, Sanitary Inspector, for the Invention of "Improvements in means for collecting and treating excreta, and other similar matters, in order to obtain a useful manure therefrom, and to render the same inoffensive in such collection," dated 6th September, 1879, No. 3594.

Notice is Hereby Given that an application has been made by the said John Turner, in conjunction with James Robertshaw (the assignee of one-half share in the said Letters Patent) under Sections 18 to 21 of the Patents, &c., Act, 1883, and Rules 48 to 56 of the Rules made thereunder, for leave to amend the Specification filed in pursuance of the said Letters Patent.

A copy of the said Specification, as proposed to be amended, can be seen at the Patent Office, and full details of the proposed amendment were advertised in the Official Journal of the Patent Office, published on the 1st day of July, 1884, page 16.

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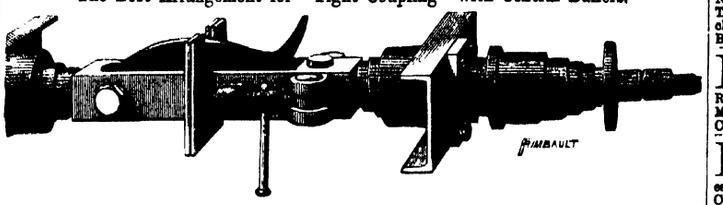
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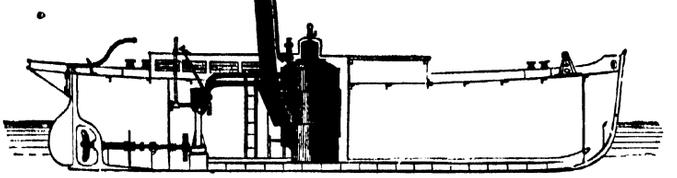
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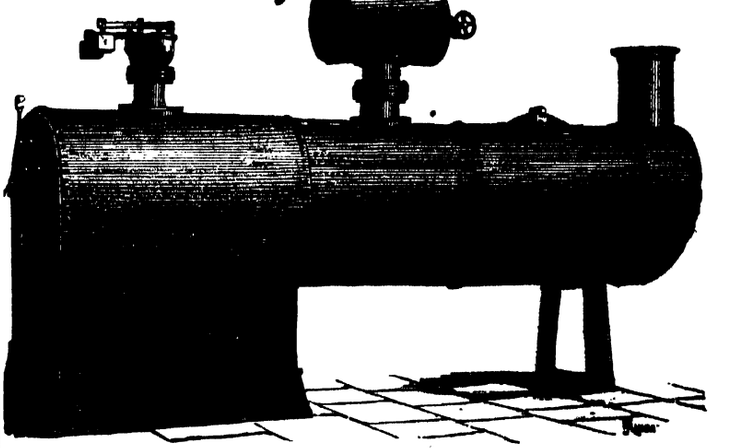
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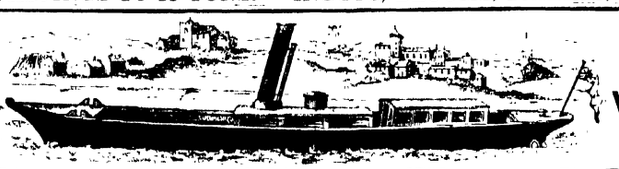
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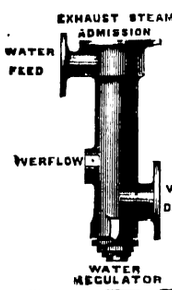
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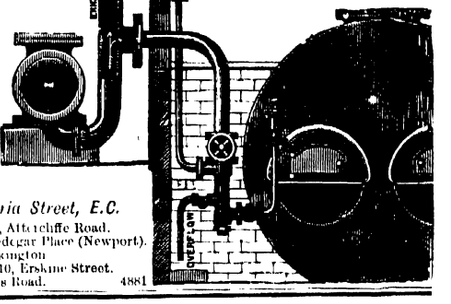
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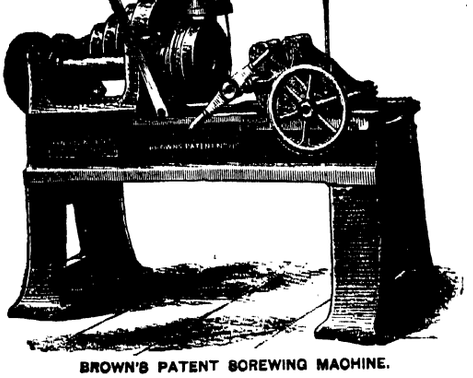
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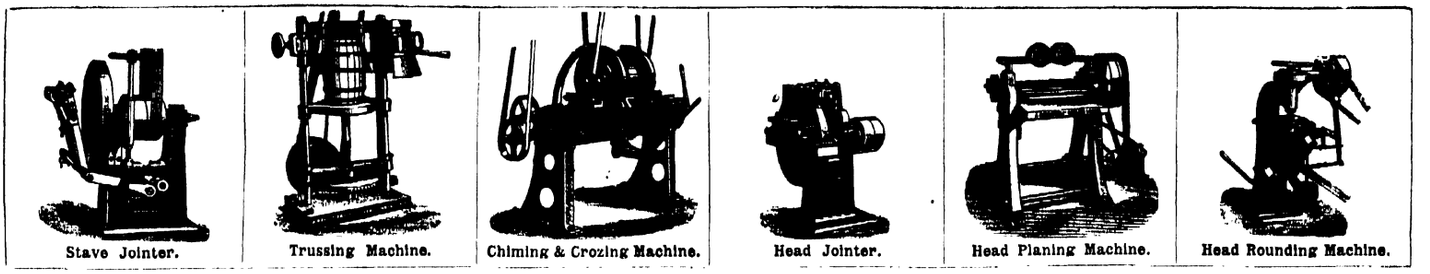
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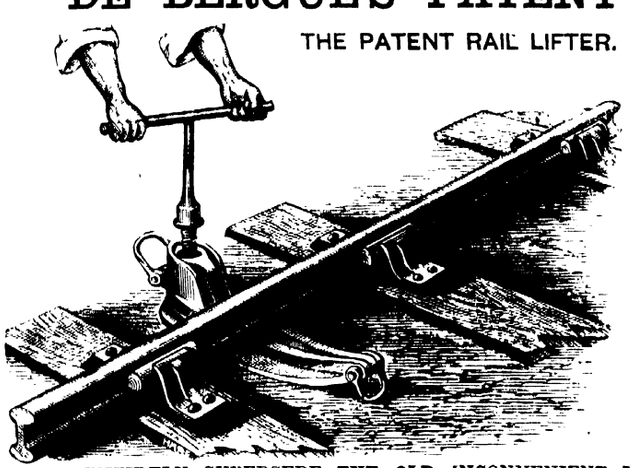
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ELECTRIC LIGHTING EITHER BY ARC OR INCANDESCENT SYSTEM,

AS UNDER:

ARC LIGHTING.

	£	s.	d.
10-light set (including Burgin Dynamo machine, Ten 16-hour, 2,000 candle-power lamps, cable, switch, &c.) packed and delivered free to any railway station in England	330	0	0
6-light set do. do. do. ...	195	0	0
3-light set do. do. do. ...	120	0	0

INCANDESCENT LIGHTING.

	£	s.	d.
30-light set (including self-regulating Burgin Dynamo machine, Thirty Swan 20 candle-power lamps, 30 holders, cable, branch wire, cut-outs, plain wall brackets or pendants) packed and delivered free to any railway station in England	100	0	0
75-light set do. do. do. ...	195	0	0
150-light set do. do. do. ...	300	0	0

OTHER PRICES AND LIST ON APPLICATION.

Extract from a Letter from the Manager of the South Wales Tin Plate Works (who have since increased their installation by the addition of both Arc and Incandescent Lamps), with reference to an Installation by R. E. CROMPTON & CO.

"Six months' experience is too short a time to enable me to give anything but an estimate of the cost of Electric Lighting, as some parts of the machines only require renewing once in every two or three years. In fact, as yet the cost of renewals has been almost nothing, except in lamps. I, however, estimate that over a series of years this item of expense will not exceed £60 per annum for 100 lights, exclusive of lamps, and this is confirmed by the reports of others, who say that 10 per cent. upon the cost of the plant will quite cover repairs, and £60 is a great deal in excess of 10 per cent. upon the cost of our plant. Taking this sum as the expenditure on repairs, the cost of the Electric Light will be as follows in cases similar to our own, where there is spare steam at night:—

Wages	£62	0	0
Lamps	90	0	0
Repairs, &c.	60	0	0
Oil and Stores	13	0	0
	225	0	0
Less work done by Engineer ...	41	6	8
	£183	13	4

I deduct the above amount for the work done by the engineer. He has nothing to do except to oil the bearings once or twice during the night, and can turn rolls, screws for the mills, &c., in a lathe driven by the same engine as the Dynamos; in fact, it is an advantage in more ways than one to give him this work to do, as it prevents him from going to sleep and so neglecting oiling the machinery, as well as the saving in wages.

"This cost is for 100 lamps of 17 candle power for a year, using them on an average five nights a week for 14 hours in the winter six months, and nine hours in the summer six months; this gives a total of 2,990 hours, during the whole of which we have 1,700 candle power of light for the sum of £183 13s. 4d.

"What would an equal light cost in Gas at 3s. 9d. a 1,000 cubic feet? We cannot calculate on burning less than one cubic foot of Gas per hour for every three candles' power; so to get 1,700 candles power for 2,990 hours, we should burn 1,694,300 cubic feet of Gas costing £317 14s. 7d. against £183 13s. 4d. for the same light if supplied by the Incandescence Electric system.' 4813

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Turned true and bright to Whitworth's Gauges, any length, from 2 in. to 8 in. diameter, **14s.** per cwt. at Nottingham. Also Couplings, Pulleys,' Plummer Blocks, Hangers, Machine-made Spur, Bevel, and Mitre Wheels, Friction Gearing, &c.

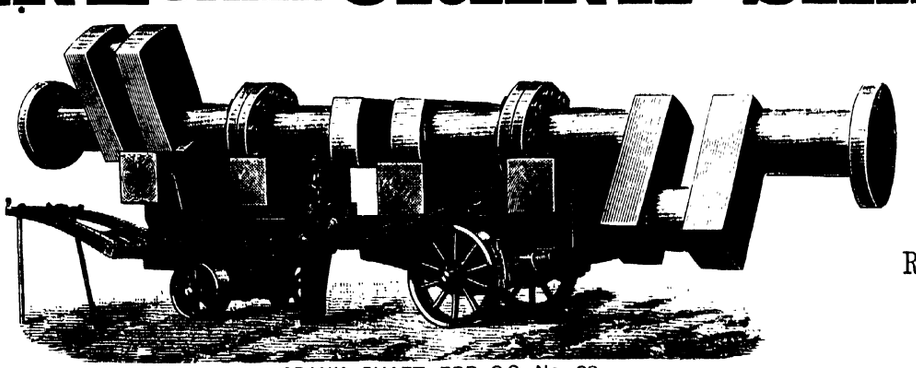
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MANUFACTURERS OF

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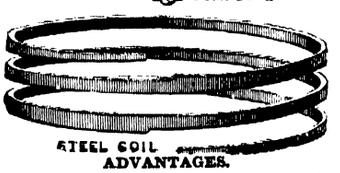
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WIGZELL, POLLITT & MELLOR'S PATENT STEEL COILS.



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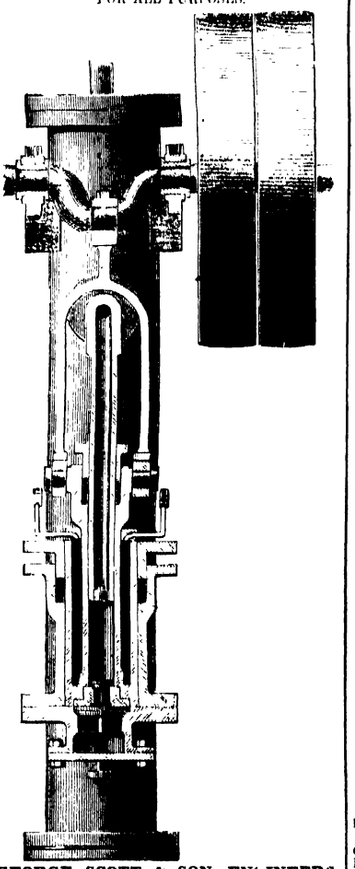
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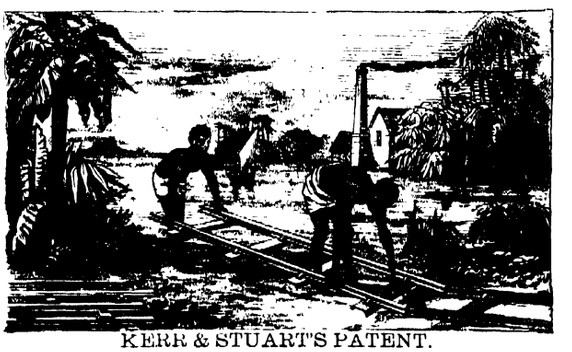
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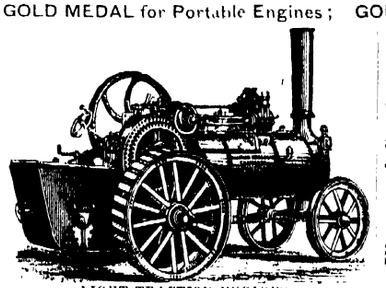
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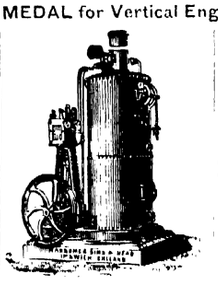
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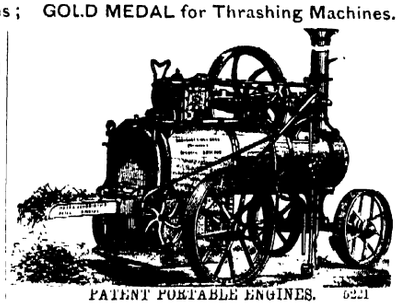
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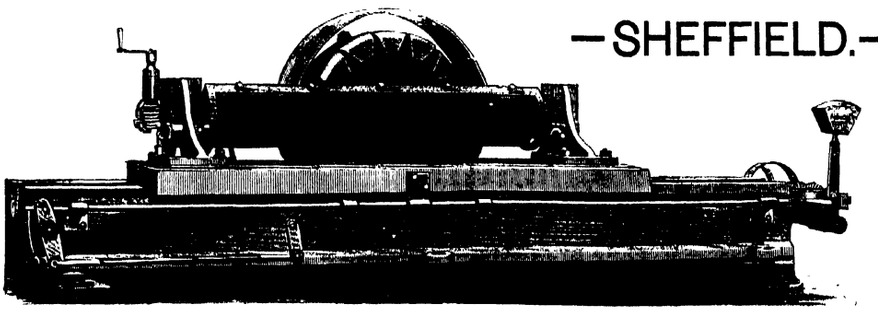


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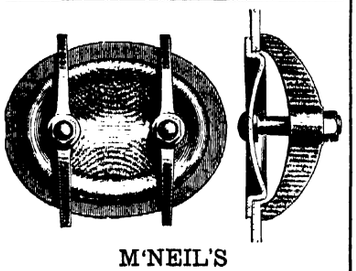
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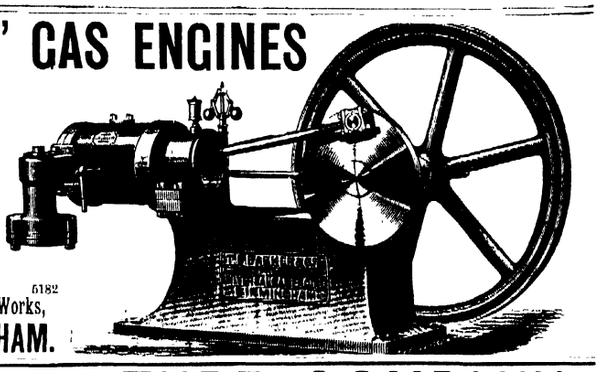
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Over 800 ovens are already at work or arranged for by owners of over 10,000 ovens.
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MANUFACTURED AT
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This Furnace and Apparatus makes one ton of oil do the heating duty of three tons of coals for the generation of steam.
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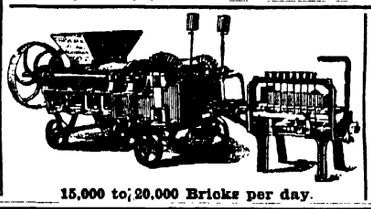


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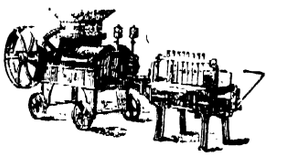


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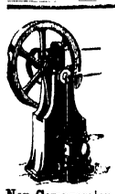

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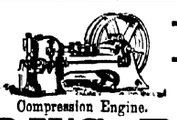

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New Patent Barring Engine.
AUTOMATIC MOTION FOR MOVING INTO GEAR, AND FALLS OUT OF GEAR AUTOMATICALLY WHEN MAIN ENGINE STARTS.
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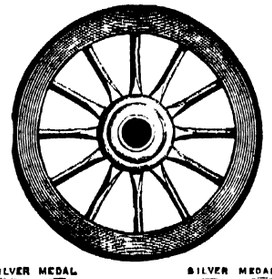
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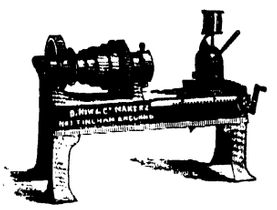
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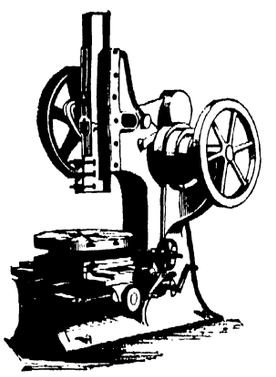
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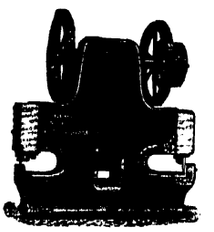
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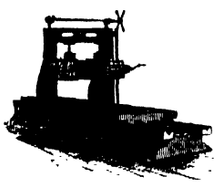
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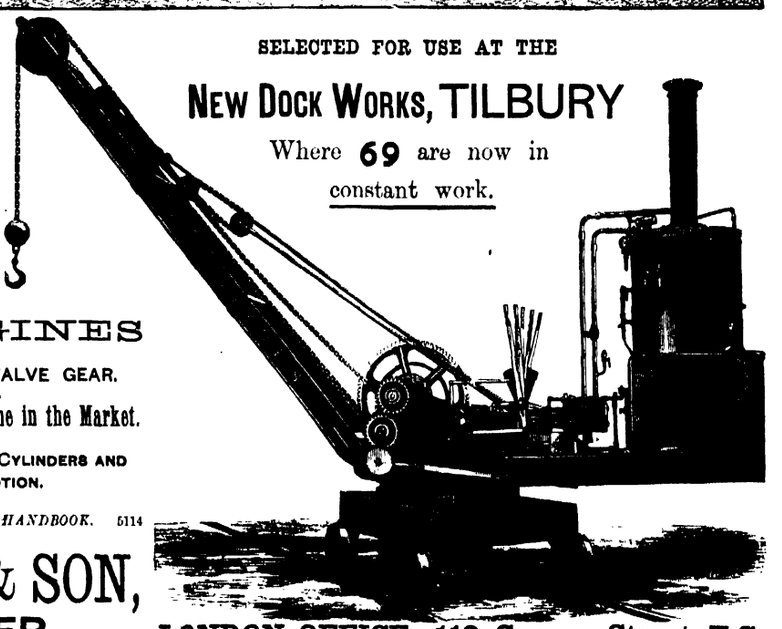
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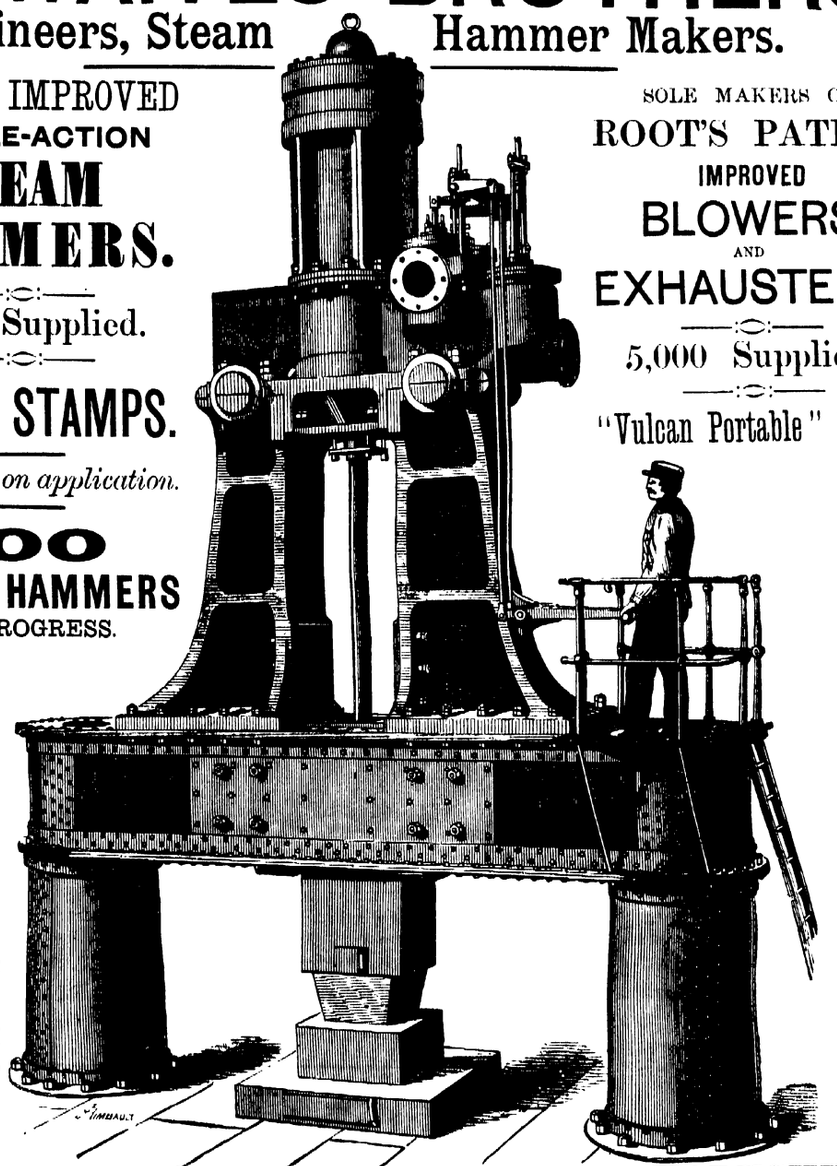
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British Exhibits,
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THWAITES BROTHERS

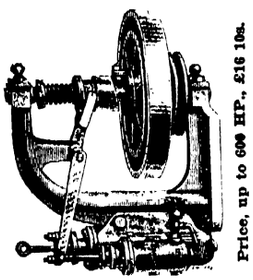
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4455

VULCAN IRON WORKS, BRADFORD, YORKSHIRE.

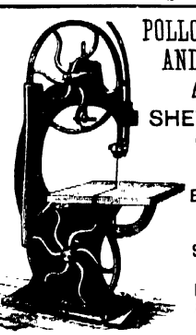
BLAIR'S IMPROVED MARINE
ENGINE GOVERNOR

SENSITIVE & RELIABLE.



Price, up to 600 HP., £16 10s.
Has been supplied to numbers of Screw Steamers.

For further particulars apply to 5222
GEORGE BLAIR, 38, Queen St., Glasgow.



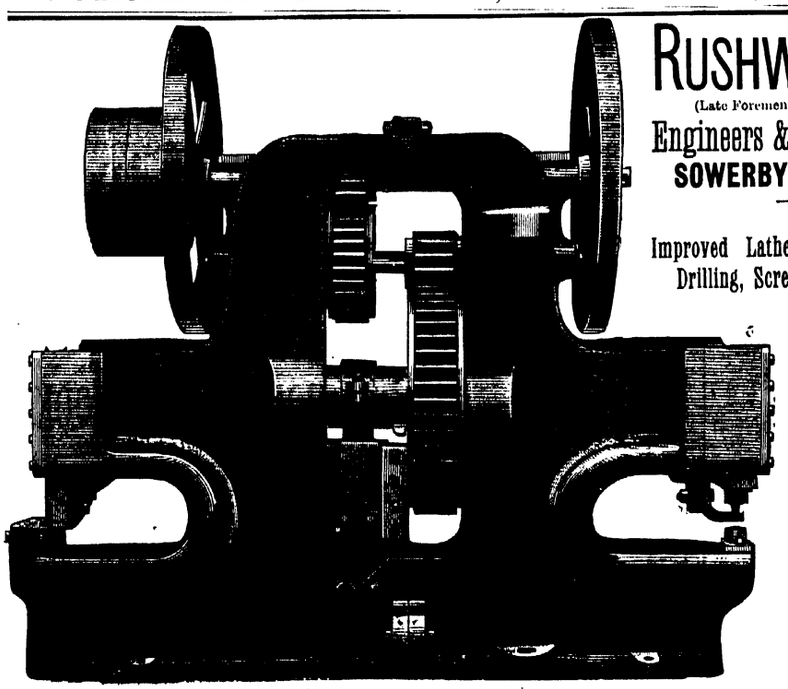
POLLOCK, MACNAB, AND HIGHGATE,
Engineers,
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SPECIALITIES:
BAND SAWING MACHINES.
PUNCHING AND SHEARING MACHINES
STEAM HAMMERS,
FUEL ECONOMISERS.
Prices & Lithographs on application. 5176

W. G. BAGNALL
STAFFORD



LOCOMOTIVES
PORTABLE RAILWAYS
TRUCKS AND WAGONS
4840



RUSHWORTH & Co.,

(Late Foremen with Messrs. Francis Berry & Sons,)

Engineers & Machine Tool Makers,
SOWERBY BRIDGE, YORKSHIRE.

MAKERS OF
Improved Lathes, Planing, Slotting, Shaping, Drilling, Screwing, Punching and Shearing Machines.

Plate Bending Rolls, Special Angle and T Iron Bending Machines.

SPECIAL MULTIPLE PUNCHING AND SHEARING MACHINES FOR GAS HOLDER AND TANK MAKERS.

STEAM HAMMERS,
Geared and Steam Riveting Machines, &c.

PLATE EDGE PLANING MACHINES,
For Boiler Makers and Ship Builders.
5103

W. BOWSER & SON,

ENGINEERS
Great Wellington Street,
GLASGOW.

ESTABLISHED
1842.

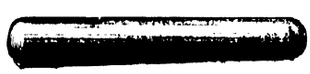


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STEAM & HAND CRANES
HOISTING MACHINERY,
AND
CONTRACTORS' PLANT, &c.
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H. FORD SMITH,
Seddon Street, Salford, MANCHESTER.

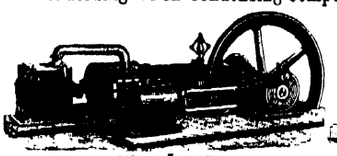
FINISHED, PLAIN, & HEADED KEYS
TAPER PINS. 5218



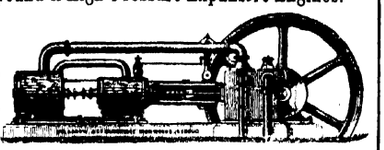
HOLBOROW & CO., DUDBRIDGE IRON WORKS, STROUD,

MANUFACTURERS OF IMPROVED

Condensing & Non-Condensing Compound & High-Pressure Expansive Engines.



COUPLED ENGINE.



TANDEM ENGINE.

THE **Coupled Engine** is fitted with HOLBOROW & Co.'s Invention of DISENGAGING VALVES, enabling either half to work independently should it be necessary through accident or repair, thus virtually making two Engines.

THE **Tandem Engine** is designed so that pistons can be withdrawn altogether for repairs by simply removing covers; it has no more working joints than ordinary engine, occupies no more space, nor requires more expensive foundations.

A vacuum of 14 lbs. below atmosphere is readily maintained by new SINGLE-ACTING AIR-PUMP AND CONDENSER; while consumption of fuel, as proved by exhaustive trial, does not exceed 2 lbs. per HP. per hour, and piping is above floor.

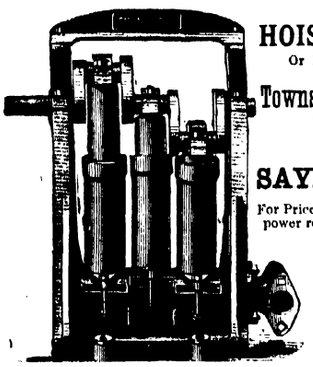
THEIR SIMPLICITY ENABLES VERY LOW PRICES TO BE QUOTED.

"An excellent action of the valves and an unusually good and well maintained vacuum . . . Exceptionally high vacuum—very great economy—exceptionally good results in economy."—*See* ENGINEERING, Nov. 12th, 1875, May 17th, 1878, and July 8th, 1881.

STEAM USERS, PLEASE SEND FOR PRICE LISTS. 4051

JOHN RAMSBOTTOM'S

PATENT WATER ENGINES & STEAM PUMPS



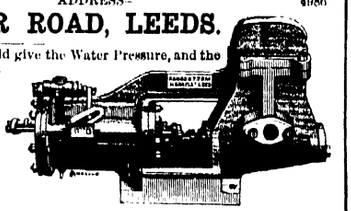
Are for **HOISTING USES,** Or Driving all kinds of Machines by **Towns' Water Pressure** Where sufficient.

This Pump is **UNSURPASSED** Either for **SIMPLICITY, PRICE,** Or for General Efficiency.

ADDRESS— 4086

SAYNOR ROAD, LEEDS.

For Prices, should give the Water Pressure, and the power required.



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ENGINEERS,

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LONDON OFFICE: 123, CANNON STREET, E.C.,

MANUFACTURERS OF

MARINE ENGINES,

COMPOUND

SURFACE

CONDENSING

to 600 I. HP.

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ALSO

BOILERS

For ditto in

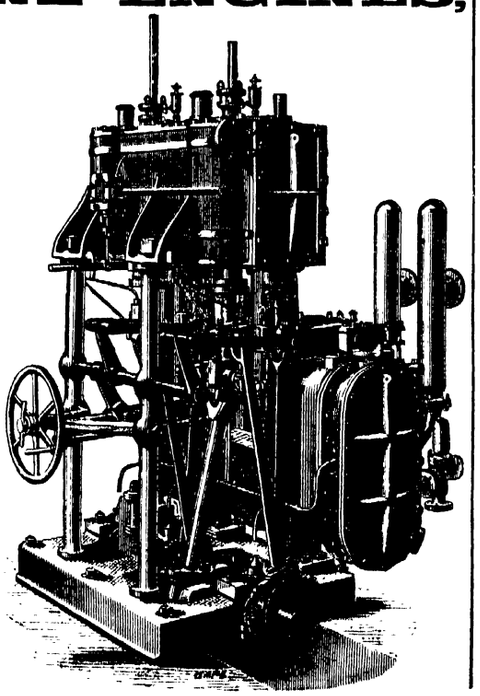
Steel or Iron.

—:—

PRICES

ON

APPLICATION. 4051

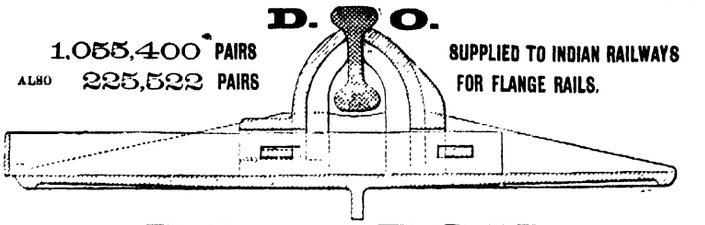


D. O.

1,055,400 PAIRS

ALSO 225,522 PAIRS

SUPPLIED TO INDIAN RAILWAYS FOR FLANGE RAILS.



D-O. AND D-O-M.

PATENT TRANSVERSE CAST IRON PLATE SLEEPERS,

For any Gauge and for any form of Rail; without Wooden Keys or any perishable part. As in use on Guaranteed and State Railways in India.

COST IS LESS THAN INDIGENOUS TIMBER.

Vide "Minutes of Proceedings of the Institution of Civil Engineers," Nov., 1881, Vol. LXVII., p. 87).

FOR PARTICULARS APPLY TO

MESSRS. THOMSON & BROWNING,

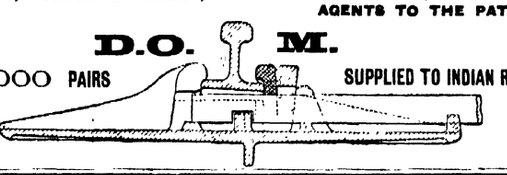
3, VICTORIA STREET, WESTMINSTER ABBEY, S.W.

AGENTS TO THE PATENTEES.

D.O. M.

230,000 PAIRS

SUPPLIED TO INDIAN RAILWAYS.



5175

Ships' Engine and Steering Telegraphs.

Over 3000 Vessels have been fitted with **CHADBURN & SON'S** Patent Telegraphs, including all the noted Steamers in the World, also 200 Vessels for English and Foreign Navies.

EXHIBITION AWARDS: LONDON, PARIS, N.E. COAST, AMSTERDAM, FISHERIES.



CHADBURN & SON'S NEW PATENT 'DUPLEX GONG 1883.

ENGINE AND STEERING REPLY TELEGRAPHS.



ORDERS INDICATED BY SOUND & SIGHT.

A DEEP GONG from **Astern to Ahead.**

A SHRILL GONG from **Ahead to Astern.**



TELEGRAPH WORKS—WATERLOO ROAD,

GLASGOW-69, ANDERSTON QUAY. **LIVERPOOL.** LONDON-96, FENCHURCH ST.

6040

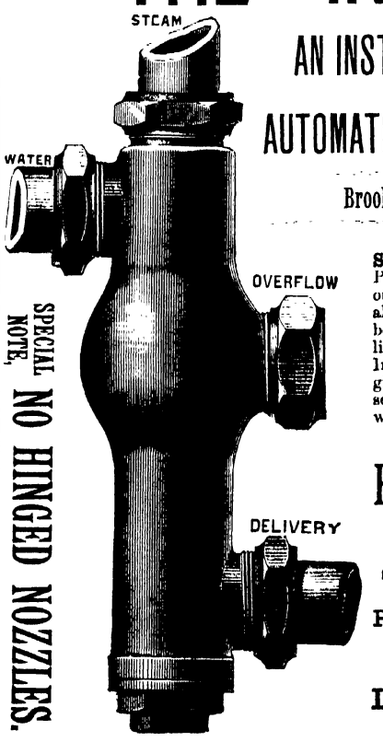
THE "INFLUX"

STEAM

WATER

OVERFLOW

DELIVERY



SPECIAL NOTE, NO HINGED NOZZLES.

AN INSTANTANEOUS STARTING AND AUTOMATIC RESTARTING INJECTOR

Brooke, Holden, & White's Patent.

The **only** Lifting Injector **devoid of Spindles,** Levers, Adjustable Internal Parts, or **hinged** Nozzles which lifts without manipulation and restarts automatically. **Instantaneous action** on Steam being turned full on. Works equally well lifting up to 12 ft., or as a "non-lifter." Invaluable for Locomotives, Traction Engines, Marine, and other Boilers. Can be seen working on application; or reference will be given as to their perfect reliability.

For Prices, &c., apply to

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SALFORD,

SOLE MANUFACTURERS.—Also Sole Makers of

BORLAND'S 5086

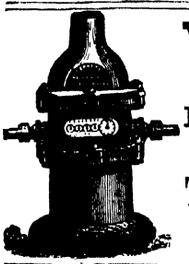
PATENT BOILER DRILL

For Drilling Boiler Shells.

LICENSEES FOR THE SOUTH:

LEWIS OLRICK & CO.,

LEADENHALL ST., LONDON.



WATER METERS.

H. FROST'S PATENT.

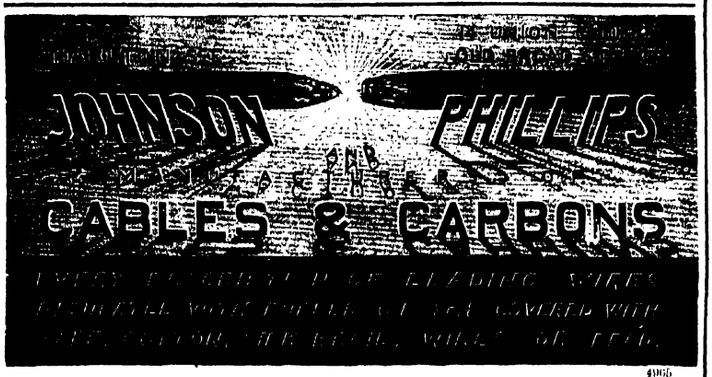
POSITIVE! RELIABLE! DURABLE!

Many Thousands in use both at Home and Abroad.

THE MANCHESTER WATER METER CO., Ltd.

TIPPING STREET, ARDWICK, MANCHESTER.

ESTABLISHED 1860 4133

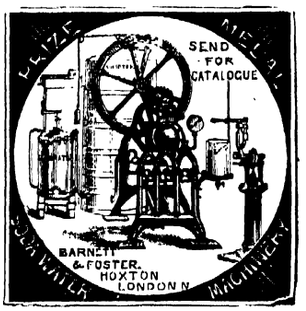


4965

Soda Water Machinery,

For the Manufacture of all kinds of Aerated Drinks in the highest state of perfection,

— BY —



BARNETT & FOSTER,

"NIAGARA WORKS,"

25½, EAGLE WHARF ROAD,

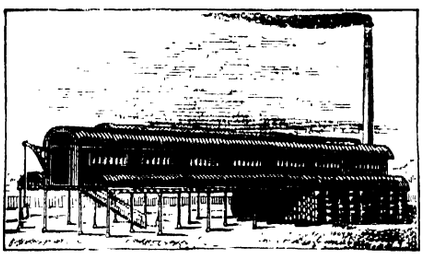
LONDON, N.

A COMPLETE SODA WATER MACHINE, including Bottling Apparatus, is supplied for £40 per set for producing 100 doz. Lemonade, Ginger Ale, &c., per day.

No technical knowledge is required, as all information is given to purchasers of Machines. 4910

ILLUSTRATED CATALOGUE FORWARDED FREE.

IRON ROOFS & FIRE-PROOF BUILDINGS.



TANKS & CISTERNS.

Galvanizing Baths.

DAVIES BROS & Co. CONTRACTORS FOR IRON ROOFS BUILDINGS BRIDGES &c. CROWN IRON WORKS WOLVERHAMPTON

Galvanized and Painted Corrugated Sheets.

IRON ROOFS, IRON BUILDINGS,

ENGINE SHEDS, STORES.

Constructional Iron Work and Smiths' Work of every description. 5027

DAVIES BROS. & CO., Crown Ironworks, Wolverhampton.

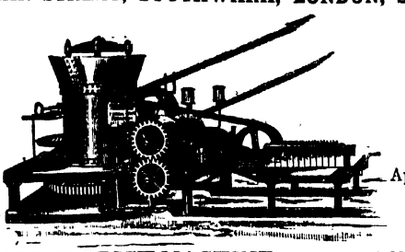
MURRAY'S PATENT BRICKMAKING MACHINERY.

Sole Manufacturers, THOMAS MIDDLETON & Co., Engineers,

LOMAN STREET, SOUTHWARK, LONDON, S.E.

Patent Steam Driven Cutting Tables.

Patent Lubricating Solid Die, for all sorts of Clay.



Patent Plunger Brick Press, for Bricks or Tiles.

Patent Brick Shaping Apparatus, for all kinds of Fancy Bricks.

IMPROVED ROLLER BRICK MACHINE, 12,000 to 40,000 Bricks per day, for Clamp and Kiln Burnt Bricks. 3164

Also Manufacturers of all kinds of Clay Crushing Rolls, Mixing Mills, Steam Engines & Hydraulic Machinery.

S. OWENS & Co.,

WHITEFRIARS ST., LONDON, E.C.

HYDRAULIC ENGINEERS,

SOLE MANUFACTURERS OF

Blake's Patent Steam Pumps.

More than 16,000 in Use.

FOR PUMPING

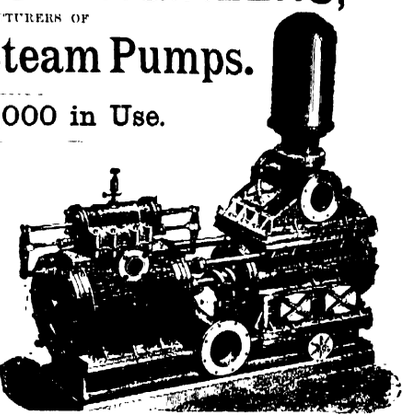
TAR WATER,

OR

Ammoniacal Liquor.

5094

Price Lists and full Particulars furnished on application.



CROWN PHOSPHOR-TIN.

BY USING OUR PHOSPHOR-TIN,

Phosphor-Bronze can be made Superior to any now in the Market,

AT 30 PER CENT. LESS COST.

Three cwt. of our tin will produce one ton of Phosphor-Bronze, thereby effecting a considerable saving in carriage, and enabling Manufacturers to use the same stock of Copper for all purposes.

(See our Circular.)

BILLINGTON & NEWTON,

LONGPORT, STAFFORDSHIRE. 6159

Agents.—London: HAUGHTON & CO., 110, Cannon Street, E.C.

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TRADE O T T O MARK REGISTERED.

PHOSPHOR-COPPER

MANUFACTURED BY

W. G. OTTO, DARMSTADT,

GUARANTEED ABSOLUTELY PURE AND TO CONTAIN FROM 14 TO 16 PER CENT. OF PHOSPHORUS.

Is the CHEAPEST and BEST adapted material for producing PHOSPHOR BRONZE (only 15 to 20 lbs. being required per ton of metal) and all other COPPER ALLOYS, as well as Castings from pure Copper, Brass, German Silver, and Alloys of all kinds with or without admixture of Tin; also for re-casting old Metals and Filings.

NO WASTE OF METAL BY OXYDATION.

OTTO'S PATENT STIRRER

For producing homogeneous Metal Castings. *Particulars on application to*

G. HARTMANN,

16, GREAT ST. HELEN'S, LONDON, E.C.

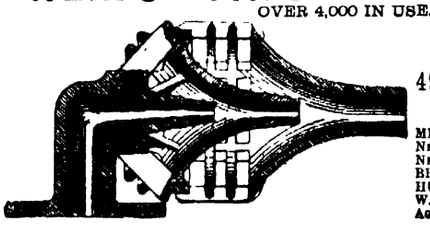
SOLE AGENT FOR GREAT BRITAIN AND COLONIES. 4787

HIGH PRESSURE MARINE BOILERS.

Best and Cheapest Means of Preventing Unequal Expansion.

"WEIR'S" PATENT HYDROKINETER.

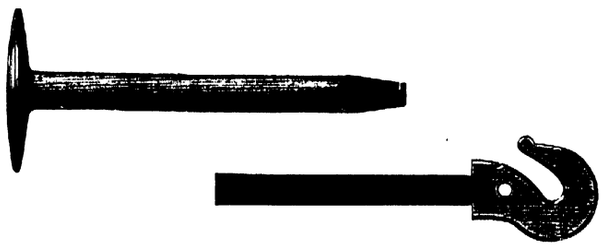
OVER 4,000 IN USE.



G. & J. WEIR,

49, JAMAICA STREET, GLASGOW.

MENZIES & BLAGBURN, KING STREET, NEWCASTLE-ON-TYNE WM. REID & CO., 5, NEW LONDON STREET, LONDON, E.C. A. & R. BROWN, WATERLOO ROAD, LIVERPOOL. R. HUGHES & CO., FULTON STREET, DITTO. W. S. VON EGGEN, ENGINEER, HAMBURG, AGENT FOR SCANDINAVIA & GERMANY. 4670



Apply THE KIRKSTALL FORGE CO., near Leeds. 4036

"STANDARD" STEAM BOILING NOZZLE

FOR

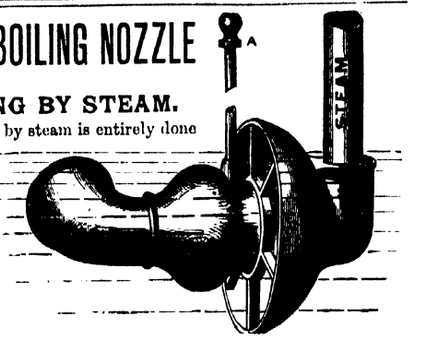
HEATING OR BOILING BY STEAM.

The objectionable noise when boiling by steam is entirely done away with, and the liquor Heated or Boiled QUICKLY, ECONOMICALLY, and SILENTLY.

½ ¾ 1 1½ 2 3 4 in. pipe

50/- 60/- 65/- 100/- 130/- 175/- 260/-

NUMEROUS TESTIMONIALS. 4091



PICKING, HOPKINS & CO.

BOW, LONDON, E.

—: MAKER OF :—

SUGAR, RICE AND FLOUR MILLS, STEAM ENGINES, Boilers, LINOLEUM MACHINERY.

SUGAR MACHINERY

JAMES LANDALE,

Engineer, KIRKCALDY, N.B. 4945

THE BOWLING HOOP

STEEL CASTINGS OF EVERY DESCRIPTION IN IRON OR STEEL

THE BOWLING IRON Co LTD

BRADFORD YORKS

ORIGINAL PATENTEES AND SOLE MAKERS

4567

East Ferry Road Engineering Works Co., Limited,

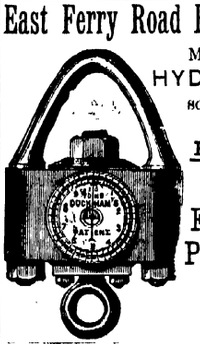
MILLWALL, LONDON, E.

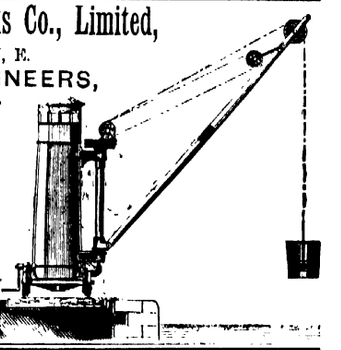
HYDRAULIC ENGINEERS,

SOLE MANUFACTURERS OF

Parkes's Patent Portable Hydraulic Cranes, Lifts, and Hoists.

F. E. Duckham's Patent Suspended Weighing Machines. 5123





JOHN BELLAMY,

BYNG STREET, MILLWALL, LONDON, E.,

MANUFACTURER OF

CORNISH, LANCASHIRE & VERTICAL BOILERS

IN IRON OR STEEL.

WROUGHT IRON AND STEEL BUOYS OF EVERY DESCRIPTION.

Tar Stills, Steam Pans, Jacket Pans, Shoots, Hoppers, TANKS, CISTERNS, *&c.*

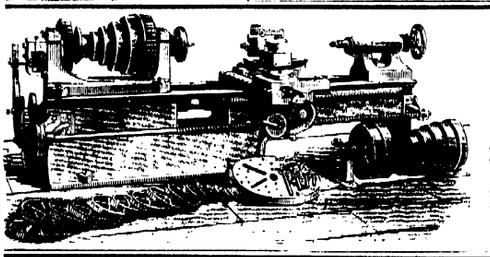
PATENTEE AND SOLE MAKER OF

BELLAMY'S PATENT TUBULAR BOILER,

Unsurpassed for quick Steaming and Economy of Fuel. Also

BELLAMY'S PATENT HEATING BOILER,

SPECIALLY ADAPTED FOR HORTICULTURISTS. 4022



SPECIALITY IN LATHES.

SMITH & WILSHAW,

HALIFAX, ENGLAND

Makers of all kinds of

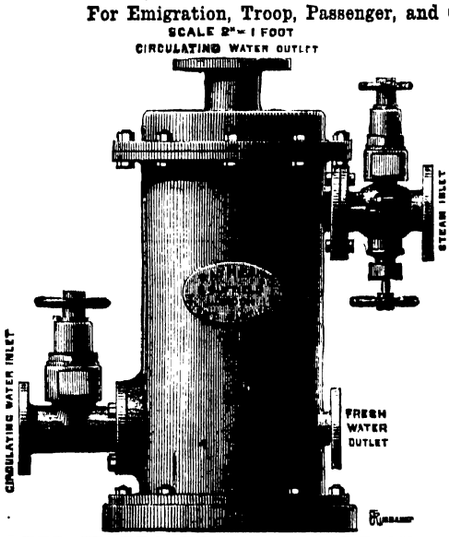
Improved Self-Acting, Sliding, and Screw Cutting Lathes,

For Foot or Power. 4608

PATENT VOLUTED FRESHWATER CONDENSERS

(SANCTIONED AND APPROVED BY THE BOARD OF TRADE),

For Emigration, Troop, Passenger, and Cattle Ships. Also



Surface Condensers

FOR ENGINES, REFRIGERATORS, BREWERS, &c.

Smallest and Best in the Market.

Made entirely of Sheet Copper, BRAZED TOGETHER, with Gun-Metal Fittings

Gallons per day.	Dimensions. Dia.	Height.
750	7 in. ×	14½ in.
1000	9½ in. ×	16 in.
2000	10½ in. ×	24 in.
3000	12½ in. ×	24 in.
4000	14 in. ×	26 in.
6000	14 in. ×	32 in.

This quantity is guaranteed perfectly cold and fit to drink at exit.

The Highest Testimonials and Price Lists ON APPLICATION TO

SUFFIELD & BROWN,

Coppersmiths & Sole Manufacturers,

JAMES ST. AND DEVONPORT ST.,

Commercial Road East, London, E. 4684

TELEPHONE No., 5307.

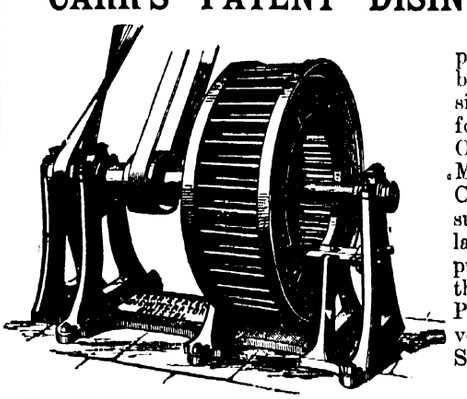
FEED WATER HEATERS MADE ON THE SAME PRINCIPLE.

"CARR'S DISINTEGRATOR,"

Registered Trade Mark, No. 6380.

AWARDED BRONZE MEDAL, PARIS UNIVERSAL EXHIBITION, 1878.

CARR'S PATENT DISINTEGRATOR.



This Machine effectually pulverizes by the combined influences of percussion and of centrifugal force, Iron, Zinc, and other Ores; Asphalte, Artificial Manures, Phosphates, Fire Clay, and many other substances. It is also largely in use for the pulverization of Coal for the manufacture of Coke, Patent Fuel, &c.; and is very effective for mixing Sugar.

These Machines are capable of reducing to a fine granular powder from 50 to 200 tons per day (according to size) of any unfibrous material. Machines made to order from 18 inches diameter, to suit special requirements of purchasers; these small machines being specially adapted to the requirements of Chemical Manufacturers for Mixing and other purposes.

No Agents. All Machines will in future bear the Registered Trade Mark ("Carr's Disintegrator") in three places—viz. on Bedplate, and on outside Face of each Cage.

A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee, 2523

PHILIP TRIGGS, Albion Chambers, BRISTOL.

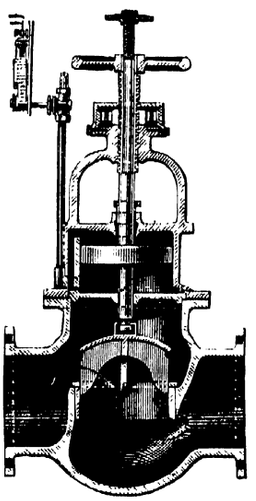
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FOR STEAM ENGINES.

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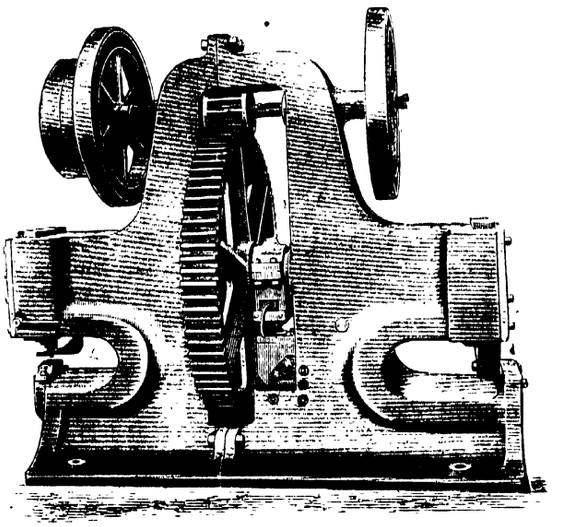
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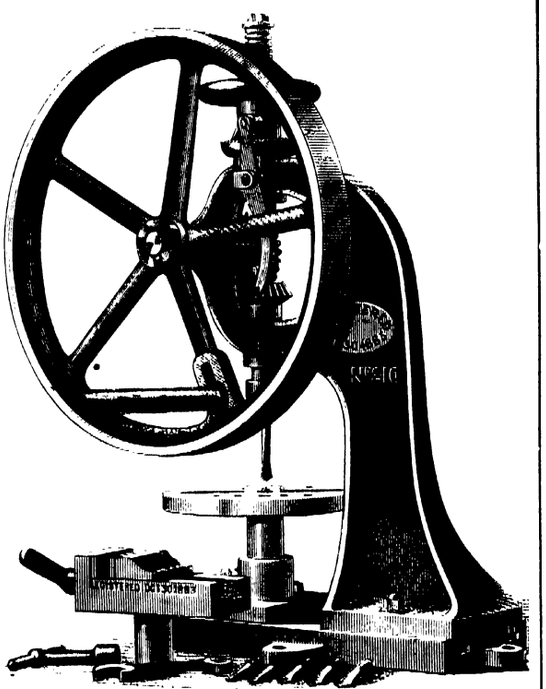
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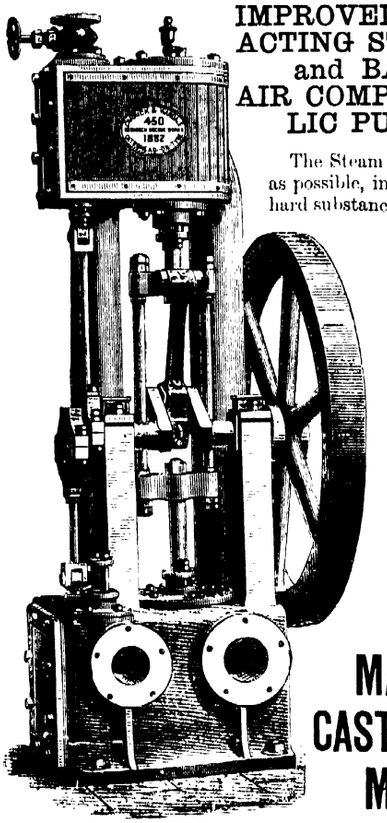


4128

No.	Height.	Weight.	Depth of Feed.	Diameter of Table.	Drills up to
210	2 ft. 3 in.	100 lbs.	2½ in.	9½ in.	⅝ in.

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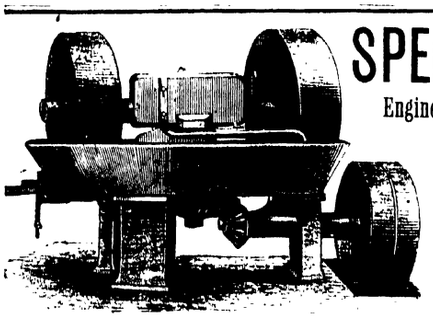
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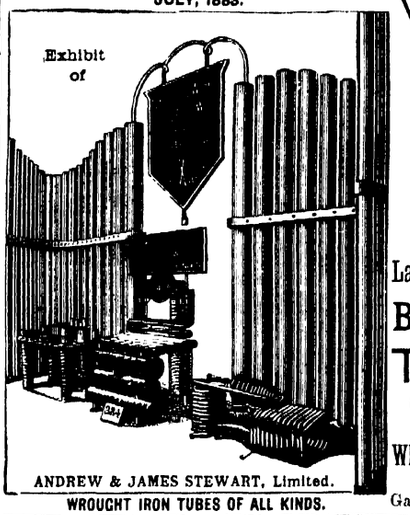
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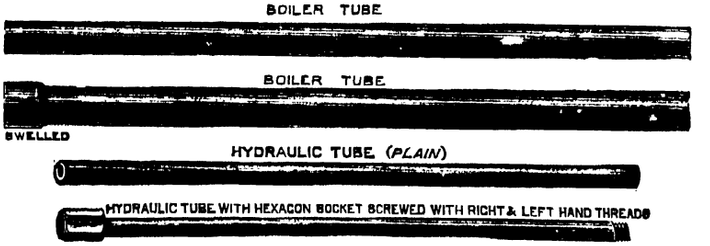
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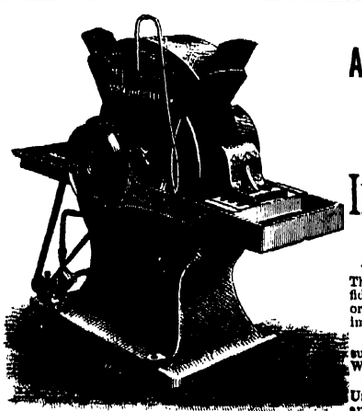
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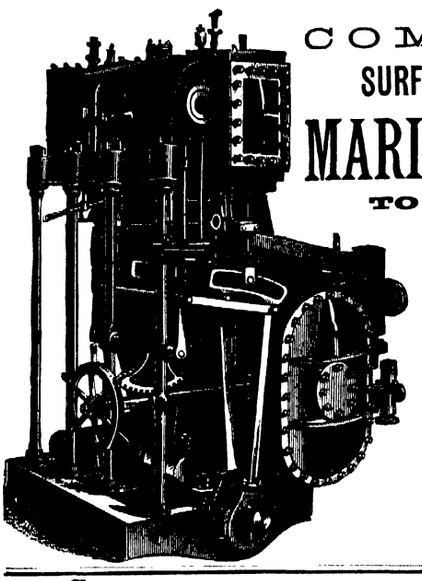
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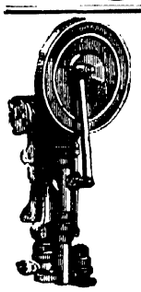
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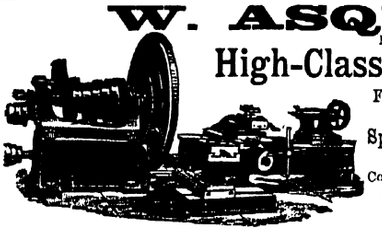
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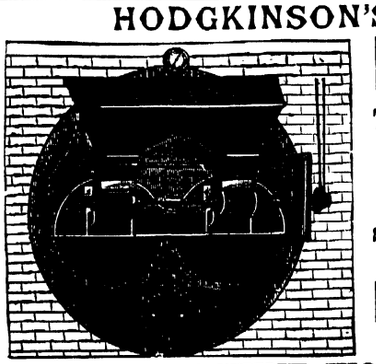
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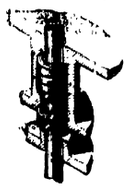
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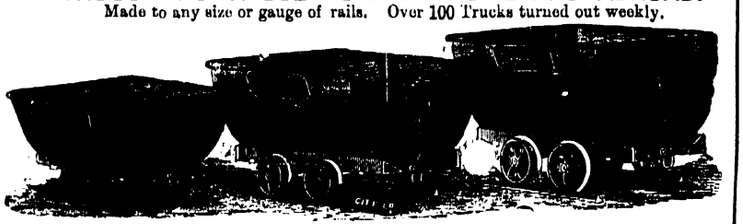
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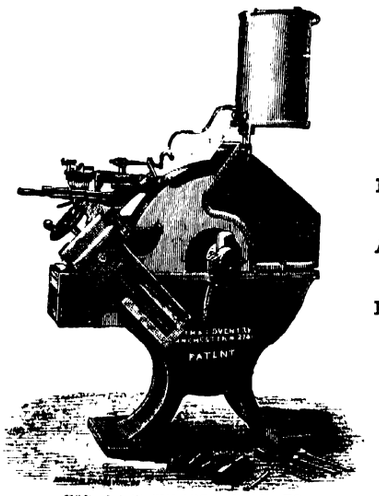
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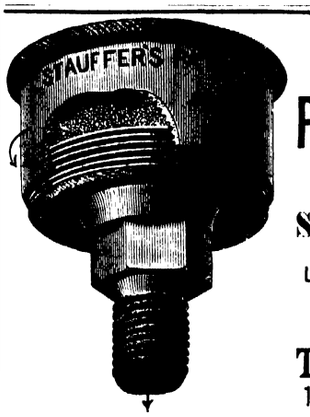
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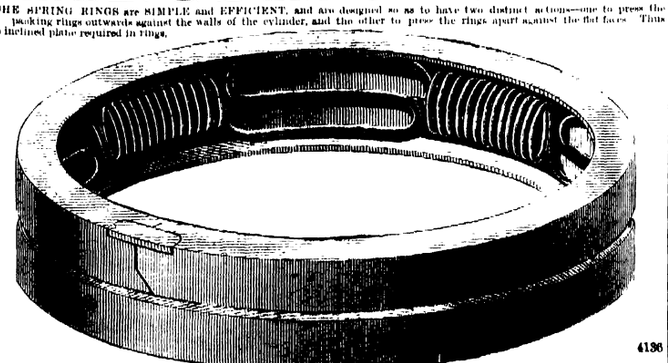
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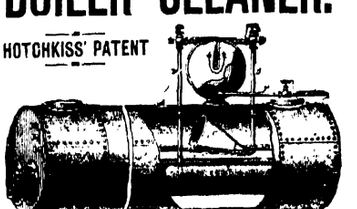
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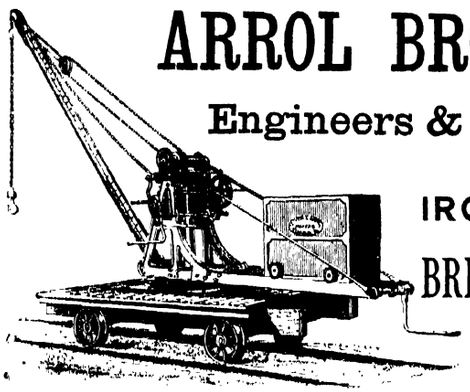
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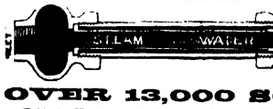
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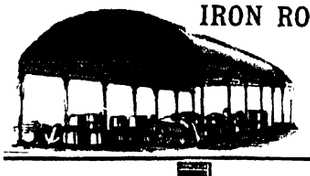
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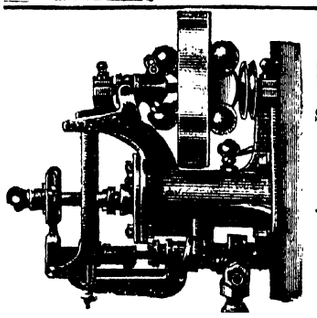
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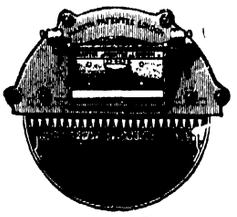
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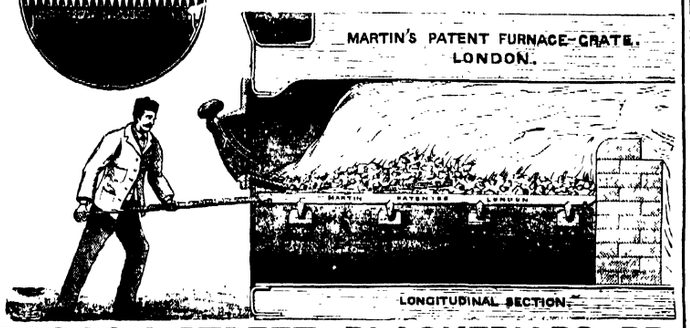
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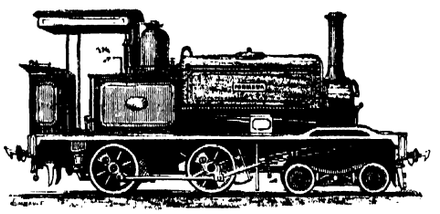
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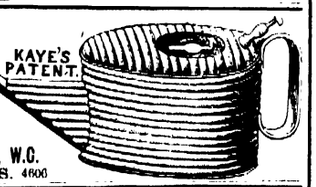
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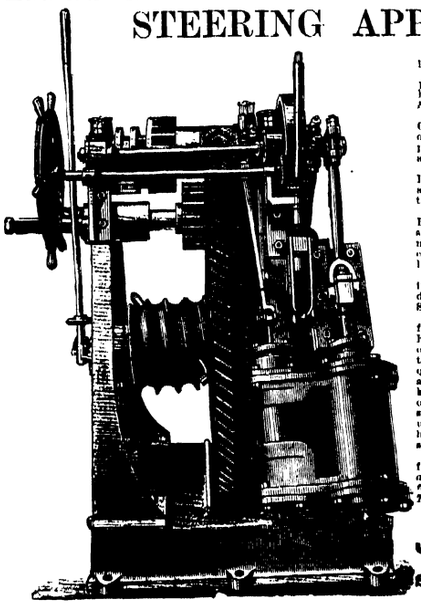
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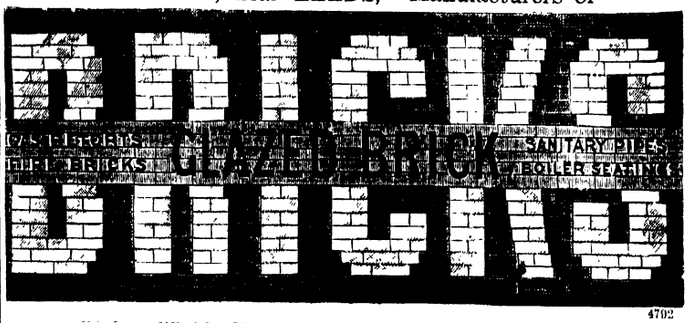
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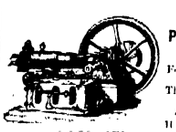
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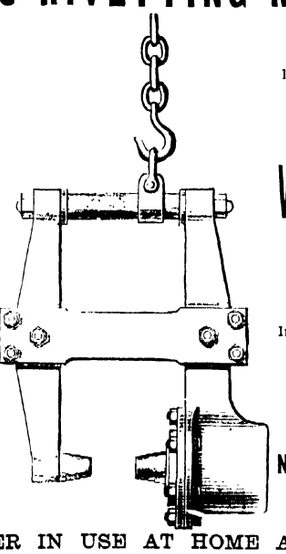
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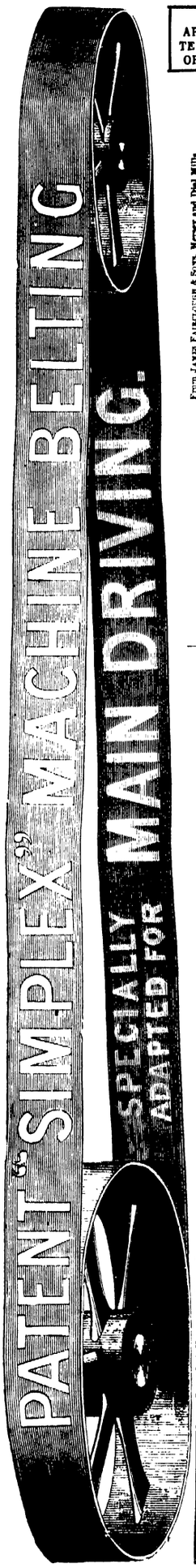
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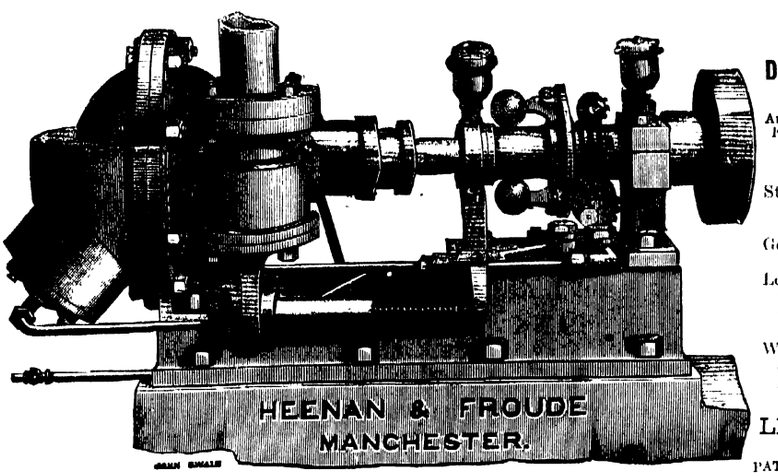
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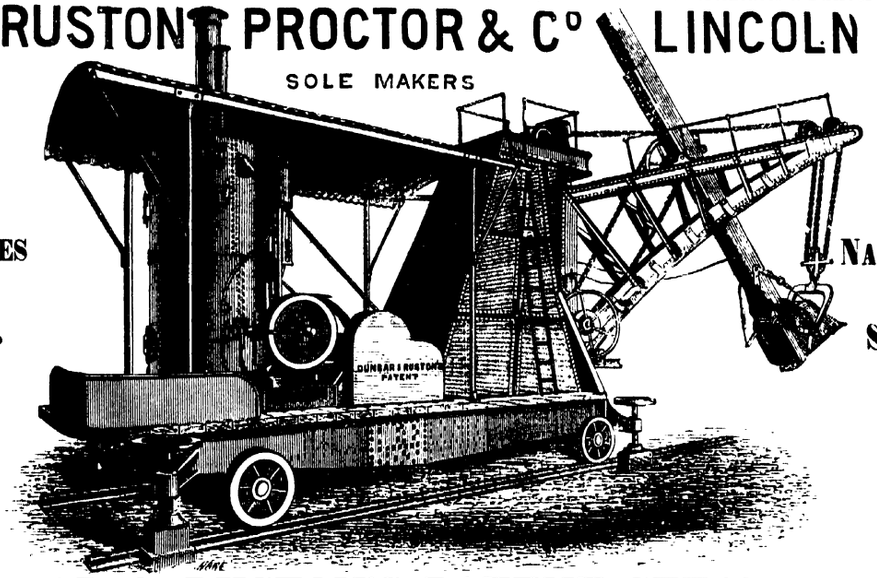
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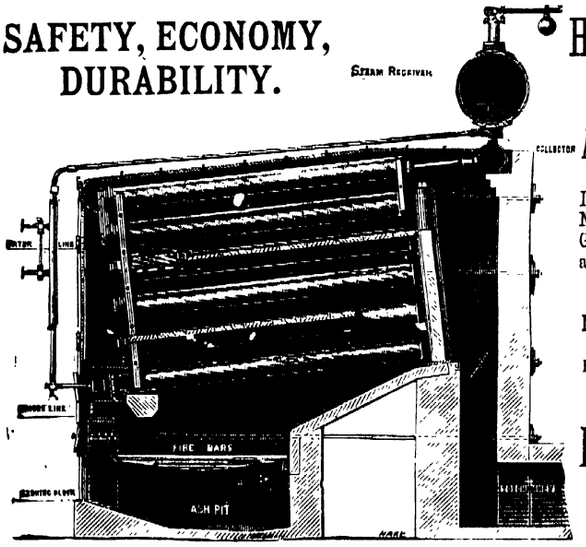
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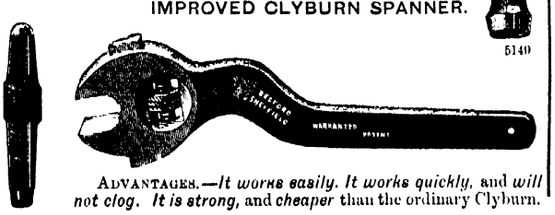
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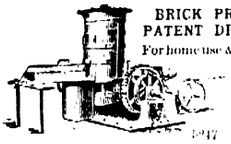
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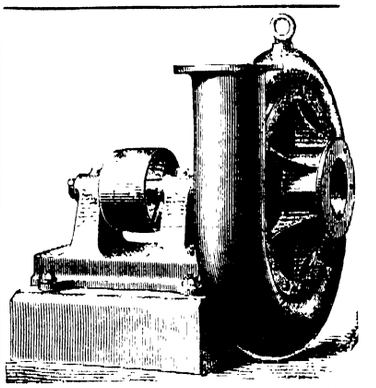
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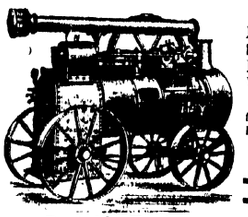
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Single Cylinder, 4 to 12 HP. nominal
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Portable and Semi-Portable Engines, Semi-Fixed Engines and Boilers, Horizontal Engines, Vertical Engines and Boilers,

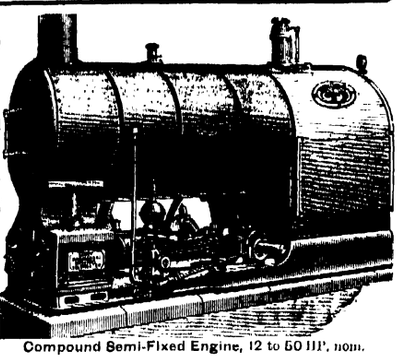
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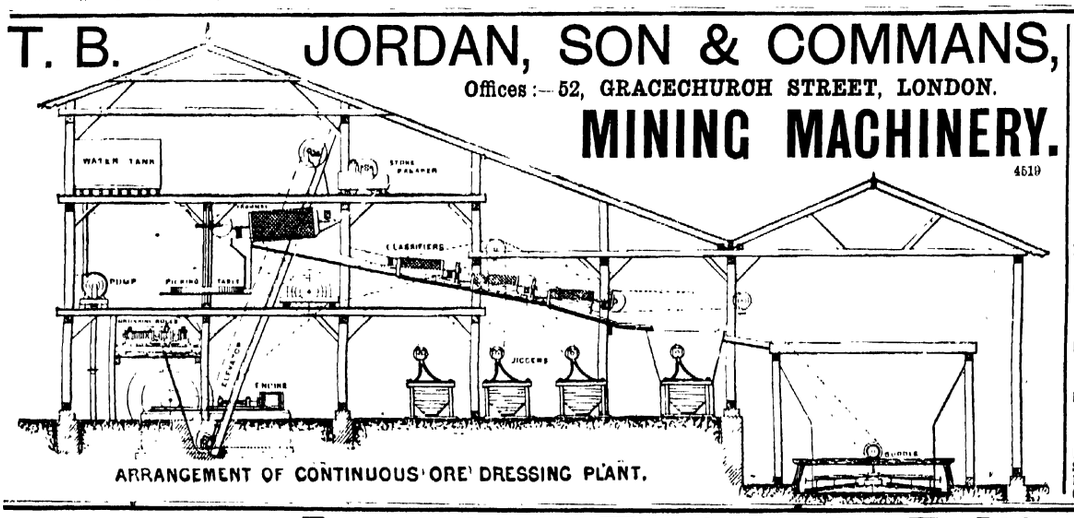


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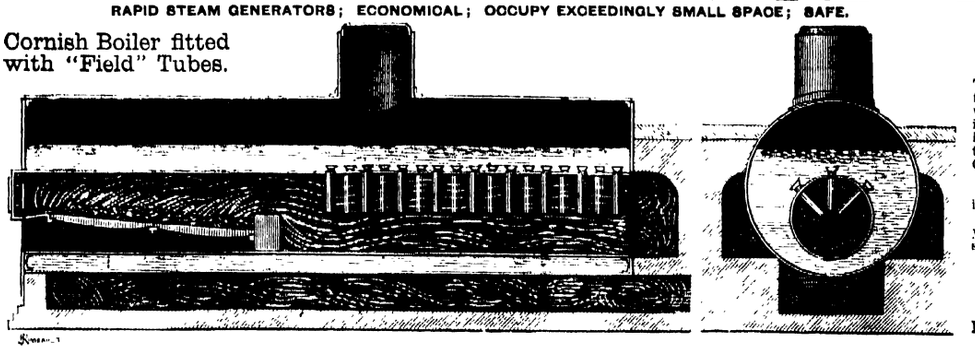
AT the Bath and West of England Show, held at Maidstone, from the 2nd to the 6th June, various belts were in use on the Machinery in motion there. On the 4th, about noon, the rain came on, and continued up to the close of the Show on the 6th. *During the whole of the rain, out in the open,* one of GANDY'S PATENT AMERICAN COTTON BELTS *continued to do its work satisfactorily,* driving a set of Messrs. TAYLOR & NEATE'S, of Rochester, 12 in. three throw Slurry Pumps. This was the only Belt that continued to work in the rain. All the Leather and Rubber Belts *had to be taken off, owing to their inability to drive in wet weather.* This fact alone speaks volumes. How long will it take to convince Englishmen (the Americans are already convinced) that the "GANDY" BELT is the **CHAMPION** Belt of the **WORLD?** 3149

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FIELD'S PATENT BOILERS.

RAPID STEAM GENERATORS; ECONOMICAL; OCCUPY EXCEEDINGLY SMALL SPACE; SAFE.

Cornish Boiler fitted with "Field" Tubes.



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INFANT ORPHAN ASYLUM, WANSTEAD, March 3rd, 1884.

GENTLEMEN,—I have pleasure in reporting that the "Field" Patent Tubes which you inserted in our Cornish Boilers give every satisfaction. Our coal consumption in each of these boilers was 5½ tons per week, and we had difficulty in keeping steam before the Tubes were inserted. We now have plenty of steam, and our coal consumption is 4 tons per week; and the results have been altogether so satisfactory that we are preparing a third boiler to be fitted.—I am, Gentlemen, yours truly, (Signed) R. J. HAMMOND, Engineer.

We have just received the following testimonial from a customer in Grahamstown:—

GENTLEMEN,—I have fixed the 38 in. Field Tubes I received from you in my boiler, and they are acting splendidly. I reckon they save me at least 33 per cent. of fuel.—Yours faithfully,
(Signed) J. McLEOD,
Caledonian Iron Foundry.

FIELD'S PATENT TUBES.

Easily fitted in Cornish, Egg-ended, Cross Tube and other Boilers.

Licensed Manufacturers: **LEWIS OLRICK & CO.,** 5045

Offices: 27. LEADENHALL STREET. LONDON. E.C. Works: MANCHESTER.

LITERATURE.

A Treatise on the Application of Wire to the Construction of Ordnance. By JAMES A. LONGRIDGE, Memb. Inst. C.E. London and New York: E. and F. N. Spon. [Price 25s.]

AFTER thirty years spent in vain endeavours to persuade the English Government to adopt his system of building up wire guns, Mr. James Atkinson Longridge has at last given up the attempt and published a book on the subject, under the above heading. We cannot help feeling sorry that a valuable work like this should be placed at the disposal of the world generally, when the information contained in it might have been devoted only to the interests of the nation. However, as we have said, Mr. Longridge has now made his views public property, and we cannot blame him in the matter; the only wonder is that he has waited so long. The public will now be able to judge whether he has been treated as he deserves to be; but we are afraid that there is good ground for the charge that the Woolwich authorities are slow to adopt outside views until they are actually obliged so to do, and that when this is the case, the invention adopted is modified with some arrangement of their own that may, or may not, be an improvement.

The theories of the author, and the reasons given for their maintenance, may be summarised as follows, principally from the opening chapter, which contains the copy of a letter written in March, 1882, by the author to the Right Honourable Hugh Childers, the then Secretary of State for War:

1. "That the introduction of a slow-burning powder is a retrogade step, and is introduced, not because it gives the best results, but because we cannot build guns strong enough to burn the quick powder in; and further, that weight for weight, the quick powder gives the best results."

He argues that the quick-burning must develop more force than the slow-burning powder, because with the latter we have a uniform pressure from the moment of ignition up to the instant of the projectile leaving the gun, hence the powder, if entirely consumed at all, can only be consumed just as the shot leaves the muzzle, and that therefore the whole force of gas from the powder is not evolved until the moment of the shot leaving the muzzle, while in the case of the powder that is ignited at once, the total amount of gas is doing work the whole time. In an 8-in. gun, in which the length of barrel was 112 in., and the charge 35 lb. of pebble powder, the initial velocity was 1374 ft. a second. If (the author says) the whole of this powder were converted into gas before the shot moved, we should have an initial velocity of 1780 ft. a second.

2. That the theory propounded by Colonel Maitland, R.A. (of the Royal Gun Factories at Woolwich), at the Society of Arts on February 8, 1882, is entirely untenable. This theory is that "the velocity with which a strain is transmitted through steel or iron is so slow compared with the duration of the pressure of the explosion, that the strain does not reach the outer portion of the gun till it has nearly or altogether passed away from the interior in the case of quick-burning powder, but that with slow powder the outside has time to bring up its strength to reinforce the interior to a greater or less degree.

This he proves on the assumption that the transmission of strain through a material is equal to the velocity of sound in that material, and taking the pressure and velocity diagrams of the Committee on Explosives, he shows that the time to transmit the strain in the case of an 8-in. gun used by them with R.L.G. powder, was only about one-third that during which the explosion lasted, and that therefore the internal pressure had ample time to strain the gun through before it was removed.

3. That the Elswick guns have always been and are at the present time in advance of Woolwich. This is a dogmatic statement, which the author appears to think requires no proof, as we do not see any reasons given in support of the statement, beyond the assertion that the Elswick manufacture is conducted on more scientific principles than that at Woolwich.

4. He claims to have solved the question of wire gun construction 22 years ago, and to have made a gun on these principles which was perfectly successful in every respect. This is a very important statement, and it is a pity that the author does not go more into details as to how the gun was tested, &c. From his explanation, however, of the failure of the principle, or rather of his gun, when tried by the Ordnance Committee, and our knowledge that guns are now being constructed more or less on these principles, we can only infer that there was a great amount of official short-sightedness somewhere at the time.

5. He maintains that Sir William Armstrong's theory that: "In hooped guns critical nicety in the contraction of each coil is not important, providing that the actual contraction be on the excess side of that which is mathematically correct," is untrue.

The author sustains this statement in Chapter XIV. of his work. This chapter contains tables and diagrams, comparing the tension at rest and under fire, of guns built up with different tensions of laying on. These, if the author's formulæ can be relied on, show conclusively that for a particular pressure there is a certain laying-on tension which gives the best results, and hence any excess must take away from the strength of the gun.

6. He condemns the practice of chambering guns, since in muzzle-loaders it weakens the longitudinal strength, and in breech-loaders it increases the longitudinal strain.

As an example of this, in a 12-in. gun chambered out to 14 in., the excess of longitudinal strain in the latter case over the former, is not less than 820 tons.

7. The longitudinal strain should be provided for by an arrangement separate from that giving circumferential strength.

In Chapter XXI. the author gives his reasons for this assertion. The main point of this reasoning is that no material can resist the joint action of two tensile strains perpendicular to each other, and that, therefore, each strain should have its own support.

Such are the premises with which the author starts. He then proceeds with the work in hand, and:

1. He compares the hooped and wire gun construction, giving a verdict in favour of the latter. In the former case he considers the chief difficulties to be:

(*a*) The extreme accuracy of workmanship required in boring and turning the immense masses of material.

(*b*) The impracticability of insuring the modulus of elasticity which has been assumed in the calculation.

(*c*) The contingency of latent defects in the heavy forgings or castings which are used.

These difficulties can be overcome in the wire construction because:

(*a*) The exact amount of tension in each wire can be insured as it is being laid on.

(*b*) There is no difficulty in ascertaining the exact modulus of elasticity.

(*c*) There is no risk of latent defects.

Finally, the cost of construction is vastly less.

The all important question as to what the tension of the wire should be, depends on a number of variables:

1. The maximum internal pressure.
2. The limit of tensile strength allowed for the wire, and which should not exceed its elastic limit.
3. The limit of tensile strength of the material of which the core is composed.
4. The limit of compressive strain of the same material when the gun is complete and at rest.
5. The ratio of the modulus of elasticity of the core to that of the wire.
6. The ratio of the internal radius to the external radius of the coil or tube.
7. The ratio of the internal to the external radius of the wire coil.

The author then proceeds to give investigations and formulæ as follows:

1. Investigation of the state of the core considered as a homogeneous cylinder.
2. Determination of the internal strain when the tensions of the surfaces are given.
3. On the shrinkage equation.
4. Determination of tension of laying-on wire.
5. Investigation of laying-on tension and condition of gun when the normal forces are taken into account.
6. Uniform tension of laying on the wire.
7. Investigation of the conditions of the core when the extension of the wire is uniform under fire.
8. Determination of the radii of the core and coil.
9. Application of formulæ.
10. Examination of the Schultz 34 cm. gun and Armstrong 13-in. wire gun.

A chapter is then devoted to "Chambering and Slow-burning Powder" (which amongst other things contains a comparison of a gun proposed by the author with Sir W. Armstrong's 13-in. gun), and another to combating the objections to the use of wire.

Then come details of construction and concluding remarks. In the latter the author asserts that he has shown in his investigations that:

1. Cast iron or some other material having a low modulus of elasticity, is an excellent material for the core of the gun, and as a further proof, the author gives certain details of an experimental gun, designed by the late Captain Blakely, R.A. The gun, according to this account, did wonders, but the Ordnance Committee reported "that, taking into consideration the different expansive powers of wrought and cast iron, they are of opinion that guns so constructed could never be considered safe."

2. That the thinner the core the better, provided it has sufficient strength to carry the rifling and resist transverse fracture from external force.

This he proves by a reference to the formulæ mentioned before, and which go incontestibly to prove the truth of his statement. Further, he points out the guns of Captain Schultz and Sir William Armstrong, referred to in Chapter XX., as showing very strikingly the disadvantages of a thick core.

Such is the gist of the information now made public property, and as we look at the manner in which the construction of guns has been approaching that indicated by Mr. Longridge, we cannot help wondering at the patience displayed by him, and the denseness exhibited by the authorities in allowing this knowledge to thus slip through their fingers. Even now, at the eleventh hour, we hope justice may be done the mathematician, engineer, and inventor combined, and that a trial may be made of his system in detail. Not a few of the principles caught up and worked out by crude hands, as appears only too likely to be the case, but the whole thing carried out under the superintendence of the inventor himself. Thus, and thus only, would the system have a fair trial. In conclusion, we would warn our readers against criticising Mr. Longridge's principles from the rough sketch we have given here. Space does not permit us to enter fully into the matter, and those who wish to criticise should read the book, and do so from the work itself. We hope shortly to publish a further criticism on the work ourselves.

SECONDARY BATTERIES.—No. II.*

By THOMAS WILKINS.

IT was while endeavouring to form a circuit in which an electric current could be generated without the intervention of a fluid, that De Luc devised the "dry pile," subsequently improved by Zamboni in 1819. Zamboni's pile consists of upwards of a thousand discs, cut out of sheets of paper, one side of which is coated with thin silver, tin, or zinc foil, and the other side with finely powdered black oxide of manganese, slightly moistened and rubbed on with cork. The discs are placed with their similar sides all one way, and are generally confined in a glass tube of about three-fourths of an inch internal diameter. The ends of the tube are closed with caps through which a rod passes, by means of which the discs can be pressed together. A dry pile will remain effective for many years. A pile of 1000 or 2000 discs, as ordinarily made, would not give a spark, but it can be used to charge condensers, although its action is slow. Zamboni ascertained that the action is really due to the slight moisture absorbed by the paper from the atmosphere. The action is stronger in summer, when the percentage of moisture in the atmosphere is large, than in winter, when there is considerably less moisture in the air. It is a pile of this kind, but of 11,000 discs of material coated on one side with tin and on the other side with copper, which has recently been used as a miniature accumulator by Messrs. Elster and Geitel, of Wolfenbuettel. These gentlemen have also constructed similar dry piles of one metal, lead, placed between discs of paper, one of which was left dry, the other being coated with oxide of lead. The same results as obtained by them would have been attained by coating a sheet of paper with lead on one side and oxide of lead upon the other, instead of tin and oxide of manganese as used by Zamboni.

In the communication to the "Annales de Chimie," in which this pile is described, Zamboni relates some of his experiments which led up to the

* See *ante*, p. 1.

arrangement above mentioned, which he called "binary pile," because he found it possible to make piles of the paper coated with tinfoil, or other metal, without the binoxide of manganese. These circuits were made up of a metal and "humid" element, which it was necessary should be an imperfect conductor. It was also necessary that the two elements should be in contact at unequal surfaces. To repeat one of Zamboni's experiments, take tinfoil and cut it into squares of about ½ in., but with a very fine tail 2 in. or 3 in. long from one corner of each square. On a well-insulated surface place some thirty watch glasses all filled to a like depth with distilled water. Make the communications as in Volta's *couronne de tasses*; placing the tinfoil in the glasses in such a way that a whole square is in each watch-glass, but that its fine tail only just touches the water in the next glass. Leaving the circuit open, join one of its ends to earth, and the other to a good condenser. This will show that the arrangement has two poles, the squares are positive. A similar arrangement in which rectangular strips of tinfoil were used instead of the squares with tails, gave no sign of electricity when equal parts of their ends were immersed. Directly there was inequality of immersion electricity was manifest at the poles. The same pole could, in this arrangement, be made alternately positive and negative according to the surface of the metal immersed. Zinc and copper gave similar results to tin. Paper coated with oxide of zinc gave no effects.

In these experiments the condenser was not instantaneously charged; but the electricity manifested its presence in about half a minute. Zamboni at first thought the current was due to oxidation of the tin or other metal; but at the end of three days, though the electric tension was the same as at the first, there was no trace of oxidation. Moreover, a further proof that the electricity was not due to oxidation, was, in Zamboni's opinion, the fact that, when zinc was used, it did oxidise, but as it did so, the electric tension was diminished, and quickly became *nil*, and electricity of opposite character soon began to show at the respective poles.

A pile constructed of ten discs of tinned paper, without the assistance of any other substance, gave to a condensing electrometer a repulsion of ½ in. The metal face was positive, the paper face negative. The effects increased steadily with the number of discs.

Another pile of tinned paper discs which were coated on their reverse sides with honey to give a more constant humidity, also gave electricity; but forty or fifty discs were needed to give the same tension as the ten discs of paper. Moreover, the metal was now negative, and the honey positive. The following day there was no tension; the honey having penetrated the paper, the tin was in contact with honey equally on both surfaces. When a tinned paper pile became inert it could be rendered active by rasing the discs and exposing the surfaces to the air. In this way the influence of the moisture on the two faces of the metal was rendered unequal, when the discs were replaced.

A few drops of solution of chloride of ammonium put into the distilled water in the watch glasses in the experiment above alluded to, slightly augmented the tension; the further addition of a few drops decreased the tension; and with still more it came altogether to nothing. Hence Zamboni considered it essential that the liquid element should be a non-conductor.

In constructing dry piles with tinned paper and black oxide of manganese, Zamboni recommends that it should be ascertained that the paper used is of the same polarity to the tin as is the oxide of manganese alone. He, however, adds that whatever kind of paper be used, if it be first impregnated with sulphate of zinc and dried, its polarity will be the same as that of the oxide to the tin.

Zamboni preferred dry weather for making his piles. After the reverse side of the tinned paper had been coated with sulphate of zinc it was allowed to dry naturally, without drying out the natural moisture of the paper, and then the reverse side was coated, as above described, with the oxide of manganese. A fine unsized paper should be used. If the paper is sized, alcohol should be added to the solution of zinc sulphate. The best way to preserve the pile is to keep it in a glass tube of rather larger diameter than the discs, and to fill in the space with a warm cement of wax melted in turpentine. A pile of this description containing 2000 discs, gave a spark visible in daylight.

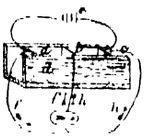
The next step in the development of the voltaic circuit was that announced by Ritchie in 1829, to the effect that he had obtained an electric current from plates of similar metal immersed in a fluid, *i.e.*, in a circuit consisting of only one metal and one fluid. Zamboni can hardly be said to have obtained a current. This was effected by hardening one of the plates by hammering it upon an anvil. In the case of zinc, copper, iron, and brass, the hardened plate answered to the negative pole, and the soft one to the positive pole. It is, however, curious to observe that in the case of soft steel and tempered, the opposite effects were noticed; the steel hardened by tempering being the positive pole, while the soft steel was the negative pole.

In 1832, Ritchie, with a galvanic cell constructed of a narrow U tube, *a* Fig. 6, the extremities of



FIG. 6.

which were connected with wide vessels *b* and *c*, tried the effect of using plates of different sizes. He came to the conclusion that there was no advantage in using a plate of larger area than a section of the liquid conductor in the narrow tube, whatever that might be. He also suggested that in Ritter's secondary piles there was an electric fluid, on or in the plates, which fluid became polarised, the one side of the plates becoming negative and the other positive. He came to this conclusion from the following experiment: Three very thin copper plates, 2 in. square, *a b c*, Fig. 7, were cemented into a



wooden trough *d*. The spaces between the plates were filled with dilute acid. The two outer plates were then connected to a galvanic battery *e*, so as to form a circuit, and a current was passed. The battery was then disconnected, and plates *a b* were connected to a galvanometer *g*; a deflection was obtained, which showed a current from *a* to *b* in the direction of the arrow *f*. Afterwards plates *b c* were connected with the galvanometer, and the deflection then obtained showed a current from *b* to *c* in the direction of arrows *h*. Thus *b* was a positive pole with respect to *c*, and a negative pole with respect to *a*. He therefore considered that the electric fluid, which he supposed to exist on or in the plate *b*, retained its polarity, owing to the coercitive force of the metal of which the plates were composed. He speaks of this supposed electric fluid as consisting of molecules composed of atoms of positive and negative electricity, each molecule being possessed with polarity, and with a tendency to unite at opposite points; and suggests that in the zinc and copper plates of a battery these opposite poles become arranged facing each other, and hence react on each molecule of the chain of liquid molecules of the electrolyte between them.

Faraday was, at this time, prosecuting his researches on induction, and formed the opinion that particles of matter forming conductors, when under the influence of a current in a neighbouring conductor or of a magnet, assumed a regular but forced electrical arrangement in the direction of the current, which arrangement, if the matter forming the conductor were non-decomposable, produced, when the constraining influence was removed, a return current. If, however, the conductor consisted of decomposable matter, he considered that the constraining influence might subject it to such forced condition as to make an elementary particle leave its companion particle, with which it is in a constrained condition, and associate with a neighbouring similar particle, in relation to which it might be in a more natural condition; the forced electrical arrangement being at the same time discharged or relieved, as if the conductor had been freed from the effects of induction. He also thought that, in the circuit carrying the inducing current, a similar constrained state was being assumed and discharged. He, however, subsequently withdrew his opinion, on observing that currents excited in conductors moving in the neighbourhood of magnets, were dependent on the intersection of lines of magnetic force; and that conductors in which a current was passing, had magnetic circles surrounding them. Seeing that these magnetic circles differed in intensity as they were more or less close to the conductor, and were analogous to those which exist between two contrary magnetic poles, he considered that they gave a perfect reason for the effects produced in conductors, and removed any necessity for supposing that the material of the conductor itself had assumed the constrained state previously alluded to. He, however, continued his investigations on this subject, and in the following year, 1833, reviewed the theories as to the condition of the particles of matter charged with electricity not in motion, and their condition when an electrical current passes. He thought it necessary first to give some definite view of what is called the voltaic current, because there were great differences of opinion as to the state of wires or other substances carrying voltaic electricity, and "ordinary" (*i.e.*, frictional) electricity, such view being in contradistinction to any supposed peculiar state of arrangement, not progressive, which the wire, or the electricity it carried, might be thought to assume.

As an example, he took two batteries *a b*, Fig. 8,

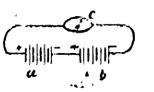


FIG. 8.

insulated them, and joined the positive pole of one and the negative pole of the other to a galvanometer *c*. Then he completed a circuit by joining the negative pole of the battery *a* to the positive pole of *b*, by doing which he obtained a considerable permanent deflection of the needle. The inference he drew was, that if batteries act by causing a peculiar arrangement of the particles of a wire, or of the electricity which may be supposed to be in the wire, that arrangement itself constituting the electrical and magnetic state of the wire, then the wires connecting the two batteries to the galvanometer should have been in the same condition before the other poles of the two batteries were joined as afterwards; at least to the extent of one-half the deflections. If, however, the magnetic effect is dependent on a progressive current, the reason of the deflection on joining the last-mentioned poles is obvious, for before that was done there was no circuit in which the current should circulate. By the term "arrangement" a local adjustment of the particles of the conductor, or of a fluid in or upon it, or of a force or forces, in contradistinction to a progressive action along the conductor, is to be understood. He brought forward numerous instances to show the similarity of the effects produced by electricity, whatever the source from which it was obtained might be; but showing that the effects of electricity were, in some cases, noticeable because of its intensity, and in others because of its quantity. Hence he considered that whatever means might be adopted to generate it, it was always identical in nature.

Faraday's views were favourable to the theory which assigns to chemical agency the origin of electricity; and, although his opinion finds fewer followers now, owing to more recent experiments, especially those of Sir William Thomson, which will be reviewed in due course, it is always well to consider both sides of a question impartially. It is, therefore, felt that no excuse is needed for bringing forward the views of so eminent an electrician, although some may now consider them exploded.

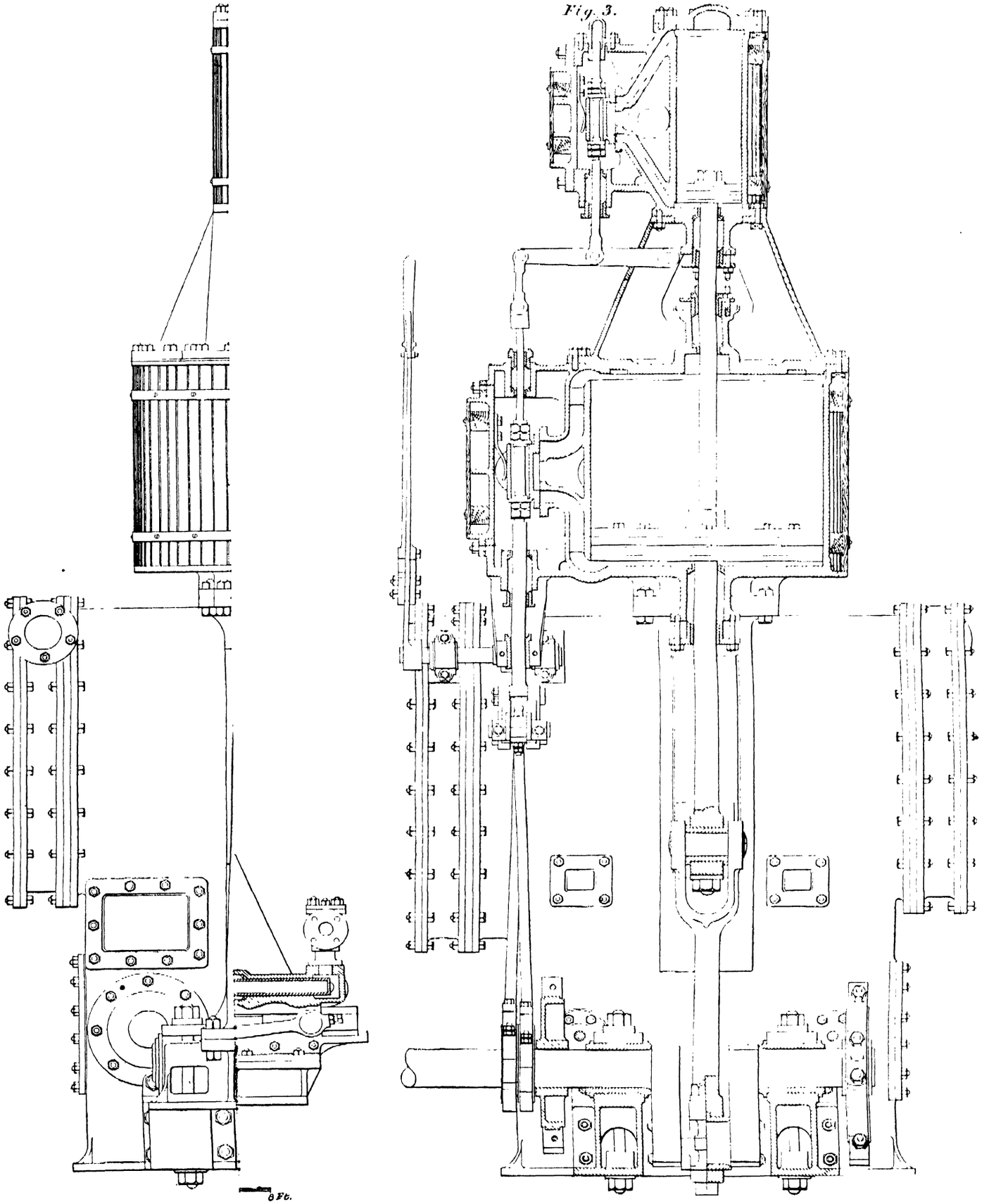
CANADIAN PACIFIC RAILWAY.

No. XIV.

PORTAGE LA PRAIRIE TO REGINA.

AT Portage la Prairie an important feeder to the Pacific Railway turns off in a north-west direction, which is ultimately intended to strike the Saskatchewan River at Fort à la Corne, below the Forks, and some 350 miles from the portage. This line, the Manitoba and South-Western, is subsidised by the Government with a grant of land, which is sold to the company at less than 1 dol. per acre, and which is worth, when the line is complete, from 3 dols. to 5 dols. per acre, and it is expected by this

S.S "ARABIAN."



means that the railway will ultimately cost its proprietors but very little. During the last year some 50 or 60 miles were opened for traffic, and it passes through a magnificent country, which is already fast filling up with an excellent class of settlers. At Melbourne, 99 miles from Winnepeg, another and more important line, the Souris and Rocky Mountains—a strangely misnamed road, as Souris is south of the Pacific line, whilst this is entirely to the north of it—comes into the main line, and is intended ultimately to strike the valley of the North Saskatchewan, some 600 or 700 miles from its starting point. It is graded as far as Rapid City, where it will cross the Little Saskatchewan. Still following the old western trail, the main line of the Canadian Pacific Railway leaves the valley of the crooked Assiniboine to the south, and again joins it at the foot of the Rapids, where it crosses the river into the town of Brandon, 133 miles from Winnepeg, and the end of a locomotive division.

Brandon House was an old fort of the fur traders of the North-West Company, and it more than once figured as the rendezvous where the Indians and half-breeds met for the fray, or to plunder the forts of some of the traders within snow-shoeing or canoeing distance. The modern history of the town is very recent, and the first white child born here, a grandson of the late Sir William Colles, is not yet three years old. In May, 1881, the Pacific Railway Syndicate decided to change the route from the more northern line that had been staked out, and to cross the river at this point. Surveys were going on for two or three months before this, and prospectors were watching eagerly the stakes as they were driven, for where the bridge across the river was there would be a station and a town. Squatters took possession of every quarter section, and as soon as the decision was known, lots were surveyed and houses began to grow on every desirable place round the probable station ground. Pleasantly situated just west of the river crossing, on higher land than any that has so far been encountered, it commands a glorious view of the Grand Valley eastward, the beautiful Brandon Hills 10 miles to the south, and the Little Saskatchewan Valley westward. Reserving a strip 300 ft. wide through the town for railway purposes, the Syndicate had their own land at once laid out in lots, each about the eighth of an acre, and at the first auction sale in Winnepeg on the 2nd of June, 1881, the town then a month old, 250 lots were disposed of at prices varying as high as 400 dols. a lot. A good many buildings were at once commenced, and on the 15th of October the railway was opened to this point, and settlement rapidly took place. At first a dearth of building material, and the impossibility of the just-opened railway carrying the necessary supplies for its own wants, and the rush of emigrants in addition, retarded the progress of all but the slightest structures, and for the first year canvas with a few rough boards, constituted the majority of the buildings. With a description of house that could be built within twenty-four hours, it did not take long for the town to be extemporised, and before a year had elapsed there was a population of not less than 1500 or 2000 people. During the next winter the iron bridge across the Assiniboine was completed, but it proved too low, and had subsequently to be raised. Brandon has now become the centre of a very large farming district, and promises to be one of the largest and most beautiful towns of the north-west. It is the county town, and the buildings for the municipal offices are to be on a large and effective scale. Other nice towns and villages are growing up round it, and all prospering. Rapid City is 18 miles north, and Minnedosa 24, both on the Little Saskatchewan, which falls into the Assiniboine near Brandon. Milford is 24 miles east on the main river, and Souris Mouth 20 miles, where that river runs into the Assiniboine, and at least a score of other flourishing villages already dot the prairie in every direction round it, and look to Brandon as their main centre for business. The Souris branch of the Pacific will leave the main line at this station, and run in a south-west direction towards the boundary line, to the coalfields that exist some eight or ten miles north of the international line, and cover a considerable area. This coal, or rather lignite, was the first that was discovered near the line of railway in 1879, and as at that time fuel was a "burning" question, and coal in Winnepeg 24 dols. per ton, its discovery was regarded with unmixed satisfaction. The Souris River rises on the American side of the line and close to the boundary, which it crosses at least three times, and the veins of lignite, which are found in great abundance on both sides of the boundary, are exposed near the sources of the river in an admirable position for mining operations. Since the discoveries, however, other and more accessible veins of both true coal and lignites have been made, and the isolation of these Souris veins, until the branch railway is complete, will prevent any great amount from being mined.

Nearly north-west from Brandon, and not over 100 miles in a direct line, is Fort Ellice, one of the most important of the Hudson's Bay forts, most beautifully situated upon the Assiniboine River, upon the high prairie bluff that, overlooking the river at a sharp bend, commands a magnificent view of the valley for many miles. As the crow flies, Fort Ellice is not over 230 miles from Winnepeg, but by the windings of the river, which is navigable for steamers to this point, it is at least 600 miles, and occupies on the up journey from eight to ten days, whilst the downward trip is made in perhaps one-third of the time. Fort Ellice is on the main western trail, and at this point half a dozen routes diverge to the north, north-west, west, and south-west. The valley of the Assiniboine is wide and deep, but like the Red River it is liable to floods, especially in the lower reaches, where its muddy waters rise over its banks and sweep everything away with resistless energy. The banks of the river are a succession of bluffs weathered in some places into the most fantastic forms, and seamed with ravines where the small rivulets have cut away and eroded and corrugated the soft alluvial soil into strangely varied shapes. But all these figures and bluffs are on one uniform elevation at the top, the largest hills and the smallest rivers rise to the level of the prairie and there stop. Viewed from the prairie they are all a dead level, and the deep channel of the river is only a dark thread along the monotonous surface of the ground. Of the whole land to this point from Winnepeg 95 per cent. is put down as excellent wheat land. For some distance there is the uninteresting treeless prairie, but the greater part is an undulating rich park-like country, furnished more or less liberally with little clumps of poplar, black alder, and willow. As seen from the windows of the railway train this constant dead level, even where the land is, as in this case, a rich alluvial loam, is very monotonous and unattractive, and the traveller does not grudge losing the scenery for 200 to 300 miles of the distance when night intervenes, more than he would if amongst the rocks and bays of the Lake Superior section. But to the young nationality of Canada this district with its exhaustless soil, means the backbone of a wealth only limited by the population which she can induce to come into it, settle upon it, and cultivate it. The space is so large that the thinking part of the community grudge little the 25,000,000 acres given for this railway, nor the 7,000,000 of the Hudson's Bay Company, nor the reservations of the Mennonites, or for the Icelanders, nor for any gift or bonus of land that improves its communications and helps to settle the unemployed space. The country wants inhabitants, agriculturists, tillers of the soil; men to come here and live here, grow up with and be a part of the great community destined ultimately to own all these broad acres, and to bring wealth into the country by the surplus above their own wants that they have to dispose of and to export to other countries.

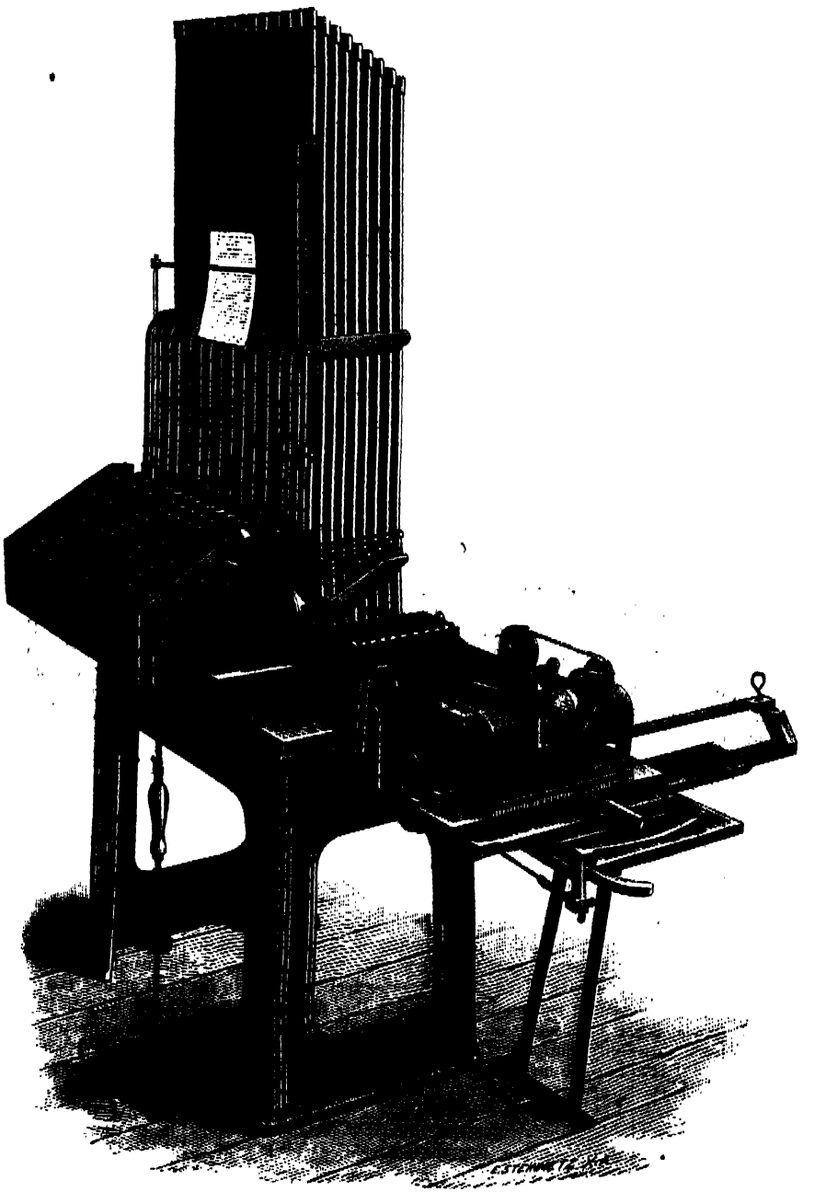
The old map makers, who showed all this country as a great lake or sea, were probably not far wrong in their delineation of what this district undoubtedly was some short time back, speaking geologically, in the world's history. Winnepeg, only 720 ft. above the sea level, and the low alluvial district all round it, looks as if it not so long since had been the bed of a great shallow lake. As we come west we are gradually rising, and Brandon Station is 1170 ft. above the same level. Beginning at the Height of Land, which roughly approximates to the international boundary, at the Pembina Mountain, if a line be drawn from the east side of this on the map north and west to the eastern face of the Riding Mountain, and continued in the same direction along the slope of the Duck and Porcupine Mountains and the Basquia Hills, it follows a long range of contorted sand hills full of sea shells and marine remains, which has every appearance of having once been the long sloping foreshore of an ocean expanse. Even the little limestone rock or ridge at Stony Mountain shows on its floor and polished prominences, the spots where the floating icebergs once crashed rudely along, by, and over, the Rocky Island, and wrenched off its projecting excrescences. This line is the first steppe or terrace of the series, rising about 300 ft. along an unmistakable regular section, which varies but little for hundreds of miles. Going west you never descend, nor do you again see the dead flats so objectionable in Minnesota and Dakota, or in the portion of Manitoba over which we have passed. At sea the storms are resistless because there is nothing to break their force or retard their motion, so the immense flat treeless plains of Dakota and Minnesota, 1000 ft. above the level of the sea, are storm swept, whilst the Canadian north-west, with its frequent wooded eminences, such as the Cyprus Hills, 3800 ft. above the sea level, and the Wood Mountains, 3400 ft. high, challenge and throw back the bitter storms which sweep northwards from the immense sterile plain which occupies so much territory in the heart of the United States. This steppe is passed some distance east of Brandon, and the deeper erosion of the Assiniboine River and its affluents marks the increased height of the prairie. This second track of land upon which Brandon and the places to the west of it are—this higher prairie, covered in its natural state with thick waving grass bespangled with flowers, and called the Big or Beautiful Prairie—is as rich and productive as the Portage Prairie, although the soil is somewhat lighter, and it will shortly be, in fact almost now is, as densely peopled. It is abundantly watered, and the streams are clear and sweet, unlike the muddy affluents of the Red River. The old explorers crossing this in the autumn, called it an arid desert, but they never saw it at its best, for the thick grass was almost impassable for horses, and in the winter all of it looks the same. But this Qu'Appelle Valley is going to be the best district of these western prairies, and ultimately the most sought after by the farming community.

To Oak Lake, 166 miles from Winnepeg, 595 from Port Arthur, the road was opened during 1881, and though the trains were only running regularly to Brandon, yet construction trains would forward emigrants and travellers to the furthest point to which the road was open. It was at this point that Langdon and Shepard's contract commenced in the spring of 1882. The Assiniboine River, which runs on the lower plateau to the north of the railway, here approaches the line which has to curve round the elbows of the river, and is slightly deflected from its true course by the sinuosities of its waters, but at Virden, the next station, 609 miles, the river takes a sharp bend to the north-west to Fort Ellice, above which its direction is nearly north. Just above Fort Ellice it is joined by the Qu'Appelle, whose course is generally west, and along which valley the railway is laid for the next 220 miles, but generally from 10 to 15 miles south of the river. Along the whole of this distance there is a beautiful rich soil, and every inducement for settlement. It is all well watered, not so unpleasantly flat as the first 100 miles from Winnepeg, and apparently equally productive. At Broadview, 693 miles, is the second locomotive division, 264 miles from Winnepeg, to which point, the railway was opened August 14, 1882, and here are good repairing shops for the engines and cars, and the usual appliances of a locomotive establishment. It is intended that every second division shall be thus provided, so that all the ordinary repairs and requirements shall be available at one end of each division. By this arrangement Brandon, the end of the first division, and Moose Jaw, the end of the third division, will simply be changing places, any repairs necessary being done at Winnepeg for the first division, and at Broadview for the second and third divisions,

The Qu'Appelle Valley has attracted attention from the system first introduced here, and adopted from Minnesota, of large joint-stock farms. The first and perhaps so far the most successful of these is the Bell Farm. The head-quarters of this concern are at Indian Head Station, 312 miles west of Winnepeg, where are also the Indian agency for the Qu'Appelle district, and the largest and best-finished brick hotel in the north-west. In 1881, Major W. R. Bell, of Brockville, made arrangements for a great wheatfield of 64,000 acres, one half of which he purchased from the Canadian Government, and the other half from the Canadian Pacific Railway. With several leading capitalists, he organised his company with a capital of 600,000 dols., and in 1882 operations were commenced. On the 15th of June the ploughs commenced breaking the turf, the buildings were started on the 13th of August,

FISCHER'S TYPE-COMPOSING MACHINE.

(*For Description, see Page* 80.)



and 2700 acres of land were seeded with wheat which produced an average yield of something over 20 bushels to the acre, and was sold in the fall at the elevator at Indian Head at 89 cents, 3s. 9d. sterling, per bushel, or 30s. per quarter. In September, 1883, no less than forty farm-houses had been built, 9000 acres were under the plough, of which 3400 had yielded excellent crops, over 90,000 bushels of very superior wheat, and the whole was working in perfect order. During the last year they built twenty-two homesteads, in addition to eighteen the year before, each with a stable attached, at a cost of 800 dols. each, besides two barracks for the extra hands employed during harvest. They erected, besides a granary for 30,000 bushels and a seed granary for the farm, a blacksmith's shop, and other necessaries, the gross expenditure to the end of 1883 being 244,720 dols., of which 102,346 dols. had been laid out during that year on capital account alone. This Bell Farm aims at more than the Minnesota idea of a large farm; it is in fact a huge colonisation scheme, intended to bring the land first into cultivation with the facilities due to sufficient capital, division of labour, and thorough organisation, and when this has been accomplished to divide the 100 square miles that the farm now covers into 300 farms, each with a comfortable residence, stabling, and shedding enough for the stock. It is then intended to value these farms with the stock and implements upon each, and the men who helped to carry out the improvements are each to have the offer of his own farm at the valuation price, he paying for the same in five or ten annual instalments. In the mean time each man receives 84*l.* per annum as wages, and his house and one acre of garden ground rent free. Major Bell calculates that they will be able to get 9000 acres under wheat in 1884, 18,000 acres the next year, and 25,000 acres in 1886, by which time he expects to have for sale 500,000 bushels of wheat for the year's surplus.

In one respect this wheat district is remarkable, and that is for the quality of the grain produced. Mr. Archibald, the well-known proprietor of the Dundas Mills, in Southern Minnesota, visited Manitoba for the purpose of finding a seed that should improve their spring wheat, the quality of which he found was gradually deteriorating or softening, and he wanted a mixture that would restore its hardness. This he found in Manitoba, but the thing that astonished him more was the yield of this superior quality of wheat. "Look," said he, "we have had a good harvest in Minnesota, but you will only find two well-formed grains in each group or cluster forming a row, but here in Canada, the rule is three grains in each cluster. That is the difference between 20 and 30 bushels per acre." There is a physical cause for this improvement in the Manitoba and Assiniboa wheat over that grown south of the line in the United States. The nearer the northern limit of its growth the finer is the quality, the soil is better suited for it, and the duration of the sunshine is longer when the ears are ripening. From the 15th of June to the 1st of July there are nearly two hours more daylight in Manitoba than in Ohio. It is not heat alone that is wanted to bring wheat to maturity, but the greater the amount of solar light the better the result.

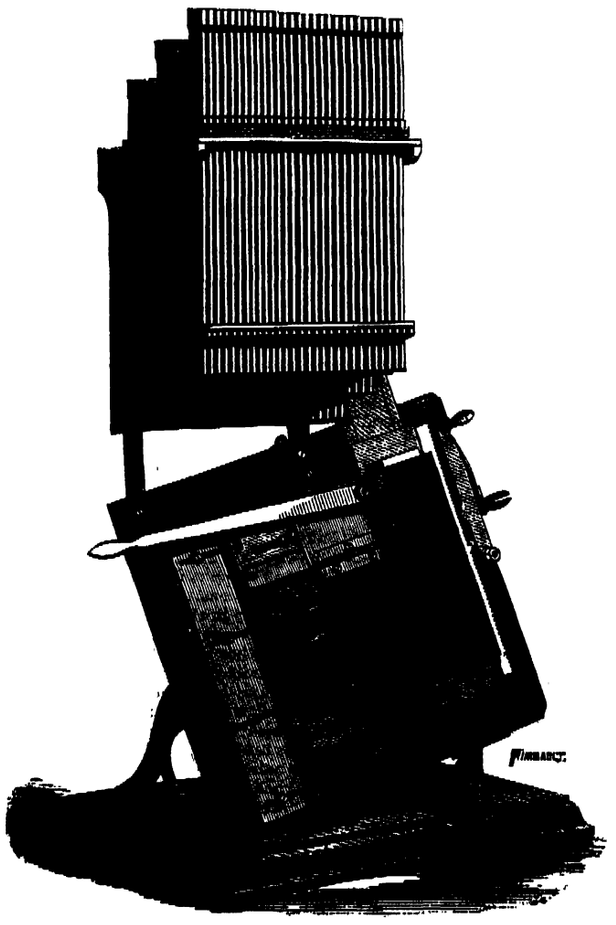
This wheat-growing question for the supply of Great Britain, seems now to be almost settled in favour of this country For the 36 millions of people to feed in the old country it seems that five bushels per head, or 180,000,000 bushels of wheat, are required.

	Quarters.	Bushels.
For the 14 years from 1866 to 1880 the average home production was	11,583,000	92,664,000
And there were imported an average of	10,842,000	86,736,000
Together ...	22,425,000	179,400,000

But during this 14 years the average home production for the first nine years was 12,282,666 quarters, whilst for the last five it was reduced to 9,115,111 quarters, the British-grown wheat having fallen off, in round numbers, 25 per cent. The result is that now it requires an average of 110,000,000 bushels of imported wheat to feed the people per annum, and if the production falls off more, whilst the population increases, the amount required to be imported will be further increased. The fact is that in consequence of the necessity for the use of expensive manures, the high rents, and possibly the exhaustion of the soil, this particular branch of farming is likely to be smaller still than

FISCHER'S TYPE-ADJUSTING MACHINE.

(*For Description, see Page* 80).



it has been in Britain, and as it has already become in the State of New York and the older parts of Canada, will cease to be profitable, in competition with the immense virgin soils of the Western States and the north-west of Canada. Supposing only one-fifth of the 375,000,000 acres of wheat land said to be available in the Canadian north-west, to be brought into cultivation, supposing in addition that the average yield is only 21 bushels to the acre and that six of this is reserved for seed and local consumption, it still leaves 1000 millions of bushels as the capability of this country to export. By the evidence of one of the delegates, Mr. Wallace, of Nithsdale, supported by several of the others, wheat can be grown in Manitoba and sent to Liverpool at a net cost of 26s. per quarter, or 3s. 3d. per bushel. This delegate exhibited a sample of wheat grown for thirteen consecutive years without manure, and which had averaged the last year 30 bushels to the acre. As another of the delegates expressed it in going over the items of cost of the wheat productions here; "Satisfactory as these figures are to the British consumer, they are not very encouraging to the British wheat grower. For his fuller berried wheat, richer in starch but poorer in gluten, he may get 3s. or 4s. per quarter more than can be realised for the Canadian wheat, but 42s. to 45s. a quarter," which is all that wheat is likely to average for years to come, cannot be remunerative to the British agriculturist. Mr. Barclay, M.P., in the *Fortnightly Review* says, "I believe that hope is maintained, in some quarters, by the notion that the supply of agricultural produce from America will fall off; this hope is based on the expectation of an increase in the cost of transport, and of the inability of the American farmer, in the face of an increased home demand, to grow wheat as cheaply as he has hitherto done. It seems to me that, for some years to come at all events, these expectations will prove delusive. It cannot be doubted that, in the Western States, wheat can be raised on the grand scale at a price with which the British farmer cannot compete, assuming that he continues to pay the same rents. From the improvements to be expected in steamers, and the increase in competition, by the opening of new lines of communication by land and by water, the reasonable prediction is that the rates of carriage will be lower in the future than in the present. I cannot, therefore, bring myself to think that we have seen the last of American competition, or that the lowest point in agricultural depression has yet been reached." This refers only to American competition. How much more important and discouraging to the British farmer must be the inevitable result of opening up the Canadian wheatfields. The average wheat crop of Manitoba and Assiniboia is 33 per cent. better than the average from the best of the American wheat-growing districts. The official returns give an average to Minnesota of 17 bushels per acre; Massachusetts, 16; Pennsylvania, 15; Wisconsin, 14; and Ohio only 12.8, whilst the reports to the Minister of Agriculture, in Canada, show that the average in Manitoba is nearly 30 bushels, and the weight from 62 lb. to 66 lb. to the bushel.

Regina, 356 miles from Winnepeg, to which the road was opened October 1, 1882, is the capital of the new Province of Assinibora, through which the railway runs for 270 miles. The site of this place was selected by the governor, Mr. Dewdney, as the capital, and immediately there was a wild outcry about the affair, as if some most important political blunder had been committed. The situation was described as a flat, treeless, uninviting prairie, entirely devoid of good rolling ground, and extending in every direction over the same dreary country. The Creek upon which it is located, rejoices in the disagreeable name of the Pile of Bones Creek, which is not so pretty as Wascana, the Indian name, which means the same thing, and ought never to have been translated, because now they cannot get it back again to the original appellation. It was asserted that this stream froze solid to the bottom every winter and ran dry every summer; that no fuel could be obtained excepting wet poplar, which costs 12 dols. per cord, and this was not so economical as the Souris lignite, which was worth here 28 dols. per ton. However, the mounted police head-quarters were moved here, the Government voted 20,000 dols. to start the public buildings, during the year temporary wooden structures for the accommodation of the Governor-General were erected, and last year an additional vote was passed to complete these. In a very short time every quarter section of land within ten miles was taken up by purchasers or squatters, and under the combined impulse of the Government, the Pacific Railway, and the North-West Land Company, the town soon began to be marked out, and to assume regularity and order. Not far from the station to the north is a big basin in the "Pile of Bones," or Wascana River, as nobody now calls it, which was dammed and forms a large natural reservoir. On the south and west of this plots have been allotted for public parks. On the south portion of what was laid out as the principal block, the Ontario Bank picked a site for their intended new bank building, and the Merchants' Bank picked another site lower down the street. The Government have reserved three or four plots for public buildings, and the six leading churches each selected a site for their chapels to accommodate the large congregations that were on their way, but not yet arrived. This was in October, 1882. In six weeks there was a population of between 800 and 900 people, and in fourteen weeks there were 97 first-class buildings, 52 second-class or more temporary buildings, and altogether 177 houses in which people were living, besides the police barracks, the Governor's residence, and a number of small houses, built in connection with the railway, and in which 150 people were living. In the same time the Presbyterians and Episcopalians had each organised a congregation, and the former had already a portable building erected to serve both as church and manse. The Methodists actually built and dedicated a church within sixteen days from the time that the first plank was on the ground, and in a week after its completion they gave an entertainment and lecture, and at its conclusion took up a subscription which defrayed the whole cost, excepting 100 dols., whilst the ladies, in a second effort, raised half the cost of a first-class organ.

In breaking new land three horses or mules are yoked in a single plough, which turns over from two to two and a half acres per day, the sod turned over being 10 in. to 15 in. wide and 2 in. thick. This work is usually done in June or July; the whole is then ploughed in the fall and sown the following spring. Seeding commences as soon after April begins as the frost will permit, and harvest begins August 1st. The ordinary seeding is from one and a half to two bushels per acre. The self-[illegible]ing machines take three mules, a driver and two stokers for each machine, which will cut from 12 to 15 acres per day, and two or three days after these commence, the steam thrashers are set to work, each turning out 1000 to 1200 bushels per day, using the straw for fuel. The wheat is taken from these direct to the railway elevator. As soon as possible after the harvest the ploughs are set to work on the stubbles and back-setting the new land for the spring crops, the whole of the wheat being sown in the spring-time. For ploughing they use double sulky ploughs, with 16-in. shares, drawn by four horses, travelling from eighteen to twenty miles per day, and turning over five acres of land, whilst the men ride upon the ploughs. On this system an acre of wheat costs 30s. to 35s. to cultivate, which on the basis of 25 bushels to the acre, is about 1s. 4d. a bushel, and as the selling price at the elevator last year was 88 cents, or 3s. 8d., the profit on this description of farming is enormous. Of course to do this work well and realise the best results requires a knowledge of farming, some previous experience, and some means; and probably one reason for the orderly, well-educated, and superior class of people that are so rapidly filling up the country, is that the employment addresses itself to just that middle class of young men who with sufficient means to start here, but not quite enough to do the same thing "at home," know that energy and industry must command success, whilst it holds out scanty encouragement for the rowdy element that disgraced the name of manhood in the early settlement of the Western States. Still it is marvellous where the people come from that are taking up these western lands, closely following the track of a railway building three miles per day, dotting the country with houses every quarter of a mile of its area and building towns every ten miles along its course. At Virden, a small station west of Brandon, with nothing extra to mark its position, the telegraph

receipts for the first few months after the office was opened averaged 400 dols. per month, for prepared messages only, principally 25 cents., a shilling each, those for longer distances being mostly payable at their destination, and therefore not included. At Regina in a shed of unplaned boards, with a canvas tent drawn over it to keep out the wet, a storekeeper took 7000 dols. in cash for goods sold in three weeks.

COMPOSING MACHINE AND ADJUSTING APPARATUS.

Messrs. F. WYVILL AND Co., of 69, Old-street, London, are introducing into this country a type composing, adjusting, and distributing plant, the invention of Messrs. Fischer and Von Langen. These machines are already in successful operation in Berlin and in the office of the *Cologne Gazette*. On pages 78 and 79 we illustrate the two former, and in an early issue we shall give engravings of the distributing machine. The whole of the machines are characterised by great ingenuity, and they are well worth attention.

Upon first glancing at the composing machine one notices that it is in some respects similar to a small organ, as there are rows of keys which a compositor touches when he is setting up type, and there are vertical tubes in which the type are stored. The mechanism and working parts of the machine are attached to a base-plate which stands upon a cast-iron table, so that the keys and the point where the letters are delivered, are at a convenient height from the ground. The keys are arranged in transverse parallel rows upon castings, which are bolted to the base-plate of the machine. In each lateral row,* of which there can be any number, there are nine keys, one behind and a little above the other. Immediately behind the keys the letters are stored in vertical tubes, and these tubes are likewise arranged in transverse parallel rows, each key having a tube that corresponds with it, and to which it is connected by means of a spring. Into the castings which carry the keys, pillars with horizontal arms are screwed, and the tubes hang on these arms by means of hooks rivetted on them. At the bottom of each rectangular tube there are two bearings, or feet, upon which the letters rest longways on their sides, and piled up one above another, the head of the letter being on the left hand of the compositor when he is in front of the machine. The feet of the tubes hang in longitudinal canals, which for a certain distance are parallel, but afterwards converge one into another. Upon the sides of the canal, where they are parallel, there are a number of stops—one opposite to each tube. Each stop is adjusted so that it is nearly as thick as a letter in the tube in front of it. Beneath the canals a belt runs at a very high velocity.† Now, therefore, when a key is pressed, the lower end of a tube that corresponds with that key, is drawn towards the compositor and over the stop piece on the side of the canal, the bearings or feet which support the latter passing on each side of the stop. While this is taking place the bottom letter in the tube remains stationary. The stop piece prevents it moving with the tube while the bearings and tube are being withdrawn; but, as soon as the bearings are withdrawn, one letter, and one letter only (the opening in the side at the bottom of the tube not being large enough to admit of more than one letter passing out at once) drops on the endless belt, and is carried away to the fall or passage that leads to the point at which it it delivered. When the pressure is taken off the key the tube is returned to its normal position by a spring.

The fall, into which the canals deliver the letters, is a contrivance for changing their position from a horizontal to an upright one, and this is done by the letters sliding down an inclined plane in front of a pusher, which then delivers them into a galley, as shown in the illustration, or into an endless line. Before the letters arrive at the point where their direction is changed, they have to pass under a brake wheel, on an axle running in a bearing which is free to slide, so that the wheel puts the same pressure on each letter whatever its thickness may be, and as the speed at which this brake wheel revolves is considerably less than that of the endless belt, the letters, when passing under it, are checked and drawn forward at a uniform speed, to such a position that they tilt themselves and slide down in front of the pusher.

The galleys into which the type are delivered in the manner just described, consist of flat pieces of iron, which have a number of chases on their upper sides, formed by thin steel plates being let into them. These chases are parallel and equidistant from one another, also they are a little wider than the body of the letters, being set up so that the type can easily slide along them; inside each chase is a friction clutch.

* The machine which Messrs. Wyvill and Co. have in operation at 69, Old-street has thirteen lateral rows of keys, making 117 different letters.

† About 300 ft. per minute.

When the machine is arranged for working with galleys, one of them is put on a sliding saddle, which is at such an angle that the letters have a tendency to fall away from the pusher. The saddle is at right angles to the endless belt, and is drawn forward by a weight which hangs over a pulley placed under the slide; it has also a rack on one side into which two pawls work. When therefore an empty galley is placed upon the machine, the slide is pulled back by hand until the first chase is immediately opposite the foot of the fall, and it is held in this position by the pawls, which are pressed into the rack by a spring. The friction clutches having been placed on the side of the galley nearest the fall, everything is ready for the compositor to set to work, and upon the letters being delivered by the pusher into the chase, the friction clutch, which holds the type in an upright position, is moved along until it comes into contact with a sliding pin, which enters about ⅛ in. into the chases, the steel plates or ridges of the chases being recessed so that it can pass from one to another. This pin is connected with an indicator and bell; when therefore the pin is moved, it moves with it a pointer working on the face of a graduated plate, and releases the hammer of the bell. As soon as the bell is struck the attention of the compositor is drawn to the indicator, so that he can see at a glance how full the line is which is being set up. The hammer is adjusted so that it strikes the bell before the line is terminated in order to give the compositor an opportunity of either dividing a word or filling up the vacant place with blanks or spaces; by this means the lines are almost adjusted in the alley.

When the compositor sees from the indicator that the line is full he presses a button on the right of the keys; this button, being connected with the pawls, allows the saddle to advance half a tooth forward, or to a distance equal to half the pitch of the teeth; by this movement another chase is brought opposite to the foot of the fall ready to receive another line of letters.

When the galley is completely full of lines of letters partially adjusted, the saddle is drawn about ½ in. forward by hand and fastened in this position by a hook. A bar on the same side of the chase as the fall, is then detached from the machine, and by means of a hook and pin attached to the galley, when it, together with the bar just mentioned, which prevents the letters from falling out of the chase, can be taken off the machine and replaced by a second galley and bar.

The galley thus filled with composition is taken to the adjusting apparatus, which has a similar saddle on a slide to that on the composing machine, only instead of its being in almost horizontal position, and being drawn forward by a weight, it is nearly vertical, and the galley and saddle are pushed up by hand, but slide down by their own weight, pawls working in a rack on the slide only allowing it to fall at one movement to a distance equal to the width between the centre lines of the chases, so that after the type has been taken out of one chase, and the pawls have been moved, the galley falls so that another line can be taken out.

On the left of the vertical slide upon which the galley works there is a frame, the longitudinal sides of the frame being the exact width to which the lines have to be adjusted; between these longitudinal sides there are two sliding blocks; between the frames and the galley there is a passage through which the types are pushed by hand; the bottom of the galley, the bottom of the passage, and the bottom of the frame are all in one plane. Above the frame where the letters are made up into solid blocks, there is a store of letters and spaces arranged in vertical tubes, each different letter having a separate tube. The type are put into these tubes so that the heads of the letters are towards the person adjusting the lines, and the feet of the tubes are so arranged that, upon their being pressed, the head of the bottom letter is forced out of the tubes a sufficient distance to enable the compositor to draw the letter out and use it for adjusting the line. The great advantage of this arrangement is, that when a compositor picks up a letter it is always the right way up. Hence when any one is adjusting matter, after the galley has been put on the saddle of the slide, the first chase is brought opposite to the passages leading to the frame, the clutch in the chase is taken out and the matter is pushed along the passage on to a plate resting on the bottom sliding block in the frame, then, should the line require any adjusting, this is done, and after that the top sliding block, which is fastened to a lever, is drawn down, so as to push the adjusted lines into the frame, and allow room for the next one to slide along above it. The handle of the top sliding block being released it is drawn back to its normal position by a spring. The plate resting on the bottom sliding block is then drawn away from under the letters and put above them, so that the next line may have a smooth surface to slide and be adjusted; on the handle which works the pawls being then touched, the galley falls and the next line is in position to slide into a frame.

To return to the composing machine. As up till now it has been found impossible to adjust lines mechanically with sufficient accuracy for practical use, some people consider it more convenient to have the letters set up in an endless line, and therefore the composing machine adjusting apparatus have been designed so that they can be worked either with a galley or an endless line, and can in a few minutes be altered from one arrangement to the other. After the machine has been worked with a galley all that it is necessary to do, to alter it to an endless line, is to disconnect the lever that actuates the indicator and bell, remove the saddle from the slide, and take off the slide, and the casting in which the sliding pin works. After this has been done, a casting, which has one chase or passage in it, has to be attached to the frame [illegible] has on its under side a wrought-iron strut projecting from the machine to hold the tube into which the letters are delivered. The chase in the casting being opposite to the fall the letters are pushed direct into it against a clutch which slides with them into the tube, the casting being recessed to receive the tube. As soon as one tube is full of letters it is lifted off the casting and strut, and an empty one is put in its place. The tubes that are full can then be taken to the adjusting apparatus, which is so arranged that the letters can be pushed direct into the passage which leads to the frame.

(*To be continued.*)

CENTENARY OF THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND.

SCOTLAND was early astir in the way of founding organisations having for their aim the improved cultivation of the soil, for so far back as the year 1723 there was brought into existence a corporation bearing the pretentious title of "The Honourable Society of Improvers in the Knowledge of Agriculture in Scotland." That Society, however, bore good fruit, judging by the other institutions that it was the means, directly or indirectly, of calling into being, not the least important of them being the Highland Society of Scotland, which for many years has borne the fuller title which heads this notice, and is this week celebrating its centenary in Edinburgh, the city of its birth. It would be difficult to overestimate the national good which has resulted from the establishment of the Society in question, alike by its annual shows, by the diligence which it has shown in furthering agricultural education in the fullest meaning of that term, and by stimulating counties and lesser districts of country to form societies more or less similar to itself.

Very early in its history the Society had a Royal Charter, and in order that the Society's sphere of operations might be further extended, a new charter was obtained in the year 1834. But so far back as the year 1806 an Act of Parliament was passed granting to the Society the sum of 800*l.* a year for ten years; then in 1836 a grant of 300*l.* per annum was begun and continued for ten years; and in 1844 a lump sum of 5000*l.* was granted by Parliament to the Society. There are now about 5300 members on the Society's roll, and its reserve capital is upwards of 70,000*l.* For many years the Society has been most active and diligent in its encouragement of all inventions calculated to be of practical value in economising labour on the land, or rendering it more efficient. The first reaping machine, invented by the Rev. Patrick Bell, of Carmyllie, gained, in 1827, the Society's premium of 50*l.* and forty years afterwards the inventor was presented with a testimonial amounting to 1000*l.* by the agriculturists of Scotland in recognition of his eminent services in producing an implement which had done so much to lighten the labours of the harvester. It was under the auspices of the Society that the steam plough was introduced to Scotland in the year 1837, when the first trial was made on Lochar Moss, near Dumfries. During the night, however, the plough disappeared in the moss, where it still lies buried. But the Society did not relax its efforts in favour of having steam applied to the cultivation of the land, and its action was ultimately to some extent successful.

The annual shows of stock, implements, &c., have been held as far north as Inverness and Aberdeen, and as far south as Dumfries, Kelso, and Berwick-on-Tweed; but now the movements of the Society embrace no more than eight towns, and even some of them might with advantage be dropped out of the programme, as the shows held in them generally result in a serious loss rather than gain to the Society. Prior to the present year ten annual shows have been held by the Society in Edinburgh, and the centenary show being held this week is the eleventh. Nine have been held at Glasgow, but in no other town have more than seven annual shows been held. Strenuous efforts have been made to render the centenary exhibition the largest and best that the Society has yet held. The ground inclosed is about forty acres in extent, being more than on any former occasion. There is an unusually large number of entries in the various classes of live stock, and the premiums offered for competition amount to the handsome sum of 4343*l.*, or more than one-third greater than in connection with any previous

annual show. By way of giving some additional *éclat* to the centenary celebration, a number of the office-bearers of the two leading Agricultural Societies of England and Ireland, have been specially invited to attend and take part, as also commissioners representing various foreign governments.

Contrary to the former practice of the Society, no prizes have been awarded during the past few years on account of implements and machinery exhibited at the annual shows, though in some cases premiums have been given on account of implements that have been successful in actual competitions in the field. On the present occasion premiums of a total of 100*l.* are offered for the following machines: 1. Exhaust fan for agricultural purposes, to be worked by hand, horse, or steam power. 2. Broad-cast manure distributor, suitable for all kinds of artificial manures. 3. Machine, at a price within ordinary farmers' means of acquisition, adapted for cleaning all sorts of grain and other seeds from weeds. 4. Cream and milk separator. 5. Machine for working butter. 6. Travelling steam engine, suitable for drawing reaper, binder, and for other farmwork. For each competition, with the exception of No. 4, several entries have been made.

The number of exhibits entered under the general head of implements is 2241, a total which has been exceeded on two or three previous occasions, especially at the last Glasgow show in 1882, when the number reached was 2622. All the famous makers of agricultural implements and machinery in England are represented on this occasion, many of their exhibits having been brought direct from the Royal Show at Shrewsbury, on which account it is scarcely necessary to enlarge upon them. Many of the Scotch makers have made a step in advance in respect of machines that are either new or in process of evolution towards a condition of greater perfection, and now bring them to challenge the criticism of the farmers.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, July 11, 1884.

THE condition of the American blast furnaces is as follows: there are 279 furnaces in blast and 424 out of blast. Weekly capacity in blast, 84,859 tons; capacity out of blast, 87,701 tons; of those in blast, 80 are charcoal, which might be cast out of the account of the others, 101 are anthracite furnaces with a weekly capacity of 26,949 tons. One year ago the number of anthracite furnaces in blast was 124; two years ago, 164; there are 98 bituminous furnaces in blast against 144 three years ago. The total make of pig iron last year was 5,146,972 tons. The production for the first half of this year is estimated at a little under 2,250,000 tons. This decline in the number of furnaces in blast and their producing capacity, is the natural result of the unprofitable condition of the iron trade, the falling off in railway building, and the general sluggishness of the demand in all parts of the country. American railway building sustains about the same relation to the iron trade here, as the shipbuilding industries of Great Britain sustain to the iron trade there. There is but little to be said in regard to business. The general falling off in activity is likely to be indefinitely continued, not because prices are not low enough, but because there is a very strong feeling abroad that we have as many railways as we can take care of for the next two or three years, and a good deal more manufacturing capacity than we can keep busy. The Bessemer steel rail men are seeking orders for rails at 30 dols., and are finding fewer of them than they found a year ago at 35 dols.; the wonder now is what the bottom price of steel rails will be a year hence. One company has just made a 10 per cent. reduction in wages, and it is probable that others will do the same. The railmakers are complaining of a competition they cannot control, and, what is worse, of a sluggish demand, which it is possible may drive them into a shutting down of some of their works until the dawn of brighter days. The demand for merchant steel, steel plate, car iron, and shipbuilding iron still continues of moderate proportions, but not sufficiently active to prevent a shading of prices. A large order has just been secured in a near-by town for structural iron, amounting to several thousand tons, for Brooklyn. Merchant iron is had readily at 1¾ cent; nails can be had in thousand keg lots at 2.35 dols.; 2000 or 3000 tons of plate iron were ordered in this market within two or three days, and the mills obtaining the business are now safe for the summer. Several manufacturing conventions are being held this month; our manufacturers have a good deal of complaint to make over narrow margins, because they have never yet become accustomed to diminutive profits, and think it is about time for another boom to come, so that they can charge their own prices. This hope will never be realised. The question of manufacturing tin-plate in the United States in competition with Welsh makers has long been a subject of discussion. The cost abroad is estimated at 33 dols.; the cost here, in the neighbourhood, 56 dols. This is an insuperable objection. Nothing less than a duty of 2¼ cents to 2½ cents per lb. will secure the establishment of this industry, and in the present condition of the public mind in reference to tariff matters it is not likely that this duty will be secured.

THE PATENT LAW.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent who signs himself "J. R." appears to have written his incorrect letter under the influence of prejudice.

That the reduction of fees in the early stages of what I may call "patent leases," is a very great boon to poor men, is now beyond dispute. Such persons are now capable of securing their inventions, and obtaining purchasers, at a very small outlay, and I could name several instances which have come under my own observation in which they have done so, and that at a much less cost than in the United States.

"J. R." repeats the statement, which has been often contradicted, that a patent can be obtained in the States for 7*l.* 10s. This is an error. The fees alone amount to that, and he is not a wise man who "does it himself," even in that land where "distance lends enchantment to the view" of "J. R." I must remind him that great skill is necessary to secure a patent there; that carefully prepared drawings are necessary; that applications are rejected and re-presented, argued and fought out by skilled patent attorneys; and that all this has to be paid for. And, to convince "J. R." that America is not yet the rosy land that he appears to think, I would refer him to the speech of the Hon. Orville H. Platt, of Connecticut, which was delivered in the Senate on the 31st March, 1884, consisting of 54 closely printed pages, very much of which would have been applicable to England in 1883, but *not* in 1884. The Hon. O. H. Platt is not quite so satisfied with the American patent law as "J. R." appears to be.

Yours truly,
THOMAS MOY.

8, Quality-court, July 21, 1884.

"WIND PRESSURE."

TO THE EDITOR OF ENGINEERING.

SIR,—I have only just read the letter signed "G. Pinnington" in your number of July 4.

He proposes to indicate the vacuum (reduced pressure) at back of the surfaces by means of barometer. If he can do this, he can also indicate the increased pressure at the front by the same means, which would enable him to do away with the motion of the surfaces, and to make these of any size he chooses.

Yours faithfully,
Madrid, July 21, 1884. T. A. G.

ROLLER MILLING.

TO THE EDITOR OF ENGINEERING.

SIR,—I am receiving your paper here regularly, and in your last issue of July 11, I see an article under the heading of "A Modern Flour Mill." Further on I find that the writer of that article qualifies the mill in question as the latest and most efficient development of the English gradual reduction process.

Now, seeing that the mill constructed by the firm you mention, is the first attempt by these gentlemen in the automatic gradual reduction process, it speaks volumes for their confidence, or for the confidence of the writer of your article, to call it the latest and most efficient development. I beg to inform you that the mill in question is neither the latest, nor is it likely to be the most efficient mill lately built, for since the mill was started, I have started several others, neither of which required weeks of tentative running.

The total number of complete mill plants erected by me during the last few years in Great Britain and Ireland, amounts now to over ninety. There are half a dozen each in Glasgow and Liverpool alone. In the latter place one for the Liverpool North Shore Rice and Flour Milling Company, Limited, producing 10,000 sacks of flour a week, or, say, one sack of flour a minute, being by far the largest complete roller mill in the United Kingdom. The weekly capacity of the roller mills erected or erecting by me, is now about 150,000 sacks of flour.

So far from weeks of tentative running being required in any of the mills I start now, it is the usual thing for my men to put on the wheat, start the mill, and take off the flour without ever stopping the mill again, except for religious scruples.

In justice to myself I think I may say that the first complete roller mill plant (without the use of millstones in any shape or for any purpose whatever) was built by me in 1878-1879, and that since then I have built a far larger number of roller mills than any of the competing firms which sprung up after me.

I inclose copy of a map showing the spread of my roller mill system in Great Britain and Ireland, but since it was printed the number has been considerably increased. I also send you a small book, "Facts on Roller Milling," which I got printed for distribution at the late millers' convention in Stockton.

I have at the present moment in hand roller mill plants for the following places: Nottingham, Sheffield, Leeds, Warrington, Manchester, Whitley Bridge, Sowerby Bridge, Banbury, Matlock, Exeter, Elland, Glasgow, York, London, Bombay (the first complete roller plant for India), and Melbourne. Yours truly,
HENRY SIMON.

P.S.—The mill going to be erected by me in London is for one of the largest millers, and will be capable of grinding 7000 sacks per week; it will be started in November, although the order was only received last week. Whilst writing these lines I receive advice from my Manchester office of a further complete order for Glasgow, and one for Hull. You will therefore see that the revolution which I predicted long ago is going on rapidly.

Weissbad, Canton Appenzell, Switzerland,
July 16, 1884.

[The Albert Bridge Mills had not been running *experimentally* as Mr. Simon appears to have understood, but, as a matter of convenience, they were started some weeks before the formal opening ceremony could be held.—ED. E.]

FOREIGN AND COLONIAL NOTES.

Victorian Railways.—The Victorian Railway Commissioners are taking steps to have effective brake power applied to all passenger trains upon the Victorian Government railways. The Railway Department is also to be generally reorganised.

The Electric Light at Melbourne.—A tender of the Australian Electric Light Company has been accepted for lighting the Victorian Parliamentary buildings. The light is to be supplied to the chambers and vestibules.

German Coal Exports.—The aggregate quantity of coal exported from Germany in the first four months of this year was 2,763,884 tons. The corresponding exports in the corresponding period of 1883 were 2,084,999 tons.

New South Wales Railways.—Tenders have been opened at the New South Wales Department of Public Works for an extension of the railway from Goulburn to Cooma, between Burgendore and Michelago. Five tenders were received, the lowest being that of Messrs. A. Johnston and Co., 497,766*l.* Seven tenders were also opened for the erection of railway station buildings at Burgendore.

Tricycles in Victoria.—The Postmaster-General of Victoria has decided to make a trial of the tricycle postal delivery system at Portland, Sale, and Ararat. If the plan should be successful he will have it extended to other districts at an early date.

Brisbane Tramways.—The Brisbane Tramway Company has provisionally accepted the tender of an English firm for rails and fastenings, to be delivered in Brisbane complete in four months, the price being 16 per cent. below the estimate of the company's engineer.

A Mammoth Ferry Boat.—A mammoth iron ferry boat named the Kalama, and built for the Northern Pacific Railroad, has just been launched at Portland, Oregon. The boat will be used by the railroad company in transferring passengers and freight across the Columbia, connecting the Portland Branch with Puget Sound. The boat will be ready for service at the close of this month.

Bessemer Steel.—The production of Bessemer steel in the principal countries of the world last year is estimated at 4,852,956 tons. This total was made up as follows: Great Britain, 1,553,380 tons; United States of America, 1,119,576 tons; Germany, 955,000 tons; France, 440,000 tons; Belgium, 220,000 tons; Sweden, 50,000 tons; Russia, 340,000 tons; and Austria, 175,000 tons.

Fire Plugs at Philadelphia.—Mr. Ludlow, chief engineer of the Philadelphia Water Department, after an exhaustive examination of the various kinds of fire plugs, has decided to adopt a three-way plug, which is said to be the most complete arrangement now in use. Attachments to a single plug can be made by two fire engines and one line of hose at the same time, thus giving three streams of water, where one is given under the present system. It is expected that over 100 of the improved plugs will be introduced in various parts of Philadelphia during the current year.

Belgian Rails.—The exports of steel rails from Belgium in the first five months of this year, amounted to 16,582 tons. The corresponding exports in the corresponding period of 1883 were 15,005 tons.

INEFFICIENT BRAKES ON THE MANCHESTER, SHEFFIELD, AND LINCOLNSHIRE RAILWAY.—In connection with the Penistone disaster, and our article thereon in this week's issue, the following case is not devoid of interest. About 9.15 p.m. on Monday night last, the 21st inst., a heavy returning special train from Boston to Sheffield, was detained at Manton, two miles on the Retford side of Worksop, until the train from Mansfield *viâ* Worksop, was got well on its way to Sheffield. A second special from Grimsby to Sheffield was standing behind the Boston train, but protected by the block at Chequer's House Station. On the line being cleared beyond Worksop the signal was given to the Boston train to proceed, and the driver had only advanced a few yards before he discovered that only a van and one coach was attached to his engine. He promptly whistled to call the attention of the guard in the detached portion of the train, and went ahead to avoid the threatened collision by being run into by his own train, and he got well through Worksop Station before pulling up. The line at this point is on a considerable falling incline, but most fortunately the warning given by the driver was promptly responded to by the guards, who were able by applying their hand-brakes to stop the detached carriages and thus avoid what might have been a serious collision. It was found that a coupling had given way, and had the train been fitted with an automatic brake, both parts would have instantly been stopped without any risks being run. The Smith vacuum brake in use on the Manchester and Sheffield Railway is of course useless under such circumstances, and had the incident occurred on a rising gradient, the detached parts of the train might easily have run back, and acquiring a speed which the hand-brakes could not control, have come into collision with a following train.

SPRING-MOUNTED ROAD LOCOMOTIVE ENGINE AT THE SHREWSBURY SHOW.

CONSTRUCTED BY MESSRS. JOHN FOWLER AND CO., ENGINEERS, LEEDS.

Fig 1

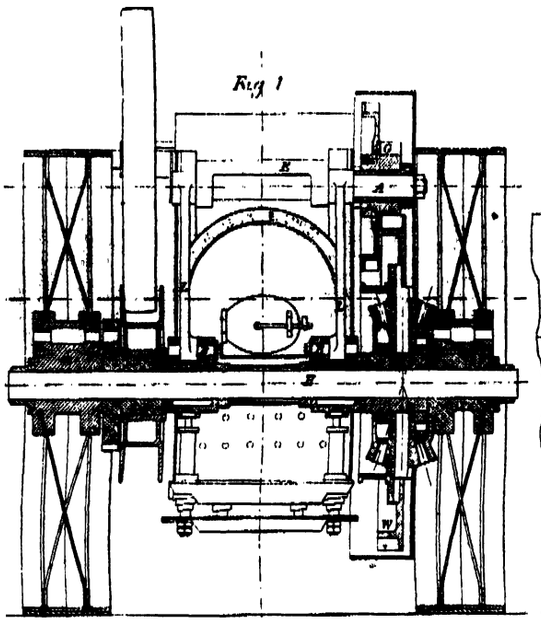
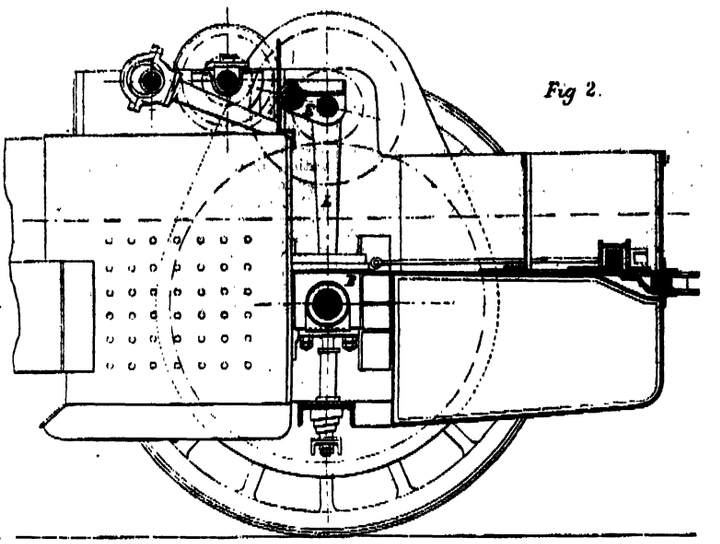


Fig 2.

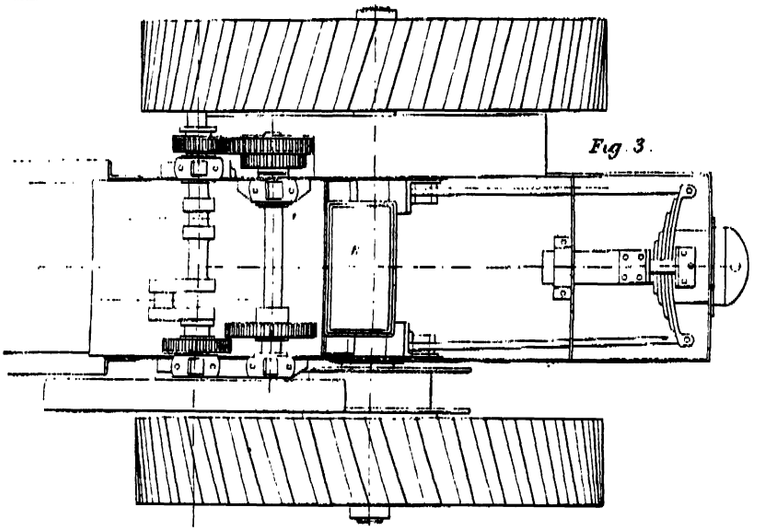


In our recent notice of the Royal Agricultural Society's Show at Shrewsbury, we gave a short account of Messrs. Fowler and Co.'s spring-mounted road locomotive, and this we now supplement by the engravings annexed. The feature of novelty in this engine, as compared with that exhibited by the same firm last year at York, lies in the way in which the gear is caused to accommodate itself to the rise and fall of the engine on the springs. The first and second motion shafts are mounted in fixed bearings, while the third motion shaft is carried in a rocking frame E pivotted on studs fixed to the framing. These studs are not coaxial with the second motion shaft, but, as will be seen by the engraving, are situated at a lower level, and between it and the third shaft. The rocking frame is connected by two links L L to the axle boxes B B in which the driving axle H rotates. These boxes, which are free to move up and down in guides, carry the weight of the engines by means of springs situated below them, and as they move they communicate their motion to the rolling frame E. The centres of the second motion shaft, the frame E, and the third motion shaft are so arranged upon an inclined line that, within the limits of the motion of the spring, the wheels remain about the same depth in gear as the axle boxes rise and fall. At the same time their rotation, as the one rolls over the other, is not so great as in the arrangement adopted in last year's engine, when the third motion shaft was carried in links, the other ends of which was pivotted on the second motion shaft.

The pinion G and the wheel by which it is driven run loose, side by side, upon their shaft, which does not rotate in the links L L. By the use of two links, instead of one as formerly, the main axle is kept parallel to the motor shafts in all positions it may assume, owing to the irregularities of the road. Thus, if one wheel pass over a stone and be raised by it, so that the axle is no longer horizontal, the boiler and engine are tilted sideways upon the front bearing, to incline the crank and other shafts at the same angle to the horizontal as the main axle, and thus the parallelism is maintained just as correctly as if there were no springs. From practical experience this gear has been found very efficient, the springs working most satisfactorily, and preventing the usual jumps and jarring.

The cylinders of the engine illustrated are 6½ in. and 11¼ in. in diameter respectively, and the boiler is designed to work at 140 lb. pressure per square inch. The spur gearing is of steel, and fitted with compensating wheels and pinions. The driving wheels are 7 ft. in diameter, and driven through the axle. The drag bar is fitted with a spring, and the engine throughout is designed to withstand the heavy wear and tear of continuous road haulage.

Fig 3.



ENGINES OF THE S.S. "ARABIAN."

WE illustrate this week by a two-page engraving and by a perspective view on page 86, a set of triple-expansion twin-screw engines recently constructed by Messrs. Rankin and Blackmore, of Greenock, for the s.s. Arabian, these engines being marked by certain special features which cause them to be of particular interest. The Arabian is a small twin-screw steamer intended for the trade on the west coast of Scotland, and is 126 ft. long, 22 ft. beam, and 9 ft. 6 in. depth of hold. She was built by Messrs. Murray Brothers, of Dumbarton, for her owners, Messrs. Morton and Williamson, consulting engineers, of Greenock, and is intended to carry a considerable amount of cargo (about 240 tons) on a light draught, so as to render her suitable for trading to the Hebrides and West Highlands. This requirement of course necessitates full lines, and it was expected that the Arabian would realise a speed of 9½ knots when light. The speed actually attained on her trial on April 26 last, however, was 10 knots with 40 tons of coal, water ballast, &c., on board, and a mean draught of 5 ft. 7½ in., and this has led to her being chartered for the herring trade between Stornaway and Strome Ferry. The Arabian is fitted with twin screws on Messrs. Rankin and Blackmore's overlapping system, an arrangement which is now applied to a coasting vessel for the first time, although the firm just named have applied it most successfully to tugs and light-draught steamers for special trades.

The engines of the Arabian are constructed on plans patented by Messrs. John F. and Matthew Rankin, and they have certain points in common with Messrs. Rankin and Blackmore's disconnecting compound engines for tug-boats, examples of which we have already illustrated and noticed favourably in ENGINEERING.* The engines of the Arabian, however, have been designed to use steam at 150 lb. pressure, while they are arranged to complete the expansion in three cylinders instead of two.

Referring to our two-page spective view on page 86, it will be seen that each screw shaft has but one crank, above which are mounted two cylinders arranged tandem fashion. Above the port shaft are a high-pressure cylinder 9 in. in diameter, and an intermediate cylinder 18 in. in diameter, while above the starboard shaft are a high-pressure cylinder 9 in., and a low-pressure cylinder 32 in. in diameter. The stroke in all cases is 22 in. The intermediate cylinder is surrounded by a receiver which is divided into two parts, of which the lower is connected to the exhaust pipes from the two high-pressure cylinders, and also communicates with the valve chest of the intermediate cylinder. The upper part of the receiver is in communication with the exhaust from the intermediate cylinder, and is also connected by a pipe with the valve chest of the low-pressure cylinder, this pipe being fitted with a spring-loaded valve opening to a pipe which can discharge into the atmosphere any steam passing the valve. There is also a smaller spring-loaded valve, the casing of which has branches communicating with the upper and lower portions of the receiver surrounding the intermediate cylinder, the arrangement being such that this valve will allow steam to pass from the lower to the upper part of the receiver as soon as the pressure in the lower part exceeds a certain determined amount.

The course of the steam in these engines under different conditions of working is as follows: With both engines at work the exhaust steam from the high-pressure cylinders passes down through the exhaust pipes shown, to the lower part of the receiver which surrounds the intermediate cylinder, and passes thence to the valve chest of that cylinder. After having done its work in the immediate cylinder it is exhausted into the upper part of the surrounding receiver, and is thence led through the horizontal pipe shown, to the valve chest of the low-pressure cylinder, and doing its work in this cylinder it is finally exhausted into the condenser in the usual way.

Next suppose the starboard engine to be stopped (by means of the reversing gear, the two throttle-

* Messrs. Rankin and Blackmore's system of disconnecting compound engines was first described and illustrated by us about eight years ago (*vide* ENGINEERING, vol. xxii., pp. 254, 255). We subsequently on pp. 8 and 9 of our twenty-fourth volume gave engravings of the engines of the twin screw tug-boat Otter, and on p. 412 of our twenty-ninth volume, illustrations of the paddle tug-boat Mount Etna, both constructed on this system.

BOILER OF THE S.S. "ARABIAN."

CONSTRUCTED BY MESSRS. RANKIN AND BLACKMORE, ENGINEERS, GREENOCK.

FIG. 4

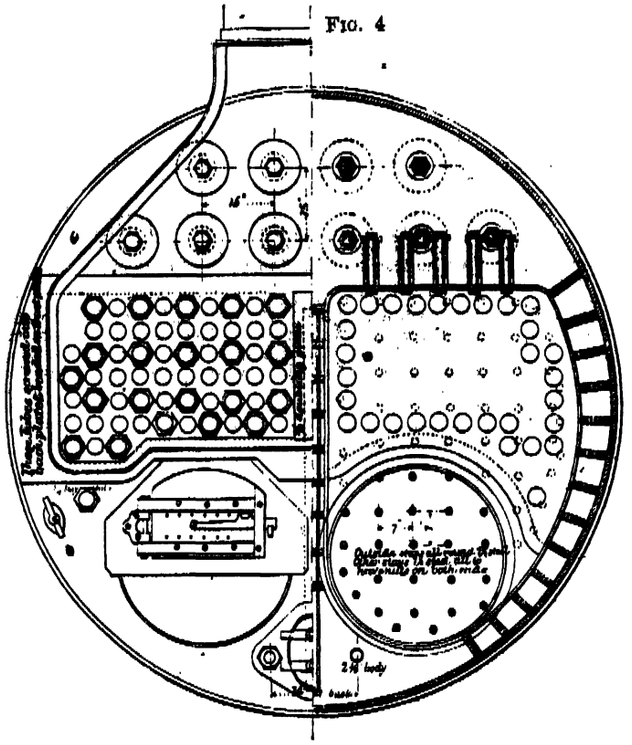
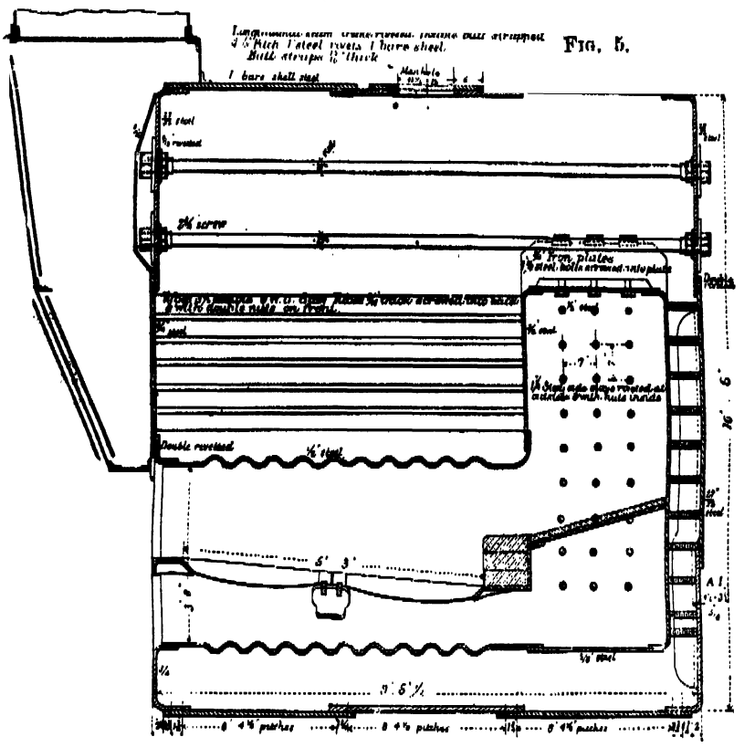


FIG. 5.



valves remaining open) and the port engine to be worked alone. Under these circumstances the steam from the port high-pressure cylinder will exhaust into the lower part of the receiver surrounding the intermediate cylinder, passing thence into the valve chest of that cylinder, doing its work in the intermediate cylinder, and exhausting into the upper part of the receiver. The starboard engine being stopped there is no escape for the steam through the low-pressure cylinder, so it will accumulate in the upper part of the receiver until the pressure is sufficiently high to raise the large spring-loaded valve, the steam then escaping into the atmosphere.

On the other hand if the port engine be stopped and the starboard engine be worked alone, the steam from the starboard high-pressure cylinder exhausts into the lower part of the receiver around the intermediate cylinder, and—there being no escape through the intermediate cylinder valve chest—it accumulates there until the pressure is sufficiently high to lift the smaller spring-loaded valve, when it escapes into the upper part of the intermediate receiver, and hence through the connecting exhaust pipe to the valve chest of the low-pressure cylinder, where it is utilised, and finally exhausted into the condenser in the ordi-

It will thus be seen that when both the engines are running they are of the triple expansion condensing type, while the port engine, when running alone, is of the compound non-condensing class, and the starboard engine, when working alone, of the compound condensing class. These [explanations of the courses taken by the steam under different conditions of working may appear rather complicated to follow, but there is not in reality any complication in the matter, and the spring-loaded valves being automatic in their action the arrangement does not involve any extra work in handling the engines.

The high-pressure pistons are fitted with Ramsbottom's rings, and the intermediate and low-pressure pistons with Buckley's rings and springs, the latter being adopted to avoid the necessity for frequent overhauling. It will be seen from our illustrations, that the high-pressure cylinders are mounted on standards or distance-pieces which are cast in one with the top covers of the intermediate and low-pressure cylinders respectively. All the cylinders have their lower ends cast solid with them, and there are no loose liners or steam jackets. The intermediate and low-pressure cylinders are each supported on one side by projections from the condenser which stands between them, while on the side next the sides of the vessel each of these cylinders is carried by an independent standard as shown. The bedplates with the crankshaft bearings are both bolted to the condenser, so that the two engines form one solid structure.

The valve motion is marked by some special features, it having been designed to keep clear of the condenser,

FIG. 6.

which would have been in the way of ordinary double-plate quadrants when working in full gear ahead. To avoid this difficulty there is bolted to the end of each valve spindle a double head which carries the quadrants within it, and which enables them to be made much shorter than would be possible with the ordinary arrangement with a solid spindle head between the quadrants. The double heads on the valve spindles look somewhat massive, as they have of course to be made large enough to allow of the eccentric rod heads passing between them; but Messrs. Rankin and Blackmore have found the arrangement answers thoroughly well in all cases where they have used it. The whole of the working parts of the valve gear are adjustable.

As will be seen from the views on our two-page engraving, the valves of the high-pressure cylinders are driven by their spindles being coupled to rocking levers, one end of each of these levers working on a fixed fulcrum, while the other is coupled to a prolongation of the corresponding low-pressure (or intermediate cylinder) valve spindle. The high-pressure valves are thus given a travel equal to half that of the valves of the larger cylinders below.

The air, circulating, feed and bilge pumps (one of each) are worked from the crankshaft of the starboard engine by eccentrics, the port engine driving no pumps. The air and circulating pumps are each double-acting and are 10 in. in diameter by 10 in. stroke. They are of the pattern in which a plunger works to and fro through a central partition, as shown by Fig. 2, on our two-page engraving, from which their arrangement will be readily seen. The pumps with these valve chambers form part of the condenser casting. The only packing used for the plungers is water, which is admitted round the plunger where it works through the partition by the apertures shown. This arrangement is found to give excellent results; the pumps work with exceedingly small friction, and the vacuum obtained is quite as good as with pumps having packed buckets. In fact Messrs. Rankin and Blackmore state that they have repeatedly obtained from 28 in. to 29 in. vacuum in engines working with steam admitted for three-fourths of the stroke. The section, Fig 2, just referred to, is taken through the circulating pump which is fitted with india-rubber valves. The air pump is fitted with Kinghorn's metallic valves for both suction and delivery. The feed and bilge pumps are plunger pumps and are worked by arms from the rods of the circulating and air pump as shown.

The condenser contains 555 solid-drawn brass tubes, 5 ft. long between tube-plates, $\frac{3}{4}$ in. in diameter and No. 18 W.G. thick, the condensing surface exposed being 545 square feet. The tubes are packed with cotton cord and screwed brass glands. The condensing water is forced through the tubes, making three runs of the length of the condenser.

The engines above described have, as we have already stated, been designed for a working pressure of 150 lb. per square inch, and the boiler provided in connection with them is shown by Figs. 4 and 5 on the present page, while Fig. 6, annexed, gives details of the rivetting of the longitudinal seams. The boiler, which is constructed to pass Lloyd's tests, is of the ordinary single-ended type, and is 10 ft. 6 in. in diameter by 9 ft. 6 in. long, and has two furnaces 3 ft. in internal diameter. The boiler is of steel throughout, the barrel plates having a thickness of 1 in. bare, and the end plates being $\frac{15}{16}$ in. above the level of the tubes. Below this level the front plates are $\frac{7}{8}$ in. and the back end plates $\frac{15}{16}$ in. thick. Each furnace has an independent combustion chamber, the tube-plates being $\frac{3}{4}$ in., the bottoms of the combustion chambers $\frac{5}{8}$ in., and the rest of the combustion chambers $\frac{1}{2}$ in. thick. The furnaces are Fox's corrugated furnaces $\frac{1}{2}$ in. thick.

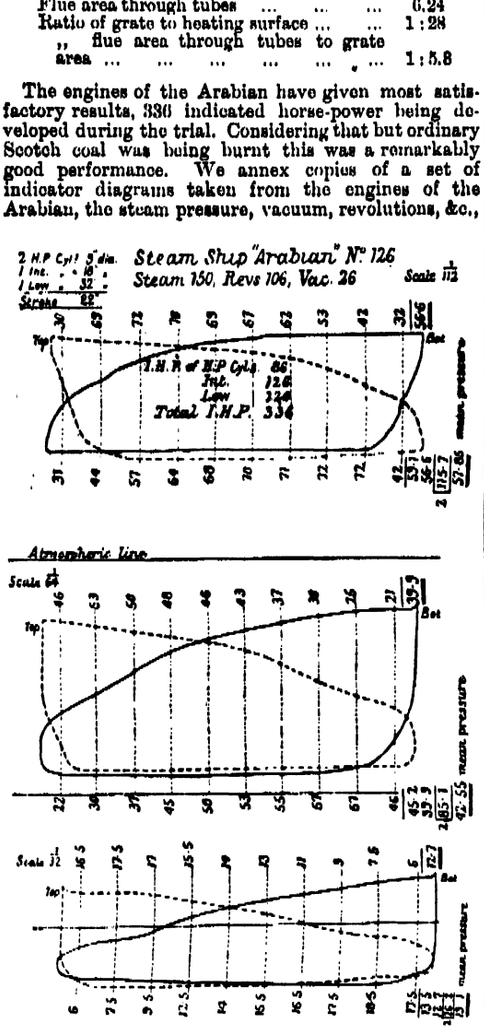
The boiler contains 122 tubes, $3\frac{1}{2}$ in. in diameter, of which number forty are stay tubes, while six others are screwed into the back tube-plate and headed over at the front ends. The stay tubes are screwed into the back tube-plate and have double nuts at the front ends. The stay tubes are $\frac{7}{8}$ in. and the ordinary tubes No. 9 W.G. thick. The stays of the backs of the combustion chambers are of steel and $1\frac{1}{4}$ in. in diameter with the exception of those forming the outside row, which are $1\frac{1}{2}$ in. in diameter. These stays all have nuts on both ends. The sides of the combustion chambers are stayed by $1\frac{1}{4}$ in. steel stays with nuts on the inner ends only, the outside ends being rivetted over. The upper part of the boiler, and also the lower part below the furnaces, is stayed by steel longitudinal stays $2\frac{3}{4}$ in. in diameter at the body, with $2\frac{3}{4}$ in. screws. A stay tube running through to the front plate below the smokebox is also provided on each side as shown on Fig. 4, to support the part of the combustion chamber into which it enters.

The circumferential seams of the boiler and the junction seams of the end plates are double rivetted, while the longitudinal seams are triple rivetted and have inside and outside butt straps $\frac{15}{16}$ in. thick. The rivets used are of steel 1 in. in diameter, and, in the case of the longitudinal joints, they are placed at $4\frac{1}{2}$ in. pitch,

as shown in Fig. 6. The chief proportions of the boiler are as follows:

	sq. ft.
Grate surface	33
Tube heating surface	727
Other ,, ,, ...	193
Total ,, ,, ...	920
Flue area through tubes	6.24
Ratio of grate to heating surface	1 : 28
,, flue area through tubes to grate area	1 : 5.8

The engines of the Arabian have given most satisfactory results, 336 indicated horse-power being developed during the trial. Considering that but ordinary Scotch coal was being burnt this was a remarkably good performance. We annex copies of a set of indicator diagrams taken from the engines of the Arabian, the steam pressure, vacuum, revolutions, &c.,



being noted on the figures. We may add that the valves of the two high-pressure cylinders are set to cut off at three-fourths of the stroke, while those of the intermediate and low-pressure cylinders cut off at five-eighths.

Messrs. Rankin and Blackmore inform us that in designing the engines of the Arabian they made no attempts to balance the power developed by the steam in its three stages of expansion, their object being to balance the two divisions—port and starboard—of the engines. In this endeavour they have been very successful, there being a difference of but two indicated horse-power between the powers developed in the intermediate and low-pressure cylinders, while the two high-pressure cylinders give, of course, uniform results.

Of course a point of importance in comparing engines of the class we have been describing with those of the ordinary type, is their relative weight, and respecting this Messrs. Rankin and Blackmore have given us some interesting data. The net weight of the machinery of the Arabian per indicated horse-power is, they state, practically identical with that of their two-cylinder twin screw engines, but the gross weight, including water in the boiler, is actually less by the difference between the weights of water in the respective boilers, this difference amounting in the case of the Arabian's machinery to nearly 4 tons. This saving is the result of the smaller diameter of boiler which suffices for the triple-expansion engines.

It is to be regretted that there has not yet been an opportunity of thoroughly testing the fuel consumption of the engines of the Arabian, but their makers, judging from the power developed by the boiler during the trial, estimate the saving of coal as fully 20 per cent. compared with the performance of ordinary compound engines working at 80 lb. pressure. Judging from the results obtained in other triple expansion engines using steam at pressures of about 140 lb., there is every reason to believe that the estimate thus formed is not an extravagant one.

In conclusion we may say that the system of twin screw engines we have been describing appears to us to be one admirably adapted for securing the benefits due to the triple expansion of high-pressure steam, combined with great handiness for manœuvring purposes, and it is thus well worth the attention of our Admiralty.

STANDARDS OF LENGTH.

*Standards of Length and their Subdivision.**

By GEORGE M. BOND, Hartford, Conn.

(*Continued from page* 46.)

LET us now briefly refer to what has been done to fix permanently the metric standard of length. The metric system is represented in Great Britain by two bars made of platinum, one being a line measure, and the other an end measure standard.

These bars are of the following dimensions:

Line metre ...	Length ...	41.000	in.
	Breadth ...	1.000	,,
	Thickness ...	0.311	,,
End metre...	Length ...	39.37+	,,
	Breadth ...	1.000	,,
	Thickness ...	0.287	,,

The defining lines nearly traverse the face of the bar for the line meter, and arrows, arbitrarily placed, indicate the position on the lines when measurements are to be made.

The line meter has the words "Royal Society, 45," engraved on the underside. The end meter, being made of so soft a material as platinum, is at present not in a condition to use as a standard for very accurate work, the edges of the end surface being indented and other signs of change in the surface being visible. The end meter has the words "Mètre à Boute" engraved on one side, and "Fortin à Paris, Royal Society, 44," on the other. These bars, together with the original standard prepared by Hassler in 1832, are the only recognised standards which have been compared directly with the "Meter of the Archives," as the French standard is called.

The Meter of the Archives is also made of platinum, the dimensions being about the same as the metric standard in London, and this bar was made a legalised standard after all attempts to make it conform to a natural unit were abandoned. It is standard only at 0 deg. Cent. or 32 deg. Fahr. Thus we see, that after all, the actual use of a natural unit for creating and reproducing a standard of length was not realised, and standards, made standard by law, were really the final result.

It is has been said that "a mystery is a truth hid behind some other truth, and about which the latter throws a veil," and it would seem as if this definition might apply to the great difficulties met with in the attempts to obtain a standard of length from natural laws and natural conditions, using the grand truths which are known and accepted, but which seems to throw just enough uncertainty around the truth sought, as to make the results doubtful for the purposes for which they are intended. Truth is exacting, it allows for no "errors of observation" or of "personal equation," and in no other kind of investigation does this requirement seem more difficult to be fulfilled, as so many "variables"—to use a mathematical term—enter into the problem; variations of temperature, internal strain, due to position of the bar; errors of curvature, errors of observation in using optical instruments; differences in material or of density, thus effecting the rate of expansion or contraction, and a score of other variables, all tending to make the problem a complicated one. We cannot fail to realise—at least partially—the wonderful skill and patience necessary to conduct the experiments which gave us, as English speaking people, the standard imperial yard, and which fifty years ago, were engaging the attention of some of the greatest minds the world has ever known.

There is still another natural unit that has been proposed as a standard of length. This is the length of a wave of monochromatic or single-colour light.

We have all seen the beautiful colours so wonderfully arranged in the thin film of a soap bubble. These colours are caused by what is termed "interference." To briefly explain this kind of interference, we should know that light is made up of seven distinct coloured rays, which blended together produce clear white light. Each of these separate rays of colour has an undulatory or wave motion through space, and the length of a wave, or the distance from the crest of one wave to the top of the next, is different for each as compared with unlike colour, but constant for its own; that of the green ray, for instance, being computed as being about $\frac{1}{50,000}$ th of an inch from crest to crest.

When light is reflected from the two surfaces of the thin film of a soap bubble to the eye, a portion of it must evidently travel a distance twice the thickness of the thin film of the bubble, as part is reflected from the outer and part from the inner surface of the film. The particular ray which must thus travel further, loses a half of a wave length in the reflection, so that when these two portions of the reflected light come into the same path again, there is more or less interference, and if the retardation has been such that the wave crest of one falls into the trough of the other, they completely neutralise each other, and the corresponding colour rays are destroyed. Without attempting the mathematical discussion of this subject, we know that when this relation becomes more or less coincident, the rays are either deadened or are so blended that they form the beautiful rings or bands so often noticed. As the film of the bubble changes in thickness, these colours are rearranged, as different sets of colour rays, or waves are deadened, and as different colours disappear from the reflected light.

This unit, no doubt, could be relied upon to produce a standard within certain small limits, but the addition or multiplication of such minute units for the purpose of obtaining a practical standard of length, might introduce errors in the total greater than would be likely to result from either of the methods already mentioned.

The use made of this unit seems to confirm the theories in regard to the limit of divisibility of matter, and these same soap bubbles which are such a delight to children—and we might include some of the older people too—have shown a way in which to estimate, in a purely scientific manner, the dimensions, approximately, of a molecule, a form of matter so minute that the smallest object visible under a powerful microscope is made up of countless numbers of them.

It has been demonstrated that the mechanical energy required to pull apart the molecules of water in forming steam, is no greater, according to the theory of capillary action, than is required to reduce the thickness of a film of water to the $\frac{1}{500,000,000}$ th of an inch; a force quite large when compared with the small amount of water which we are considering. The measurement of this minute thickness is based upon the varying colours, using the length of any given wave. Probably before this extreme tenuity could be attained, there would remain only a single layer of molecules held together by their mutual attraction, giving as the estimated average diameter of a molecule the $\frac{1}{500,000,000}$ th of an inch, a dimension so infinitely minute as to be quite beyond our ability to realise.

Sir William Thomson, from a comparison of these phenomena, has estimated the limits or range of size of these minute molecules to be between $\frac{1}{250,000,000}$ th and $\frac{1}{5,000,000,000}$ th of an inch, and in order to give some conception of the "coarse-grainedness," as he calls it, thus indicated, he has said, "that if we conceive a sphere of water as large as a pea, magnified to the size of the earth, each molecule being magnified in the same proportion, the magnified structure would be coarser grained than a heap of small lead shot, but less coarse grained than a heap of cricket balls."

We can thus faintly begin to grasp the idea of the infinite divisibility of matter, and the science of exact measurement of length must stop far short of this limit, as it does far short of the limit of infinite extension.

We have now seen how difficult has been the work of obtaining a standard for final reference, and as it must certainly be supposed to remain an invariable or fixed length after having been once established, great care must be taken to preserve this standard from injury, caused either by wear or oxidisation, or change of form.

The materials available for standards of length, taken in the order of their rate of expansion under the same conditions of temperature, are wood, glass, platinum, gold, silver, iron, brass, and copper. Wood may be rejected at once for our purpose, though it does very well for yard-sticks and pocket-rules for every-day use. Glass has been, and is now, used in certain cases, though its great brittleness makes its use restricted and the changes going on within its structure are now the subject of rigid investigation, requiring time to prove its value as a material for standards.

Platinum, alloyed with about 10 per cent. of iridium, is used for the Meter of the Archives, and also for the bars representing the line and end meter standards in Great Britain, to which reference has already been made.

Gold and silver may be said to be excluded for various reasons, that of cost is the case of gold, and its extreme softness, and silver, because of its great affinity for sulphur, which is always present in the atmosphere of cities, forming the dark sulphide that would soon ruin it for use as a standard. There is, however, a silver centimetre scale, ruled by Brunner of Paris, subdivided into 100 parts, in the office of the Coast Survey at Washington.

Iron bars were used by the French Commission, four standards being made of this material, with polished ends. From one of them was constructed the platinum Metre of the Archives. One of these bars, the only one known to be in existence, bearing the stamp of the Commission, is now in the possession of the United States Coast Survey at Washington.

The Russian standard of length, used for geodetic surveys, was constructed of iron, using conical pieces of tempered steel in each end. This bar has a length of 7 ft.

We have already noticed how largely brass, or Bailey's metal, has been used for our standard yard, and for the numerous copies made of it. There remains only a brief mention of standards made of copper. M. Tresca, acting director of the Conservatory of Paris, constructed a copper line meter of a form which he proposed. This bar is X shaped, very light and strong, and has the lines ruled on a plane midway between the top and bottom edges.

The method adopted at the Conservatory in Paris for comparing the platinum line meter bar with the end "Mètre des Archives" is the use of a plate having the same thickness as the meter, to which is attached a thin piece of platinum terminating in a sharp point. As a statute law forbids contact of any kind whatever in the use of this platinum end meter, the reflection of this sharp point upon the surface of the end of the standard gives the means of observing the instant of contact without contact being actually made. It is the opinion of M. Tresca that the error can be in this way reduced below 1 mikron = .001mm, or about $\frac{1}{25,000}$ th of an inch, in the transfer to line measure.

(*To be continued.*)

* A lecture delivered before the Franklin Institute, February 21, 1884.

BELGIAN MINING AND METALLURGY.

SOME valuable official statistics have just appeared in Belgium in illustration of the progress of coal mining and metallurgical industry in that thriving little kingdom. It appears from these statistics that the coal extraction in Belgium in 1882 amounted to 17,590,989 tons, showing an increase of 717,038 tons as compared with 1881. To the extraction of 17,590,989 tons effected in 1882, the three provinces of Belgium made the following contributions: Hainaut, 13,131,342 tons; Namur, 466,165 tons; and Liége, 3,993,482 tons. The value of the 17,590,989 tons of coal raised in Belgium in 1882 was 7,035,840*l.* The average price per ton, which stood in 1880 at 8s. 2d., declined in 1881 to 7s. 8d., but it rallied in 1882 to 8s. The production of 1882 was supplied by 300 working centres; there were besides eighty pits in what may be termed a state of reserve, while twenty others were in course of development. There were 1960 steam engines at work in 1882 in the coal mines of Belgium, the aggregate force of these engines being 166,444 horse-power. The average thickness of the coal beds in working in Belgium in 1882 was, as nearly as possible, 2 ft. 1½ in. It is computed that in the fifty-two years ending with 1882, inclusive, 460,773,910 tons of coal were raised from the soil of Belgium, this heavy aggregate representing a value of 209,200,000*l.* The coal production of Belgium would appear to be steadily increasing, although it is not growing very rapidly. In 1873 the production was 15,778,401 tons; in 1874, 14,660,029 tons; in 1875, 15,011,331 tons; in 1876, 14,329,578 tons; in 1877, 13,938,523 tons; in 1878, 14,899,175 tons; in 1879, 15,447,292 tons; in 1880, 16,866,698 tons; in 1881, 16,873,951 tons; and in 1882, 17,590,989 tons; giving an annual average for the ten years of 15,540,497 tons. It will be seen that the production of 1882 was larger than that effected in any previous year. Nevertheless, the advance made, comparing 1882 with 1873, did not exceed 1,812,588 tons. The value of the coal production of Belgium has been subject during the last ten years to very great fluctuations. In 1873, the aggregate value of the production was officially estimated at 13,505,480*l.*, giving an average of 17s. 7d. per ton. In 1874 the aggregate value of the production was 9,636,400*l.*, giving an average of 13s. 2d. per ton. In 1875 the aggregate value was returned at 9,193,600*l.*, giving an average of 12s. 1d. per ton; in 1876 at 7,764,760*l.*, giving an average of 10s. 9d. per ton; in 1877 at 6,118,280*l.*, giving an average of 8s. 8d. per ton; in 1878 at 5,912,840*l.*, giving an average of 7s. 2d. per ton; in 1879 at 5,799,800*l.*, giving a ' average of 7s. 5d. per ton; in 1880 at 6,787,200*l.*, g.ving an average of 8s. 2d. per ton; in 1881 at 6,548,160*l.*, giving an average of 7s. 8d. per ton; and in 1882 at 7,035,840*l.*, giving an average of 8s. per ton. The number of workmen engaged in Belgian coal mining does not appear to have increased of late years. In 1873, this number was 107,902; in 1882 it stood at 103,701. As the production of 1883 was 1,812,588 tons larger than the production of 1873, it follows that the average quantity of coal raised by each working miner in 1882 was 169 tons, as compared with 146 tons in 1873. The aggregate amount paid away in wages in 1882 was 3,984,760*l.* The cost of raising the 17,590,989 tons of coal produced in Belgium in 1882 was 6,844,800*l.* The profit realised for the year was 191,040*l.*

There were thirty-eight blast furnaces in activity in Belgium in 1882. These furnaces employed 3791 workmen, and consumed 539,287 tons of minerals, scoriæ, &c., of which 206,403 tons were indigenous minerals. The quantity of pig produced by the thirty-eight furnaces in working in Belgium in 1882, was 726,946 tons, viz., refining pig, 539,287 tons; casting pig, 58,474 tons; manganesiferous pig, 5957 tons; Bessemer pig, 118,297 tons; Thomas-Gilchrist pig, 4631 tons; and worked pig, 300 tons. The average value of the 726,946 tons of pig produced in Belgium in 1882 was 2*l.* 8s. 2d. per ton. The number of iron works in operation in 1882 was eighty-two; these furnaces employed 17,414 workmen who produced 503,113 tons of various descriptions of iron of an average value of 6*l.* 13s. 5d. per ton. There were four steel works in Belgium in 1882; these works produced 182,627 tons of steel ingots, and 151,291 tons of finished steel, of an average value of 6*l.* 8s. 3d. per ton. The total of 151,291 tons of finished steel was made up as follows: Rails, 109,809 tons; tyres, 11,308 tons; rolled steel, 10,684 tons; beaten steel, 10,028 tons; heavy plates, 1252 tons; thin plates, 648 tons; and steel wire, 7562 tons. In 1881 the production of steel ingots in Belgium was 141,640 tons, of an average value of 4*l.* 12s. 9d. per ton, while the production of finished steel was 119,237 tons, of an average value of 6*l.* 10s. 2d. per ton. The production of iron in Belgium in 1873 was 503,432 tons; the corresponding production in 1882 having been 503,113 tons, it follows that the production has not made any progress during the last ten years. On the other hand, the production of steel ingots and finished steel has made very great strides in Belgium in the same period, the output of 1873 having been 21,657 tons of ingots, and 18,533 tons of finished steel, while the output of 1882 was 182,627 tons of ingots, and 151,201 tons of finished steel. The production of Bessemer steel in Belgium dates from 1864, when the Bessemer process was introduced at the works of the John Cockerill Company. Before 1864, Belgium produced annually only from 1500 tons to 3000 tons of puddled steel. The Martin process was introduced in 1872 at the Seleasin works; and the Thomas-Gilchrist, or basic process, was adopted in 1879, at the Angleur Works.

INTERNATIONAL FORESTRY EXHIBITION IN EDINBURGH.

IN many respects, the International Forestry Exhibition now being held in Edinburgh has already proved itself to be possessed of an amount of importance and scientific and practical interest far beyond the estimate generally formed of it by those persons who have not yet had the pleasure of visiting it and making a careful survey of its many and varied collections. For some days after the opening of the Exhibition there was a considerable extent of unoccupied space, in consequence, chiefly, of the non-arrival of the Japanese collection, which was known to be of very large proportions, and of high interest. Now, however, that collection has been laid out with great neatness, care, and effectiveness, and henceforth the Japanese Court will doubtless prove to be one of the most attractive features of the Exhibition. Its extent is so very considerable that it occupies the entire space embraced in both of the eastern transepts of the main building, and as regards its instructiveness some comprehensive and correct idea may be formed by those persons who have given attention to the striking advance which Japan has made during the past twenty years or so in scientific culture and industrial progress. On the occasion of our last visit to the Exhibition, which was only a few days ago, there were still several space allotments remaining unoccupied, but they were of small extent and comparatively unimportant. The Executive Committee of the Exhibition are from week to week actively exerting themselves to make the undertaking a great success by increasing and varying the attractions, one of them being the completion of a very extensive installation of electric lighting, chiefly by means of between fifty and sixty Brush arc lamps. It is thus rendered possible to continue the collections of exhibits in the main building open to the inspection of visitors up till ten o'clock at night, whereas for fully two weeks it was necessary to close at dusk. On several occasions the number of visitors passing through the turnstiles at the entrances to the building has exceeded 5000 per day, and there is every reason for confidence that the Exhibition will become extremely popular.

WOOD-WORKING AND OTHER MACHINERY.

As was to be expected, a display of wood-working machinery on a somewhat extensive scale, forms one of the prominent departments of the Forestry Exhibition. Most of the machinery in question is shown in the northern portion of the open grounds under a stretch of covered shedding some 250 ft. in length by 20 ft. in width. A large proportion of that space is occupied by Messrs. John M'Dowall and Sons, Walkingshaw Foundry, Johnstone, who are, we believe, the oldest firm of wood-working machinery manufacturers in the kingdom. They make a really splendid display—by far the largest on the ground—the machines on exhibition being about twenty in number and capable of doing almost every kind of woodwork. In all these machines there has been embodied a great amount of ingenuity and constructive skill, and in every instance the finish is extremely good. The arrangement of the machinery at Messrs. M'Dowall's stand at once arrests the attention of practical men and of such persons as are familiar with the best examples of the planing adopted in the large joiners' shops which always form an important feature in the leading shipbuilding yards on the Clyde and elsewhere. Notwithstanding the fact that the space allotted for the display of the machinery is comparatively narrow, the various exhibits have been laid down in such a way as to admit of free access to each machine without crowding. As it was practically impossible to put down an engine powerful enough to drive all the machinery at once, it was deemed prudent to erect one capable of actuating the tools in groups. The engine used is one having a 10-in. cylinder, with stroke of 20-in., and automatic cut-off gear. This engine drives a line of shafting about 95 ft. long, fixed under the floor of the shedding, and supplied by the firm. Steam for the engine is provided by a vertical boiler made of Siemens steel, and fitted with cross tubes and improved mountings. With this supply of power it is possible to run together any two or three machines that it may be desired to see at actual work. Standing on an independent platform behind the engine, there is a vertical saw frame, with direct acting engine overhead. Placed on a somewhat light wooden foundation, without any overhead support, this frame is occasionally shown at work cutting, in first-rate style, a log of wood of nearly its full capacity, which is 30 in.; the steam cylinder being 12 in. in diameter, and the total weight of the frame is 10½ tons. Such frames as the one under notice are made by Messrs. M'Dowall to saw trees up to 6 ft. in diameter, and many of them are annually exported to the East and West Indies and other colonies and foreign countries, in addition to those ordered for use at home. Near to this frame there is a circular saw bench, which is fitted with Casson's continuous feed. This machine, which is now well known, is capable of running through 25,000 ft. of 9-in. deals with great ease in an ordinary working day. Another very serviceable machine at this stand is a general joiner, comprising a saw bench, provided with rising and falling spindle, and tools adapted for sawing, grooving, tonguing, rabetting, mortising, boring, cross-cutting, and tenoning; it is suitable for a small workshop or for an estate where general work has to be done. Further on we find a moulding machine (to do work 9 in. by 3 in.), a panel-planing machine, and a hand-planing machine. One of the most recent machines amongst Messrs. M'Dowall's exhibits, and certainly one of the most ingenious machines in the Exhibition, is Anderson and Hunting's patent dovetailer, as constructed by the Johnstone firm, who are the sole makers for Scotland. When in operation, this machine always attracts the attention of crowds of visitors. Besides the foregoing, Messrs. M'Dowall show a band saw having 36 in. pulleys. This saw will cut to a depth of 16 in., the table is 36 in. square, and the weight of the machine is 1 ton 4 cwt. We need scarcely speak in detail of the other exhibits at Messrs. M'Dowall's stand, but we may simply state that they embrace a mortising and boring machine, a tenoning machine, a machine for sharpening and setting band saws, a saw-sharpening machine, a band and saw brazer, a moulding iron grinder fitted with seven emery stones, a self-acting plane-iron grinder for working cutters up to 36 in. long, a self-acting rack-saw bench for 4-ft. saws and with an iron table 20 ft. long, and a cross-cut saw for operating on logs up to 5 ft. in diameter. The last-named machine embodies several ingenious devices. Its weight is only 16 cwt., and yet there is shown alongside of it as a specimen of work it has accomplished, a portion of an elm tree measuring 4 ft. 10 in. in diameter, which was grown in front of Hamilton Palace, and was blown down in one of the recent storms that have done so much destruction in the Scottish forests. Such of our readers as may intend visiting the Forestry Exhibition will doubtless find much to interest them in the collection of exhibits just dealt with.

Messrs. Thomas Robinson and Son (Limited), Rochdale, also have an excellent collection of wood-working machinery, though not nearly so extensive as that just spoken of. First of all there is a 12 horse-power semi-portable engine, which is specially designed for driving such machinery in countries where transport is difficult; all the parts of the engine are so arranged that they can be readily disconnected from the bed and carried separately.

The crankshaft is of steel, and is carried in three gun-metal bearings, and the steps are made in three parts. The boiler, which is multitubular and of the ordinary locomotive type, is fitted with a specially large firebox for burning wood, or miscellaneous forest or woodyard refuse. A semi-portable log frame, driven overhead, and designed for cutting timber up to 24 in. in diameter, occupies a prominent position at the stall. One feature of importance in connection with this frame is that it requires no stone foundations, and hence it is well adapted for use in new countries, and in districts where masons' labour is difficult of obtainment. The saws are carried in a working frame made of steel of H section, which is at once light and strong. The crankshaft, which is also of steel, is carried in two long gun-metal bearings, and is fitted with two flywheels, one on each side of the frame. The fluted rollers, by means of which the timber is fed through the machine, are worked by an adjustable arrangement, so that the feed can be varied to cut from 9 in. to 7 ft. per minute. This log frame is made to carry one saw to the inch, and, as it runs at a very high speed, it will get through a large quantity of work in a day. When fixed on wheels it makes an excellent portable frame. Another machine of great utility is an improved band saw, having pulleys 30 in. in diameter. The pulleys which carry the band are built entirely of steel, after the manner of bicycle wheels, thus combining rigidity with lightness; and the top one, which can be canted to any angle, is held in tension by means of a weighted lever, so that the strain on the saw never varies. The saw itself has adjustable packings both above and below the table, those below being carried by a bracket, which, by the assistance of a balance weight, can be readily raised or lowered to any position. This same bracket also carries an adjustable steel bar, which takes the thrust of the saw when cutting. For the purpose of doing bevel cutting, the table is made to cant at any angle. Another of Messrs. Robinson's exhibits is a continuous feed saw bench, measuring 6 ft. long by 3 ft. wide. It is more especially intended for cutting deals, though it may likewise be used with great advantage for flat cutting. The deal is fed by means of a fluted roller, which can easily be moved to or from the saw spindle. Deals can be cut on this machine at the rate of 70 ft. per minute. The standard from which the feed roller swivels can be removed at pleasure in the event of it being wished to flat-cut very broad stuff at this bench. Not the least interesting of Messrs. Robinson's exhibits is their universal wood-worker, an extremely useful little machine for a joiner's shop or pattern shop. It can be used for doing an almost endless variety of work. On the cutter block for planing there are carried three knives, which are so arranged that one end of the cutter strikes the timber before the other, and in that way an excellent finish is given to the work. There are two tables, one on each side of the cutter block, which are made to rise or fall separately on inclined slides, so as to keep the opening through which the block works as small as possible. The front table is fitted with a canting fence, which is very handy for bevel cutting and stop-chamfering, &c. The mortising is done by a revolving bit attached to one end of the cutter-block spindle, the timber being clamped down on a table and fed up to the mortising bit by means of a screw worked by a handwheel, and at the same time it is worked to and fro by means of a hand lever with stops to regulate the length of the mortise. The same table serves for the boring, and the circular saw is fixed on the outer end of the spindle. This can be changed for a block to carry the cutters for tonguing and grooving, &c. It will thus readily be seen what a great variety of work this machine will perform if needed. All the machines, of which we have spoken, are well designed and finished, and are well fitted for their work.

Of the other exhibitors of wood-working machinery, we may incidentally mention Messrs. Robey and Co., Lincoln, Messrs. J. Sagar and Co., of Halifax, Mr. E. S. Hindley, Queen Victoria-street, London, and Messrs. Carrick and Ritchie, Waverley Engineering Works, Edinburgh. In the same department of the Exhibition Messrs. John Tullis and Son, Glasgow, show some excellent examples of the machinery belting, both plain strap and link, for which they have acquired a high reputation. Messrs. Miller and Co., London-road Foundry, Edinburgh, have on show a capital assortment of chilled-iron wheels, mounted on axles, and suited for the transportation of timber and other purposes. Weighing machines, specially adapted for weighing cut timber, and for use on estates, are exhibited by the well-known firm of Henry Pooley and Son. A patent two-horse hedge cutting and trimming machine is shown at the stand of Messrs. R. Hornsby and Sons, Grantham. It is mounted on two road wheels, which are of large diameter, to secure light draught, and both of them are employed in driving the working parts, the motion being communicated by an arrangement of gearing to one of a pair of knives which are carried by a sliding bar projecting from the side of the machine. Both sides of the hedge may be cut from the same side, so that the machine may be kept on that side which is most convenient. The working of the machine is remarkably simple, and the cutting apparatus can either be raised or lowered to suit high or low hedges, or the level of the ground on which the machine may be travelling.

In addition to their wood-working machinery, Messrs. Robey and Co. have on the ground quite a formidable array of their well-known semi-fixed, portable, and other steam engines. Two of them are compound "Robey" engines of 30 horse-power each, which, together with a 25-horse single cylinder engine, are driving the dynamos for the electric light. A single cylinder engine of 10 horse-power is set apart for actuating the wood-working machinery, and a double cylinder engine of 12 horse-power is used in generating the current for the electric railway. There are two very fine engines—a single cylinder portable, and an improved horizontal fixed—on exhibition, together with a 5 horse-power traction engine fitted with winding drum, steel rope, water lifter, and suction hose. Altogether, Messrs. Robey and Co. have on the ground plant whose market value is well-nigh 4000*l*. Close by in the machinery department Messrs. Crossley Brothers, Manchester, show in action two of their "Otto" gas engines, one of 6 horse-power nominal, and capable of indicating 12 horse-power actual, and one of ½ horse-power nominal. At first it was intended that they should do some useful work in the way of driving machines in the main building, but some of the actual promotors of the Exhibition were of opinion that in allowing them to run and develop power that might be utilised within the building, they were running a considerable risk. Truly, some of the prominent men of Edinburgh require a little education in regard to modern machinery.

In our next article we shall probably have something to say regarding several other machinery exhibits, including Greig's tea-working machinery; and some notice may also be taken of the implements and tools used in forestry in different parts of the world.

ELECTRIC LIGHTING AT THE INTERNATIONAL HEALTH EXHIBITION.

No. III.

THE ILLUMINATION OF THE FOUNTAINS AND WATER WORKS IN THE GROUNDS.

ONE of the most popular of the many attractions at the Health Exhibition, and that which more than anything else renders the Wednesday and Saturday evenings, as well as special holidays, so remunerative, is the brilliant exhibition of the illuminated fountains and system of water works which have been designed upon a very novel and extensive scale by Sir Francis Bolton, R.E., the object, which has been so successfully attained, being to produce as many different combinations as possible of form, colour, total reflection, and general effect of composition.

The arrangements are as follows. In the middle of the ornamental water there has been constructed an island, which is in reality a chamber underneath the principal group of fountain jets. In this there are placed the regulating valves by which the various systems of fountains are controlled, the optical and electric light apparatus by which some of the more brilliant effects are produced, and the electric signalling apparatus by which the assistants receive their orders from the "commanding officer," whose position is in the tower just below the clock face. Upon the island, and therefore above the hidden roof of the chamber, are fixed nine fountain jets, that is to say, a high central jet projecting a column of water from an orifice of 1¼ in. in diameter to a height of 120 ft., four jets, each having a 1-in. orifice, disposed at the four corners of a square, of which the high jet is in the centre. Around each of these corner jets is fixed a horizontal ring 2 ft. 6 in. in diameter, constructed of 2-in. pipe, and carrying twelve ¼-in. jets, and between these corner jets are four "dome and convolvulus" jets, the water issuing from them taking the form of a dome surmounted by a lily or convolvulus. Around the edge of the island is a set of small jets, which form a sort of water fringe, and a somewhat similar set of little jets is fixed around the edge of the main basin.

In this basin there are three distinct systems of fountains, which we may refer to as the outer, the middle, and the inner rings; they carry various kinds of jets, some revolving after the manner of a Barker's mill and scattering water with a sort of spiral motion, others fixed and of different shapes, while many are fitted with finely perforated roses by which very beautiful effects of mist can be produced. There is also a curtain of water spray about 39 ft. long, which is thrown up immediately in front of the cascades to such a height as will admit of effects being produced upon the curtain by the dissolving view apparatus, which is in the island.

The water for the whole system of fountains, after passing the special meters, is delivered by a 9-in. main at a pressure, varying throughout the day, of about 65 lb. per square inch, or a head of 150 ft.; this supply is connected direct to the West Middlesex Water Company's pumping main at Hammersmith. The 9-in. main is carried along the bottom of the basin into the chamber in the island and there forms a square loop, of the same cross-section, and from which the services leading to the different systems of fountains take their supply. Each of these service pipes is fitted with a regulating valve by which its respective series of fountains can be turned up and down, either gradually or suddenly, for some of the most interesting effects are produced by raising one jet while another is lowered, or by causing a single jet, or a group of jets, to pulsate. In order to facilitate the prompt execution of the orders signalled from the clock-tower the various mains within the chamber and their respective valves are painted different colours; thus, the pipe which supplies the outer set of fountains is painted blue, that for the middle ring red, for the inner ring white, black for the little rings encircling the corner jets on the island, and yellow for the fringe around the edge. It is therefore only necessary to signal a colour in order to indicate to the assistants the particular sets of fountains to be operated. We shall, however, refer again to this when describing the signalling apparatus.

Besides the various fountains above referred to, there is below the Albert statue, the cascade, which has, from the first, formed part of the permanent decorations of the Royal Horticultural Gardens, and two temporary water-towers, from the top of which three illuminated streams of water pour into the lake. In addition to these there are the four canals, in which the only feature of interest is the illuminated device and cascade at the inner end of each basin, four Soleil lamps being used for this purpose.

The simple, yet elaborately worked-out system, by which these water works are illuminated at night, and by which the various very charming effects are produced, is one of the most interesting features at the Health Exhibition. In this installation alone there are no less than 21 arc lights, and we understand that some 200 incandescence lamps will shortly be added. The arc lamps are distributed as shown by the Table on the opposite page.

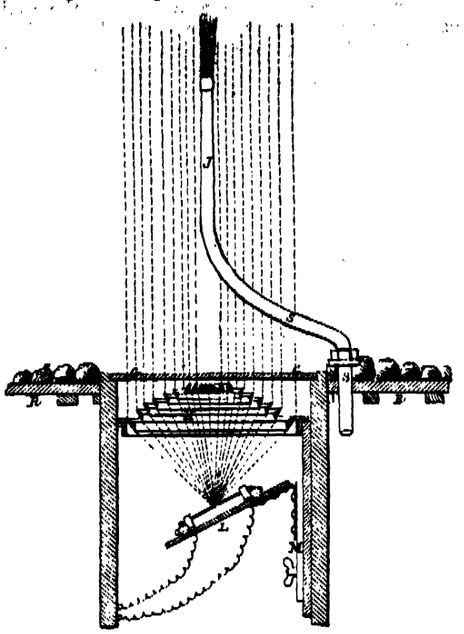
The illumination of the fountains in the central basin is effected partly by throwing upon them from the clock-tower concentrated beams of electric light, both white and coloured, and partly by projecting from below them, by means of suitable optical apparatus, vertical columns of light which, by strongly illuminating the water as it issues from the jets, and being reflected by the countless drops of water as it breaks up in mid-air, fills the atmosphere in and around the jets with tens of thousands of sparkling gems of light and colour, thereby producing beautiful and very remarkable effects.

Pleasing effects are also obtained by throwing upon the cascades bands of differently coloured light, or by employing the water curtain as a screen to receive images projected by a magic lantern, while another series of effects are brought about by illuminating the central group of jets with concentrated light and surrounding them with mist illuminated by diffused light.

ARRANGEMENT OF LAMPS USED IN ILLUMINATING FOUNTAINS.

Island	Underneath fountains in magic lantern	5. (Hand adjustment) 6. Siemens (focus-keeping)	Worked by Siemens direct-current machine and by Clerc machine.
Clock	Over clock face in holophotal projector	1. (Hand adjustment)	Worked by Crompton-Bürgin machine.
	At sides of face in parabolic reflectors	2. Brush (focus-keeping)	Worked by Brush machine.
	Above sides of face at foot of mast light in lenticular projector	1. Siemens "	Worked by Siemens alternate current machine.
Towers	Tower jets	6. Siemens (focus-keeping)	Worked by Siemens direct current machine (420 ampères).
Side basins	Behind ruby glass	2. Soleil	Worked by Clerc machine.

The arrangements by which the central fountains are illuminated from below will be understood by referring to the accompanying figure, which is rather an illustrative diagram of the method of illuminating the central fountain than a sketch of the actual apparatus employed. Immediately below the nozzle J of the central jet is fixed a circular plate of glass G G which forms a water-tight window in the roof R R of the chamber under the island, and below this, and co-axial with the jet, is fixed a sixth order cata-dioptric holophote H about 23 in. in diameter



built up of six reflecting zones and a central Fresnel lens constructed of a middle lens surrounded by two refracting rings. The focal length of this holophote is 150 millimetres, and it condenses all the upper rays emanating from a source of light at its focus (which lies in the plane of its outer zone), into a vertical cylindrical beam of the same diameter as the outer reflecting belt. Near the focus of this holophote is placed a simple arc lamp L, carrying a pair of carbon rods which are regulated by hand by a simple rack and pinion adjustment; the lower pencil is one of Siemens's 18 millimetre cored carbons having a hard shell and soft core, and the upper pencil is hard carbon 16 millimetres in diameter. In this case the lower and cored carbon is the negative in order to get the light-giving crater at the bottom. The lamp is, for this reason, set at an angle with the horizon (but not so great as that shown in the diagram), and is attached by a bracket to a sliding block of wood, while its focal adjustments can be made. The four corner jets are illuminated in a precisely similar way, except that in the place of a holophote, a horizontal Fresnel lens of 20 in. in diameter is employed, the lamp and other arrangements being exactly the same as for the central fountain.

In each of the two water-towers and fitted with suitable optical apparatus are three Siemens focus-keeping lamps, each placed in such a position as to throw a concentrated beam of light through the axis of a horizontal glass tube which projects over the ornamental basin and through which a stream of water will be allowed to pass; the effect of this will be that six luminous streams of water will flow from the top of the towers into the lake below. All the lamps, both in the island and in the towers, (that is to say, eleven lamps), are worked in parallel circuit from a new form of Siemens direct current, machine, to which we shall refer later on, and the resistances of the lamp circuits are so balanced by means of wire and ribbon resistances (fixed in a small hut in the grounds), that the six Siemens lamps, each taking 20 ampères of current, and the five hand lamps each taking 60 ampères, receive neither more nor less than their proper working current.

The electric light apparatus within the clock-tower consists (1) of a hand-adjustment lamp, fixed in a military holophotal projector, which is capable of being directed in different directions both in altitude and azimuth, and deriving its current from a Crompton-Bürgin machine; this apparatus is fixed just above the clock face and projects its beam through a window on to the fountains. (2) A second military projector fixed above the clock room and at the foot of Edmunds's mast light. In this is a Siemens focus-keeping lamp deriving its current from a Siemens alternate current machine. (3) Two Brush focus-keeping lamps, one on each side of the clock-face. and each in the focus of a silvered parabolic reflector which can be directed to different angles of altitude and azimuth. All these lamps, as well as those on the island and in the towers, are fitted with suitable switches by which they may be thrown in or out of the circuit at any moment. Various colours and combinations of colours are given to the beams by sheets of colou red glass or gelatine plates interposed in the beam in front of lenses, and the rapidly changing effects of colour are produced by a set of differently coloured gelatine plates drawn in succession through the path of the beam.

The electric signalling apparatus consists of a keyboard of thirty-six pushes fixed in the clock-room from whence the orders are given, and these are connected by wires with the indicating apparatus in the island and on the water-towers. This latter apparatus consists of two electric bell indicators, one for giving instructions respecting the valves, and the other for controlling the lights. The eight tablets in the "water indicator" are labelled respectively "Steady," "Red," "Green," "Blue," "White," "Black," "Centre," and "Yellow," and refer to the valves which regulate the different systems of fountains, and which, as we have described, are painted with the above colours in order to readily distinguish them and to facilitate the signalling. The "Light indicator" has six tablets labelled respectively "Centre lamp," "4 Side lamps," "Blue," "Yellow," "Red," and "Green." There are besides several electric bells, one large bell labelled "On," and a smaller bell "Off," indicating that the water or the lights are to be turned on or off, the signals on the indicators showing to which it refers; and, in addition to these, there are bells of different tones for calling attention or for answering an order. The pushes on the keyboard correspond of course with the tablets on the indicators, but an almost infinite number of orders can be conveyed by combining two or more signals together, and Sir Francis Bolton employs this means to indicate to the assistants, in charge of the valves and lights, any one of the multitudinous effects which he may at any moment desire to produce.

The hand lamps and Siemens focus-keeping lamps are, as we have already pointed out, worked in parallel circuit by a Siemens direct current machine which is fixed among the other electric lighting machines of the Exhibition. This machine is of a very interesting and novel type, and we hope on an early occasion to illustrate and describe it. The special feature of novelty lies in the fact that the armature is not coiled with wire as the Siemens machines usually are, but, more like some of the Edison machines, is built up of thick longitudinal bars or prisms of copper connected at the ends of the armature in the manner peculiar to the Siemens machine. This armature rotates at a speed of 773 revolutions per minute within a magnetic field, the coils of which are partly in shunt and partly in direct circuit with the external circuit of the apparatus, which is thus in itself to a great extent self-regulating. It gives a current of 420 ampères with an electromotive force of 80 volts—equal to 33,600 watts. The contact of the commutator brushes is maintained against the commutator by means of springs adjusted by a screw, and their position with respect to the magnetic field is regulated by a well-designed worm and wormwheel adjustment fitted with locking gear to hold the brush holders in their most efficient position. The current for the machine is conveyed to and from the hut in the grounds by four well-insulated cables each made up of nineteen strands of No. 12 B.W.G. copper wire, and from thence is distributed to the island and towers, the respective currents to each branch being balanced by resistances placed within the hut.

The only feature of interest in the side basins consists in a set of spiral glass tubes, placed close together vertically side by side, and rotated alternately in opposite directions by means of an undershot water-wheel driven by a cascade which falls over them. Above this mechanical device, which has been constructed by Messrs. J. Defries and Sons, is fixed a Soleil electric lamp behind a sheet of ruby or other coloured glass.

We may mention that the whole of the hydraulic arrangements of the fountains and water works have been carried out by Messrs. Simpson, of Pimlico, under the direction of Sir Francis Bolton.

PRIVATE BILL LEGISLATION.

WITH the abruptly approaching end of the session, the labours of the Committees are rapidly drawing to a close, and we shall have but little more to place on record. In the Lords, since our last article, the Barrmill and Kilwinning Railway Bills have been passed as well as most of those railway Bills which had successfully worked through Committee in the Commons. The only Bill of importance now before this House is that of the Barry Dock and Railway, which is being rapidly proceeded with before a Committee of which the Marquis of Waterford is chairman. The case of the promoters has been completed, and the chief opponents, the Taff Vale Railway and the Marquis of Bute, are now endeavouring to show that the present arrangements and those contemplated at that railway and the docks belonging to that nobleman, are such as to leave little to be desired, and that the construction of the proposed works will be of little use and unremunerative to the promoters. The Lincoln and Skegness Railway Bill has been withdrawn.

In the Commons, the Select Committee that rejected both the rival Thames communication schemes first considered—the Nightingale-lane Subway and the Duplex Bridge—have made a special report upon the matter in which they state that they are unanimously of opinion that the Duplex Bridge ought not to be passed, and that it is undesirable that so large a sum as 2,000,000*l.* should be expended upon the construction of the subway, which at best could only be considered as a compromise, and which would have entailed an expenditure of a like amount further east at no distant date.

They then state that two means of crossing the river below London Bridge are immediately required, and should receive the sanction of Parliament; these are, first, a low-level bridge at the site of the rejected Duplex Bridge at Little Tower-hill, with two openings, each of 100 ft. clear width, spanned by a pivot swing bridge similar to that which has been erected over the River Tyne at Newcastle; and, secondly, a subway at or near Shadwell similar to that proposed by Sir Joseph Bazalgette in his report of 1882 to the Metropolitan Board of Works, and which has been so frequently alluded to during the course of the inquiry.

The Committee are also of opinion that the two great public bodies of London, the Corporation and the Metropolitan Board of Works, and not a private company, should undertake these works, and suggest that the Corporation should build the bridge out of the funds of the Bridge House Estate, which, according to a letter from the Chamberlain to the Remembrancer, dated June 28, 1884, appears to be in a condition so favourable as to be able satisfactorily to bear the proposed burden of raising a sum of 750,000*l.*, which is the amount required. The subway at Shadwell might, on the other hand, be advantageously carried out simultaneously by the Metropolitan Board of Works; no mention, however, is made of the desirability or otherwise of continuing the coal and wine duties upon which the fate of this subway rested in 1882.

In view of the mass of evidence given before this Committee, however, it is impossible, in spite of the above-mentioned report, to consider the ques-

tion of the style of bridge at the site named, as by any means settled. There are many, in fact, who believe that Parliament would never sanction a proposal for such a bridge as is recommended, it being alleged by the opponents of such a scheme that it meets neither the wants of the road traffic nor the requirements of that on the river, but would undoubtedly prejudice both; while its construction would, it is urged, seriously affect the navigation, and thus injure disastrously the valuable wharf property lying between its site and London Bridge. Further, it is maintained that the liability of the passage over it to be blocked at uncertain intervals, and possibly for a long time, would dislocate the free current of traffic over it, and the stagnation thus caused would make itself injuriously felt in all the important thoroughfares near its approaches on both sides, such as Thames-street, Eastcheap, and Tooley-street.

On the announcement of the decision of the committee, the Metropolitan Board of Works stated that they would not proceed further with that part of their Bill which related to the establishment at Greenwich and Woolwich of steam ferries with the necessary piers and approaches. That part of their Bill relating to the change in position of their authorised new Battersea Bridge was then proceeded with. This structure, as originally sanctioned, was so laid out as to enable the existing timber bridge to be maintained temporarily, but this necessitated a rather unsightly bend in the approach, and permitted the avoidance of some costly property on the Battersea side of the river. This was opposed unsuccessfully in both houses by the Wandsworth Board of Works. It is now proposed to take the direct line and incur the expense of acquiring the property in question, but the carrying out of the amended project involves either the closing for 2½ years of this route across the river to some 8000 daily passengers, lengthening their journey about half a mile, or the construction of a temporary bridge at a cost of about 10,000*l*. After some days' discussion the Bill was passed, a compromise having been come to by which the Metropolitan Board of Works agreed to maintain a sufficient footway across the river at this spot during the construction of the new bridge. This is a satisfactory arrangement, and contrasts favourably with the obstinate refusal, until within the last few years, of the First Commissioner to allow the passage across St. James's Park to remain open after dusk, a refusal which entailed a longer journey, and far greater inconvenience to a larger number of people, than that which the closing of Battersea Bridge would have caused.

The Bill of the Corporation for the acquisition of the undertaking and property of the unsuccessful Thames Steam Ferry Company, and for the establishment of similar communication on other parts of the river was then passed without opposition.

The only Bill of importance now in committee in this House is that of the Manchester Ship Canal, which is being discussed before Mr. Sclater Booth and three other members. The principal interest, as in the contest here last year, is centred in the navigation question, the opponents alleging that, though undoubted advantages would result from the formation of the training walls in the upper estuary, yet the possibility of accretion being formed behind them, and of thus diminishing the tidal capacity and scouring power of the river, is so important in its effects that on no account should the scheme be sanctioned whilst it contains such an element of evil. On the other hand, the promoters say, the evidence of experts who appeared both for and against the scheme has proved the absolute certainty of the good effects arising from the proposed works, and but the bare possibility of the evil result. Supposing that there should be accretion, as is so much dreaded, it can be but small and very slow in progress, and there is one thing to be said in its favour should it take place, the site of material is known, and it can no longer float up and down with the tide, to find a probable resting place on the bar, where its presence is so much dreaded.

Great progress has been made with this case, and all the evidence is being curtailed as much as possible, so as to prevent its failure through lapse of time.

THE HEALTH EXHIBITION.

EDUCATIONAL EXHIBITS.—No. III.

THE next rooms of the Technical Institute which we proceeded to examine were those allotted to the French Ministry of Public Instruction. Here we found printed copies of the programmes followed in the Government schools of various grades and a collection of schoolwork generally.

We noticed that a vigorous effort is being made in some of the higher primary schools to give a practical turn to the system of teaching. For this purpose workshops are provided in which the elder boys may exercise themselves in such handicrafts as carpentry, modelling, turnery, &c. Besides enabling the youths to acquire some manual skill, this system has the rare advantage of offering opportunities for observing their dispositions and natural bent. It would be interesting to know how far such a system—which is yet in its tentative stage—has been found applicable and what results it has produced. The idea is certainly good, experience alone can establish its practicability. We must say that the specimens of work sent from these embryo technical schools of the Department du Nord, are very good. We had just a shade of scepticism about the genuineness of a few of them, which, however, was quickly dispelled by the information courteously given us by the representative of the French Educational Department, M. Buisson.

A step from the cases containing these attractive specimens of boyish mechanical skill, we met a small collection which appeared to have a merit quite *sui generis*. It consists of articles carved in wood, early attempts in ironwork, and an unpretentious scientific collection, made in their free hours, by the little bereaved ones of the Orphanage, founded at Cempuis, by the generous philanthropist M. Prévost.

We have already pointed out the great care bestowed in French schools upon the study of drawing. Such a valuable subject is not relegated, as with us, to the group of optional studies, but is made an integral part of the school course. It is true something has been done for us by the South Kensington authorities to wake up the country from its deplorable lethargy; but it is none the less true that we are far—very far—behind our Continental neighbours in this matter. For one art student in this metropolis, you will find a score in Paris; and as to proficiency, the difference will become unpleasantly patent to any one who will spend a few hours in comparing our drawings with these from the Ville de Paris. There seems to be a consensus of opinion that much good will result from the scholastic exhibition; let us hope that it will give a much needed impetus to the study, not only of freehand, ornament, and figure drawing, but also to the careful study of geometrical and linear drawing, and the applications of art to industrial design.

Turning our attention to educational appliances, we examined the political and physical maps supplied to schools by the Government. Some of these were excellent; there were others, however, that could be improved in every respect save that of cost. These wall maps are not all supplied by the same publisher, the Government discountenancing the principle of monopoly and purchasing the best article wherever it may be found. With respect to terrestrial globes, we noticed with satisfaction the almost total absence of those finely coloured, neatly delineated, and expensive toys of the past generation. In their stead we found good sized blackened spheres with which an able master can appositely illustrate, and that not to a small group but to a whole class, the principles of mathematical and physical geography. Akin to these geographical adjuncts were the *tableaux-cartes*, or outline wall maps drawn on slated cloth and intended to be filled in with chalk, according to the directions of the teacher. Unfortunately these maps are found to be somewhat inconvenient owing to the practical difficulty of easily cleaning them.

We also found in this section another useful class of school appurtenances, viz., natural history charts, and models. The collection of M. Emile Deyrolle is pre-eminent for its general excellence, illustrating as it does so beautifully the leading types of the animal, vegetable, and mineral kingdoms. That of M. Armengaud represents a number of trades and industries, and is especially designed for school decorative purposes. The collection of the late Dr. Auzoux comprises the finest models of human comparative anatomy and botany ever made. Each model—and there are 150 in the complete collection—is built up of solid pieces, which may easily be removed as in the process of actual dissection, and also easily readjusted again. Such delicate and accurate specimens of scientific work necessarily require much labour and skill, and hence it is not surprising to find that their acquisition involves an expenditure beyond the financial resources of many of the higher schools.

Many of the text-books used in French primary and secondary schools may be seen in the collective exhibit of the "Cercle de la Librairie." This *cercle* has ramifications throughout France; it consists of members from the various branches of the publishing trade associated together for the better protection and advancement of their mutual interests. Some of their science books are favourably known in this country, as the works of Deschanel, Fernet, and Langlebert.

Leaving the French section we proceeded towards the Belgian annexe, regretting somewhat that this branch of the Educational Exhibition should be so far away from the main trunk. But we were well repaid by the variety and completeness of the Belgian exhibits. Here again we realised the advantages of a systematic classification indicating that one organising mind had planned and presided over the whole arrangement.

Taking up in succession a few of the well bound albums of class-work, we noticed that they contained not the papers of picked scholars, but those written out by the whole class for examinational tests, or in the ordinary routine of school work. These were compositions in French and Flemish, specimens of map-drawing, arithmetic, physics, chemistry, and physiography. A cursory inspection showed that great care is bestowed in these elementary schools in the correction of home work. It is not hastily dismissed with a general *viva voce* correction, but is minutely controlled by painstaking teachers. Doubtless the vigilant solicitude of Belgian inspectors serves as a check to remissness, and contributes to keep the teaching staff up to a high degree of efficiency.

The exhibits from the normal schools are numerous, interesting, and suggestive. These training colleges, as we would call them, seem to be directed by an ardent and cultured body of men, who with judicious eclecticism, assimilate whatever they find in other countries that may best promote the educational interests of their own. It is well, however, to always remember from what quarter a method, a system, or an idea has been borrowed so as to give every one his due. This, we fear, some authoritative writers of that interesting kingdom of Belgium occasionally fail to do. We were listening, not long since, to a conference given in the theatre of the Technical Institute by the director of one of these Belgian training colleges, and we were quite amazed to hear the large claims made by the *conférencier* for pedagogical discoveries of his country. Despite this idiosyncracy into which eclecticism often lapses we admire the intelligent method in which these colleges train the future teachers of the country. Every effort is made to give them a practical turn and enable them to provide, in an emergency, whatever they may require for class illustration. They have to draw the plan of their school, its play-ground, and surroundings; then a plan of the parish, the city, and its environs; and lastly a sketch map of the whole province; they are taught to build up with slips of paper their own hypsometrical maps, and are required to cut out of cardboard all sorts of geometrical forms.

The effects of such a thoroughly practical system of training are visible even in the elementary schools, in which the youthful scientists of the rural districts, aglow with enthusiasm for the arcana of nature, are wont to chip off pieces of rocks, to gather specimens of plants, and collect samples of the local industries. With these trophies, won in their leisure hours, they form their herbaria and build up school museums which they learn to cherish as their *monumentum ære perennius*. Many of these juvenile attempts at practical science may be seen among the exhibits from the Government schools, and are well worthy a passing notice.

There are two other collective exhibits in this section, besides that of the Ministry of Public Instruction, viz., that of the City of Antwerp and the adjacent one of the Christian Brothers.

The first includes numerous albums of excellent class-work, articles of furniture, school museums, and wall-maps. These last make rather a conspicuous show. We use this word designedly, such maps appearing quite unsuited for class purposes. They would add to the decoration of a railway station, but would be out of place in a schoolroom. They are less maps than gaudy panoramas.

The second collective exhibit shows the methods followed and results obtained by the Christian Brothers in Belgium. Every branch, from the elements of arithmetic to theoretical mechanics and descriptive geometry, is illustrated by albums and portfolios of very good work. We should specially mention the colleges of Malonne and Carlsbourg for the variety and excellence of their exhibits. Nor can we omit St. Luke's School of Art, Ghent, which shows a most interesting collection of architectural designs, painting, and modelling. It is evident that this school makes a specialty of architecture, as all the drawings are original designs of academies, schools, churches, &c., made after the subjects had been given and explained in the class-room. All the details and working plans are placed just below the overhanging designs, in order to facilitate inspection and invite criticism. As the work of young men, this collection is exceedingly good, and worthy of comparison with many of the elaborate drawings of professed architects which adorn the walls of the neighbouring compartments. As the collective work of one single school, it is unsurpassed in the Exhibition.

Among the numerous educational appliances, we noticed a very fine series of photographs of the principal monuments and buildings of Belgium, these beautiful specimens of photography being supplied by the State to the training colleges. M. Windels has prepared a number of charts representing ethnographical types, a few of which, we confess, were quite new to us. Of greater educational value are his models of animals reduced to the same convenient scale for the sake of comparative study.

M. Arens shows an arithmometer which is by far the best we have seen. It is large and substantially made. It gives accurate representations of the metrical units, explains the formation of fractions and the theory of decimals, and illustrates a variety of properties of numbers and quantities, such as the square and cube of a binomial. This instrument reminded us of the words of an eminent contemporary writer. "It is by arithmetic," says Mr. Fitch, "more than by any other other subject in the school course, that the art of thinking—consecutively, closely, logically—can be effectively taught."

Brother Mémoire, of Malonne, exhibits his well-known models for the study and illustration of the principles of projections, whilst several of his colleagues show their works on method, school government, literature, science, and natural history.

Lastly, Mr. Dierckx exhibits a method of writing devised by him, which has several features to recommend it.

On the whole the exhibits from Belgium well deserve the careful examination of all who may be immediately interested in the work of education.

NOTES.

A Simple Sunshine Recorder.

Professor Herbert Macleod, of Cooper's Hill Engineering College, has devised a simple and effective sunshine recorder by merely placing a globular bottle of water (or water lens) in front of the lens of a camera, in such a position that the focussed ray falls on a sheet of sensitised paper spread on the bottom of the camera box. A curved white line or band is produced on the paper as the sun revolves, and when clouds cross the sun the line stops.

Soldering Aluminium.

The use of aluminium in the arts has been much restricted by our ignorance of any method of soldering it, either to itself or other metals. Now, however, a French engineer, M. Bourbouze, has discovered a way of effecting both classes of the operation with ease. The process consists in plating both surfaces to be soldered, not with pure tin, but alloys of tin and zinc, or tin, bismuth, and aluminium, &c. Good results are obtained with all such alloys, but those containing tin and aluminium are best. They should contain different proportions, according to the work the soldered parts have to do. For parts to be fashioned after soldering, the alloy should be composed of 45 parts of tin and 10 of aluminium, as it is sufficiently malleable to resist the hammer. Pieces thus united can also be turned. Parts which have not to be worked after being soldered, may be united with a soft solder of tin containing less aluminium. This last solder can be applied with a hot soldering iron, as one solders white iron, or even with a flame. Neither of these solders requires any prior preparation of the pieces to be soldered. It suffices to apply the solder, and extend it by help of the iron over the parts to be joined. When, however, it is desired to solder certain metals with aluminium, it is best to plate the part of the metals to be soldered with pure tin. It is sufficient then to apply to the part the aluminium plated with alloy, and to finish the operation in the usual manner.

The American Association for the Advancement of Science.

The annual meeting of the American Association for the Advancement of Science is to be held this year at Philadelphia, and the members of the section for mechanical science are striving to make this one of the most important gatherings of engineers, and of those interested in mechanical science, ever held. They have appointed a committee, of which Mr. J. Burkett Webb, of Cornell University, Ithica, N.Y., is the secretary, to issue invitations to all persons interested, and particularly to the members of the British Association, which is this year to meet in Montreal. Arrangements have been made to carry the members to Philadelphia on September 3, in time for the opening of the Electrical Exhibition. Anyone willing to join the American Association, or to contribute papers, is requested to apply to the secretary.

The Conductivity of Saline Solutions.

The electric conductivity of different salts dissolved in water varies in a complicated manner with the degree of concentration. As yet there is no general law or empirical formula on the subject. M. Bouty, the French physicist, has been studying the matter by means of solutions so diluted that their densities and viscosities were practically the same as that of pure water, although their conductivities varied enormously. He finds that the conductivity is connected with their chemical constitution by a simple law. Let p be the weight of salt contained in unit weight of the solution, e the chemical equivalent, c the conductivity of a liquid cylinder of unit length and section. There is for each salt a value p_1 for p, below which the conductivity varies proportionally to the weight of salt dissolved. Compared among themselves the conductivities of different salts are in inverse ratio to the equivalent, and we can write $c=k\,\frac{p}{e}$, where k is a co-efficient, the same for all the neutral salts studied by M. Bouty. Making $p=e$, that is, considering the solutions which contain in the same volume an equivalent of different salts, *i.e.*, the same number of molecules, the conductivity c is the same for all. The molecular conductivity of all the neutral salts is found the same. For salts which crystallise anhydrously the law is exactly verified from $\frac{1}{1000}$ to $\frac{1}{4000}$, but for hydrated salts it is necessary to go below these limits, and their conductivity obeys the law better as their dilution augments.

Cardiff Water Supply.

The Bill for supplying Cardiff and its district, which includes Penarth and other outlying places, with water from a new source at the foot of the Breconshire Beacons, and distant 32 miles from Cardiff, was passed by a Committee of the House of Lords on the 16th inst., having previously passed a Special Committee of the House of Commons. The very extraordinary growth of Cardiff and Penarth has altogether outstripped the capabilities of the existing water works, and to meet immediate and future demands for water it was imperatively necessary to seek for other sources of supply. Mr. J. A. B. Williams, the water works engineer to the corporation, acting on their instructions, reported in 1881 on every available source, and recommended the Brecon Beacon source as being pre-eminently the best from all points of view. The Bill just passed through Parliament is substantially the same scheme as that then recommended, and provides three large storage reservoirs of a united capacity of 1159 million gallons, with reducing reservoirs at four points along the route of the main from the storage reservoirs to Cardiff. Also a high-level service reservoir at Rhubina. A large storage reservoir, to contain 300 million gallons, at Llanishen, adjoining the present reservoir, is now in progress under the powers obtained in 1879. The estimated cost of the works included in the Bill is 373,000*l*. The Bill was opposed in both Houses of Parliament by a combination of millowners and other parties interested in the water of the Taff Faur River, but was passed unaltered. The engineer for the works is Mr. J. A. B. Williams, M. Inst. C.E., of Cardiff, and the following eminent engineers assisted and gave evidence in support of the Bill, viz., Mr. J. F. Bateman, F.R.S.; Mr. T. Hawksley, F.R.S.; Mr. J. Mansergh, M. Inst, C.E.; and Mr. G. H. Hill, M. Inst. C.E. Cardiff is to be congratulated on obtaining one of the finest gathering grounds in the kingdom for a pure and abundant supply of water.

Electric Light Wires and Lightning.

A curious accident recently happened at the new drill hall of the State University of Minneapolis. On June 12, in the afternoon, this building, which stands on a bluff overlooking the Falls of St. Anthony, was used as a concert room, about 1000 children being in the orchestra and 3000 in the auditorium. During the festival, at which Madame Nilsson assisted, a thunderstorm arose, and it was noticed that the electric lamps were affected from time to time. Suddenly there was a loud report or thunderclap, and fireballs were seen travelling along the overhead electric light wires running from the building. Subsequent examination showed that the building had been struck by lightning. The flagstaff over the door was shattered, and the splinters had broken the glass of a skylight. There was a metal ball on the flagstaff about 50 ft. from the wires, and to pass from this ball to the wires the discharge traversed the flagstaff and a beam which were wet with rain, then passed down an iron bolt running through a piece of timber, from which it leaped to the electric wires and escaped to earth. This accident clearly points to the necessity for some precaution in the running of these aerial electric wires into buildings. For though they make good earth connections, and partial lightning conductors, it is to be remembered that they only act as partial and therefore imperfect rods. Now an imperfect lightning rod is often more dangerous than none at all, since it may invite and direct a discharge when without it there would be none. It seems fair to conclude from the accident at Minneapolis that had the wires not offered a good avenue of discharge to earth there might have been no destructive accident at all. It must not be forgotten that a lightning discharge always takes place where its road to earth is facilitated by some means or other, in other words, at the point of least resistance, and hence if the entry of wires into a building is conducted in such a way that prominent points of it, such as steeples, flagstaffs, and so on, are brought within discharging distance of the wires, without any intermediate conductor, we may expect accidents. We may add that Mr. Noyes, foreman of the Brush Company, while at work on the wires during the accident, and in the act of splicing, was for a few moments rendered insensible, and on descending afterwards to the ground he felt an intense pain in his right foot. On examining it he found that the bolt had struck his leg below the knee, tearing the clothing to shreds, bursting open the boot from toe to heel, and blistering the flesh as with a hot iron.

Water Supply in South Australia.

Drought is the far too frequently recurring curse of the antipodean colonies, and the Government of South Australia appears to be setting a good example as regards the attention which it is giving to the improvement of the water supply of that vast province. In the course of the past financial year, twelve reservoirs have been cleaned out and furnished with improved appliances under contract in the hundreds of Cavanagh, Crozier, Coonatto, Pichirichi, Wirrearta, and Erskine, and at Farina. A well in the township of Wilson has also been fitted with a pump, windmill, and tanks. The Government construction parties have deepened, improved, and fitted with appliances seven wells in the hundreds of Appila, Bendleby, Coomooroo, Eurelia, Woolyena, and at Farina and Hawk's Nest, in the hundred of Coolinong. An important work has been carried out in forming Lake Edith into a natural reservoir. This was done by constructing a dam with steam excavating machinery, which has since been removed to another site. As regards works in progress under contract, it may be added that at Traveller's Rest, in the hundred of Coglin, a well bore has been put down 800 ft., with the result, so far, that a small supply of good water has been obtained. Three wells were commenced by Government construction parties on the Mount Browne-road, near the boundary of the province, and were stopped for want of water. These works are now let on contract. Trial wells are being sunk at

various points on the Overland Telegraph line, and on the route from Hergott Springs to Diamantina. Tanks of varying capacity are being constructed in the townships of Cowell, Franklin Harbour, Coolyanna, near Streaky Bay, and Corrie, Franklin Harbour. Repairs are being effected to the reservoirs in the hundreds of Yarrah, Everard, Lindley, Tickera, Pichirichi, and Worra. Storage tanks are being furnished, with a pipe main, at the springs, Endunda, and tanks and sheds are being constructed on the route from Fowler's Bay to Ooldea. The well-borings, which have been carried on by the Government construction parties, are extremely interesting. The bore at Tarkannia is down 1220 ft., and good water was struck on April 12, which rose a considerable height above the surface, and continues to flow from the pipe. At Dublin a bore has been put down 383 ft. A large supply of brackish water was struck at 317 ft., and rose to within 14 ft. of the surface. At Perryton a bore has been put down 260 ft., but no water has been obtained so far. At Willochra the bore has been sunk to the depth of 356 ft. Salt water was struck at 342 ft., and rose to within 30 ft. from the surface. It is thought that there is a good prospect of obtaining good water here by sinking a little farther. Brackish water has been obtained at Willowie, where the bore has reached a depth of 326 ft., and at Gibson's Camp, on the Port Augusta and Coondambo-road, very brackish water has been struck, the bore now being down a depth of 92 ft. only. Well-sinking operations are being conducted with varying success on the road from Port Augusta to Coondambo. Trial wells are being sunk on the route to the Musgrave Ranges, the party now working between Arckaringa Creek and the Everard Ranges. New wells have been put down in Nantawarra, Hundred Goyder, township of Belton, Hundred Errilpa, and near Callington, in Hundred Morarta. Reservoirs have been constructed on some of the more important stock routes. The first reservoir excavated was that at Ketchowla, which has a capacity of 5,000,000 gallons, and was filled to overflowing by recent heavy rains. At present on this route to the Barrier Ranges two reservoirs, which are to be 240 ft. square and 20 ft. deep when completed, are being constructed. The first of these has been excavated to a depth of 9 ft. 6 in., and the catchpit has also been constructed. The second reservoir has been scooped out to a depth of 8 ft. 6 in., and the catchpit has been made. Both catchpits were filled by recent rains. On the route from Port Augusta to Coondambo one reservoir has been excavated to the depth of 11 ft. 9 in., and another to the depth of 3 ft., and at the Port Lincoln Gap on the route from Port Augusta to Yardea, the work of making another reservoir has advanced to the depth of 7 ft. 6 in. On the route from Hergott Springs to Diamantina, the construction of a dam has just been commenced in the Clayton Creek at Wyenleura.

THE NATIONAL SMOKE ABATEMENT INSTITUTION.—In the report submitted on July 16 the Council of the National Smoke Abatement Institution call attention to the greater interest evinced in the large towns of the country in the suppression of the smoke nuisance, and to the way in which the hands of the local authorities are thus strengthened. Since last year some of the largest bakeries have adopted gas-heated and other modified furnaces, and are now producing no smoke whatever. The number of gas engines at work has increased largely, and it is estimated that there are 6000 of them in London alone. Domestic fireplaces show signs of improvement, and are being made shallower from back to front, as well as being modified in other ways. Coke can be obtained from the chief gas companies, and can be made to burn alone, or mixed with coal, in modern grates. In the manufacture of coke various methods of recovering and utilising the volatile constituents of coal have been further perfected and applied. The Council have given special attention to the Jameson process, as it is applicable to the common descriptions of coke oven. It has been found to produce excellent coke, together with oil and ammonia, worth from 1s. to 3s. 3d. per ton. Several new systems of steam boilers and furnaces have been tested. Two of these were of American invention, both based on Mallett's system, called "controlled combustion." Among the boilers tested was one with flues of curved or "quadrantal" form. This, it is stated, was found efficient and superior for generating steam to the common type of vertical boilers. An exhaustive series of tests of gas stoves and grates, gas boilers, gas regulators, and other gas appliances, have been conducted for the Gas Committee of the recent Crystal Palace Exhibition by Mr. D. K. Clark. These tests have proved, it is stated, that under 20 per cent. of the heat generated in gas cooking stoves is directly utilised in cooking a joint, while in gas heating stoves of the best construction the proportion utilised sometimes reaches 90 per cent. A collection of heating and smoke abating apparatus is being shown at the Parkes Museum.

NOTES FROM THE SOUTH-WEST.

South Wales Institute of Engineers.—A meeting of this Institute was held on Thursday at Cardiff. Mr. Colquhoun, manager of the Tredegar Iron Works, presided. The president delivered an inaugural address. After briefly tracing the history of the South Wales coal trade from the opening of the Glamorgan Canal, in 1796, down to the present time, he observed: With the exception of North and South Durham this has a larger output than any of the other mining districts. But the increase over 1882 is no less than 2,158,055 tons, being double the increase of Yorkshire, and about four times that of North and South Durham. Coal is the backbone of South Wales, and it is a matter of pre-eminent importance that those entrusted with the management of collieries should apply themselves assiduously to keep pace with the newest discoveries that are found most suitable for each particular locality or colliery. Of late years many improvements have been adopted in the method of working the various seams of coal, in the introduction of mechanical ventilation, and in the numerous appliances for the greater security of the workmen and the prevention of disastrous accidents to the mines. In sinking operations two notable instances may be mentioned in Monmouthshire and in the Aberdare Valley, where rock drills and dynamite skilfully applied have won the coal with a rapidity hitherto unsurpassed in South Wales. A very important item in the cost of working coal is that of haulage. The pits are now sunk to a considerable depth, and upon economical grounds it is absolutely necessary to work larger areas of coal. The maintenance of a large establishment of horses, with the small quantity of coal hauled per horse, has led to the introduction of various systems of underground haulage by machinery.

Institution of Mechanical Engineers. — The summer meeting of this Institution will commence at Cardiff on Tuesday, August 5. The proceedings will open with a reception by the mayor (Mr. R. Bird) in the lecture theatre attached to the public hall. At half-past ten the members will adjourn to the main hall, where the president, Mr. I. Lowthian Bell, F.R.S., will deliver his inaugural address, and the following papers, or, at least, as many of them as possible, will be read and discussed: "On Recent Coal Shipping Machinery at the Bute Docks, Cardiff," by Mr. J. M'Connochie, of Cardiff; "Description of the New Locomotive Running Shed of the Taff Vale Railway, Cathays," by Mr. C. H. Riches, of Cardiff; "Description of the Francke 'Tina,' or Vat Process for the Amalgamation of Silver Ores," by Mr. E. P. Rathbone, of London; "On the Use of Petroleum Refuse as Fuel in Locomotive Engines," by Mr. T. Urquhart, of Russia; "On the Causes and Remedies of Corrosion in Marine Boilers," by Mr. J. H. Hallett, of Cardiff; "On the Mineral Wagons of South Wales," by Mr. A. Slater, of Gloucester; "On the Application of Electro-Magnets to the Working of Railway Signals and Points," by Mr. J. A. Timmis, of London.

Dock Matters at Bristol.—All difficulties in the way of the acquisition by the Bristol Town Council of the outside docks at Bristol, may now be said to have been overcome. After a great deal of negotiation, the Great Western Railway Company and the Midland Railway Company have agreed to a differential rate of 2½d. per ton in favour of the city being allowed on ships and steamers of all sizes. As the consideration for the sale of the undertakings, the Town Council is to issue to three directors of each of the several companies, to be nominated in that behalf, Bristol corporation stock of the following amounts on the 1st of September, 1884, which is "the transfer days." To the Avonmouth Company, as a first instalment, 290,000*l.*; to the Avonmouth Warehouse Company, 160,000*l.*; and to the Portishead Company, as a first instalment, 175,000*l.*; and on the transfer of the Portishead Warehouse Undertaking to the Town Council a further or second instalment to the Portishead Company of 50,000*l.* Subject to certain possible deductions the Town Council is also to make the following payments on the 1st of September, 1889. To the Avonmouth Company, as a second instalment, 75,000*l.*; and to the Portishead Company, as a third instalment, 25,000*l.*

Dowlais.—Drought difficulties appear to be disappearing. The leakage in the side of the pond at Cleharris has now been repaired, and, thanks to the heavy rains, the pond has been tolerably well filled with water. The pond at Penwaunfawr, made for the new Copper Company's washing machine in the top yard, shows no sign of the draw upon it through having supplied the whole of the Lower Works, while the quantity of water in the ponds between Pengwern and Pengarnddu give promise of keeping the Upper Works in a state of activity for some time to come.

Bristol and South Wales Railway Wagon Company, Limited.—The directors of this company have resolved to recommend a dividend for the past half-year at the rate of 10 per cent. per annum.

Cardiff.—There has been no material change in steam coal. In the patent fuel trade the better state of affairs noticed recently still continues, and, in consequence, prices are slightly firmer. The house coal trade is quiet, and no great amount of animation is anticipated for some little time to come. The iron ore trade does not yet show any marked improvement. Last week's clearances comprised 152,404 tons of coal, 2150 tons of iron, 1780 tons of fuel, and 500 tons of coke. From Bilbao there were received 6802 tons of iron ore, and 3288 tons came to hand from other sources.

Newport.—The best qualities of steam coal have been in fair request, but for secondary qualities, as also for house coal, the demand has been easy. The quantity of iron ore which has arrived has been comparatively small; taking the tone of the market generally there is not any material alteration to record. The clearances of iron, &c., have been but small, the total being 2400 tons forwarded to the following destinations: New York, 1550 tons; Campane, 850 tons. Last week's coal clearances amounted to 64,780 tons. From Bilbao there arrived 3850 tons of iron ore, and 3650 tons came to hand from other sources.

Shipbuilding on the Bristol Channel.—In his inaugural address to the South Wales Institute of Engineers, the president (Mr. J. Colquhoun) observed: "The gross tonnage of vessels built in iron and steel in the United Kingdom during the last three years is as follows. In 1881, 730,686 tons; 1882, 913,519 tons; 1883, 1,012,735 tons. The number and tonnage of iron and steel vessels built for classification in Lloyd's Register in the Bristol Channel during the same period was, in 1881, 1 vessel for 179 tons; 1882, 7 vessels, 2446 tons, and in 1883, 17 vessels, 9009 tons. The number of vessels being built on the 31st of March, 1884, was, 5 of steel, the tonnage being 2705, and 17 of iron, the tonnage being 4695. Chepstow has been the most important shipbuilding place, and from 1879 to this date has built 12,796 total gross registered tonnage. This, although showing some advance, points to the fact that it would be interesting to discover a reason why this industry has not received greater attention from the enterprising people who are largely concerned in the prosperity of South Wales. It has been alleged that until the iron and steel manufacturers compete in price with those of the North, and deliver the plates promptly, there will be no great amount of shipbuilding; while, on the other hand, it is affirmed that the principal difficulty is in attracting skilled labour. The men on the Clyde, Tyne, and Wear have had a long practical training, and possibly could not permanently be removed to a new sphere of labour, without many difficulties and disadvantages. But the energy and perseverance which have been displayed by capitalists in other branches of trade would no doubt devise some means of gradually obtaining all the skilled people required.

The Mechanical Engineers at Cardiff.—The following works will be open to the members of the Institution of Mechanical Engineers during their approaching visit to South Wales.—Cardiff: Bute Docks (entrance end), Cardiff junction dry dock and engineering works, Dumfries ship-repairing and engineering works. Bute dry dock, Wallsend shipway and engineering works, Tyneside engine works, Rhymney Railway locomotive shops, Thausis sulphur and copper works, Adamsdown fire-brick works, paint works, Bute gas works, Crown Preserved Coal Company's fuel elevator, Hill's dry docks and engineering works, Taff Vale railway locomotive running shed, Taff Vale railway carriage and wagon works, Cardiff gas works (old works), steam bakery, Taff Vale railway locomotive shops, Mount Stuart dry docks, Bute shipbuilding and engineering works, Lloyd's Bute proving house, Grangetown gas works, Grangetown rope works, steam dye works, Penarth docks, and Penarth slipway and engineering works. Newport: Alexandra Docks, Cambrian foundry and engineering works, Mordey, Carney, and Co.'s shipbuilding works and dry docks, and Emlyn foundry and machinery stores.

Bristol and Portishead Railway.—A special meeting of the shareholders in the Bristol and Portishead Railway and Pier Company and the Portishead Dock Company was held on Wednesday, when resolutions approving of the purchase of the railway and pier by the Great Western Railway Company, and of the Portishead Dock by the City of Bristol, were carried with but one dissentient. The debenture holders in the dock are to be paid in full, the preference shareholders 50 per cent. in cash and 50 per cent. in ordinary shares, and it is expected that the ordinary shareholders will receive about 25 per cent. of their capital.

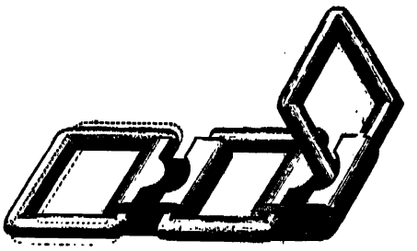
VICTORIAN RAILWAYS.—The Victorian Railway Commissioners have decided to thoroughly reorganise the system under which the Victorian lines are now supervised and inspected. Hitherto the lines have been divided into four systems, but the Commissioners propose to divide them into six sections, and to place six of the best qualified and most experienced officers in charge. The Commissioners also propose to adopt, as far as practicable, the system of supervision and inspection which is now in force on the Midland and Great Western Railways in England.

MR. MASSEY BROMLEY.—Many of our readers will have read with regret the name of Mr. Massey Bromley in the list of those who were killed in the railway accident near Penistone. The deceased was a member of the firm of Messrs. Wilson and Bromley, Westminster Chambers, but was better known from his connection with the Great Eastern Railway, of which line he was locomotive superintendent from the time that Mr. William Adams left it to join the South-Western Railway, until about a year and a half ago. Indeed, the whole of his professional life, until recently, is identified with the Great Eastern Railway. He served as an apprentice in the workshops, under Mr. T. W. Johnson, from February, 1869, to February, 1873. Then for a few months he was inspector of rolling stock, chiefly at the Avonside Engine Works, while afterwards he became assistant to Mr. W. Adams in the locomotive department, subsequently succeeding that gentleman as locomotive superintendent. He took the degree of Master of Arts at Oxford in 1872, and was elected to the Institute of Civil Engineers in 1874. At his death he was 37 years of age.

HARRISON'S PITCH CHAIN.

THE annexed engraving illustrates a novel and exceedingly neat form of pitch chain invented by Mr. J. Harrison, of Mowbray-place, Thirsk. Its general construction will be seen at a glance; the links are joined by metal bands, the edges of which are not closed together, but have sufficient space between them for the insertion of the link, as shown. The curved form of this space prevents the link escaping when turned into the working position.

The most important feature, however, lies in the fact that the pitch of the chain can be adjusted to compensate for stretching. In some kinds of machinery, as, for example, lawn mowers, a large spurwheel is connected by a chain to a small pinion, which will



allow but a small pitch and very little clearance. The relative positions of the two wheels cause a large number of the teeth of the driving wheel to be engaged by the chain at the same time, so that when the chain stretches it becomes useless, as some of the bars of the chain strike on the point of the teeth. To counteract this stretching the links are made slightly oblong, and are put together in the first instance, with their greater dimension in the direction of the length of the chain. When the chain gets out of pitch every sixth link is turned, as shown in dotted lines, and thus its length is reduced; should it stretch again every third link is turned, and it is thus again reduced.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF SPECIFICATIONS PUBLISHED DURING THE WEEK ENDING JULY 19, 1884.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

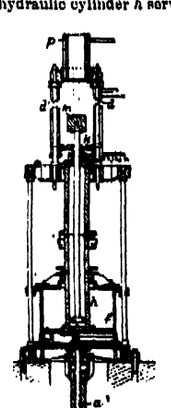
Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

Copies of Specifications may be obtained at 33, Ourvitor-street, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, and addressed to MR. H. READER LACK.

NUMBER OF APPLICATIONS FOR PATENTS.

	1884	1883	1883
July 15th	56		17
16th	39	15	
17th	43	29	
18th	45	18	
19th	50	18	
20th	..	17	
21st	43	18	
Total for week ..	274	115	48
Total from January 1st to July 21st (inclusive)	10,419	3598	1728

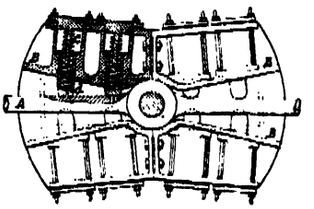
Steel Ingots: C. A. Day, London. (*G. W. Bil-* ..., *Ohio, U.S.A.*) [8*d.* 22 *Figs.*]—The metal is rapidly and violently compressed within the mould immediately after pouring. Referring to the illustration, the machine comprises an ordinary steam cylinder *f* having its piston bolted to the lower extremity of a hydraulic cylinder *h* serving as a piston rod.



The piston of the cylinder *h* is connected by its rod to the stay *k* sliding on the tie-rods *d*. A solid block *m* secured to the upper end of the piston rod forms the bottom of the ingot mould *p* and has formed in it a dovetailed tapering transverse slot provided with a key by which the ingot is secured to the block *m*. The ingot mould *p* has double walls inclosing an annular space for water, and its inner surface is protected by a lining of black lead. An iron or steel compression plate immediately under the mould is moved into and out of position by means of a hand lever. Water under pressure can be admitted to and exhausted from the cylinder *h* by means of the pipe *a*³ and also by an aperture at the top of the cylinder. The rods *d* are surrounded by a water jacket. The block *m* is first raised to the position indicated by dotted lines, the joints between the block and mould being stopped with fire-clay; molten steel is then poured into the mould and the block *m* gradually lowered, drawing with it the ingot; the key in the block is then released and steam admitted to the lower side of the steam

ingot. To prevent buckling of the ingot, guides or stays are supported from the tie-rods. A turntable, provided with a series of removable moulds, each of which can be successively brought into a position to be poured from the same locality and to have its contents compressed by the same contrivance, may be employed. The mould for casting the ingots is composed of a series of lengths adapted to be secured together in line axially and provided with means for their securement to the compressing machine. Each section or length is composed of sheet metal shell made in halves longitudinally and suitably braced or strengthened and lined with brick and coated internally. The contrivance for coating the interior of the mould comprises a perforated receptacle containing the material and designed to be moved backwards and forwards within the mould to plaster over its interior surface, and a screw follower for compressing the contents of the receptacle and forcing them through the perforations. (November 13, 1883).

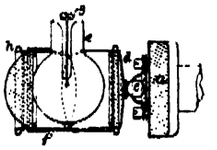
object is to provide appliances for cushioning and overcoming the shocks from the wave action on the steering gear. The whole power used to move the rudder is transmitted through springs. Referring to the illustration, the tiller A is loose on the rudder head to which is secured the casting B. Between the tiller A and the casting B, there is a clear space on either side allowing the tiller to move against the pressure of the springs to the extent of



the said space. The boss of the tiller has a circular groove in it, there being a similar groove in the abutting part of the plate B; a number of metal balls or rollers are placed in the groove so formed, the friction between the parts being considerably lessened. The springs C are contained in recesses in the casting B, their forward ends entering sliding cases or bearing pieces *d*, whose outward movement is limited. The plate carrying the springs may be loose on the rudder head, a short double-ended boss being secured to the rudder stem, which, combined with the loose plate, forms the tiller. (December 4, 1883).

5703. Hose or Flexible Pipes: O. Blodner and H. Viersohrodt, Gotha, Germany. [4*d.* 2 *Figs.*]—A tube of fibrous material is first woven or plaited upon a circular loom in such manner that longitudinal threads are interwoven or interplaited between every two shoots or layers of crossed or diagonal threads. The woven tube is coated inside and out with India-rubber or equivalent substance which may be vulcanised in the ordinary way. (December 11, 1883).

5714. Electric Lighting Apparatus for Surgical Operations, &c.: A. M. Clark, London. (*G. Trouvé, Paris*). [8*d.* 15 *Figs.*]—Referring to the illustration, the entire apparatus is attached to a frontal plate *a* padded on the inside and secured to the forehead by an elastic band, by one or more springs, by means of a spectacle frame, or by other suitable means. The lighting apparatus is mounted on the plate *a* by a ball-and-socket joint *c*, the ball being attached to a plate *d* which may or may not be provided with a reflector, and which forms



the end of a cylindrical casing *e* upon which fits a tubular socket *f*, carrying preferably an incandescent lamp, to whose terminals *g* are attached the conductors from a generator. The socket *f* carrying the lamp is fitted upon the cylindrical part *e*, and a tube *h* carrying a lens *i* is fixed in the end of the part *e*, the rays ... directed either in parallel, converging, or diverging lines by adjusting the tube *h* in the part *e*. The conductors conveying the current to the lamp may be inserted in the band securing the apparatus to the forehead. (December 11, 1883).

5716. Pumps: F. P. Preston, J. T. Prestige, and E. J. Preston, Deptford, Kent. [6*d.* 5 *Figs.*]—A chamber is formed below each bucket of the so-called Stone's portable ship's pump and fire engine having two vertical barrels each fitted with a bucket. On each side of the chamber is formed an aperture provided with a cover to which one of the suction flap valves is hinged. The pump is provided on each outer side with a stop, cast or fitted on in such a manner as to distribute the blow of the yoke at each stroke over a suitable large surface of the pump barrel. The pump handles have corresponding parts to work against the stops, the stops being provided with India-rubber or other buffers. In the Downton three-bucket pump, the chamber is formed between the upper and middle and also between the middle and lower buckets. (December 12, 1883).

5727. Measuring Water, &c.: W. H. Tooth, London. [6*d.* 7 *Figs.*]—A chamber is fitted with two valves having weighted levers connected together by means of a vertical rod on which slides a tube carrying a float. The water from the main passes in at one valve, and as soon as the chamber is filled, the float closes the inlet valve and opens the outlet valve. When the chamber is emptied the float opens the inlet and closes the outlet valve. The plug of one valve is connected to the registering mechanism. Referring to the illustrations, the weighted lever of the inlet valve *b* is connected by the vertical rod *j* to the lever of the outlet valve *c*. The movement of the sliding float *m* is limited by nuts. The lever of the valve *c* is fixed upon its valve spindle, but that of the valve *b* works freely upon its spindle, and is provided with an escapement arrangement shown clearly in Figs. 2 and 3 for preventing the inlet valve *b* from being opened or closed before the outlet valve *c* is closed or opened. The arrangement consists of two tappets *r* fixed upon the valve spindle between which the vertical portion of the lever is free to oscillate. This portion of the lever also carries a roller which strikes upon the pallets of an escapement working in the catch wheel *v* fixed upon the valve ... A slot is provided in the lower end of the rod *j*, in which

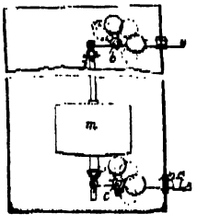


Fig. 1.

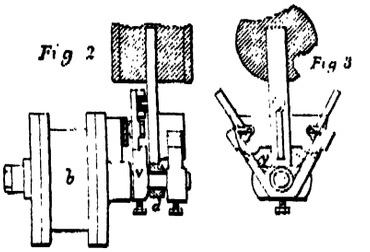
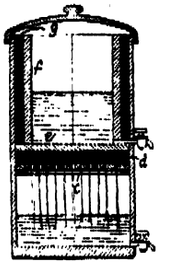


Fig 2 *Fig 3*

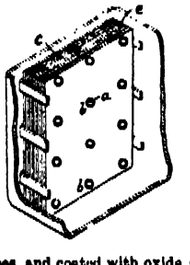
slot works the end of the lower lever so as to allow the float to operate the upper lever to a certain extent before the lower lever. A meter of this construction is in connection with a supply tank. (December 13, 1883).

5732. Water Filters: W. L. Barstow, Pontefract. [6*d.* 3 *Figs.*]—The filter is constructed so that the water to be filtered must pass through a partition formed of a combination of porous stone, earthenware, or terra-cotta, and carbon, spongy



iron, or carbon and silicon. Referring to the illustration, the water first passes through the porous plates *f* and porous stone *e*, afterwards through the carbon *d* and *g*, and lastly through the perforated plate *c*. (December 13, 1883).

5741. Secondary Batteries: J. S. Sellon, London. [6*d.* 5 *Figs.*]—Strips, plugs, discs, or pieces of wood, insulate, porous clay, or like substance, keep the plates equidistantly apart, and are combined with a framework or container, or a clamping or binding device capable of yielding under pressure, by which the plates and separating pieces are bound or forced together. The illustration shows the plates provided with plugs *a* upon which are placed discs *b* for separating and supporting the plates. Side pieces *c* (which may have holes in them, or which may consist of one or more strips or pieces), and india-rubber bands are employed for binding the whole together. The battery plates *e* may be roughened, perforated, grooved, corrugated, indented, or cast, or manufactured with interstices,



cells, cavities, or spaces, and coated with oxide, spongy, reduced, or precipitated lead, or other material. The separating discs may be threaded on rods passing through the plates. The plates may be separated by "wood matting," the pieces of which are woven together by elastic threads, the matting being wrapped around the plates and the whole being bound together by elastic bands. Corrugated porous material may be employed to separate the plates. A smaller amount of metallic lead is used on the negative electrode than on the positive, so that there is a larger amount of porous material to be rendered active, and the active material is adjusted relatively with the work required. The negative plate is made somewhat larger than the positive, so that the sizes are more equalised when the positive plate has expanded in course of use. (December 14, 1883).

5744. Apparatus Employed in the Manufacture of Flour: T. N. Robinson, Rochdale. [6*d.* 4 *Figs.*]—The roller mill is provided with three rollers disposed in a horizontal plane, the outer rollers being revolved in opposite directions, and the centre roller being stationary, or nearly so. The feed hopper is provided with two shoots, an adjustable deflector, and a vibrating distributor fitted at the discharge end with a serrated or indented delivery plate. The ground product passes to a purifier consisting of a series of superposed screens kept clean and caused to vibrate by means of a current of air passing through the chamber containing the screens. (December 15, 1883).

[6*d.* 2 *Figs.*]—The two sides of the mill are fitted with screen frames, each formed with a central ring, through which the main shaft of the mill passes. This ring is fitted with a chamber diminishing in size down to the shaft, and

fitted with a gland or stuffing-box for packing the shaft. At the back of the gland is an annular water or air space surrounding the shaft and forming a circular jet, through which the water flows on its way to supply the mill in wet grinding or a current of air. According to another arrangement, the machine is constructed as described in Specification 4325 of 1870, and the propelling blades are arranged in discs so as to draw the substances from the action of the ball into two chambers fitted one on each side of the mill, and formed with suitable channels through which the substance drawn from the mill is returned to it and kept in circulation by the propeller until properly amalgamated or mixed. (December 15, 1883).

5759. Secondary Electric Batteries: A. C. Henderson, London. (*N. Basset, Paris*). [6*d*. 4 *Figs*.]—The electrodes are constructed of oxide and haloid compounds capable of passing to a superior or inferior state of combination under the action of an electric current. Preferably an element is constructed of two plates of retort charcoal or agglomerated carbon covered with natural peroxide of iron or granulated colcothar wrapped in blotting-paper and held together by one or more strings; these plates forming the electrodes, are placed without a

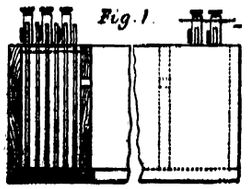


Fig. 1.

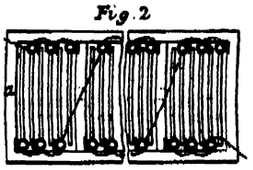


Fig. 2.

diaphragm in a solution of protochloride of iron. The illustrations show a complete battery. The box *a* is divided into a number of compartments communicating, as shown clearly in Fig. 1, with each other and containing the same number of plates joined two and two as shown in Fig. 2. The elements may be connected in tension or for quantity. Oxide of tin, binoxide or deutoxide of manganese or copper may be employed. The patentee refers to his former Patent 4728 of 1883. (December 17, 1883).

5760. Winding Apparatus for Mines: C. Pieper, Berlin. (*A. Lindenberg, Dortmund, Prussia*). [6*d*. 6 *Figs*.]—This relates to winding apparatus for mines, in which counterbalance ropes are used for equalising the resistance which the winding engine encounters during the operation of raising a loaded cage and lowering an empty one. Supposing the two cages to be called A and B, a thin rope having sufficient strength to bear the weight of the counterbalance rope, is attached to one end of this rope and conducted upward over a guiding sheave, and then passed downward parallel and close to the winding rope of the cage B, and finally attached to the top of this cage. Another thin rope attached to the other end of the counterbalance rope passes upwards over guiding sheaves and downwards to the top of the cage A. The counterbalance rope is of such weight that it will balance the weight of the winding rope together with that of the thin ropes. In a modification the thin ropes attached to the end of counter balance ropes are fixed to the winding rope, so that they are coiled and uncoiled simultaneously with it. The two thin ropes may be replaced by a rope with a single turn around one of the drums. (December 17, 1883).

5775. Transmitters for Printing Telegraphs: H. J. Allison, London. (*S. D. Field, New York, U.S.A.*) [8*d*. 9 *Figs*.]—An ordinary transmitter, having an arm attached to the shaft of an escape wheel driven by suitable power and sending into the main circuit when in motion the pulsations for controlling the magnets operating the type wheels, is employed. A range of keys, adapted to arrest the motion of the arm and consequently that of the type wheel, is provided. One pole of a local relay battery is connected to the rotating arm and the other to the range of keys. When the rotation of the arm is stopped by the depression of a key, the local circuit is closed, causing one electro-magnet to close the main printing circuit, and throwing the printing current to line, and another magnet closes at the same instant a local shunt around the first magnet, causing its armature to fall away, and break the main printing circuit. The object of the second part of this invention is to provide a transmitter capable of controlling a large number of printing telegraph circuits, each of which contains a large number of printing telegraphs, and which shall automatically control the circuits for positioning the type-wheel and the circuits for effecting the printing. The transmitter comprises a cylinder or cylinders, each provided with conducting spaces and springs bearing thereon, and circuit connections for controlling one or more main lines, a prime motor and a clutch connecting the motor and cylinder or cylinders, a magnetic stop controlling the movement of the cylinder or cylinders, local circuits controlling the stop and a keyboard controlling the local circuits. (December 18, 1883).

presses of the class in which the platen is moved to and from the bed about an axis located below the platen, and in which both the platen and the bed are vibrated, and consists in the construction and arrangement of the devices for operating the platen and bed, and for opening the grippers for holding the sheet to be printed in place upon the platen. (December 18, 1883).

5786. Producing Fluid Currents Available for Ventilation, &c.: A. Lorrain, Richmond, Surrey. [6*d*. 6 *Figs*.]—This consists of a sail or flexible sheet, one end of which is held stationary in position, whilst the other is caused to revolve by its connection to a revolving crank-pin. (December 18, 1883).

5789. Torpedoes: C. A. McEvoy, London. [4*d*. 8 *Figs*.]—The torpedo is provided with a screw propeller and driving mechanism, and at the same time that the torpedo is set free from the spar the driving mechanism is started. The power for driving the propeller is provided by powerful springs within the torpedo or by an electromotor and a primary battery, the circuit being closed by the act of liberating the torpedo or by compressed air. (December 18, 1883).

5818. Ships' Windlasses, &c.: W. Clarke, Gateshead-on-Tyne. [6*d*. 9 *Figs*.]—In order to give increased holding power between the driving wheels and lifters when hauling in cable, grooves and projections are formed on the sides of the wheels and lifters, and have gripping surfaces of wood, india-rubber, leather, or asbestos. Referring to the illustrations, the blocks or strips of wood, india-rubber, or other material are fitted in specially shaped recesses in the main spurwheels, and a corresponding projection is arranged on each of the cable lifters. Screw nuts M on the main shaft force the projections of the lifters into the grooves of the wheels, elastic washers and sliding metallic

Fig. 7

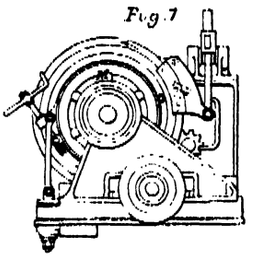
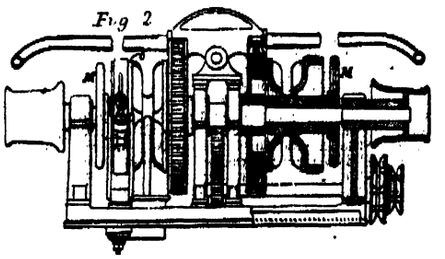


Fig. 2

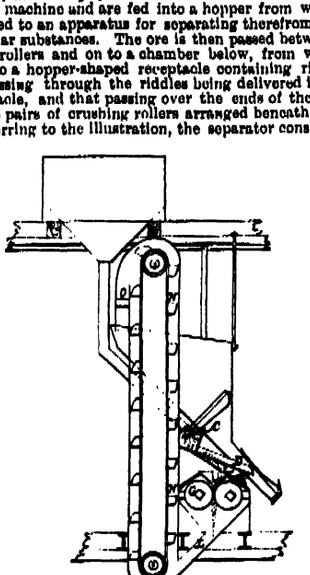


washers being arranged between the nuts and lifters. A spring holder is attached to each cable lifter. A brake sheave *c* is arranged on each lifter, and around it is fitted a brake strap, one end of which is provided with a screw nut engaging with a screw carried by the other end. A flexible rod is fastened to one end, and is connected to a rod passing to the underside of a volute spring. (December 20, 1883).

5821. Working of Marble and other Stone, &c.: G. M. Morgan, London. [6*d*. 6 *Figs*.]—The marble to be worked is fixed upon a table which traverses backwards and forward under a tool-rest fitted with two or more rigid steel tools having a cutting edge somewhat more acute than used for cast iron. The end of the moulding is bedded to a cast-iron open three-sided box having its end shaped to the form of the moulding. The ends may be trimmed by a traversing saw. The roughing out of the stone is effected by a multiple series of tools. (December 20, 1883).

5845. Materials for Insulating Purposes: J. L. Clark, London. [4*d*.]—Oxidised oil, prepared by mixing a vegetable oil with a mixture of bisulphide of carbon and chloride of sulphur, mixed or not with oil oxidised by the action of the atmosphere, is combined with asphalte, pitch, or bitumen, and with a small quantity of hydro-carbon oil, or spirit such as paraffine oil or spirit, kerosine, benzine, or naphtha. This compound is used alone or mixed with india-rubber or gutta-percha and if desired with black wax (obtained in the purification of crude paraffine), ozokerite, earth wax, resin, pitch, or the like. (December 22, 1883).

6 *Figs*.]—The substances are first broken by any suitable machine and are fed into a hopper from which they are conducted to an apparatus for separating therefrom pieces of iron or similar substances. The ore is then passed between a pair of crushing rollers and on to a chamber below, from which it is elevated into a hopper-shaped receptacle containing riddles, the material passing through the riddles being delivered into a suitable receptacle, and that passing over the ends of the riddles is delivered to pairs of crushing rollers arranged beneath the receptacle. Referring to the illustration, the separator consists of per-



forated plate D, on to which the material from the hopper C is allowed to pass through an adjustable slide. The material passing through the plate D falls on to a spreader and passes to the rollers G. The plate D is operated by a rotating cam driven from the rollers G. The material from the rollers passes on to the inclined shoot L and is raised by the endless chain of buckets N and discharged into the chest O, which conducts it to the separating receptacle. The material requiring to be reground is passed rollers and again elevated to another separating receptacle. bearing on the surfaces of the crushing rollers keep them clean. The separate receptacles may be provided with deflector plates by means of which the material passing over the ends of the riddles may be conducted partly back to the crushing rollers of the preceding receptacle and partly to the succeeding mill or entirely to one or the other. (December 22, 1883).

Preservative ...ns: (*J. A. Koch, Galveston,* ..., *U.S.A., and W. Herre, Berlin*). [4*d*.]—The wood or textile fabrics, &c., are introduced into cold water which is raised to a temperature of from 170 deg. to 248 deg. Fahr. Sulphate of iron, common or rock salt and alum is then added, the temperature being maintained for some considerable time, after which the bath is allowed to cool gradually. Lime water may be used in lieu of common salt. A bath already prepared or a spent bath may be employed instead of cold water. (December 24, 1883).

5914. Manufacture of Metallic Alloys or Compounds: G. A. Dick, London. [4*d*.]—Phosphuret of iron or ferro-manganese or spiegeleisen is dissolved in molten zinc and added to molten copper. (December 29, 1883).

5923. Gas Engines: C. M. Sombart, Magdeburg, Germany. [1*s*. 14 *Figs*.]—The engine is constructed with two working cylinders. When the piston of the first motive cylinder moves forward in virtue of an explosion behind it, a charge of fresh air in front of it is forced into an air chamber beneath the crosshead guides. The piston, near the end of this stroke, uncovers an exhaust opening, an exhaust valve is opened by a lever and cam, and the residues of the explosion escape, and the air compressed in the front end of the cylinder flows into its rear end forcing out the remainder of the products. The piston on its return stroke compresses the air, a gas pump simultaneously forcing gas into the working cylinder, and when the piston has reached the end of its stroke the compressed mixture of gas and air is ignited. The same operation is also accomplished in the second cy... cranks of the two cylinders being diametrically opp... other. The gas pump is double-acting, and serve... cylinders. The igniting apparatus comprises a small cy... taining two small air valves and a gas valve, and ... valves communicating respectively with the working cy...

... in the small cylinder being greater than that in the working cylinder, and consequently igniting the compressed mixture in the working cylinder. The ... gas to either end of the gas pump can be cut off, the pump ...idered single acting, as is also the engine. The speed of the ... is regulated by means of a governor which operates when the ... is too great, so as to keep open the suction valves of the gas pump, the gas being forced back into the receiver. A gas pump for a single cylinder engine is closed at both ends and the piston acts as a suction valve. When it moves forward the gas in front of the piston passes to the other side of the piston, and on the return stroke the piston rod moves independently in the piston until its conical end reposes upon the valve seat in the piston, when the piston drives the gas into the working cylinder. A valve is inserted between the pump and motive cylinder, and operated by the governor, regulates the working of the engine. A self-acting lubricator comprises a vessel divided into two compartments, between which two wheels rotate. The prolonged ends of the axis of one wheel are provided with a right and a left-hand screw thread respectively passing through sockets in the vessel, the sockets having a clearance between themselves and the screws, so that a spiral channel is formed. The lubricant which enters the first threads by gravity is conveyed through the channel to small tubes which conduct it to the desired places. (December 29, 1883).

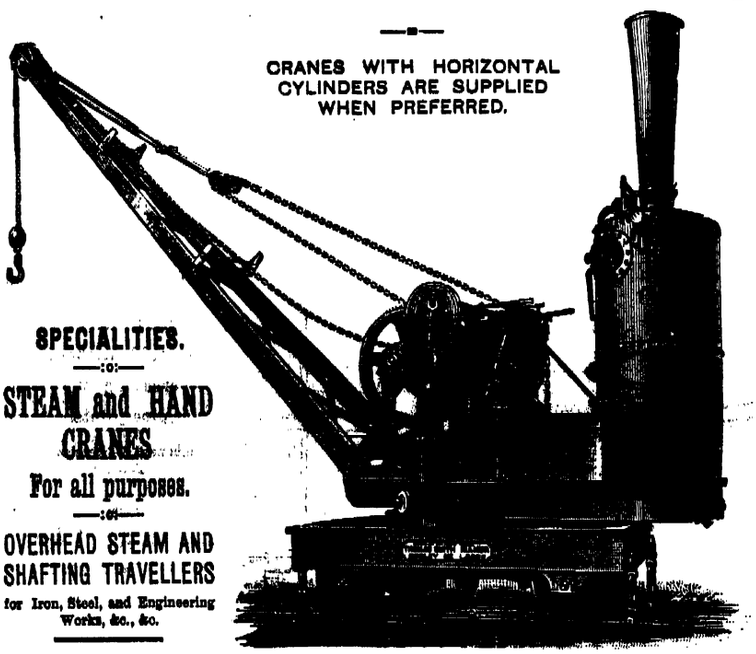
UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

STEELMAKING AT BILBAO.—It is reported from abroad that extensive steel works are shortly to be started in Bilbao by a Spanish company, which has obtained large concessions from the Spanish Government, for the manufacture of rails and other materials. The ore of Bilbao is hematite, and new blast furnaces and other works are being constructed for the smelting of it, and for the conversion of the product into rails, bars, and beams of various sections. The company has ordered a large portion of the required plant from an English firm, and it is now in course of manufacture. The converters are of eight tons capacity. The engines for rolling rails, bars, and beams are of massive construction. They are compound, with two high-pressure cylinders, 42 in. in diameter, and two low-pressure cylinders, 60 in. in diameter, with 5 ft. stroke. The crankshaft is of steel, 25 in. in diameter in the centre. The total weight of the engine is 400 tons. Some of the hydraulic rams are also of great size, one of them being 32 in. in diameter. The centre crane, which receives the molten steel from the converters, weighs about 90 tons. Portions of the machinery are now being delivered, and it is intended that the works shall commence operations early in 1885.

THE MURRAY.—An iron lattice girder bridge over th Murray is now practically completed. All, in fact, that is now needed for the completion of the contract is the fixing of a portion of the cap of one of the cylinders, the necessary casting for which was never sent from Sydney, and had to be manufactured at a local foundry. The finishing touch is, however, now being put to the work. The Government will not take the bridge over for some time to come, as it cannot be effectually tested until connected with the railway on one side or the other, and the connection is not likely to be effected for some months. On the New South Wales side of the river a good deal of work yet remains to be done on a viaduct joining the bridge with the permanent embankment. Several bays of piles have still to be driven, and the girders have to be laid for a distance of about 100 yards. The difficulty of obtaining suitable timber experienced in the earlier stages of the contract, has continued all through, and has seriously impeded the progress of the work. The delay is, however, of no significance, inasmuch as the bridge cannot, of course, be used until connected with the Victorian line, and on the southern bank of the river there is also plenty yet to do. The connection on the Victorian side is to be by means of a wooden viaduct on piles, and some 14 chains of an embankment. The contractor has made fair progress with the embankment, which is nearly completed, and a start has been made with pile-driving at the end of the iron bridge.

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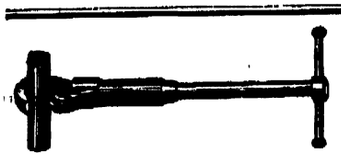
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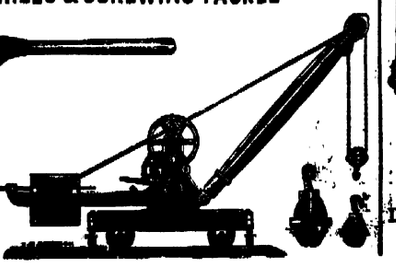




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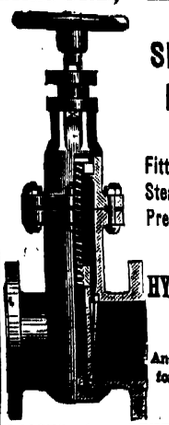


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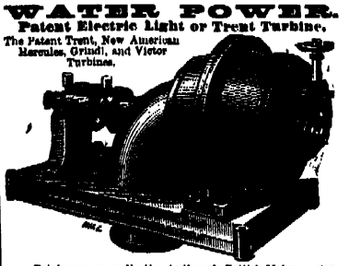
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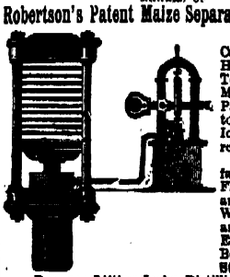
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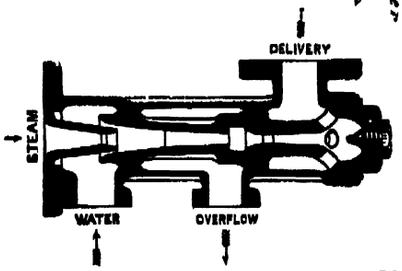
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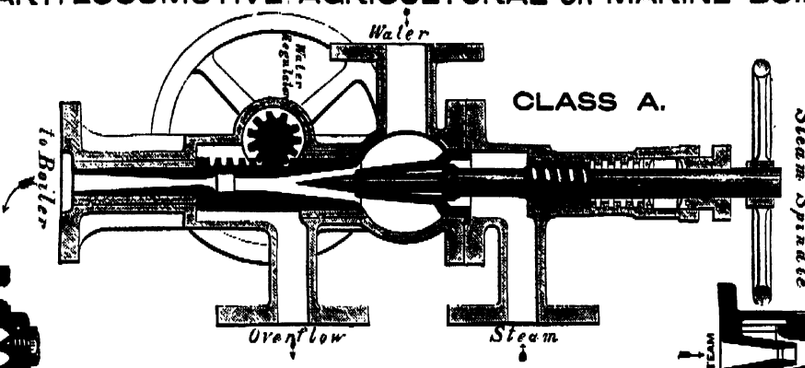
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(GRESHAM'S PATENT.)



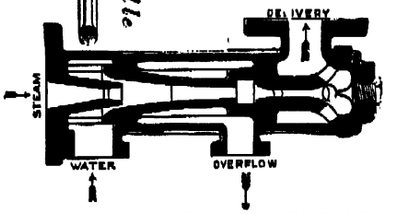
CLASS A.



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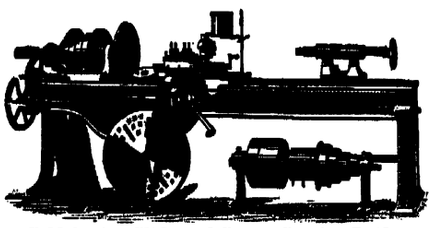
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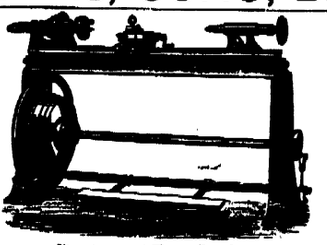
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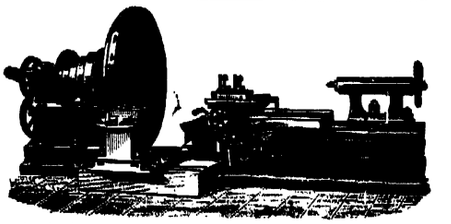
OXFORD WORKS, SOHO, BIRMINGHAM.



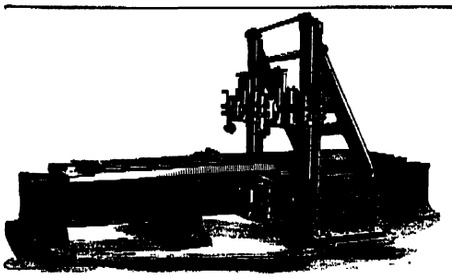
Self-Acting Slide and Screw-Cutting Lathe.



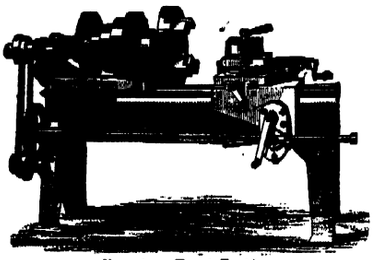
Engineers' Foot Lathe.



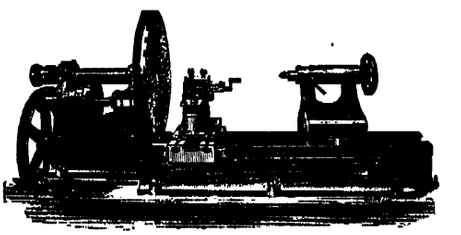
S. A. Slide Surfacing and S. C. Break Lathe.



Self-Acting Planing Machine.



Capstan Rest Lathe.



Single Railway Wheel Lathe.

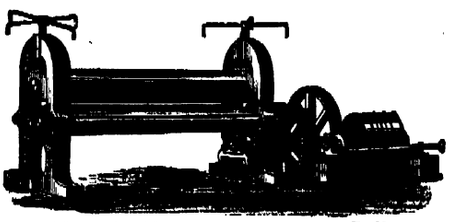
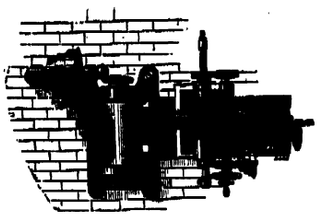
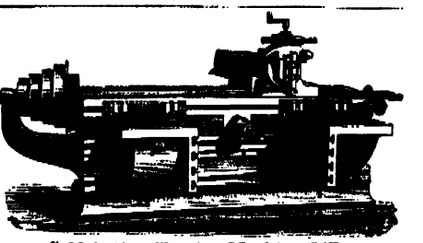


Plate Bending and Straightening Rolls.



Radial Wall Drilling Machine.

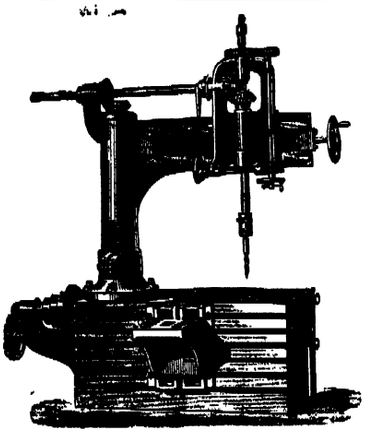


Self-Acting Shaping Machine.

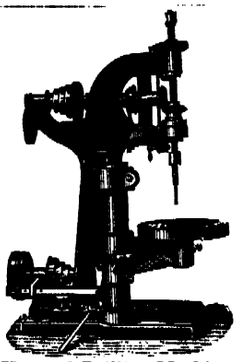
WOOD-WORKING MACHINERY

OF EVERY DESCRIPTION.

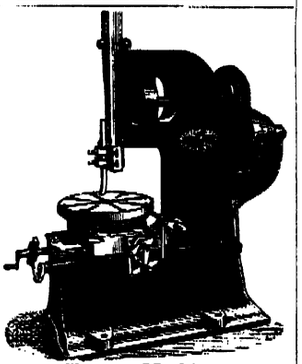
CATALOGUES ON APPLICATION.



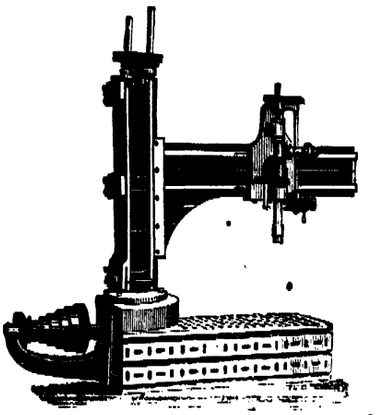
Radial Drilling Machine.



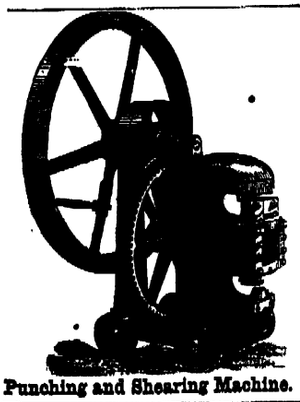
Vertical Drilling Machine.



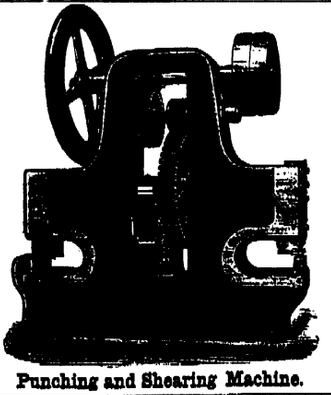
Slotting Machine.



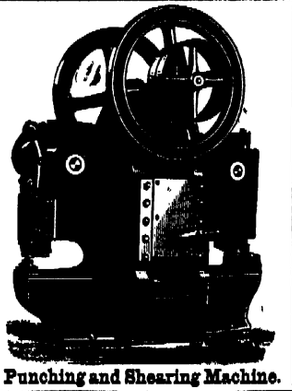
Radial Drilling Machine.



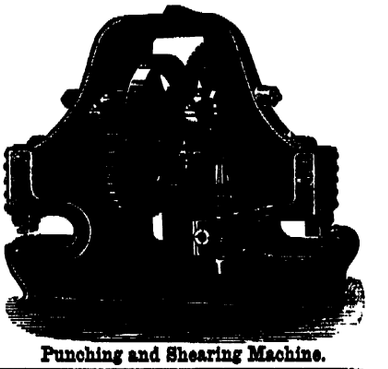
Punching and Shearing Machine.



Punching and Shearing Machine.



Punching and Shearing Machine.

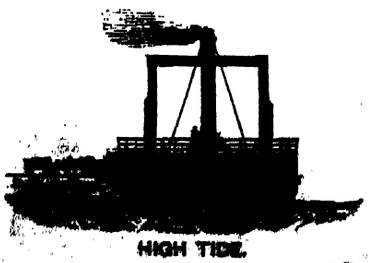


Punching and Shearing Machine.

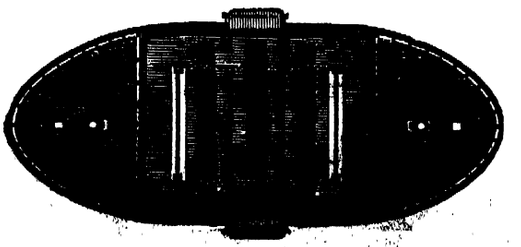
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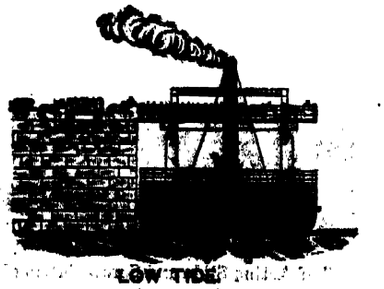
PATENT ELEVATING STEAMER,



HIGH TIDE.

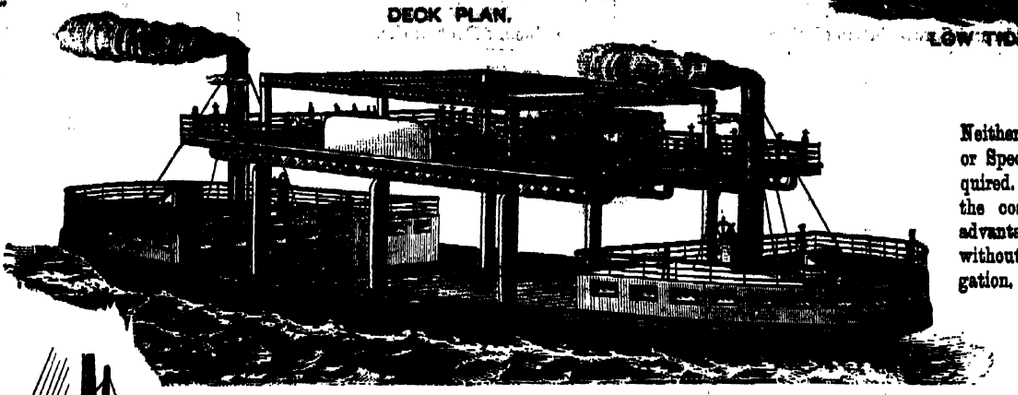


DECK PLAN.

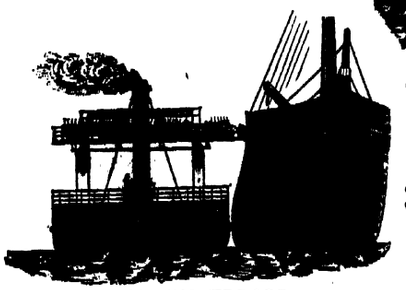


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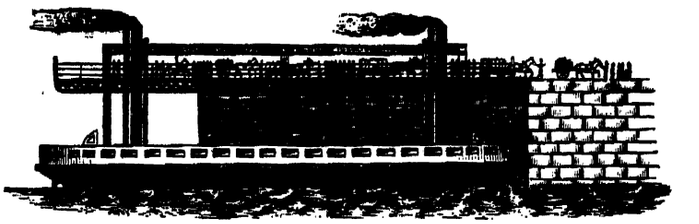


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5157

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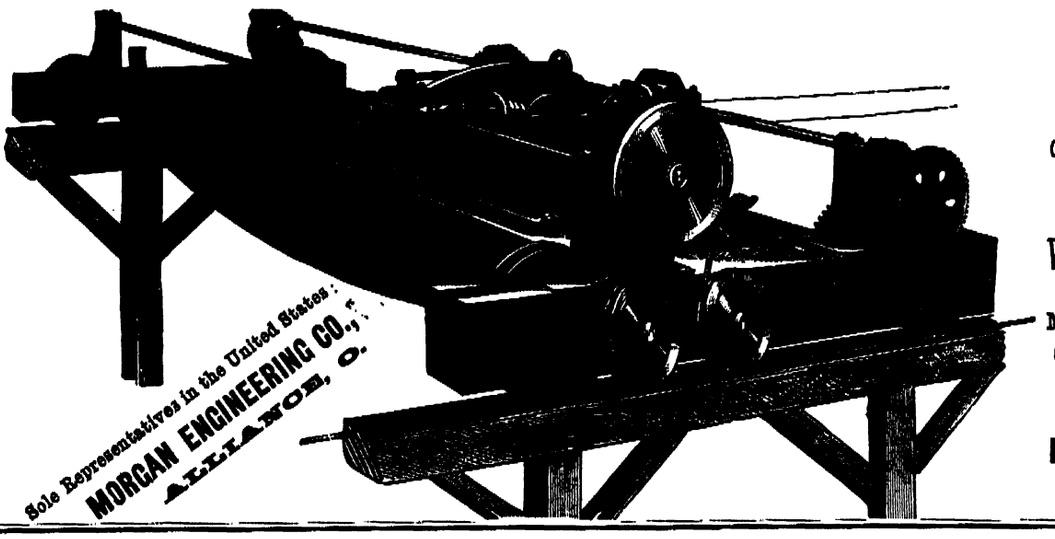
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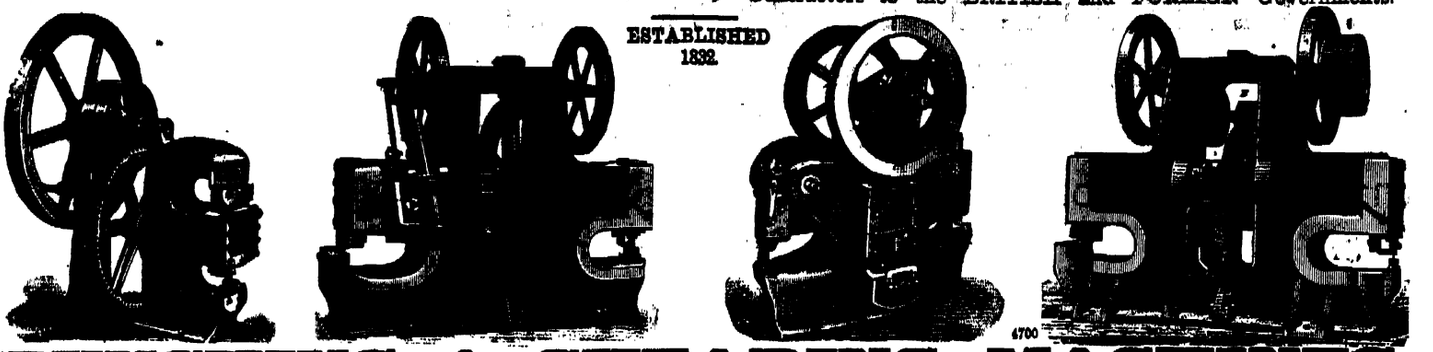
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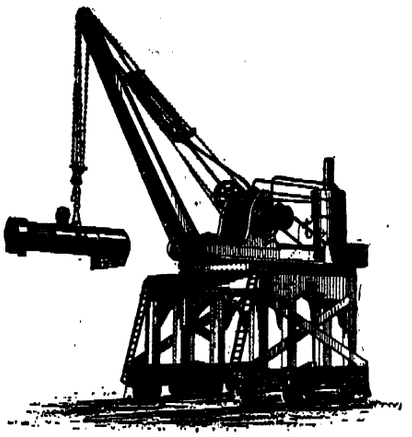
— MAKERS OF ALL KINDS OF —

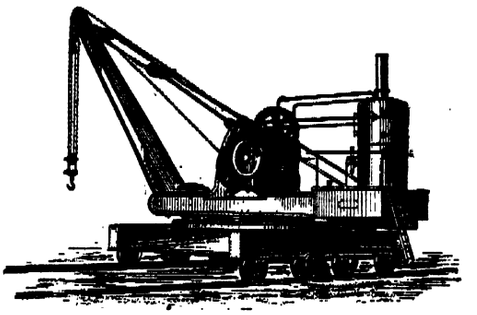
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—:o:—

From 5 Cwt. to 50 Tons Load.

—:o:—



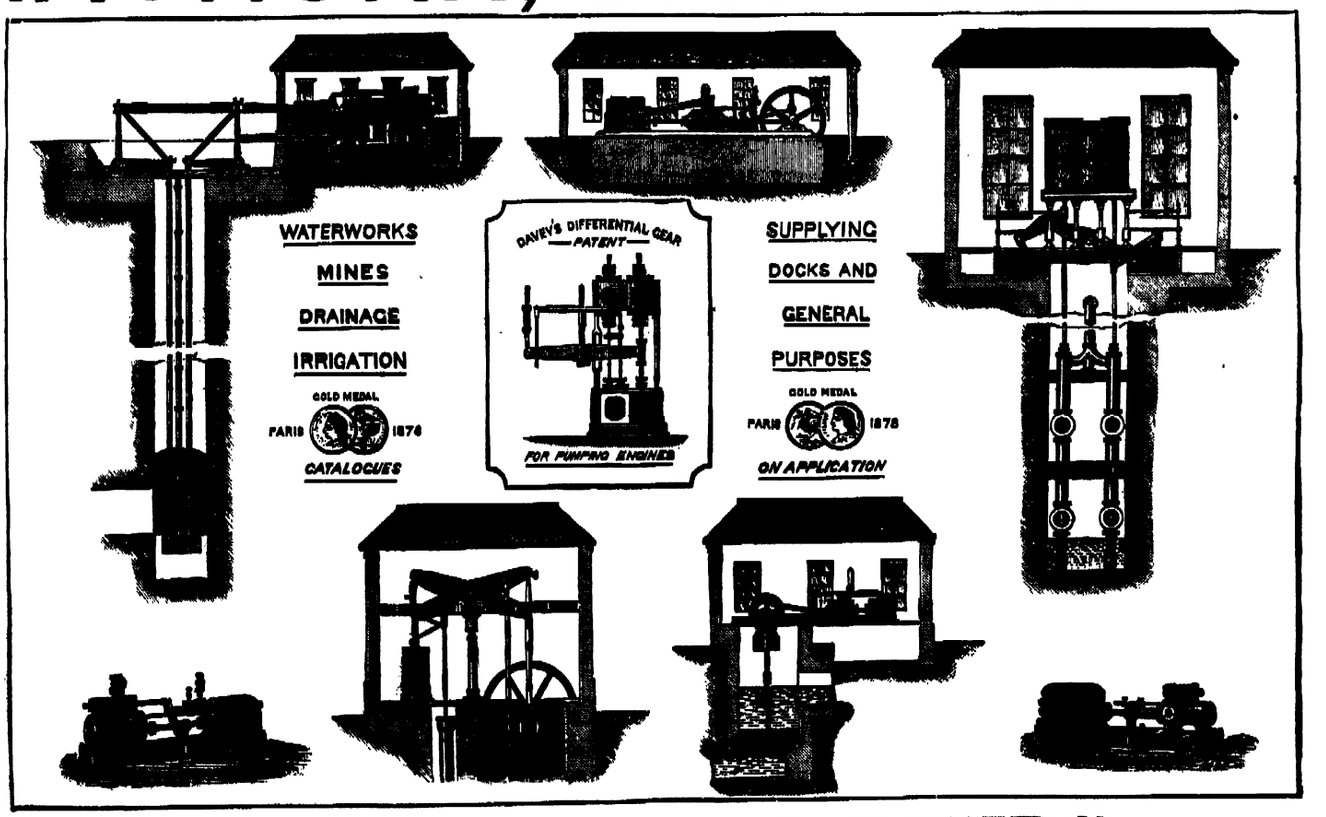




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SUN FOUNDRY, LEEDS.

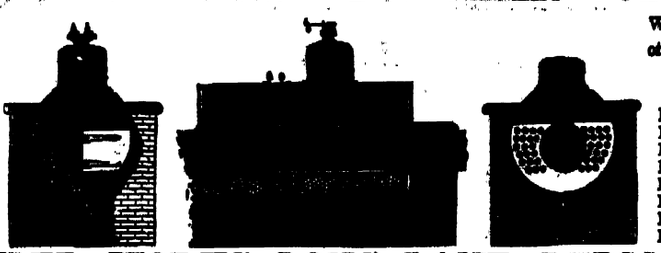
4978

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Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
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9. Will Burn either Tan, Breeze, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



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9ft.	long,	5ft. 6in.	diameter,	20-horse	power.
10ft.	,,	5ft. 6in.	,,	30	,,
12ft.	,,	6ft. 6in.	,,	40	,,
13ft.	,,	6ft. 6in.	,,	50	,,
14ft.	,,	7ft. 6in.	,,	60	,,
15ft.	,,	7ft. 6in.	,,	70	,,
16ft.	,,	8ft. 0in.	,,	80	,,
17ft.	,,	8ft. 0in.	,,	90	,,
18ft.	,,	8ft. 0in.		100	,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

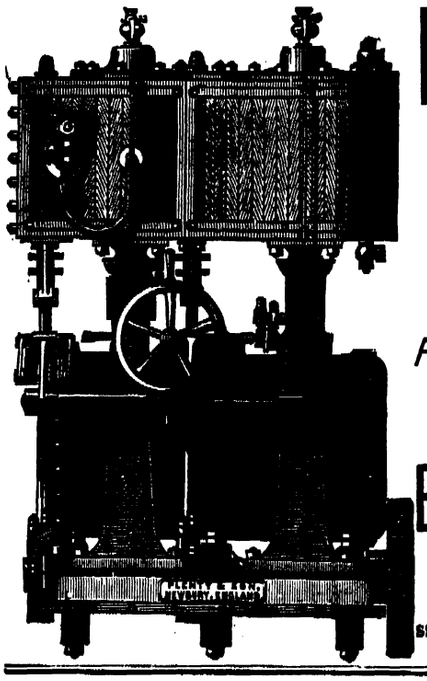
A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

BRASS & COPPER TUBES

SEAMLESS & BRAZED, FOR BOILERS, SURFACE CONDENSERS &c 4857

BRASS & COPPER WIRE, SHEETS &c.

BIRMINGHAM BATTERY & METAL CO. BIRMINGHAM.



PLENTY & SON,

EAGLE IRONWORKS,

NEWBURY, BERKS.

MANUFACTURERS TO THE ADMIRALTY.

First Prize, Royal Yacht Club, Cowes.

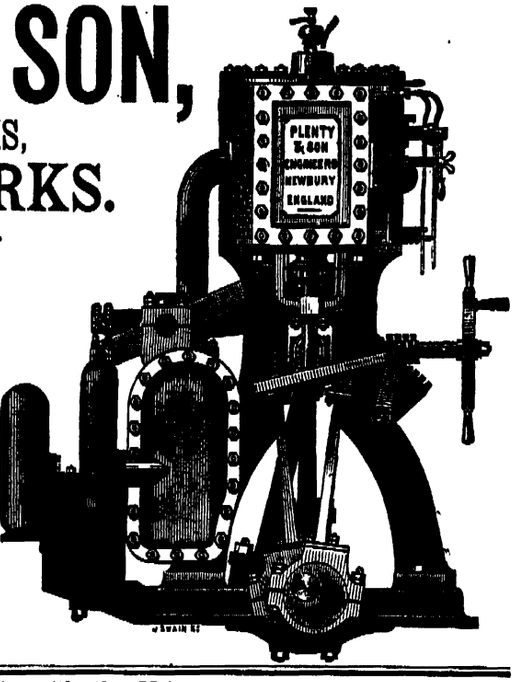
PATENT

ENGINES & BOILERS

FOR

SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &c.

Simple, High-Pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works. 4927

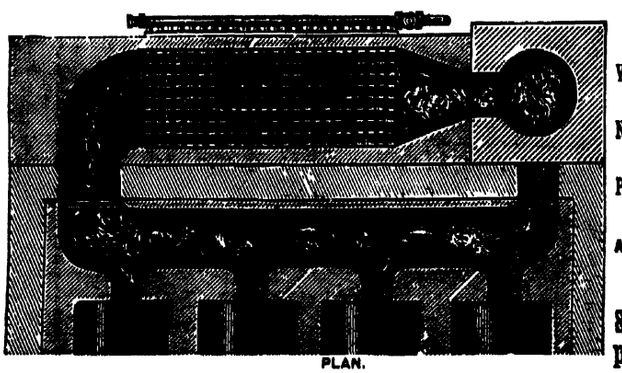


Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(FOR UTILISING THE WASTE HEAT FROM STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION



PLAN.

SPECIAL ADVANTAGES.

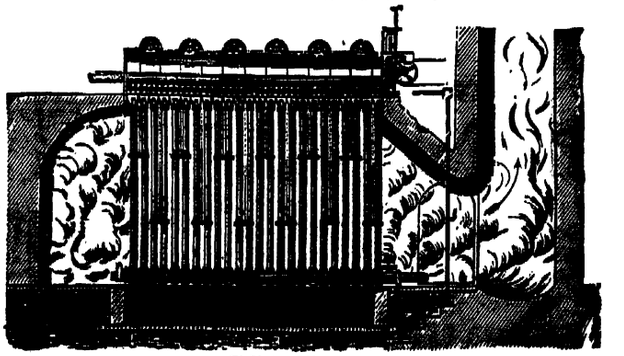
Vertical Pipe Castings. Guaranteed sound and perfectly true.

New Patent Spiral Scrapers The most effectual removers of soot.

Patent Reversing Gear. Never sticks or gets out of order.

ALREADY IN OPERATION TO HUNDREDS OF STEAM BOILERS.

Saves from 20 to 25 per cent. of the fuel.



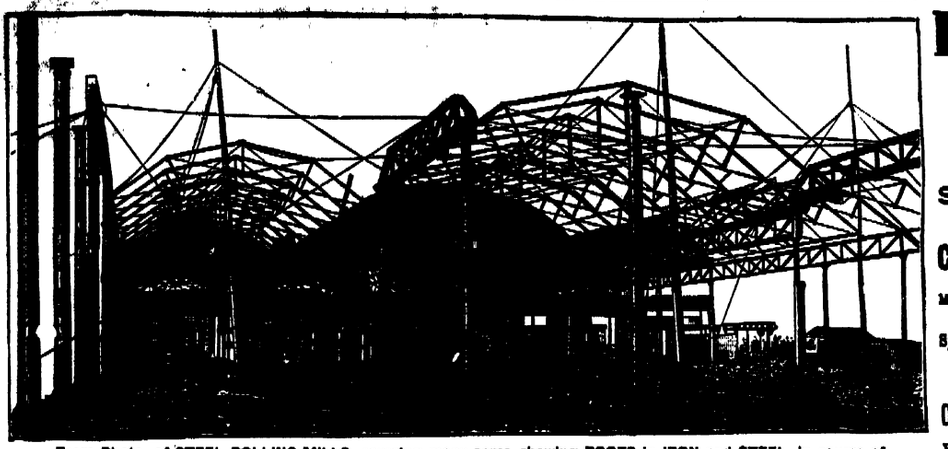
ELEVATION.

N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and abroad.

PRICES, TESTIMONIALS, AND FURTHER PARTICULARS ON APPLICATION TO 4430

ARTHUR LOWCOCK, (PATENTEE & SOLE MAKER) Cobham Foundry, Shrewsbury, England.



From Photo. of STEEL ROLLING MILLS, covering many acres, showing ROOFS in IRON and STEEL, in course of erection by MOREWOOD & CO.

Roofs and Buildings
IN IRON AND STEEL.

MOREWOOD & CO.
WOODFORD IRONWORKS,
SOHO, BIRMINGHAM
LONDON OFFICES—158, LEADENHALL STREET, E.C.

CORRUGATED AND GALVANISED SHEETS
LION WORKS, BIRMINGHAM
Manufacturers of every description of Roofs and Buildings in Iron and STEEL for Forges, Rolling Mills, Railway Stations, Goods Sheds, Yards, Docks, Stores, and General Purposes.
Special Curved Corrugated Iron Roofs without Framing for moderate Spans
WROUGHT IRON WATER TANKS, any size.
ANNEALING AND GALVANIZING POTS.
Corrugated Iron & STEEL Sheets & Fastenings, & Ridges, Gutters, and Tanks, Galvanised or Painted.
Wrought-Iron Lattice and Plate Girders. Railway, Road and Foot Bridges
DESIGNS AND ESTIMATES ON APPLICATION. 4901

Paris, 1878.—GOLD MEDALS AWARDED.—Melbourne, 1881.

WM. JESSOP & SONS, LIMITED,

BRIGHTSIDE WORKS, SHEFFIELD,

MANUFACTURERS OF

EVERY DESCRIPTION OF TOOL STEEL & STEEL CASTINGS,

Cast, Shear, German, Spring, Blister & Sheet Steel for all purposes.

Files of First Quality.—Steel Lagging Plates for Cylinders.—Steel Boiler & Ship Plates & Forgings of all kinds.

DEPOTS:—Manchester, Paris, Dusseldorf, St. Petersburg, New York, Boston, Philadelphia, Cincinnati, St. Louis Chicago, San Francisco, Baltimore, Providence, Montreal.

LONDON OFFICE: MESSRS. CORNES, CALVERT & CO., 30, WALBROOK, E.C. 5197

DAVY BROTHERS, LIMITED,

SHEFFIELD,

MANUFACTURERS OF

STEAM HAMMERS

From 1 Cwt. to 50 Tons, for every kind of work,

Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.

BESSEMER STEEL WORKS PLANT,

FORGE AND ROLLING MILL MACHINERY,

Steam Engines for Mills, Ironworks, Collieries, &c.

SINGLE AND DOUBLE FLUED BOILERS. 5178

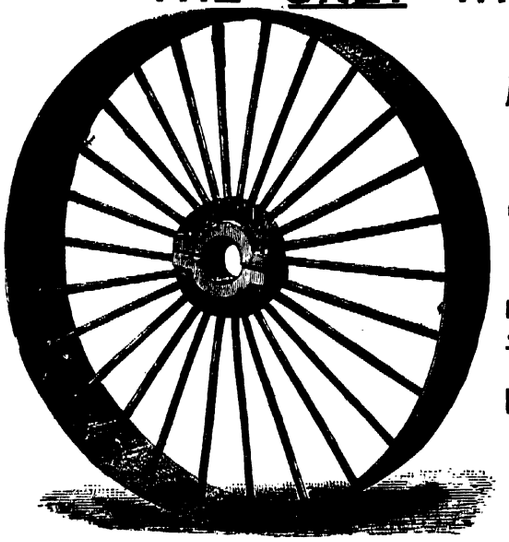
RODGERS' PATENT
WROUGHT IRON PULLEYS

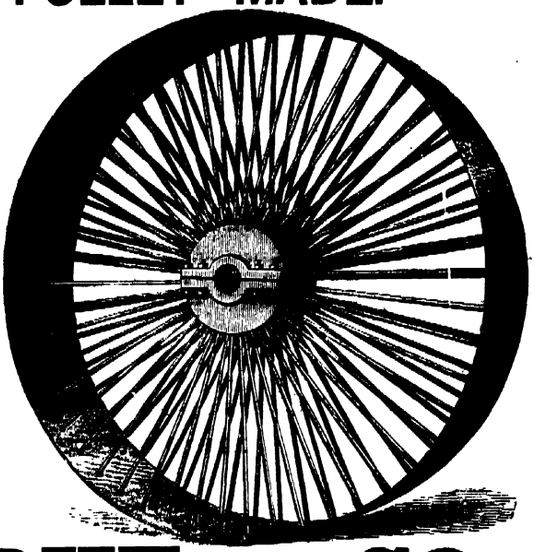
WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.

THE ONLY WROUGHT IRON PULLEY MADE.

SPLIT OR SOLID.

All Sizes up to 24 feet Diameter.





40,000

IN USE.

The Best Pulley in the World

USED SOLELY FOR

DRIVING THE ELECTRIC LIGHT

AT THE

HEALTH EXHIBITION,

SOUTH KENSINGTON.

SOLE MAKERS:

HUDSWELL, CLARKE & CO.,

RAILWAY FOUNDRY, LEEDS.

—SOLE AGENTS—

France—C. BORISSOW, Rue a Fiens, 3ter, Lille.
Russia—S. G. MARTIN, Galerny No. 12, Quartier 8, St. Petersburg.
Austria—J. EGLI, I, Berz Freiung 7, Vienna.
Saxony—W. W. DERHAM, Leipzig.
Belgium—D. GRANDY, Rue de l'Abattoir 30, Gand.
Italy—A. SINGTON & CO., Manchester and Milan.
Holland—VAN RIETSCHOTEN EN HOUWENS, Rotterdam.
Portugal—ALFD. HARRISON, Rua Nova St. Domingos 95, Oporto.
Dominion of Canada—T. J. CHURCH, 672, Craig St. Montreal.
Lancashire & District—F. B. WELCH & CO., Market St., Manchester.
North of England—SNOWBALL & CO., Side, Newcastle-on-Tyne.
W. of England—Townsend & Young, Arch House, John St., Bristol.
Glasgow and District—ROBERTSON & Co., 8, Old Sneddon St., Paisley. 4925
South of Ireland—JAS. F. ROBERTS, 72, Francis Street, Dublin.

MATTHEW PAUL & CO.,

MAKERS OF

Steam and Hand Windlasses,

STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,

AND EVERY DESCRIPTION OF SHIP FITTINGS.

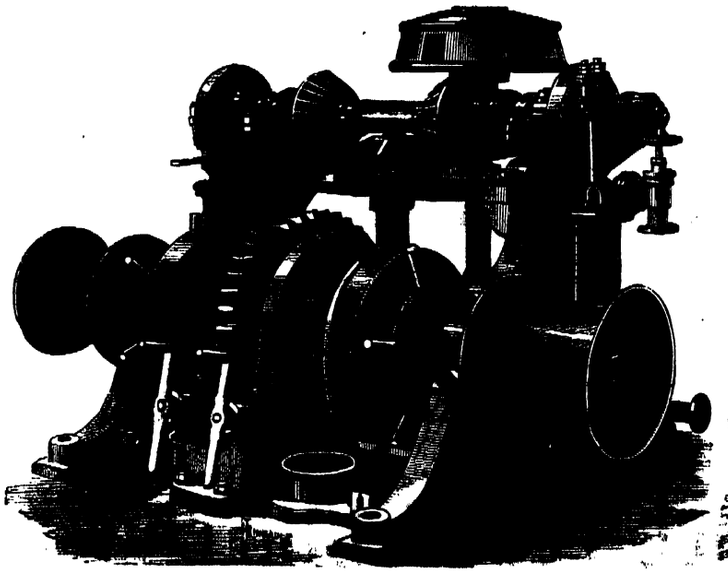
LAND & MARINE ENGINES,

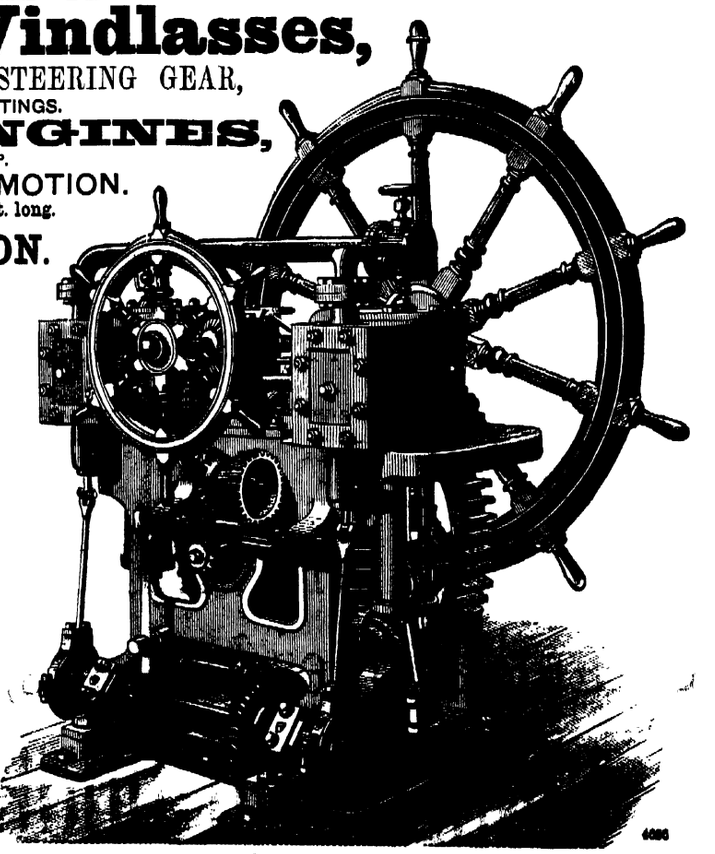
OF ALL SORTS AND SIZES UP TO 1,000 I.H.P.

LAUNCH ENGINES, WITH PATENT VALVE MOTION.

BUILDERS of LAUNCHES, BARGES, and YACHTS, up to 100 ft. long.

LEVENFORD WORKS, DUMBARTON.





4926

FOR MINING, LEATHER

ENGINEERING, INDIA-RUBBER

AND GENERAL MECHANICAL PURPOSES GUTTA-PERCHA

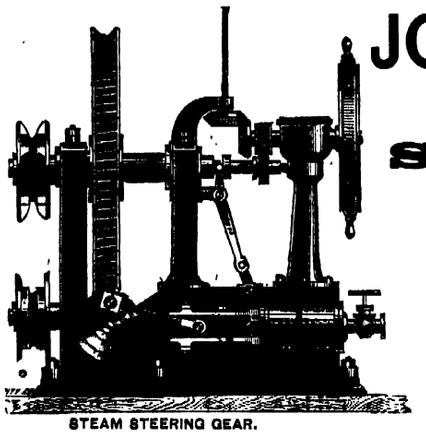
GEO. ANGUS & Co. NEWCASTLE-ON-TYNE 13, BILLITER STREET, LONDON. LIVERPOOL. And BUTE DOCKS, CARDIFF.

5101

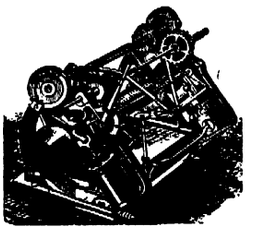
JOHN H. WILSON & CO.,

ENGINEERS AND BOILER MAKERS, &c.

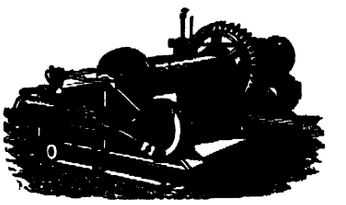
SANDHILLS, LIVERPOOL.



STEAM STEERING GEAR.



VERTICAL STEAM WINCH.



HORIZONTAL STEAM WINCH.

4662

MANUFACTURERS OF STEAM CRANES, OVERHEAD TRAVELLERS, STEAM PUMPS, &c.

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

S.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

BELL'S Asbestos Works, Southwark.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure.....110 lbs. | **Vacuum**.....**20 inches.**

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,

D. HENDERSON, Chief Engineer, S.S. "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department,

Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,

Mr. J. BELL. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts,

Admiralty, Whitehall, 20th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core.....square. | Elastic core.....round.

To Mr. JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 60 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING,

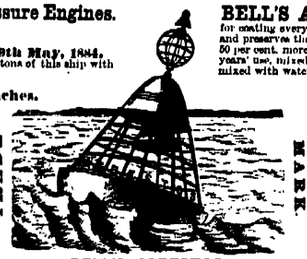
for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



TRADE MARK.

— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the unconventional depôts and not through agents or factors.



FIG. 1.

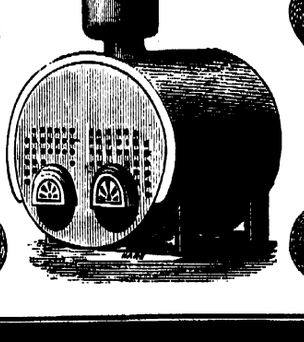




FIG. 4.



FIG. 2.



FIG. 3.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates .. .. **186 deg.**

" **Covering**.. .. .. .. **94 deg.**

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 28th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly,

"W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

Mr. JOHN BELL, Southwark, S.E. Gunnislake, Tavistock, 8th April, 1884.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ¼ in. to 8 in. wide, and any thickness from 1-16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and ¼ millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts,

Admiralty, Whitehall, S.W., 17th May, 1884.

SIR,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,

Mr JOHN BELL. Director of Navy Contracts.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve. Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT"

REG'D.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

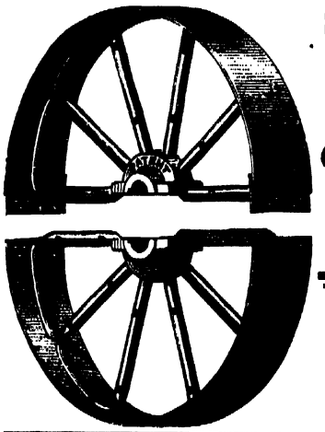
BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

OR THE DEPOTS—

4043

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

SOLE MAKERS, **READING IRONWORKS, LTD.** READING, ENGLAND.



THE PULLEY FOR THE WORLD.

THE PATENT WROUGHT IRON

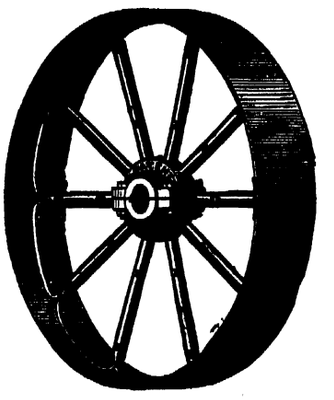
"UNIVERSAL,"

Supplied to HER MAJESTY'S DOCKYARDS and Leading Engineers throughout the Kingdom, the Continent of Europe, the Colonies, &c., &c.

TENS OF THOUSANDS IN USE.

SILVER MEDALS
AWARDED AT THE INTERNATIONAL EXHIBITIONS:
AMSTERDAM, 1883; CALCUTTA, 1884.

PRICE LISTS FREE BY POST. 4781



THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

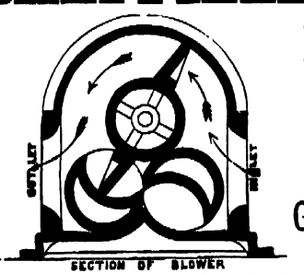
Baker's Patent Rotary Pressure

—:o:—

BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

Blower and Gas Exhauster

—:o:—

HALL'S PATENT STONE BREAKER.

—:o:—

General Machinery of Every Description.

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4658

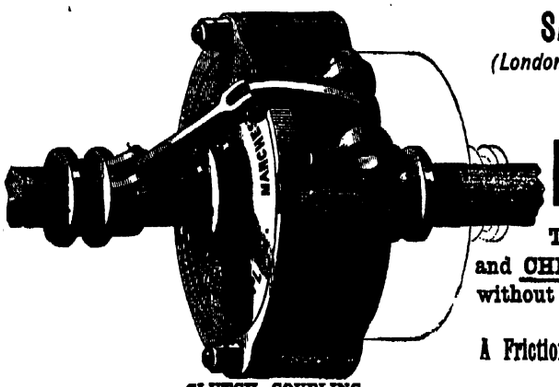
MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

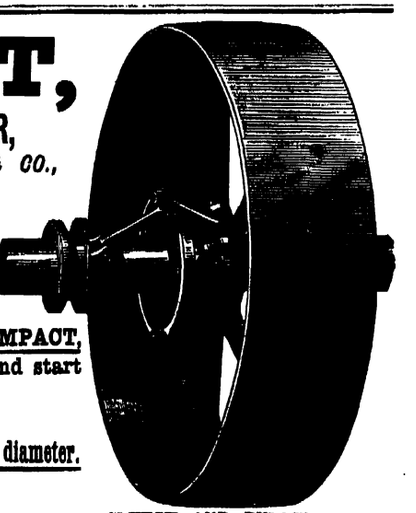
(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.

— PATENT —

FRICTION CLUTCH.



CLUTCH COUPLING.


CLUTCH AND PULLEY

These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.

LIBERAL TERMS TO THE TRADE. PRICES ON APPLICATION. 4661

GOODFELLOW & MATTHEWS,

(LATE B. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS.

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

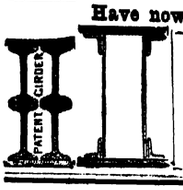
FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 4660

MEASURES BROS. & CO., SOUTHWARK STREET, LONDON,

Manufacturers of Patent Girders, Rolled Joists in Iron or Steel, Rivetted Girders, Flitch Plates, Bulb and Channel Iron, Contractors' Rails, Tee, Angle, and Sash Iron, Bending Hoops, Bolts, Rivets, Washers, Chequered Flooring Plates, Patent Fire-proof Floors, Cast or Wrought Iron Columns, Stanchions, Tanks, and every description of Builders' Iron Work,

Have now in their TOWN STOCK 5,000 TONS, and can guarantee prompt delivery at lowest Market Prices.

ESTIMATES, SECTION SHEETS, AND BOOKS FREE ON APPLICATION.



ANGLES.

8 × 4	3½ × 3½
6 × 6	3 × 3
6 × 3½	2½ × 2½
5 × 3½	2 × 2
4 × 3½	1½ × 1½
4 × 4	1 × 1

SECTION OF JOISTS.

8 × 8	= 18lbs.	4½ × 8	= 18lbs.	7 × 3½	= 14lbs.	9½ × 3½	= 24lbs.
8 × 1½	= 6 ,,	5 × 4½	= 23 ,,	7 × 3½	= 20 ,,	9½ × 4½	= 29 ,,
4 × 1½	= 7 ,,	6½ × 2	= 11 ,,	8 × 4	= 22 ,,	10 × 4½	= 32 ,,
4 × 3	= 12 ,,	6½ × 3½	= 16 ,,	8 × 5	= 29 ,,	10 × 5	= 36 ,,
4½ × 1½	= 8 ,,	6 × 5	= 29 ,,	8 × 6	= 34 ,,	10 × 6	= 56 ,,

12 × 5	= 42lbs.
12 × 6	= 56 ,,
14 × 6	= 60 ,,
16 × 6	= 62 ,,
17½ × 6½	= 82 ,,
19½ × 7½	= 100 ,,

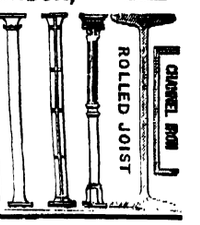
Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to ¾". 5126

TEES.

5½ × 5½	
4 × 4½	
5 × 3	
3½ × 3	
2½ × 2½	
2 × 2	
1½ × 1½	
1 × 1	

CHANNELS.

12	× 5
9½	× 3½
9	× 3½
8	× 3½
5½	× 2½
4	× 2½
2½	× 1½



DANIEL ADAMSON & CO.,

Established 1851.] ENGINEERS AND BOILER MAKERS, [Established 1851.

DUKINFIELD, NEAR MANCHESTER,

HIGH-PRESSURE, CONDENSING, & COMPOUND STEAM ENGINES.

SOLE MAKERS OF

THE WHEELOCK AUTOMATIC EXPANSION ENGINE,

(Grand Prize Paris, 1878, and First Prize Cincinnati, 1880, in competition with Corliss and other Automatic Expansion Engines).

THE BULKLEY PATENT INJECTOR CONDENSER, USED in the UNITED STATES at all the LARGE IRON and STEEL WORKS

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PATENT HYDRAULIC JACKS.

GENERAL HYDRAULIC ENGINEERS. 4793

GEORGE SALTER & Co.

WEST BROMWICH,

MANUFACTURERS OF

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BOURDON'S, SCHAEFFER'S, & SILVESTER'S

PRESSURE GAUGES,

COLLIERY SIGNAL BELLS, RASTRICK'S TUBE SCRAPERS,

CONICAL, SPIRAL, and all kinds of COILED SPRINGS made to order.

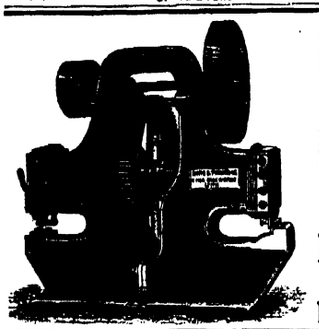
DYNAMOMETERS

For Testing Strength of Wire, Rope, Cement, Cloth, &c.

GOODS SUPPLIED THROUGH ALL MERCHANTS AND FACTORS



4769



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ETNA IRONWORKS, BANGOR ROAD, LEITH, N.B.

IMPROVED DOUBLE-ACTING STEAM HAMMERS

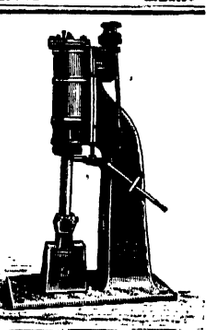
For Forges, Smithies, Stamping, &c.

AWARDED THE

FIRST PRIZE at SYDNEY EXHIBITION, 1880.

Sizes from 1½ cwt. to 12½ cwt. usually in Stock. 4377

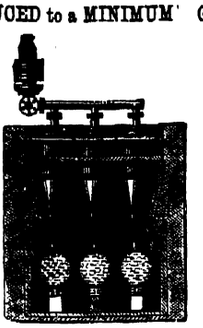
Punching and Shearing Machines, Shipbuilders' and Boiler Makers' Tools, &c.

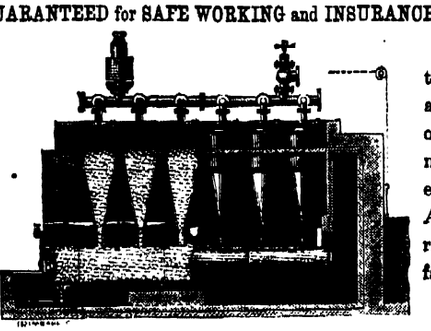


SHEPHERD'S IMPROVED PATENT INTERNALLY FIRED CONE SECTION BOILER.

RISK of EXPLOSIONS REDUCED to a MINIMUM GUARANTEED for SAFE WORKING and INSURANCE up to 150 lbs. PRESSURE.

BOILERS on this principle have been in constant work for some years, with great success in the economical production of steam without priming. There are no parts liable to collapse, or stays subject to corrosion. They can be exported cheaply





to all parts of the world. They are suitable for every description of work, and, consisting of a number of similar sections, are easy to erect, examine, and repair. Any portion can be removed and replaced quickly, and with great facility.

4880

For PLANS, ESTIMATES, and PARTICULARS of TRIALS, apply to the SOLE LICENCEES and MAKERS,

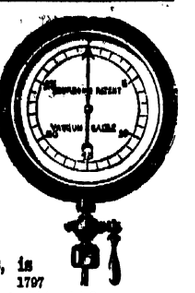
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Makers of Marine Engines, and of every kind of Land and Pumping Engines, Boilers, Hydraulic Machinery, Mining Plant, Air Compressors, Rock Borers, Rolling and Sugar Mills, Mint Machinery, and of Coins for the British Government and Foreign Countries.



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TELEPHONE No. 6583.] SOLE AGENTS IN LONDON. [TELEPHONE No. 6583.

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TORPEDO BOAT for the ITALIAN GOVERNMENT. Official Trial Dec. 18, 1881. SPEED on the Measured Mile 22.46 KNOTS. 4994
TORPEDO BOAT for the BRAZILIAN GOVERNMENT, tried June 27, 1882. Mean SPEED during a continuous run of 3 hours with 12½ TONS on board, 20.3 KNOTS.

BERKLEY STREET, BIRMINGHAM.



RICHARD C. GIBBINS & Co.

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PORTABLE, WHARF, DERRICK,
FOUNDRY, OVERHEAD, TRAVELLING,
Warehouse Cranes and Pile Drivers,
1691
Warehouse Lifts and Hoists,
CRABS, JACKS, PULLEY BLOCKS, SCREW
COUPLINGS, PLATELAYERS' TOOLS, &c.

11, QUEEN VICTORIA ST. LONDON, E.C.

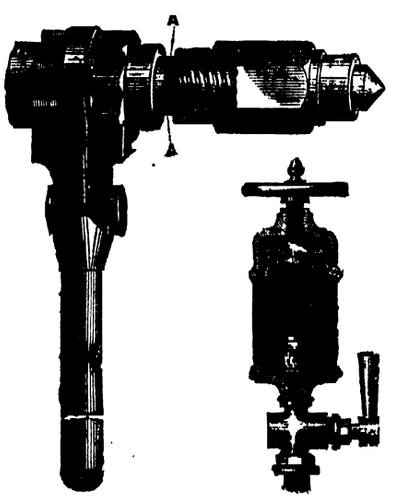


NETTLEFOLDS LIMITED, BIRMINGHAM,

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WESTON'S PATENT DIFFERENTIAL RATCHET BRACE.

STORER'S PATENT OPEN TOP SUET LUBRICATOR.



These BRACES, which have been several years before the public, and are MUCH APPRECIATED by them, NETTLEFOLDS have lately CONSIDERABLY IMPROVED by enclosing the SCREW in a SLEEVE (A) which always PROTECTS it from INJURY either from DIRT or BLOWS. This SLEEVE also acts as a GUIDE for the NUT, thus keeping it steady throughout the whole of its traverse, and consequently enabling the drilling to be effected with PERFECT ACCURACY.

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MANCHESTER	Edmundsons & Co.	DERBY	Handyside & Co.
GLASGOW ..	W. McGeoch & Co., Schaffer & Budenberg.	RUSSIA	Sumner, John M. & Co., Manchester.
EDINBURGH ..	Redpath, Brown & Co., Thos. Scott.	AUSTRIA	Simon Henry, Manchester.
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SYSTEM OF DREDGING AND EXCAVATING.

9, VICTORIA CHAMBERS, WESTMINSTER, S.W.



HYDRAULIC DREDGER FOR CANAL WORK.

THE SIMPLEST AND BEST

Direct-Acting Dredger

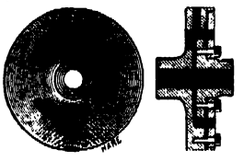
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FIVE DREDGERS on this principle already constructed, and are working in the most satisfactory manner, working expenses being reduced fully FIFTY PER CENT. below that of BUCKET AND LADDER DREDGERS.

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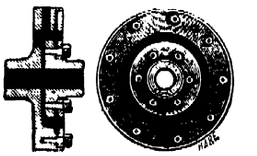
PETER BROTHERHOOD,

MECHANICAL ENGINEER,

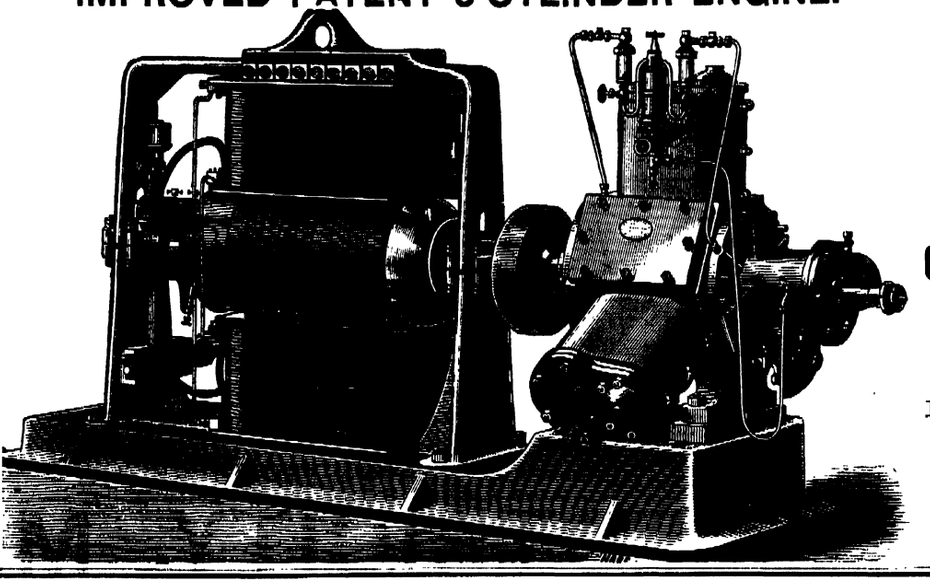
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EFFECTIVE

FOR

SHIP LIGHTING

As in General Use in the British, French, Italian, Danish, &c., &c., Navies.

FOR DRIVING

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CENTRIFUGAL PUMPS,

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HIGH-SPEED

MACHINERY.

5204

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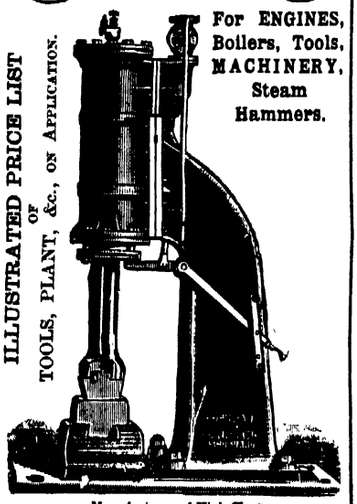
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PULLEY BLOCKS.

The New **"Patent Geared"** Blocks are manufactured with great care, and of the best materials throughout, and are in every sense

SAFETY HOISTING MACHINES.

With the "PATENT GEARED" Blocks a man can lift from 2,000 to 4,000 lbs., being two or three times the lifting power of the Direct Differential Blocks.

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Are the SIMPLEST and CHEAPEST for Boiler Feeding, Mining, and all other purposes. Every Pump tested in steam and water before leaving the Works. Best Material and Workmanship Guaranteed.

— THOUSANDS IN USE AT HOME AND ABROAD. —

	SINGLE ACTING.							DOUBLE ACTING.						
Size Nos.	1	2	4	6	8	10	14	22	24	26	27	28	30	32
Diameter of Pump..	¾	1¼	1½	1¾	2	2½	2¾	2½	2⅞	2⅞	3¼	3½	5¼	7¼
Gallons per hour ..	60	97	119	184	330	466	727	900	1200	1455	1800	2800	5200	12400
HP. of Boiler	4	6	8	12	21	35	55	60	90	110	180	180	335	750
Hand Lever, extra..	7/6	7/6	8/6	9/6	10/6	13/-	13/-	15/-						
Prices d/d London..	£4 15	£6 5	£7	£10	£13 12	£15	£19	£17	£21	£25	£29	£35	£53	£84

All Pumps fitted with gun-metal plungers and valves unless otherwise ordered. A large number always in stock. Catalogues with testimonials and full directions for fixing on application.

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CRANES
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GAS ENGINES
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PUMPS
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WELL BORING TOOLS 5022

EFFICIENCY. ECONOMY.

WATER TUBE BOILER

HARDINGHAM'S PATENT SECTIONAL BOILER.

Section of Water-Tube,

FULL SIZE.

Inner Tube Removable.

191, FLEET STREET, LONDON, E.C.

ACCESSIBILITY. COMPACTNESS.

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(DR. HOPKINSON'S PATENT.)



An Instrument for measuring and continuously recording quantity of Electricity, and for ascertaining the amount due from a consumer for the quantity or energy of the Electric current supplied during a given time.

Made in 5 sizes, to register from 1 to 200 amperes. PRICE, £15 to £35.

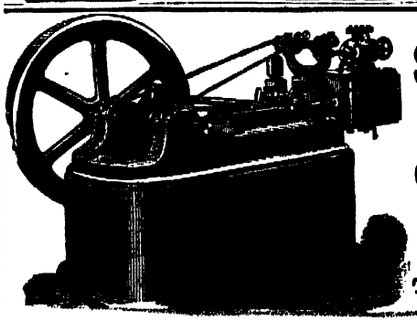


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ELECTRIC LIGHT ENGINEERS,

BIRMINGHAM. 4960



THE CHEAPEST AND BEST

STEAM ENGINES AND BOILERS

In the Market are Manufactured by

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PRICE LISTS ON APPLICATION.

SPECIAL TERMS TO SHIPPERS AND LARGE BUYERS.

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MACHINE TOOLS.

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Manufacturers of all kinds of Slide Lathes, Planing, Shaping, Slotting, Boring, Drilling, Punching, Shearing, Bending, and Screwing Machines, suitable for every class of Engineers and Shipbuilders

GIBBS' PATENT HEATING APPARATUS

As fitted in "Engineering," "Daily Telegraph," and "Daily Chronicle" Offices.

FULL SIZE OF PIPE — TRADE MARK

980 Working Successfully.

Highest Award for Heating Apparatus, INTERNATIONAL SANITARY EXHIBITION, LONDON, 1881. 4113

ST. JAMES'S HEATING APPARATUS WORKS, MILL STREET, LIVERPOOL.

EDWIN LEWIS & SONS,

WOLVERHAMPTON, STAFFORDSHIRE.

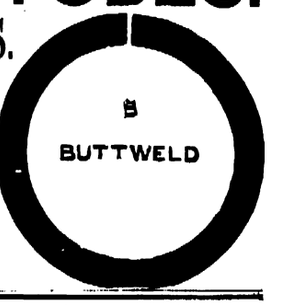
LAPWELDED IRON BOILER TUBES.

BUTTWELDED GAS, STEAM, and WATER TUBES.



DIAGRAM SHOWING LAP AND BUTT WELDS.

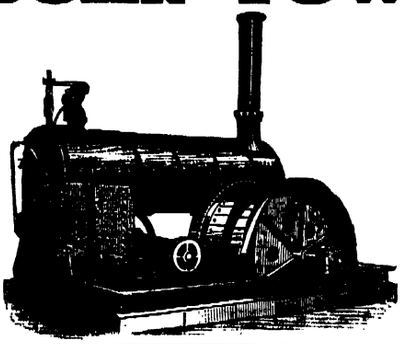
These two Engravings, representing sections of Lapwelded Wrought Iron Tube (at A) and Buttwelded (at B) show conclusively the superior strength of Lapweld, which has nearly four times the surface in contact in the Weld over that given in Buttweld.



All Gas, Steam, or Water Tubes over Two-inch size are made Lapwelded by us. 4864

JOHN FOWLER & CO., LEEDS, ENGLAND,

MANUFACTURERS OF



Steam Cultivating Machinery — Traction Engines — Patent Compound Yorkshire Semi-Portable and Fixed Engines — Semi-Portable Engines — Horizontal High-Speed Stationary Engines — Hauling, Winding, and Pumping Engines — Patent Automatic Expansion Valve Gear and Governor, for ensuring Economy, Regularity, and Safety—Boilers of all types, adapted for every kind of fuel and country—Steel Portable Railway, for Sugar, Cotton, and Indigo Plantations, Contractors' Works, Military Depots, Workshops, Mines, Timber Yards, Agricultural Holdings, &c.—

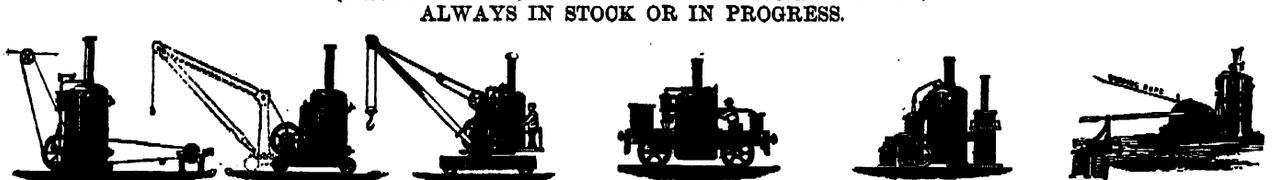
Locomotives of various gauges. 3061

CALCUTTA EXHIBITION, 1884, FIVE FIRST PRIZES.

Budapest Agricultural Meeting, 1882—Two Gold Medals and other Awards.
Vienna Agricultural Meeting, 1882 — Special Diploma for excellency of work.
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(PRIZE MEDAL, INTERNATIONAL EXHIBITION.)
ALWAYS IN STOCK OR IN PROGRESS.



STATIONARY ENGINE. From 1 to 30-horse power. No Building required.
HOISTING ENGINE. 1 to 20-horse power. With or without Jib.
STEAM CRANE. 15 cwt. to 20 tons. For Wharf or Rail.
CONTRACTORS' LOCOMOTIVE. 9 to 27-horse power. For Steep Inclines and Quick Curves.
SHIPS' ENGINE & DISTILLER. For Winding, Cooking, and Distilling. Sanctioned by H.M. Government.
WINDING & PUMPING ENGINE. 6 to 30-horse power. 2468

PARTIES ARE CAUTIONED AGAINST USING OR PURCHASING IMITATIONS OR INFRINGEMENTS OF THESE PATENT MANUFACTURES.

Patentees and Sole Manufacturers—ALEXANDER CHAPLIN & Co., Cranstonhill Engine Works, Glasgow.

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THE CLAY CROSS COMPANY,

COAL, LIME, & IRON WORKS, CLAY CROSS, near CHESTERFIELD,

SUPPLY HOUSE, GAS, AND STEAM COAL,

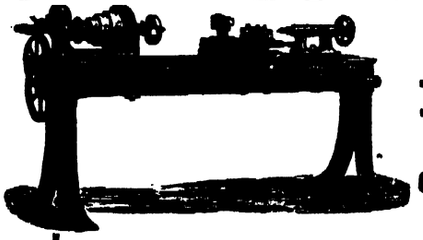
AND ARE MAKERS OF

PIG IRON, GAS and WATER PIPES, and ALL CASTINGS

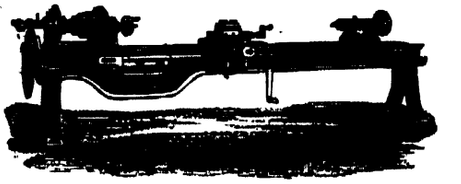
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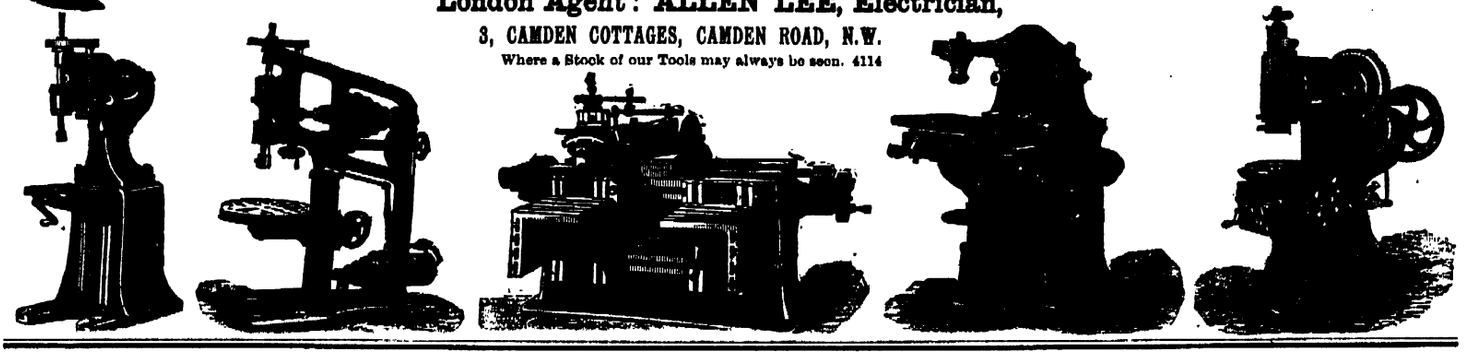


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Where a Stock of our Tools may always be seen. 4114

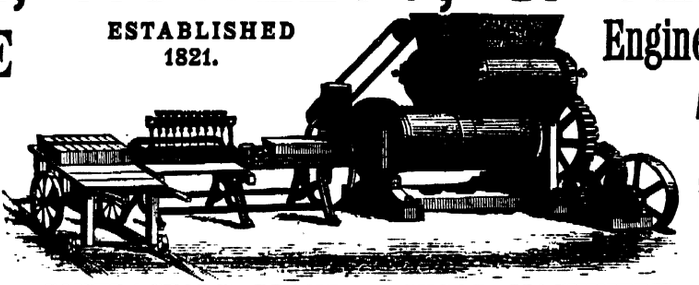


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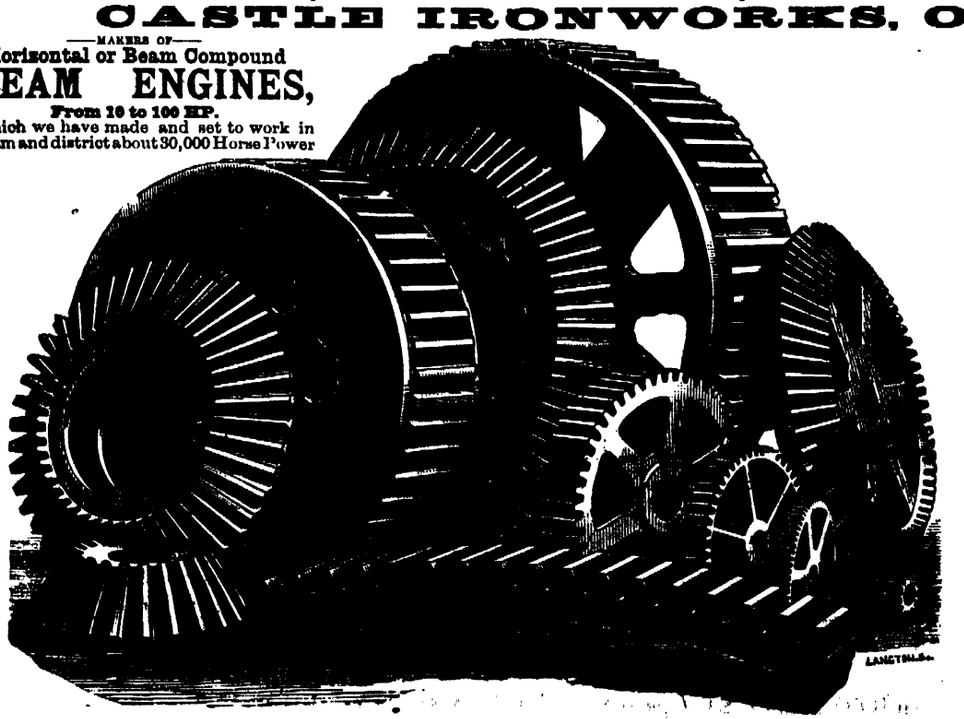
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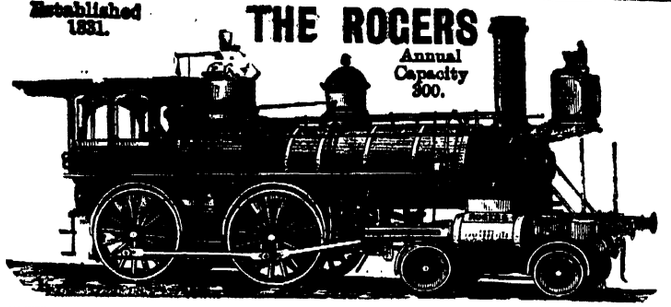
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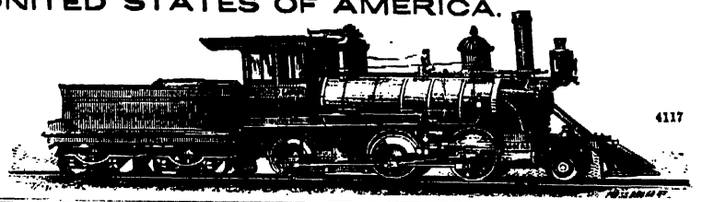
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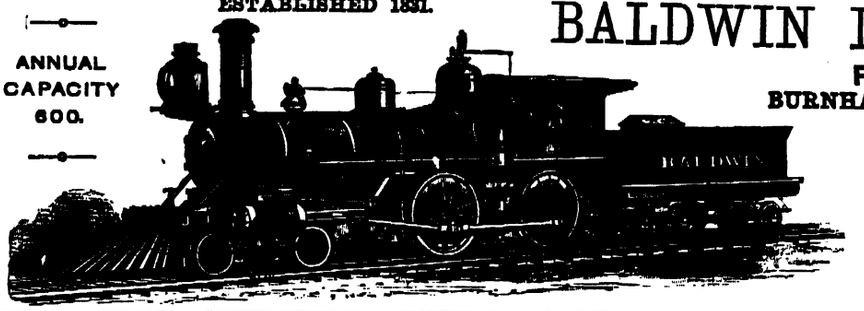


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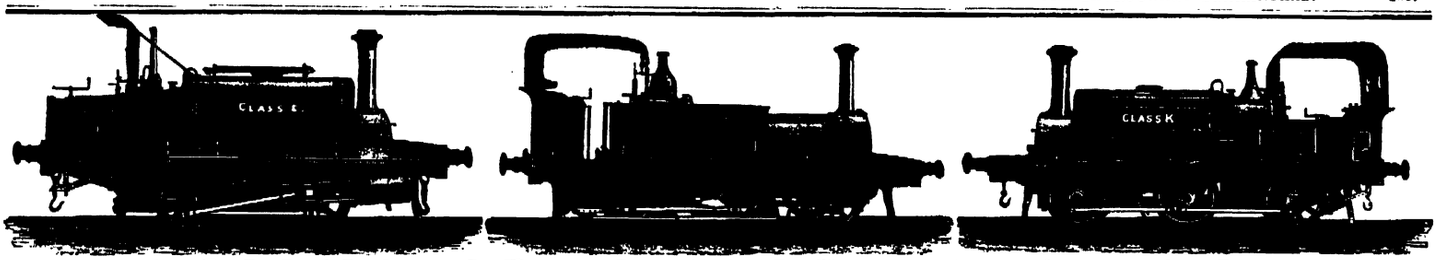
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MANUFACTURERS OF
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Adapted to every variety of service, and built accurately to standard gauges and templates. Like parts of different engines of same class perfectly interchangeable.
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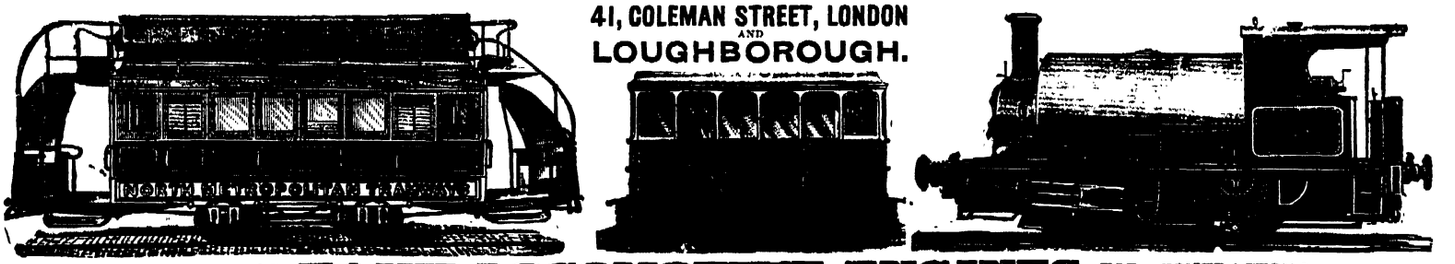
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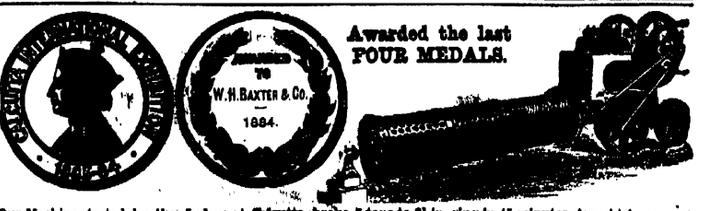
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We have much pleasure in informing our Customers and the Public that the above-mentioned old-established Business, together with all its Branches, will in the future be carried on under the style of WOODS & COMPANY.

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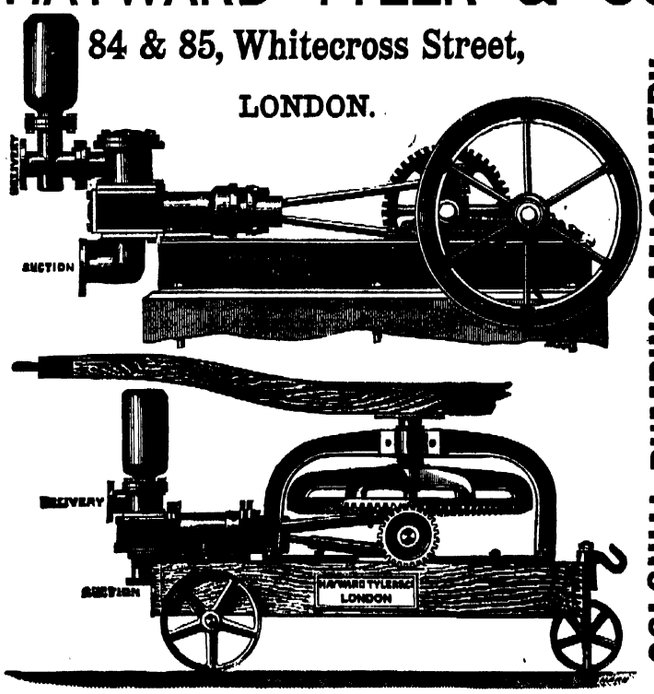
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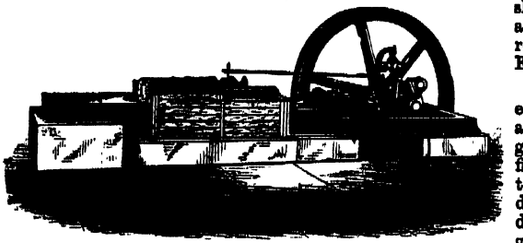
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PATENT HORIZONTAL

COMPOUND CONDENSING STEAM ENGINES.

The great and well-known economy in fuel of these Engines has been fully proved by very careful trials, particulars of which sent on application. (See also "Minutes of Proceedings of the Institution of Civil Engineers," Vol. 66, Session 1880-81, Part IV.)

They have repaid their cost in a short time, are not more complicated than ordinary Condensing Engines, require much less water for condensing, no greater skill to drive, and are as easily accessible for repairs as ordinary Engines.



In cases where Boilers are overworked, the adoption of these Engines leads to easy firing, saving of wear, tear, and labour, rendering old Boilers more durable and capable of giving off additional Engine power, thereby saving the cost of new Boilers, where an increase of power is wanted. All joints and working parts adjustable.

N.B.—One of these Engines was run from November 25, 1877, NIGHT and DAY, until October 28, 1879, without having the steam shut off (except on two occasions for a few hours to examine driving belts), being a continuous run of 712 days of 24 hours each, or about 17,080 hours in all.

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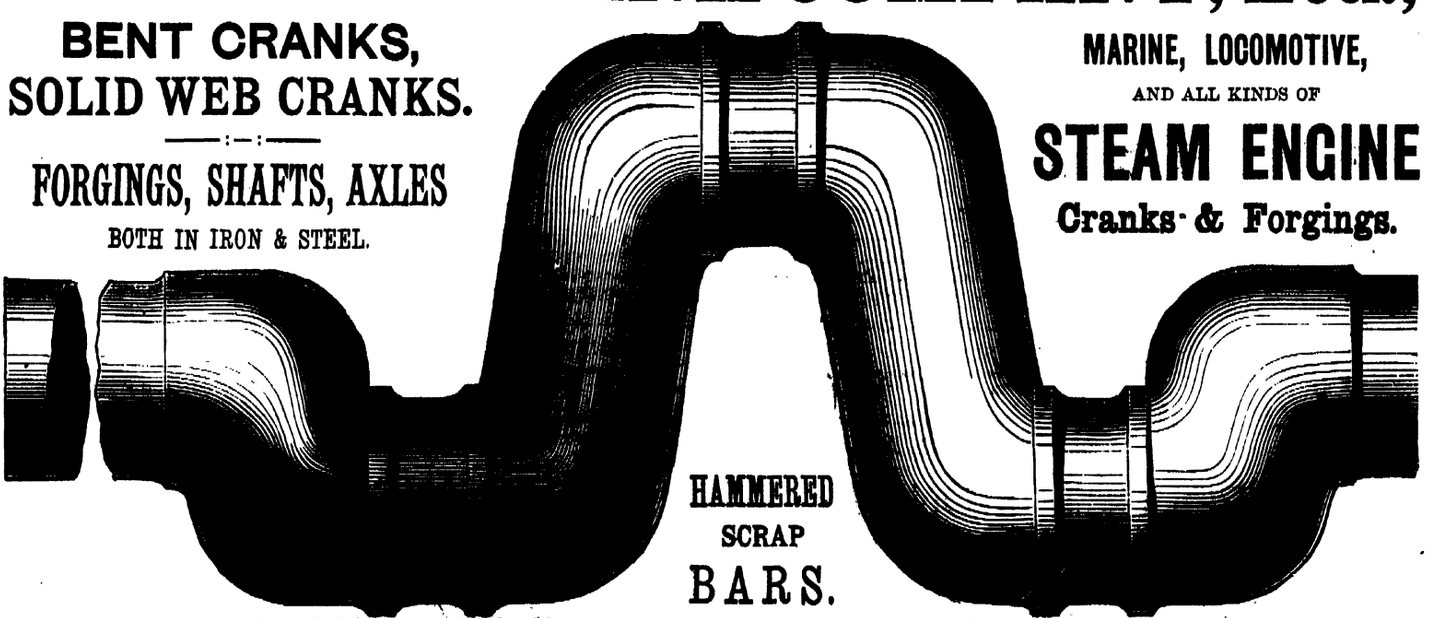
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STEAM CAPSTANS.

LEATHER MACHINERY.

Fig. 134, Engraved from a 4-Ton "Wellington" Crane, supplied to the Royal Albert Docks. 4629

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AND WATER ELEVATORS.

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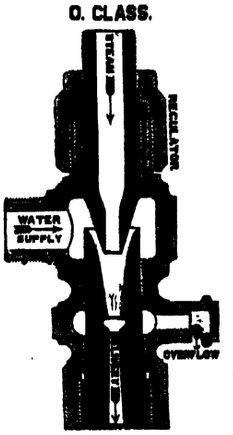
Will find these High-Class Boiler Feeders the most thoroughly reliable ever sent into the Market for supplying all classes of Steam Boilers with Water, from 2 lbs. to 200 lbs.
Our D.L. Class, No. 4, lifts 8 ft. (set from 20 lbs. to 150 lbs.) ONE MOTION ONLY—SIMPLY TURN ON STEAM.

Lifting. D. L. CLASS.



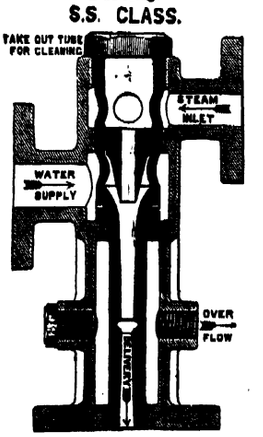
TRACTION.

Forcing. O. CLASS.



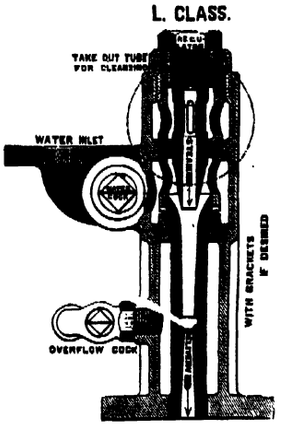
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Forcing. S.S. CLASS.



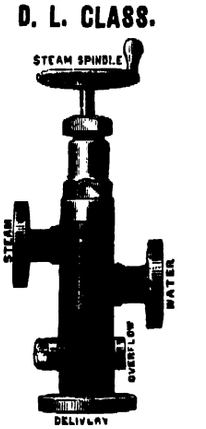
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LOCOMOTIVE.

Lifting. D. L. CLASS.



TRAMCAR ENGINES.

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Removes the Carbonates of Lime, Magnesia, and Iron from **Hard Waters**, and thus, the **causes of Incrustation in Boilers and Pipes.** This Process is in use in Paper Mills, Breweries, Sugar Works, India-rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c. One Railway Company employs it for feed-water to the extent of **1,000,000 gallons** daily, and one of the London Water Companies at two of its Pumping Stations. It is also in use in County Asylums, Public and other Schools, and Private Mansions. The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich, are rendered soft and clear. 5226

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PORTABLE ENGINES.
MORTAR MILLS.
"SPECIAL CLAY MILLS."

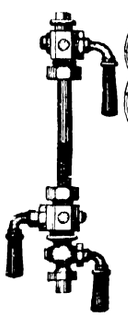
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Messrs. SMEDLEY BROS. J. & R. BOWDEN (Builders)

EAGLE IRONWORKS, BELPER.
VERTICAL Combined Engines and Boilers. 5109
HORIZONTAL ENGINES.



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THE PERTH GAUGE GLASS,

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These Medals have been awarded for the above-mentioned qualities.

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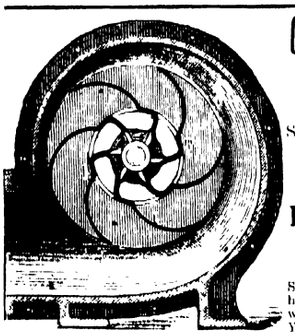
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ALSO
SUGAR MACHINERY
Of every description

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Punching, Shearing, Angle Iron and Bar Cutting MACHINES. 506

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Illustration Showing Application of Silicate Cloth.

Incombustible.
Best Non-conductor Extant.
Easily Applied.
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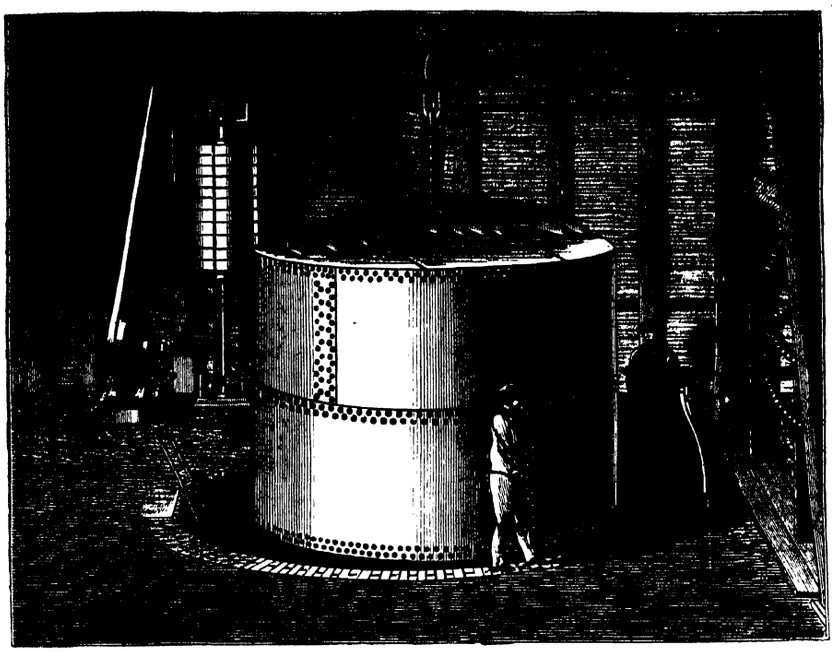
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STOLLWERCK'S PATENT FEEDWATER PURIFYING APPARATUS,

APPLICABLE TO ALL KINDS OF STEAM BOILERS,

Increasing their POWER, preventing INCRUSTATION, and thus effecting GREAT ECONOMY in FUEL.

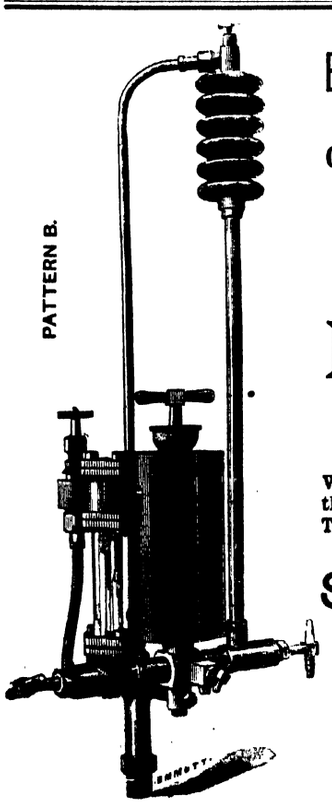
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MANUFACTURERS OF

GRANDISON'S

Empire Lubricator

Which shows each drop of oil passing into the steam through the medium of a Glass Tube, and is the BEST APPARATUS now known for Lubrication of

STEAM ENGINES,

LAND OR MARINE.

Lubricators sent on approval to any part of the kingdom, and references given to users in all parts of the inhabited world.

4768

FURTHER PARTICULARS ON APPLICATION.

RAGOSINE OIL

THE RUSSIAN NATURAL LUBRICATING OIL. Gold Medal, Paris, 1878.

Pure Hydro-carbon, free from acid. Body superior to Olive or Lard Oil | Never gums or clogs. Never freezes or thickens.

No. V 2s. 6d. PER CAL

RAGOSINE & CO.,

7, IDOL LANE, LONDON, E.C.,

And Love Lane, Quayside, Newcastle-on-Tyne.

Works—BALACHNA and CONSTANTINOW, RUSSIA.

Price Lists and full particulars on application 4779

No. VIII 2s. 0d PER CAL

HANSON'S SPECIALITIES

Steam Pumps, Steam Engines, Steam Winches, Steam Dryers, Steam Traps, Steam Reducing Valves, Steam Purifying Apparatus for Boilers, Water Engines and Hoists for Warehouses.

WILLIAM HANSON,

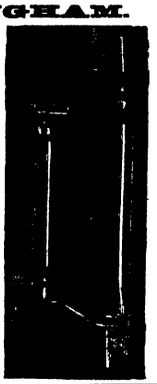
QUEBEC WORKS, BRADFORD.

LONDON OFFICE: 87, WALBROOK. 5227

(See Illustrated Advertisement July 18th, page 11.)

TAYLOR & CHALLEN,
ENGINEERS,
BIRMINGHAM.

SOLE MAKERS OF
WITHINSHAW'S PATENT
Feed Water HEATER.



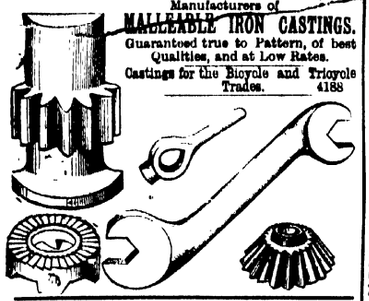
The most powerful invented.
Great Saving in Boilers, Coals, and Labour.
LARGE HEATING SURFACE
Solid Drawn Brass Tubes.
Free Expansion.
No Scurf adheres to the Tubes.
—o— 4837
List on application.

BY ROYAL LETTERS PATENT.



MATHER'S
Fly-Wheel Portable Engines
ARE THE BEST FOR SMALL POWER.
They have large Fly Wheels on which they travel; they are light in draught and are handy.
—o— 5104
G. R. MATHER,
WELLINGBOROUGH, ENGLAND.

W. R. PALMER,
LIMITED,
BACOT STREET FOUNDRY,
BIRMINGHAM.
Manufacturers of
MALLEABLE IRON CASTINGS.
Guaranteed true to Pattern, of best Qualities, and at Low Rates.
Castings for the Bicycle and Tricycle Trades. 4188



GOLD MEDAL, PARIS, 1878.

GAUGE GLASSES
AND
ENAMELS
For Iron, Cast-iron, Copper, &c.

PATENT GUILBERT MARTIN
Patentee and Manufacturer of the
PATENT
RED REFLECTING GAUGE GLASS,
Showing through the water a Broad Red Line.
N.B.—All Glasses are of the finest quality, and manufactured expressly to resist extreme pressure.



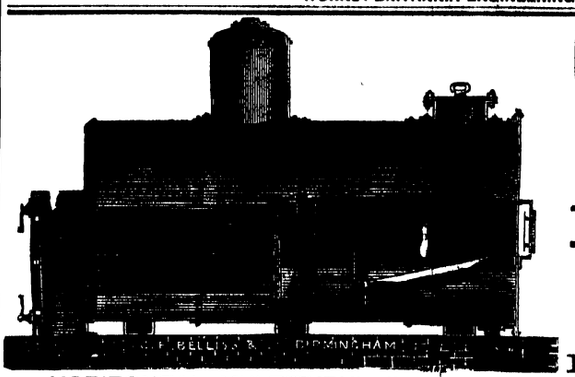
DEPÔT:
1 & 2, FALCON STREET,
Aldersgate Street,
LONDON, E.C.
REPRESENTED BY
E. M. HAMBURGER.
The above line shown in black is of a rich Red. 5002

Highest and only First-Class Award at the Calcutta International Exhibition, 1883-4.

TRAMWAYS **DICK, KERR & CO.,** TRAMWAYS



Over 150 miles of Line now laid in England on the above systems.
BUILDERS OF TRAMWAY LOCOMOTIVES AND TRAMWAY CARS. 5023
Estimates, Specifications, and Drawings on application to HEAD OFFICE: 101, LEADENHALL STREET, LONDON, E.C.
WORKS: BRITANNIA ENGINEERING WORKS, KILMARNOCK.



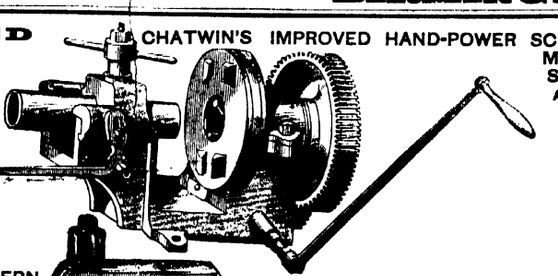
HORIZONTAL MULTITUBULAR BOILER.

C. E. BELLISS & CO.,
Engineers & Boiler Makers,
MANUFACTURERS OF
STEAM
BOILERS
OF ALL KINDS WITH
IRON or STEEL PLATES.
LEDSAM STREET WORKS,
BIRMINGHAM. 5011

STOCKS AND DIES. PATTERN ENGINEERS' ANGULAR

AWARDED
A
Gold & Silver Medal
AND
Two 1st Class Certificates at
Calcutta Exhibition, 1884.

CHATWIN'S IMPROVED HAND-POWER SCREWING MACHINE, SCREWING AT ONCE OVER.

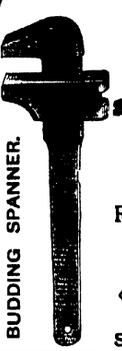


WHITWORTH PATTERN GUIDE STOCKS AND DIES.





THOMAS CHATWIN,
GT. TINDAL STREET, BIRMINGHAM,
MANUFACTURER OF
STOCKS, DIES, AND TAPS,
PATENT HAND-POWER SCREWING MACHINES, TWIST DRILLS,
STANDARD CYLINDRICAL GAUGES, RIMERS,
CLYBURN, BUDDING, AND OTHER SPANNERS,
RATCHET BRACES, TUBE CUTTERS, TUBE WRENCHES, TUBE VICES,
And General Tools for Engineers, Gas Fitters, &c. 4234





STRAIGHT LIP TWIST DRILL, WITH INCREASE TWIST AND GRINDING LINE.

FUEL ECONOMISER
GREEN'S PATENT
Has been awarded the GOLD MEDAL at the CALCUTTA EXHIBITION, in addition to TWELVE MEDALS previously given at other Exhibitions. 5021
ST. ANN'S SQUARE, MANCHESTER. WORKS: WAKEFIELD.

BUTTERS BROTHERS, Contractors' Engineers

PERCY CRANE AND ENGINE WORKS, LAMBHILL STREET, PAISLEY ROAD,

MAKERS OF

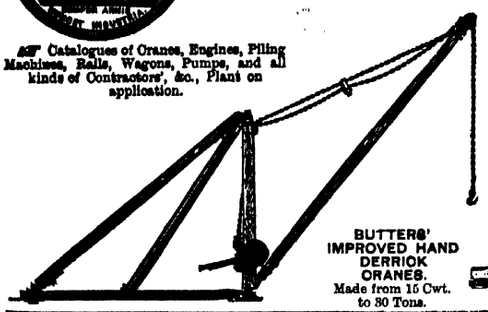
Henderson's Patent DERRICK CRANES, from 15 Cwt. to 30 Tons

ALSO

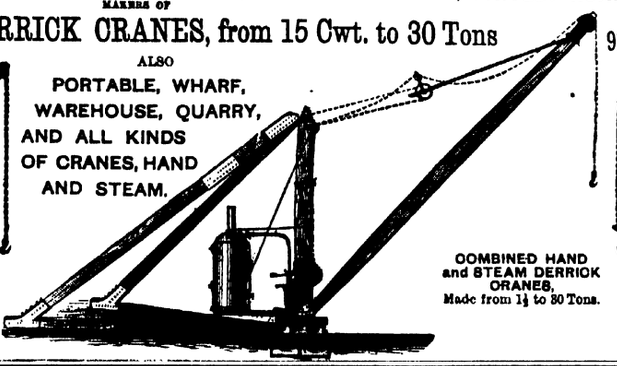
PORTABLE, WHARF, WAREHOUSE, QUARRY, AND ALL KINDS OF CRANES, HAND AND STEAM.

OFFICES: 93, Hope Street, GLASGOW.

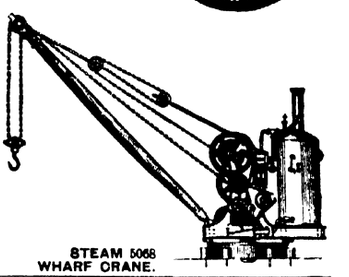
☞ Catalogues of Cranes, Engines, Piling Machines, Rails, Wagons, Pumps, and all kinds of Contractors', &c., Plant on application.



BUTTERS' IMPROVED HAND DERRICK CRANES. Made from 15 Cwt. to 30 Tons.



COMBINED HAND and STEAM DERRICK CRANES, Made from 1½ to 30 Tons.



STEAM 50CB WHARF CRANE.

TEST BAR, Half Actual Size.



HADFIELD'S UNHAMMERED Steel Castings

Tested by H.M. Govt., and stood 45 tons per sq. in. tensile strain with 20 p.c. elongation.

STEEL CASTINGS

STEEL CASTINGS

GOLD MEDAL PARIS 1878

SPECIAL DIPLOMA AND MEDAL SYDNEY 1880 TWO SPECIAL DIPLOMAS 1880 MELBOURNE

GOLD MEDAL MELBOURNE 1881

SOUND TOUGH DURABLE

HADFIELD'S STEEL FOUNDRY CO. ATTERCLIFFE SHEFFIELD.

MACHINE MOULDED GEARING.

4592

REGISTERED TRADE MARK

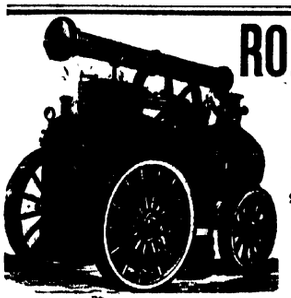
'PHOSPHOR BRONZE'

The Best and Most Durable Metal for Bearings and Bushes of every Description; Hydraulic Pumps, Pinions, Valves, &c. &c Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c.

SOLE MANUFACTURERS UNDER SEVERAL PATENTS— 1475

The PHOSPHOR BRONZE COMPANY, Limited, Sumner & Emerson Streets, Southwark, London, S.E.

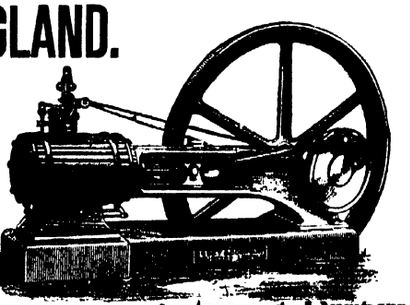
ROBEY & CO., ENGINEERS, LINCOLN, ENGLAND.

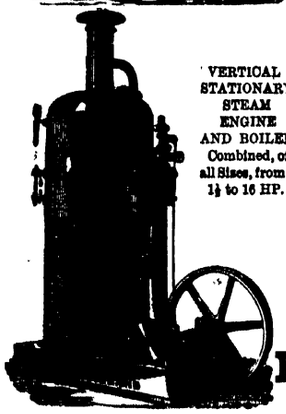


SUPERIOR PORTABLE ENGINES 2½ to 50 HP.

First PRIZE for PORTABLE ENGINES, Melbourne Exhibition, 1881.

PARIS, 1878, GOLD MEDAL.





VERTICAL STATIONARY STEAM ENGINE AND BOILER Combined, of all Sizes, from 1½ to 16 HP.



The Patent "Robey" Mining Engine

Prices and full Particulars of the Machinery here illustrated on a

ROBEY & CO., Engineers, L

London Office: 117, CANNON ST

4919

description of ...raphy, Engraving, and ...Architectural, and Pictorial ...er. Paper Drawing, photo-litho- ...g St., Covent Garden, W.C. 3462

n Cranes.

Thomas Smith,

STEAM CRANE WORKS, OLD FOUNDRY, 4845

RODLEY, NEAR LEEDS.

See Illustrated Advertisement last week, page 27.

International HEALTH EXHIBITION.

PAUL PFLEIDERER'S PATENT Bread-Making Machinery

In Bakery Section.

4755

86, UPPER GROUND STREET, BLACKFRIARS, LONDON, S.E.

Heaters and Purifiers,

WITH

STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels.

Emery Machines,

Spiral Springs.

The Crown Iron Works, GLASGOW.

The Crown Iron Works (Hollinwood), MANCHESTER.

10, Victoria Chambers, WESTMINSTER.

City Office and Show Rooms, 40, CANNON STREET, E.C.

10, Rue Laffitte, PARIS.

Royal Agricultural Society of ENGLAND.

SHREWSBURY MEETING, 1884.

The TRIALS of SHEAF-BINDING MACHINES, using any other material than wire, will COMMENCE on WEDNESDAY MORNING, AUGUST 6th, upon Mr. HAWKIN'S FARM, at Dinthill, near Shrewsbury.

H. M. JENKINS,
Secretary.

12, Hanover Square, London, W.
N.B.—Dinthill is about four miles from Shrewsbury, on the Welshpool turnpike road. G 599

Metallurgical Department,

King's College, London, under the direction of Prof. A. K. HUNTINGTON.

In the Laboratory metals and alloys are examined mechanically with the aid of powerful testing machinery, as well as chemically. Extraction and manufacturing processes investigated and assays and analyses made.

A few free entries to the division of studies (day or evening) are obtainable through the City and Guilds' Institute. G 484

TENDERS.

The Directors of the BENGAL and NORTH-WESTERN RAILWAY COMPANY, Limited, are prepared to receive

Tenders for the Supply of

UNDER-FRAMES and BODY IRONWORK for 200 Covered Goods Wagons.

The Form of Tender, Conditions of Contract, and Specification may be obtained, on payment of Ten Shillings, by application at the Company's Offices, and no Tender will be received after Noon of the 6th August, 1884.

The Directors do not bind themselves to accept the lowest or any Tender.

By order, W. S. S. BISSET,
237, Gresham House, Acting Secretary.
Old Broad Street, London, E.C.
25th July, 1884. G 602

MANCHESTER, SHEFFIELD, AND LINCOLNSHIRE RAILWAY COMPANY are prepared to receive

Tenders for the Supply of

80,000 BALTIC REDWOOD SLEEPERS

The Sleepers to be 8 ft. 11 in. long, 10 in. by 5 in. section, and delivered free in trucks at Grimsby, in quantities of six to seven thousand per month, commencing 1st October next.

Specification and Forms of Tender to be obtained from the undersigned.

Tenders, to be marked "Tender for Sleepers," to be in the hands of the undersigned, at London Road Station, Manchester, not later than Nine a.m. on Friday, 8th August, 1884.

The Company do not bind themselves to accept the lowest or any Tender. G 603

London Road Station, EDWARD ROSS,
Manchester, 29th July, 1884. Secretary.

TO CONTRACTORS.

RIBBLE NAVIGATION AND PRESTON DOCK ACT, 1883.

To be Let, the Construction

of a DOCK of 40 acres, Tidal Basin, Locks, Diversion of River, and other Works, for the Mayor, Aldermen, and Burgesses of the Borough of Preston.

Plans, Specification, and Detailed Drawings, may be seen, and Quantities and Forms of Tender obtained at the Office of EDWARD GARLICK, Esq., C.E., 33, Winckley Square, Preston, from the 28th inst. to the 20th day of August next, by noon on which day, Sealed Tenders, addressed to "The Chairman of the Ribble Committee," and endorsed "Tender for Dock and other Works," must be deposited at the Town Hall, Preston.

A charge of Ten Guineas will be made to Contractors for a Copy of the Quantities, which will be returned on receipt of a *bond fide* Tender.

The Corporation do not bind themselves to accept the lowest or any Tender. G 552

Town Hall, Preston, HENRY HAMER,
17th July, 1884. Town Clerk;

IN THE HIGH COURT OF JUSTICE, CHANCERY DIVISION.

To be Sold, by Private Tender,

in ONE LOT, as a going concern, pursuant to an Order of the Honourable Mr. Justice Pearson, made in the matter of the Companies' Acts, 1862 and 1867, and in the matter of the JABLOCHKOFF ELECTRIC LIGHT AND POWER COMPANY, Limited, THE STOCK-IN-TRADE, PATENTS, AND GOODWILL of the above Company, together with the Furniture, Fixtures, and Fittings, also the Leasehold Premises, situate and being No. 33, Albert Embankment, Westminster; also the Leasehold Premises, situate and being Canterbury Dock Wharf, 65, Belvedere Road, Lambeth, Surrey. Also the Beneficial Interest of the Company in two agreements, one relating to the hiring of Railway Arches, Nos. 97 and 98, in the rear of No. 33, Albert Embankment, and the other relating to the Company's suite of Offices, 1, Great Winchester Street, Old Broad Street, and the furniture and fittings appertaining thereto.

Tenders are to be sent to the Liquidator, Mr. WILLIAM AUGUSTINE SPAIN, at his Offices, 76, Coleman Street, in the City of London, not later than Four o'clock in the afternoon of 6th August, 1884; and Saturday, the 9th day of August, 1884, at Twelve of the clock at noon, at the Chambers of the said Mr. Justice Pearson, Royal Courts of Justice, Strand, in the County of Middlesex, is fixed for the consideration of such Tenders, and for the acceptance or non-acceptance of any of the same being decided upon and certified by the Chief Clerk; but the Liquidator, under the direction of the Judge, may decline to accept any Tender.

Full particulars of the leases, furniture, fixtures, and patents, and Conditions of Sale, with Form of Tender annexed, may be obtained on application to the Liquidator, at his Office aforesaid, and at the Works and Offices of the Company, and of Messrs. MILLS, DOWSON & Co., 28, Bedford Row, and of Mr. FREDERICK KENT, 111, Cheapside, Solicitor to the said Liquidator.

Dated this 16th day of July, 1884.

E. W. WALKER,
FREDERICK KENT, Chief Clerk.
111, Cheapside, E.C.,
Solicitor for the Liquidator. G 562

GREAT WESTERN AND OLDBURY RAILWAY COMPANIES.

Tenders are invited for the

CONSTRUCTION of a new PASSENGER STATION at Langley Green Junction, Worcestershire.

Plans may be seen, and Specifications with Bills of Quantities obtained, on payment of Two Guineas, on and after Monday next, the 4th August, at the Offices of Mr. J. S. MACINTYRE, Civil Engineer, 9, Dean's Yard, Westminster. G 612

ALEXANDRIA WATER COMPANY, LIMITED, ALEXANDRIA, EGYPT.

CAST IRON PIPES.

The Directors of this Company are prepared to receive

Tenders for the Supply of

about 1,000 TONS of CAST IRON PIPES in accordance with the Specification, copies of which, and Forms of Tender, may be obtained from the Company's Secretary, Mr. F. SANDERS, 50, Parliament Street, Westminster, on payment of Five Shillings.

Tenders will be opened at Alexandria, on the 22nd of August, but the Company does not bind itself to accept the lowest or any Tender. G 597

SINGAPORE TRAMWAYS.

KER, BOLTON & CO., Glasgow, are prepared to receive

Tenders for the Supply, f.o.b.,

of the necessary IRON or STEEL SLEEPERS and relative FIXINGS required for the Singapore Tramways, according to Drawings and Specifications to be seen on and after 21st July, at the Office of JOHN STRAIN, C.E., 154, West George Street, Glasgow, from whom a Copy of the Specification and Form of Tender may be obtained on payment of One Guinea, which will not be returned.

Tenders addressed "Singapore Tramways" to be lodged, not later than Tuesday, 5th August, with KER, BOLTON & Co., who do not bind themselves to accept the lowest or any Tender. G 536

TO CONTRACTORS.

The DUBLIN PORT and DOCKS BOARD is prepared to receive

Tenders for the Construction

and ERECTION on the North Quay Extensions of a 10-TON CRANE. Drawings can be seen, and the Specification, together with a special Form of Tender, obtained on payment of Five Shillings, at the Office of the Engineer, BINDON B. STONEY, Esq., North Wall, Dublin. Tenders marked on the outside of the envelope, "Tender for Crane," must be sent in through post, prepaid, and addressed "the Secretary, Port and Docks Office, Westmoreland Street, Dublin, on or before Wednesday, the 13th day of August, 1884.

The Board does not bind itself to accept the lowest or any Tender.

By order,
Port and Docks Office, N. PROUD, G 622
Dublin, 28th July, 1884. Secretary.

LANCASHIRE AND YORKSHIRE RAILWAY.

The Directors are prepared to receive

Tenders for the whole of the

WORKS REQUIRED (except ironwork) in connection with the alteration of levels, deviation of line, and new lines, and new Exchange Station at Liverpool.

Drawings and Specification can be seen, and Quantities and Forms of Tender obtained from the Engineer's Office, Hunts Bank, Manchester, on and after Monday, the 21st inst.

Tenders addressed to the Directors, and endorsed "Tender for Alteration of Levels, Deviation of Line, and New Lines, and New Exchange Station, at Liverpool," to be in the hands of the undersigned, not later than Ten o'clock on Monday morning, the 25th August proximo.

J. H. STAFFORD,
Hunts Bank, Manchester, Secretary.
12th July, 1884. G 610

LANCASHIRE AND YORKSHIRE RAILWAY.

The Directors are prepared to receive

Tenders for the whole of the

CAST and WROUGHT IRONWORK required in connection with the alteration of levels, deviation of line, and new lines, and Station at Liverpool, including the principles, girders, and columns of new roof, girders, floor plates, &c., required in subway and cab approach; girders, floor plates, and columns, &c., required for Bridges over Leeds Street and Waterloo Tunnel, and Viaduct between Leeds Street and Chadwick Street.

Drawings and Specification can be seen, and Quantities and Forms of Tender obtained from the Engineer's Office, Hunts Bank, Manchester, on and after Monday, the 21st inst.

Tenders addressed to the Directors, and endorsed "Tender for Ironwork required, New Exchange Station, &c., Liverpool," to be in the hands of the undersigned, not later than Ten o'clock on Monday morning, the 25th August proximo.

J. H. STAFFORD,
Hunts Bank, Manchester, Secretary.
12th July, 1884. G 611

TO CONTRACTORS.

CARDIFF CORPORATION WATERWORKS.
(SCHEME B., LLANISHEN SECTION.)
CONTRACT NO. 1.

The Waterworks Committee of the Cardiff Corporation are prepared to receive NEW

Tenders from Competent

PERSONS for the CONSTRUCTION of a large STORAGE RESERVOIR, including Embankments, Valve Well, Culverts, Gauge Basins, Overflow, Bye-Channel, Road, Fencing, and other Works, at Llanishen, near Cardiff.

Plans and Drawings may be seen on and after Monday, the 11th August next, at the Offices of the Engineer, Mr. J. A. B. WILLIAMS, Queen's Chambers, Queen Street, Cardiff, and printed copies of the Specification, Form of Tender, and Bill of Quantities may be obtained from the Engineer, on payment of Five Guineas, which will be returned after the receipt of a *bona fide* Tender.

Tenders must be enclosed in a sealed envelope, endorsed "Cardiff Corporation Waterworks, Tender for Llanishen Reservoir," and addressed to, and left with me, the undersigned, before Ten o'clock of the morning of Friday, the 22nd day of August next. G 604

Town Hall, Cardiff, J. L. WHEATLEY,
28th July, 1884. Town Clerk.

EAST INDIAN RAILWAY COMPANY.

The East Indian Railway Company is prepared to receive

Tenders for the Supply and

DELIVERY of the
STEEL AND IRONWORK FOR THE CENTRAL CANTILEVER OF THE HOOGHLY BRIDGE,
in all about 1,400 Tons,
as per Specification and Drawings to be seen at these Offices.

Tenders are to be delivered in sealed envelopes, addressed to the undersigned, marked "Tender for Steel and Ironwork for the Central Cantilever of the Hooghly Bridge," not later than One o'clock p.m., on Thursday, the 4th day of September next.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
A. P. DUNSTAN,
Nicholas Lane, London, E.C. Secretary,
31st July, 1884. G 638

CLYDE NAVIGATION.

HORSE AND CARRIAGE FERRY-BOAT.

The Trustees of the Clyde Navigation invite

Designs for a Large Steam

FERRY-BOAT, to Ply in the Harbour of Glasgow, capable of carrying six Loaded Lorries, or four Loaded Ordinary Railway Wagons, with from 150 to 200 Passengers at one time.

Parties submitting Designs are requested to give a general description of them in writing, and to state price, time within which the Boat could be constructed, and what alterations, if any, would require to be made on the Wharfs of the Harbour to suit the Boat that might be selected.

Any further information required by Parties furnishing Designs may be obtained on application at this Office, to Mr. DEAS, the Trustees' Engineer; and Designs will be received by the undersigned up to and including Monday, the 11th August next.

By order,
GEO. REITH, General Manager.
Clyde Navigation Chambers, 208, St. Vincent Street, Glasgow, 22nd July, 1884. G 594

Wanted, Tenders for Pair of

WINDING ENGINES, 30 in., 33 in., or 36 in. cylinders, with drums, complete.—For further particulars apply in writing to SAMUEL SPRUCE, Esq., Mining Engineer, Tamworth, to whom Tenders must be delivered on or before 21st August, endorsed "Tenders for Engines." G 567

APPOINTMENTS OPEN.

Civil Service Commission

—Examination for ASSISTANT EXAMINERSHIPS in the Patent Office (21-25) 20th August. Salary £250 to £400. The date specified is the latest at which applications can be received. They must be made on forms to be obtained with particulars from the SECRETARY, Civil Service Commission, London, S.W. G 578

Wanted, at once, a General

FOREMAN, experienced in making and repairing Engines and other kinds of agricultural implements. Must be used to the Template system and turning out work expeditiously, able to make neat drawings, and get out estimates.—Address W. S., Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C.

Wanted, a thoroughly efficient

CHIEF DRAUGHTSMAN to take charge of Locomotive Drawing Office.—Address R. and W. HAWTHORNS' WORKS, Newcastle. G 634

Wanted Immediately, a good

DRAUGHTSMAN accustomed to large Hydraulic Cotton Presses.—Apply N 159, *Guardian* Office, Manchester. G 628

Junior Draughtsman in a

Milling Engineer's Office WANTED at once.—Address letters, stating age, experience, and salary required, to 104, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. G 606

Storekeeper Wanted at Engine

Making and Launch Building Works a few miles from London; must have had experience either as Storekeeper or as Assistant, and be able to keep Issue Books clearly and accurately.—Address, with full statement of experience, age, and wages required, to G 616, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. G 616

Vacancy for a Pupil in a

Civil Engineer's Office at Newcastle-upon-Tyne; no premium required; one having had some experience in workshops preferred.—Write, stating age, education, &c., to G 605, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 605

Lists of Berths Vacant or

WANTED. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5262

SITUATIONS WANTED.

To Consulting Engineers.—

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Notice is Hereby Given that the said John Walker has applied under sections 18 to 21 of the Patents, &c., Act, 1883, and Rules 48 to 56 of the Rules made thereunder for leave to amend the Specification filed in pursuance of the said Letters Patent.

Full details of the proposed amendment are advertised in the Official Journal of the Patent Office, published on the 22nd July inst., and a copy of the Specification as proposed to be amended is open to inspection at the Patent Office.

Any person intending to oppose such application must leave particulars in writing of their objection to the proposed amendment at the Patent Office, 25, Southampton Buildings, London, W.C., within one calender month from the date hereof.

Dated this 22nd day of July, 1884.
H. READER LACK,
Comptroller General.
GEORGE DAVIES, C.E., 4, St. Ann's Square, Manchester, Agent for the said John Walker. G 607

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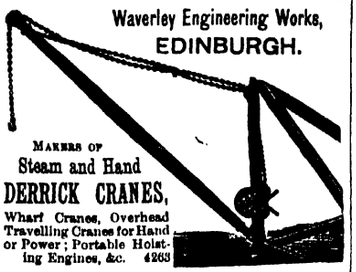


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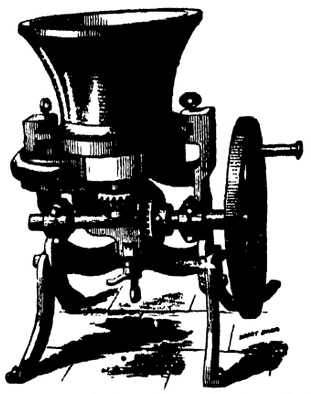
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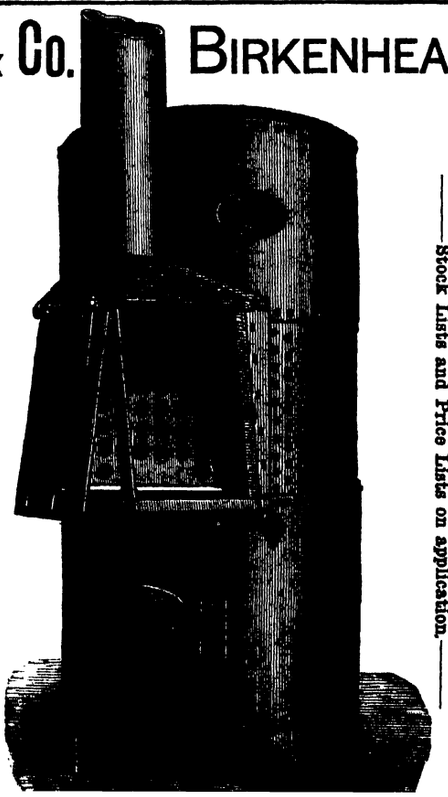
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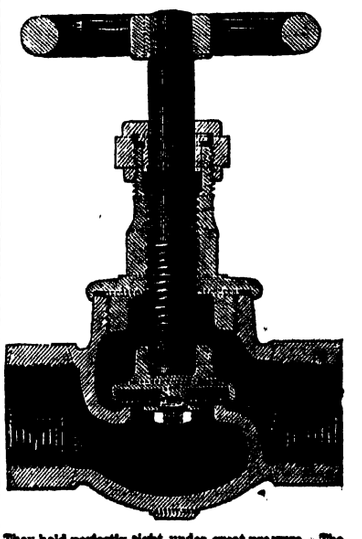
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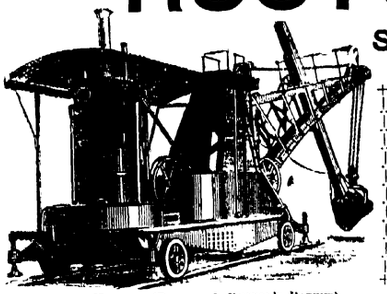
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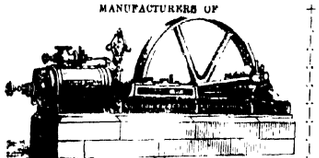
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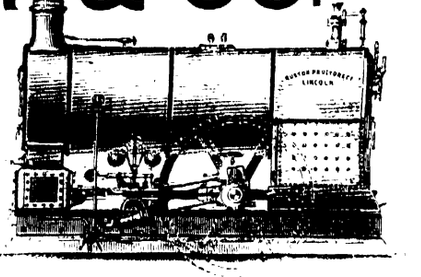
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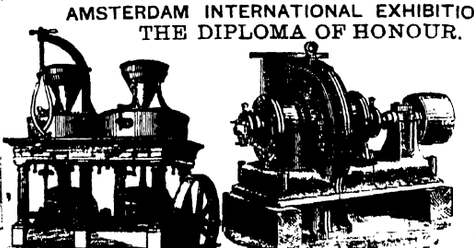
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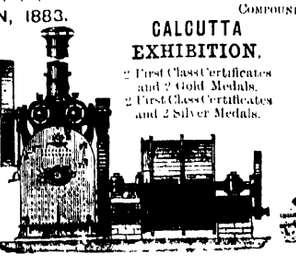
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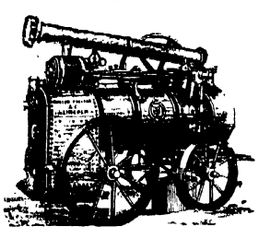
STEAM THRASHING MACHINERY



CORN GRINDING MILLS. CENTRIFUGAL PUMPS.



MINING MACHINERY.



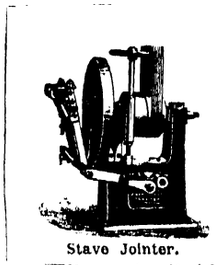
PORTABLE ENGINES.

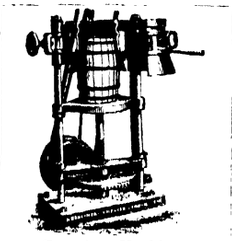
Catalogues, with full details of the above and other SPECIAL MANUFACTURES on application. 4891

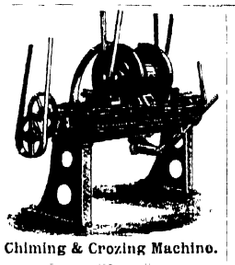
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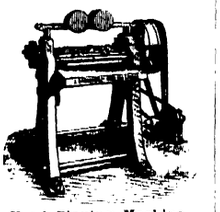
PATENTEES & SOLE MANUFACTURERS,


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Trussing Machine.


Chiming & Crozing Machine.


Head Jointer.


Head Planing Machine.

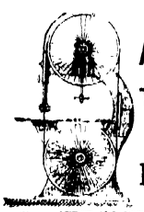

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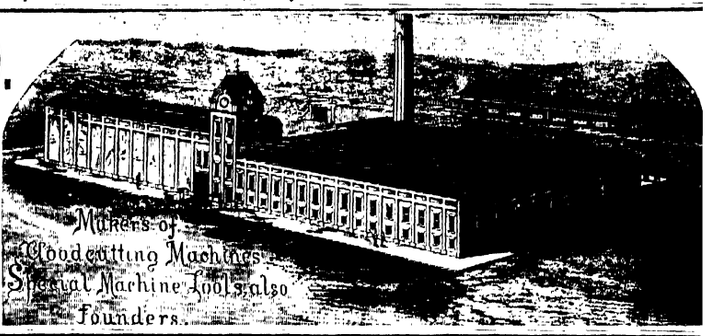
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Great Improvement in the Manufacture of Italian Asbestos for the Joints of Steam, Water, and other Pipes.

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This material continues to be in large demand for Steam Joints of every description, but is specially recommended for Joints where there is any Lodgment of Water, Hot and Cold Water Pipes, &c., &c. GREAT DURABILITY is ensured by the use of ITALIAN ASBESTOS CLOTH, whilst the India-Rubber in combination renders the Packing more elastic and specially suitable for Unfaced Joints. The Sheeting is sold in continuous rolls up to 50 yards long, or in sheets 36 inches or 40 inches square, any thickness from 1-16th inch. The advantage of the Tape is that WASTE IS AVOIDED in making the Joint, and it can be easily bent into position without puckering. Sold in 100 feet rolls, from ¾ to 2½ inches wide, and from ⅛ in. thick. Washers in all standard sizes, and for Manhole Doors, 16 inches by 12 inches by ⅛ inch. By applying a little Plumbago these Joints can be broken and re-made with the same material almost any number of times.

OUR PURE ITALIAN ASBESTOS MILLBOARD

Continues to maintain its high reputation for all Dry Steam Joints. Rings of all standard sizes kept in stock; other sizes cut to order.

NEW ITALIAN ASBESTOS ROLLED CLOTH PACKING,

WITH INDIA-RUBBER CORE. (FIG. No. 1)



FIG. No. 1.

This is similar to "Tuck's" Packing, except that it has the great advantage of being made of fine ITALIAN ASBESTOS CLOTH instead of ordinary canvas, which is soon destroyed by the heat. Specially recommended for Steam Hammers, Winding and Pumping Engines, and for Hydraulic Work.

ITALIAN ASBESTOS CLOTH PACKING

(SQUARE), WITH INDIA-RUBBER BACK. (FIG. No. 2)

This Packing is composed of the same materials as those employed in the construction of the *round* Packing (Fig. No. 1). Both Packings are remarkable for their thorough efficiency and durability, and are recommended for H.P. Engines with the fullest confidence. The square Packing consists of a base of soft vulcanised india rubber, upon which there are built up edgewise a number of layers of thick Italian Fibrous Asbestos Cloth. Sufficient elasticity is thus imparted by the rubber back, whilst great durability and protection to the rubber is ensured by the use of Asbestos in place of more perishable fibres and substances used in this well known and approved form of Packing.

The Packing should be lubricated before being put into the gland, and screwed up very lightly in the first instance, as, being principally composed of Asbestos, which is a mineral substance, it expands with the heat of the steam, and so makes itself tight. A little Powdered Black Lead rubbed over the surface of the Packing is also an advantage. This also applies to the *round* Packing.

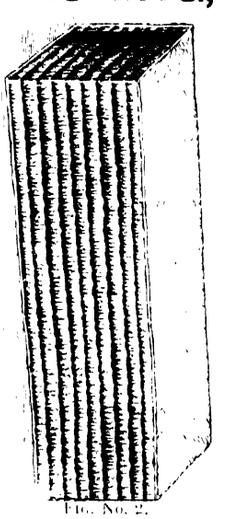


FIG. No. 2.

PURE ITALIAN ASBESTOS PATENT WOVEN PACKING FOR GLANDS.

The following refers to the above Packing:—

THE STANDARD IRON WORKS, COLCHESTER,
10th September, 1883.

To the UNITED ASBESTOS COMPANY, LIMITED.

DEAR SIRS,—After having used your Asbestos Packing for a considerable time, we are quite satisfied and pleased with the results. It is a decided advance in this direction.—Yours faithfully,

DAVEY, PAXMAN & CO.

N.B.—This Packing was used in all Davey, Paxman & Co.'s Engines employed at the Crystal Palace Electric Exhibition in 1882-83 and at the International Fisheries Exhibition, South Kensington, 1883.

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This is the best and most durable non-conducting composition known. It is sent out in 5 cwt. casks, with full directions for use, and very quickly saves its cost in fuel. One cwt. will cover approximately 25 square feet of surface 1¼ inch thick. The following Testimonial has been recently received:—

MESSRS. THE UNITED ASBESTOS COMPANY, LIMITED.

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DEAR SIRS,—We have pleasure in stating that the Asbestos covering supplied by you for our Boilers and Steam Pipes gives us entire satisfaction, and we find it a considerable saving in fuel, in addition to preventing the condensation of the steam between Boilers and Engines.

Yours truly, for the Beaufort Tin Plate Company, DAVID DAVIES.

ADMIRALTY CONTRACT FOR ASBESTOS PACKING.

After making severe critical examinations and tests of the goods of five competing firms, the LORDS of the ADMIRALTY have recently selected the COMPANY'S PACKING for use in Her MAJESTY'S NAVY. The following letter refers to the Asbestos Rolled Cloth Packing with India Rubber Core:—

GREAT WESTERN RAILWAY, MARINE SUPERINTENDENT'S OFFICE, NEW MILFORD, June 10th, 1884.

DEAR SIRS,—In continuation of the latter part of my letter of 16th ulto. relating to some round packing of yours that we have had on trial, I now write to say that for funnions we have found it very satisfactory, and so long as it continues to give equally good results it is my intention to supply it to such of our Steamers as have oscillating engines. The orders will come to you through the stores department.

The United Asbestos Co., 161, Queen Victoria Street, London.

Yours truly, SQUIRE S. LUCKY.

SEE LAST ISSUE FOR PARTICULARS OF OUR ASBESTOS PATENT FIRE-PROOF AND OTHER PAINTS.

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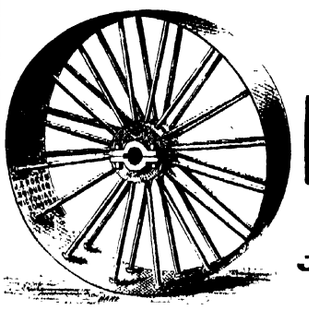
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MANCHESTER—12, LANCASTER AVENUE.
LIVERPOOL—27, WATER STREET. 5031
SUNDERLAND—6, Tavistock Place, Borough Rd.



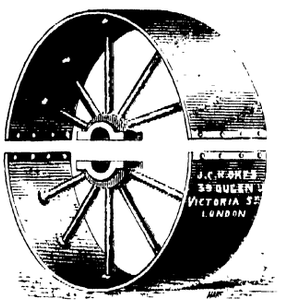
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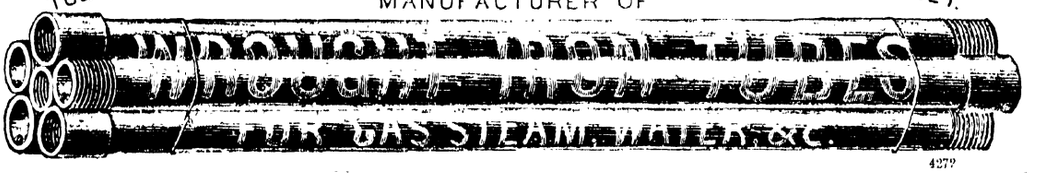
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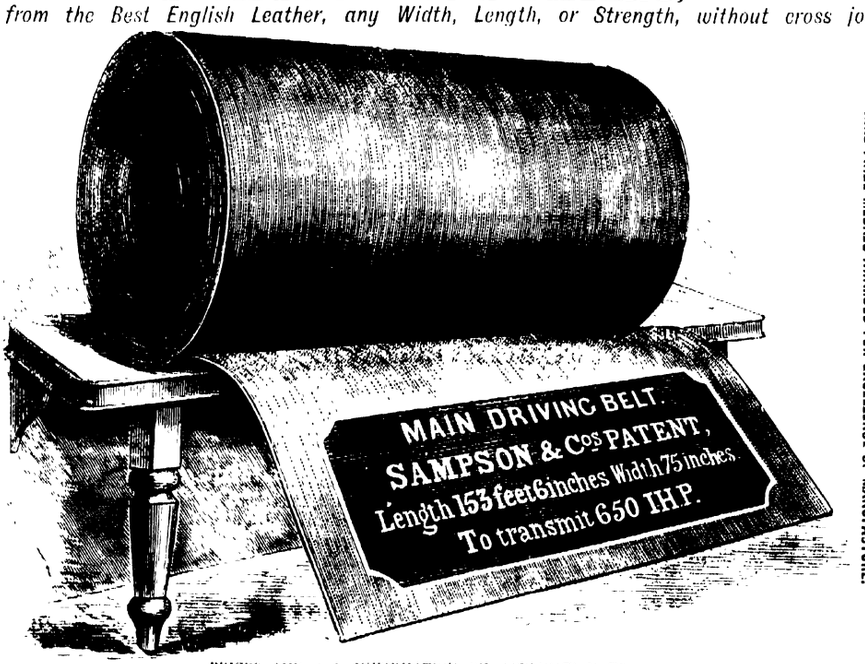
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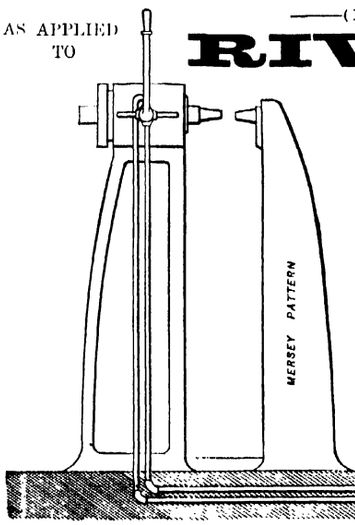
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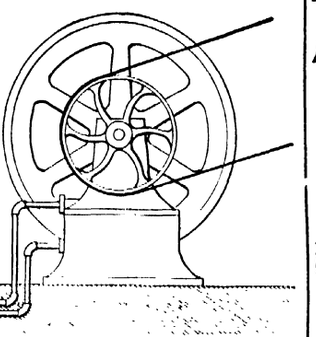
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2nd. The power required to drive the Pump 70 per cent. less than any other system.

3rd. The working pressure in each machine easily varied to suit different classes of work.

4th. The weight of a complete plant is about one-third of any other Hydraulic system.

5th. The first cost of a complete plant is considerably less.



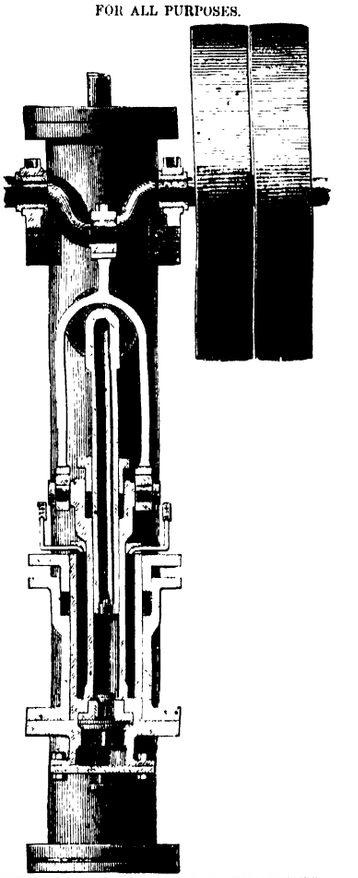
Patentees and Sole Manufacturers,

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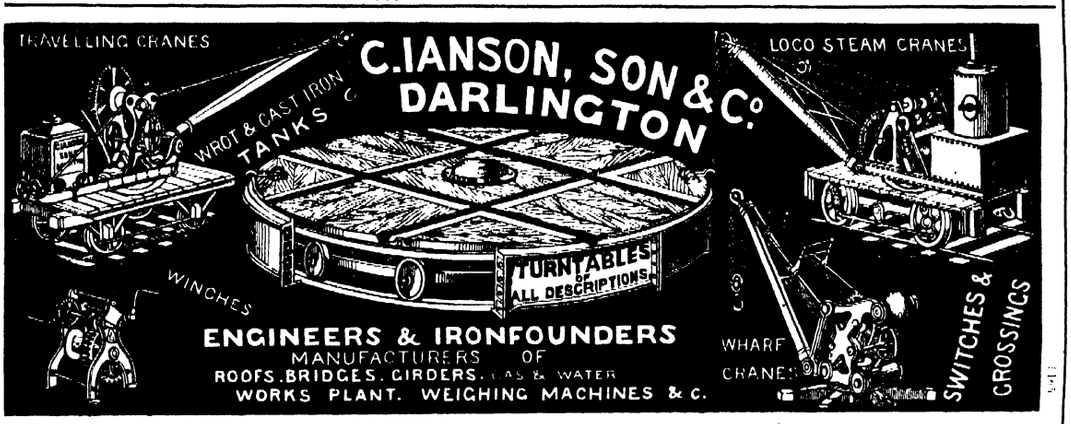
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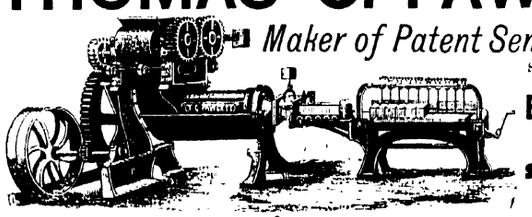
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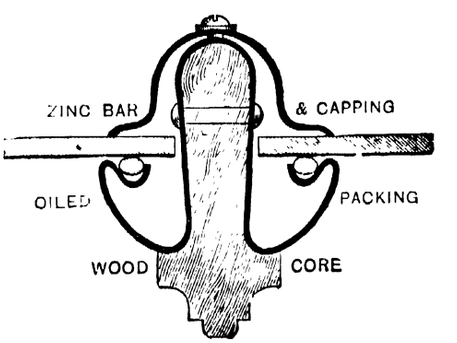
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MODELS AND SECTIONS ON VIEW. 5112



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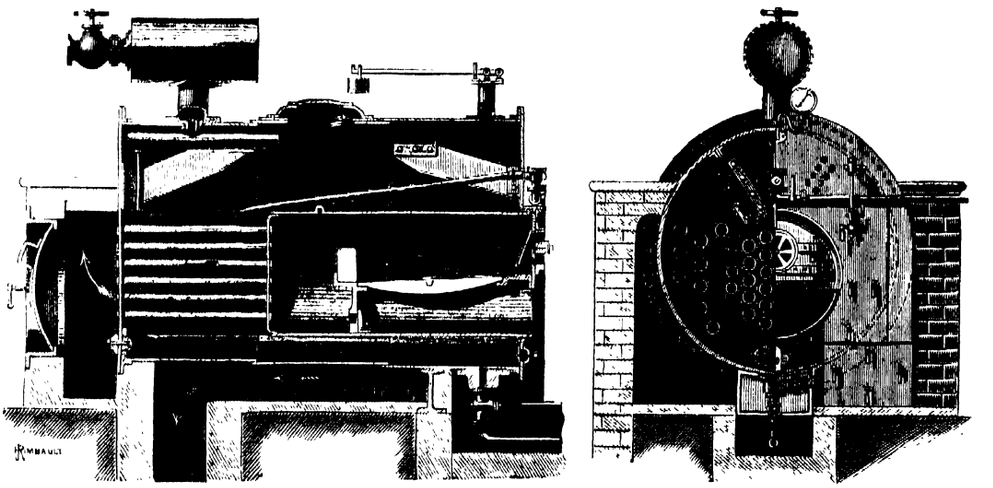
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SOLE MAKER OF

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BY ROYAL LETTERS PATENT.

Well Adapted for Export.



Suitable for every description of work.

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Steady in work, no priming, easily accessible all over for inspection, requires no expensive brickwork setting. Confidently recommended to all users of Steam Power as the most economical and effective Steam Generator yet introduced.

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Calcutta, 1884.—HIGHEST AWARD.



THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

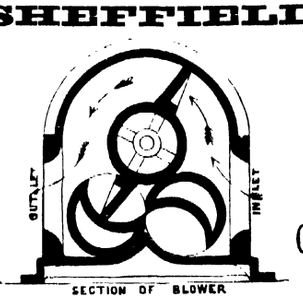
Baker's Patent Rotary Pressure

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BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

Blower and Gas Exhauster

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HALL'S PATENT STONE BREAKER.

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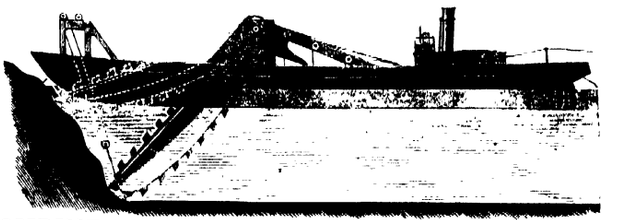
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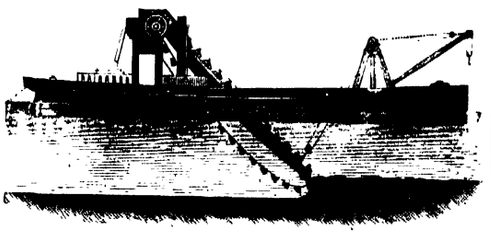
DREDGERS for River Bar, Dock, Canal or Harbour.

LAND DREDGERS or **EXCAVATORS**, for Dock, Canal, or Railway Cutting.





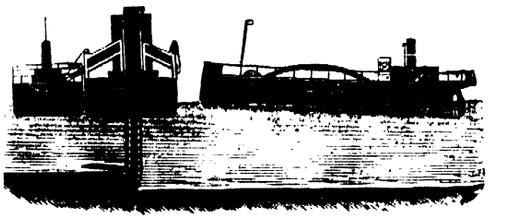
COMBINED DREDGER & HOPPER. All the Plant contained in one Hull, on the most improved principle, designed to cut its own way, and fitted for Towing, Fire Engine, or other Harbour uses.



PARTICULARS ON APPLICATION TO

FLEMING & FERGUSON

PAISLEY, N.B. 5102



JOHN MARSHALL & SONS,

GLASGOW TUBE WORKS, GLASGOW,

MANUFACTURERS OF

LAPWELDED IRON BOILER TUBES

FOR MARINE, STATIONARY, AND LOCOMOTIVE BOILERS, &c. 4751

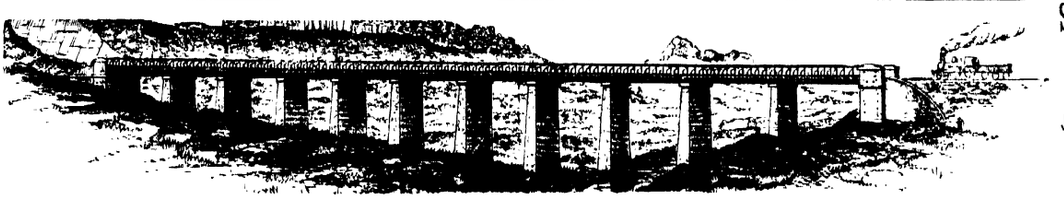
WROUGHT IRON AND STEEL TUBES OF EVERY DESCRIPTION.

JAMES GOODWIN & Co.,

Ironfounders, Bridge Builders, Engineers, & Boiler Makers,

MOTHERWELL NEAR GLASGOW.

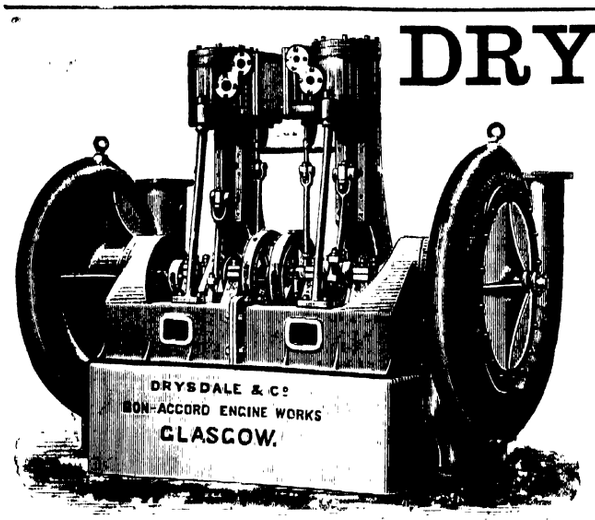
MAKERS OF
Cast Iron Chairs, Cast Iron Sleepers.
COLUMNS, TANKS,
Ingot Moulds, and General Castings.



VIADUCT AT HIGH BLANTYRE, CALEDONIAN RAILWAY. LENGTH, 730 FEET. ERECTED 1882.

SOLE MAKERS OF
HOPE'S PATENT
Stone Breakers.
—10.—
Foundries also at
Ardrossan, Ayrshire,
AND
Johnstone, Renfrewshire.

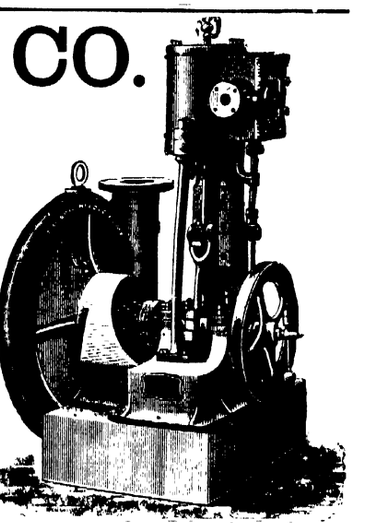
MAKERS OF IRON ROOFING AND GENERAL STRUCTURAL WORK.



DRYSDALE & CO.

LONDON ROAD, GLASGOW.

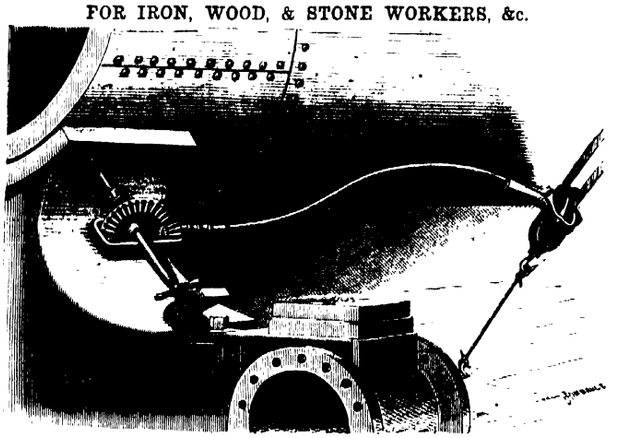
DIRECT-ACTING
Vertical Centrifugal
PUMPING ENGINES
FOR
Circulating or Ballasting Purposes.



RECEIVED AWARD AT THE NORTH-EAST COAST EXHIBITION, TYNEMOUTH, 1882. 4981

THE "STOW" FLEXIBLE SHAFT.

FOR IRON, WOOD, & STONE WORKERS, &c.



Transmits rotary motion in any direction from motive power, so that the power can be brought to the work instead of the work to the power.

BOLLING & LOWE, 2, LAURENCE POUNTNEY HILL, LONDON.

Representatives of the "Stow Company, Limited," for Great Britain and the Continent.

PATENT EXPANDING MANDRELS

To run in Lathe Centres as shown.

PULLEYS, BUSHES, GEARS AND COLLARS

Can be Turned QUICKER and TRUER than on solid Mandrels



Our Expanding Mandrels are applied to

LATHES,

Milling & Wheel-Cutting MACHINES.

Sizes, to hold from ¼ in. to 6 in. 4694

USED AT THE ROYAL ARSENAL, WOOLWICH, AND BY MANY MACHINE AND TOOL MAKERS.

H. B. BARLOW & CO., Engineers, Cornbrook Works, MANCHESTER.

NUMBER ONE

THE LANCASTER STEAM TRAPS

WILL BE EXHIBITED AT THE ABOVE STAND AT

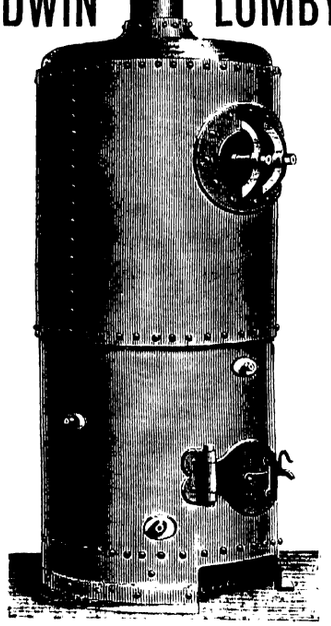
Textile Trades Exhibition,

AGRICULTURAL HALL, LONDON.

LANCASTER & TONGE, 4335

Engineers and Brassfounders, **PENDLETON,** near **MANCHESTER,** Patentees and Sole Makers.

EDWIN LUMBY, SON & WOOD,



WEST GROVE WORKS,

HALIFAX,

Manufacturers of

WROUGHT WELDED,

AND

RIVETED

STEAM BOILERS

(Cross Tubes & Multitubular).

ALSO

WROUGHT WELDED AND RIVETED

BOILERS

FOR

Hot Water Heating Apparatus.

HOT WATER VALVES.

FIRE & BURGLAR PROOF SAFES.

GOLD AND SILVER MEDALS, PARIS EXHIBITION, 1878. 6097

Illustrated Price Lists on application.

W. BOAZ'S PATENT BOILER TUBE CLEANER



THIS SCRAPER is acknowledged by all the leading Engineers to be the most durable and effective Scraper that has ever been brought before their notice.

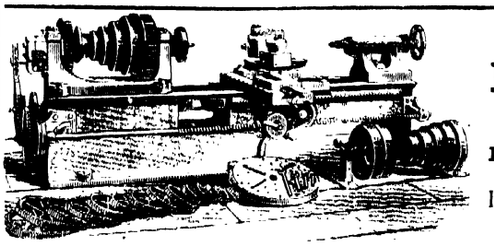
In ordering please state inside diameter of tubes.

PRICE LIST —

Upto 2in. 2¼in. 2½in. 2¾in. 3in. 3½in. 3¾in. 4in diam.

3- 3/6 4- 4/6 5- 5/6 6- 6/6 7- each

WORKS:—29, WEST INDIA DOCK ROAD, LIMEHOUSE, LONDON, E. 5258



SPECIALITY IN LATHES.

SMITH & WILSHAW,

HALIFAX, ENGLAND

Makers of all kinds of

Improved Self-Acting, Sliding, and Screw Cutting Lathes,

For Foot or Power. 4668

FRANCIS BERRY & SONS,

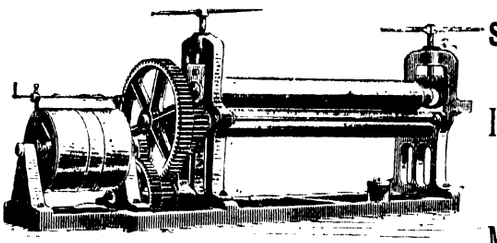


PLATE BENDING MACHINE.

SOWERBY BRIDGE, ENGLAND,

Ironfounders, Engineers, AND **Machine Tool Makers** 4701

WOOD ENGRAVING

Draughtsmen & Engravers on Wood

HARE & Co

31 ESSEX STREET STRAND LONDON

ESTIMATES ON APPLICATION

AIR INJECTORS



FOR ALL PUMPING ENGINES.

Beating Valves rendered noiseless.

LIVERPOOL CORPORATION WATER WORKS,
DALE STREET, LIVERPOOL, August 24th, 1880.

DEAR SIR,—Referring to your letter of the 23rd instant, I have much pleasure in stating that the two Air Injectors supplied for the Liverpool Pumping Stations have been in use about two years, and that during that time they have acted satisfactorily and have maintained a uniform volume of air in the air vessels.—Yours truly,

GEORGE H. DEACON.

WILLIAM TURNER,

Late OMMANNEY & TATHAM, 4873

SALFORD, MANCHESTER.

INTERNATIONAL EXHIBITION, AMSTERDAM, 1883.

HIGHEST AWARD FOR "LIFTS."

HOISTING MACHINERY.

Patented in Great Britain and Ireland, Germany, France, Belgium, and the United States.

SAFETY "Self-Sustaining" { SACK, DINNER, WAREHOUSE, INVALID, AND PASSENGER, } **LIFTS.**

SINGLE and DOUBLE, for HAND, GAS, and STEAM power.

4179

THOS. THOMAS & SONS, "Acme" Hoist Works, CARDIFF.

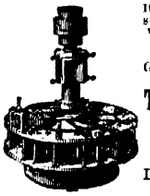
W. C. BAGNALL
STAFFORD



LOCOMOTIVES
PORTABLE RAILWAYS
TRUCKS AND WAGONS
4840

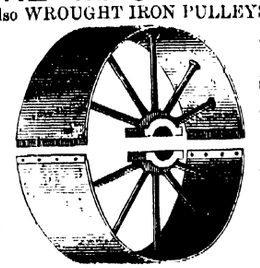
ORMEROD, CRIERSON & CO.,
St. George's Ironworks, Hulme, Manchester,
Have the largest assortment in the trade of
PATTERNS OF SPUR WHEELS, BEVEL WHEELS, AND MITRE WHEELS, WITH TEETH CUT BY MACHINERY.
Also Fly Wheels, Driving Pulleys, and Drums can be supplied Bored and Turned if required.
Catalogues on application. Also Manufacturers of Blast Engines, Colliery and other descriptions of Stationary Engines and Boilers, Mill Gearing Cranes, and Turntables, &c
London Office: 5, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W. 4710

IMPROVED AND ECONOMICAL APPLICATION OF WATER POWER.
LEFFEL'S IMPROVED PATENT
AMERICAN
Double Turbine Water-Wheel.



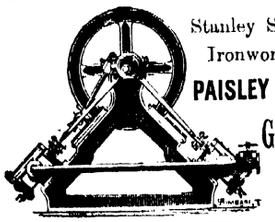
It is applicable to all heights of fall giving the greatest amount of power with the least consumption of water
OVER 10,000 IN USE,
Giving over 400,000 HP
Thos. McKenzie & Sons, LIMITED,
16, Holborn Viaduct, LONDON, E.C.;
DUBLIN and BELFAST.
SOLE AGENTS FOR EUROPE FOR 5116
JAMES LEFFEL & CO.

GEORGE CROSSLEY,
ALBION MACHINE WORKS,
CLECKHEATON, YORKSHIRE.
Maker of all Descriptions of
WIRE MACHINERY.
Also WROUGHT IRON PULLEYS,



London Office: DUNCAN BROS., 32, Queen Victoria Street, LONDON, E.C.
With Single or Double Arms and Cast-Iron Bosses (which for CHEAPNESS, LIGHTNESS, and STRENGTH are UNSURPASSED.) Price List on Application. 4411

SMITH & JOHNSTON,
ENGINEERS AND MILLWRIGHTS,



Stanley Street Ironworks,
PAISLEY ROAD,
Glasgow
MAKERS OF
SMITH'S PATENT STEAMING MACHINE
Do. do. CALICO DRYING do.
Do. do. YARN do. do.
Do. do. SOAPING do.
Steam Engines of every description to drive one or more of the above machines, fitted with One, Two, or Three Cylinders.
SPECIAL QUOTATIONS GIVEN,
Also references to firms in England and Scotland where these Machines are working. 4355

Effects a Saving on Application.



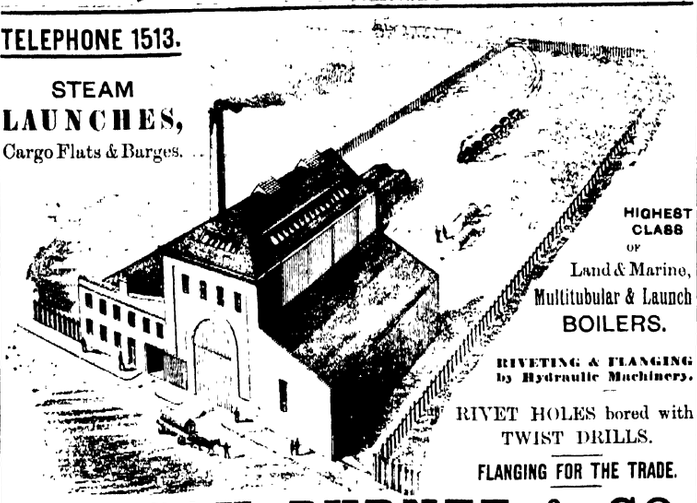
Testimonials of 50% over Oil.
WASHINGTON BUILDINGS, 4238
23, BRUNSWICK STREET, LIVERPOOL.

THE DARLINGTON STEEL & IRON CO., LTD.
BESSEMER STEEL RAILS from 10 to 84 lbs. per yard.
STEEL AND IRON FISH-PLATES,
PATENT FLEXIBLE, CLIP, ANGLE, AND OTHER SECTIONS.
— ROLLED STEEL SLEEPERS. —
STEEL TRAM RAILS, A SPECIALITY.
STEEL ANGLES, TEES, CHANNELS, BULBS, and BARS of other SECTIONS,
For Shipbuilding and Constructive purposes.
Guaranteed, if required, to stand the Admiralty or Lloyds' Tests.
STEEL CASTINGS OF ALL DESCRIPTIONS.
Offices { LONDON: 3, VICTORIA ST., WESTMINSTER ABBEY, S.W. Messrs. THOMSON & BROWNING, Agents.
MANCHESTER: 27, CORPORATION STREET, Messrs. BARNINGHAM BROTHERS, Agents. 5109

TUBES
SILVER MEDAL, MELBOURNE, 1881.
TUBES and FITTINGS for Gas, Steam, and Water; Galvanised, Enamelled, and Hydraulic Tubes; Boiler Tubes and Fittings, Gasfitters' Tools, Brass Cocks. Anti-Corrodo Tubes and Fittings coated by Barff's Rustless Process.
JOHN SPENCER,
GLOBE TUBE WORKS, WEDNESBURY
And 3, Queen Street Place, London, E.C. 4892

ROBERT HARVEY & COMPY.
(Late D. COOK & Co.)
COLONIAL ENGINEERS,
Park Grove Iron Works,
GLASGOW,
Makers of
Sugar Machinery.
ALSO
STEAM HAMMERS,
Shipbuilders' and Boilermakers' Tools. 4734
PATENT STEAM & HYDRAULIC RIVETTING MACHINERY.

TELEPHONE 1513.
STEAM
LAUNCHES,
Cargo Flats & Barges.



HIGHEST CLASS OF
Land & Marine, Multitubular & Launch BOILERS.
RIVETING & FLANGING by Hydraulic Machinery.
RIVET HOLES bored with TWIST DRILLS.
FLANGING FOR THE TRADE.
LINDSAY BURNET & CO.,
MOORE PARK BOILER WORKS, GOVAN, GLASGOW. 4934

CRANE'S PATENT OIL
FOR
CYLINDERS AND VALVES.
As Supplied to H. M. Navy and the Principal Steamship Companies.
Manufactured solely by
P. MOIR CRANE & Co.,
BANK STREET, MANCHESTER;
4, James Street, Liverpool; and 131, Fenchurch Street, London, E.C.



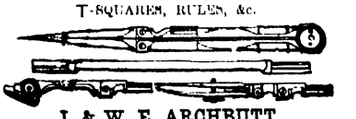
TRADE MARK.
PROVED to be the BEST OIL by the EVIDENCE before the COMMITTEE appointed by the LORDS COMMISSIONERS of the ADMIRALTY.
FREE from ACID, leaves no DEPOSIT in the CONDENSERS, PRESERVES the BOILERS and SAVES FUEL.
All oils except those covered by Crane's Patent become acid in passing through the high-pressure cylinders, and consequently corrode boilers, leaving at the same time Deposits in the internal part of the machinery.
AGENTS—GEO. E. PHILIP, 18, Renfield Street Glasgow; G. A. BUSHELL, Lombard Street, Quayside Newcastle-on-Tyne, R. BARTON, 18, Commercial Road Hull 4904
N.B.—As parties are imitating P. Moir Crane & Co.'s Advertisements and Circulars, and offering Oil for Cylinders and Valves professing to give the same results as Crane's Patent Oil, the Patentees distinctly state that their Patent Rights cover the use OF ALL THE CLASS OF OILS which give these results, and that for their own security they must proceed against those infringing Crane's Patent Oil, the quality of which is fully established, can be obtained at about the same price as the imitations of it.

PRICE'S
THAMES AND MERSEY
LUBRICATING OILS.

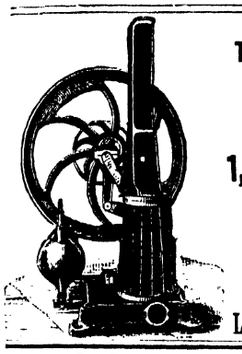


Trade *Mark.*
PRICE'S SPECIAL GAS ENGINE OIL,
Strongly recommended by MESSRS. CROSSLEY BROS., LTD, MANCHESTER.
PRICE'S COMPOUND ENGINE OIL,
For Marine Engines and Locomotives.
PRICE'S SHERWOOD SPERM OIL,
For General Machinery.
PRICE'S CYLINDER OILS.
PRICE'S BELMONT SPINDLE OIL.
PRICE'S RANGOON OIL.
As recommended by
THE WAR OFFICE AUTHORITIES,
"For the preservation of SMALL ARMS and Articles made of Metal from oxidation."
Price Lists on application to
PRICE'S PATENT CANDLE COY., LIMITED,
BATTERSEA, LONDON 5217
BROMBOROUGH POOL, LIVERPOOL.

Mathematical Drawing
INSTRUMENTS, THEODOLITES, LEVELLS, CIRCUMFERENTERS, SCALES, TAPES, CHAINS, T-SQUARES, RULES, &c.



J. & W. E. ARCHBUTT,
201, WESTMINSTER BRIDGE ROAD, LAMBETH, Near Astley's Theatre,
Manufacturers of the above and every description of Surveying Instruments, unequalled for quality and price.
Illustrated priced Catalogues forwarded on receipt of three stamps.
EVERY ARTICLE WARRANTED
Second-hand Instruments of all kinds, by the best makers, always in stock.
Stencil plates in great variety. 840



THE "BISSCHOP" PATENT
GAS ENGINE.
1,700 Engines Working in Great Britain.
J. E. H. ANDREW & CO.,
STOCKPORT. 4161
London Office—123a, QUEEN VICTORIA STREET, E.C.

ALLDAY'S ROOT'S
BLOWERS & EXHAUSTERS
All Sizes in Stock.
SILENT BLOWING FANS, from 1 to 150 Fires, in Stock.

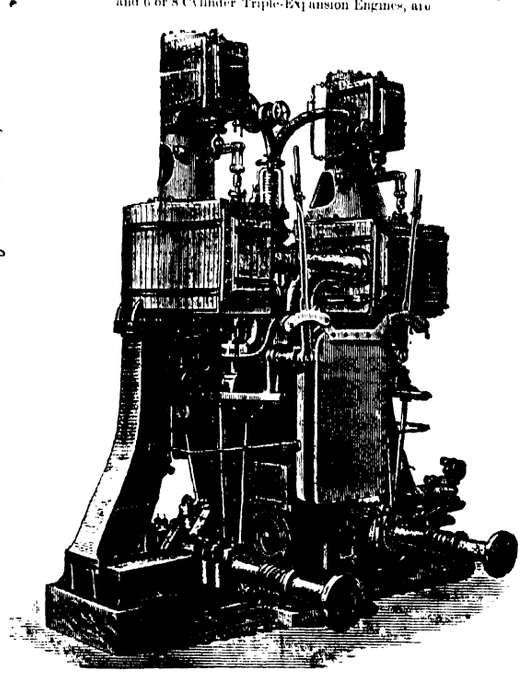


ALLDAY'S
6 ROOT'S PRESSURE BLOWER SIZE N°4 OF THESE BLOWERS WERE SUPPLIED WITH THE 150 N° ATO HEARTHS FOR THE INDIAN STATE RAILWAYS OCTOBER 1882
THE BEST BLOWER IN THE MARKET.—GREAT SAVING IN FUEL AND POWER.
PRICES AND PARTICULARS ON APPLICATION. 4334
Wm. ALLDAY, SONS & CO., Engineers, Birmingham.

RANKIN & BLACKMORE, Engineers,
GREENOCK,
MAKERS OF
Rankin's Patent 2-CYLINDER DISCONNECTING COMPOUND ENGINES
AND
4-CYLINDER DISCONNECTING TRIPLE-EXPANSION ENGINES,
FOR PADDLE AND TWIN-SCREW STEAMERS.

The principal advantages claimed for these Engines, as compared with the ordinary 4-Cylinder Compound and 6 or 8 Cylinder Triple-Expansion Engines, are

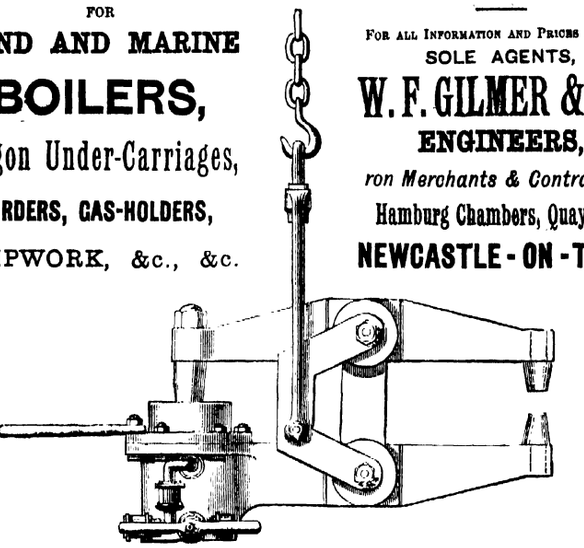
Simplicity of Construction. Economy of Fuel,



Accessibility of Working Parts, Superior Efficiency, and Less Tear and Wear.

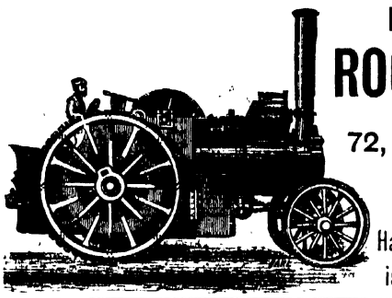
FULL PARTICULARS AND PRICES ON APPLICATION. 5229
For Illustration of 2-Cylinder Paddle Engines, see ENGINEERING of this day Fortnight.

ARROL'S PATENT PORTABLE
HYDRAULIC RIVETTING MACHINES,
FOR
LAND AND MARINE
BOILERS,
Wagon Under-Carriages,
GIRDERS, GAS-HOLDERS,
SHIPWORK, &c., &c.



FOR ALL INFORMATION AND PRICES APPLY TO
SOLE AGENTS,
W. F. GILMER & CO.
ENGINEERS,
Iron Merchants & Contractors,
Hamburg Chambers, Quayside,
NEWCASTLE-ON-TYNE.
4064
LARGE NUMBER IN USE AT HOME AND ABROAD.

TRACTION ENGINES
AVELING & PORTER,
ENGINEERS,
ROCHESTER (KENT),
AND
72, CANNON STREET,
LONDON. 4847

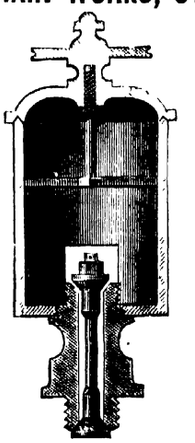


Haulage by Steam on Common Roads is 50 % cheaper than by horses.

WHITEHOUSE & CO.'S
PATENT
Self-Acting Adjustable Lubricator,
TIPTON HALL CHAIN WORKS, STAFFORDSHIRE.

A Clear Saving of 50 per cent. in Oil, Tallow, or Grease.

Cannot get out of order.



Perfectly Clean in working.

One Month's free trial allowed.

SIZES.
2 in., 2½ in., 3 in., 3½ in., 4 in.

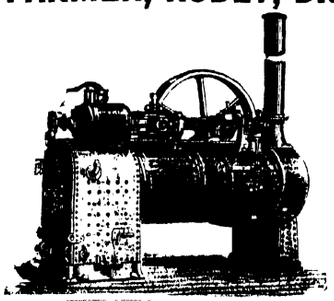
Prices on Application.

Self-acting, with two valves which are set to requisite feed by means of lock-nut, to permit only necessary lubricant to flow. It ceases working with the engine, and remains closed until the engine commences working again, thus effecting every possible saving.

Agents { LONDON: J. C. S. OGG, 13, Crutched Friars, E.C.
MANCHESTER: C. J. BROWN, 7, Exchange Arcade.
LIVERPOOL: HOLT & ADDLINGTON, 24, Fenwick Street. } 5212

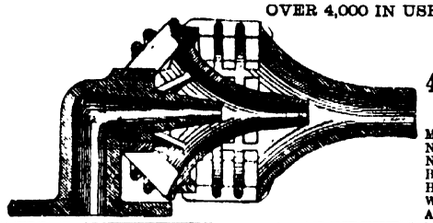
Awarded the SILVER MEDAL at the Worcestershire Agricultural Society's Meeting, 1883, and CERTIFICATE OF MERIT and MEDAL at the Calcutta Exhibition, 1884.

FARMER, ROBEY, BROWN & CO., LIMITED,



TRENT FOUNDRY, GAINSBOROUGH,
London Offices and Show Room:
59-63, QUEEN VICTORIA STREET, E.C.,
MANUFACTURERS OF IMPROVED
Portable & Semi-Fixed Engines
Of extra size and strength per Nominal HP.
THRASHING MACHINES
With Improved Composite Truss Frames.
INDEPENDENT VERTICAL ENGINES,
Improved Sm ck Engines, Steam Boilers, &c.
Illustrated Catalogues and Price Lists
ON APPLICATION. 4603

HIGH PRESSURE MARINE BOILERS.
Best and Cheapest Means of Preventing Unequal Expansion.
"WEIR'S" PATENT HYDROKINETER.
OVER 4,000 IN USE.



G. & J. WEIR,
49, JAMAICA STREET,
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MENZIES & BLAGBURN, KING STREET, NEWCASTLE-ON-TYNE. WM. REID & CO., 5, NEW LONDON STREET, LONDON, E.C. A. & R. BROWN, WATERLOO ROAD, LIVERPOOL. R. HUGHES & CO., FULTON STREET, DITTO. W. S. VON ESSEN, ENGINEER, HAMBURG, AGENT FOR SCANDINAVIA & GERMANY 4670

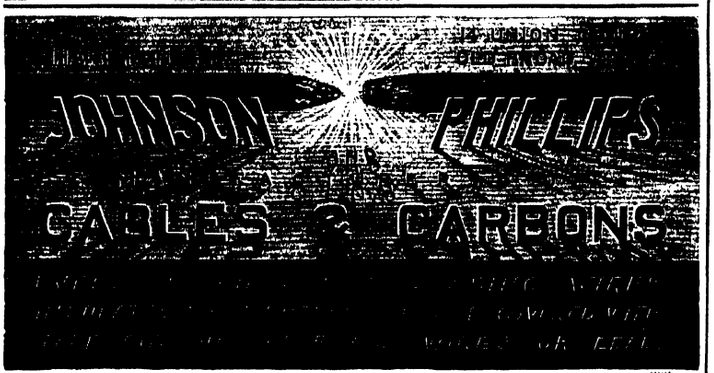
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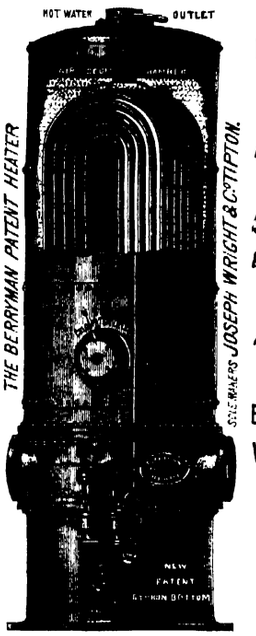
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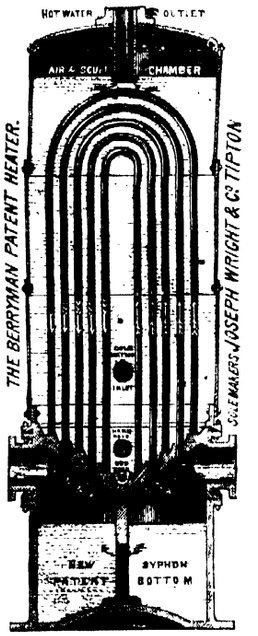


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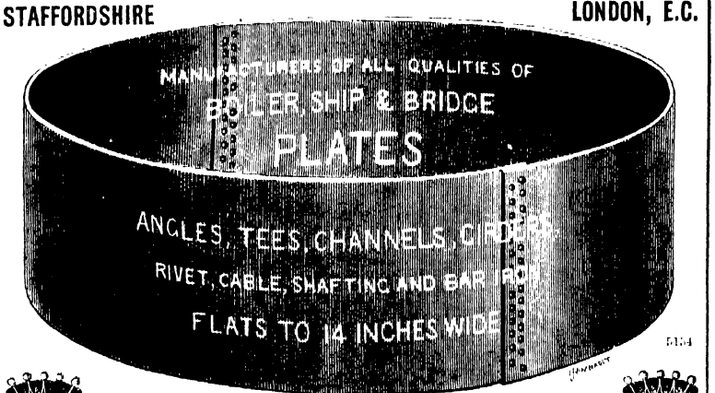
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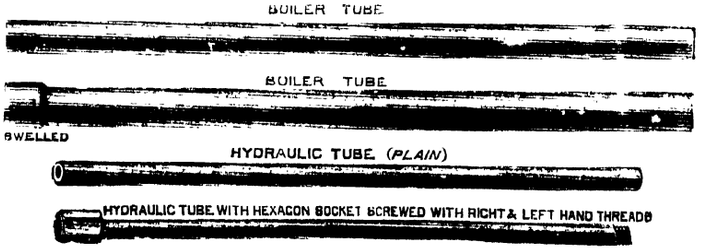
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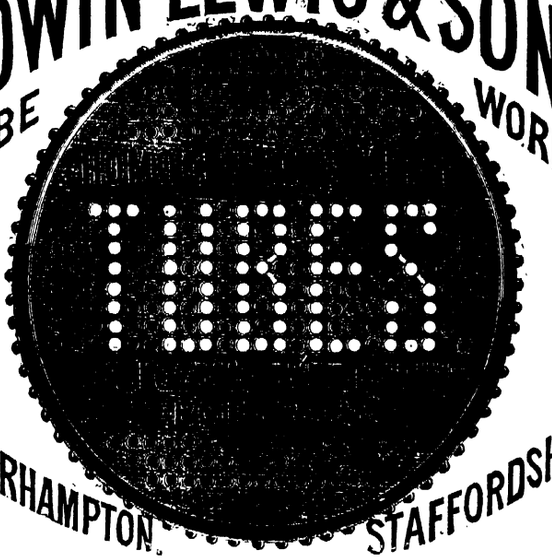
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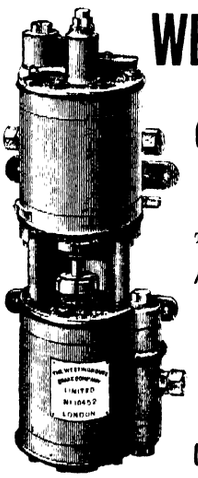
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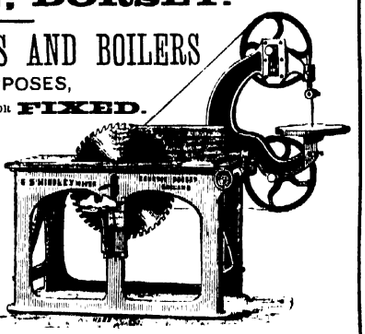
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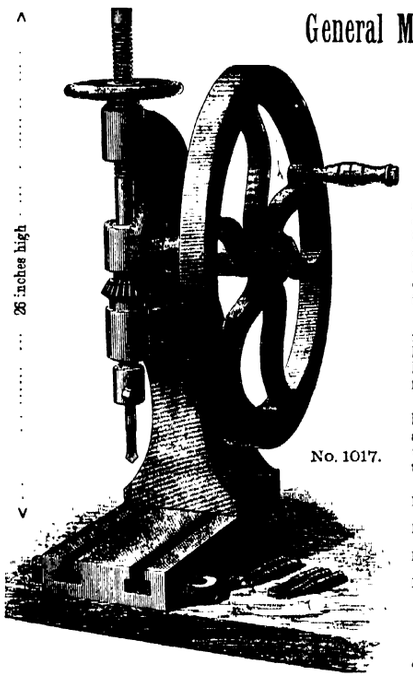
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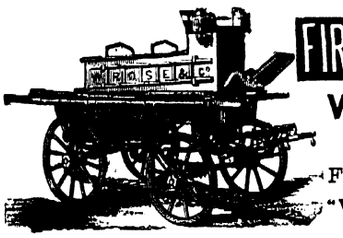
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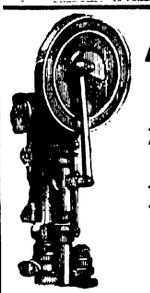
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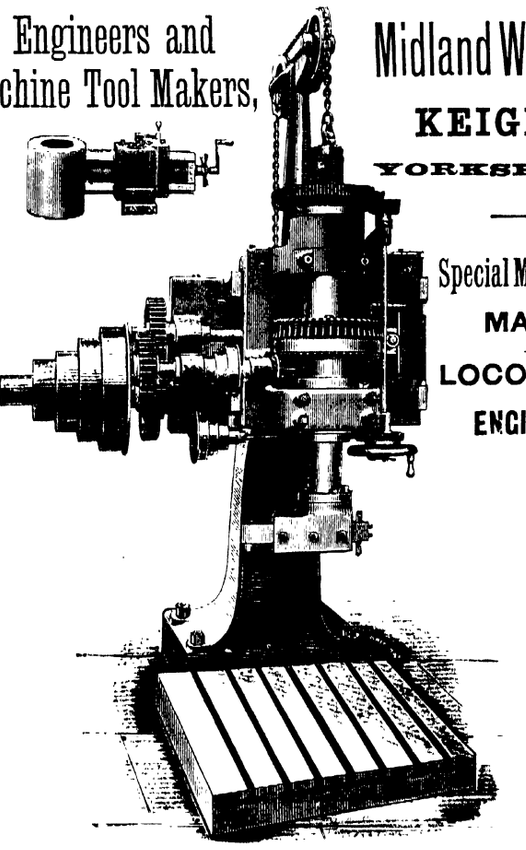
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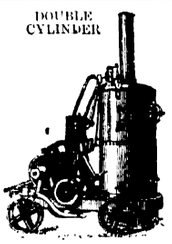
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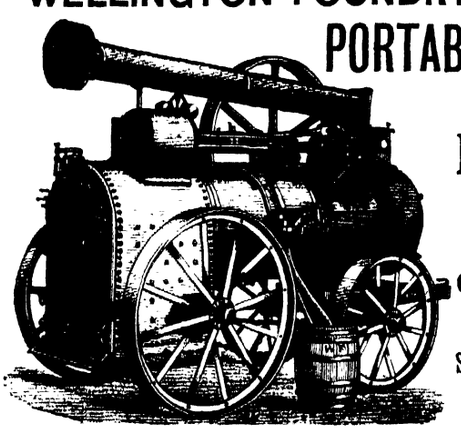
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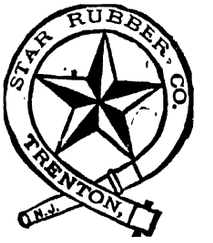
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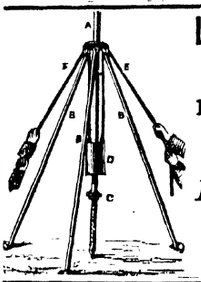
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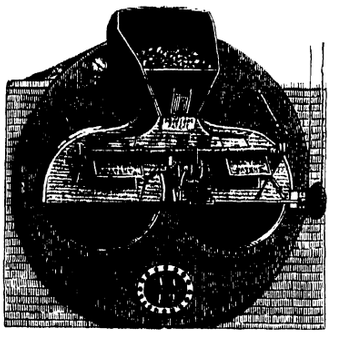
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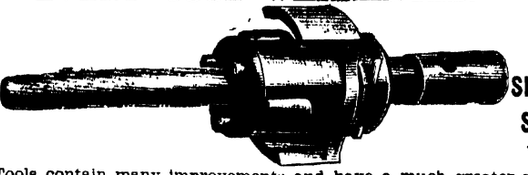
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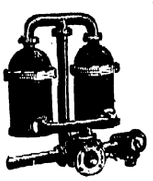
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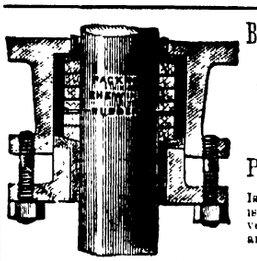
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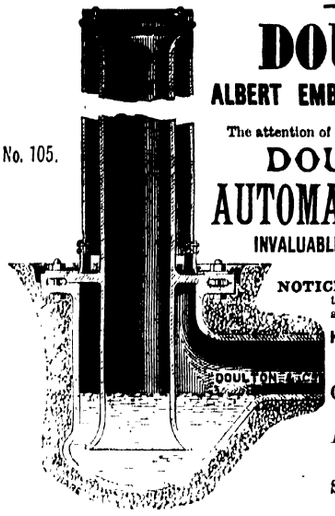
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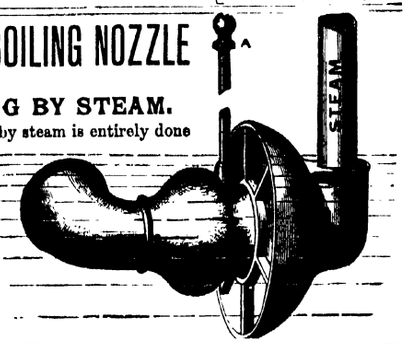
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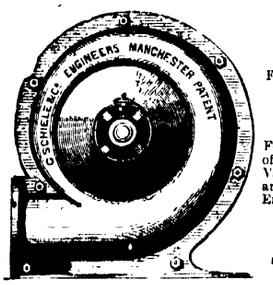
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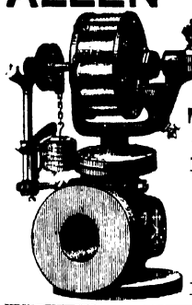
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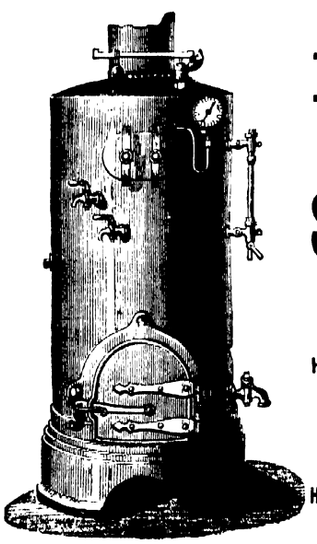
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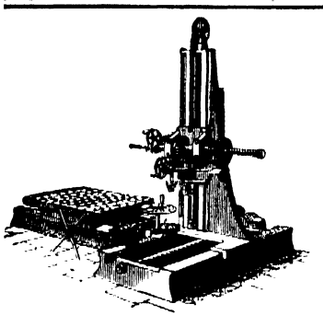
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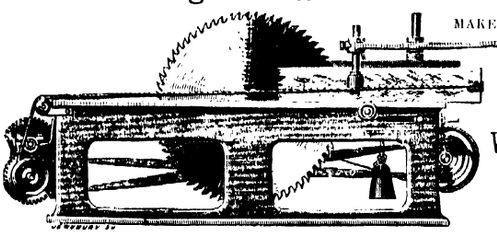
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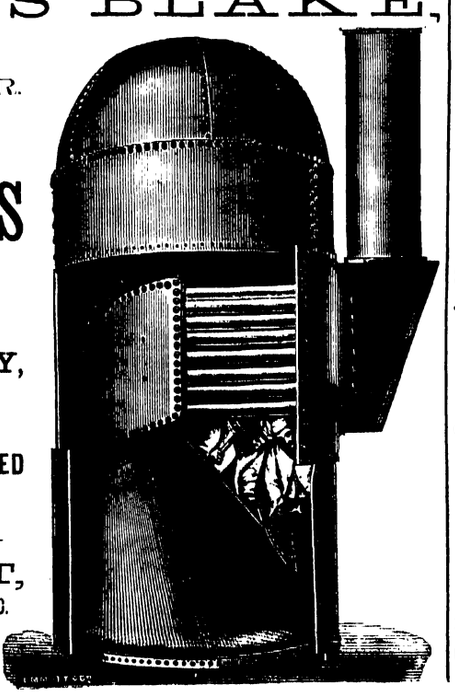
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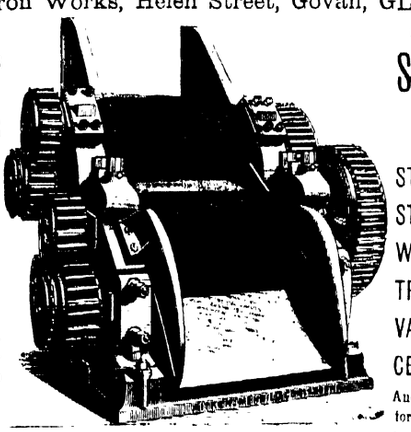
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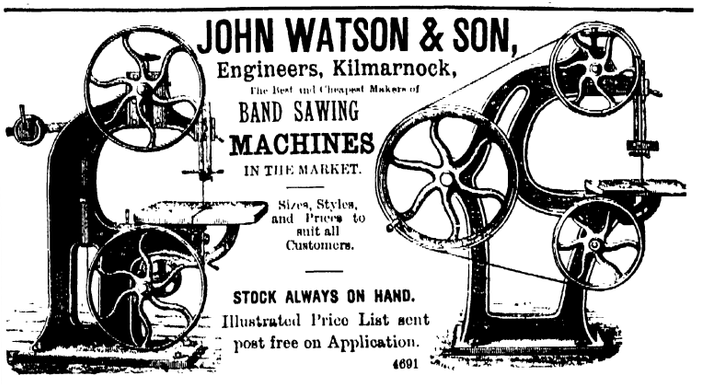
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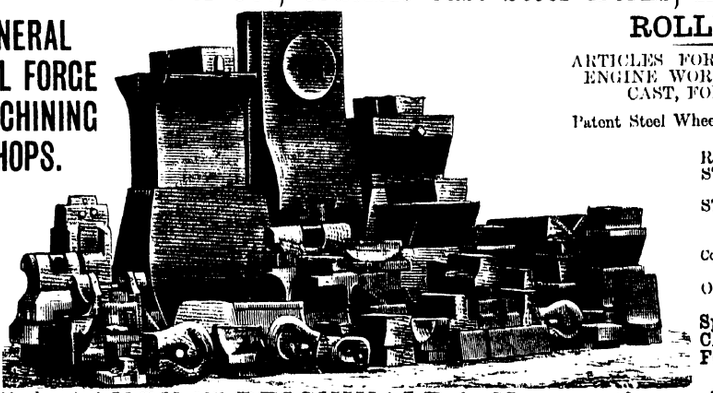
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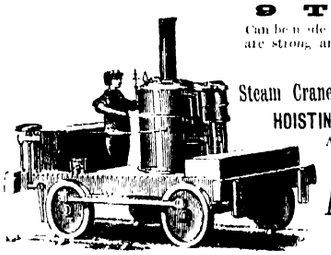
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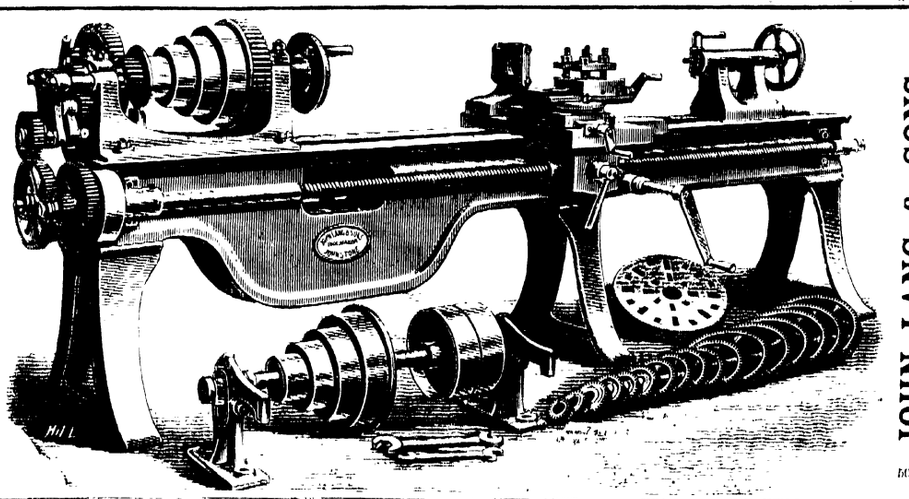


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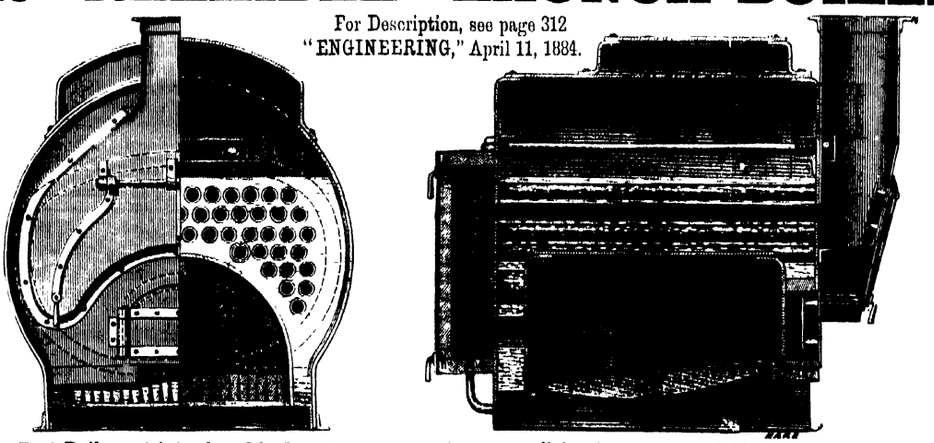


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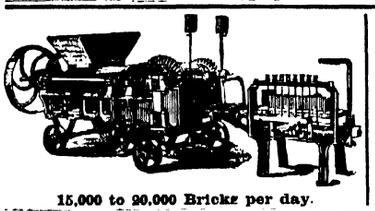
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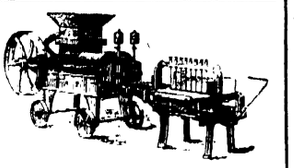
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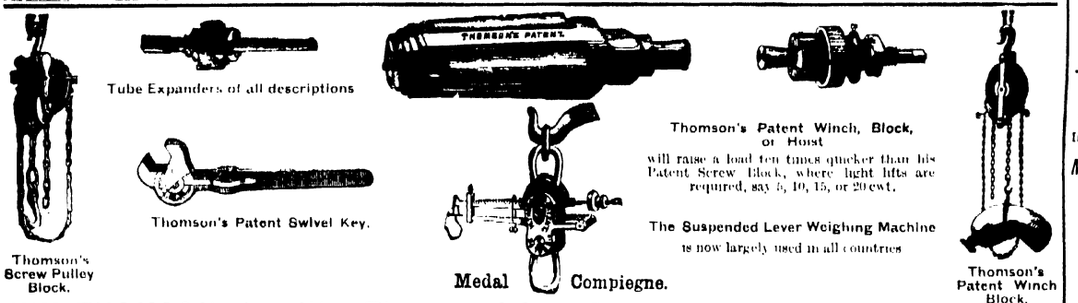
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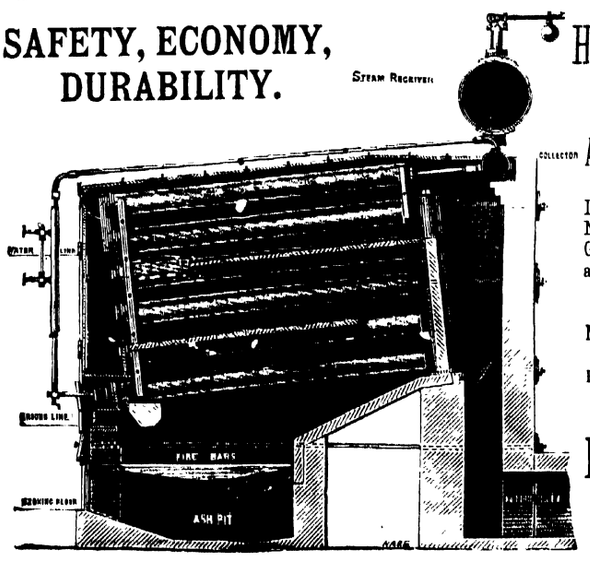
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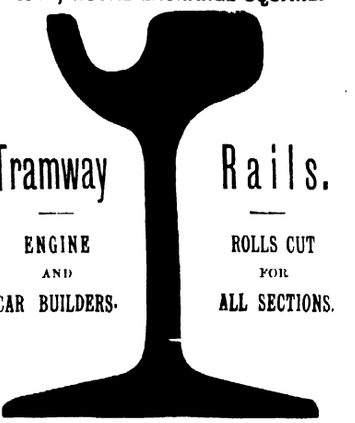
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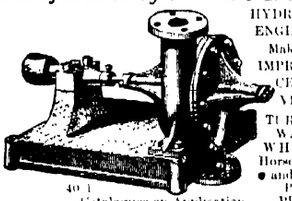
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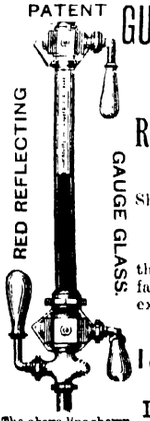
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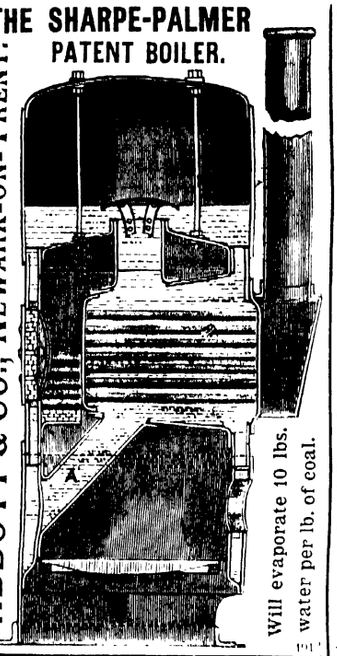
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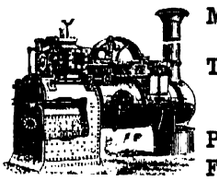
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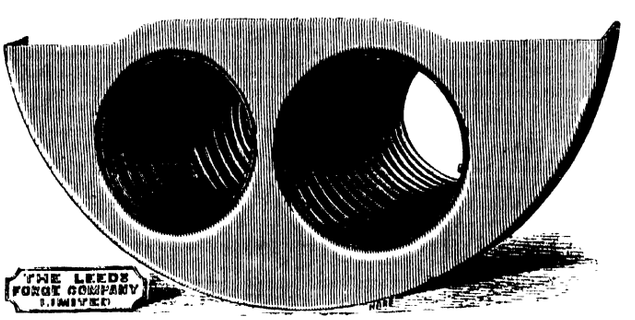
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LITERATURE.

The Nordenfelt Machine Guns Described in Detail and Compared with other Systems; also their Employment for Naval and Military Purposes. Illustrated with Fifty-seven Full-Page Illustrations and Diagrams. Portsmouth: Griffin and Co.; London: Simpson, Marshall, and Co.

This book, written by Mr. Thorstein Nordenfelt for the purpose of bringing his machine guns before the world generally, is full of interest, and though all, perhaps, may not be prepared to agree with the theories enunciated by him, every one must feel that in the invention and construction of the guns here described, no ordinary talent has been displayed.

The first chapter gives a brief sketch of the history of machine guns (which the author describes as having been used as far back as the 15th century, or even earlier), and a statement of the systems of machine guns now in use, namely, "Hotchkiss," "Gardner," and "Nordenfelt." These he takes as the representatives of machine guns generally.

Chapter II. is devoted to a description of the Nordenfelt guns and mechanism, and with the aid of some very fine engravings, the different parts and their working can be easily understood. The guns are classed under three headings.

A. Rifle calibre machine guns.
B. One-inch calibre ,,
C. Shell ,,

and details as to the different circumstances under which each is intended to be used, as well as the mechanical details mentioned above, are given. Tables of weights and dimensions complete the description.

Chapter III. deals with gun carriages and mountings as follows:

A. Naval carriages.
B. Field ,,
C. Special ,,
D. Mountain ,,

The naval and special carriages are particularly good, and indeed it is a recognised fact that Mr. Nordenfelt is well ahead of his rivals (if so we may call Messrs. Hotchkiss and Gardner) in this respect. The rapidity with which the training and elevating can be carried out in the naval carriages, and the ingenious way by which the recoil is absorbed in the special carriage, are particularly striking.

Chapter IV. gives details of ammunition, classified:

A. Rifle calibre ammunition.
B. One-inch calibre ammunition.
C. Shell-gun ammunition.

The base fuze in the armour-piercing shell is noticeable here, since it holds out hopes that ere long we may probably see this system extended to our larger shells. The difficulty in this latter case, has hitherto been to get something strong enough to withstand the shock of discharge, or rather of strength enough to prevent it being forced into the shell by the powder pressure. Since, however, we have here 7 lb. shell fitted with base fuzes, we may soon hope to see that the attempts now being made at Woolwich to apply this principle to all shell, may be successful.

Chapter VI. compares the Nordenfelt and Hotchkiss, and Chapter VII. the Nordenfelt and Gardner systems. It must, of course, be expected that these comparisons are made from the author's point of view, and there would probably be a bias in favour of his own principles. However impartial he may endeavour to be, he always must be able to say more for himself than his opponents, and bring to light many points in his own favour, whereas many of theirs may be hidden. Still a very fair general case is laid before the reader, and when, as doubtless will soon be the case, Messrs. Hotchkiss and Gardner follow the author's example in the way of publishing their experiences, we shall be better able to judge between them. At present we must point out that many foreign nations have adopted Mr. Hotchkiss's system, and that the Gardner rifle machine guns are well known to have been very favourably reported on in the trials in which they have taken part, and indeed form part of the armament of some of our own ships.

Part III., Chapter VIII. In this chapter the general purposes of machine guns in naval warfare are dealt with, and the matter has evidently been well thought out, and carefully considered. The author winds up the chapter with the declaration, "With the exception of the introduction of the Nordenfelt anti-torpedo boat guns, the naval armament of machine guns is most inefficient." Very true, and doubtless the power of ships would be materially augmented by the addition of many sorts of guns and the increase of armour so as to make them quite impervious to projectiles; but, unfortunately, there must be a limit to a ship's displacement, and the increase of weight, were every specialist to follow his own bent in the construction and armament, would soon render the vessel more suitable for resting at the bottom than for navigating the top of the sea.

Chapter IX. We now come to Mr. Nordenfelt's own views as to what naval armaments should be. Space does not permit us to enter deeply into this interesting chapter, which, however, is well worthy of attention. There is one point, nevertheless, to which we must call attention. In considering the lighter armament of our ships Mr. Nordenfelt has confined himself to dealing with seven, nine, and twelve-pounder guns (all of which are more or less obsolete), whereas the gun lately introduced as the light armament, is the 25-pounder rifle breechloading gun. This gun is capable of firing from five to six rounds a minute easily, and under most circumstances would, we think, be certainly more effective than the four or six-pounder he proposes. However, our purpose here is not to enter into an argument as to relative advantages, and we but point out that the comparisons given here have hardly sufficient latitude. As to the rest, our boats' armament certainly requires ameliorating, though we by no means agree with Mr. Nordenfelt's proposal to arm them with a two-barrelled gun incapable of firing shell.

Part IV., Chapters X. to XVII. This part is military, and deals with the guns when used for military purposes. The author lays down the following rules for the employment in the field:

1. Their real accurate range is only exceptionally greater than 1200 yards.

2. They are of special value up to about 800 yards, which is beyond the range of effectively aimed rifle fire, as well as that of case shot, while at this distance shrapnel has not attained its maximum power; that is to say, the angle of dispersion at this range would be too small.

3. They should be kept concealed until the decisive moment for their use has arrived.

4. They should be at once retired as soon as the special object of their attack has been achieved.

5. They should principally be used only against troops in close order.

6. They should be employed against field artillery where from cover or concealment they can open fire on a battery of artillery, specially when limbered up, or in the act of unlimbering or limbering up, also when the galloping machine gun carriage is used.

7. They should not be massed.

The rest of Part IV. is devoted to details as to how and under what circumstances, the different kinds of machine guns should be used, the whole being illustrated.

The foregoing is a brief summary of Mr. Thorstein Nordenfelt's book, and we have no hesitation in saying that it is one of the most valuable works, if not *the* most valuable, that has appeared on machine guns. As we have before pointed out, in questions of comparison, the author naturally prefers his own guns to those of other people, and he would indeed be an exceptional character if he did not. Be this as it may, the work is valuable in the extreme, as giving the results of the labours of one who has more or less devoted his time to the invention and manufacture of these weapons, and who consequently has had to think out the different circumstances which have a bearing on the matter. Furthermore, Mr. Nordenfelt has had the advantage of being constantly in communication with, and knowing the views of, naval and military men of different nations, and so of being able to add to his own theoretical ideas the experience of those who would have the practical working of his guns. Besides this, the constant trials which have taken place, and the competitions that the different systems of machine guns have been engaged in, have all afforded opportunities for practical study. Hence, apart from our own conviction of the value of the work, we have no hesitation in recommending this book to our readers as giving valuable information on machine guns in general and Nordenfelt machine guns in particular. Indeed, if only as a picture book, the work is very valuable, as the plates are magnificent and form a most interesting collection. It must, of course, be understood that we do not at all assert that the Nordenfelt guns are the guns of the day, nor do we profess to agree with all the views laid down. The author expresses certain views, and, as a rule, gives his reasons for entertaining these views. Whether the reasons are valid we leave the reader to judge, but we feel sure that whatever conclusion he may arrive at in this respect, he will find much valuable information and food for thought in "Nordenfelt on Machine Guns."

We must, in conclusion, congratulate Mr. Nordenfelt on the admirable manner in which the book has been completed. The printing, paper, typography, and illustrations leave nothing to be desired.

Royal Cornwall Polytechnic Society: The Fifty-first Annual Report. 1883.

Few scientific societies can boast of fifty years of useful and prosperous existence, and it was therefore only natural that the members of the Royal Cornwall Polytechnic Society should unite in a special effort to celebrate their Jubilee last year. The meeting was very successful, and served to call special attention in other parts of the country to the good work which is being done in the west. A disappointment has, however, since befallen them. The Royal Meteorological Society determined to reduce its first-class observatories from seven to three, and accordingly notified to the Polytechnic Society, under whose local management it was, that no further grant would be made after this year to the Falmouth Observatory. Urgent representations were made, and finally it was arranged that a new building should be erected, and plans are now being prepared.

At the last exhibition the judges in the Mechanical Section reported a large entry of unusual variety and excellence. There were competitive trials of pulverisers and rock drills, and many inventions relating to mining were shown. Naval architecture was poorly represented, as was also oil painting and water-colour drawing, but the display of photographs was large and valuable. The scope of the Society is very wide, and its long and prosperous existence is evidence that its exertions are appreciated.

CANADIAN PACIFIC RAILWAY.

No. XV.

Moose Jaw to Medicine Hat.

Moose Jaw, 132 miles from Broadview and 398 from Winnepeg, is the end of the third locomotive division. It was intended that Regina should have had this honour or advantage, and it certainly was one of the inducements that were held out to the purchasers of building lots at Regina, that this divisional selection would induce a large permanent settlement of men working in connection with the railway, to whom the end of the division would necessarily be a home. But the distance to Broadview was too short, and to Swift Current, which is a natural geographical division, too long, and so the round-house and divisional buildings were erected at Moose Jaw. Just east of Broadview a second steppe or ocean terrace, is crossed, and the line rises to an elevation of 1781 ft. above the sea. The whole of this third division is singularly level, Moose Jaw being only 1793 ft. in altitude, but west of this there is another terrace, and a rougher country to cross, the good wheat land gradually becomes poorer, and finally the line crosses a prolongation of that great American desert, which the Union Pacific passes over for 800 miles, and which thrusts one corner of its barren solitude over the boundary line into Canada. Moose Jaw is a still newer town than Regina, but its growth this last summer, the first of its existence, has been a surprise even to those who are accustomed to see the rapid strides of western cities. It has no extraneous assistance, as being the seat of Government, or the head-quarters of a cavalry regiment, as Regina has, but it is the honest upgrowth of a vast new country that is springing into life, and under the pure conviction of a number of far-seeing men that it is destined to become an important business centre. Situated at the junction of two creeks, which together form one of the main affluents of the Qu'Appelle River, it has no difficulty to contend with as to water supply, whilst it has around it certainly as good an agricultural district as Regina. It is expected also that this will be a somewhat important railway centre, and it will probably be the

erminus of what is called the Saskatchewan Branch, which turning off north-west from the main line, will run over a sandy and not very promising country to the North Saskatchewan, crossing the South Branch at the Elbow, and continuing over a rolling prairie to the excellent district of Battleford and the Peace River beyond. To the north of Moose Jaw, for which this is the natural depôt, is the land of the Temperance Colonisation Company, one of the large land companies which having secured a large block from the Government, in this instance over 2,000,000 acres, proposes to put some improvement on the land and then to resell it to actual settlers. The central depôt of this company is now being laid out on the South Saskatchewan, nearly in the centre of their land, and from this they expect ultimately to have a radiation of roads and railways and to make it an important place. They have called it Saskatoon, said to mean in the Cree language "cold water," and therefore very appropriate for a temperance colony. They are tolerably sure of securing a railway from Moose Jaw, and this will place the whole of their block, some 90 miles long by 30 miles wide, accessible from the Pacific Railway. These colonisation companies are rather a feature of this New Canada, some fourteen or fifteen of them being in full operation. The most important of these is the Canada North-West Land Company, which has purchased 5,000,000 acres from the Canada Pacific Railway, and in this district owns nearly half of the land belonging to that company.

The system of survey and laying out the land throughout the north-west is so simple and complete that really it leaves nothing to desire, as every farm of 160 acres is at once identified without difficulty or delay. It was no small matter to lay out a country the size of Europe so that each spot should have an individuality, and be capable of immediate recognition. Like many others of the Canadian systems, it is an improvement upon and an amplification of a system that had been thoroughly tested in the United States, and the improvements were principally in the details. Two initial lines, one due east and west and the other due north and south, were chosen to commence with, and the lines of latitude and longitude at once offered the necessary data. From the Lake of the Woods to the Pacific the 49th degree of latitude is the boundary between Canada and the United States for 1400 miles. In 1826 this line was run by a joint commission of the British and United States authorities, was carefully chopped out where brush or forest intervened, and after the centre line had been determined by astronomical observations, cairns, iron pillars, earth mounds, and timber posts were erected at intervals along it. A stone cairn is about 7 ft. by 8 ft., and in lakes or swamps these were built up till they were sufficiently high to form a guide; in some places they are founded in 18 ft. water, and they are always carried up so as to be 8 ft. above the highest water mark. The earth mounds were 7 ft. by 14 ft. The portion east and west of the Red River is marked by iron pillars, of which there are 382 between the Lake of the Woods and the base of the Rocky Mountains. They are placed at even mile distances, the British placing theirs every two miles and the United States the intermediate ones. They are hollow iron castings in the form of a truncated pyramid 8 ft. high, having at the top a solid pyramidal cap, and at the bottom an octagonal flange. Upon the opposite faces, north and south, are cast in letters 2 in. high, on one side, "Convention of London," and on the other "October 20, 1818." One of these iron posts can be seen at the head of Main-street, Emerson, whilst at West Lynne several, both of wood and iron, are in sight. This line is the first base line of the new survey, and every 24 miles from this is another base line, known as the second, third, fourth, and so on. The first north and south meridian, called the first principal meridian, is in west longitude 97 deg. 30 min. from Greenwich, and passes about ten miles west of Winnepeg. The 102 deg. is the second, the 106 deg. is the third, 110 deg. the fourth, and 114 deg. of west longitude, the fifth principal meridian. Starting from each of the principal meridians, the surveyors run lines parallel to the base lines from one principal meridian to the next, marking off every sixth mile along a line intermediate, that is 12 miles from each base called the first, second, and so on, correction line. Thus an intermediate line between each base and each correction line, and vertical lines parallel to the meridians, divided the whole into blocks six miles square, which are called townships. These townships are numbered from one upwards, going north consecutively, and are marked in the maps in ordinary Arabic figures. The "ranges" number from the first principal meridian west, going towards the west and east, for those to the eastward are marked in Roman figures on the map. Remembering that the townships are exactly six miles square, it is of course easy at once to identify pretty nearly the situation of any one when the range and the township are given. Thus the middle of the tenth township in the nineteenth range, being the one in which Brandon is situated, is 17 miles north of the boundary, and 117 miles west of the first principal meridian, that is, 127 miles west of Winnepeg, taking its central point. Moose Jaw, between the sixteenth and seventeenth township, that is on the line between them and on the twenty-sixth range west of the second principal meridian, is 156 miles west of the 102nd parallel, and 96 miles north of the boundary. The townships being set off six miles along each of the base lines, at each of these correction lines there will be a jog corresponding to the difference made in 24 miles in the length of the parallels of latitude, so that, say in the second or third base line, the lines between the township, north and south of the correction line, will not be opposite to each other, and so whilst there are nearly thirty-four full townships between the first and second principal meridians on the first base line, there are not quite thirty-three on the fifth, and fewer still as the survey is continued further north.

North.

	31	32	33	34	35	36
	30	29	28	27	26	25
	19	20	21	22	23	24
West.	18	17	16	15	14	13	East.
	7	8	9	10	11	12
	6	5	4	3	2	1

South.

The townships themselves are divided into 36 sections each one mile square, and uniformly numbered as in the above diagram, beginning at the south-east corner, and counting backwards and forwards consecutively to the north-east. In all these townships Nos. 11 and 29 are reserved by the Government for school purposes solely, whilst Nos. 8 and 26 belong to the Hudson's Bay Company. Each section is again subdivided into four quarters, each having 160 acres of land. The even numbers throughout, excepting the two lots mentioned above, are reserved by the Government for homestead and pre-emption claims, whilst all the odd ones, within a certain distance of the Pacific Railway, are given to the company as part of their land bonus. Throughout the Qu'Appelle Valley, and in other parts, the Canadian Pacific have sold to the North-West Land Company six out of the fourteen sections originally given to them, so that in these townships—

Nos. 2, 4, 6, 10, 12, 14, 16, 18, 20, 22, 24, 28, 30, 32, 34, and 36 are open to settlement under the Homestead and Pre-emption Laws;

Nos. 1, 9, 13, 21, 25, and 33 are sold to the North-West Land Company;

Nos. 3, 5, 7, 15, 17, 19, 23, 27, 31, and 35 belong to the Railway Company; whilst

Nos. 8, 11, 26, and 29 are reserved for the Hudson's Bay Company and for school purposes.

The lands under the Homestead Laws, belonging to the Government, are offered as a free gift to intending settlers, a homestead, that is a quarter section 160 acres, being obtainable on condition of cultivation and actual residence for three years, and on payment of 10 dols. (2*l.* sterling) for entry certificate. Settlers taking advantage of this offer, and who wish for a larger farm, can secure a pre-emption of an additional 160 acres without the payment of anything except the entry fee; the whole 320 acres, however, must be cultivated for three years, and the conditions of the homestead grant must be faithfully carried out. All the other arrangements and conditions are made in the most liberal spirit to the actual settler, and are so far only restrictive that they are intended to prevent, as far as possible, speculation in lands or the securing of large blocks for the purpose of locking them up from actual settlement and cultivation, or to hold them in idleness for future sale.

Rising over another terrace to the west of Moose Jaw, and attaining a summit of 2600 ft. above the sea level, to the south-west the highlands can be seen which form the Cote du Missouri, of the main east and west watershed of the continent which separates the waters flowing into the Missouri and then south towards the Gulf of Mexico, from those that find their way into the Saskatchewan, and by it to the Hudson's Bay. The summit over which the railway passes the Vermilion Hills, is an outlying sandy prolongation of the great American desert which fortunately does not project into Canada very far, nor is there a great breadth of it, but there is a sample of it for some 100 or 150 miles here, and this whole district of the Elbow of the South Saskatchewan is only poor land, though better than that encountered further south, where the sand is more arid, and the vegetation confined simply to arenaceous plants that alone can find sustenance upon it.

Swift Current, 511 miles from Winnepeg and 113 miles from Moose Jaw, is the end of the fourth locomotive division, and here it is intended to erect repairing shops and the necessary establishment for the maintenance of the machinery on the fourth and fifth divisions, which meet at this point. The station here is 2400 ft. above the sea, and the river is the largest stream that has been crossed since the Assiniboine at Brandon. The river is navigable, as far as body and depth of water is concerned, and in 1882 two vessels were built here intended to ply upon the North Saskatchewan, following down Swift Current into the South Branch, and by it to the Forks, and then up the North Fork of the river, their total run being not far from 1000 miles before they reached their destination above Battleford. From Swift Current to Colley, 76 miles, the rails were laid in 1882, whilst the grading was nearly complete for 73 more to the crossing of the South Saskatchewan, the end of this division. The railway runs for the whole of this long division, 149 miles, over very indifferent ground, principally the sand hills of the American desert, for though the line is laid out about 70 to 80 miles from the international line, yet the water shed of the Missouri Valley and its feeding streams, is further north here than anywhere else, and White Mud River, a branch of the Missouri, runs for over 150 miles in Canadian territory, from 30 to 40 miles north of the boundary. At Walsh, 631 miles from Winnepeg, the road is within 20 miles of the Cypress Hills, a wooded elevation of considerable eminence, and an important post of the mounted police, who have some troublesome people in this district to watch. This was for a long time the home of the redoubted Sitting Bull, whose company was not desired on either side of the line, and whose band was one of the most unscrupulous of the whole number of this particularly unscrupulous lot of Indians.

We are now approaching the country that for years was roamed over by the dreaded Blackfeet Indians, a race so treacherous and cruel, yet so clever and persevering, that even the Hudson's Bay Company could do nothing with them and left their country almost a blank from their trading posts. Between the 49th parallel and the North Saskatchewan, almost 300 miles as the crow flies, and for almost an equal distance east and west, an immense area of country, the great fur company had but one solitary trading post. It was not for want of a wish to do business nor that the Indians were not a profitable race to deal with, but so many posts had been destroyed and their inmates murdered, that the company dreaded a repetition of these disasters, and retired, much to the annoyance of the Indians themselves, from a district so dangerous for an establishment.

This was all the country of the Blackfoot, whose hand was against every man, and every man's hand against him. The Canadian portion of their territory was, as a rule, not bad land, but south of the international line, their hunting ground stretched for 1000 miles over the vast treeless, sandy sage brush plains that extended almost to the Canadian river of the south, and over this ocean-like expanse of ground these Cossacks of the desert found their fitting home. Around their border raged the whole summer a perpetual relentless warfare, and it seemed a matter of perfect indifference to them whether it were the more harmless Crees or Assiniboines of Rupert Land, or a troop of American soldiers

that they were intent upon annihilating, the pursuit of blood, and the exercise of rapine and murder, was ever a pleasure to them. At war with every other nation and tribe, these wild dusky men swept like a whirlwind over the sandy plains of the south, or the better land of these Canadian hunting grounds, to exterminate every human being that trenched upon their boundaries or crossed their path. Different in language, customs, and characteristics, the Blackfoot Confederacy, Bloods, Peagans, Sircees, or Gros Ventres, they were the most dangerous of all the Indian tribes, and they were shunned accordingly. Scarcely a dozen years since, few traders and fewer strangers cared to visit this dreaded locality, or to linger longer than necessary when compelled to cross their country. But a great change has now come over them. In 1870 the Peagans, numbering 3000, and the Bloods 2000 fighting men, were attacked by the small-pox, and one-fourth of their number perished directly from the disease. The confederacy numbered before this 14,000, but since the settlement of the Missouri Valley and the North-West States, the mounted police of Canada, and the gradual enforcement of law and order, together with their own diminished numbers, have all reduced their independence, and moulded them into more civilised beings. But they are still powerful, perhaps the most powerful of any of the Canadian tribes, whilst their fine, intelligent faces, their symmetrical forms, and their brilliant eyes, mark them as the aristocracy of the red men. "Their scope of thought is as boundless as the land over which they roam, and their speech the echo of the beauty that surrounds them." Originally perhaps not indisposed to tolerate the white men, long years of injustice and wrong from the American pioneers and Government, have developed an animosity that can never be eradicated. Constantly at war, anything like regular trade with them was almost impossible, and the only place where this was attempted in Canada, the Rocky Mountain House on a high bank of the Saskatchewan, in the thick pine forest which clothes the foot of the Rocky Mountains, has such an ingenious combination of bars, locks, and long passages with loopholes above and in every direction, that it showed plainly the class of customers that were expected to trade there, and the scant confidence that was reposed in those wily enemies of the white man's race.

This division ends at the crossing of the South Saskatchewan, a place known by the singular name of Medicine Hat. The bridge here is by far the heaviest structure that occurs, so far, after leaving Ottawa. The river was crossed by the trains all last year on a temporary wooden bridge, the new iron structure being left for the work of last winter, when the trains were only running occasionally. The piers are of stone and the superstructure consists of two deck girders of 30 ft. span each, three spans of 215 ft. each, and one draw girder of 295 ft. length over all. The station is 3142 ft. above the sea level, and the prairie, for we are again on good ground, is 293 ft. above the ordinary level of the water in the river, the Saskatchewan running in a trough nearly as deep as this for over 600 miles to the Forks, where the two branches run together. Medicine Hat itself is a most beautiful location. It is situated on a plateau covering several hundred acres surrounded by hills, and crossed by the beautiful Saskatchewan. At the beginning of June, 1883, there were only two or three tents at Medicine Hat. In three months there were 500 people there, and the houses were going up on all sides as if by magic. At Maple Creek, three or four stations east of this, a small station, interesting particularly from the fact that there is an Indian reserve near where about 3000 Crees are located, and a small body of mounted police are stationed, on June 26 last, a "sun dance" was held. It was the longest and one of the hottest days of the year, and fifteen warriors were tested. It is one of the most sacred of their feasts, and one not generally held where white spectators could be witnesses. The operations are too disgustingly cruel to particularise, but consist of different self-inflicted tortures to which the "braves" submit to illustrate their powers of endurance. The most important of these was suspending the novitiates by a stake passed through two incisions cut on either side of the breast. Out of the fifteen only five were successful, and the greatest length of time that the hero of the day remained suspended was only fifteen minutes. The Indians here are well cared for, and seem perfectly satisfied with their treatment by the Dominion Government.

In the bank of the river, near this crossing, six or seven seams of coal showed themselves from 3 in. in thickness to 5 ft. On the lowest of these, and 70 ft. above the ordinary elevation of the water, operations for extracting the coal were commenced upon a 4 ft. 6 in. seam, and from that time till the close of the season, from 300 to 400 tons per day were extracted and sold. The discovery of the large deposits of coal at this and other places along the Pacific Railway, seemed to be the one thing that was needed to make this country complete. Before this, fuel was the subject upon which every man shook his head, afraid to commit himself to an opinion. In Minnesota and Dakota it had already proved the great tax that robbed the district of half its advantages, and made some parts of it a poor place to live in, whatever the wheat crops were. In Winnepeg and through Manitoba it was as bad, and a five months' winter with the thermometer not unfrequently frozen, if it were mercury, and down to – 60 deg. if it were a spirit instrument, and with coal up to 22 dols. and 24 dols. per ton, this question of fuel was of vital consequence. The opening of the railway to Lake Superior put coal at once down to 12 dols., and as far as Winnepeg was concerned, improved the prospects immensely. The Souris discoveries were again a further relief, but did not much affect the price, as the quality was poor and its "staying" power indifferent, as compared with the American coal. At last the Medicine Hat coal, close to the railway, easily quarried, and in immense quantity, was produced, and the first train load that went into Winnepeg sent coal down to 7 dols. per ton, nor has it ever since been higher there than at Toronto or Ottawa. The Souris coal, or rather lignite, proves now not only to be abundant there, but to extend through an immense territory west of the 106th degree of longitude. In addition to the researches of the Geological Department, extensive explorations have been made by private enterprise, and the result has been to confirm all that was previously hoped as to its general diffusion and great commercial value. The fact that within the twelve months ending June 30, 1883, over 800 applications for coal locations, each of 320 acres, have been recorded in the Department of the Interior, is an evidence of the extent to which public attention has been directed to this matter. It has been thought expedient to reserve from ordinary sale and settlement several townships at different points. These reserves, which will probably be enlarged and added to in the future, consist of areas of different extent near the sources of the Souris River, at Medicine Hat, Coulée, east of Fort M'Leod on the Belly River, and a large tract on the Bow River between the 18th and 24th ranges west o the second meridian.

In describing these coals, Mr. George M. Dawson, assistant director of the Geological Department, observes that both the coals and lignites of the north-west are entirely of cretaceous and tertiary ages, and differ in this respect from the fuels of the eastern provinces and states, and of Great Britain, all of which are included in the carboniferous system. The district in the north-west, which as far as yet known affords the most abundant and valuable deposit, is that in the proximity of the Bow and Belly rivers, extending eastward from the Rocky Mountains to the 111th meridian, and it is quite possible that the corresponding district further north, when it is better examined, may prove to be equally rich in mineral fuel. In the district that has been examined on the Bow and Belly rivers, the mineral varies from lignite, but slightly superior to the Souris fuel, to coal containing a very small percentage of water, forming a strong coke on being heated, yielding abundance of highly luminous hydrocarbons, and resembling highly bituminous coal, though of cretaceous age. The occurrence of workable coal seams at several different levels, and the proved continuity of some of them over wide areas, guarantees an abundant supply for a district almost destitute of other fuel. The quality is suitable for transport to a distance, and the quantity underlying the square mile shows a very satisfactory result Approximate estimates give the following :

	Tons.
Main seam, Belly River, per square mile	5,000,000
Grassy Island, Bow River, probably the same seam	5,000,000
Horseshoe Bend, Bow River	4,900,000
Blackfoot Crossing exposure on Bow River	9,000,000

These seams are all proved to extend far to the north and west, though how far it is difficult to determine. On the North Saskatchewan several seams of lignite, resembling the Souris mineral, crop out at Edmonton, the most important seam being 6 ft. in thickness. Thirty miles above this a much more important coal seam occurs with a thickness of 18 ft. to 20 ft. It is of excellent quality and much resembles the Coal Banks coal from the Bow River. It contains :

Water	7.82
Fixed carbon...	54.97
Volatile combustible matter	31.35
Ash	5.86

Large seams are exposed at many other places in that part of the country. On the North Pembina, a tributary of the Arthabasca, about 56 miles west of Edmonton, a seam 8 ft. thick crops out, with 57.25 per cent. of fixed carbon, and 28.66 of volatile combustible matter. Still further north on the Arthabasca, seams of lignite occur, and may be traced for miles. On the Peace River are numerous exposures, and a sample from a seam in the Mountain of Rocks yielded 71.63 of fixed carbon, and 21.54 volatile combustible. The interior basin of coal-bearing rocks is widest, however, in the south; and near the boundary it extends further east than on the northern rivers. Eastward from the Bow River the best known important locality is Medicine Hat, and exposures occur on nearly every bend of the South Saskatchewan, from 30 miles below the junction of the Bow River to Medicine Hat. The seam, however, varies much in thickness, and at two places on the river, scarcely a mile apart, it changes from 2 ft. in thickness of shaly impure lignite, to 6 ft. of very fair coal. One exposure, 10 miles above Medicine Hat, showed two seams 4 ft. 6 in. and 4 ft. respectively. At three miles above the Hat, the seam is again well shown, on the side of the river valley, about 80 ft. above the water, where it is 4 ft. in thickness. In the Cypress Hills seams are known to occur, being, like those of Medicine Hat, distinctly lignite, and containing a larger percentage of water than those of the Bow and Belly rivers. On the Souris River the measures are almost horizontal, and the valley having been deeply eroded they are exposed very favourably for working. The thickest bed is a little over 7 ft., and Mr. Dawson, who examined this coal in 1880, thinks there is 8 ft. of available coal for an area of 128 square miles at least, over 600 millions of tons, that can be put into the market, taking the cubic foot at only 50 lb. weight. The analysis shows a composition, on an average of twenty-one samples :

Fixed carbon	41.21
Volatile combustible	37.97
Water	15.46
Ash, &c.	5.36
	100.00

Whilst therefore this fuel is of an inferior value to the coals found further west, it closely resembles the lignites of Bohemia and other districts of Europe, where the possession of this mineral has given rise to important manufacturing and metallurgical establishments.

THE HYDRAULIC DISTRIBUTION OF POWER.

AT the time of the visit of the Institution of Mechanical Engineers to Hull we gave a short notice of the system which was adopted there in 1875 for the distribution of power to private users in a certain portion of the town. The plan followed is essentially the same as that employed in most of the docks and great railway yards. A hydraulic pumping engine is erected in some central position and forces water into an accumulator from which mains diverge in different directions carrying water at a pressure of about 700 lb. per square inch, to the various points where it is to be utilised in hoists, presses, or hydraulic engines. The sole difference between the Hull installation and previous ones of the same nature, is that the mains, instead of being laid upon private premises, and supplying the machinery of one owner or company, are placed under the public streets and supply water to many consumers, who bear the same relation to the Power Company that the ordinary householder does to the gas company, that is, they pay a quarterly charge according to the indication of a meter, using much or little water as they choose, or as their business requires.

The experiment at Hull proved that it was perfectly feasible to supply hydraulic power to a large number of consumers, and that for the purposes of

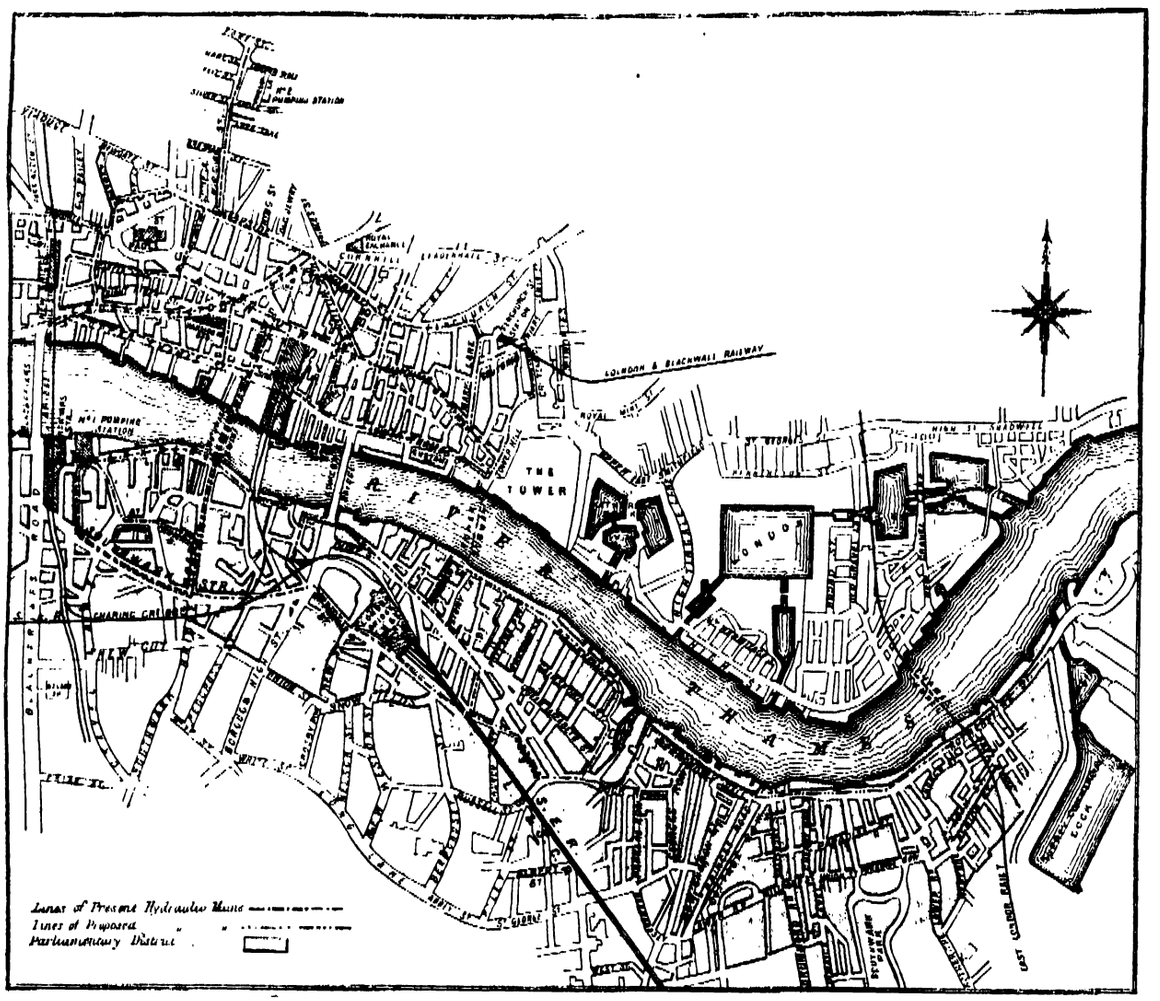
hoisting, pressing, and the like, the expenses were much less than when each user had his own gas or steam engine. Some of the promoters of the Hull scheme therefore determined to turn their experience to advantage on a larger scale, and prepared a plan for the hydraulic distribution of power in the City of London. In no other place in the world could they have found so suitable a field for their enterprise. Hydraulic power can be applied for producing rotary motion, but it is in apparatus requiring rectilineal motion that its great advantages are most apparent, and consequently a power distribution enterprise has greater opportunity of being commercially successful when located among merchants and warehousemen, than among manufacturers. The City of London is most distinctively the focus of the trading community, and its narrow, tortuous streets, high buildings, and enormous ground rents, render it a most fitting field for power distribution, since hoists and cranes are required in nearly every building, and the space available for the erection of engines and boilers is both small and expensive.

In 1882 a company, called the General Hydraulic Power Company, was floated, and obtained powers to break up the streets and for other purposes, with certain limited area represented by the shaded portion of the map above. The position chosen for the central station was at Falcon Wharf, on the south side of the river almost close to Blackfriars Bridge, and at the western extremity of the company's district, which extends along this side of the river past London Bridge, and through Bermondsey and Rotherhithe to the Surrey Commercial Dock. During the present session of Parliament a further Act has been obtained, greatly increasing the area of the company's operations. The district now conceded to them extends on the north side of the river from the West India Docks to Vauxhall Bridge, and is 1200 yards wide the whole distance. On the south side it reaches from the Surrey Commercial Docks to Vauxhall Bridge, and is 600 yards wide all the way. The Bill has only lately passed and as yet the company's operations are confined to the area represented on the map.

The machinery already erected comprises two centrifugal pumps, driven by Brotherhood engines, to raise water from the river into tanks upon the top of the building, two Thames filters,* a pair of pumping engines, and a pair of accumulators. The company is empowered to take one million gallons of water per day from the river, a quantity which is of course much beyond their requirements at present. If used in ten hours it would correspond to 800 horse-power equally distributed, but as supplied to an intermittent demand it would represent 2000 to 3000 horse-power. When raised it is in a very muddy condition, often containing so much sediment that if used as it is received, it would quickly destroy the pumps, and would deposit a great amount of mud in the pipes. It is cleared by being allowed to settle, and then by being passed by gravity through compressed sponge in the filters of the Pulsometer Engineering Company. This sponge, which is thoroughly cleaned every few hours by self-acting mechanism, retains nearly the whole of the suspended matter, and delivers the water into a second tank, in a condition, to all appearance, fit to drink. From this it runs to the suction of the pumps. These are illustrated on page 101, and are driven by inverted compound three-cylinder engines, having one high-pressure cylinder 19 in. in diameter, and two low-pressure cylinders 25 in. each, with a stroke of 2 ft. The valve gear is of the Correy type, the expansion valve being forced down by the pressure of the steam acting on an area equal to the valve rod, as soon as the trigger gear is tripped by the cams, which are regulated by a governor, and by a chain from the accumulators. The pumps are 5 in. in diameter and in a line with the steam cylinders, having their plungers coupled direct to the piston rods, the crankshaft being driven by forked connecting rods. The pumps deliver into two accumulators 20 in. in diameter and 23 ft. lift, loaded to give a pressure of 700 lb. to the square inch in the mains. There are two sets of pumping engines, each capable of indicating about 160 horse-power, already in position, and another set is in course of construction. The engine house is designed to accommodate six such sets when the system is fully developed.

From the pumping station a network of mains extends eastwards, embracing the numerous blocks of warehouses situated in this district. The north side of the river is supplied by two arterial mains which run along Southwark-street and across Southwark Bridge, one being connected with Upper and Lower Thames-street, and the other with Cannon-street. From these the principal streets of the City are served, the connections being so arranged that in the great majority of instances each main can be fed from either end. Thus if a leak occur at some part of it, the faulty portion can be isolated by the stop-cocks, which are inserted at intervals, without cutting off the supply from any great number of consumers.

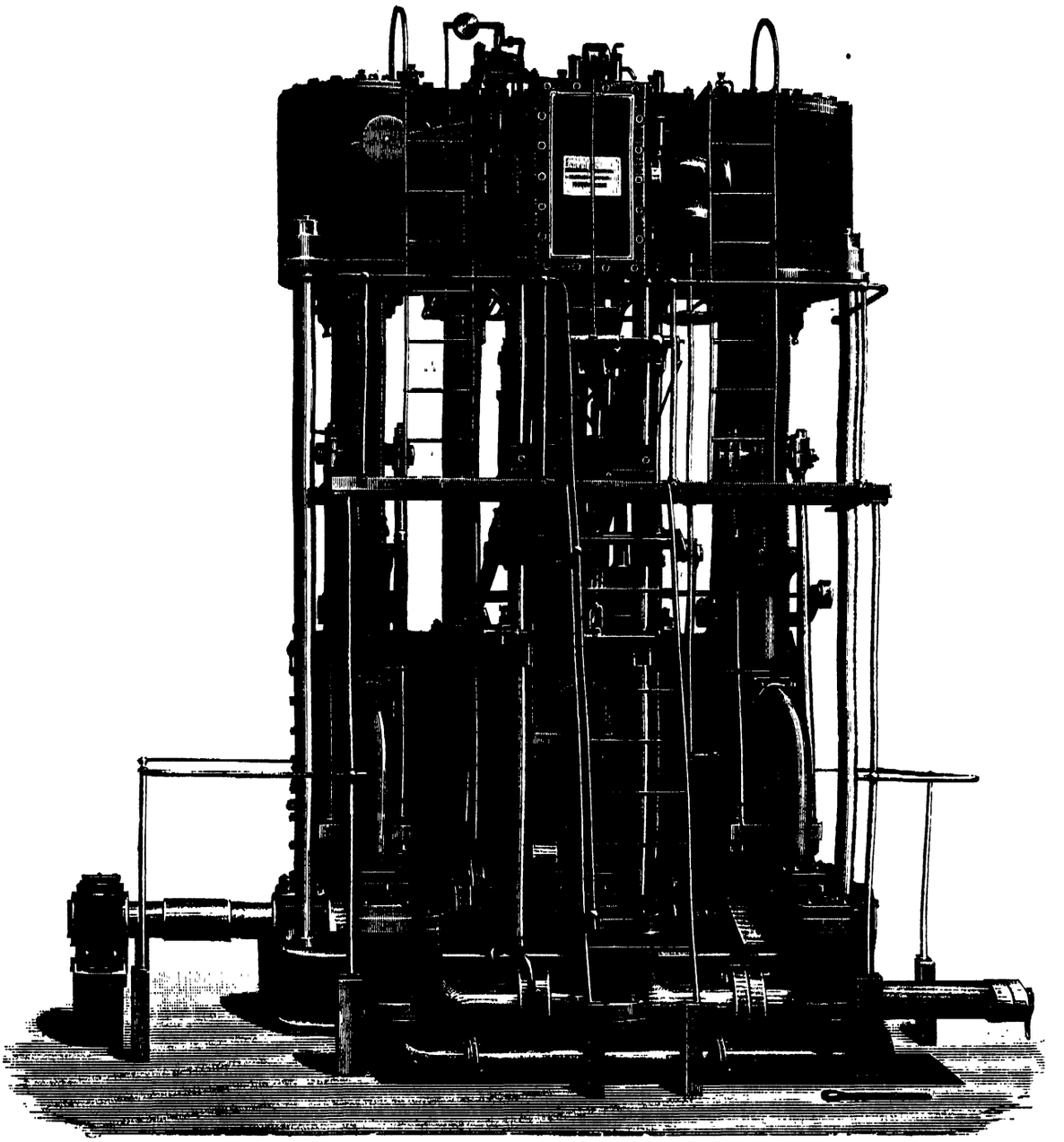
The general scheme of the mains can be clearly followed on the map. It will be seen that there is a long extension northwards along Wood-street. The immediate cause of this was the great fire which occurred among the warehouses in this district about two years ago. The premises were rebuilt with the latest modern appliances, and contain a very large number of hoists. Application was made to the Hydraulic Power Company to furnish high-pressure water to work them, but the spot was at that time outside their Parliamentary district, and they had no power to break up the roadway to lay the mains. The City authorities were therefore petitioned to grant the necessary permission, and strong evidence of the appreciation of the trading classes of the new venture is given by the fact that nearly all the firms in Wood-street signed a memorial to the Commissioners of Sewers, although the opening of such a narrow thoroughfare of necessity produced considerable interference with their business. Perhaps their readiness may not be entirely due to a desire to be rid of the trouble of having steam engines on their premises. The fires of the last few years have left a profound feeling of insecurity in the City, and has produced the conviction that the Brigade and its appliances are of but little avail against fire in high buildings surrounded by narrow lanes. Accordingly every



* See ENGINEERING, vol. xxxvii., page 337.

ENGINES AT THE WORKS OF THE GENERAL HYDRAULIC POWER COMPANY, LIMITED.

MESSRS. ELLINGTON AND WOODALL, ENGINEERS.



auxiliary is welcomed, and the high-pressure water promises to be an additional and powerful safeguard against this ever present danger. To subdue a strong fire it is not only necessary that it should be met with large volumes of water, but that they should be applied with very considerable force, so that the flames may be stamped out by the impact of the jet. This result cannot be attained directly by the use of high-pressure water, as the pumping machinery is not designed to supply it in great volume, but by the use of a Greathead's* hydrant, which acts on the principle of the ejector, a small jet at the pressure of 700 lb. per square inch may be made to take up four times its bulk of low-pressure water, and to propel it with great force. Thus the jet acts the part of a steam fire engine without its bulk, and what is of far more importance, is always on the spot ready for action on the first alarm, instead of having to be fetched half a mile through crowded and possibly blocked streets.

A second pumping station was erected in Wood-street, 9500 ft. from the Blackfriars Station, measured along the nearest mains. It is not in operation at present, and was instituted more as a measure of precaution than from actual necessity. It contains two accumulators, which hold a reserve of pressure water in readiness for a sudden demand, and it is in contemplation to add other accumulator stations in different parts as the system extends.

The mains, which now measure in the aggregate seven or eight miles, are cast-iron pipes 6 in. in diameter. They are cast in 9 ft. lengths, and are tested to 2500 lb. per square inch at the works. The joints are turned and bored spigots and sockets, and are made tight with gutta-percha rings, the necessary pressure being obtained by two 1¼ in. bolts passing through lugs on each pipe. As each section is laid, the water is admitted to test the joints; and after that, if they are tight, very little more trouble is experienced. Stop-valves are inserted every 400 or 500 yards, and by their aid the position of a leak can be located within that distance, after which it is easily found. Of course it is no light matter to lay a fresh network in the already crowded underground system of London, and great patience and ingenuity has often been required in threading the pipes over one obstacle and under another. Fortunately many underground pipes are "dead," that is, they have been abandoned by their owners for some cause or other, and with them very summary methods are adopted by those whose experience enables them to distinguish them; for of course there is no plan of the underground arrangements, and those who made them are often dead and forgotten.

The financial success of the company is no longer a matter of doubt. Since January 1 of the present year the amount of water delivered has increased 40 per cent., and would be much greater if all the intended consumers had their machinery in place. The charges for power are based upon a minimum payment of 25s. per quarter for each machine, and a sliding scale for the water, which is measured by meter as it is exhausted. The following is the scale of prices:

		Per Machine. £ s. d.
Under 3,000 gals., per quarter	... ...	1 5
		Per 1000 gs.
Above 3,000	not exceeding 5,000 gals.	0 8 0
5,000	10,000	0 7 0
10,000	20,000	0 6 0
20,000	50,000	0 5 0
50,000	100,000	0 4 0
100,000	200,000	0 3 0
„ 200,000 by special terms.		

In many cases the cost of lifting by the company's power is as low as one halfpenny per ton lifted 50 ft. high.

Messrs. Ellington and Woodall, of Palace Chambers, Westminster, are the engineers to the company, and the Chester Hydraulic Engineering Company the contractors for the machinery.

* See ENGINEERING, vol. xxviii., p. 80, and vol. xxxvii., p. 44.

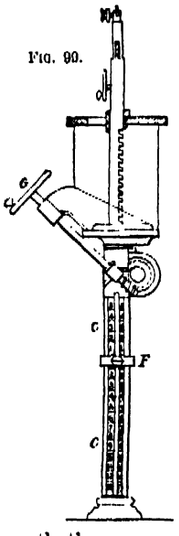
BRITISH NAVAL GUNNERY.

Guns in Turret Ships.

(Concluded from page 41.)

Now let us examine the action of the sights. Suppose we are going to fire at an object 1000 yards off, say the top of the bastion of a fort; the captain of the turret raises the top sight E (Fig. 98, p. 41 *ante*) to the distance named, and clamps it, then by means of the handle G moves the whole sight D (the upper sight working with it) down, until the notch in the back sight, the top of the fore sight, and the object, are in one; then he stops. Meanwhile the pointer F has been showing below the movements of the sight, and when it stops, the elevating number at the gun, lays it for the elevation shown there. Now let us compare the direction of the line passing through the sight with the axis of the gun. If the distance bar E had not been raised at all in its box *d*, then of course, however much the whole hind sight was raised or lowered, if the gun was moved the same amount, the axes would be parallel still. Let us suppose this to have been done, and the line of sight and axis of the gun both to make 2 deg. elevation with the plane of the racers. Now if the upper sight be raised for 1000 yards, the result is that in order to get the line of sight on again, the whole sight must be lowered through the amount by which the upper sight has been raised. Call this 2 deg. in the present case; then, though the

Fig. 99.

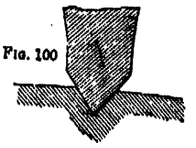


line of sight is exactly the same as it was in the first instance, the reader below, shows 4 deg. elevation instead of 2 deg., and therefore the gun being laid for this amount, will have 2 deg. more elevation than the sights. This additional amount is the elevation due to the distance, and is necessary to allow for the fall of the shot. Again, the distance bar A is, as we have seen, inclined slightly to the left; the result of this is that when the turret sights are trained on any object, the axis of the gun is actually pointing a little to the left of that object. This is to compensate the deviation or drift of the projectile, which owing to the rotation being from left to right, is to the right. In the Inflexible, and in those turret ships now being fitted, the elevation is given by means of a long bar, which is pivotted in rear of the guns, passes under the breech, and is worked by a hydraulic ram underneath. This possesses the advantage that the gun can be elevated up to the instant of firing, that it always recoils into the same vertical position after firing, and readily admits of an arrangement being fitted by which to connect the gun and sights. This latter arrangement consists of gearing, working from the rear end of the bar into the bar *d*, so that any motion of the elevating bar causes a corresponding motion of the sight. In fact the sight becomes part and parcel of the apparatus, as in an ordinary gun, and a small hand lever, connected with the valve for working the elevating bar, being placed near the captain of the turret, he (having adjusted his sights) works the gun up or down till they are brought on.

Communication.—A system of speaking tubes and pointers affords a means of communication between the interior of the turret and those outside.

Locking Bolts.—Two locking bolts are fitted to the turret, their function being to stop and hold the turret when in the proper loading position. One of these, called, the "hydraulic locking bolt," is worked by hydraulic power. The bottom of it is edged, and fits into a slot in the racer, as shown in Fig. 100. The use of it is as follows: The turret being in motion and approaching the loading position, the pressure is put on the bolt, which is thus forced against the racer; it moves along this until it comes to the slot, when it immediately is dropped into it, and if the turret is not going too fast, it stops it. If, however, the momentum is too great, it jumps out again, and the turret must be trained slowly back until it catches. The object of fitting it like this, is to prevent the bolt being broken in arresting the turret suddenly when it is going too fast.

Fig. 100



After the hydraulic locking bolt is down, the hand-locking bolt, which is conical and fits into a hole in the racer, is shot, and so holds the turret completely.

Means of Firing.—The usual way of firing is by electricity, but an arrangement for firing by hand in case of a break down, is also fitted.

Dead Points.—In both these fittings it is necessary that they should be so arranged that it is impossible to fire the guns on certain bearings, namely, those on which any part of the superstructure of the ship would be in the line of fire. To do this an iron rod carrying a roller at the bottom, is run through the flooring of the turret, so that the roller works on part of the racer, the rod being in communication with the electric and hand-firing gear. That portion of the racer over which the roller must pass when the gun is on those bearings where firing must not take place, is raised above the rest, so that the roller on coming to this part is raised up, the bar being connected to it is also lifted up; this action breaks the circuit of the electric firing gear, and locks the hand-firing arrangement.

The Director.—The director is placed in the conning tower, so that the plane of the horizontal arc shall be parallel to that in which the turrets work, and the diameter of the horizontal semicircle, parallel to the fore-and-aft line.

Converging Arrangements. — The arrangements for converging turrets, though on the same principle as in broadside ships, yet differ in the details. The turrets, as we have already pointed out, have no converging marks on them, and the corrected bearing is passed down at once from the director. In this case the director is always laid on a fixed bearing, and the turret guns are converged on it; in fact, the director is here what the centre gun is in an ordinary broadside ship.

A Table is made out for each director in the following form:

Starboard Side.

Foremost Turret.

Distance.	Director Bearing.	Abeam.	Before the Beam.		Abaft the Beam.		
		0 deg.	deg. 15	deg. 30	deg. 45	deg. 15	deg. 30	deg. 45
yds.		deg. min	d. m	d. m.	d. m.	d. m.	d. m.	d. m.
400	Turret	0 29	14 40	29 46	44 50	15 20	30 14	45 10
600	...	0 20	14 44	29 50	44 53	15 16	30 10	45 7
800	Bearing	0 15 abaft	14 47	29 53	44 55	15 13	30 7	45 5

After Turret.

Distance.	Director Bearing.	Abeam.	Before the Beam.		Abaft the Beam.		
		deg. 0	deg. 15	deg. 30	deg. 45	deg. 15	deg. 20	deg. 45
yds.		deg. min.	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.
400	Turret	2 52	17 0	31 24	46 0	18 0	28 30	44 0
600	...	1 54	16 26	31 0	45 42	18 24	29 0	44 10
800	Bearing	1 20 before	16 18	30 42	45 30	18 42	29 18	44 30

These Tables are calculated from the following data: Distance of foremost turret from director, 20 ft.; distance of after turret from director, 80 ft.; guns in turrets 12.5 in., 38 ton battery charge and chilled projectile.

It will be observed that the actual bearing of the guns corresponding to certain bearings of the director, are given, so that the bearing and distance on which the broadside is to be fired being fixed, the officer at the director finds from his table the actual bearing to which each turret is to be trained and passes it down. It will be seen that no allowance for speed is made here; this has to be applied to the director, a table being furnished for the purpose. This table combines the speed of the ship and the drift of the projectile, and is in the following form:

Horizontal Correction—Starboard Side.

Distance.	5 Knots.	10 Knots.	15 Knots.	—
yards.	min.	min.	deg. min.	
400 } 600 } 800 }	22	45	1 8	Move vernier to right.

One more Table is yet required, namely, the vertical correction, and this is exactly the same as in broadside ships.

Correction for Elevation.

Distance.	Correction. deg. min.
400	1 7
600	1 11
800	1 24

Note.—The height of the director is taken as 10 ft. above the axis of the guns.

Systems of Firing.—There are three kinds of firing used in turret ships.

1. Independent firing in which each gun is fired independently of the others by the captain of the turret or its own No. 1.

2. Simultaneous firing in which the guns of each turret are fired together, but the turrets are fired independently of one another.

3. Electric firing by director in which all the guns (on each turret) are fired together by directors.

The first method would never be used in action, but is very useful for practice, where one gun is just as efficient for showing if the aim is good, as two. Simultaneous firing is generally acknowledged to be the proper system for turret ships. The officer of the turret being in a position where he can see all round, readily regulates the fire, and is probably also in easy communication with the captain. The two guns in the turret form a broadside in themselves, and yet a comparatively continuous fire is obtained by firing each turret separately. The object and distance being settled, the order given to the officer of the turret, and through him, to the men, "Simultaneous firing, deflection, yards, object," the captain of the turret adjusts his sight for the deflection and distance named, and trains the turret for the object. As the turret is moving round, he adjusts the sight roughly, the number below keeping the gun elevated according to the elevation shown on the scale below (if the gun is connected with the sight, this is all done by the captain of the turret). The guns being properly laid, the captain of the turret orders "Ready," both as a signal to the officers that he is ready for firing, and to every one to keep clear of the guns. The order to commence being given, the captain of the turret fires when his sight comes on, then immediately trains the turret to the loading position, the gun is loaded, and the firing carried on as before.

Electric Firing by Director.—The only occasion on which this firing would be used, is when the ship is manœuvred with a special object, and it is necessary to have the guns previously laid on some fixed bearing. It is carried out in the same way as in a broadside ship, with the exception that the officer at the director, passes down the corrected bearing to the turrets as before explained, and the only horizontal correction to be applied to the director itself, is that due to the speed.

Barbette Towers.—This system is coming into fashion. We have it represented in our service by the Téméraire, and in the Imperieuse now building. The upper deck guns are to be placed in four barbette towers. In these, the towers themselves are fixed and the tops are open, the gun working on a turntable inside. In the Téméraire, these guns are fitted to disappear when loading, on the Moncrieff principle (see "Treatise on Military Carriages," page 162), but the guns mounted in the barbettes of the Imperieuse, are to be fixed with a shield above, for protection from machine gun fire. There is no doubt that the crews of unprotected barbettes would suffer heavily from the fire of these weapons worked from the enemy's tops.

COMPOSING AND DISTRIBUTING MACHINERY.

(Concluded from page 80.)

Type-Filling and Type-Distributing Machine.—After the type has been made up into solid blocks and used, it has afterwards to be distributed, and the way this is done mechanically is as follows: The solid blocks are broken up and put into tubes about 2 ft. 6 in. long by the filling machine, and after that each letter is distributed into a separate tube.

On one side of the filling machine there is a rectangular receiving table, lying at an oblique angle, on one edge of this table and at right angles to it there is a guide plate; a movable rest on the table works against this guide plate, and it is so arranged that it can be locked by a screw in any position. Raised parallel with the rest and working at right angles to it, there is a plunger, and above the first plunger there is a second one, these plungers are connected together to one handle. When this handle is pushed to and fro, the plungers work alternately at right angles to one another.

A block of type tied up with string having been put upon the table of the machine, owing to the angle at which the table is, the letters lean against the guide plate and the locked rest; hence, when the string is taken off they still retain their rectangular formation. The screw on the rest is then slacked back, and the rest, with the block of type, is pushed forward until the first line of the block is dead against the frame of the machine. Upon the handles which actuate the pusher being drawn back, a line of letters is drawn upwards by the first plunger into a box. When the plunger arrives at its highest position, it becomes automatically locked. As soon as the click of the catch is heard which holds the first plunger in position, the handle is pushed in the opposite direction, and then the second plunger comes into action and forces the letters sideways into the tube, which is opposite to the mouth of the box, a sliding clutch being in the tube to support the letters. The handle, at the end of its stroke, releases the first plunger, which drops again to its old position, and another line of type is then pushed on the top of it, when the handle is withdrawn as before, and returned again until the tube is full of type. As soon as the tube is full, the drum which carries it is moved forward, and a second tube is brought opposite to the mouth of the box, and after it is duly filled others follow on until all the tubes in the drum are charged with letters, when they are taken out and stored ready to be sorted by the distributing machine.

In the type-distributing machine the type are sorted by being passed through eight boxes, which are all attached to arms radiating from the centre of the machine; the mouths at the top of these vertical distributing boxes are recessed to receive one end of the tubes that have been filled by the filling machine, the other ends of the tubes are held in an upright position by catches on pillars which are screwed into the radiating arms. In the first instance, the type are slid by hand from the tubes into the boxes, but after this has been once done and the boxes are full, the letters drop into them at the same speed that they are drawn out at the bottom; as soon as one tube is empty it can be replaced by a full one without the machine being stopped. In order that the mechanism of the machine may be understood we will first give a description of the principal working parts, and then explain the system upon which the type is distributed, and the action of the machine upon the type.

The distributing box is a plain, rectangular casting, having on one side a recess or passage cut into it of the same dimensions as the body of the type that has to be distributed. Above this recess there are two movable covers, the inner one having two projections reaching beyond the outside of the distributing box. This cover holds the type in its place, guides it to the bottom of the box, and is so actuated by means of the above-mentioned projections, that it only opens a sufficient distance to allow the bottom letter to be taken out; thus this cover is raised or opened different heights to suit the various thicknesses of the letters; for instance, it has to open more when a capital "M" is the bottom letter than when a hair space is in the same position. The second cover slides on the first one and is raised with it; it has two forked arms bending downwards, which serve as top guides, while the letter is being conveyed from the box to the tube assigned to receive it.

At the bottom of the distributing box there are two flat pieces of steel, upon which the columns of letters rest; three pieces of steel or bearings extend beyond the distributing box, the top surface of the projecting parts being in an inclined plane, down which the letters are pushed after they are extracted.

At the back of the distributing box, and working on a pin carried in the above-mentioned bearings, there are a number of feelers or levers; these feelers are divided into two classes, called first and second feelers respectively. The points of all the feelers just enter the distributing box, and upon their tail ends there are teeth which gear into catches on the extractor bolt, but the position of the teeth of the feelers depends upon which class they belong to; the teeth of the first feelers being further from the distributing box than those of the second feelers.

To the side of the distributing box a wrought-iron arm is attached; the end of this arm is at such an angle that it stretches in front of and below the box, and serves to return the extractor bolts to their normal positions after a letter has been distributed or drawn into the tube assigned it.

On the inside of the returning arm there is a regulating guide, which the levers of the extractors ride against when a letter is being drawn out of the box. This guide is so shaped that, as the extractor comes into contact with the bottom letters in the distributing box, it adjusts the height to which it shall rise according to the thickness of the letter it has to take hold of, and also after the said letter has been deposited in the tube assigned for it, it throws or draws the extractor down out of gear, and holds it out until it is locked by the extractor bolt. Upon this regulating guide there is a stop which works against the periphery of a cam situated between the returning arm and the distributing box. On the inside of the cam there is a second and smaller one, which, in certain positions, comes into contact with the upper projection on the inner cover of the distributing box and thus raises it. In addition to the cams and on the inside of the inner one there is a wedge, the head of the wedge being towards the front of the distributing box. The cams and wedge revolve on an axis, but are turned by hand to their different positions and are fixed in them by a pin which passes through the side of the returning arm, and is situated immediately above the axis. The different positions are numbered and stamped on the outer cam.

Behind the double cam there is a fixed arm, the controlling arm. This arm adjusts and controls the extractor bolts, so that the catches are drawn exactly in position before they come into contact with the teeth of the feelers.

Underneath the distributing box there revolves the top disc of a drum, which contains the extracting mechanism; this disc has on its periphery two raised vertical flanges, and is divided into forty partitions; of these forty partitions there are only twenty-five that are characteristically different from one another, that is, that as there are only twenty-five different combination of feelers, there are only twenty-five different combinations of catches on the extractor bolts, but all the partitions contain separate extracting mechanism similar in principle. Fifteen partitions are exact duplicates in every respect of one of the twenty-five partitions that are characteristically different from one another; for instance, as the "n" space occurs more frequently than any other type, there are three partitions arranged to extract it, so that when this space is at the bottom of any distributing box, instead of the drum having to make almost a complete revolution before it is drawn out, by having three partitions arranged to receive it, it cannot remain without being distributed for a longer period than it takes the drum to make one-third of a revolution, as the partitions which receive it are arranged round the circumference of the drum at as nearly equal distances as is possible. In the same way letters which occur frequently, such as vowels, have more than one partition into which they are sorted.

In each partition there is a bolt, which passes through, and has its bearings in the flanges of the upper disc; this bolt is so arranged that it can make about one-third of a revolution, and has two recesses cut in it, also it has two catches or projections on it which come into contact with corresponding teeth on the feelers. On the end of the bolt, that is towards the inside of the machine, there is a pin which prevents it from being turned too far over by the second feelers. On the other end of the bolt outside the flange, there is a short lever by which it is returned to its normal position after a letter has been extracted; the boss of this lever has two flat surfaces planed on it, so that it can be drawn exactly into its right position by these faces sliding along the inclined surfaces on the controlling arm.

In each partition, immediately in front of the bolt, there are two vertical grooves in the flanges of the disc; in these grooves the extractor, which is a forked-shaped piece of steel, works up and down as it is either put in or out of gear. At the back of the extractor there are two lugs opposite the recesses in the bolt behind it, and in the bottom part there is a pin which connects the extractor with a lever which has its fulcrum towards the inside of the disc; under the lever there is a spring always pressing the lugs of the extractor against the bolt.

On the outer end of the lever there are two steps; all the outer steps are exactly the same vertical distance from the top of the flange of the disc, while the inner steps are each adjusted according to the thickness of the letters the partition is designed to receive.

On the front of the lever there is a pin which supports a slide having a wedge-shaped head; the slide works in a vertical direction in the outside flange of the top disc, and is also adjusted according to the thickness of the letters the partition is designed to receive. Immediately before each extractor there is a rectangular vertical passage through the top disc of the machine, and under the passage there is a socket which holds the upper end of the receiving tube in position, so that after a letter has been sorted it passes through this passage into the tube designed to receive it.

Attached to the top disc and almost opposite to the passages through which the letters are delivered there are a number of castings with pins in them upon which hooked-shaped rammers work; these rammers rise and fall as they revolve with the drum in guides, and are so arranged that they are pressed down into the rectangular passage or mouth of the receiving tube each time they pass a distributing box, and are raised again before they come opposite to the following box.

The lower ends of the receiving tubes rest in slots in the bottom disc of the drum, and are held in position by springs, so that they can easily be taken out of the machine when they are full, and replaced by empty ones. In each receiving tube there is a friction clutch upon which the sorted letters rest, and projecting from it to the outside of the tube, there is a tappet, which, when the tube is full, is pressed against the head of a pin that passes through the bottom disc of the drum. As soon as this pin is pressed down it comes into contact with stops on the handles of the friction wheels that drive the machine, and thus throws them out of gear, bringing the machine to a standstill.

Now with regard to the system upon which the type is sorted; the machine by means of nicks into which the feelers work, first of all divides the type into twenty-five different tubes. This is called the first sorting. The type in ten of these twenty-five different tubes have to go through the machine again before each letter is separated into its proper tube. In the first sorting about two-thirds of the letters on an average composition are distributed direct into their tubes, leaving one-third that requires resorting. The type that is used most, and only goes through the machine once, such as the four spaces, the vowels and "t," "f," "s," "n," "r," "h," "d," have only nicks in one of their sides, but all the rest of the fount have nicks on each side. The nicks on both sides of the type are arranged to tally with two feelers, one with a first and one with a second feeler. The letters that go through the machine twice are, while they are going through the machine, divided into ten groups, all the letters in each group being almost the same thickness.

By arranging for distribution upon this principle there is no limit to the number of different letters that the fount may contain; to illustrate this, suppose it is arranged that all the letters have to pass through the machine twice, then twenty-five multiplied by twenty-five is equal to the number of different letters that could be sorted by the machine, that is six hundred and twenty-five.

When the type are being distributed for the first time the front of the type, or the side in which is the principal nick, is towards the back of the distributing box, and the action that takes place is as follows: the bottom letter of the column of type resting on the bearings presses the points of the feelers down, except those that have entered nicks; the points of these feelers, *i.e.*, a feeler of the first and feeler of the second class being at a higher level than the rest, the teeth on their tail ends fall below the other teeth and directly into the path of the catches on the extractor bolts, which are being carried round by the revolving drum; as soon therefore as an extractor bolt comes round having a catch on it that corresponds with a first feeler, it is turned about one-sixth of a revolution, by so doing the second face on the top of the returning lever is brought into contact with the controlling arm, so that the bolt cannot be turned further. As the extractor bolt is thus turned it releases itself from the tooth of the first feeler and raises a second catch. Should the second feeler not be the one that corresponds with this catch, then the extractor bolt, after having passed the box, is returned to its original position by the lever on the outside coming in contact with the returning arm. If, however, the second feeler corresponds with the raised catch, the tooth turns the bolt another sixth of a revolution, when the bolt is again brought up with the utmost precision, but on this occasion not by the controlling arm, but by the projecting pin on its inside end coming into contact with the disc. Thus, the bolt having been altogether turned one-third of a revolution, the recesses opposite the lugs of the extractor are brought above them, so that they rise into them through the action of the spring on the extractor lever, and therefore the working parts, namely, the fork of the extractor, the wedge-shaped head on the slide, and the inner step of the extractor lever, are all raised and thrown into gear ready to draw out the bottom letter in the box. When the mechanism is in this position, that is, when the extractor is thrown into gear, and is between the second feeler and letter, all the extractors rise to the same height above the edge of the flanges of the disc, but as the drum continues to move forward, the inner step on the end of the extractor lever comes into contact with the regulating guide, and thus draws the lever, and the extractor down to a height suitable for the thickness of the bottom letter in the box. Before the extractor takes hold of the letter, the thin end of the wedge-shaped head on the sides, is forced between the wedges on the cam and the lower projection of the inner cover, thus raising the cover a sufficient height to allow the extractor to push one letter down the inclined plane formed by the projecting steel bear-

ings; as soon as the letter is on this plane the inner cover drops at once to its normal position, so that no other letters can slide out until the cover has been again raised in the same way, but the outer cover rests on the top of the letter, and serves as a top guide until it drops off the bearings into the passage to the receiving tube. While the letter is being pushed into the receiving tube in the way just described, the extractor is being drawn, or thrown out of gear by the inner step of the extractor lever sliding on the inclined surface of the regulating guide; this, however, does not affect the hold the extractor has upon the letter, as it is simultaneously going down the inclined plane; when the extractor has arrived at its lowest position the lever on the outside of the extractor bolt comes into contact with the returning arm, and the bolt is turned back one-third of a revolution to its original position, the surfaces of the recesses in it being then no longer above the lugs on the extractor, it is, so to say, locked into its place. The letter having been dropped into the passage leading to the receiving tube, is then continuously carried round in the drum until the said tube is full, but before it reaches the next distributing box, a rammer presses it and the friction clutch which supports it, down to a distance equal to its own thickness, so that there is room for another letter to drop into the space it had previously occupied. This action is repeated as often as a letter is delivered or dropped into the passage, until the tappet on the friction clutch presses against the head of the pin in the bottom disc; when this takes place the pin pushes against a stop piece on one of the handles of the driving friction wheels, so that it is thrown out of gear and the drum ceases to revolve, the full tube is then taken out and replaced by an empty one.

When it is required to sort type for the second time the distributing boxes have to be adjusted for this purpose; the type having been by the first distribution sorted into thicknesses, all the letters in one group are equally thick, hence the covers can be permanently fixed open and the extractors can all rise to an equal height. To alter the machines all that it is necessary to do is to draw out the pin above the axles on the double cam piece, and turn the cam until the number opposite to the pointer on the returning arm, corresponds with the number of the group that it is required to sort. For instance if the sixth group is to be distributed the cam has to be turned until the number six which is stamped on it is opposite to the pointer. By the cams being turned the outer one forces the regulating guide away from the distributing box to that of the outer step of the extractor lever, rides on this guide as the drum revolves instead of the inner one, and the inner cam, by coming into contact with the upper projection on the inner cover of the distributing box, holds it permanently open. As soon as this has been done, and the cams are fixed by the pins being replaced, the distributing box can be filled with type as before, only the reverse or opposite side of the type to that on which the principal nick is, is towards the feelers.

The speed at which the composing machine can be worked depends upon how quick the compositor can read the copy and touch the keys. In Berlin, where the machines have been some months at work, two girls, one setting and the other adjusting, average five thousand letters an hour, this not being piecework. A compositor on the staff of the *Cologne Gazette* the first hour he used one of these machines set 5800 letters, in the second hour he set 6300 letters. There is no doubt any competent compositor accustomed to the machine could set from eight to ten thousand letters an hour with ease.

The distributing machine sorts letters at the rate of from thirty to forty thousand letters an hour, but as about one-third of the type have to go through the machine twice, the effective rate at which it works is from twenty to twenty-five thousand letters an hour.

Price of Composing and Distributing Type by Machinery.

Cost of plant about 900*l.*
Five per cent. interest on capital.
Ten per cent. deterioration.
Fifteen per cent. per annum on 900*l.* = 135*l.*, and taking 300 working days in the year:

		£	s.	d.
$\frac{135l.}{300}$ = the cost of machinery per day	...	0	9	0
One fitter's wages at 8s.	...	0	8	0
Two boys' wages at 1s. 6d.	...	0	3	0
Six girls' wages at 2s. 8d.	...	0	16	0
Power	...	0	1	0
Total cost of day's work	...	1	17	0

Amount of work done in a day, taking a day of nine hours and an average turnout of 6000 letters from three machines, then $6000 \times 3 \times 9$ = the number of letters set up and distributed in one day = 162,000; therefore

= 2.74, or 2¾d. per 1000 letters.

BESSEMER BLOWING ENGINES.

We have published in a previous number, viz., on our two-page plate for July 18, some general views of a pair of compound blowing engines, specially designed by Professor A. Riedler, of Münich, for the steel works, Heft, near Hüttenberg in Carinthia, and we now supplement these illustrations by some further views on the double-page engraving, which we publish this week, and also by views on the present and opposite pages. Since very considerable interest attaches to these engines and very excellent results have been obtained with them, we intend to devote some further space to them in an early issue, when our description will enter fully into the constructive details; at present we shall only give a general outline of these engines, stating as we advance the reasons and causes which led to certain special arrangements in the design no only of details, but the disposition of the plant as at whole.

In 1882 it became necessary at the steel works, Heft, to replace an old Bessemer blowing engine by a new and more powerful engine, and Professor Riedler was intrusted with the designs by the chief director of the company who own these works.

These old and well-known works are situated at a considerable distance from any railway station, at the foot of the Erzberg, and from the very excellent local ores manufacture steel with the exclusive use of charcoal. The situation in a narrow valley unfortunately necessitated, in consequence of great scarcity of room, that previous to the erection of any new plant, some of the existing machinery should be shifted and changed.

Since the year 1865 a pair of horizontal Bessemer blowing engines, with two cylinders of 22.84 in. in diameter and 3 ft. 1.32 in. stroke, and blowing cylinders of 27.95 in. diameter, running at from 70 to 90 revolutions, and fitted with rubber valves, had supplied the necessary blast. The valves had from the very beginning required frequent renewals, and the engines had by constant use become fairly worn out, requiring a most excessive amount of steam, which was supplied by one boiler heated by furnace gases and others fired direct by coal; the latter had to be transported by road from a considerable distance at great cost.

The general conditions to be taken into consideration in designing the new engines, were dictated by circumstances, and comprised the following points: Greatest possible reliability and absence of repairs, great economy in steam, adaptation to the very limited space at disposal, and finally the erection of the new engines, and the change of position of the old engines without materially interfering with the working.

The general conditions demanded (*a*) a blow which with a steam pressure of from 70 lb. to 85 lb. boiler pressure, should compress about 5500 cubic feet of air to 28 lb. to 35 lb. pressure; (*b*) the engines to work as economically as possible as regards steam; and (*c*) to be of the compound condensing type, but capable of supplying sufficient blast of 21 lb. pressure without condensing, in which case, however, the two cylinders might be worked independent of each other both with live steam. The working out of this problem was left entirely to Professor Riedler without any intervention on part of the owners or manufacturers, the latter,

DETAILS OF BESSEMER BLOWING ENGINE.

CONSTRUCTED BY MESSRS. BREITFELD AND DANEK, ENGINEERS, PRAGUE.

Fig. 14.

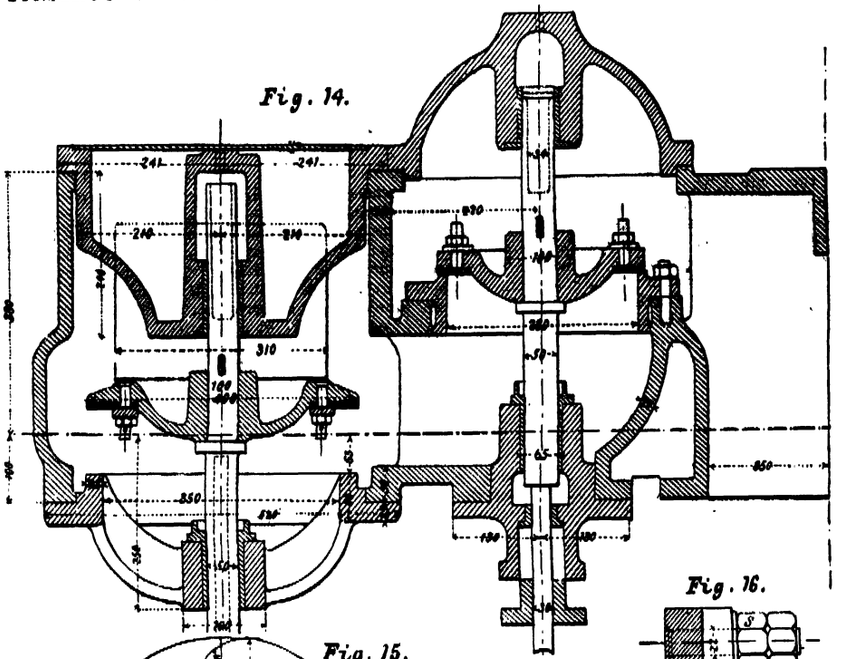


Fig. 15.

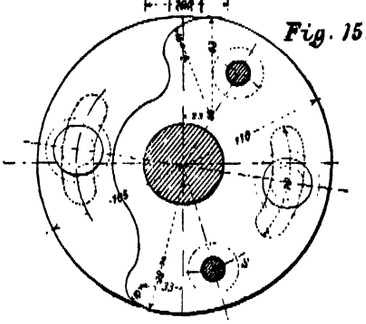
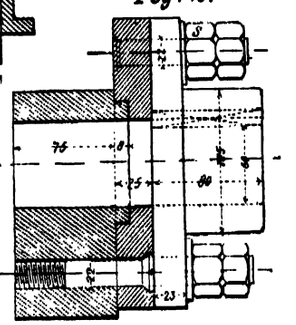


Fig. 16.



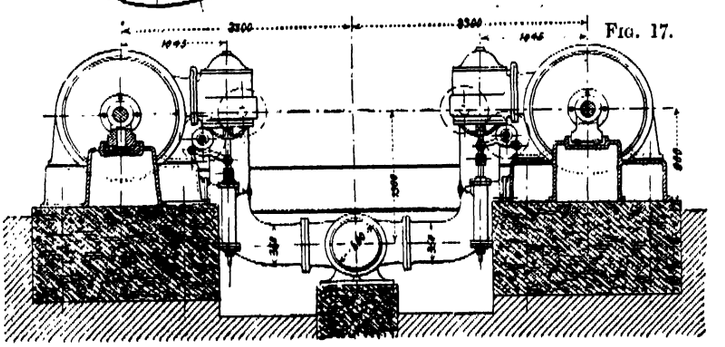


Fig. 17.

DETAILS OF BESSEMER BLOWING ENGINE FOR THE HEFT STEEL WORKS.

CONSTRUCTED BY MESSRS. BREITFELD AND DANEK, ENGINEERS, PRAGUE; FROM THE DESIGNS OF PROFESSOR RIEDLER, MÜNICH.

Fig. 12.

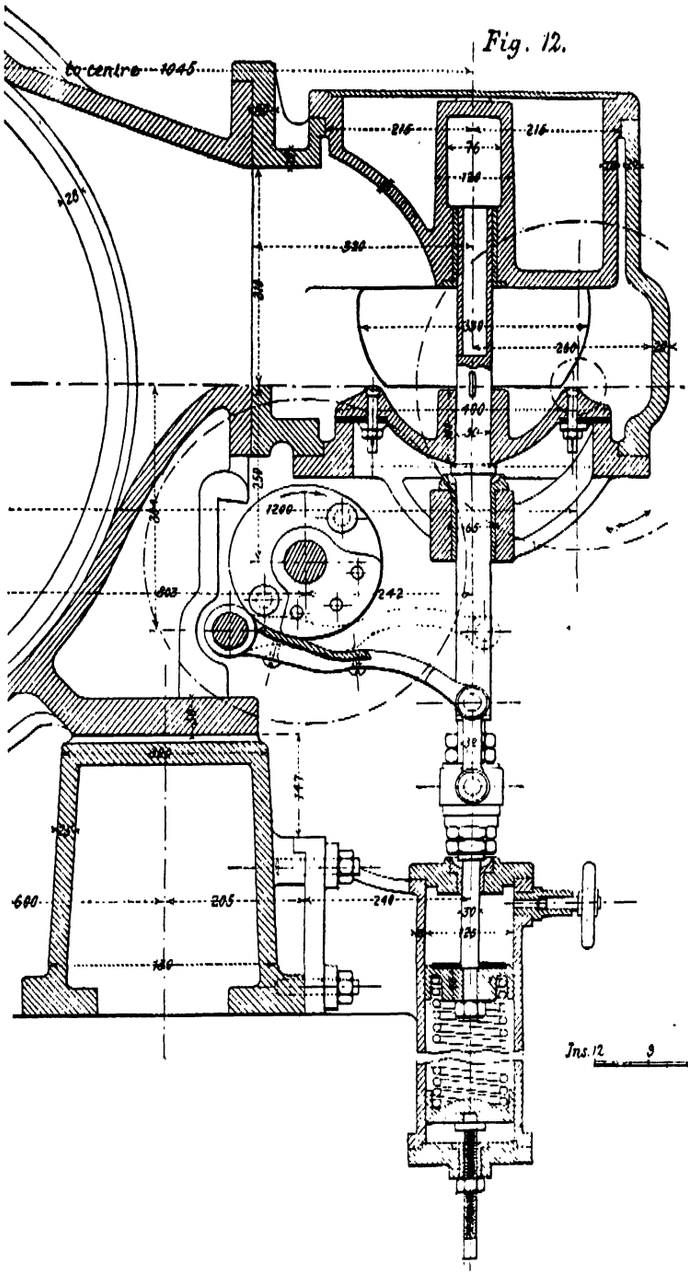
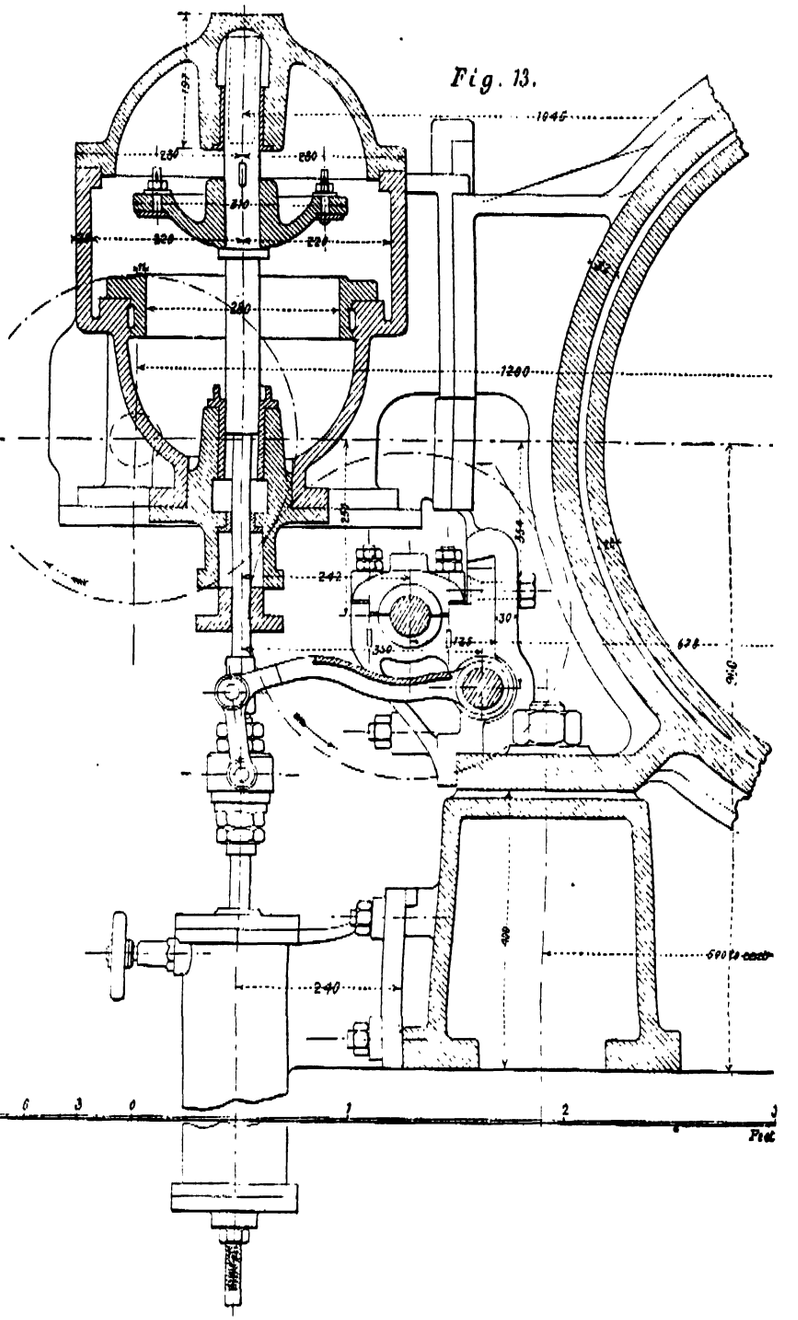


Fig. 13.



Messrs. Breitfeld and Danek doing all in their power to further the work, and execute the designs with despatch and accuracy. Under these circumstances, notwithstanding considerable disadvantages and a very short space of time for execution, perfectly satisfactory engines were produced, as we shall show by results obtained later on. The plans had to be settled in a few weeks, and in another two weeks the details were sufficiently settled to permit the makers to start on the large pieces, since only seven months were available for building, erecting, and starting these engines.

To the engravings already published on our two-page plate on July 18 and the further views this week, the general arrangement of the engines will be at once understood.

Standing at the flywheel, the high-pressure cylinder with a diameter of 35.24 in. lies to the left; the steam from here, when working compound, passes through the superheater and from thence to the low-pressure cylinder, which is 4 ft. 1.6 in. in diameter, and from it to the injection condenser, placed with its air pump in vertical position in a pit between the two cylinders. The air pump is 21.27 in. in diameter and 29.53 in. stroke, and is driven from a rocking shaft, coupled by means of links to the crosshead of the high-pressure piston. The air cylinders are arranged tandem fashion, one behind each of the steam cylinders, coupled to the same piston rods; they are 3 ft. 5.34 in. diameter each, and their stroke is 4 ft. 11.06 in. These engines, with a flywheel 22 ft. 11.59 in. in diameter, and a normal speed of only 20 revolutions per minute, thus insure great durability to the blowing cylinder valves. Since we intend to shortly publish further detail drawings we will postpone the rest of our description.

THE PENISTONE DISASTER.

To the Editor of Engineering.

Sir,—Sir Edward Watkin is reported at the half-yearly meeting of the 24th inst. of the South-Eastern Railway Company, to have been asked by a proprietor whether the brake in use on the South-Eastern Railway was the same as that in use on the Manchester, Sheffield, and Lincolnskire Railway, and Sir Edward's reply, as given in the three principal railway papers, is to the same effect, viz.: "The chairman replied that the brake used on the South-Eastern was the vacuum brake, which was the very best brake out. The brake spoken of in competition with it, viz., the Westinghouse brake, was, in his opinion, one of the most complicated and dangerous brakes that could be put into operation. The Westinghouse was worked with an air pump at a pressure of 90 lb. to the inch. This was on the engine, so that if the air pump were to explode—and it was not an impossibility—it would lead to a most dreadful disaster. In the accident which had been alluded to, the brake did its duty. The brake was on, and the carriages held together, and if, through Providence, the engine-driver could have gone another 60 yards, the train would have got into the cutting and there might not have been a single injury."

Sir Edward is a little apt to quote "Providence" in the wrong direction in furtherance of his own particular views, and is equally fond of making violent attacks upon anything or anybody that he may conceive to be antagonistic at any particular time. It is not the first occasion on which he has made similar statements in regard to the Westinghouse brake (see the report of the January meeting of the Metropolitan Railway Company), and his repetition of them at the recent South-Eastern meeting was no doubt prompted by the feeling that the vacuum brake had failed most unfortunately, when it was most wanted to save life, in the course of the recent accident at Penistone on the Manchester, Sheffield, and Lincolnshire Railway.

The Westinghouse Brake Company, however unwilling they might otherwise be to interfere at such a time, is now bound in self-defence to reply to the above uncalled for and unjustifiable statements of Sir Edward Watkin, and I have to request on behalf of that company that you will kindly afford them a limited amount of space for that purpose.

Sir Edward Watkin has here pitted the ordinary non-automatic vacuum brake against the Westinghouse automatic brake as worked on the North-Eastern, Great Eastern, Brighton, Chatham and Dover, North British, Caledonian, Glasgow and South-Western, and other railways in this country. As a proof of the danger of em-

ploying the latter he states that it is worked with an air-pump at a pressure of 90 lb. to the square inch, and that if the air-pump or the engine were to explode, it would lead to the most dreadful disaster. Our answer, Sir, to this allegation is, that the Westinghouse air-pump is worked by the steam from the boiler itself, which carries a pressure of 140 lb. or 150 lb. per square inch, and supplies the cylinders of the engine; and although there are upwards of 11,000 of these air-pumps upon engines in different parts of the world which are fitted with the Westinghouse brake, and of which large numbers have been working for upwards of ten years, not one of them has ever exploded, which is more than can be said for the boilers of the locomotive engines themselves. Moreover, if an air-pump were to explode the damage to be feared from it would be infinitesimal as compared with that of an explosion of the engine boiler.

We can only suppose that Sir Edward Watkin has ventured upon this absurd statement for the reason that he could not find a better argument, and that "any stick is good enough to beat a dog with;" and the only conclusion to be derived from it is that, according to Sir Edward's views, the locomotive engine itself is a most dangerous appliance, and should no longer be employed on English railways.

In disproof of Sir Edward Watkin's other assertions we cannot do better than refer to Mr. T. E. Harrison's notes* on the working and maintenance of the Westinghouse brake on the North Eastern Railway, which were published by you on page 71 of your issue of July 18. No railway engineer in this country can be considered more competent, more impartial, or more independent than Mr. Harrison, and his testimony on this subject is the most valuable that could be adduced, as it has been compiled by himself unsolicited, for his own information.

But what is of still greater interest to the general public is the action of the vacuum brake in the Penistone accident, and the results that would have been obtained if the train to which this disaster happened had been fitted with the Westinghouse brake. The facts of the case are briefly these; the crank axle of the engine failed whilst the train was running at its usual high speed near the Bullhouse signal-box. The engine of the train ran upwards of 320 yards before it came to a stand, with the tender and the horse-box still attached to it. The other vehicles of the train were more or less damaged or destroyed after running upwards of 200 yards from the point at which, according to the evidence, after the fracture of the crank axle, the vacuum brake was applied. This distance of 200 yards was sufficient to bring the train to a stand, as shown not only by experiments specially tried on different lines of railway, but also in the ordinary working of the Westinghouse brake on every line on which it is in daily use for every stoppage of every train, which is so fitted. The engine and every vehicle of this particular train might, and would, either have been brought to a dead stand within these 200 yards, or the speed at the end of the 200 yards would have been so much reduced that none of the carriages would have been damaged, and that *no man, woman, or child would have been injured.* Major Marindin, the Government inspector, himself says: "Had the brake been automatic I think there is no doubt that the rear vehicles would have gone over the bank at very much less speed, even if they had not been stopped before going over." If there is any doubt on this subject, let a train, fitted with the Westinghouse brake, similarly constituted, be removed from the same spot, and let it be ascertained within what distance such a train running the same speed could be stopped. Surely, Sir, the frightful loss of life and injuries which have been sustained by so many passengers would justify this easily made experiment.

One point to which we should not, in conclusion, omit to refer is this, that when a coupling fails between two carriages or elsewhere, or if the brake apparatus is injured in any way, there is no brake power left on a train fitted with this vacuum brake, whereas, when a coupling fails on any portion of a train fitted with the Westinghouse brake, or should any part of the apparatus be damaged, the brake blocks are applied with full force to the engine and every wheel throughout the train.

I may add that during three years and nine months there has been an increase in the sales of Westinghouse automatic brakes of 8276 sets of apparatus for engines and 40,563 for carriages and wagons, there being altogether on April 30 last 11,553 sets for engines and 63,065 for carriages and wagons. These figures should in themselves be sufficient refutation of Sir Edward Watkin's groundless accusations.

Yours truly,
A. Kapteyn,
Manager and Secretary of the Westinghouse Brake Company, Limited.

Canal-road, King's Cross, London, N.,
July 28, 1884.

* See Engineering, page 71 *ante*.

ROLLER MILLING.

To the Editor of Engineering.

Sir,—Though not the writers of the article in your issue of the 11th inst. (which Mr. Simon has thought fit to criticise), we are evidently the objects of his special attention, and perhaps you will kindly permit us a word or two in reply.

We wish to bear testimony when Mr. Simon approaches a fact, and admit the mills in question *are* the first which have been fitted with our system in its complete form; this is generally known in the milling trade, at the same time it is as well known that our experience of gradual reduction milling dates quite as far back as the time Mr. Simon fixes for *his* early experience. We have been since then advocating certain principles as of quite as much importance as rolling, which are embodied in our system, and not now wholly disregarded in the many milling systems offered. We have not had the same good fortune in securing orders as Mr. Simon, but the inference that we may be of those "who sprung up after him" does not belong to us at all, for we have not sought to make him our model in any way.

We freely admit Mr. Simon has fitted and is fitting many mills on the roller system; but no right-minded milling engineer would begrudge him his success, if only he would let that content him; it is easy to see he is not the most likely or unprejudiced person to pass an opinion on mills fitted by a competitor. "In the mills he starts now," it is gratifying to learn they are so rapidly built, and go off with such wonderful success; but if, after all the experience of his system he has had, he cannot count on a good start, when can he? The other portion of his letter calls for little remark, most of it appears in the shape of advertisements in other papers.

We, however, observe he has converted a prominent London miller to the roller milling system, and we wish him the success with his first complete roller mill in London, that he neither seems to have wished nor anticipated for us.

Yours truly,
Thompson and Williamson.

Wakefield, July 30, 1884.

To the Editor of Engineering.

Sir,—Under the above heading in your last issue we notice a letter from Mr. H. Simon, in which he takes credit to himself of being the introducer into this country of systems of flour milling without the aid of millstones, and that speaking generally, his system, beyond any doubt, is the most important.

We must take exception to both these assumptions. For before Mr. Simon had a plant working in this country in which stones played no part, Messrs. Nagel and Kaemp's system had been introduced into two mills here, viz., that of Messrs. Eisdell and Soundy, Reading, started December, 1878, and Messrs Pattinson and Winter, started March, 1879. And as regards the output of the mills now running, or about to run his system, 150,000 sacks per week, we venture to say that this capacity is greatly exceeded by those at present working, or about to work the system of Messrs. Nagel and Kaemp; but we do not take credit to ourselves as being the representatives of the most important plant in this respect, for we are aware that there are others that can boast a considerably larger weekly output.

We are, Sir, yours truly,
Sanderson and Gillespie.

London, July 30, 1884.

THE FOUNTAIN DISPLAY AT THE HEALTH EXHIBITION.

To the Editor of Engineering.

Sir,—As the name of our firm was omitted from the graphic description given in your last number of the illumination of fountains and water works at the Health Exhibition, you will greatly oblige us by stating in your next issue that the electric apparatus used in signalling was supplied and fixed by

Your obedient servants,
J. and W. E. Archbutt.

London, July 30, 1884.

WIND PRESSURE.

To the Editor of Engineering.

Sir,—The suggestion of "T. A. G." to measure wind pressure by means of barometers placed before the surfaces of my scheme will not answer, as the rising of the mercury in the tube of a barometer will have an action analogous to that of a spring behind a surface, and so case off sudden pressure, and this I wish to avoid. A homely illustration will convey what I desire.

Take, for instance, an ordinary machine—common at country fairs—for the testing of the power of a man when striking a straightforward blow with his fist. If we were to do away with the spring behind the buffer and replace it with a weight hung over a pulley—the striker to raise the weight instead of compressing a spring—the inertia of the weight would cause the striker to feel a far greater concussion and pressure than would be experienced when exerting his force against a spring; and this pressure against inertia and comparative rigidity of structure is actually what we require to know in engineering.

If we had good wind velocity measures we might calculate pressures as by the "heads" velocities could sustain; but before, or in front, of surfaces impinged upon by currents there are heaped up conical and pyramidal, &c., shaped masses of air, which somewhat mitigate pressures, and, as we cannot, theoretically, value their influences, I prefer my "dead weight" lifts, which will show what *actually* occurs in Nature. Theory has gone a long way too far in modern times; let us hark back to sound experiment and just inferences therefrom.

Yours truly,
(*Jr.*) Pinnington.

23, Chichester-street, Chester, July 30, 1884.

THE MECHANICAL EQUIVALENT OF HEAT.

To the Editor of Engineering.

Sir,—I hope it may not be considered impertinent in me to express a desire that, before entering on the question of wind pressure, Mr. Pinnington would now favour us with the account of his equivalent and how it is obtained and proved, which I understood him to promise in his letter in your issue of April 11, as soon as the question there asked had been solved by a direct method.

As for the "mistake" which he, in his letter in your issue of July 4, says that I make, I can only state it as my opinion that the work done by 772 lb. descending through a distance of 1 ft. amounts to 772 foot-pounds, no matter whether this work is spent solely in overcoming the inertia of the falling body itself, or partly in raising some other weight; or whether it is spent in increasing the temperature of some gaseous body, as in the case in question. Also that the amount of the work is in no wise affected by the time occupied in the descent. Apologising for intruding so far on your space,

I remain, yours faithfully,
Glasgow, July 28, 1884. H.

ROYAL CORNWALL POLYTECHNIC SOCIETY.

To the Editor of Engineering.

Sir,—In the new catalogue lately issued by Messrs. Tangye Brothers I find a note as to an award by the above Society that may lead to misconception. I refer to the statement that the special gold jubilee medal of the Society was awarded to the "Robson" gas engine, the "Wilson" gas producer, and Tangye's new donkey feed pump. Now this medal was not awarded to any one of these three particular exhibits, but to the whole collection exhibited by Messrs. Tangye on the ground of the "extent, utility, adaptation, and practical value of their exhibits." Had this medal not been thus awarded for their exhibit as a whole "the judges would have awarded a first silver medal to the new gas engine shown by this firm, and second silver medals also for their gas producer and new donkey feed pump" (the clauses in inverted commas I quote verbatim from page 61 of the Report of the Royal Cornwall Polytechnic Society for the year 1882, being the year when the collection in question was exhibited by Messrs. Tangye)

Inclosing my card, I am, Sir, yours truly,
One of the Judges.

THE CARDIFF FLOATING DOCK.

To the Editor of Engineering.

Sir,—The floating dock illustrated in your issue of July 18, seems to involve some considerations of the means of raising and lowering the dock with a vessel on over the blocks.

It would probably be interesting to some of your readers if they could see the exact method of working; for instance, the stability of the dock with a vessel on and just raised above the water as in Fig. 1; with a vessel on and partly borne by the dock as in Fig. 2; and with a vessel on ready for lifting as in Fig. 3. It would seem that any tendency of the dock to cant with the vessel on, is entirely taken by the system of side beams on the principle of the parallel rule. Now, upon a vessel being taken on the dock, unless the vessel is very exactly placed over the centre of buoyancy or lifting power of the dock, there will be a tendency, directly the weight of the vessel is

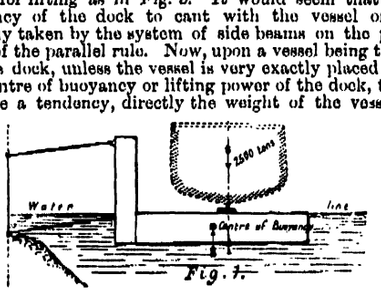


Fig. 1.

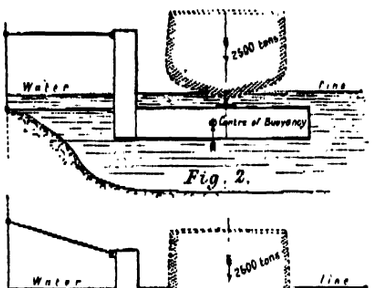


Fig. 2.

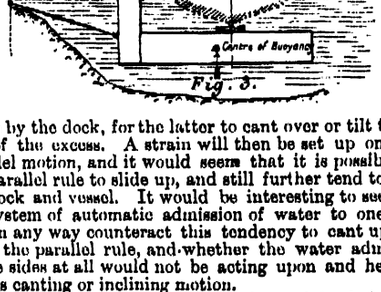


Fig. 3.

borne by the dock, for the latter to cant over or tilt to the side of the excess. A strain will then be set up on this parallel motion, and it would seem that it is possible for the parallel rule to slide up, and still further tend to cant the dock and vessel. It would be interesting to see how the system of automatic admission of water to one side will in any way counteract this tendency to cant up and move the parallel rule, and whether the water admitted to the sides at all would not be acting upon and helping to this canting or inclining motion.

I should like to see the principle explained, having taken a certain interest in the matter from your illustration and description of the dock.

I am, Sir, your obedient servant,
Charlton, July 21, 1884. J. A.

INFORMATION WANTED.

To the Editor of Engineering.

Sir,—Can you or any of your readers give me, or inform me where I will find, *accurate* information as to the frictional resistance of different kinds of earth (sand, gravel, clay, &c.) on the surface of cast and wrought-iron piles, while being screwed down into the earth?

In the case of screwing a pile so much power is re-

quired to overcome the friction on the vertical surface, and so much to drive the thread into the ground. I wish to ascertain how much power is lost in overcoming the friction.

July 25, 1884. SCREW PILE.

TRIAL TRIPS AND LAUNCHES.

ON Thursday, July 10 Messrs. E. Finch and Co. (Limited) launched from their yard at Chepstow an iron screw steamer, built to the order of Messrs. W. Williams and Son, Newport, and intended to be used by them as a passenger steamer in the Bristol Channel, and also for towing purposes. She has been designed with a view of obtaining great speed and power. Her principal dimensions are: Length over all, 95 ft.; extreme beam, 18 ft. 1 in.; depth moulded, 10 ft. 1½ in. She is fitted with five water-tight compartments, with wheel-house, and steam windlass. She will be supplied by the builders with engines of 90 horse-power nominal.

On Saturday, July 12, there was successfully launched from the shipbuilding and engineering works of Messrs. Oswald, Mordaunt, and Co., the Alexandra, a fine iron sailing ship of 2500 tons register, built under the superintendence of Mr. Malcolm to the order of Mr. John Coupland, Goscote Hall, Leicester, of the following dimensions: Extreme length, 322 ft., breadth, 41 it. 3 in., depth of hold, 24 ft. 9 in.

On Tuesday, the 15th July, Messrs. Lobnitz and Co., Renfrew, launched a screw steamer named the Magnus, a vessel measuring 260 ft. by 34 ft. 4 in. by 17 ft. 6 in. and built to the order of Mr. L. H. Carl, of Copenhagen. She is being fitted by the builders with compound engines of 160 horse-power nominal. She is the tenth vessel built for the same owner by Messrs. Lobnitz and Co.

The handsome steel screw steamer Thorsa, recently built by Messrs. Barclay, Curle, and Co., Whiteinch, near Glasgow, went on her official trial trip on the same day. She is owned by Messrs. James Currie and Co., Leith, and is intended for their Copenhagen and Christiansund trade. She is a vessel of 1370 tons register, and measures 247 ft. by 33 ft. by 23 ft. She has accommodation for 46 first-class passengers, together with ample room for second-class and emigrants, and very complete fittings for the carrying of cattle. On the measured mile the Thorsa attained a speed of over 13 knots per hour.

Also, on the same day, the screw steamer Elm, the latest addition to the well-known channel fleet of Messrs. Alexander A. Laird and Co., Glasgow, ran her official trial trip on the Firth of Clyde. She has been built by Messrs. A. and J. Inglis, Pointhouse, Glasgow, and measures 182 ft. by 27 ft. by 12 ft. 9 in. She was fitted by her builders with engines of 780 indicated horse-power, having cylinders of 26 in. and 50 in. in diameter, respectively, with 3 ft. stroke. A mean speed of 12.24 knots was attained on the measured mile, being three-quarters of a knot in excess of the speed anticipated by the owners.

The screw steamer Gran Chaco Argentino, a vessel recently built by Messrs. Aitkin and Mansel, Glasgow, for Messrs. Torrado and Molers, of Buenos Ayres, had her trial trip on Thursday, the 17th of July. With half her cargo on board she attained a mean speed of upwards of 10½ knots, which was greater than that contracted for. She measures 200 ft. by 28 ft. by 18 ft. 9 in., and is a vessel of 750 tons gross. Her engines were supplied by Messrs. Hutson and Corbett, Glasgow. The vessel is for a line of steamers trading in the River Plate, between Buenos Ayres and Rosario de Santa Fe.

On Saturday the 19th of July, Messrs. Ramage and Ferguson, Leith, launched the Otter, a steel twin-screw steamer which is intended for combined passenger and towing traffic in Queensland, her owners being Messrs. Webster and Co., Brisbane. She has been especially designed for great speed and efficiency in towing, and measures 128 ft. by 21 ft. by 11 ft. She will be propelled by two sets of compound engines, having cylinders 15½ in. and 30 in. in diameter, respectively, with stroke of 20 in.

On Wednesday, the 23rd of July, Messrs. Pearce Brothers, Dundee, launched the Herald, a steel screw steamer of 850 tons gross register. She has been built under special survey to the order of Messrs Stone Brothers, Auckland, New Zealand, and measures 180 ft. by 28 ft. by 13 ft. She is to be employed in the New Zealand coasting trade, and is the first of a fleet of steamers by which Messrs. Stone Brothers are about to replace the sailing craft with which they hitherto conducted their coasting trade.

Messrs. Murdoch and Murray, Port-Glasgow, on the following day launched the Espord, the last of three sailing schooners built by them to the order of the Argentine Lloyd's. She is a vessel of 247 tons, and measures 130 ft. by 31 ft. by 8 ft.

Also, on the following day, Messrs. Russell and Co., Port-Glasgow, launched the Wynnstay, a handsomely modelled iron sailing ship of 2500 tons deadweight carrying capacity, built to the order of Messrs. D. W. Davies and Co., Liverpool, and intended for the San Francisco trade.

Messrs. Russell and Co. also launched on Saturday, the 26th of July, from their shipyard at Cartsdyke, Greenock, the General Roberts, a magnificent four-masted iron sailing ship of 2000 tons gross register, and measuring 274 ft. by 40 ft. by 24 ft. She has been built under special survey for Captain L. Davies, of Liverpool, and is to be employed in the Australian passenger trade.

On Monday, the 28th of July, Messrs. M'Knight, M'Cradie, and Co., Ayr, launched an iron screw steamer named the Coila. She is a vessel of 350 tons gross register, and has been built to the order of Messrs. Thomas M'Laren and Co., Glasgow. She is intended for the general coasting trade, and will be fitted with machinery by Messrs. John Gilmour and Co., Glasgow.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—No change was reported in the pig-iron market last Thursday, and any business that took place was done at 41s. 3½d. cash and 45s. 5½d. one month. The market was very quiet on the following day, and prices again remained practically unchanged over the whole day. Prices experienced an advance of 1d. per ton on Monday, the market being somewhat stronger. The closing rates in the afternoon were 41s. 5d. cash and 41s. 7d. for sellers, with buyers offering ½d. per ton lower. Yesterday's market was very firm, and prices advanced 1½d. per ton, reaching a rise of 2½d. on the two days. Transactions were reported on forenoon 'Change at 41s. 4½d. to 41s. 5½d. cash, also at 41s. 6½d. to 41s. 7½d. one month, the close being buyers at the top quotations and sellers wanting ½d. per ton more. Business was done in the afternoon at 41s. 6d. and 41s. 6½d. cash, also at 41s. 8d. to 41s. 9d. one month, and the close was sellers at 41s. 6½d. cash and 41s. 8½d. one month, and buyers at ½d. per ton under. Some change took place to-day, and closing quotations were sensibly under those of yesterday. Business was transacted during the forenoon at 41s. 6d. down to 41s. 4½d, and back to 41s. 5½d. cash, also at 41s. 8d. down to 41s. 6d. and back to 41s. 7d. one month, the closing prices for sellers being 41s. 5½d. and 41s. 7½d. cash and one month respectively, with buyers offering ½d. per ton less. Little change took place in the afternoon and the closing quotations for sellers were 41s. 6d. cash and 41s. 8d. one month, with buyers at ½d. less per ton. Comparatively little business has been done in warrants during the past week, as the outside investors are still much averse to embarking in speculative purchases of pig iron, notwithstanding the very low prices now ruling; and any business that is being done from day to day is almost entirely confined to the trade. The inquiry for makers' iron is moderately good, and prices display very little variation. It cannot be said that the languor that has for so long surrounded the home trades has in any way been reduced, and the reports from the United States and the Continent are still exceedingly unsatisfactory; from Canada, however, some improvement is reported. There are now 94 blast furnaces in actual operation as compared with 96 last week, one having been damped out at the Shotts Iron Works and one at the Langloan Iron Works. At this time last year there were 115 furnaces in operation. Last week's shipments amounted to 10,315 tons, as compared with 8706 tons in the preceding week, and 14,058 tons in the corresponding week of last year. They were as follows: To Canada, 901 tons; to the United States, 1060 tons; to India, 100 tons; to Australia, &c., 300 tons; to France, 1020 tons; to Italy, 1375 tons; to Germany, 690 tons; to Holland, 922 tons; and lesser quantities to other countries, with none to Russia. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood yesterday afternoon at 587,581 tons, as against 587,831 tons yesterday week, showing a decrease of 250 tons for the week.

Shipment of Patent Slip and Steamer for Patagonia.—Messrs. Kincaid and Donald, engineers, Greenock, have lately shipped the patent slip formerly belonging to Mr. Watson, of the Ladyburn Boiler Works, for conveyance to Patagonia, South America, where it will be erected for the convenience of small steamers requiring an overhaul in that part of the world. The paddle steamer recently built in a field adjoining Messrs. Kincaid and Donald's works, after being taken to pieces, was shipped on board this vessel also for conveyance to South America.

Kinghorn Shipbuilding Yard.—There is now a prospect of operations being continued at Kinghorn Shipbuilding Yard, an offer by Mr. G. A. Key, one of the partners of the bankrupt firm, to purchase the trust estate at 6s. per 1*l.* having just been made to the creditors and accepted. Mr. Key is allowed till October 1 to meet the offer, failing which the arrangement is to fall, and the estate is to be wound up by a trustee. It is generally believed that Mr. Key will be able to overcome the difficulty, and that when once trade has revived, Kinghorn Shipbuilding Yard will again be busy.

Sandpoint Shipbuilding Yard, Dumbarton.—The shipyard which belonged to the bankrupt firm of Messrs. Henry Murray and Co., Dumbarton, and which has laid idle for a short time, has just been purchased at a public sale by Messrs. Babtie and Craig, solicitors, Dumbarton, for a client, whose name in the mean time is not publicly known. The sum paid was the upset price of 10,000*l.*

The Greenock Sugar Refineries.—At a meeting of the Greenock sugar refiners held on Monday, it was agreed to reduce the output of sugar by about 700 tons per week, which is about 15 per cent. of the total quantity refined in Greenock per week. Of late the weekly output has been about 5200 tons. There are some fourteen or fifteen sugar houses in that town, and two or three of them, which are very large, have a refining capacity of about 1000 tons per week.

The Shipyards.—The fair holidays having now come to a close, most of the shipbuilding yards on the Clyde have resumed work, but there are at least two or three, if not more, that will not be re-opened till Monday of next week.

Fife and Clackmannan Miners.—There seems to be a probability of another strike arising at one of the Fifeshire collieries, not on account of wages, but in consequence of two of the workmen having been made martyrs in a case lately raised in the Sheriff Court to challenge the legality of the "Billy Fairplay" system of weighing the coals brought to the pithead. In the event of the threatened strike being declared, it is probable that the coalmasters of Fife and Clackmannan will declare a general lock-out.

Gas Managers' Meeting.—On Thursday of last week the annual meeting of the North British Association of Gas Managers took place in Glasgow, under the presidentship of Mr. F. T. Linton, manager of the Leith Gas Works. There were several interesting communications made to the meeting, which was in all respects a very successful one.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was only a small attendance on 'Change at Middlesbrough and the tone of the market was very quiet. No. 3 Cleveland pig iron was quoted 36s. 9d. per ton, and No. 4 forge was offered at 34s. 6d. to 35s. These prices were considered quite nominal, and only trifling lots changed hands. Shipments are not equal to what they were last month, and it is feared that when the Cleveland Ironmasters Association issue their returns for July it will be found that makers' stocks will have increased very considerably. The policy of restriction is still adhered to by the ironmasters collectively, but individually there are differences of opinion, and merchants believe that the doctrine of the survival of the fittest, however unpalatable, will in the end prevail.

The Manufactured Iron Trade.—There is no change in the prices of manufactured iron and only a limited business is being done. Many of the works are only partially occupied and a great many men are out of employment. Owing to the general slackness in the shipbuilding trade on the northern rivers there is next to nothing to do for the angle and plate makers. The Tyne is more favourably off than the other rivers, but with that exception the shipbuilders and engineers in the northern counties find it most difficult to obtain orders.

The Steel Trade.—The steel trade is suffering from the general depression, Messrs. Bolckow, Vaughan, and Co., of the Eston Steel Works, Middlesbrough, are unable to obtain orders to keep their enormous plant in full operation and they have closed the works. It is hoped that work will soon be resumed.

The Prospects of Trade.—Trade prospects were never so bad during the past ten years as they are now. Wages are down to the lowest point, and the doctrine of economy of production has been practised to the utmost extent. Time seems the only remedy for bad trade. All the idle ships laid up must be afloat before capitalists will give out orders for new vessels. It is hoped that the harvests will be so good as to give an impetus to trade.

The Coal and Coke Trades.—There is no alteration in the fuel trade.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Brown, Bayley, and Dixon (Limited).—A general meeting of the shareholders of Brown, Bayley, and Dixon (Limited), has been held at the Royal Victoria Station Hotel, Sheffield. The meeting was called by the liquidators, Mr. J. H. Barber and Mr. William B. Peat, "for the purpose of having the account of the liquidators, showing the manner in which the winding up of the affiairs of the company had been conducted, and the property of the company disposed of, laid before the company, and hearing any explanation that may be given by the liquidators." The meeting, to which representatives of the press were not admitted, was stated to be purely formal."

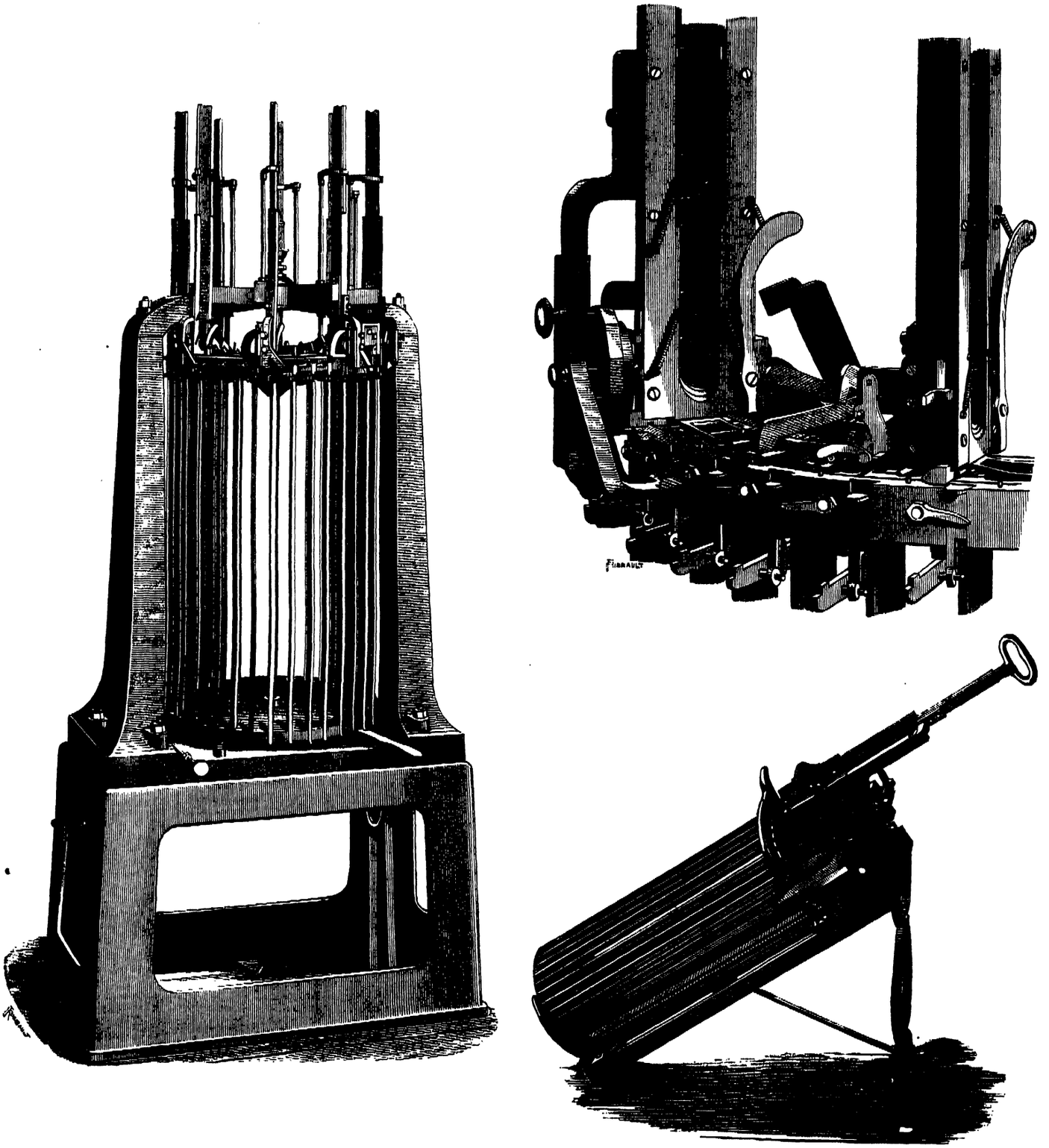
Messrs. Briggs and their Collier.—The men at the Don Pedro pit, of Messrs. Briggs and Co., Normanton, have returned to work after being on strike for a fortnight. The reason of the dispute which terminated so abruptly, was that 200 men were served with notices for leaving their work without giving notice. The company claimed 2*l.* 13s. 4d. for each man. Several alterations will be made in the mode of working, but the short-lightning in the afternoons will be continued as before. Unless the short-lightning question be remedied, it is believed the men will give a fortnight's notice shortly.

Depression in Sheffield Trade.—There are no good accounts to hand from any travellers engaged in the Sheffield trades. Both continental and home buyers are slack of work, and there being universal complaint, the whole of those complaining cannot be wrong. Coal at the pit mouth is only realising 8s. 9d. per ton for best, and this is a criterion not to be despised.

WATER SUPPLY OF GEELONG.—Colonel Sargood, the Victorian Minister of Water Supply, has opened a supplementary source of water supply for Geelong. A weir has been constructed across the eastern branch of the Moorabool about four miles from Ballan, and by this means storage capacity is obtained for 12,000,000 gallons on an area of about six acres. The water supply of Geelong will thus be increased from between 300,000 and 400,000 gallons daily to 500,000 gallons daily. The gathering ground of the two reservoirs at Upper and Lower Stony Creek has proved too limited in area, and this rendered the new works necessary. They have cost about 21,000*l.*

FISCHER'S TYPE-DISTRIBUTING MACHINE.

(*For Description, see Page* 102.)



The Late Sir William Siemens.—The executors of the late Sir William Siemens have arranged for the continuance of his practice as a consulting engineer by transferring his obligations or rights, including his patents for regenerative furnaces and iron, steel, and glass processes, to his brother, Mr. Frederick Siemens, who was co-inventor of the regenerative gas furnace, and has since been continuously engaged in its development.

South American Railways.—The Andine Railway has been completed to Mendoza, the capital of the province of that name, and lying at the foot of the Andes. The new line crosses the South American continent stretching from the Parana to the Cordilleras, a zone of immense natural wealth is thus thrown open, and the traffic on the line promises to be large. Mendoza covers an area of about 5000 square leagues at the foot of the Andes, with a population estimated at 150,000 souls. The rivers Mendoza, Tunuyan, Desaguadero, Diamante, and Atuel, irrigate over 1000 square leagues of the province, and the soil is so bountiful that the yield is often a hundred-fold. The mineral wealth of the province is also great.

The Verein Deutscher Ingenieure.—The twenty-fifth general meeting of the Verein Deutscher Ingenieure will be held this autumn at Mannheim from September 1st to 3rd inclusive. Some of the most interesting public works, the harbour, water works, &c., and a number of private manufacturing establishments, will be visited by those of the members who avail themselves of this opportunity. Of the more important subjects to be discussed at the meeting we may mention the reports of specia commissions appointed to investigate the law of industrial protection (patent law, registration of trade marks, &c.), investigation on steam boilers and engines, and practical education of young engineers. Papers will be read by Professor Dr. Engler, "On the present State of the Aniline Colour Industries;" Mr. O. Smreker, "On a New Method for the Direct Measurement of Speeds;" Professor Herrmann, "The Graphical Treatment of the Mechanical Theory of Heat;" Mr. L. Post, "The Industry of Mannheim and Surroundings," and others. This Society is one of the largest scientific bodies, numbering now over 5100 members and having 29 branches in various districts. Further particulars of the meeting may be had on application to the chief secretary, Mr. Th. Peters, Kurfürstenstrasse, 89, Berlin, W.

NEAR HÜTTENBERG, CARINTHIA.

SOR RIEDLER, MÜNICH.

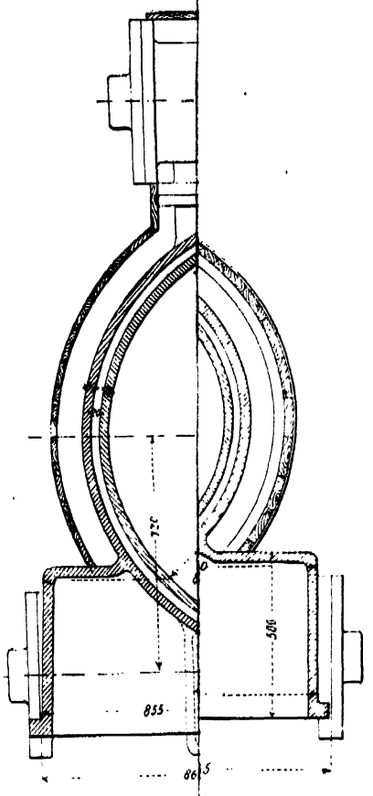


Fig. 9.

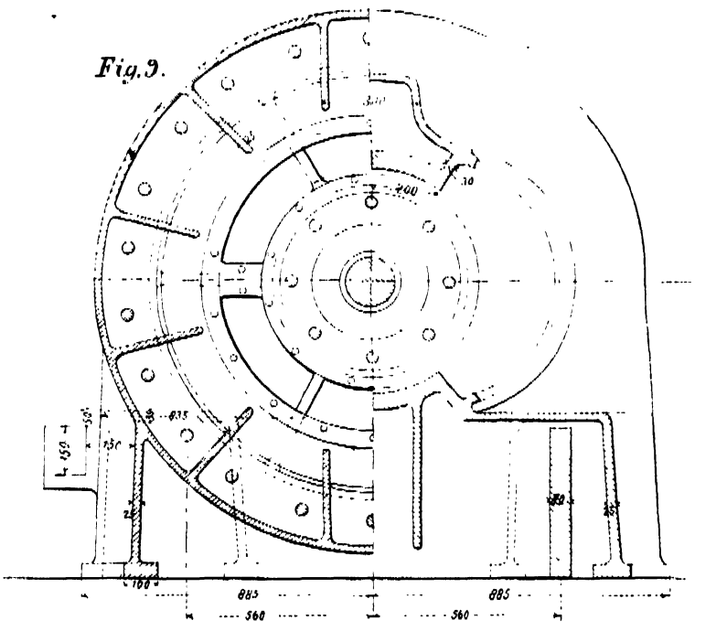
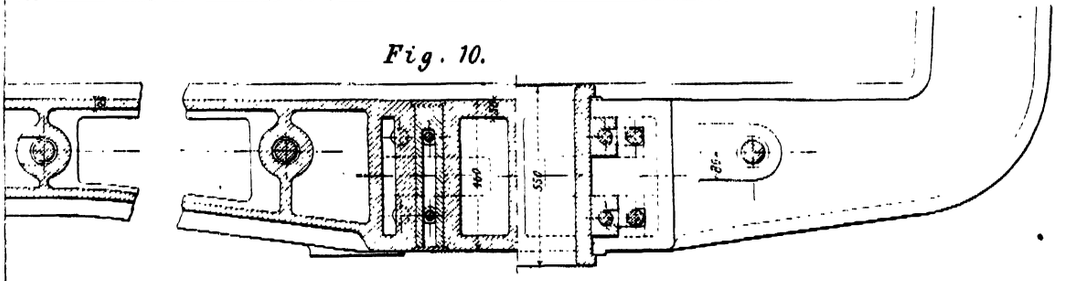
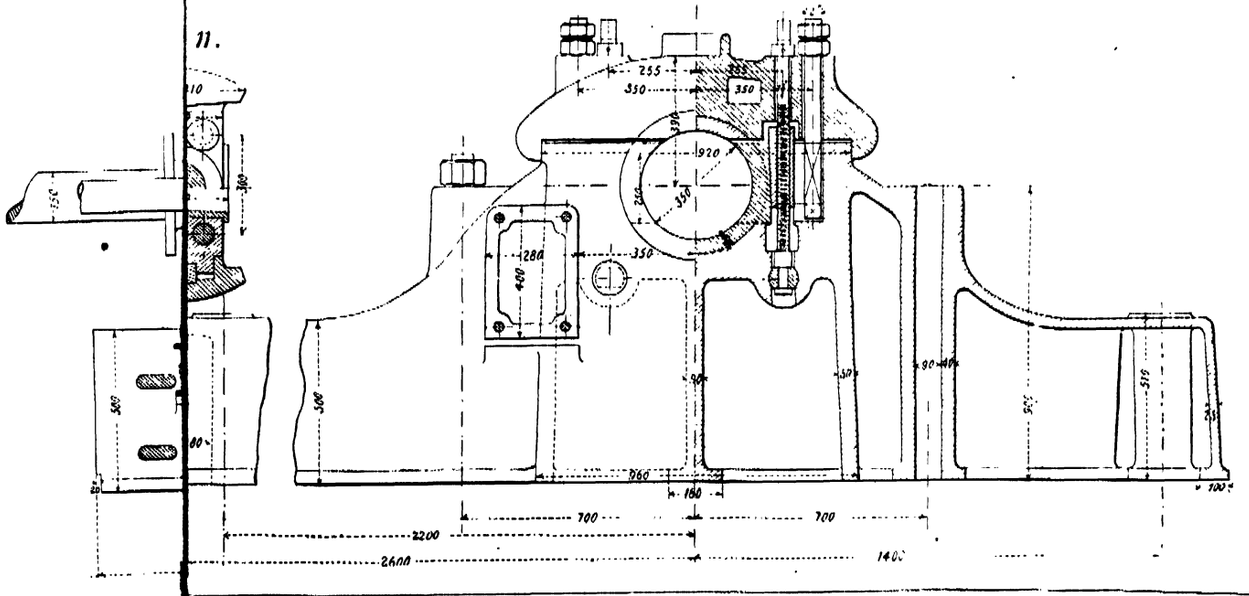


Fig. 10.



11.



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GLASGOW: William Love.
LEIPSIC: Alphons Dürr.
F. A Brockaus.
LIVERPOOL: Mrs. Taylor, Landing Stage.
MANCHESTER: John Heywood, 143, Deansgate.
OSTEND: Kirkland and Cope.
ROTTERDAM: H. A. Kramers and Son.
UNITED STATES: John Wiley's Sons, 15, Astor Place, New York.
VIENNA: Lehmann and Wenzel, Karntnerstrasse.

Advertisements intended for insertion in the current week's issue must be delivered not later than 6 P.M. on Thursday. The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. Serial advertisements will be inserted with all practical regularity, but absolute regularity cannot be guaranteed.

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The price of ENGINEERING to annual subscribers in the United Kingdom receiving copies by post is 1*l.* 9*s.* 2*d.* per annum. If credit be taken, the charge is 2*s.* 6*d.* extra, the subscriptions being payable in advance. There being two double numbers published each year, the amount of the annual subscriptions should be reckoned as Fifty-four numbers, with postage accordingly.

The publisher begs to state that since January 1, 1882, the ordinary copies of ENGINEERING sent abroad are printed on thin paper. The illustrations being, however, so much less effective on thin paper, foreign subscribers are strongly recommended to order thick paper copies, which they can have by paying the difference in postage as indicated below.

The rates for subscriptions to ENGINEERING from abroad are:
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2*l.* 0*s.* 6*d.* to India, Ceylon, the Straits Settlements, China, Japan, and the Hawaiian Islands. Thick paper copies, 2*l.* 7*s.* 8*d.*

All accounts are payable to the publisher, Mr. CHARLES GILBERT, 35 and 36, Bedford-street. Cheques should be crossed "Union Bank, Charing Cross Branch." Post Office Orders to be made payable at 407, Strand, London, W.C.

Foreign subscribers, especially when renewing their subscriptions, are particularly requested to advise the Publisher of the transmission of the Post Office Order, and the exact amount for which it is made payable. If this precaution is omitted, some difficulty is very likely to occur in obtaining the name of the sender.

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READING CASES.—Reading cases for containing twenty-six numbers of ENGINEERING may be had of the publisher or of any newsagent. Price 6*s.* each.

NOTICE TO AMERICAN SUBSCRIBERS.

We beg to announce that we have appointed the firm of John Wiley's Sons, 15, Astor Place, New York, the sole agents for ENGINEERING in the United States, and all subscriptions for the United States will in future be payable to them. They will also be prepared to receive advertisements for ENGINEERING, and will afford full information as to terms, &c., on application.

The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

NOTICE OF MEETING.

THE INSTITUTION OF MECHANICAL ENGINEERS.—The summer meeting will commence at Cardiff on Tuesday, August 5, and will terminate on Saturday, August 9. The following papers have been offered for reading and discussion after the address of the President, Mr. I. Lowthian Bell, F.R.S.: "On recent Coal-Shipping Machinery at the Bute Docks, Cardiff;" by Mr. John McConnochie, of Cardiff. "Description of the new Locomotive Running Shed at the Taff Vale Railway at Cathays, Cardiff;" by Mr. Charles Hurry Riches, of Cardiff. "Description of the Francke 'Tina' or Vat Process for the Amalgamation of Silver Ores;" by Mr. Edgar P. Rathbone, of London. "On the Use of Petroleum Refuse as Fuel in Locomotive Engines;" by Mr. Thomas Urquhart, of Russia. "On the Causes and Remedies of Corrosion in Marine Boilers;" by Mr. J. Harry Hallett, of Cardiff. "On the Mineral Wagons of South Wales;" by Mr. Alfred Slater, of Gloucester. "On the Application of Electro-Magnets to the Working of Railway Signals and Points;" by Mr. Illius A. Timmis, of London. The proceedings will commence at 10 a.m., on Tuesday, by a reception in the Cardiff Public Hall, by the Mayor. This will be followed by the presidential address, and after luncheon, by a visit to the Cardiff Docks, and the works in the neighbourhood. In the evening there will be a dinner by invitation of the Marquis of Bute. On Wednesday morning papers will be read, and in the afternoon there will be alternative excursions to four collieries on the Taff Vale Railway, viz., the Great Western Colliery, Lewis's Merthyr Colliery, the Cymmer Colliery, and the Llwynypia Colliery. Afterwards members will visit Penarth Docks and Windsor Gardens (by invitation of Lord Windsor). On Thursday morning there will be an excursion to Dowlais and Cyfarthfa Iron Works, and in the evening a conversazione at the Cardiff Free Library. On Friday Rhymney and Ebbw Vale Iron Works, Abercarn Tin Works, and Newport Docks will be visited, dinner being provided by Sir George Elliot, at Newport. The proceedings will conclude on Saturday by an excursion to the Severn Tunnel. A large number of works in the neighbourhood will be open to inspection.

ENGINEERING.

FRIDAY, AUGUST 1, 1884.

PRIVATE BILL COMMITTEES IN THE LORDS.

THE recent motion of Lord Rosebery for the appointment of a Select Committee to consider the best means of promoting the efficiency of the House of Lords, although it occasioned an animated and interesting discussion, proved abortive, if for no other reason than that the motion did not sufficiently indicate any particular object to which the attention of the proposed Committee was to be directed.

By no means the least noteworthy feature of the debate, at the present period of the House's history, was the tacit *esprit d'corps* inherent in all the speakers, irrespective of politics, which clearly indicated that in their estimation at least the traditional thanksgiving for their existence remains in force and has still a numerous and faithful following.

It is not, however, of the public duties of the Lords, whether efficiently performed or otherwise, that we desire to speak; stump demagogues will insure their clients an ample supply of talk upon that head; our theme runs solely in the private business direction, where we venture to suggest that "some slight readjustment, if not new machinery," as Lord Rosebery puts it, might indubitably increase their efficiency, and at the same time be highly advantageous to those who are professionally concerned in conducting it. Moreover, our case differs from Lord Rosebery's in that we have something definite to point to, while the remedy lies within easy reach of those who can apply it without the aid of further powers than they already possess.

Casual reference was made by several peers to private business, and we may remark in passing that, as regards joint committees, the idea of their utility, not to say necessity, appears, by what transpired, to have taken effectual root in ground where it may some day ripen into operation.

For many years past the Standing Orders of the two Houses have been practically assimilated, and a move in the right direction will assuredly be effected when the rules and regulations underlying those ordinances are rendered similarly identical by stamping out the defective portions on either side and adopting as a mutual code what is best of both departments.

In justice to the Upper House we must mention that in some respects its private business arrangements are in advance of its neighbour. For instance, the daily Minutes enable practitioners to ascertain at a glance the particular stage which each Bill before the House has reached, namely, whether it is waiting reference to the examiner, second reading, commitment, committee, report, or third reading, or whether it has been sent on to the other House. This useful information has no parallel in the Lower Chamber.

It may be serviceable to explain here how the two Houses differ in practice with reference to what are called originating Bills, that is to say the Bills which every session are allotted to each at the meeting of the two Chairmen of Committees. This is the backbone of our argument, inasmuch as we contend that as regards originating Bills the two Houses start upon an equal footing. As the time for petitioning against the Bills in both Houses expires, they are respectively divided into two classes, one comprising those upon which committees are to be nominated by the Committee of Selection in the Lords, and by the Railway and Canal Committee and Committee of Selection in the Commons; the other containing those which are to be adjudicated upon as unopposed and under the jurisdiction of the respective Chairmen of Committees. In the House of Commons the opposed cases are formed into groups according to the nature and character of the Bills; but in the Lords a list is compiled of Bills periodically added as they become eligible, and those referred to committees, when appointed, are culled from it upon some mysterious principle best known to those who perform the operation.

To illustrate our meaning more clearly, we will go no farther back than the present session, which is devoid of peculiar circumstances lifting it out of the ordinary run.

The Private Bills originating in the House of Lords this year amounted to the symmetrical number of one hundred, which was made up as follows: 21 related to railways, 4 to tramways, 19 to harbours, docks, piers, bridges, and navigation, 14 to corporations, local boards, and improvement commissions, 17 to gas and water, and 24 were of a kind too dissimilar to be classed under any governing denomination, while the Manchester Ship Canal, with a committee to itself, completes the total.

Speaking as among the uninitiated, and guided purely by what is done in the Commons, it seems to us that these one hundred Bills might have been distributed thus: the 25 railways and tramways, sorted geographically, would have composed four groups; the 19 harbours, &c., three; the 14 corporations, local boards, and improvements, two; the 17 gas and water, two; and the 24 miscellaneous, three.

Some modification of the above arrangement would, of course, be necessary when the unopposed Bills were eliminated from the groups, but the same thing happens in the Commons without creating difficulty, and we should suppose might with equal facility be managed in the Lords, notwithstanding the proportion being virtually two to one against the latter.

The progress of Bills in both Houses is subject to a slight protraction in cases of non-compliance with Standing Orders, and as regards those commencing in the Lords, the time for petitioning is extended to the seventh day after second reading, which latter stage is again dependent upon whether the Bill requires submission to a Wharncliffe meeting; but under any circumstances these matters can be completed in about twenty-one days from first reading, so that all Bills ought to be ripe for committee within a month of their commencement in the Upper Chamber.

Neither to all appearance need the passage of Bills between the two Houses affect either the grouping or appointment of committees. The Commons adopt pretty much the same course with both classes, and the Lords regularly pass a Sessional Order that no Private Bill brought from the House of Commons shall be read a second time later than a particular day, which is generally fixed at about the middle of June. The majority of Bills which began in the Commons are consequently, owing to this timely warning, ready for committee in the Lords at the limiting date, while the defaulters come flocking in as speedily as possible afterwards, therefore by the third week in June the bulk of Bills waiting commitment are fairly in the hands of those who arrange that branch of the business.

The culminating point of divergence between the two Houses is in the proceedings incident to the appointment of committees. In the Commons the Railway and Canal Committee and the Committee of Selection, hold periodical meetings which are advertised in the votes, [illegible] are open to the attendance of Parliamentary agents, solicitors, from whom the Committees invite and obtain information as to the Bills about to be referred. The probable date at which each group will be committed is intimated from time to time by the two committees to the agents, and about six days' notice appears in the votes when each committee is finally nominated, and the meeting fixed; in effect the intimation usually extends over about fourteen days.

A further and most important convenience as regards cost is conferred by the two committees naming the Bill or Bills to be considered on the first day, after which two clear days' notice is published in the votes of the House, stating when each of the remainder will be taken; thus ample time is afforded throughout for the briefing of counsel and arrangements as to witnesses; furthermore the time allowed is available for settlement of disputed cases by which expense is saved on both sides. In the Upper House no such custom prevails, in fact, beyond the names of the peers who ostensibly compose the Committee of Selection, which are inserted in the Minutes of the House, the committee to outsiders is a myth—when and where the members meet, what their functions are, and upon what basis the Bills are selected, alike form impenetrable enigmas; all that is known about the matter is that occasionally during the sitting of the House a written paper appears at the door of the Committee Clerks' Office, announcing the fact that certain committees have been nominated, and the

date of their meeting fixed, which latter varies from one to three clear days later, and has been known in previous sessions to happen on the following morning. To watch the advent of this edict, Parliamentary agents who have opposed Bills before the House must be in attendance every evening until their Bills are appointed. The first Lords' Committee this year was nominated on the 3rd of March. The opposed list then contained fifty Bills of all classes; those referred appear, however, to have been picked (putting it mildly) at discretion, and the group comprised one pier, two gas, one harbour, one drainage, and one improvement Bill, being about as heterogeneous a collection as could well be selected, and harmonising on a par with the happy family of itinerant menagerie notoriety. The committee was to meet on the 7th of March, being three clear days from nomination. The most flagrant instance of short notice in this session occurred on Monday, the 23rd of June, when two groups were appointed for the following Wednesday morning at eleven o'clock; both these groups took a wide range so far as locality is concerned, but one will suffice to illustrate the present point; it consisted of seven Bills, namely, Dore and Chinley Railway, Liverpool, Southport, and Preston Junction Railway, Dewsbury Improvement, Wirral Railway, Manchester, Bury, and Rochdale Tramways, and Hendon Railway.

It will thus be seen that somewhere between five and seven o'clock on Monday evening, the agents for the several Bills included in this group, were made aware of their appointment, and witnesses for and against every case had to be in attendance the next day but one. It will further be observed that, with the exception of Hendon Railway, which, with characteristic forethought, is put at the bottom, no Bill in the group relates to a place within 170 miles of London.

The first case is that of a railway through the Peak district of Derbyshire, where postal arrangements are leagues behind those of ordinary civilisation. Even in the provincial towns affected, only one clear day's time is open for the passage of correspondence either by letter or telegram as to when the attendance of parties is imperatively necessary.

The argument on the other side, from an official point of view, is doubtless to the effect that promoters should always be prepared to go on with Bills pending in the House of Lords, at any notice, more particularly as regards those brought from the Commons; professional people are fully alive to this doctrine and act accordingly as to briefs, proofs, &c., but where the shoe pinches is in relation to witnesses.

In the debate to which we have alluded, reference was made to the cost of private Bill legislation, and if we remember rightly even the courtly Lord Granville stigmatised it as a scandal; now one of the most prominent items of expense in Parliamentary private business as at present administered, is that incidental to the attendance of witnesses, and it tells hardest upon promoters when the Bill is in the Lords, because as the practice stands, in order to provide against contingencies which might be fatal, the whole retinue attached to each Bill in the group, is obliged to be in waiting until the case is called on, which necessarily involves paying for time and hotel expenses meanwhile, and attendance might under certain circumstances extend over a fortnight or three weeks.

In the Dore and Chinley Railway Bill thirteen local witnesses were examined on behalf of the promoters and doubtless more were summoned, for experts know that Scylla and Charybdis have both to be considered in such matters; if on the one hand a full complement of local evidence is tendered the Committee may possibly grow fatigued, but if on the other you limit the number of witnesses to what seems adequate to the occasion (say perhaps six for twenty miles of railway) the opposing counsel are down upon you with sneers and asseverations that the vaunted merits of the line are little appreciated in the locality affected, inasmuch as after scouring the district from end to end all the people who could be coaxed, bribed, or intimidated into saying a word in its favour are limited to six. As a rule it may be assumed that if twelve witnesses are called in support of a Bill, fourteen upon the Bobadil principle will appear against it, and that is how the golden total is amassed. It must further be borne in mind that much of the eloquence spent upon this subject offers no remedial bearing and is generally argued by results.

These points open up a vexed but burning question in private Bill legislation, which Mr. Sellar and his supporters will do well to ponder over before bringing forward their next reforming machinery. The main thing to be settled is what evidence ought reasonably to suffice as proving the necessity for, or expediency of, a public undertaking, and what is the cheapest mode of obtaining it consistent with efficiency. Mr. Sellar suggests provincial and roving commissions, but we believe it could be done equally well by affidavit in a similar manner and upon the same conditions as are followed in the Chancery Division of the Supreme Court of Judicature.

We have previously stated in these columns that such a course has been approved by a highly competent authority upon private Bill legislation, and it is freed by precedent from the charge of dangerous innovation. With a view, however, to adopting the British sheet-anchor of compromise, we would point out that, pending the establishment of joint committees, the efficacy of the system might be experimentally tested by tendering local evidence on affidavit in the second House to which the Bill is referred.

In deference to official bias we deem it prudent to remark that our animadversions have not been actuated by an acrimonious or irreverent spirit; but viewing the question from the opposite side, if we have perchance presented some matters in a light hitherto disregarded or unduly appreciated in certain quarters, our efforts may possibly lead to remedial measures, and will not have been in vain.

SIR EDWARD WATKIN AND THE PENISTONE DISASTER.

The fatal accident at Penistone, occurring just before the half-yearly meetings of the shareholders of the Manchester, Sheffield, and Lincolnshire, and South-Eastern Railways, the question as to what Sir Edward Watkin, the chairman of these lines, would have to say on a calamity which shocked the country from one end to the other, was awaited with some interest. Sir Edward Watkin is a man of many parts; as a railway financialist, orator, tunnelborer, and legislator, he is already well known. Having immense confidence in himself and his gift of speech, and a pretty accurate estimate of his shareholders, Sir Edward Watkin appears to have done his utmost to turn the Penistone disaster to the best account at the Sheffield meeting. A most sorry report had to be dealt with, and comfort had to be administered to both the shareholders and the relatives of those who had been killed a few days previous. The Chairman opened the proceedings by proclaiming, with questionable taste, that the company were under no pecuniary liability for the lives of the twenty-three persons killed, or the injuries to some forty or fifty others who escaped death. So far as concerns the shareholders, who were to receive ½ per cent dividend, this announcement may have been very gratifying; but, that the injured should not feel more injured by the announcement, and although stern Justice would not allow of the shareholders' money being devoted to their relief, Philanthropy was ready, though in a modified way, to deal with the matter, and Sir Edward modestly informed the meeting that he "had himself instructed the secretary, for himself, and not for the shareholders, to offer some relief in different directions in urgent and sad cases of poverty and difficulty." It is quite possible some of the sufferers, even those who are the recipients of Sir Edward's largesse, may consider that insult has been added to injury, and will take steps to ascertain the amount of the railway company's liability, which it is not at all improbable may prove to be greater than the Chairman has yet realised. An announcement so novel as that referred to, however, was well calculated to distract the attention of the shareholders, and Sir Edward went on to make suggestions as to the better prevention of such accidents for the future, these consisting mainly of advice from his colleague and son, Mr. Alfred Watkin, who proposes that the speed of trains should be reduced to a uniform forty miles an hour. Such a proposal—however absurd—was at once open to the suggestion that the Penistone accident was due to excessive speed, but Sir Edward, seeing whither his parental instincts had led him, hastened to assure the shareholders that this was not so. In this case it is difficult to see why the idea should have been mentioned, except to draw away the minds of the shareholders from the wretched results of their half-year's work.

From Manchester Sir Edward Watkin proceeded to London to address the South-Eastern meeting, and whereas at Manchester he posed as a philanthropist, at the meeting in Cannon-street he assumed the *rôle* of engineer. With the scene at Penistone fresh in the mind, an anxious shareholder, apprehensive of a similar catastrophe on the South-Eastern, asked whether the brake in use on that line was the same as that in use on the Manchester and Sheffield line. To this the chairman replied in the following remarkable words: "That the brake used on "the South-Eastern was the vacuum brake, which "was the very best brake out. The brake spoken of "in competition with it—viz., the Westinghouse "brake—was, in his opinion, one of the most com"plicated and dangerous brakes that could be put "into operation. The Westinghouse was worked "with an air-pump at a pressure of 90 lb. to the "inch. This was on the engine, so that if the air"pump were to explode—and it is not an impos"sibility—it would lead to the most dreadful "disaster. In the accident which had been alluded "to, the brake did its duty. The brake was on, "and the carriages held together; and if, through "Providence, the engine-driver could have gone "another sixty yards the train would have got into "the cutting, and there might not have been a "single injury."

We do not wonder that these remarks have evoked comments from the Westinghouse Brake Company, a letter from whom we publish on another page of the present issue. Probably, no chairman of a railway company ever managed to condense so many mis-statements, and so much evidence of a want of knowledge in a compass so brief, as Sir Edward Watkin has succeeded in doing in the present case. On page 71 of our issue of the 18th ult. we published a report which had been sent us by Mr. T. E. Harrison, engineer-in-chief of the North-Eastern Railway, on the working and maintenance of the Westinghouse brake on that line. In both respects the results are most satisfactory, and the figures contained in the report indicate that such is the case whenever this appliance is in use, for "complicated and dangerous," though Sir Edward says it is, the Westinghouse brake has increased in use during the last four years at the enormous average rate of some 1200 sets a month in all parts of the world. As to the air-pump and its liability to explode with 90 lb. air pressure, we need hardly say that no such event has occurred or is likely to occur; but Sir Edward might have made his case stronger by stating—as is pointed out in the letter from the Westinghouse Brake Company to which we have already referred—that this air-pump is worked by steam at 140 lb. or 150 lb. pressure. In other words, the steam for driving the Westinghouse air-pump is drawn from the same source as that which supplies the cylinders of the locomotives, and, we may add for Sir Edward's information (as he is apparently not aware of the fact) which also works the ejectors of his vacuum brake!

Sir Edward Watkin would act more usefully to his shareholders and the travelling public, and in a manner more worthy of the position he holds, if he admitted frankly that he has been mistaken in the matter of brakes, instead of clinging desperately to his error, and appealing to Providence. The Board of Trade returns of accidents contain many cases in which the vacuum brake has not only been of no service whatever, but has positively been the means of causing accidents owing to its defective principle. As pointed out last week, no amount of simplicity can be of service in preventing accidents. In the vacuum brake efficiency has been sacrificed for simplicity; in the Westinghouse system absolute efficiency has been obtained at the cost of a very moderate amount of complexity. At Penistone, Sir Edward says, the vacuum brake "did its duty, and the carriages held together." We will not attempt to discuss Sir Edward Watkin's idea of brake duty, but that the carriages did *not* hold together, any one who has read the accounts knows to be the fact, and that the loss of life resulted from their breaking away. Had the carriages kept attached to the engine, as they probably would have done had the brake been automatic, all would have been well, and there would have been no need to take refuge in a cutting as Sir Edward suggests. "If, through Providence, the engine could have gone another 60 yards," he says, "there might not have been a single injury." The engine, as a matter of fact, ran over 500 yards, and

considering that both it and the tender, as well as the horse box, were off the road, and that the driver was applying the vacuum brake all the time, the engine did pretty well as it was, but had it gone double the distance it is difficult to see how this could have benefitted the train, which was left behind, and capsized over the bridge after running some 230 or 240 yards.

It is in no way likely that Providence is going to oblige Sir Edward Watkin by performing a miracle, and nothing short of this can ever make a non-automatic brake efficient under circumstances similar to those at Penistone. From Sir Edward's remarks it would be useless to hope that the only real remedy will be voluntarily adopted, that is, an efficient automatic brake complying with the Board of Trade conditions, and this is much as we feared. There is, however, a power to which even Sir Edward Watkin can be made to bend, as he has already found to his chagrin, and we have no doubt that in this attempt to resist the Board of Trade injunctions he will again receive a fall.

Before discussing for the present the Penistone accident, we may remark that in the *Times* of yesterday there appears a letter from Professor F. G. Armstrong, of the Yorkshire College, Leeds, in which some singular conclusions are drawn respecting the lesson which the disaster at Penistone teaches. Professor Armstrong attributes the results of the accident solely to the fracture of the crank axle, and remarks that "as regards the brake question, the Government inspector, with an intimate knowledge of the details of the case, has given it as his opinion that no known form of brake would have saved the train from destruction." We shall be glad to know what authority Professor Armstrong has for attributing such an opinion to the Government inspector by whom the matter was investigated, as certainly all the facts available point to a directly opposite conclusion. Passing over this point, however, Professor Armstrong proceeds to compare the strains imposed upon a crank axle by the blows received on the flanges of the wheels, to those to which it would be subjected if used as a column—an entirely erroneous comparison—and eventually arrives at the conclusion that, if we wish for safety, locomotives with cranked axles must be discarded for working fast traffic. We are ourselves admirers of outside cylinder engines with straight driving axles, but we cannot be blind to the fact that inside cylinder locomotives have many advantages of their own, and to sweepingly denounce them as unfit for working express trains, as Professor Armstrong has done, is simply ridiculous. Considering that for years past the expresses on the Midland, the Great Western, the North-Eastern, the South-Eastern, and the London, Brighton, and South Coast have been entirely—and those on the London and North-Western almost entirely—worked with great success by locomotives with cranked axles, Professor Armstrong's conclusion requires some revision by the light of practical experience.

A FRENCH TELEPHONE CASE.

The Civil Tribunal of the Seine is at present occupied with a case, the issue of which will settle an important point of personal rights in the application of electricity. It is already more than a year since the Société Générale des Telephones of France, which owns the Edison patents, commenced the prosecution, for infringement, of several makers of telephonic apparatus, and placed such apparatus under the control of the Court. In consequence of these actions, the present case was commenced on the 25th of July, before the Third Civil Court, and this will prove of high interest to a very large number of persons. On the one hand is the Société Générale des Telephones, whose rights extend back to the patent granted in France to Mr. Edison, the 19th November, 1877, and to the addendum to this patent dated the 15th January, 1878; on the other hand are the various telephone inventors, MM. Maiche, Paul Bert, d'Arsonval, Journaux, Bourdin, Locht-Labye, and de Baillehache. The Breguet Company, Mildy-d'Argy, and Destnelles are also being prosecuted for manufacturing telephonic apparatus. Engaged on this action are two of the most able French advocates, MM. Pouillet and Huard, whose specialty lies in dealing with patent cases. M. Pouillet represents the Société Générale, and he has already replied to certain objections raised in a published pamphlet by one of the defendants. The line of defence adopted by M. Maiche in this pamphlet, and which presumably is approved by the other adversaries of the Telephone Company, may be thus summarised. M. Maiche maintains that the Edison patents in France are invalid, because, contrary to French law, he claims several distinct inventions, the telephone, the electromotograph, and the phonograph; the descriptions are imperfect; the inventions were not new; and those of Reiss, Elisha Gray, and Berliner can be advanced as anticipating the Edison inventions. Moreover, Mr. Edison has compromised the validity of his patents by premature publication of his experiments. M. Huard, advocate for the defence, has enlarged on these arguments. He charges Mr. Edison with drawing up too elastic and ambiguous specifications, which enable him to charge as infringements all inventions having the same objects. In support of this assertion, he refers to the large number of claims (25) contained in his principal specification. He mentions, moreover, a number of publications prior to the date of this patent, and which contain notices of the ideas subsequently patented. The two advocates have only reviewed very generally the various points at issue, to show the Court the necessity of prolonged expert evidence. But, what is curious, they have not agreed on the special requirements and qualities of the technical witnesses. M. Pouillet requests the Court to sanction the aid of practical engineers, well versed in questions of detail, construction of apparatus, and applied mechanics. M. Huard on the contrary, wishes to secure the aid of physicists as being better able to discuss impartially industrial questions in which they are not directly nor indirectly interested. Each advocate has conceded an expert of the class desired by his confrère, either two engineers and a physicist, or two physicists and an engineer. This distinction appears a very foolish one. There are plenty of engineers who are men of high scientific attainments, and it is difficult to understand why such a point has been raised seriously. The tribunal has deferred the case for the selection of the three experts. When these have been chosen, they will have to study the various points of the action and report on them, and this report will doubtless be of high interest. Unfortunately cases of this class are, in France as in England, long and tedious, and it is not likely that the decision of the Court which will follow the experts' report can be given in less than six or eight months. A second technical action of importance now pending in Paris, is that brought by the Edison Company against the proprietors of the Maxim lamp patents in France. The examination of this case has also been intrusted to experts. We shall refer again to these actions which not only present great importance of themselves, but are interesting as showing the difference of procedure in English and French courts of law.

THE INSTITUTION OF MECHANICAL ENGINEERS.

The summer meeting of the Institution of Mechanical Engineers will be held next week at Cardiff, and, as will be seen from the programme which we publish under our "Notices of Meetings" on another page, the visitors will on Thursday and Friday next pay visits to four of the historical works of South Wales, namely, those at Dowlais, Cyfarthfa, Rhymney, and Ebbw Vale, all of these being establishments which have during the last few years undergone striking developments. We shall of course have to speak of all these works in connection with the ensuing meeting, but in the meanwhile we subjoin notes on two of them, those at Cyfarthfa and Rhymney, which will to some extent serve as a guide to those of our readers who may take part in the excursions. We may add that in these notes the various parts of the works have been dealt with as far as possible in the order in which they will be shown to the visitors next week.

The Cyfarthfa Iron Works.

These works are, as is well known, of great antiquity, dating back to the earliest days of the South Wales iron-producing industry. They present a striking contrast of ancient and modern practice in iron and steel manufacture. The new Bessemer plant now in course of erection embodies the most recent appliances, whilst some of the machinery in other parts of the works will probably make gentlemen fresh from Middlesbrough almost wonder whether or not they have got into a museum of antiquities.

We do not know precisely when the Cyfarthfa works were founded, but one of the old blast furnaces bears the date 1765, although it was rebuilt in 1827. For many years the iron manufactured was carried over the hill-tops to Cardiff on the backs of mules, the roads, probably for military reasons, not having been made in the valleys. In 1790 an Act of Parliament granted to Lord Cardiff, Richard Crawshay, and several others the right to make a canal. By this the produce was for many years carried, and indeed at the present day it is used to a considerable extent for the same purpose. In 1840 the Taff Vale Railway was made, since which time Cyfarthfa has been in direct and immediate communication with Cardiff.

The principal entrance to the works is on the lower ground near the stream which divides the works. We will, however, commence our description at the Swansea-road entrance on the hill-side above the furnaces. Here the iron ore is brought in, together with that part of the coke which is not made on the works. A short line carries the materials for the furnaces on to a gantry, beneath which is a depôt where it is stored ready for use. Twenty thousand tons of material can in this way be kept within easy filling reach of the furnaces. To the left of the gantry are two blocks of coke ovens, numbering 54 in all. These are of the ordinary drag type, and are arranged for top charging, whilst the coke is withdrawn by a self-traversing steam crab running on rails in front of the tiers. From the coke ovens, which are placed on the high ground, we proceed to the platform in front of the gantry. This is formed by the tops of the old blast furnaces. These are now considered of no further use, excepting to form the platform in question, and serve also as an admirable retaining wall to the hillside at the back of the new furnaces we are about to describe. The materials are taken from this platform to the furnace tops, a height of 20 ft., by means of carriages running on an inclined plane, and worked by a winding engine at the hearth level below. This lift is designed to supply four furnaces, but at the present time only three of these are built.

The furnaces are of the latest type, having been completed within the last three months. They are 70 ft. high from hearth to charging plate. The diameter at the top is 12 ft., at the boshes 17 ft. 6 in., and across the hearth 7 ft. 6 in. The internal capacity of each is between 11,000 and 12,000 cubic feet. They are, of course, iron-cased and close topped. Descending from the top of the old furnaces we pass the blowing engine which worked them, but which is also superseded by more modern appliances, as it is not capable of giving the required pressure of blast. The new engine-house is a short distance beyond, and contains three vertical direct-acting blowing engines by Messrs. J. C. Stevenson and Co., of Preston. The steam cylinders are 33 in. in diameter, the blast cylinders 72 in. in diameter, and the stroke is 4 ft. 6 in. They are supplied with steam at 80 lb. pressure, and have ordinary jet condensers. The air pump works from a crank-pin on the flywheel, and expansion valves are fitted of the usual type. The general pressure of blast is 4½ lb. to 5 lb. per square inch, but a blast of 6 lb. can be got if required.

In front of the engine house is a range of nine Lancashire steel boilers by Messrs. W. and J. Galloway and Sons, of Manchester. They are usually fired by the waste gases from the furnaces, sometimes supplemented by a little coal; or they can be fired entirely by coal. The feed water for these boilers is heated by means of two Green's economisers. Descending to the hearth level of the furnaces we find seven Cowper's regenerative blast heating stoves ranged in a line at the back of the furnaces. The "down comers" from the latter convey the gases from the throat of the furnace into a brick main running between the lines of furnaces and stoves. The gases are tapped into the latter in the usual way. The tuyeres to each furnace are six in number, and are placed at equal distances around the hearth. They are of the ordinary coil type, and are surrounded by a water arch. Between the furnaces and the pig beds a line of rails runs, upon which the ladle for supplying the Bessemer converters is carried, the tapping level being sufficiently high to allow the metal to run down into the ladle while the latter is on its carriage. This railway carries the metal over a skew bridge across the river, and on to the platform of the new Bessemer

foundry, which is now being erected. It will be understood that our description of this foundry and the mill attached to it has reference more to the plant as it will be when completed, than as it now exists. The converters are two in number, and are each of 8 tons capacity. They are of the most recent type. The bottoms are changed by means of a hydraulic ram, which is mounted on a truck. This runs on rails which lead from the tuyere shed to beneath the converters. It is estimated that an old bottom can be taken out with this plant and a new one replaced within a space of 20 minutes. At the back of the converters and sunk through the platform, are the cupolas for spiegel and scrap. The spiegel is tapped into a ladle at the low level, and lifted by means of a hydraulic hoist to the converter stage, along which it is conveyed by a small railway and tipped direct into the converter. It should be mentioned that the cupolas have been placed low in this manner, in order that the whole may be roofed in if found necessary at some future time.

The casting pit is 40 ft. in diameter, and is served by three single ram cranes. The casting crane is of Messrs. Tannett, Walker, and Co.'s three-ram water-saving type, having two hydraulic pressure rams and a centre guide ram.

To the left of the casting pit a large building has been built to contain the blowing engines. We were not able to get into this building on the occasion of our recent visit, but we learn that these engines are of the vertical high-pressure compound condensing type with steam cylinders 42 in. and 78 in. in diameter, and blast cylinders 55 in. in diameter, the stroke being 5 ft. There is also in this house a pair of hydraulic pumping engines, which are fitted with rams working behind the steam cylinders and connected to the piston rod. The cylinders are each 18 in. in diameter by 24 in. stroke. The blast for the cupolas is supplied by one of Messrs. Tannett, Walker, and Co.'s patent three-cylinder engines. Perhaps it would be as well here to mention that the blowing engine and hydraulic engines just mentioned, are also supplied by Messrs. Tannett, Walker, and Co., of Leeds. The condenser for this machinery is one of Bulkley's patent and is fitted to the outside of the engine house. With this type of condenser no air pump is required, the vacuum being formed by condensation and the water of condensation and injection water being carried downwards through a vertical pipe and expressed against the atmospheric pressure by the momentum received. This condenser is by Messrs. Daniel Adamson and Co., of Dukinfield.

On the ground level beneath the converter platform on the left, the tuyere shed, already referred to, is placed. Here the tuyeres for the bottoms of the convertors are made and dried. Overhead there is a hand-power traveller by Messrs. Booth Brothers, of Rodley. In front of the casting pit there are to be placed four heating furnaces which will be conveniently arranged for taking the ingots hot from the moulds. They will have four charging doors each, and each one will be capable of taking nine ingots at once. There will be a hydraulic apparatus common to these furnaces for charging and drawing the ingots. From the heating furnace the ingots will be taken to the 36 in. cogging rolls, which will be driven by a fine pair of condensing geared engines by Messrs. W. and J. Galloway and Sons, of Manchester. The cylinders are each 40 in. in diameter by 5 in. stroke, and the engine is geared 2 to 1. The ingot will be taken by live rollers from the cogging mill to the roughing rolls, which are 27 in. in diameter, and are placed on the opposite side of the shed. From thence it will be pushed across to the finishing rolls—which stand in a line with the roughing train—by means of a hydraulic apparatus. This consists of a horizontal cylinder and piston lying below the ground level at the back of the floor and parallel to the rolls. To the piston rod is attached an inverted rack which is geared into a pinion keyed on to the end of a shaft, also below the floor, and which naturally is at right angles to the rolls. Upon this shaft are three drums on which are wound or unwound, according to the motion of the shaft, three wire ropes which pass beneath the floor on which the bar has to pass from one set of rolls to the other, vertical projecting horns being attached to the ropes for the purpose of taking hold of the bar. Messrs. Davy Brothers, of Sheffield, have supplied the 36 in. cogging mill rolls, and also the 27 in. roughing and finishing rolls.

The engines for working the rail mills are also by Messrs. W. and J. Galloway and Sons; they are not geared, and the cylinders are 50 in. in diameter by 54 in. stroke. These have also the Bulkley condenser.

On the left of the rolling mills and close to the blowing engines, is a range of twelve Lancashire boilers by Messrs. D. Adamson and Co., of Dukinfield, the feed water being heated by two of Green's economisers. The coal for these boilers is brought in on a railway at a higher level and shot into bunkers. A subway is provided in front of the boilers, in which is laid a light railway. This is used for removing the ashes, which being elevated by a hydraulic hoist and carried by a railway to the tip. The chimney to these boilers is designed to serve two ranges of twelve, and is 200 ft. high.

Returning to the rolling mills we find the rails are to be taken by live rollers from the finishing rolls to be cut to lengths by a circular swinging saw 5 ft. in diameter, the required lengths being gauged by a stop arrangement of excellent design. It consists firstly of a platform spanning the hot-bank on which the operator stands, this platform being supported at each end by dwarf cast-iron supports. In front of this is a girder which supports a strut carrying the stops, twelve in number. These are balanced and swing down at given distances measured by feet, odd inches being allowed for by a screw. The rails are carried down the hot-bank by skids, or they can be passed back under the stop. The hot-bank is of the hollow type. It is 210 ft. long, and has single and twin skids which are worked by a pair of 6 in. horizontal engines at each end. The hot-bank machinery, as well as that of the rail yard, which we are about to describe, has been supplied by Messrs. Joshua Buckton and Co., of Leeds.

Opposite the rolling mills is the rail yard, which is roofed by five spans, each 34 ft. wide and 118 ft. long of galvanised iron, by Messrs. Morewood and Co. In the lower part of the yard are five double straightening presses. There are also four rail-ending machines and six double drills. These are all driven by overhead shafting, also supplied by Messrs. J. Buckton and Co. Power is supplied by one of Messrs. Robey and Co.'s 40 horse-power semi-portable engines having cylinders 14 in. in diameter by 22 in. stroke. The rail benches are so placed that the finished rails are delivered straight into trucks on a lower level, so that no lifting is required.

The whole of this new and extensive plant has been designed by Mr. Edward Williams, of Middlesbrough, and has been carried out under the supervision of Mr. E. Hambly, the resident engineer.

Passing now to the principal entrance we come to an older part of the works. This consists of the bar rolling mills, in which there is a 10 in. train and a guide mill for smaller sizes. This is driven by the inverted oscillating engine we referred to when describing the visit of the Institution of the Mechanical Engineers ten years ago.* The cylinder of this engine is 34 in. in diameter, the working pressure being about 20 lb. to 24 lb. In this part of the works there is now being erected a powerful lathe with overhead crane and gantry to be used for turning the heavy rolls of the steel rail mill. There is another old mill, known as the Castle mill, close by. At the time of our recent visit it was undergoing alterations and will be started again shortly.

We now pass on to a still older part of the premises, and come firstly to a puddling forge on the south side of the river. Here there are eighteen puddling furnaces of the ordinary type with trains of puddling, roughing, and finishing rolls, and other necessary plant such as shears and a crocodile squeezer, and a tilt hammer. In another building beyond is a 16 in. train of bar rolls and roughing, planishing, and slitting rolls. It will no doubt be quite an interesting sight to some of the visitors to see a puddling forge in full work with some of the appliances we have named, but perhaps the most attractive feature will be the fact that the motive power is obtained from two waterwheels, whilst a mill that has been fitted with steam power now stands idle, unable to stand against the fierce competition of the waterwheels. These are each 20 ft. in diameter and 37 horse-power.

Working back again towards the furnaces we come to a building originally a fitting shop, but now occupied by pattern makers. Next to this is a large range of boilers, all past work but noteworthy from the fact that one of them, about 16 ft. in diameter, is spherical in form and stands on brickwork, but how fired we were unable to determine. The first blowing engine erected at these works, and perhaps one of the earliest used anywhere is here to be seen, a venerable relic of past days. In appearance it is not unlike many now at work. At back of this is a smithy still used, and next to this again is a foundry, still in use, and capable of turning out castings up to 25 tons. Passing again in front of the furnaces we reach a boiler shed which is in process of conversion into an ingot mould factory. To the west of this again is another puddling forge, with seventeen furnaces, a 16 in. puddle train driven by a waterwheel 36 ft. 6 in. in diameter, 10 ft. wide, and of 58 horse-power; and finally to the north of this are fitting shops, a smithy, and a brick yard.

Altogether Messrs. Crawshay's works are of the greatest interest. Here we find relics of the classic ages of iron manufacture, evidences of the former spirit and enterprise of this great family, side by side with the most approved appliances of the present day.

* *Vide* ENGINEERING, vol. xviii., p. 122.

The Rhymney Iron Works.

These works are situated about twenty-four miles from Cardiff on each side of the Rhymney Valley, the River Rhymney, which here forms the boundary between England and Wales, running through the middle of the works. The first furnace of this company was erected about sixty years ago at Rhymney Bridge, where the works were carried on until they were removed to their present site. In old times the iron was carried on the backs of mules to Dowlais, from thence being taken to Cardiff by the then existing tramway. It is needless to say that since those primitive days the Rhymney Iron Works have undergone many and great changes. About three years ago* we published some particulars of these works, since which date considerable alterations have been effected. We hope shortly to publish a plan of the existing premises and buildings.

The Rhymney Iron Works and the eight collieries owned by this firm, find employment for a staff consisting of about 7000 individuals. These eight collieries are situated in the Rhymney Valley. There are four pits and two drifts in the immediate neighbourhood of the works, whilst two pits producing bituminous coal are at distances of about four and a half and seven miles away. This company has experience of both the endless rope and tail rope system, working five of their collieries on the latter plan and three on the former. Mr. J. R. Williams, the resident engineer, gives unqualified preference neither to one system nor the other. As he very justly points out, where curves are numerous and gradients varying, the tail rope will be found most effective, whilst with long lengths of straight roads and easy gradients the endless rope will give excellent results. At the Darran pit, which belongs to this firm, extensive pumping operations are carried on. The engines are placed on the surface, and work one of Pearn's quadruple-acting flywheel pumps, which has a capacity of 25,000 gallons per hour. The air compressor is by Messrs. Walker Brothers, of Wigan.

We have not, however, to speak of the Rhymney Company's collieries, which are not on this year's visiting list of the Institution, but of the iron works, which are. It should be first explained, however, that the title of the company, "The Rhymney Iron Works," is a misnomer, as no iron is now produced, unless Bessemer steel may be considered simply a finer description of iron, a point of view which is, however, seldom adopted in the iron trade generally. Commencing on the English side, for the works are situated partly in Monmouthshire and partly in the Principality, we come first to the various blocks of coke ovens. These are placed on the hillside about on a level with the charging platforms of the blast furnaces, but below the line of rails upon which the coal for coking is carried. In this way the coal can all be emptied into shoots provided for the purpose. The arrangements are not yet quite complete, the coal having to be thrown from off the trucks to the shoots by hand, but in a short time a tilting arrangement will be provided. The principal block consists of seventy-two Coppée ovens, and along the top of these three lines of rails are laid, and conical trucks, three of which hold exactly the required amount of coal to charge an oven, run on these rails, the latter having a slight gradient about 1 in. in 80 ft. from the shoots, so that when full the trucks require but little power to propel them. The trams are discharged at the bottom into the open-

* *Vide* ENGINEERING, vol. xxxi., p. 612.

ings in the top of the oven. The ovens are emptied by a steam pusher, which clears them at one operation. It may be remarked that the Coppée ovens are much in favour in South Wales, being used amongst other works at Dowlais, Ebbw Vale, Blaina, Blaenavon, and also at some of the collieries on the Rhonda Valley. Besides the Coppée ovens just mentioned there is also a block consisting of thirty-six ordinary ovens.

The waste gases from both these blocks are taken through a brick downcast shaft, and thence through a culvert to a range of boilers which supply steam to the furnace blowing engines. This range consists of ten boilers in all, and of this number four are heated entirely from the coke ovens. Two more receive heat partly from the ovens, a certain portion of the furnace gases being also used at the same time. The remaining four boilers are worked entirely by the furnace gases. We must not forget to mention that there are other coke ovens of the ordinary kind in this part of the works, but the waste gases in these are allowed to escape without being put to any use.

Close to the last-mentioned boilers there is a second range, six in number, and these are also heated by the furnace gases which are carried by iron pipes entering the flues each side of the furnace doors. In these last boilers, however, provision is made for burning coal in the event of the furnaces being blown out, whilst both these methods of obtaining heat are sometimes used in conjunction, if the gases flag. In the first range of boilers referred to there is no means of heating, but by the furnace or coke oven gases. All these boilers are used for supplying steam to two blowing engines which are placed in one building. They are of the usual old-fashioned beam engine type. The first, which is a condensing engine, has a steam cylinder 51½ in. in diameter, and a blowing cylinder 104 in. in diameter; the stroke is 10 ft., and the usual steam pressure carried is 25 lb. absolute. The second engine is non-condensing. It has a 50 in. steam cylinder with 10 ft. stroke, and two blowing cylinders, the larger being 90 in. in diameter, with 10 ft. stroke. The other is 72 in. in diameter and 6 ft. stroke, and works quarter beam, it having been added after the engine had been some time in use, when more pressure of blast was found to be necessary. This engine works at about 42 lb. boiler pressure. The pressure for blast averages about 4 lb.

The blast furnaces on this, the Rhymney side of the premises, are three in number. They are rectangular in section, and of the old-fashioned solid masonry type so well known in South Wales. Their original height, when used for producing forge pig, was 42 ft., but for the purposes of smelting Bessemer pig it has been necessary to raise them another 13 ft. They are, as we have intimated, close topped, the gases being used for the boilers. The materials are brought direct from the trucks to the original platform, which is on a level with the rails, the furnaces being built against the valley side, and from thence they are elevated to the present landing by steam lifts, of which there are two. The cylinders of these are inverted, the piston rods being attached direct to the cage; the valves are, of course, worked by the attendant. This form of lift is very popular in South Wales for work of this description. Three cast-iron spiral stoves are placed beside the furnaces, and in front of these is a subway in which runs the railway connecting the furnaces with the Bessemer foundry. This subway runs immediately in front of the furnaces, being there completely covered in. A small locomotive brings the ladle on a carriage under openings made in the crown of the arch, and through these the molten metal is run into the ladle as the furnace is tapped, and from thence is taken away to the Bessemer foundry. Conveniently placed to this short railway are four iron melting cupolas, which are served by a couple of Root's blowers driven by two pairs of engines made on the works. These are for melting the iron made at any time the Bessemer works may be stopped, and also for working up scrap in conjunction with iron. It should be stated that suitable pig beds are provided into which may be run the iron made on Saturday and Sunday, or at other times when the Bessemer foundry is not in use.

In the Bessemer department we find that there are two pits which are arranged on somewhat different principles. No. 1, which is the oldest, has three converters, one being kept in reserve as an auxiliary. The metal for this pit is brought from the furnaces on the level of the foundry floor, the ladle being lifted and the metal tipped into the vessels by the hydraulic charging crane. This crane also charges the spiegel into the converters. After the blow the metal is taken by the same crane and from thence is transferred to the casting crane, which is of the usual type. Three ingot cranes are placed around the pit for handling the ingots and moulds. This pit was engaged at the time of our visit in making steel for tin-plate bars. This is a branch of trade in which the Rhymney Company seem to have made some reputation—a most fortunate thing for them considering the depressed state of the steel industry in other branches.

Adjoining No. 1 pit is a second of later construction which has two converters placed side by side. The metal is brought on to a platform in the ladle, according to the more modern practice, in which the charging crane is dispensed with. The spiegel is also charged direct into the converters, being brought on a narrow-gauge railway which leads to the cupola house. The casting crane receives the metal direct from the converters, and two ingot cranes are placed in the usual way. We may add that in No. 1 pit the converter bottoms are changed by means of the charging crane, whilst in the pit last described a portable crane, travelling on the same lines as the ladle carriage, is provided. It should also be mentioned that there is a light trussed superstructure used for charging scrap into the vessels whilst blowing. The largest make of Bessemer in one week at these works has been 3170 tons, whilst over 1800 tons of comparatively light rails have been turned out in the same time.

Adjoining the Bessemer sheds is the engine house containing a pair of converter blowing engines. These are by Messrs. Galloway, of Manchester, and are of the vertical direct-acting type, having steam cylinders 45 in. in diameter, and blowing cylinders 54 in., the stroke being 5 ft. The flywheel is driven by a return connecting rod. The boiler pressure is 70 lb., and the maximum blast pressure is 25 lb. In an adjoining house is a pair of auxiliary blowing engines of the same type, and by the same makers. The steam cylinders in these are 30 in. in diameter, the air cylinders 40 in., and the stroke 4 ft. They deliver into the same blast main as the engines before mentioned, and work from the same steam main. Both pairs of engines are non-condensing. Between these two engine houses is another building containing two pairs of horizontal hydraulic engines, also by Messrs. Galloway. The steam cylinders are 16 in. in diameter, the plungers 6 in. in diameter, and the stroke 15 in. They pump to a pressure of 600 lb., the steam pressure being 80 lb. The accumulator is placed outside the blowing engine house. It has a 24 in. ram, with a stroke of 14 ft., and is fitted with the usual self-acting gear for stopping the engine. These last-described hydraulic and blowing engines are fed by a range of ten boilers placed close by. Six of these are by Messrs. Daniel Adamson and Co., and four by Messrs. Galloway. They are 30 ft. long, and 7 ft. in diameter. Bottom stoves and ganistor sheds are near these boilers, and complete the Bessemer plant.

Passing over the river to the Glamorganshire, or to use the more general term, to the Bute side of the valley, we first come to the range of machine and erecting shops where the various work required in the mills and other parts is carried out. The most noticeable tools are naturally the large lathes which are used for turning the rolls. It may also be mentioned in this connection that on the Rhymney side of the works is a boiler yard where many of the boilers used on the works are made. From the machine shops we pass to the rolling mills.

The ingots, after leaving the Bessemer works, are conveyed on wrought-iron wagons to the steel mill, about 300 yards distant. Here they are unloaded by steam cranes, and conveyed to the heating furnaces. From these they are taken to the cogging mill, which has a pair of rolls 30 in. in diameter, and is driven direct by an inverted cylinder engine, 50 in. in diameter by 4 ft. stroke, with a flywheel 72 tons weight, 28 ft. in diameter. This engine was originally laid down for a plate mill, and the three-nitre wheel reversing gear, as then used, is still preserved, the clutches being moved by steam power. It may be remarked here that the whole of this building was originally laid down for plate rolling about twenty years ago, and the present modern machinery was erected after the completion of the Bessemer plant, whilst the surroundings were adapted to the present steel rail trade.

After passing the last groove of the cogging mill the ingots are conveyed by rollers to a powerful guillotine bloom shears. This machine, which was made at the works, cuts the blooms to the required length. The bloom is then reheated and roughed down in a 26 in. mill and finished in a 24 in. mill. The 26 in. roughing rolls are driven by a pair of 60 in. non-condensing engines, which were formerly a duplicate of those driving the blooming train, but without reversing gear. To adapt them to their present usage the flywheel was taken away, and a 60 in. cylinder supplied to replace the 50 in., while to effect the reversing a horizontal cylinder was laid down with its connecting rod working on to the same crank-pin as the vertical, having thus only one crank for both cylinders. To enable this arrangement to be carried out Joy's valve gear was adopted. The arrangement has been found to work very satisfactorily. The cylinders and gearing were made by Messrs. Tannett, Walker, and Co., of Leeds.

The 24 in. finishing mill is driven by a pair of horizontal engines of foreign make, having 40 in. cylinders, 4 ft. stroke, and worked with steam at a pressure of 80 lb. per square inch. The pinions of this mill have helical teeth. We observed several other wheels made at the company's works with this form of tooth, and they appear to be in considerable favour. The rails pass on from the finishing mill on live rollers to the saws, and when cut are drawn up a hot-bank about 200 ft. long by mechanical appliances. The rail presses, ten of which are driven by the same engine, and two other blocks of two presses each, with an engine for each block, are situated parallel with, and at the upper end of, the rail bank. No turning of the rail is required, as they are delivered in the proper direction by the pressmen or straighteners. After straightening the rails are conveyed by mechanical haulage to the measuring bench, where any that require ending are sorted out and forwarded to the ending bench. Two double and two single Buckton rail-ending machines are placed here. Punching and notching machines and a variety of drilling machines complete the equipment of the rail bank.

In addition to the above-mentioned plant there are two steam hammers, one 7-ton, and one 15-ton, which are used for adapting short blooms, bloom ends, &c., for use as billets for fishplates. These hammers also serve for other light uses. Placed around the mill are fourteen egg-end boilers and two Cornish boilers for the cogging and roughing engines, hammers, and the small engines on the rail bank and in the mill. They work at a pressure of 40 lb. per square inch. There are also seven Galloway boilers for the finishing mill.

At night the mill is illuminated, where necessary, by the Brush electric light, the dynamo and its engine being at the machine shop.

The two blast furnaces on the Bute side are interesting as showing what can be done by skilful management in the way of turning old appliances to modern uses. They bear on their front the date 1835, and as a matter of course are of that solid masonry construction seen in the old blast furnaces of South Wales. The original height was 45 ft., but within the last two years they have, by means of a superstructure, been carried up to a height of 60 ft. At the same time the bottom arrangements were altered so as to embody the most recent improvements and enable a higher temperature of blast to be used than was possible with the old stoves. The masonry has been taken out around the hearth and a gallery is thus made. Water blocks and tuyere arches with circulating water pipes have been applied according to the recognised practice of recent times. Both furnaces have six tuyeres. Four Whitwell stoves 65 ft. high and 22 ft. in diameter will heat the blast for two of these furnaces, although at the time of our visit last week only one furnace was in blast the other having been blown out for repairs.

Attached to these furnaces are two blowing engines, one with a 38-in. steam cylinder and 100-in. blowing cylinder, the stroke being 8 ft. The other engine has a steam cylinder of 60 in. diameter, a blowing cylinder 120 in., the stroke being 8 ft. The steam pressure is 40 lb. and the blast 3½ lb. The exhaust steam passes through a feed water heating apparatus. These two engines are usually coupled, but when we saw them only one was at work. The blast boxes are arranged in a somewhat unusual way, being placed in a circle around the cylinder covers. Near the furnaces is an old iron rolling mill now used for producing light steel rails and fish-plates. There is here a

compact little blooming mill with a pair of reversing engines made on the premises.

At the back of the furnaces and on a level cut in the hillside, are 80 Coppée coke ovens together with several blocks of ordinary coke ovens of an older date. These ovens are on a level with the furnace landing, which represents the old furnace top. From thence the coke and other materials are lifted to the furnace mouths by two direct-acting steam lifts similar to those on the other side of the valley. The waste gases from the coke ovens are used for firing the boilers supplying steam to the blowing engines, although at the time of our visit this arrangement was not in operation, as alterations were being made to the main chimney, and the products of combustion were being discharged through two auxiliary chimneys.

In the centre of the premises are commodious smiths', fitters', and erecting shops, together with a foundry, saw mills, &c. In the vicinity of the works a short distance up the valley are coal washing machines in which the coal for making coke is cleansed. Two of these are on the plunger system and one on the open trough principle. The coal, it should be mentioned, is obtained from the company's pits near the furnaces. There are also considerable brick works in connection with the establishment, where all bricks used on the works, except a few special ones, are made. In this department there are two hydraulic machines for making runner bricks, converter tuyeres, and other purposes.

THE INTERNATIONAL HEALTH EXHIBITION.

The Bakeries.

The dairies, the bakeries, and what *Punch* would probably call the soda wateries, are the three leading food industries practically illustrated in the Exhibition. The first we have already dealt with and now propose to give a short notice of the bakeries, leaving the mineral water section for a future notice.

Compared to the dairies the bakeries labour under a great disadvantage in being placed in the unsightly shed which was last year occupied by the life-saving display. One cannot help thinking what a pity it is the bakers could not have been placed beside the dairymen, their exhibits opening on to the great South Gallery in the same way. This would have done much to redeem the principal part of the Exhibition from being simply a big display of show cases which are at present—with one or two exceptions—nothing more than gigantic gratuitous advertisements.

By way of a preface to this notice of the bakeries, we will say a few words on breadmaking generally. The first operation, which is to set the "sponge," commences late in the evening, say seven to nine o'clock, according to the nature of the trade. After about two to three hours more, more flour is added to the sponge, which, it should be mentioned, consists of ferment and flour, and dough is thus formed, and the whole will be left for another two hours or more. When the dough has risen sufficiently, it is taken from the trough and cut up into pieces of the right size for forming a loaf, after which it is moulded and made up into the required form. The special suitability of wheaten flour, compared to that of other cereals, for making bread, lies in the fact that the gluten contained in it forms a very tenacious viscid paste when mixed with water. This has the effect of preventing the too rapid escape of the bubbles of carbonic acid gas which arise during the process of fermentation, and the light, spongy texture of wheaten bread is thus obtained. Bread made from meal or flour of any other grain is always heavy compared to that which is produced from wheaten flour. There are other ways, besides fermentation, of producing the spongy or visiculated condition requisite for making bread light and easily digestible. The best known of these is the mechanical process introduced by Dr. Dauglish, in which the gas is forced through the dough under great pressure. The process is an interesting one, but as it is not shown at the Exhibition, we are unable to dwell more fully on it here.

The first establishment met with in the bakeries' shed, on entering from the east end, is that of Mr. J. Marshall, of 442, West Strand. This, in common with the other large displays in this section, comprises a complete baker's establishment, in which bread, cakes, buns, &c. are produced in considerable numbers. The different bakeries, we may here mention, are chiefly noticeable from the various forms of ovens they are worked by. The ovens in each establishment are unlike in principle, whereas in many cases the same machinery is shown on different stands. This being the case, we will first describe some of the principal machines exhibited, and treat of the ovens afterwards. On Mr. Marshall's stand is one of Melvin's dough-ing machines. This consists of an iron trough, mounted on cast-iron standards, and in the interior of which the mixing blades, seven in number, are made to revolve. The latter receive their motion from suitable gearing at the end of the trough, the shafts on which the blades are mounted passing through the sides of the trough. The latter is tilted to discharge the dough, the motion of the blades assisting the action.

On the next stand, that occupied by Messrs. Hill and Son, Mr. Paul Pfeiderer has a large display of bread mixing and kneading machines. In our issue of December 26th, 1879, we gave a description and illustration of these machines, since which time a few alterations have been made in some of the details of design. The principal of these machines shown at the Exhibition is what is known as a 15 B machine, which is said to be capable of kneading and mixing 700 lb. of dough at one operation. These machines are made with a capacity of from 1½ lb. up to 2800 lb. of dough at one operation. The trough is tilted to discharge the mass by means of a vertical screw, which is attached at its lower end in such a manner that it will oscillate in the direction required by the movement of the trough. This engages in a screw nut on the lower part of the trough. The tilting can be performed by power or hand as required. The ingenious manner in which the reversing of the blades is effected has already been described in our previous notice. A dough-dividing machine is also shown on Messrs. Hill's stand. It consists of a small circular table, fitted with a hollowed cap or lid, working on a hinge. The dough is placed on a table and compressed into a certain form by shutting the lid. By means of a lever a number of knives are caused to rise through slits provided in the table, and these cut up the dough into certain definite sizes. The knives in fact form so many partitions, by which the space between the table and the lid is equally divided up.

Messrs. Joseph Baker and Sons have the largest collection of baking machinery in the Exhibition. This is being shown at work by Messrs. T. Watt and Sons, of Gledhow-terrace, S.W., who are principally engaged in producing what are known as angels, a species of confectionery which appears to have achieved a certain amount of notoriety from the fact that Miss Mary Anderson, the American actress, saying that it was one of the few things in England worth eating.

Messrs. Baker adopt Thomson's differential motion, reversing, mixing, and kneading machine. The knives in this machine are placed on two cranks which revolve within the trough, being actuated by suitable gearing at the end. Both mixers can be made to revolve in the same direction or in opposite ways, and at similar or different speeds at will. When the machines are made with double-speed pulleys, they can be used for stirring the sponge or mixing the dough when a quick speed is most suitable. For kneading, greater power is required, and the slow speed is then used. When the mixers are made to revolve in opposite directions at different speeds, they naturally pass each other at different points at each revolution, and it is claimed that a very efficient action is thus obtained, the mass of dough moving horizontally as well as vertically during the process.

The largest piece of machinery in this stand is a "combined hard and soft dough biscuit gauging, cutting, and stamping machine, with scrap-separating and self-panning apparatus." This consists of a cast-iron framing about 14 ft. to 16 ft. in length; on the upper part are certain rollers, over which continuous webs of a suitable textile fabric are caused to travel. The dough, which has been brought from the "brake," is first passed through a pair of rollers set the required distance apart; this gauges the thickness which the biscuits will ultimately be. From the rollers, one of the webs mentioned carries the sheet of dough to the cutters, which stamp the biscuit into the desired shape, and at the same time imprint the name or device required. The "scrap," which consists of the original sheet, which is full of holes where the biscuits have been cut out, is then passed on to a web, and by it carried to a receptacle provided; the biscuits travelling along another web and collected at the end to be taken to the ovens. One roller on each web in the machine is fitted with tightening screws and sliding bearings, so that the webs can be always kept properly stretched. All the webs and dough rollers are worked by ratchet wheels and connecting rods from one adjustable crank-pin, so that the adjustment of the crank regulates the speed of the whole. A flour-sifting and mixing machine is also shown on this stand. It will sift and mix one sack of flour in from one to two minutes, when driven by hand power. The wire bottom of the sieve is formed to the segment of a circle, over which an agitator is caused to oscillate by means of a crank movement outside the sieve. The motion may be obtained by hand or power. Several other machines used in the baking and confectionery trade are shown on this stand, such as currant cleaning and drying machines—a centrifugal machine being used for the latter process—cake mixing machines, mechanical whisks, peel cutters, muffin stoves, and apparatus of a similar kind. The ovens on the different stands are of various kinds, and are heated either by coal, coke, gas, or steam respectively. Mr. Marshall uses a form of gas oven which has recently been introduced by Messrs. Gibson and Booer, of Union-street, Southwark. It is internally fired, but in place of the ordinary furnace large jets of gas, burnt in atmospheric burners, are used. These distribute the heat under the crown of the oven in such a manner that, starting from the right-hand front angle, the flame is directed to the two opposite angles and then back to the register corner. Many advantages are claimed for the system; cleanliness, ease of working, saving of time and labour being amongst them. Perhaps the feature that will tend more than any other towards the introduction of this plan is that an ordinary baker's oven, of which there are about 6000 in London at the present time, can easily and at small expense be converted for working in this way with gas. The inventor states that he can convert an ordinary oven to this system between the bakings and without interfering with the ordinary work to any serious extent. The absence of smoke is a matter that will particularly recommend itself to bakers who find it impossible to work the ordinary coal furnace without making some smoke and are at all times liable to be fined. The question of economy is one that will at once occur when the substitution of gas for coal is proposed, and on this point there appears to be some little doubt. The inventor in a paper recently read before the Gas Institute, stated that each oven will on an average consume 1000 cubic feet per day. The oven in the Exhibition was found after a month's experience to average 1250 cubic feet per night, and with this quantity an average of five batches is turned out; this with gas at 3s. per cubic foot gives a total cost of 9½d. per batch for fuel. It is, however, stated that the gain in weight to bread more than covers the cost of gas. This saving is effected by a better diffusion of the heat and the retention of the steam in the bread.

Besides Mr. Marshall's stand is a gas oven exhibited by Messrs. Benyon and Cox, of Torquay. This is a three-tier oven, and is composed of light sheet iron in two skins, the space between being packed with a non-conducting material. It is 6 ft. 6 in. high, 7 ft. from front to back, and 3 ft. 3 in. wide. It is heated by one small gas fire, consisting of a series of ordinary Bray burners, which are placed under the bottom near the back. The heated gases pass through the flues under and over the tiers, communications being made for the purpose at the ends, and ultimately down the sides. Dampers are provided for directing the heat to any required part. By this method of carrying the heat down again to the level at which it entered, little or no draught is obtained and the heat from the gases has therefore ample time to be absorbed by the oven. There are in the furnace 50 H^2 Bray burners. All these are lit at starting when the oven is cold, but the required temperature once having been obtained 20 jets are ample to keep up the required degree of heat when the oven is briskly worked. In ordinary practice, however, 10 jets are sufficient. A batch of bread is turned out in the usual time, about one hour and a quarter. On the bottom of the ovens shelves are provided which pull right out so that the whole batch can be drawn at once. This oven will burn during the first hour of baking, when 20 burners are alight, about 40 cubic feet of gas per

hour, when everything is thoroughly warmed 20 ft. per hour will be about the quantity required. The burners are made to burn 2 ft. per hour at 1 in. pressure. The practical working in the Exhibition shows, we are informed, that the oven can be worked for ten hours at the cost of 1s. 6d. This would represent about 1000 quartern loaves being baked.

It will be noticed that Messrs. Benyon and Cox do not use the Bunsen burner, and they state that the result of their experience goes to show that the ordinary burner is preferable in their case. The burners are inclosed so that the gas and air are both brought to a very high temperature before combustion takes place. That perfect combustion is attained would appear to be proved by the fact that absolutely no soot is deposited on the flues. Mr. Cox informs us that he has wiped the bottom of the oven after it had been in use some time with a white cloth and has hardly soiled it. An oven similar to the one shown at the Exhibition, excepting that it is mounted on wheels, is now in use at the camp at Wimbledon. Messrs. Hill and Son use the Mason continuous hot-air oven. In this case the furnace is placed at the back of the oven, the heated gases and products of combustion passing into a flue so that they are not brought into contact with the bread. The bottom of the oven consists of a travelling plate which can be drawn bodily out on a framing provided, so enabling the whole of the batch to be set and drawn at once. A small boiler is provided for generating steam to heat the water for the bakehouse, as well as for injecting into the oven when baking Vienna bread. The consumption of fuel is said to be very small, and no more is required for a two decker than for a single oven.

On the adjoining stand the Perkins steam ovens are in use. These are heated by a series of wrought-iron tubes, which are welded up at both ends, a quantity of water having previously been placed in them. The ends of these tubes project into the furnace which is placed at the back of the oven. The tubes are inclined so that the lower portion is in the fire, and the heat is constantly carried away to the oven by means of the steam and water in the pipes. Messrs. Perkins also show a navy oven on the same principle. This is composed of a double casing of light iron plating with a non-conducting material between. A military field oven mounted on wheels is also exhibited.

On Messrs. Baker's stand the Bailey and Baker continuous oven is in use. In this case the heated gases are conveyed directly to the oven. What is known as a siphon flue is fitted, and this it is said permits of the escape of gas and products of combustion during baking without entailing any loss of heat. By means of dampers in the flues the heat can be directed to any desired spot. The Duntonknoll stone oven soles are shown on this stand. They are said to be better than the ordinary tile bottoms on account of their heat-retaining properties. It is to be regretted that Messrs. Hill and Sons do not illustrate their method of making whole meal bread, for the production of which they are so celebrated. The virtues of whole meal bread have been fully discussed of late. There appears to be little doubt that we throw away a large part of the nutritive constituents of the wheat berry when the middlings, sharps, and pollard are taken away. It has been objected, however, by some that the fibrine in the outer parts of the grain is not entirely assimilated, as the food is hurried through the system by the exciting action which the coarser particles has on the intestines. There is one thing, however, that can be claimed for bread made from whole meal. It is a fine natural aperient which leaves no reactionary effect behind it as is the case with nearly all, if not all, drugs taken for a similar purpose.

NOTES.

MARSH GAS AS A REFRIGERATOR.

THE pneumatic machine employed by M. Wroblewski in liquefying and evaporating ethylene and oxygen to produce intense colds, has also been recently used by him to evaporate liquid marsh gas. He has thus obtained a temperature of —155 deg. and —160 deg. C., which is the temperature of ebullition of the liquid gas. It is a useful temperature as coming between the temperatures of — 144 deg. C. and — 184 deg. C., which are obtained with ethylene and oxygen; but it varies with the degree of purity of the gas. Oxygen, at atmospheric air, nitrogen, and carbonic oxide cooled with the marsh gas, can be liquefied under feable pressures, so that a chemist who succeeds in producing pure marsh gas easily and economically will render a service to science.

THE INDUCTION SPARK IN ANALYSIS.

An interesting application of the induction spark in analysing benzine, toluene, and aniline has been made by M. Destrem, and brought before the French Academy of Sciences. The apparatus used was an electro-analyser of Hoffmann, with a medium-sized induction coil actuated by three Bunsen elements. The spark was taken between two platinum electrodes immersed in the liquids under test. Soon after it begins to pass, bubbles of gas form round the electrodes and carbon soot is separated from the liquid. In aniline there is less carbon liberated and it falls to the bottom more quickly than in the other two liquids mentioned. In the gaseous mixture coming from the decomposition of these carbonaceous substances, M. Destrem finds for benzine acetylene 42 per cent. to 43 per cent., hydrogen 57 per cent. to 58 per cent.; for toluene acetylene 23 per cent. to 24 per cent., hydrogen 76 per cent. to 77 per cent.; for aniline acetylene 21 per cent., hydrogen 65 per cent., cyanhydric acid 9 per cent., and nitrogen 10 per cent. After the action of the spark he finds besides the carbon deposited from the benzine and toluene, some diphenyl and a reddish brown paste, soluble in the carburates, which is easily isolated, either by concentration or cooling.

ELECTRIC RESISTANCE OF GLASS.

Messrs. T. Gray, A. Gray, and J. J. Dobbie, of Glasgow University, have been investigating the electrical resistance of various kinds of flint glass, as made by different makers, with a view to find out the relations existing between the resistance and the chemical constitution of the glass. The tests were made by immersing flasks of the glass in mercury and filling up the interior with mercury. The mercury formed electrodes to convey the current from 120 Daniell cells through the glass and the resistance was measured by a high resistance astatic galvanometer. They found that the resistance of the glass increased with the percentage of lead in the glass, and also with the density, but diminished as the percentage of alkal in the glass increased. The best specimen tried contained over 40 per cent. of lead oxide, and had a density of 3.141. Its specific resistance at a temperature of 130 deg. Cent., was 8400×10^{10} ohms between two opposite faces of a centimetre cube. The experiments show that the resistance of glass is halved by an increase of about 8½ deg. Cent. This rule holds for a considerable range of temperature, hence the approximate resistance of glass at a certain temperature may be estimated. In taking the temperature observations, the glass flasks were heated by means of a sand bath.

THE AMBULANCE EXPERIMENTS.

The recent experiments at Aldershot with the electric light ambulance consisted in searching for wounded men on the Redan Hill after a supposed battle; the means employed in the darkness to discover the wounded men being an arc lamp fitted to a tripod and provided with appliances for condensing, spreading, and directing the light. The electrical generating apparatus, including a Gramme dynamo fed by a Brotherhood engine of three horse-power, was all contained in a strong iron carriage on wheels. The engine had cylinders of 80 mm. diameter and was supplied by steam of 90 lb. pressure from a Field boiler, the whole plan weighing, when in working order, about three tons. The lamp had carbons 13 mm. in diameter and was hand regulated, the light being directed by Mangin reflector and a horizontal dispersive lens. A double cable of about 50 yards of insulated wire served to conduct the current to the lamp and permit of changes of position for the light. The electrical arrangements were carried out by Messrs Woodhouse and Rawson; the ambulance operations by Surgeon H. R. O. Cross, of the Army Medical Department and instructor of the Training School at Aldershot, and the expense was borne by the National Society for Aid to Sick and Wounded in War. One hundred mock wounded were dispersed over the ground and a column of the Army Hospital Corps moved forward at the same time searching the ground for the fallen men. Mock dressings were also applied to factitious wounds and a *vraisemblance* given to the operations so as to test the light as well as possible. The experiment was on the whole successful, but the intermittence of the light on this, the first trial, was unfavourable to such work as amputating; nor was the experiment altogether free from the likelihood of attracting the fire of an enemy. Further tests will shortly be made in the Green Park. The system is a commendable one, and is already adopted in France, Austria, and other Continental countries.

A NEW SALTPETRE BED.

To the eastward of Cocha-bamba, in Bolivia, South America, an immense saline deposit has been discovered near the village of Aranć. Analysed by M. Sace, the ingredients are potassic nitrite, 60.70; borax, and traces of salt and water, 30.70; organic matter, 8.60 per cent. On dissolving this mixture in boiling water and cooling it, a plentiful crystallisation of pure saltpetre is obtained. The soil on which the bed lies is brown and inodorous when it is dry, but when moistened it gives out an odour of carbonate and sulphhydrate of ammonia. M. Sace has found it composed of incombustible residue, 74.20; borax and salts, 15.50; and organic matter with water and ammoniacal salts, 10.30 per cent. The incombustible residue is formed of a very fine sand, and of phosphate of lime, magnesia, and iron, in large proportion. The saltpetre has evidently originated from the oxidation of the ammoniacal salts of the soil in presence of potash and soda produced by the slow decomposition of the schists on which they rest. The potassic nitrate has mounted by capillarity to the surface of the soil, whilst the diliquescent nitrate of soda has been drawn by the rains towards the dry and warm regions of the coast, where it forms the beds of nitrate of soda actually worked in Chili. As immense quantities of fossil bones are found in the soil around Aranć, it is possible that the saltpetre beds there, which are capable of supplying the whole world, are a result of the decomposition of a vast deposit of antediluvian animal remains.

THE PROJECTED ALGERIAN SEA.

The proposal of Col. Roudaire and M. de Lesseps to flood the dry bed of the Shotts in the south of Algeria, and thus create a North African inland sea, has of late met with a good deal of unfavourable criticism in the French Academy of Sciences, one critic, M. Cosson, asserting that, though M. Roudaire has abandoned the idea that the Shotts was the Triton Bay of the ancients, and though a Commission of Inquiry has pronounced unfavourably on the project, he, M. Roudaire, still clings to his original plan. Another critic, M. Letourneux, protests against the French Government giving any countenance to the scheme, which, in his opinion, would cause the complete ruin and destruction of Belad-el-Djerid and Souf. M. de Lesseps has replied to these criticisms, that M. Roudaire has not abandoned his theory that the Shotts is the same locality as the Triton Bay; but, on the contrary, is still engaged in supporting it; and he points out that the French Academy of Sciences has examined the project and regarded it in a favourable light. Moreover, the Commission, nominated by M. de Freycinet, has, he asserts, demonstrated the advantages of the plan, and has never disapproved of it, and, though they will not assist the enterprise, they are far from wishing to oppose it, provided it be carried out by private means. A group of projectors have already been formed and will begin to construct a port at the mouth of the Oued-Melah, a work whose importance requires no demonstration, since there is no shelter on the Tunisian coast, between Tunis and Tripoli, a distance of some 420 miles.

NEW ELECTRIC BATTERIES.

A novel thermo-chemical battery has been invented by M. Vincent Riatti, professor in the Polytechnic School at Torli (Italy). The production of the current results from the difference of temperature of two layers or strata lying at different levels in a vessel filled with liquid. The cell consists of a wooden box or vessel traversed by two copper pipes placed the one over the other, and separated by a distance equal to about half the height of the vessel, which is filled with a solution of sulphate of copper. A current of steam passes through the upper tube, and a current of cold water in the lower, with the effect that copper is deposited on the latter, while the substance of the former is reduced. By changing, from time to time, the position of the tubes, equilibrium is established. This battery is said to work well and not to polarise,

but up to the present no practical information as to its performance has been published, and consequently we cannot do more than call attention to the principle of its action. M. Grimfeld, of Vienna, has devised a modification of the Callaud battery, in which there is employed a glass vase divided in two by a mid partition half the height of the vase. The two upper halves are thus in free communication, while the two lower halves are separated by the partition. In the bottom of one of the cells is placed the disc of copper; the zinc is at the top of the other. By this arrangement the deposition on the copper of black particles falling from the zinc is avoided; at the same time, however, the resistance of the cell is increased and its cost augmented. A modification of the Leclanché element has received from its author, M. Fein, of Stuttgard, the name "immersion battery." It consists of a glass vase at the bottom of which is placed a layer of binoxide of manganese. The vase is closed by a cover carrying a carbon, and a ring of zinc. An inverted flask filled with a solution of chloride of ammonium keeps up the supply of liquid.

The Finland Polar Expedition.

M. Lemström has published the chief results of the Finland Polar expedition of 1883-84. The scientific observations were made at Sodankylà (latitude, 67 deg. 24.6 min. north; longitude, 27 deg. 17.3 min. east of Greenwich) and at Kultala (latitude, 68 deg. 29.5 min. north; longitude, 26 deg. 39.4 min. east). The earth currents were studied from September, 1882 to September, 1883, at the same time as the magnetic variations. Two conductors of copper wire, running from north to south and east to west for about 5 kilometres, terminated in platinum plates buried to a depth of 1.3 metres. The wires were insulated on telegraph poles and a sensitive galvanometer was interposed in the circuit of each. Wires of iron were also used with plates about 2.5 kilometres apart. At Kultala the earth plates were plunged in the river Fralo and its tributaries. With a Mascart electrometer giving eighteen divisions for a volt, and with the galvanometer, the perturbing forces due to the polarisation could be eliminated. From the fact that the variations of current in the east and west wires was very slight, M. Lemström is inclined to believe that there is a belt of earth currents round the pole. The magnetic variations were found to be intimately associated with those of the earth currents. The atmospheric currents were observed with the wire network, which we have already referred to in a former note. At Kultata, four of these nettings of wire, with brass discharging points and zinc earth connections, were erected at different heights on a mountain side. With these it was found if two discharging nets of similar construction and at the same height, were connected together through a galvanometer, no current was observed. With one net higher than the other, and both connected, a current was sent from the higher to the lower. The electromotive force of the currents observed did not rise above .326 volt (on March 20). Near the surface of the earth there is a layer of air which has a much greater electric density than layers higher up. The minimum density was formed at a height of 3 to 9 metres. During the aurora the atmospheric current was always positive, that is to say, going from the atmosphere to the earth; at some other times it was negative. With regard to the artificial aurora sometimes seen crowning the discharging networks, M. Lamström states that they showed either diffused light, or visible rays. They were observed by the naked eye and by the spectroscope, which showed the lines of the polar aurora. A Holtz machine working in connection with the wires could reinforce the effect under favourable circumstances. If the moon was high the phenomenon was never seen with the naked eye.

THE LATE MR. THOMAS ELLIS.

We regret to record the death on Monday last, at his residence, Whittington Lodge, Bridge of Allan, of Mr. Thomas Ellis, proprietor of the North British Iron Works, Coatbridge. Mr. Ellis was a Shropshire man by birth, but eventually he became very deeply identified with the iron manufacture in Scotland; indeed, by long residence in Lanarkshire, he had become almost a Scotchman. His father was a cabinet-maker at Wittington, in Salop, and young Ellis was left an orphan before he had had an opportunity of choosing the direction which his future life should take. In due course he elected to enter the rolling mill department of one of the local iron works, and by the time that he was twenty-two years of age he had acquired no mean amount of skill both as an iron roller and as a puddler.

At that time he was induced to turn his face in the direction of Scotland to seek his fortune, as many other English ironworkers had done before him. On arriving at Glasgow he found employment at Govan Bar Iron Works, belonging to Mr. William Dixon, who was the son of another immigrant from England. The establishment just named was for many years one of the largest of its kind, if not, indeed, the very largest north of the Tweed. Thomas Ellis was employed for some time in the bar mills at Dixon's Iron Works, and his first change was to the forge department of the famous Dundyvan Iron Works, Coatbridge. He subsequently returned to the Govan Works, where he was placed in a position of trust.

Mr. Ellis next made a still more important step, namely, to become an ironmaster himself in the Coatbridge district. That was in or about the year 1856, and when he about thirty-eight years of age. During the next dozen years or so he was a member of two or three partnerships carrying on small iron works—the Phœnix and the Globe—and in that way he came to be very well known throughout the Scotch iron trade, and acquired the confidence and esteem of a large number of merchants and consumers of iron. Some fifteen or sixteen years ago Mr. Ellis acquired a large plot of ground on the estate of Dundyvan, and erected on it a small iron works, which has since grown to be the most extensive establishment of the sort in Scotland, the material produced being exclusively bar iron. Mr. Ellis was a thoroughly accomplished worker in iron, and for years there was not better bar iron in the market than that which bore his well-know "N. B. crown" brand, a brand that has long been a favourite wherever bar iron is in request. The produce of the North British Iron Works is of great variety, and yet it does not embrace anything beyond 4 in. rounds and squares and 7 in. flat bars and angles. There are now in the works fully forty puddling furnaces, including the doubles and singles, those that are in use and others in course of erection. In addition there are ten mill furnaces, two forge trains, four steam hammers, and five separate rolling mills. One feature of the works is that each mill and forge train has its own driving engine, a fact which leads us to mention that the number of separate steam engines about the works is unusually great. The number of hands employed within the works is generally about 500—sometimes rather more—and is specially worthy of notice that the "N. B." works have scarcely ever suffered from dull trade or slackness of demand. The average output of bar iron finished for market is about 2000 tons.

Mr. Ellis has always been in the van in adopting improvements in furnaces, in machinery, and in new processes. It may be remembered by many of the members of the Iron and Steel Institute that when the Glasgow meeting of that body was held in the year 1872 he had a "Dormoy" puddling furnace in operation for their inspection. At present there are several double-puddling firms at work with Pickles's mechanical puddler. Amongst the other mechanical novelties within the works we may mention a very clever machine—Mr. Ellis's own invention—for planishing or polishing round bars for shafting. Some very excellent specimens of the work done by this machine were shown in the collection of exhibits which Mr. Ellis sent to the Engineering and Metal Trades Exhibition held in London last year. Several years ago Mr. Ellis started the manufacture of wire on a very large scale, and he was the first person to succeed in making first-class marketable wire from Scotch iron. His special plant consisted of a splendid rolling mill and no fewer than eighteen wire-drawing blocks, together with the requisite annealing furnaces, &c. At present the wire-making plant is at a standstill, as it is scarcely possible for the manufacturers of this country to compete successfully with those of Germany.

Mr. Ellis was honourable in all his dealings, and his workmen had the highest esteem and regard for him. Rarely, if ever, did a wages strike arise amongst them. He was sixty-six years of age at his death, and he has left a widow (daughter of the late Mr. James Leonard, of Gateshead) and a grown-up family, two of whom are sons connected with his iron works.

NOTES FROM THE UNITED STATES.

Philadelphia, July 18, 1884.

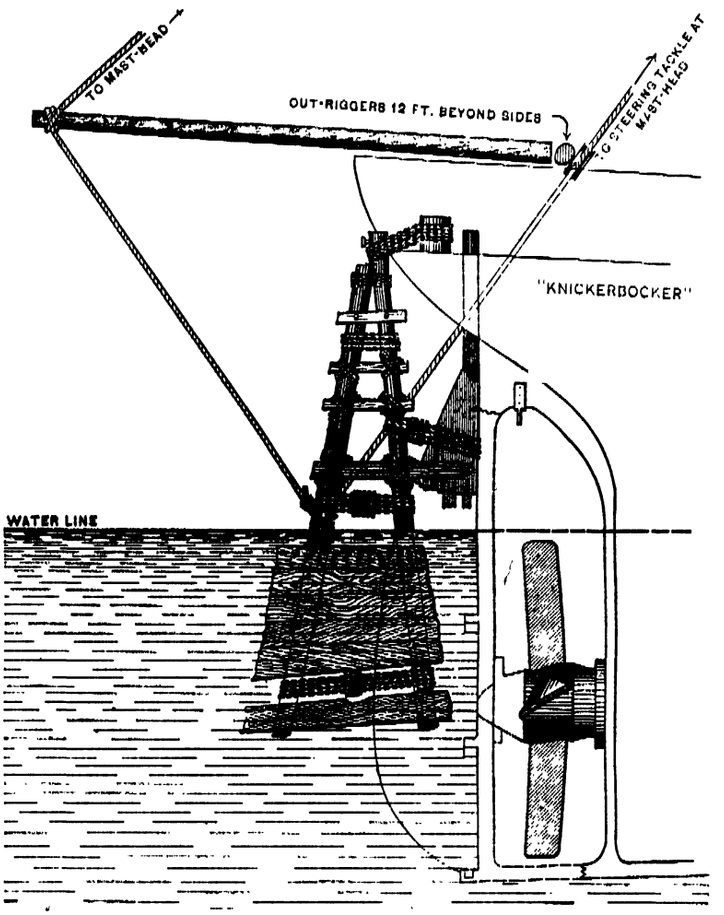
A great deal of interest is felt in the discovery of tin in Amherst and Rockbridge counties, Virginia. Prospecting is going on, and giving a good showing of cassiterite. Representatives of the owners of the territory are in communication with parties in England, with a view to interesting them in the development of the region, and it is stated that parties from there will shortly arrive here, in order to make further investigations. Deposits of oxide of zinc have been found in the tunnel head or upper portion of the stack of the Lowmoor furnace of the Allegheny Iron Mountain Company. These deposits are large, and will probably be developed. Less southern iron is coming into northern markets, as tidewater prices have declined to a limit which forbid further shipments. The copper market has been unusually stagnant. 2000 tons have been shipped abroad, 1500 tons for England. The Lake companies expect to export about 7000 tons between this time and the close of the year. The lead market closed dull, and spelter and zinc are utterly demoralised. Steel rails are selling in small lots at 30 dols. to 31 dols. at mill. A further drop is rumoured, and it is stated that 20 dols. would be readily accepted for large lots, for late delivery; but there is no disposition on the part of railway builders to anticipate requirements under any consideration. We have 275 furnaces in blast at present, and there is no immediate probability of the number being increased, for some weeks at least. Bessemer pig is selling very slowly at 19 dols. to 19.50 dols. at tidewater; spiegeleisen is quoted at 23 dols. for 10 per cent., 28 dols. for 20 per cent., and 78 dols for 80 per cent. ferro-manganese. Steel blooms are quoted at 38 dols to 40 dols. German drop ends are offered at 21 dols. The outlook for railway construction is anything but encouraging at present, but it is probable that upwards of 3000 miles of road will be constructed before the close of the year. No. 1 foundry iron is selling at from 19 dols. to 21 dols. at tidewater. Best makes of grey forge command 18 dols. Manufactured iron of all kinds is very dull. The merchant mills have nearly all resumed, after the summer rest, but very few of them have many orders ahead. The nail trade is depressed, as most of the season requirements have been anticipated. The structural mills are busier than others. Common plate iron sells at 2 cents per pound; beams and channels 3.25 in large lots. The supply of old material is large, and holders ask 19 dols. to 19.50 dols. for old rails. Throughout the west the iron trade is lifeless. There are some orders on hand for fall deliveries, but buyers refuse to take any risks. The Baltimore and Ohio, the Bankers and Merchants', and the Postal Telegraph companies have formed a combination, which will work against the Western Union. The mileage of the Bankers and Merchants' Company has been increased from 30,000 to 55,000 miles within six months. The total mileage of the combination is 120,000 miles. This combination reaches all the important trade centres and large cities, and touches about 80 per cent. of the entire telegraphic traffic of the United States. Adding the leased wires furnished to brokers, merchants, and and others, the aggregate mileage is nearly as great as that of the Western Union. There will be a money transfer system added. The Western Union will find this combination a powerful one, and some sharp cutting of rates may be looked for.

ELECTRIC LIGHTING NOTES.

It will be remembered that six months ago the Anglo-American Electric Light Corporation reorganised itself, writing off the losses of the past year in readiness to return to its former functions of a company dealing direct with the public. It had released such of the subsidiary companies as still existed from the obligation of supplying Brush machinery solely, and had obtained from them the right to enter their districts. Many of the companies had already lapsed, and their licenses, according to the terms of the agreement, had reverted to the Corporation, which thus had practically the whole country before them as a field of operation. During the slack time a complete system of incandescence lighting had been elaborated, and when freed from its financial burdens, the Brush Company came again boldly before the public, and took its place with youthful energy among competitors, many of whom fancied it was already dead, and awaiting decent burial at the hands of the Court. Six months have since elapsed, and the directors now report that the half-year's working shows a net profit on trading, after including exceptional law charges, and after making provision for all book losses and depreciation of property. This result, they say, warrants the hope that with even a partial revival of electric lighting enterprise the Corporation will be able to make fair returns on the capital. They have been successful in establishing the reputation for high efficiency of their Victoria dynamos and lamps for incandescence lighting, and their suitability for ship lighting, and contracts have been obtained from the Admiralty for fitting up the Colossus, Triumph, Raleigh, Bacchante, and Conqueror. They have an experimental installation at Buckingham Palace, and have done a large foreign trade. In consequence of the liquidation of the Metropolitan Brush Company, an important area has reverted entirely to the parent company.

Water in Queensland.—The Queensland Colonial Treasurer has received a telegram from Mr. Henderson, hydraulic engineer, stating that good water has been struck at Hadley's Creek, about forty miles from Muttaburra, on the Minton road. The bore is down 305 ft., and the yield is 126 gallons per hour.

JURY RUDDER OF THE S.S. "KNICKERBOCKER."



WE are indebted to *The Mechanical Engineer* (New York), for the following account and illustration of the very ingenious way in which a jury rudder was rigged in mid-ocean.

The steamship Knickerbocker, Captain Frank Kemble, of the Cromwell Line, from New Orleans, arrived at this port on Wednesday morning, April 23rd, steering with a jury rudder rigged at sea. Captain Kemble reported that during a heavy north-east gale on Sunday afternoon, about 120 miles S.S.W. from Cape Hatteras, the rudder and rudder-post were carried away. During the continuance of the gale the steamer was steered by towing a heavy hawser astern, which by judicious use of the sails enabled the vessel head on to wind and sea, and to proceed on the voyage toward New York. Captain Kemble at once set to work to build a jury rudder on deck, made from cargo gaffs and spars, with cross-pieces securely nailed and fastened with strong lashings and strains, as shown in accompanying drawing taken on the dock from the rudder itself. On Tuesday morning the weather had sufficiently moderated to enable the captain to get the rudder in position, and to secure it in place, further protected by guys running along each side of the ship to the deck amidship, and kept from getting foul of the propeller by guys running to the end of a spar projecting over the stern of the ship, then steering by lines running through blocks at the end of another spar (placed amidships), thence to blocks on the mast, and so down to the deck. Thus rigged, the ship was readily and successfully steered to her destination, refusing all assistance, coming in past Sandy Hook and up channel to the Quarantine Station at Staten Island. Captain Kemble telegraphed to his owners and came to wharf a little later, employing only a tug to assist the ship into her berth at Pier 9, N. R.

The Knickerbocker is a large and valuable steamer and had full cargo and forty passengers. The vessel and cargo were probably worth at least half a million dollars. Captain Kemble deserves great credit for his ability in improvising this successful and ingenious steering appliance, which enabled the steamer to complete her voyage without other assistance, saving her owners and the underwriters from large salvage and other expenses and trouble, which follow accepting assistance at sea.

NOTES FROM THE SOUTH-WEST.

Dock Matters at Bristol.—A special meeting of the Bristol Town Council was held on Tuesday, to consider a report from the Parliamentary Bills Committee with reference to the purchase of the Avonmouth and Portishead Docks. The Mayor of Bristol (Mr. J. D. Weston) presided. The report of the committee mentioned that arrangements had been made under which the Portishead Company would at once sell out their whole interest in both pier and railway to the Great Western Railway Company, without retaining any management of or interest in either. The committee also reported that both the Great Western and the Midland Railway Companies had given up the limitation of the tonnage of the vessels to which the deferential tonnage rate was to apply. As far as they could judge, the committee were of opinion that the Docks Purchase Act, as passed by the Lords, fairly carried out the terms of the purchase approved by the council on the 19th of February last. The mayor moved the following resolution: "That the report of the Parliamentary Bills Committee be approved, and that, subject to present arrangements for the immediate and complete transfer of the pier and railway undertaking of the Portishead Dock Company to the Great Western Railway Company, mentioned in the report, being carried into effect by the Railway Act, to the introduction into the Docks Purchase Act, of the consequent alterations necessary, and that the clauses carrying out the arrangement as to the deferential rate, mentioned in the report, giving the corporation use of the pier, for the purpose of vessels entering or leaving the dock, and preventing the pier from being used for loading and discharging grain and merchandise, and if provisions making it incumbent upon the companies to complete their titles to the property acquired for the purposes of their several undertakings, so that all interest therein might be conveyed by them direct to the corporation, and on satisfactory evidence of the titles of the companies to the several properties to be transferred, and as to the arrangements between the Portishead Company and the Portishead Warehouse Company being finished, the committee be instructed to proceed with the promotion of the Docks Purchase Act, and endeavour to get it passed by the House of Commons." He explained at length the details of the negotiations, and said that if the council acquired the docks he thought they might safely consider that their loss on working them would not exceed on the outside from 6000*l.* to 8000*l.* per annum. He thought, however, they might look for an increase of trade in the future. With the opening of the Severn Tunnel he believed they might fairly look forward to a very considerable increase of traffic. After some discussion the resolution was carried.

Cardiff.—Small steam coal is being disposed of without difficulty, and, indeed, in some instances pressure is being felt. Patent fuel continues to maintain the improvement recently noticed in it, being quoted at about 10*s.* 3*d.* per ton. The iron ore trade remains quiet. Last week's clearances comprised 139,511 tons of coal, 1565 tons of patent fuel, and 2260 tons of iron. From Bilbao there were received 11,479 tons of iron ore, and 2130 tons came to hand from other sources.

Newport (Alexandra) Dock.—The extension of this dock has been commenced.

Pontypridd, Caerphilly, and Newport Railway.—On Friday the Great Western Railway Company withdrew its opposition to the opening of this line, and long coal trains passed down to Newport over it from Pontypridd. Afterwards a long train of empty wagons proceeded over it through Pontypridd to Aberdare.

The Severn Tunnel.—On Thursday evening several of the directors of the Great Western Railway arrived in Bristol. The object of the visit was to make an efficient inspection of the progress of the works in the Severn Tunnel, prior to the half-yearly meeting of the Great Western Company. On Friday morning they proceeded by train to Pilring, where they alighted, and walked down the cutting in course of construction to the Severn Tunnel. The party included Sir Daniel Gooch, the chairman; Sir A. Hood, the vice-chairman; Mr. Michael Castle, Mr. MacIver, M.P., &c. They were met at the mouth of the tunnel by the contractor, Mr. T. A. Walker, and his staff, together with the resident engineer, Mr. A. W. Gooch, and the party walked through the tunnel, making a minute inspection of the works, which they found in a forward state.

Newport.—Steam coal has remained without much change. The house coal market is in an easy condition. The iron ore trade still continues depressed. The quantity of iron cleared last week was 3522 tons forwarded to the following destinations: Santos, 632 tons; New York, 1760 tons; and Talcahuano, 1130 tons. The Dowlais [illegible] are stated to be going on well. Last week's coal clearances were 53,813 tons. From Bilbao there arrived 3990 tons of iron ore, and 2930 tons came to hand from other sources.

FOREIGN AND COLONIAL NOTES.

***Canadian Canals.*—The Canadian Government has abolished the tolls on its canals for the year, as an experiment. The possible effect on Canadian railways is awaited with considerable interest.**

***Alexandria.*—Considerable activity prevailed in the port of Alexandria last year, in consequence of the frequent visits of English ships of war. In all, 466 ships were moored along the quay last year, exclusive of the steamers of the Peninsular and Oriental Steam Navigation Company. The corresponding number of vessels entering the port in 1882 was 291; and in 1881, 382. The revenue collected at the port in 1883 was 70,597*l.*, as compared with 66,058*l.* in 1882.**

English Steel Rails in Italy.—An English firm is stated to have accepted a contract for 3000 tons of steel rails to be delivered free in Italy at 5*l.* per ton.

German Coal Mining.—The deliveries of coal from the Sarrebruck district in May were 506,000 tons in round figures, as compared with 476,000*l.* tons in round figures in May, 1883.

Spanish Railways.—The French and Spanish Governments have agreed to an extension of the Madrid, Saragossa, and Alicante Railway, *vid* Huesca and Canfranc, as far as Oloron in France. The new line will comprise a tunnel 2½ miles in length.

Ontario and Quebec Railway.—This line is expected to be opened in the course of this month.

Telephonic Conversation.—That it is possible to carry on conversation by telephone at a distance of 1200 miles has been fully demonstrated in Cincinnati. An instrument was recently placed in the operating-room of the Baltimore and Ohio Telegraphic Company, and another in the cellar. They were first connected with wires to and from Chillicothe, a distance of nearly 200 miles. Conversation was heard distinctly. The distance was gradually increased until Baltimore, 1200 miles away, was reached. The same result followed, the tones of voice being quite distinct.

Copper in Natal.—A rich discovery of copper near Maritzburg is reported. A sample of the ore has been sent to England to be analysed.

Yet Another Atlantic Cable.—Stock for a new Atlantic cable is stated to have been largely subscribed for in Copenhagen. It is proposed to start from Thurso, in Scotland, from there to run to the Faroe Islands, thence to Iceland, and from Iceland to the west coast of Greenland. From this latter point the cable would dip southward to Lawrence Bay, striking the American continent finally at Gaspe Harbour. The total length of the cable is 3150 miles. The longest section will, however, be under 900 miles in length, and it is anticipated that for that reason it would do the work of any two of the cables now uniting Europe with America.

The Telephone in Russia.—The Russian authorities have recently placed telephones in all their public offices and in the principal fortresses throughout the Russian empire.

The Belgian Coal Trade.—In the first five months of this year Belgium exported 1,884,398 tons of coal, as compared with 1,617,292 tons in the corresponding period of 1883. In these totals the exports of coal to France figured for 1,782,621 tons and 1,510,799 tons respectively. It will be seen that the exports have made a sensible progress this year.

Spanish Railways.—A section from Pontevedra to Redondela has just been inaugurated. The length of this newly opened section is 11¾ miles. A concession has just been granted of a line from Segovia to Villalva.

Railways in Finland.—The cost of a line from St. Petersburg to Helsingfors has been 2,176,868*l.*, and the Government in 1883 made a clear profit of over six per cent. on the working, but as the capital was raised by an issue of obligations, this line gave the Finnish Government about 7¼ per cent. in 1883 on the money invested by it. A line more recently made, from Abo to Tammerfors, &c., cost 1,015,250*l.*, of which 78,064*l.* is already paid off,

and this line yielded nearly three per cent. profit in 1883. The Hangohead line, commenced by a private company, has been bought by the Government; in 1883 there was a gross loss on the working of 2130*l.* Seeing the good results of the lines already established, the Finnish Senate has voted 75,000*l.* to commence an a line from Willmanstrand to a point on the line from Riekimaki to the St. Petersburg line, and also another 75,000*l.* to commence a line joining existing lines to Bjorneborg.

Portuguese Telegraphy.—The Portuguese Government has concluded a convention for the laying of a telegraphic cable from St. Vincent to Santiago (Cape Verd) and from Senegal to Guinea, St. Thomas, and Angola.

New York Elevated Railroads.—The managers of the New York elevated railroad system are contemplating an extension of the Second Avenue line as soon as the plan of merger of the three companies is formally adopted by their stockholders. No doubt is expressed that the plan will be carried through, a postponement of action on the part of the Metropolitan Company being regarded merely as precautionary. The extension scheme proposes the carrying of the Second Avenue line down South-street from the existing station at Canal-street to South Ferry.

South Australian Railways.—In a special report which has been prepared by Mr. H. C. Mais, the colonial engineer-in-chief, it is mentioned that the length of the lines of railway in South Australia, which are open for traffic, are: Double lines, 8¾ miles; single lines, 894½ miles; total length of railways, 903 miles. The cost, exclusive of the rolling stock, has been 4,795,186*l.*, the average cost being 5310*l.* per mile.

The Eucalyptus and Water Supply.—Baron Von Mueller has sent to the Victorian Water Supply Department a long report as to the powers of the eucalyptus tree to absorb water, and to condense into water the moisture in the air. He speaks highly of the remarkable powers of these trees in this direction as well established, and urges judicious tree planting as an auxiliary measure for maintaining and augmenting the water supply.

A Cantilever Bridge at Louisville.—A second bridge over the Ohio, between Louisville and New Albany, is an assured fact. The bridge is being built by the Delaware Bridge Company, of Trenton, New Jersey. The bridge will be on the same plan as one recently erected near Niagara Falls, and it will be 2452 ft. long, with two channel spans. The first of these will be over the canal, from between Thirty-second and Thirty-third streets to the lower end of Sand Island, and will be 483 ft. in length. The other channel span on the Indiana side is to be 480 ft. in length. The bridge will be 54 ft. wide and there will be two wagon tracks and two railroad tracks, besides a passage way for foot-passengers on either side. The bridge, it is estimated, will cost 1,600,000 dols.

American Telegraphy.—A contract between the Mackay-Bennett Cable Company and the Bankers' and Merchants' Telegraph Company, gives the alliance control of an ocean and land system of telegraphy which will make it a formidable competitor with the Western Union Telegraph Company. At the same time, it is difficult to see how the Mackay-Bennett cable is to be worked at a loss. Sooner or later all competitive Atlantic telegraph lines have to make common cause in order to avert the inevitable ruin which otherwise awaits them.

Iron Minerals in France.—The imports of iron minerals into France in the first five months of this year amounted to 555,067 tons, as compared with 632,632 tons in the corresponding period of 1883, and 560,833 tons in the corresponding period of 1882. The total of 555,067 tons, representing the imports of the first five months of this year, was made up as follows: "Belgium, 70,318 tons; Germany, 152,075 tons; Spain, 210,103 tons; Italy, 27,153 tons; Algeria, 76,574 tons; and other countries, 9484 tons.

Commerce of San Francisco.—The foreign trade of San Francisco has declined seriously this year. The total imports during the last three months are valued at 8,500,0000 dols., which is a decrease of nearly 2,500,000 dols. as compared with the corresponding months of 1883. The decline is particularly noticeable in the importations from China and Japan. The countries showing an increase are the Central American States, Tahiti, British Columbia, British East Indies, Australia and New Zealand, the Hawaiian Islands, Mexico, the Dutch East Indies, and Manilla.

Gladstone and Laura Railway.—The Gladstone and Laura Railway, a branch of the Port Pirie and Petersburg line, South Australia, has been opened for traffic. It is built on the 3 ft. 6 in. gauge, is seven miles in length, and cost 16,555*l.*

Australian Artesian Wells.—We learn that the supply of water from the Artesian bore at Tarkanina, South Australia, is rather small, about 300 gallons a day, and that the bore is being put down still deeper with a view of striking the main supply. It is thought that the flow of the water is interrupted at present to a large extent by rubbish accumulating in the lower part of the bore, which is not tubed. The quality of the water is far better than that obtained at Hergott Springs, and an analysis will shortly be made.

French Railway Construction.—It is proposed to undertake new railway works in France next year to the extent of 7,520,000*l.* Of this proposed expenditure 4,000,000*l.* will be at the charge of companies and 3,520,060*l.* will be at the charge of the State. The aggregate expenditure proposed to be made this year is 7,640,000*l.*, of which 2,840,000*l.* will be at the charge of companies and 4,800,000*l.* at the charge of the State.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF SPECIFICATIONS PUBLISHED DURING THE WEEK ENDING JULY 26, 1884.

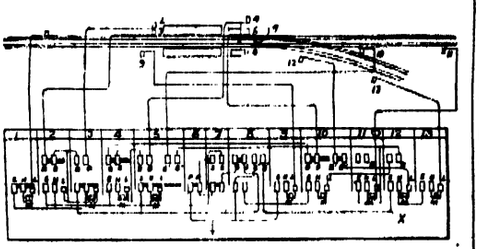
The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.
Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.
Copies of Specifications may be obtained at 88, Ourretter-street, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, and addressed to MR. H. READER LACK.

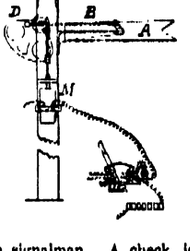
NUMBER OF APPLICATIONS FOR PATENTS.

	1884	1883	1858
July 22nd	48	..	6
,, 23rd	49	20	8
,, 24th	45	24	—
,, 25th	52	15	10
,, 26th	35	14	11
,, 27th	..	14	4
,, 28th	38	22	6
Total for week	267	109	45
Total from January 1st to July 28th (inclusive) ..	10,086	3707	1778

5527. Ventilators and Chimney Cowls: J. H. Reynolds, Troy, N.Y., U.S.A. (*A. J. Robinson, Boston, U.S.A.*) [6*d.* 4 *Figs.*]—This relates to the construction of the cap, the upper plate of which is made in the form of a dome having around its lower edge a flat or perforated curved flange. The lower plate is similar to the upper plate, but is inverted and is secured to the upper plate by brackets, an opening being left between them. A central pipe extends upwards to the lower side of the opening. A belt or shield is secured to the outwardly projecting portion of the brackets and covers the opening. (November 26, 1883).

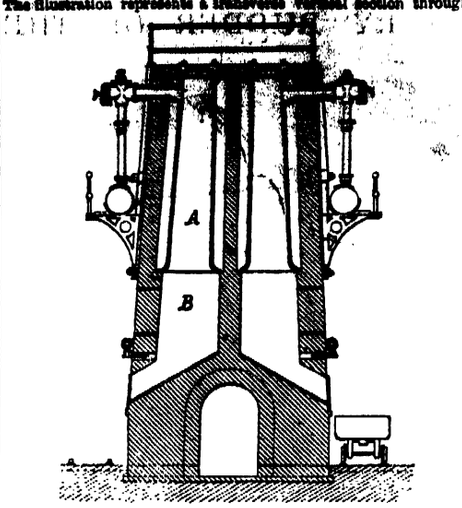
5718. Working and Interlocking Railway Signals by Electricity: S. C. C. Currie and I. A. Timmis, London. [6*d.* 6 *Figs.*]—An electro-magnet is arranged to work each signal arm and pulls it down or "free" by a direct action. The magnet is actuated by a current of electricity so arranged, that when at work the current is at its maximum, but when the armature is attracted the current is reduced There is thus a continuous current running through the magnets while the signals are held "free." Switches, making and breaking the circuit to the electro-magnets, are employed instead of the ordinary mechanical levers, and the completion of the circuit from battery to signal magnet depends upon the position of certain other switches besides its own particular switch, there being as many breaks in the circuit as there are switches upon the "setting." These contact pieces and breaks are also attached to the ordinary point levers so that the points must be in position in order that the corresponding circuit be completed and signal lowered. If the ordinary electrical power is insufficient owing to extraordinary causes such as frost, a heavy reserve of current is provided at





the disposal of the signalman. A check is also provided in the signal-box to prevent careless expenditure of current. In order to lower a signal, the signalman pulls over his switch and allows a current sufficiently strong to pull the signal arm over the pass; but, as soon as it is down, he allows the switch to assume a position regulated by a strong spring, and when in this position the current passes through a considerable resistance. An auxiliary circuit from a second signal-box is also employed for moving contact pieces and closing the circuit, and the train in passing may be arranged to automatically break or make the circuit. Fig. 1 represents the method of working and interlocking railway signals and points at a double junction station, in which X is a plan of the signal-board, 1, 2, 3 . . . 13 on the signal-board corresponding to the numbers 1, 2, 3 . . . 13 representing the signals and points and lock. The contact pieces on the signal-board are marked E H L, B B, S S; M M are incandescent lamps. Fig. 2 represents the arm A, the connecting rod B, the magnet and armature M, disc D, and the signal levers. (December 12, 1883).

5784. Distillation of Coal, Shale, &c.: P. Cowper, Edinburgh, and M. Rae, Middleton Hall, Linlithgow. [6*d.* 4 *Figs.*]—The apparatus consists of a soldily built lower chamber several times larger than the upper chamber or externally heated retort. The heat acting upon the materials in the lower chamber is generated solely from the materials within itself. The illustration represents a transverse vertical section through



a bench of retorts. Below each retort A is a firebrick chamber B, shown twice the size of the retort A. (December 13, 1883).

5772. Construction of the Ceilings and Floors of Buildings for Facilitating Exit in Case of Fire: D. R. Clymer, Reading, Penn., U.S.A. [6*d.* 5 *Figs.*]—Well holes are provided in all the floors, each having two doors, one flush with the floor and the other slightly above the flush of the ceiling. A flexible ladder is arranged in the well. By pressing down from above, the lower door is arranged to break the laths and open. Each floor may be fitted with several escapes, which are provided at their lower ends with eyes by which they can be secured to the lower floor. (December 13, 1883).

5777. Circuits for Electrical Apparatus: H. J. Allison, London. (*C. E. Allen, Adams, Mass., U.S.A.*) [6*d.* 8 *Figs.*]—A main line circuit starts from one pole of a main battery (the other pole being grounded), and runs so as to include several central offices on going out, and returns to the same central from which it started in such a way that the return portion may be grounded at any of the central offices, the battery circuit being open until some part of the return circuit is grounded. The subscribers' circuit starts from one pole of a battery (the other of which is grounded at the central office), and runs through the controlling magnets of several subscribers' instruments, and returns in such a way that the return portion may be grounded at any subscribers' station, the circuit being open until so grounded. In order to converse with a person on another exchange, a subscriber first signals his central office and gives the necessary instructions. The operator at this office then gives the signal corresponding to the main line station with which the second subscriber is connected, and gives the necessary instructions. This operator then informs the second subscriber that he is wanted, and connects him with the first subscriber. The connections are as follows: From ground at the first subscriber's station, through his telephone and transmitter and switch to return of local line, through first central office and return portion of main line to the second central office, and return of local line to the instruments of the second subscriber to the ground. Thus all the relays, signalling magnets, and batteries, are then cut out of circuit while the conversation is being held. (December 18, 1883).

5850. Treatment of Sewage: F. Herbert, London. [4*d.*]—The sewage is led, by self-acting syphons fitted to the tanks in which the sewage is collected, to a series of receivers fitted with carbon electrodes in connection with the poles of a dynamo-electric generator giving preferably a current of low electromotive force. The deposit in the tanks may be calcined for cement. A small quantity of a chloride may be added to the sewage in the tank. Sulphuretted hydrogen and other gaseous products are liberated from the receivers until the sewage is reduced 70 or 80 per cent.; the thin slush remaining is dried at a gentle heat. The gaseous products may be carburetted and employed for lighting. (December 24, 1883).

5950. Apparatus for the Generation of Steam, &c.: J. W. Gill, Birmingham. [4*d.*]—Water in a finely divided condition is injected into pipes previously heated by a gas or other fire. The steam thus generated is passed through a superheating pipe into a reservoir kept in a heated condition by the waste heat from the fire. An anti-priming diaphragm, constructed of a series of perforated plates, is arranged before the nozzle leading from the generating to the superheating tube. (December 31, 1883).

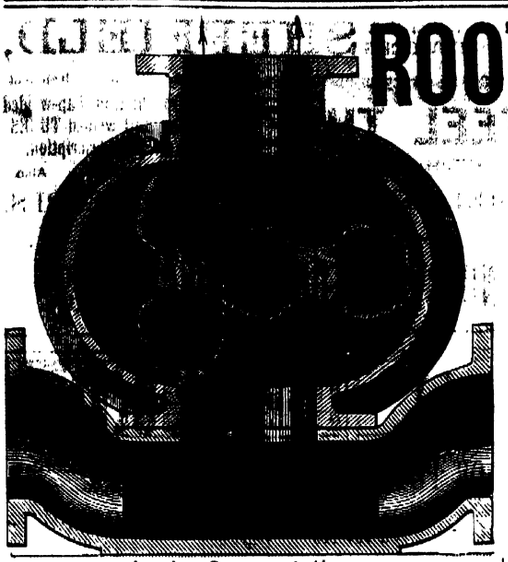
5984. Electrical Machines: J. S. Williams, Riverton, N.J., U.S.A. [4*d.*]—The magnetic or non-magnetic base or support of armatures, magnets, or other electric apparatus is covered with insulating material, such as asbestos, or a compound whose chief ingredient is asbestos, the helix or helices of the conducting material being afterwards coiled, deposited, moulded or secured thereon. The patentee refers to fourteen previous patents. (December 31, 1883).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

GAS AT MADRID.—The quantity of gas sold last year by the Madrid Gas Company was 14,374,724 cubic metres, yielding a revenue of 222,745*l.* The corresponding sales in 1882 amounted to 13,046,575 cubic metres, yielding a revenue of 210,414*l.* The net profit realised in 1883 was 61,861*l.* as compared with 60,090*l.* in 1882.

MESSRS. HAYWARD TYLER AND CO.—A new trade list just published by Messrs. Tyler and Co. contains particulars of their plumber's brasswork, high-pressure cocks, closets, pumps, &c., for 1884; their fire fittings, pumps, and pumping machinery, well frames, engineer's sundries, &c., for 1884; and their steam engine list for 1883. It is printed on toned paper, with many illustrations, and forms a guide to a portion of the very numerous manufactures in which the firm are engaged.



ROOT'S PATENT ROTARY PUMP

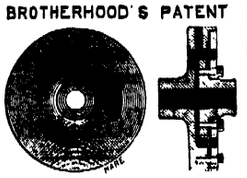
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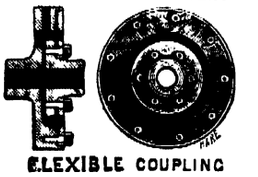
BROTHERHOOD'S PATENT



FLEXIBLE COUPLING

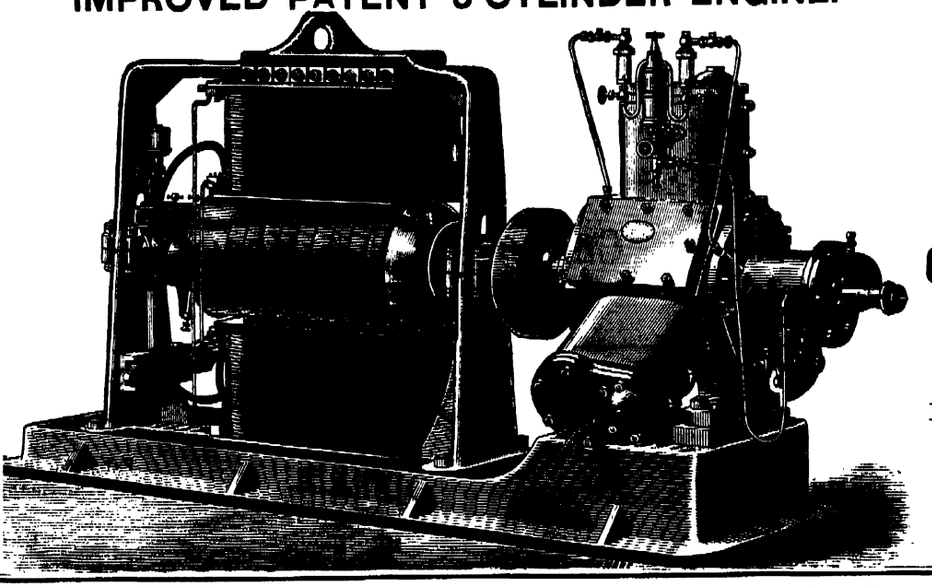
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IMPROVED PATENT 3-CYLINDER ENGINE.

BROTHERHOOD'S PATENT



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(E. B. SAUNDERS, Agent).

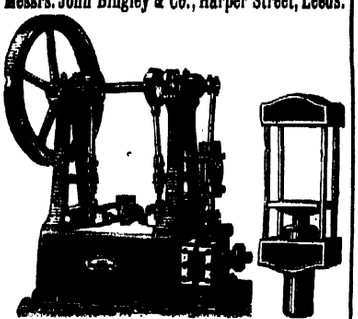
Manufacturers of all kinds of Slide Lathes, Planing, Shaping, Slotting, Boring, Drilling, Punching, Shearing, Bending, and Screwing Machines, suitable for every class of Engineers and Shipbuilders. 4988

ROBERT MIDDLETON,

SHEEPSCAR FOUNDRY, LEEDS,

SUCCESSOR TO

Messrs. John Bingley & Co., Harper Street, Leeds.



HYDRAULIC PRESSES

Of every description and size.

HYDRAULIC PUMPS for Hand, Belt, or Steam Power.

HYDRAULIC LEATHERS. 5128

"Patent Geared."



WESTON'S NEW "PATENT GEARED"

PULLEY BLOCKS.

The New **"Patent Geared"** Blocks are manufactured with great care, and of the best materials throughout, and are in every sense

SAFETY

HOISTING MACHINES.

With the "PATENT GEARED" Blocks a man can lift from 2,000 to 4,000 lbs., being two or three times the lifting power of the Direct Differential Blocks.

—:o:—

ILLUSTRATED PRICE LISTS FREE

ON APPLICATION TO THE 5090

SOLE MAKERS:

JOHN CROWLEY & CO., Sheffield.

HOWELL & CO., BROOK STEEL WORKS & SHEFFIELD TUBE WORKS, SHEFFIELD,

Manufacturers of all kinds of Blister, Shear, Spring and Cast Steel, FILES, SAWS, &c.

HOWELL'S STEEL TUBES

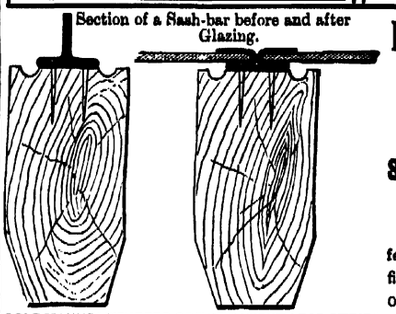
Manufacturers of all kinds of Wrought Iron, Lap-welded and Butt-welded TUBES of every description. STEAM, &c. Also

HOWELL'S PATENT HOMOGENEOUS METAL AND CAST STEEL TUBES.

"HOWELL'S" SPECIAL SELF-HARDENING STEEL FOR TURNING TOOLS. 4788

"SIMPLEX" LEAD GLAZING.

Section of a Sash-bar before and after Glazing.



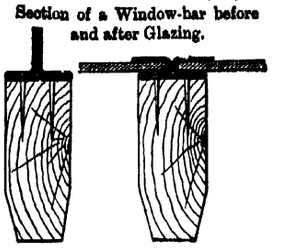
NO IRON, ZINC, OR PUTTY USED.

No Special Contract required for its adoption.

SUITABLE FOR ALMOST UNIVERSAL APPLICATION.

N.B.—The Lead Strips, which are the special feature of this System, require no Skilled Labour to fix; breakages can be repaired by anyone; and ALL OUTSIDE PAINTING IS DISPENSED WITH.

Section of a Window-bar before and after Glazing.



Write for Prospectus and Testimonials. 4556

SOLE MANUFACTURERS OF THE PATENT LEAD STRIPS

GROVER & CO., Ltd., Engineers, &c., Britannia Works, WHARF ROAD, N.

ELECTRICITY METER

(DR. HOPKINSON'S PATENT).



An Instrument for measuring and continuously recording quantity of Electricity, and for ascertaining the amount due from a consumer for the quantity or energy of the Electric current supplied during a given time.

Made in 5 sizes, to register from 1 to 200 amperes. PRICE, £15 to £35.



For further particulars, apply to the Sole Licensees and Manufacturers

CHAMBERLAIN & HOOKHAM, LIMITED,

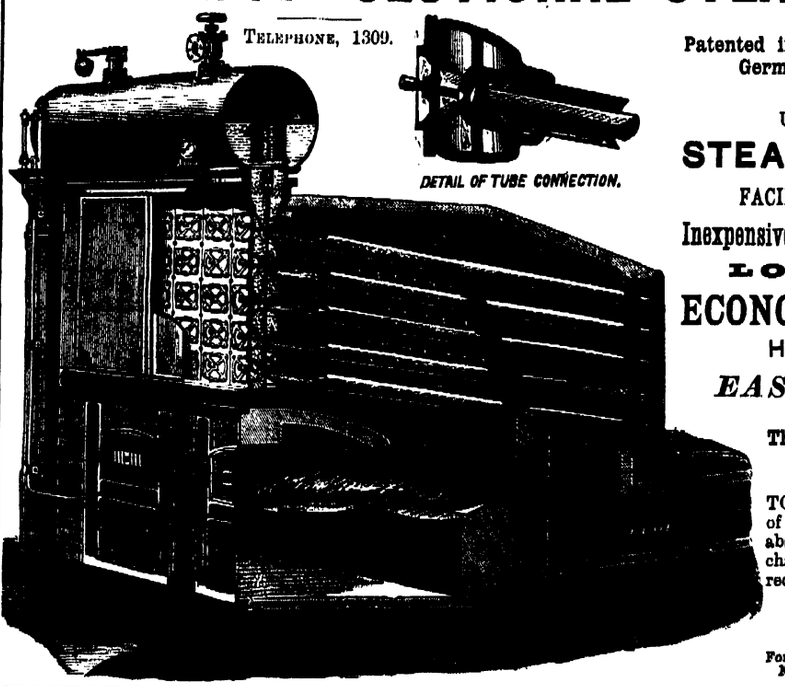
ELECTRIC LIGHT ENGINEERS,

BIRMINGHAM. 4669

THE "LANE" SECTIONAL STEAM BOILER.

TELEPHONE, 1309.

DETAIL OF TUBE CONNECTION.



Patented in England, France, Belgium, Germany, and United States.

UNRIVALLED FOR

STEAMING POWER,

FACILITIES FOR CLEANING,

Inexpensive Renewal of Wearing Parts,

LOW PRICE,

ECONOMY, SAFETY,

HIGH PRESSURE,

EASY ERECTION.

The deposit of impurities takes place in receiver only.

TO CONVINCE STEAM USERS of the splendid circulation and entire absence of priming, we without extra charge illuminate the interior of receiver with "Lane's" improved Electric Light Apparatus.

—o-o—

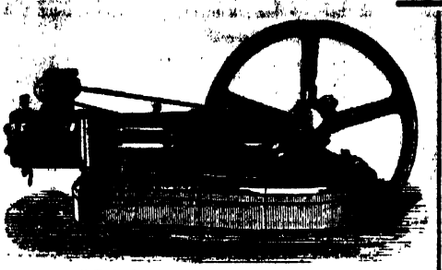
5121

For Estimates, Terms of Agency, and basis of Negotiation for Foreign Patents, address—

HOWARD LANE & CO., Palmerston Buildings, Old Broad Street, LONDON, E.C.

SHANKS'S HORIZONTAL AND VERTICAL HIGH-PRESSURE STEAM ENGINES.

THESE ENGINES ARE THE CHEAPEST AND MOST POWERFUL IN THE MARKET.



"Caledonian" Horizontal Engine.

PRICES.

4 HP.	...	£35	16 HP.	...	£120
6 HP.	...	45	20 HP.	...	150
8 HP.	...	60	25 HP.	...	200
10 HP.	...	70	30 HP.	...	250
12 HP.	...	88			



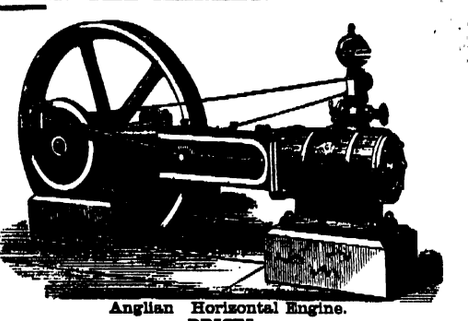
Vertical Engine & Boiler combined.

PRICES.

2 HP.	...	£70
3 HP.	...	80
4 HP.	...	90
5 HP.	...	100

PRICES.

6 HP.	...	£110
8 HP.	...	150
10 HP.	...	175
12 HP.	...	200



Anglian Horizontal Engine.

PRICES.

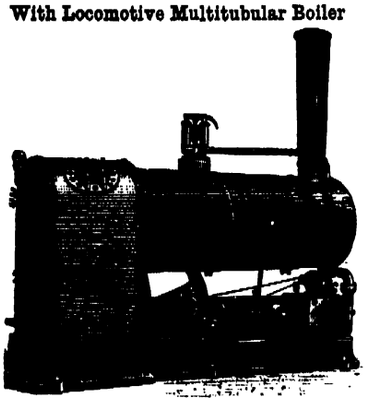
6 HP.	...	£57 10s.	16 HP.	...	£145
8 HP.	...	77 10s.	20 HP.	...	175
10 HP.	...	95	25 HP.	...	210
12 HP.	...	110	30 HP.	...	240

MARINE ENGINES

of MASSIVE CONSTRUCTION and LARGE WEARING SURFACES. The Smaller Surfaces are CASE-HARDENED, and all others provided with GUN METAL BEARINGS, with suitable provision for adjustment.

"THE CALEDONIAN,"

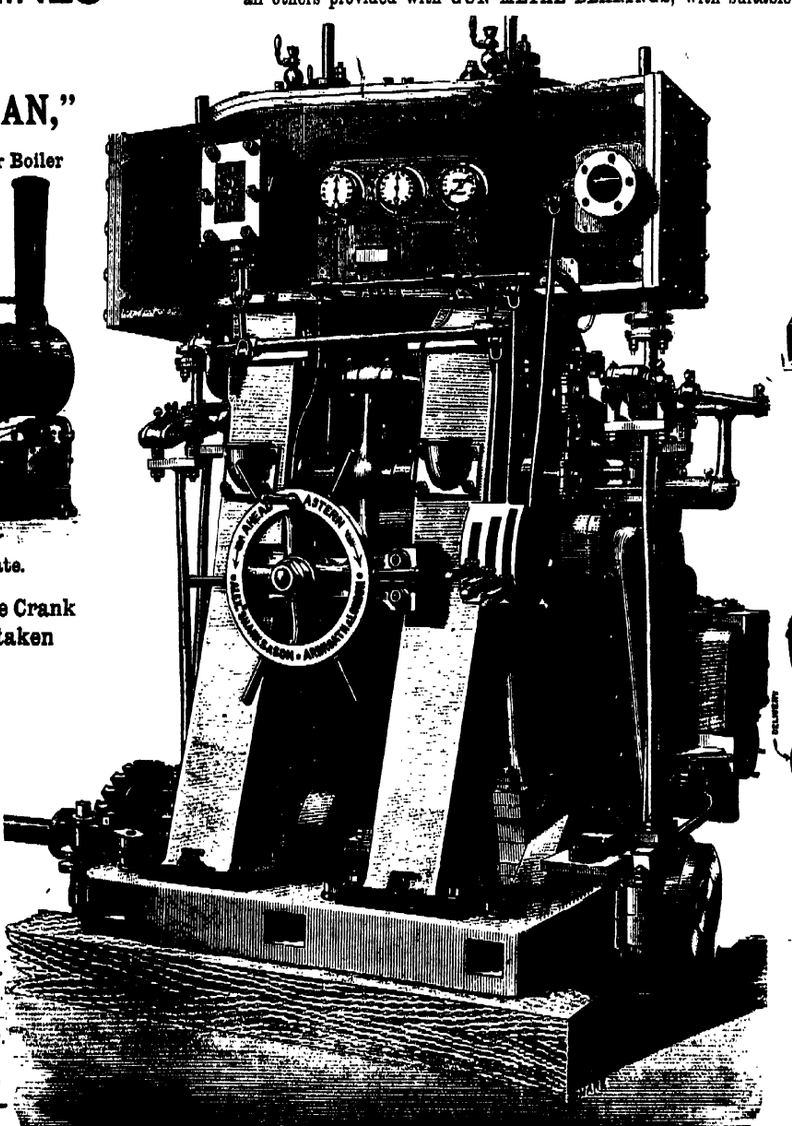
With Locomotive Multitubular Boiler



Combined on one Sole Plate.

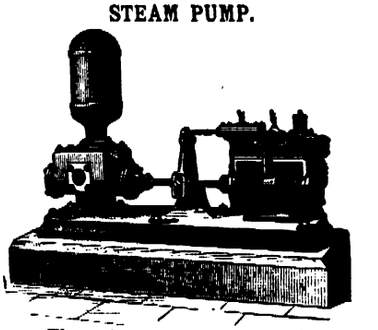
The Engine having a Double Crank enables the power to be taken from either side.

The above is the cheapest and most convenient form of Engine with Locomotive Boiler in the market.



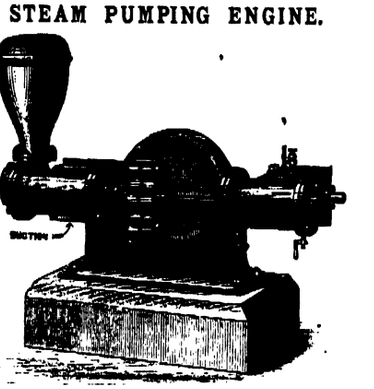
Size of Engine	4 HP.	6 HP.	8 HP.	10 HP.	12 HP.
Size of Boiler	6 HP.	8 HP.	10 HP.	12 HP.	14 HP.
Engine & Boiler as above	£130	£155	£210	£250	£300

SHANKS'S IMPROVED DIRECT-ACTING STEAM PUMP.



The utmost regularity in reversing and steadiness in working secured.

SHANKS'S IMPROVED EXPANSIVE STEAM PUMPING ENGINE.



THE SIMPLEST MADE. ACTION CERTAIN.

Prices, Illustrations & Particulars on application.

ALEX. SHANKS & SON will be glad to furnish, on application, detailed Specifications for Engines up to 1000 I. HP., with suitable Boilers, fixed on board complete, or securely packed for shipment.

STEAM CRANES AND HOISTING ENGINES OF ALL SIZES.

SHANKS'S PATENT COMPOUND STEAM ENGINES in the Horizontal or Vertical form, with or without Boilers.

SHANKS'S PATENT COMPOUND LAUNCH ENGINES.

ILLUSTRATIONS, WITH FULL PARTICULARS AND PRICES, ON APPLICATION.

ALEXANDER SHANKS & SON, DENS IRON WORKS, ARBROATH.

And 27, LEADENHALL STREET, LONDON, E.C.

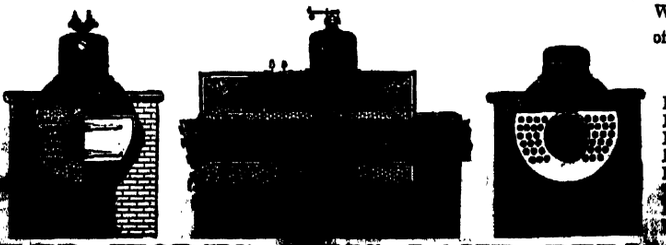
5042

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breeze, Small Coal, or Sawdust.
10. Is Separate Steam Heating

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

8ft.	long,	5ft. 0in.	diameter,	20-horse	power.
10ft.	,,	5ft. 6in.	,,	30	,,
12ft.	,,	6ft. 0in.	,,	40	,,
13ft.	,,	6ft. 6in.	,,	50	,,
14ft.	,,	7ft. 0in.	,,	60	,,
15ft.	,,	7ft. 6in.	,,	70	,,
16ft.	,,	8ft. 0in.	,,	80	,,
17ft.	,,	8ft. 6in.	,,	90	,,
18ft.	,,	9ft. 0in.	,,	100	,,

SOUTH LONDON BOILER WORKS, [illegible] LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

DICK, KERR & CO., Engineers and Contractors, (Five Medals awarded, Calcutta International Exhibition, 1883-4.)



SOLE MANUFACTURERS OF

KERR'S PATENT

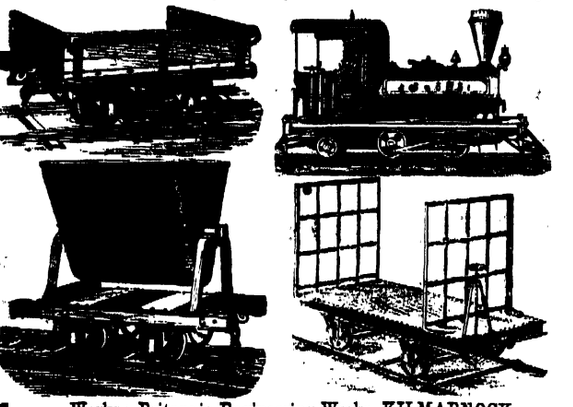
PORTABLE RAILWAY

SUITABLE FOR MINES AND PLANTATIONS.

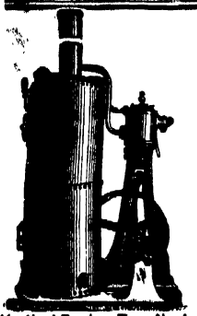
WAGONS & LOCOMOTIVES

FOR ALL CLASSES OF WORK.

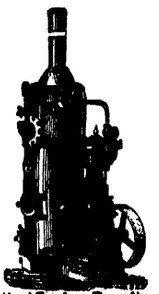
Catalogues and Prices on application. 5024



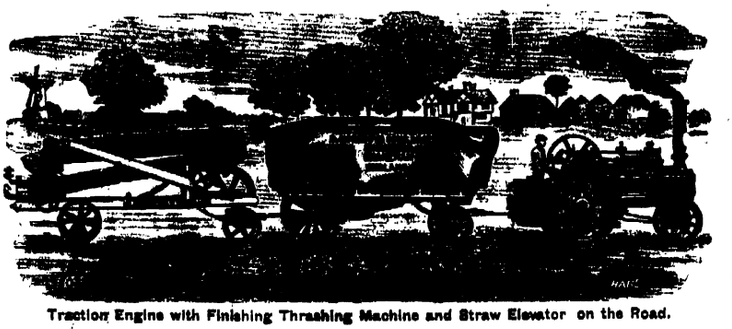
101, LEADENHALL ST., LONDON, E.C. Works: Britannia Engineering Works, KILMARNOCK.



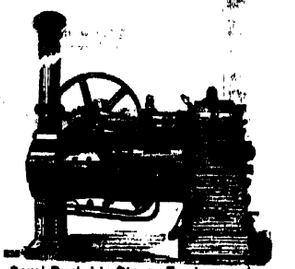
Vertical Engine, Type No. 1, with Vertical Cross Tube Boiler, 2½ to 12 HP.



Vertical Engine, Type No. 2, with Vertical Multitubular Boiler, 1 to 8 Horse Power.



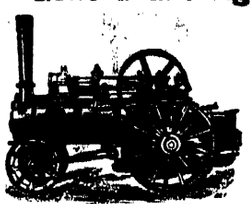
Traction Engine with Finishing Thrashing Machine and Straw Elevator on the Road.



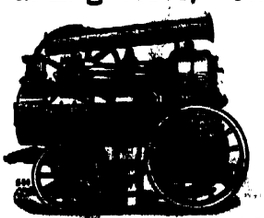
Semi-Portable Steam Engine made with Single or Double Cylinders, 2½ to 35 Horse Power.

R. HORNSBY & SONS, Limited,

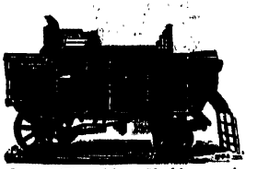
General and Agricultural Engineers, Ironfounders, Boilermakers, &c.



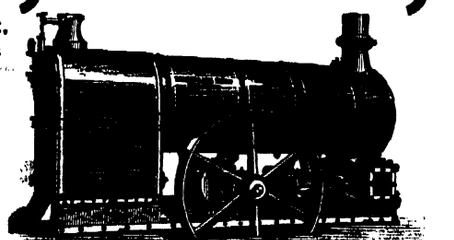
Improved Narrow Gauge Traction Engine, or Agricultural Locomotive.



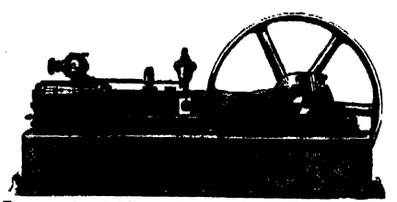
Patent Portable Steam Engine, made with Single or Double Cylinders, and from 2½ to 35-HP.



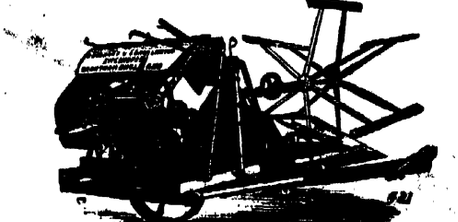
Patent Thrashing, Shaking, and Finishing Dressing Machine.



Patent Undertype Compound Engine, 6 to 50 Horse Power with Boiler above (as shewn) or separate from the Engine, as desired.



Fixed Horizontal Steam Engine, 10 to 60 Horse Power, with New Patent Automatic Expansion Gear.



Highland Society's £100 First Prize String Sheaf-Binding Harvester.



H.A.E. First Prize Mowers and Reapers.

For Particulars of the most modern improved and successful Agricultural Machinery, Ploughs, Dressing Machines, Corn Screens, Turnip Cutters, Root Pulpers, &c., SEE ILLUSTRATED CATALOGUES in English, French, German, Spanish, Russian, &c., sent GRATIS and POST FREE on application.

PLOUGH SHARES OF CAST IRON, CHILLED, WROUGHT IRON, MALLEABLE IRON AND STEEL, OF PATTERNS TO SUIT EVERY VARIETY OF WORK.

At the most important Exhibitions and trials since 1874, R. HORNSBY & SONS Specialities have gained 827 PRIZES, including 65 Gold Medals, 147 Silver Medals, and 309 HIGHEST PRIZES

SPITTLEGATE IRON WORKS, GRANTHAM.

London Office: 54, LOMBARD STREET. Telephone No. 1294. South African Depot: EDINBURGH BUILDINGS, DOCK ROAD, CAPE TOWN.

JAMES FARMER & SONS,

ADELPHI STREET IRONWORKS, SALFORD, MANCHESTER,

MAKERS OF

STEAM ENGINES, BLEACHING, FINISHING, DYEING & CALICO PRINTING MACHINERY,

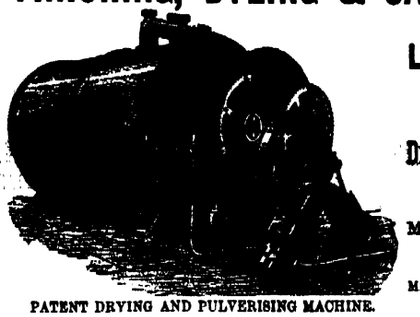
WIRE MACHINERY

Consisting of Continuous and other Rolling Mills, Wire Pointing Machines, Wire Looms, Wire Testing Machines, Wire Blocks, &c.



COPPER TUBE ROUGHING LATHE.

BRASS & COPPER TUBE MILLS. Wrought Iron TUBE MACHINERY.



PATENT DRYING AND PULVERISING MACHINE.

COMPLETE PLANT FOR

LINOLEUM MACHINERY

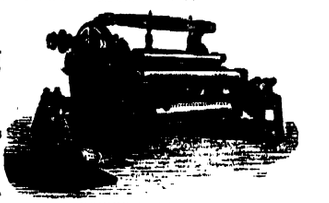
Two and Four Yards wide.

"PATENT"

Drying & Pulverising MACHINE

For Excrementitious Matter & other Materials and Compounds.

MACHINERY IN GENERAL.



POWER WIRE LOOM. 4859

FOR BRICK, TILE, & PIPE MACHINES,

JOHN WHITEHEAD & CO.,

ALBERT WORKS, PRESTON, LANCASHIRE,

HAVE BEEN AWARDED

FOURTEEN PRIZES by the Royal Agricultural Society of England,

INCLUDING THE SOCIETY'S SPECIAL SILVER MEDAL FOR SUPERIOR EXCELLENCE.

Also Awarded the PRIZE MEDALS of the INTERNATIONAL EXHIBITIONS of LONDON, 1851, 1862, and 1874; PARIS, 1855, 1856, 1867, and 1878.

ILLUSTRATED CATALOGUES FREE ON APPLICATION. 4907

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

BELL'S Asbestos Works, Southwark. S.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure.....110 lbs. | Vacuum.....29 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,

D. HENDERSON, Chief Engineer, S.S. "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department.

Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,

G. H. CLARKE, Sup. Engineer.

Mr. J. BELL.

Department of the Director of Navy Contracts, Admiralty, Whitehall, 26th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core.....square. | Elastic core.....round.

JOHN COLLETT, Director of Navy Contracts.

To Mr. JOHN BELL.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at any list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 20 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1881.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



TRADE MARK

BELL'S ASBESTOS.

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depôts and not through agents or factors.

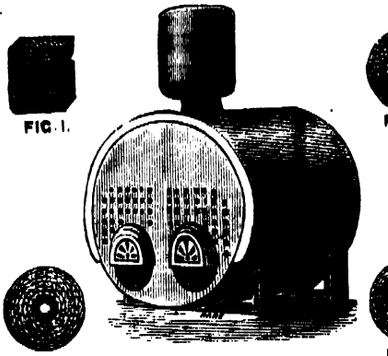


FIG. 1.

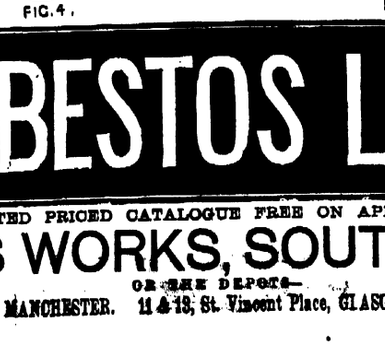


FIG. 4.

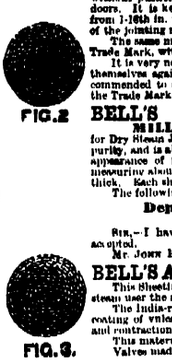


FIG. 2



FIG. 3.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 30 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates.. .. .. .. 186 deg.
" Covering.. .. .. 94 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 28th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly, "W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

Mr. JOHN BELL, Southwark, S.E. Gunnislake, Tavistock, 8th April, 1884.

Sir,—I have much pleasure in stating that the Asbestos Covering supplied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, Yours faithfully,

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without packering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ⅛ in. to 3 in. wide, and any thickness from 1-16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and 1 millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts, Admiralty, Whitehall, S.W., 17th May, 1884.

SIR,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT.

Mr. JOHN BELL. Director of Navy Contracts.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REGD.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

4943

OR THE DEPOTS—

[illegible] SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

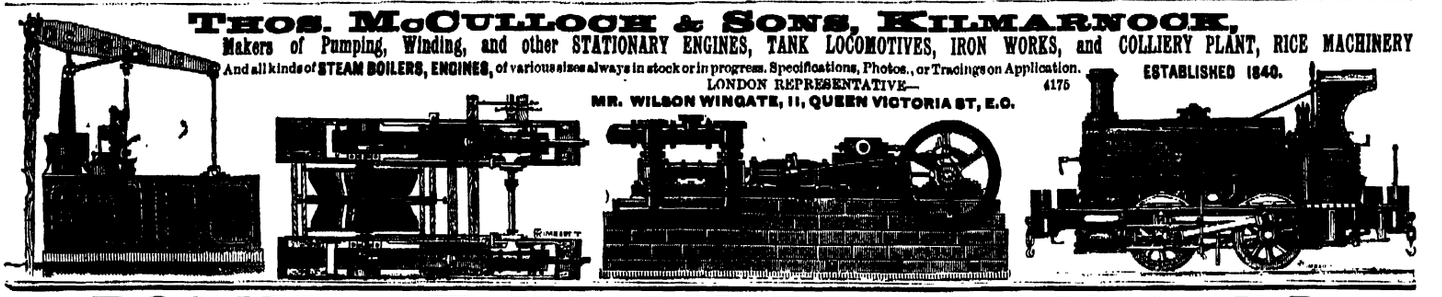
THOS. McCULLOCH & SONS, KILMARNOCK,

Makers of Pumping, Winding, and other STATIONARY ENGINES, TANK LOCOMOTIVES, IRON WORKS, and COLLIERY PLANT, RICE MACHINERY

And all kinds of STEAM BOILERS, ENGINES, of various sizes always in stock or in progress. Specifications, Photos., or Tracings on Application. 4175

LONDON REPRESENTATIVE—
MR. WILSON WINGATE, 11, QUEEN VICTORIA ST, E.C.

ESTABLISHED 1840.



JOHN I. THORNYCROFT & CO.,

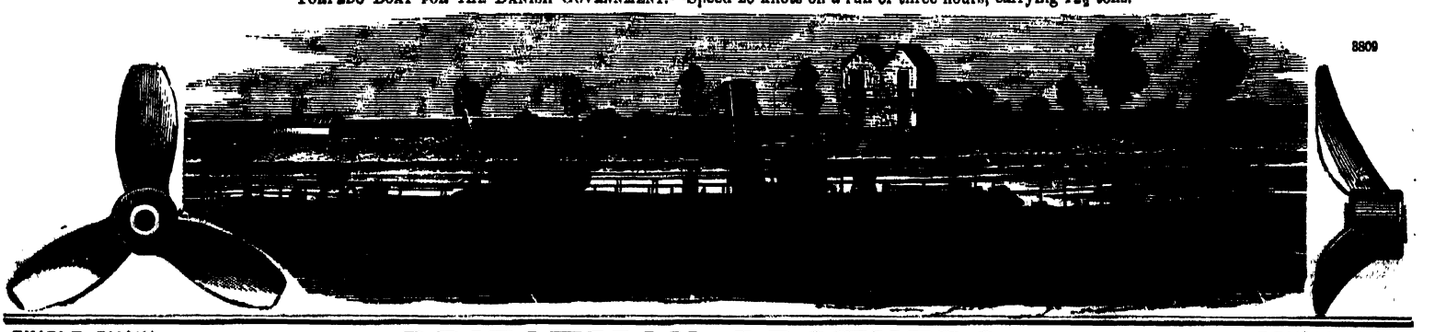
STEAM YACHT AND LAUNCH BUILDERS,

CHURCH WHARF, CHISWICK, LONDON, W.

YACHTS AND LAUNCHES FOR SEA OR RIVER SERVICE, from 25 to 100 feet in length, and Speeds from 10 to 25 Miles per Hour

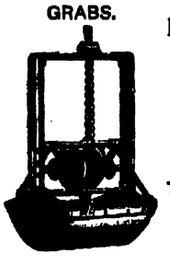
Thornycroft's Patent Screw Propellers made for all sizes of Vessels. Efficiency superior to any hitherto brought out.

TORPEDO BOAT FOR THE DANISH GOVERNMENT.—Speed 20 knots on a run of three hours, carrying 12¼ tons.



8809

SINGLE CHAIN GRABS.



SUPPLIED TO ORDER WHEN PREFERRED.

WORKS: Holderness Foundry, HULL.

PRIESTMAN BROTHERS.

CONTRACTORS FOR BARGES TO H.M. GOVERNMENT & THE INDIAN BOARD.

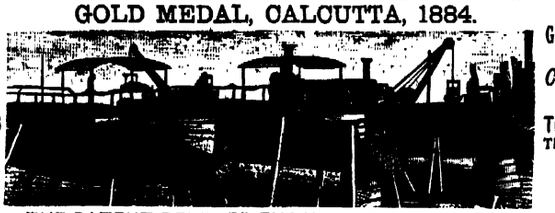
GOLD MEDAL, CALCUTTA, 1884.

LONDON OFFICE: 62, QUEEN VICTORIA STREET.

AWARDS

DIPLOMA of HONOUR AMSTERDAM, Paris, Melbourne, Adelaide.

Contractors for Dredgers to
THE ENGLISH GOVERNMENT
THE CROWN AGENTS FOR THE COLONIES
The German Government
" French Government
" Italian Government
" Cape Government
" Danish Government
" Chinese Government
" Chilian Government



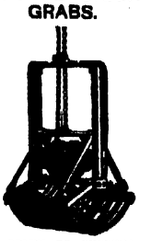
THE PATENT DREDGER EXCAVATOR & ELEVATOR.

AWARDS

GOLD MEDAL FISHERIES LONDON, Sydney, New Zealand, Tynemouth.

Contractors for Dredgers to
THE INDIAN BOARD
THE MERSEY DOCK & HARBOUR BOARD
The South Australian Government
" New Zealand Government
" Spanish Government
" Victorian Government
" New South Wales Government
" Dutch Government
" Queensland Government

DOUBLE CHAIN GRABS.

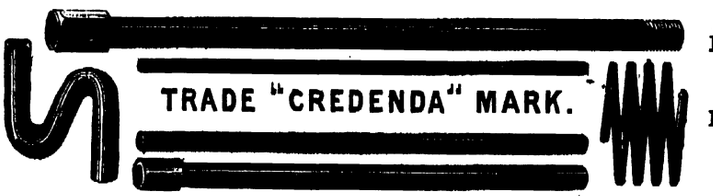


PARTICULARS, SHOWING GREAT ADVANTAGES, ON APPLICATION. 5057

—:- PATENT -:—

COLD-DRAWN SEAMLESS

THE CREDENDA COLD-DRAWN SEAMLESS STEEL TUBE COMPANY, BIRMINGHAM.



TRADE "CREDENDA" MARK.

BIRMINGHAM WORKS & OFFICES: LEDSAM STREET, MONUMENT LANE STATION.

LONDON OFFICE: 4, WATER LANE, GT. TOWER STREET, E.C.

499

FOR BOILERS AND STAYS, HYDRAULIC PRESSES, AIR RESERVOIRS,

STEEL TUBES.

BORING RODS, COUPLINGS, BUSHES, SPINDLES, COLLARS, BICYCLES & OTHER USES.



The "CLYDE" STEAM and BALLAST PUMPS.

"CLYDE" STEAM PUMP (STANDARD PATTERN). LIST OF STANDARD SIZES.

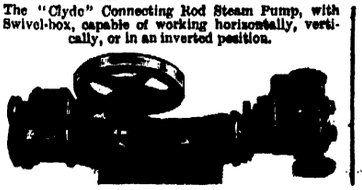
Size Double-Acting.	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Price, with Gun-Metal Valves, Plunger, &c.
	in.	in.	in.	£ s. d.
1	4	2½	4	17 15 0
2	4½	2½	4	21 10 0
3	4½	2½	4½	24 10 0
4	5	2½	5	26 0 0
5	5½	3	5½	27 10 0
6	6	3½	6	29 10 0
7	7½	4	7½	41 0 0
8	8	4½	8	53 0 0

For Feeding Marine and Stationary Boilers, Pumping Water Supply to Railway Stations, Mansions, Warehouses, Mines, Dye Works, Breweries, and for use as Stationary Fire Engines, and for General Contractors' Purposes; for Tar and other Thick Liquids.

"CLYDE" STEAM PUMP (PATTERN A). LIST OF STANDARD SIZES.

Size.	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Capacity per hour.	Suitable for Boiler.	Price, with Gun-Metal Valves and Plunger.
	in.	in.	in.	Galls.	HP.	£ s. d.
0A	3	1½	3	240	20	16 0 0
1A	4	2½	4	950	50	19 10 0
2A	4½	2½	4	1220	85	22 10 0
4A	5	2½	5	1680	125	28 10 0
6A	6	3½	6	2350	175	32 0 0
8A	8	4½	8	4275	300	58 10 0

The "Clyde" Connecting Rod Steam Pump, with Swivel-box, capable of working horizontally, vertically, or in an inverted position.



"CLYDE" BALLAST PUMP (PATTERN B). LIST OF STANDARD SIZES.

Size.	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Suction and Delivery Pipes diam.	Discharge in Tons per hour.	Price.
	in.	in.	in.	in.		£ s. d.
1B	6	6	8	4	40 to 80	50 0 0
2B	6½	6½	8	4½	47 ,, 94	53 0 0
3B	7	7	9	4½	55 ,, 110	57 10 0
4B	7½	7½	9	4½	63 ,, 126	60 0 0
5B	8	8	10	5	70 ,, 140	65 0 0
6B	8½	8½	10	5½	85 ,, 170	70 0 0

This Pump is very compact, and works with the greatest steadiness. The crosshead is of cast steel, and so arranged that it can be readily detached from the pump piston rod, if the engine is required to work alone. The Pump is reversible, that is, by merely changing the position of the Valves the suction can be converted into delivery and *vice versa*. 4729



TRADE DISCOUNTS AND FURTHER PARTICULARS ON APPLICATION.

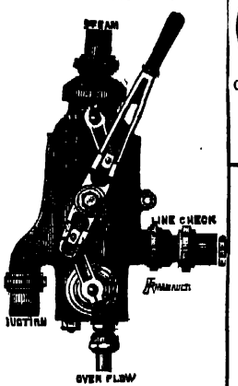
LOUDON BROTHERS,

BOTHWELL STREET, GLASGOW, } AND { UPPER THAMES STREET, LONDON.

Manchester Depot: 5, Todd Street, Corporation Street.

Cardiff Depot: T. [illegible], 7, Bute Docks.

CLASS A.



LOCO. PATTERN,
SINGLE LEVER.


ONLY GOLD MEDAL
Paris, 1878.

THE HANCOCK
INSPIRATOR
60,000 IN USE.


FIRST AWARD,
Sydney, 1879.

THE DONKEY PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND RELIABLY.

No Adjustment.
Draws Water at 140°.
All Sizes lift water 25 ft.
Delivers to Boiler up to 212°.

ESTIMATES FOR FIXING COMPLETE with Guarantee to start in good working order, and all information on application to—



Exhausts Air. Lifts Water 25 ft. Ejects 18 ft.

Feeds through Heaters.
Can be used as a Pump only.
No Valves or Wearing Parts.
Can be examined instantly.

THE HANCOCK INSPIRATOR CO.,
108, Upper Thames St., London, E.C.

CLASS O.



STATIONARY
PATTERN. 5115

Henry Bessemer and Co., Limited,

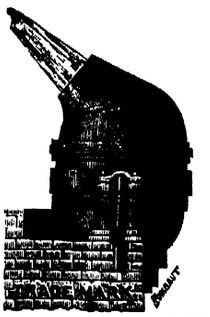
Manufacturers of Cast Steel,

SHEFFIELD.

FORGINGS
In Steel of any size.—Quotations given either for uses or finished complete.

STEEL CASTINGS
Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0.30 per cent. carbon, and to bear a tensile strain of 34 tons to the square inch.

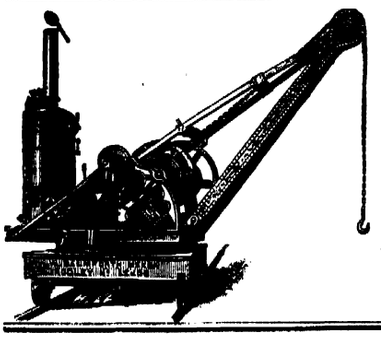
TYRES AND AXLES.



SOFT CAST STEEL
In bars and rods, for general use in Engineering Works.

BLOOMS, BILLETS, & SLABS
Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,
Of superior quality. 2127

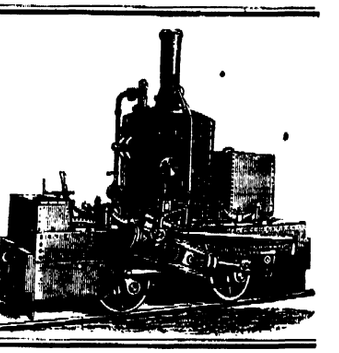


EXORS. OF WM. BALMFORTH,
RODLEY, NEAR LEEDS,

MANUFACTURERS OF
LOCO. STEAM CRANES, CONTRACTORS' LOCOS.,
TRAVELLERS, HOISTS,
AND ALL KINDS OF LIFTING MACHINERY.

4697

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes.





THE COALBROOKDALE COMPANY, LIMITED

MAKERS OF
STEAM ENGINES,
HORIZONTAL AND VERTICAL,
AND
OTHER MACHINERY.

MAKERS OF
STEAM PUMPS.
PARKER & WESTON'S PATENT
PUMPING ENGINES for Mines, Sewage and Water Works.
BOILER FEEDERS and SLIP PUMPS.

AGENCIES { LIVERPOOL - 19, SWEETING STREET.
MANCHESTER, 29, PRINCESS STREET. 5130

WORKS & OFFICES, COALBROOKDALE, SHROPSHIRE.

S. OWENS & CO.,

HYDRAULIC AND GENERAL ENGINEERS, WHITEFRIARS STREET, LONDON,

MANUFACTURERS OF

PUMPING MACHINERY OF EVERY DESCRIPTION.

SOLE LICENSEES AND MANUFACTURERS FOR GREAT BRITAIN OF

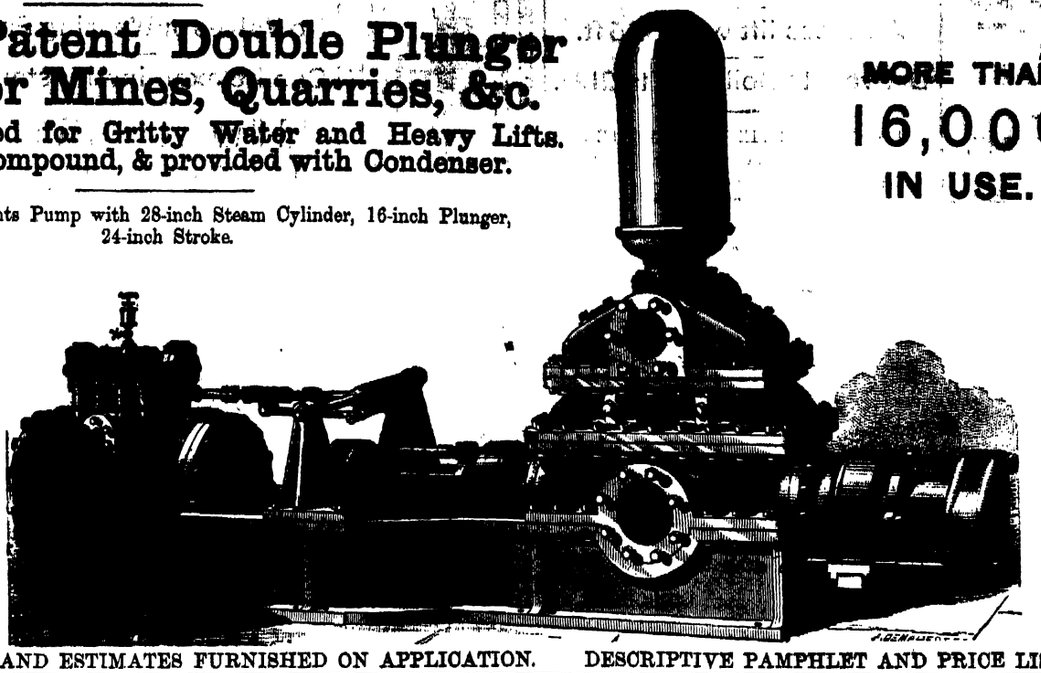
BLAKE'S PATENT DIRECT-ACTING STEAM PUMP.

Blake's Patent Double Plunger Pump, for Mines, Quarries, &c.

Specially adapted for Gritty Water and Heavy Lifts.
Also made Compound, & provided with Condenser.

Illustration represents Pump with 28-inch Steam Cylinder, 16-inch Plunger, 24-inch Stroke.

MORE THAN 16,000 IN USE.



5093

SPECIAL DESIGNS AND ESTIMATES FURNISHED ON APPLICATION. DESCRIPTIVE PAMPHLET AND PRICE LIST FREE.

POINTS & CROSSINGS

FROM EVERY SECTION OF RAIL.

Portable Railways and General Railway Plant.

HARTLEY & ARNOUX BROS.

STOKE-ON-TRENT.

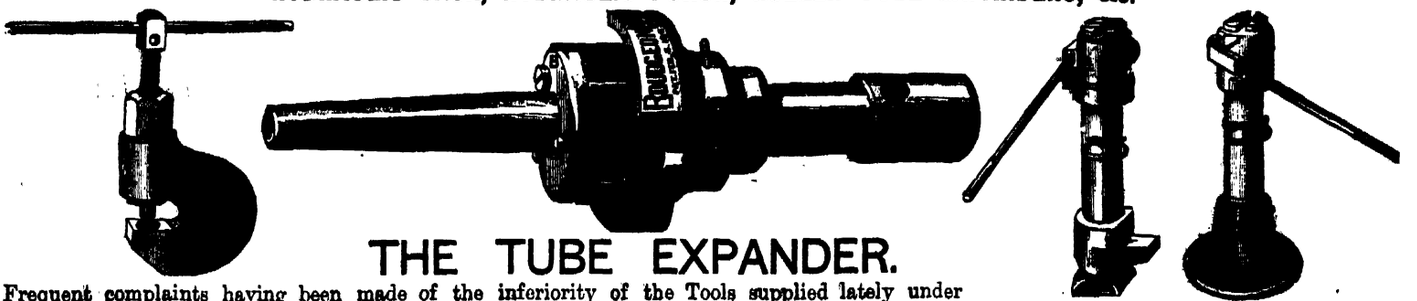
4468

RICHARD DUDGEON,

114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF HIS

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, &c.



THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "DUDGEON'S ROLLER TUBE EXPANDERS," R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only are stamped as under:—

R. DUDGEON, N.Y., Patd. Feb. 5th, 1867, on the Guide-ring of each Tool, WITHOUT WHICH NONE ARE GENUINE.

These can always be obtained at R. Dudgeon's English Depôt, 114, Fenchurch Street. If more convenient to get them through Merchants ware should be taken to specify "*Dudgeon's own make*" on the *Order*, but as R. Dudgeon observes with regret that *imitations* bearing his *stamp counterfeited* are being sold as his, he would respectfully recommend both Merchants and Users requiring Expanders of his make to apply direct. In urging this he merely seeks to secure the identity of what is made by himself, by which he is content to stand or fall.

R. Dudgeon takes this opportunity of returning thanks for past favors, either by orders or recommendation, and it being his intention strictly to maintain the Quality and Workmanship so essential for such a Tool as the Expander, begs to solicit a continuance of the same.

CATALOGUES AND PRICE LISTS ON APPLICATION TO R. DUDGEON, 114, FENCHURCH STREET, LONDON, E.C.

18 PRIZE MEDALS.] **THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED,** [18 PRIZE MEDALS.

4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 3. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1882, 1



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 4794

100 TO 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

New Patent TWIN-ENGINES. Impulse every ½ Revolution.

"OTTO." GOLD MEDAL at Crystal Palace, & HIGHEST AWARD at Paris Electrical Exhibitions.



New Patent SELF-STARTER. Best, fastest, and Simplest made, may now be applied.

CROSSLEY'S NEW VERTICAL ENGINE. Requiring little floor space.

½ TO 100 HP. IND. **MANY IMPROVEMENTS.** OVER 14,000 IN USE.

LONDON: 24, POULTRY, E.C. **GAS ENGINE** GLASGOW: 58, UNION STREET 4775

CHEAP GAS FOR MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·3 lb. per ind. H. P. per hour.

The DOWSON ECONOMIC GAS COMPANY, L'TD., 3 Gt. Queen St., Westminster, S.W. 4883

JESSOP'S CRANES

For Particulars see last Week's "ENGINEERING," or WRITE FOR HANDBOOK.

J. JESSOP & SON, LEICESTER. 5113

Or 113, CANNON STREET, LONDON.

TAYLOR & CHALLEN, ENGINEERS, BIRMINGHAM,

SOLE MAKERS OF WITHINSHAW'S PATENT FEED-WATER HEATER AND PURIFIER.

The saving effected by these Heaters is a remarkable fact, as will be seen by the two letters below.

SECTIONAL ELEVATION.



LETTER FROM MESSRS. THOMAS WHITE & SONS, HERTFORD MILLS, BALSALL HEATH, BIRMINGHAM.

June 20th, 1883.

GENTLEMEN,—It is with pleasure we can inform you that WITHINSHAW'S 10-HP. FEED WATER HEATER, which you have fixed at our works, is giving us every satisfaction. Before it was put in we were stopping three and four times a day for want of steam. Now we can keep up the steam easily with *35 per cent. less coal*, besides, we are now *burning slack, costing us 30 per cent. less* than we were giving before the Heater was put in. We have not only plenty of clean boiling water for the boilers, but we can, and are, taking boiling water for other purposes, which is a great convenience to us.

We shall be glad to show the Heater at work to anyone who you may wish to see it.

To Messrs. TAYLOR & CHALLEN, Derwent Foundry, Birmingham.

Yours respectfully, THOMAS WHITE & SONS.

—o—

September 29th, 1883.

Messrs. TAYLOR & CHALLEN,

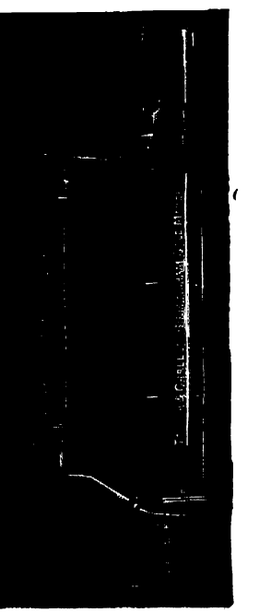
GENTLEMEN,—We have a further pleasure in stating that we are now doing as much work in one day as we were doing in a day and quarter before the Heater was put in.—Yours respectfully, THOMAS WHITE & SONS.

This Heater is the most powerful and economical yet brought out. The tubes are made of the best heat conducting metal, solid drawn. The hot exhaust is conducted to the top of the Heater, and is brought into close contact with the hottest water in the Heater, by charging the top chamber and the small inverted metal tubes. At the same time the exhaust has a free passage down the centre tubes, the remaining uncondensed steam passing to the bottom and up the out-going up-take. The cold feed water from the pump passing up and down the up-take, enters the bottom of the Heater as hot as the out-going exhaust steam.

The water capacity in these Heater being very large, considerable time is given for the water to boil; this being done under the same pressure as the boiler, precipitates the impurities to the bottom of the Heater, and they are then blown off; the boiler being kept clear from deposit and scale, by being fed with clean boiling water from the top of the Heater.

Where the Injector is connected with the Heater (as shown in the illustration), no pump is required, the exhaust steam only being used to boil feed water clean, and feed the boiler.

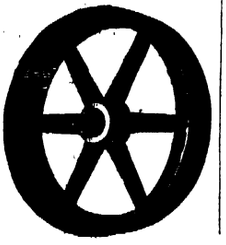
Patented in Great Britain France, Germany, Belgium.



PULLEYS

Cast of selected iron from carefully designed patterns, either whole, in halves, plain or shrouded, finished, or castings only.

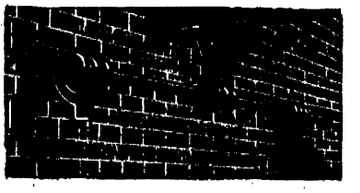
SHAFTING, COUPLINGS, Collars, Brackets, PEDESTALS, And other BEARINGS.



THE "SHAFT-CARRIER."

A GREAT SUCCESS. THOUSANDS IN USE.

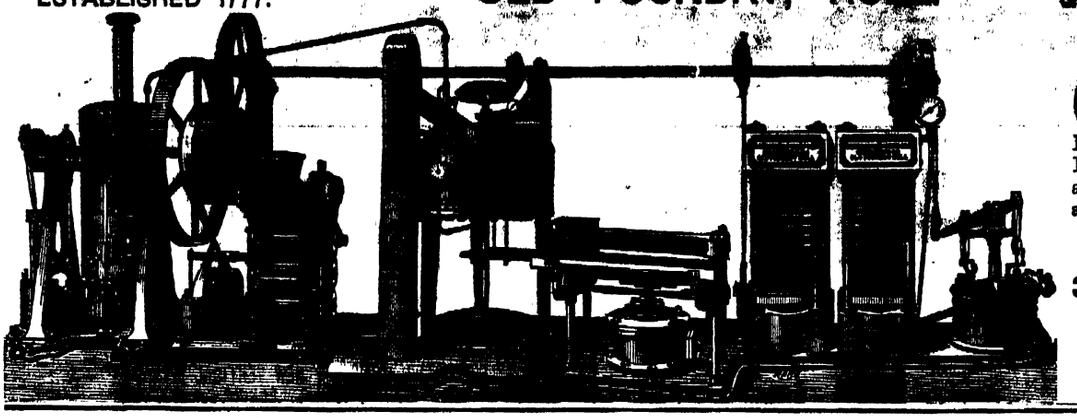
It can be fixed in any position (see cut); is self-adjusting and self-lubricating; position of bearing variable both vertically and horizontally; easily fixed; causes no undue friction is very durable; low in price.



(This Advertisement appears every eight weeks.) 4181

ROSE, DOWNS & THOMPSON

ESTABLISHED 1777. OLD FOUNDRY, HULL. GOLD MEDAL, CALCUTTA.



ANGLO-AMERICAN

OIL-MILL MACHINERY

For crushing Linseed, Cotton Seed, Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent. in labour and power, and 2 to 4 per cent. in Oil.

(See *Engineer*, May 6, 1881, and Nov. 23, 1883.)

300,000 TONS OF OIL SEEDS, PER ANNUM, Are Crushed by Mills made on this system by us. 5127

CATALOGUES FREE.

PATERSON & COOPER,

ELECTRIC LIGHT ENGINEERS AND CONTRACTORS,

76, LITTLE BRITAIN, LONDON. Steam Factory: POWNALL ROAD, DALSTON.

Complete Sets of Electric Lighting Machinery and Fittings for Lighting Hotels, Public Buildings, Factories, Mills, Ships, &c., &c.

ESTIMATES FOR INSTALLATIONS FREE OF CHARGE. EXPERIENCED MEN SENT TO ALL PARTS OF THE COUNTRY.

Licensees of the "Clarke and Bowman" Arc Lamp, and of Joel's Storage Batteries.

PATERSON & COOPER'S DIRECT CURRENT "PHŒNIX" DYNAMOS.

No. 1.—	For	16	20	candle-power	Lamps,	or	2	Small	Arcs,	or 1	Large Arc £36
No. 2.—	„	30	„	„	„		3	„	„	2	„ „ 54
No. 3.—	„	75	„	„	„		7	„	„	4	„ „ 80
No. 4.—	„	120	„	„	„		12	„	„	7	„ „ 120
No. 5.—	„	200	„	„	„		24	„	„	14	„ „ 180
No. 6.—	„	300	„	„	„		...	...	...	...	 250
No. 7.—	„	500	„	„	„		...	...	...	...	 400

4696

Awarded a First-Class CERTIFICATE OF MERIT at Manchester, and a First-Class DIPLOMA OF MERIT at Tynemouth.

PATENT DIAGONAL ROCKING FIRE-BARS

—(Can be Fixed in a Few Hours.)— ARE ECONOMICAL, DURABLE, SMOKE-CONSUMING. —(No Attachment to Boiler necessary.)—

Numerous Official Tests show an average economy of over 10 per cent. These Patent Bars last Years where ordinary Bars last only Months.

Recently supplied to the order of the eminent builders of the engines and boilers of the most powerful Ironclad afloat for use in the whole of the furnaces, to work with "Forced Draught," MAKING THE THIRD Ironclad fitted. Used by the most eminent Engine and Boilermakers (Marine and Land), Railways, Home and Foreign Governments, &c. 5119

Agents having connections among Steam Users Required in Principal Towns. — Particulars of the Manager at the Offices, 259, Gresham House, E.C.

REGISTERED TRADE MARK

'PHOSPHOR BRONZE'

The Best and Most Durable Metal for Bearings and Bushes of every Description; Hydraulic Pumps, Pinions, Valves, &c. &c Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c.

SOLE MANUFACTURERS UNDER SEVERAL PATENTS- 1475

The PHOSPHOR BRONZE COMPANY, Limited, Sumner & Emerson Streets, Southwark, London, S.E.

MANLOVE, ALLIOTT, FRYER & CO.,

ENGINEERS, BOILER MAKERS, IRON AND BRASS FOUNDERS, COPPERSMITHS, &c.

Works—NOTTINGHAM & ROUEN. London Offices—50, QUEEN VICTORIA STREET, E.C.

SOLE MAKERS OF

HALPIN'S Patent COMPOUND STEAM ENGINE,

(Patented by DRUITT HALPIN, C.E., 9, Victoria Chambers, Westminster, from whom information may be obtained.)

This Engine has given the most economical results yet recorded.

HIGH PRESSURE AND CONDENSING ENGINES of ordinary construction,

STEAM BOILERS—Lancashire, Cornish, Galloway, Multitubular, Compound, Vertical, &c.

Centrifugal Machines or Hydro Extractors of all Constructions for Sugar, Cloth, Wool, Chemicals, &c.

NUSSEY AND LEACHMAN'S PATENT CONTINUOUS CLOTH PRESSING MACHINE.

SUGAR MACHINERY. LAUNDRY MACHINERY.

MACHINERY AND APPARATUS FOR TREATMENT OF TOWNS REFUSE.

WATER WHEELS, SHAFTING, GEARING, AND ALL KINDS OF ENGINEERING AND MILLWRIGHT WORK.

THE EXHAUST INJECTOR for feeding Steam Boilers; ensures Economy of Fuel, Economy of Water, increased Steaming Power of Boiler

SEE FUTURE ADVERTISEMENTS. 3076

CHARLES CHURCHILL & CO.,

AMERICAN MACHINERY AND TOOL IMPORTERS.

21, CROSS STREET, FINSBURY, LONDON, E.C.

ESTABLISHED IN 1862.



C. C. & Co. have just removed to much larger premises with ample show rooms and warehouse, and will carry a greatly increased stock of all the best American tools.

SOLE AGENTS FOR

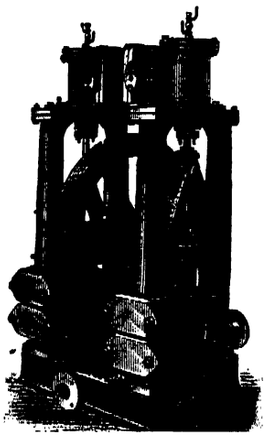
THE ONLY GENUINE AMERICAN MORSE TWIST DRILL,

WITH CENTRE GRINDING LINE, STOCKS AND DIES, REAMERS AND MILLING CUTTERS,

Stephens' Patent Vices, Horton Chucks, Cushman Chucks, Westcott Chucks, Sweetland Chucks, Stanley Rule & Level Co.'s Planes, &c., &c., Gould's Manufacturing Co.'s Pumps, and a great variety of New American Tools.

New Catalogue for 1883 just issued, 215 pages Quarto, sent on receipt of One Shilling in Stamps.

(THE LARGEST CATALOGUE OF AMERICAN TOOLS EVER PUBLISHED IN GREAT BRITAIN.) 4124



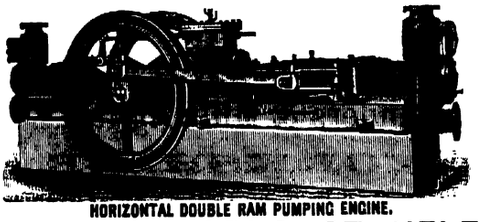
DOUBLE RAM PILLAR PUMPING ENGINE.

W. NEILL & SON,

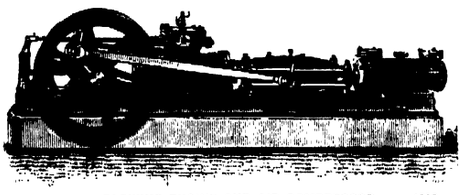
ENGINEERS, IRON & BRASS FOUNDERS, BOILER MAKERS, &c.

MANUFACTURERS OF

PUMPING ENGINES, BLOWING ENGINES, STEAM ENGINES, AIR COMPRESSORS, and VACUUM PUMPS.



HORIZONTAL DOUBLE RAM PUMPING ENGINE.



BLOWING ENGINE AND AIR COMPRESSOR. 4253

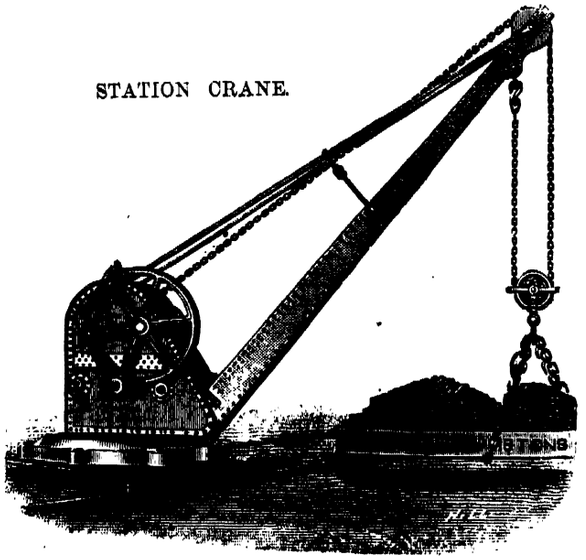
BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.

COWANS, SHELDON & CO., LTD.,

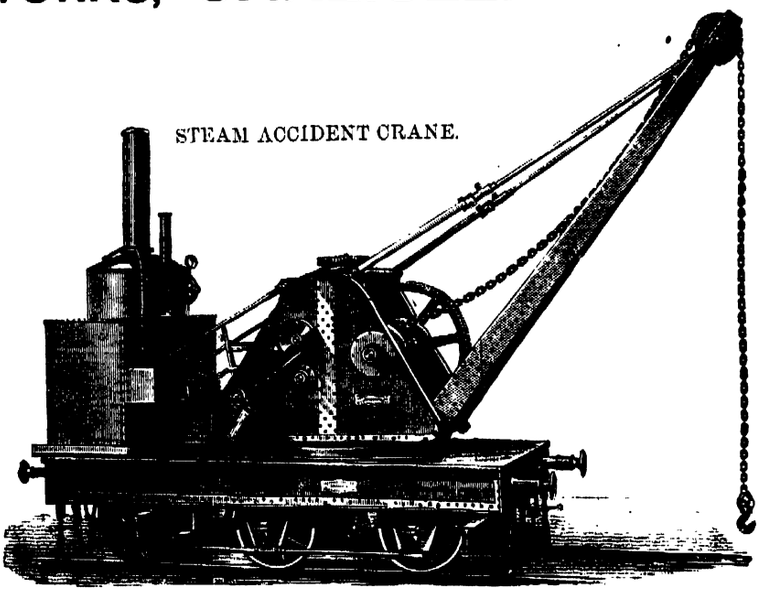
ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.

STATION CRANE.



STEAM ACCIDENT CRANE.



TURNTABLES, CRANES, MASTING SHEERS, AND TRAVERSERS OF EVERY DESCRIPTION BY STEAM, HAND, OR HYDRAULIC POWER.

6007

The Edison and Swan United Electric Light Company,
LIMITED.

Contractors to the Admiralty, H.M. Office of Works, Houses of Parliament, War Office, Science and Art Department, South Kensington, &c.; to the principal Shipping Companies, and Criterion Theatre, Holborn Restaurant, Gatti's Restaurant, &c., &c.

EDISON & SWAN INCANDESCENT LAMPS from 2½ to 100 C.P.

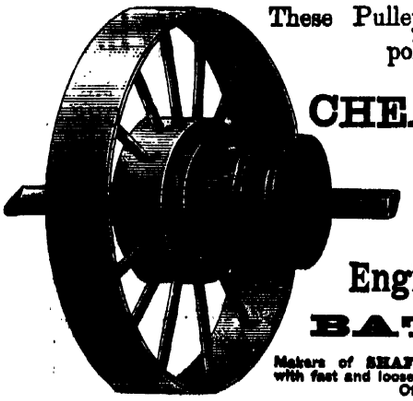
ELECTRIC METERS, SWITCHES, ELECTROLIERS, &c.

DYNAMOS: The Company are prepared to Supply the NEW and IMPROVED Type of EDISON Dynamos.

PRICES AND PARTICULARS MAY BE HAD UPON APPLICATION TO 4584

THE SECRETARY, 57, HOLBORN VIADUCT, LONDON, E.C.

TURNED WROUGHT IRON PULLEYS.



These Pulleys are TURNED IN A LATHE, and not polished on a Grindstone like those generally sold.

CHEAP, STRONG, AND TRUE.

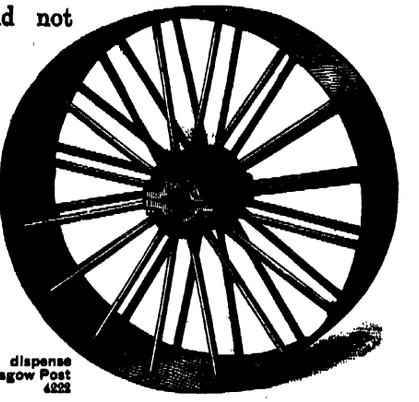
Illustrated Circular Post Free.

J. BAGSHAW & SONS,

Engineers, Ironfounders & Millwrights,

BATLEY, YORKSHIRE,

Makers of SHAFTING and FRICTION PULLEYS for Electric Lighting Machinery, which dispense with fast and loose Pulleys: one Pulley answers for both. In use at L.S.W. Railway, Nine Elms; Glasgow Post Office; King's Cross Station; and all principal Factories home and abroad. 4222

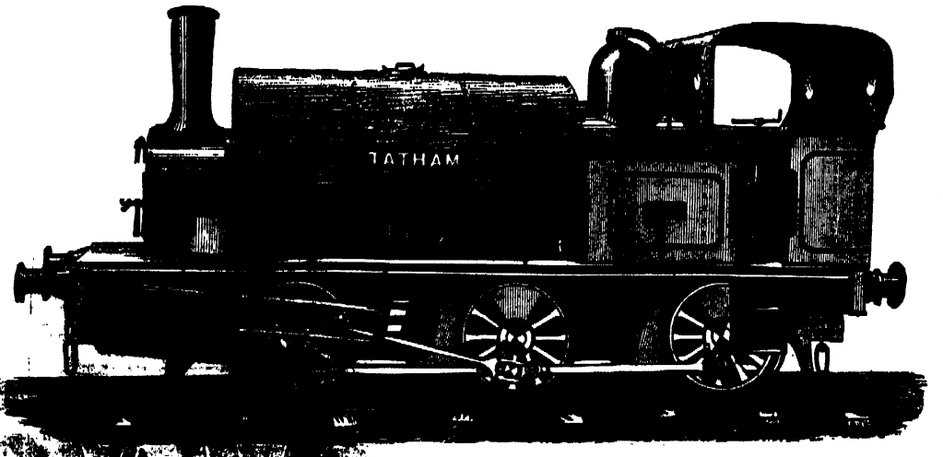


ESTABLISHED 1860.

HUDSWELL, CLARKE & Co.,

RAILWAY FOUNDRY, LEEDS.

PRICES and SPECIFICATIONS on Application.



FOR CASH or DEFERRED PAYMENTS.

LOCOMOTIVE TANK ENGINES

OF ALL SIZES AND TO SUIT ANY GAUGE OF RAILWAY.

For Main Line or Branch Railways, Contractors, Ironworks, Collieries, &c.

CRANES! CRANES!



SEE HALF-PAGE ADVERTISEMENT JULY 25th, Page 33.

RAILWAY PLANT!!



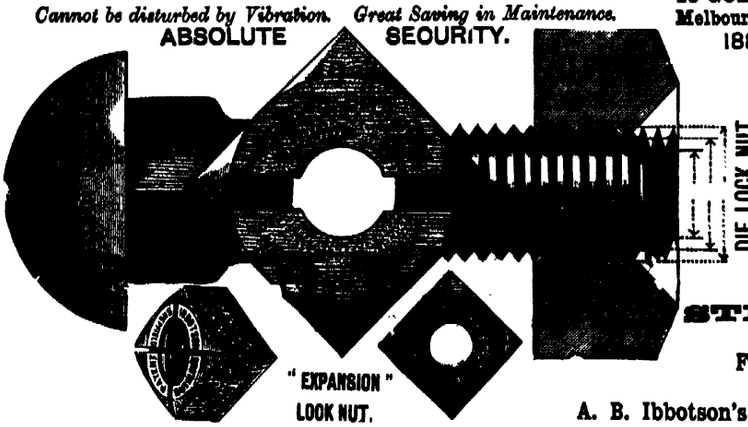
SEE HALF-PAGE ADVERTISEMENT JULY 11th, Page 35.

RANSOMES & RAPIER, 5, Westminster Chambers, LONDON, S.W., and Waterside Ironworks, IPSWICH. 5062

Patent Steel Lock Nuts and Steel Fish Bolts.

Cannot be disturbed by Vibration. *Great Saving in Maintenance.*

ABSOLUTE SECURITY.



FIRST-CLASS MEDALS, LONDON, PARIS, SYDNEY, ADELAIDE, &c.

18 GOLD MEDALS Melbourne Exhibition, 1880—81.

ONLY FIRM awarded GOLD MEDALS for Nuts and Bolts, Buffers, Couplings, Cradles, Springs, Steel Sleepers, Rail Joints, &c.
GOLD MEDALS for Steel, Files, Saws, Steel Forgings, Railway Appliances, &c.

IBBOTSON BROTHERS

AND COMPANY, LIMITED,

GLOBE IRON AND STEEL WORKS

SHEFFIELD.

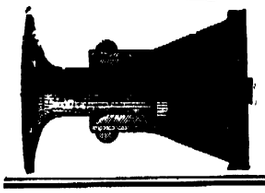
Manufacturers of

STEEL OF EVERY DESCRIPTION

STEEL FORGINGS, AXLES, &c., RAILWAY SPRINGS OF ALL KINDS.

Files (Hand Cut only), Saws, Edge Tools, and Patent Automatic Central Coupling Buffers.

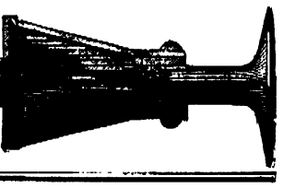
A. B. Ibbotson's Patent Steel Die and Expansion Lock Nuts, and Steel Bolts, Railway Fastenings, &c., &c.



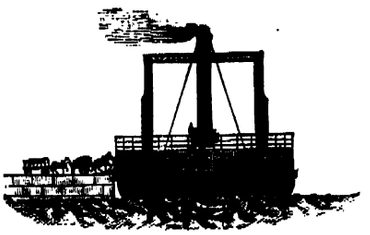
GEORGE TURTON'S PATENT WROUGHT IRON BUFFERS,

AND PATENT COMPOUND CAST STEEL SPRINGS. {4120 {3813

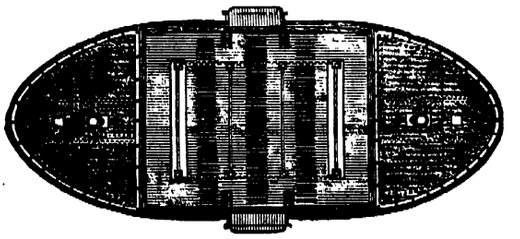
LONDON OFFICE: 4, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W.



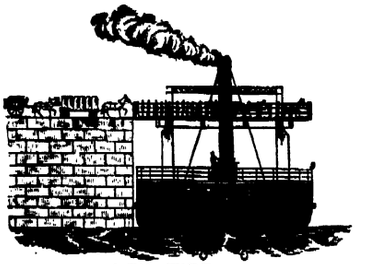
PATENT ELEVATING STEAMER,



HIGH TIDE.

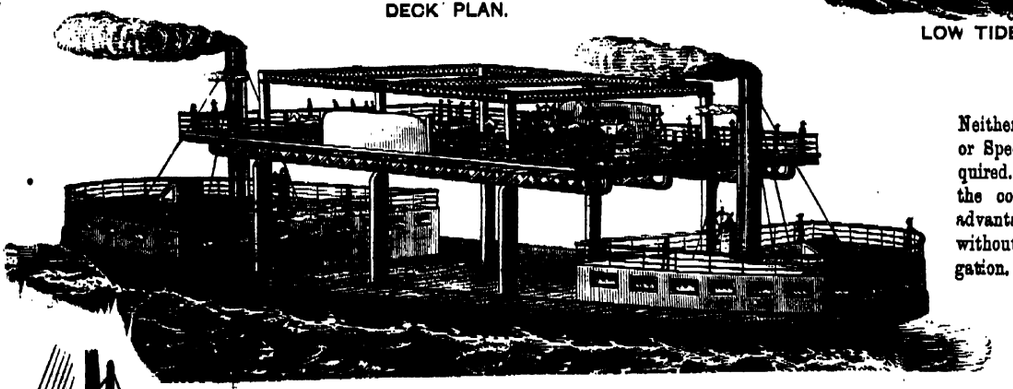


DECK PLAN.



LOW TIDE.

For Ferry Traffic, to Land and Embark Passengers, Carriages, Wagons, and Cattle on same level as Pier or Quay, irrespective of the rise and fall of tide. Also for Landing and Embarking Troops, Horses, and Artillery.



Neither Slips or Pontoons, or Special Berths are required. At a fraction of the cost it has all the advantages of a Bridge, without obstructing Navigation.



LANDING TROOPS.

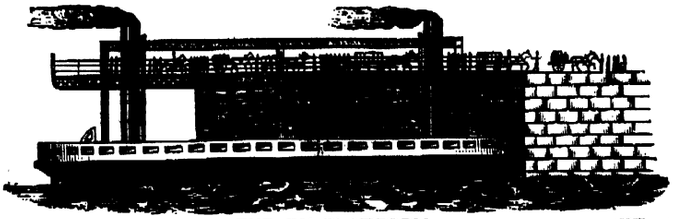
W. SIMONS & CO.,

SHIPBUILDERS & ENGINEERS,

RENFREW,

SCOTLAND,

CONSTRUCTORS.



END ON PLATFORM.

5127

ESTABLISHED 1839.

TRADE MARK. SANS CHANGER

ESTABLISHED 1839.

JOHN MUSGRAVE & SONS, Ltd.,

GLOBE IRON WORKS, BOLTON,

Manufacturers of the only Patent Safety Starting, Turning, or Barring Engine

Makers of STEAM ENGINES up to 3,000 HP.

With Patent Automatic Cut-off Motion. Adaptable to Stamper Valves, Slide Valves, and Corliss Valves, which can also be applied to existing Engines.

STEAM HAMMERS,

On Condie's principle, with Patent Valve Motions, from 3½ cwt. to 25 tons.

Wrought-Iron and Steel STEAM BOILERS with drilled rivet holes only.

MILL-GEARING IN ALL ITS BRANCHES.

LARGE ROPE OR BELT DRUMS UP TO 35 FEET DIAMETER.

BLEACHING MACHINERY.

ALSO THE ONLY MODERN PLATE-GLASS MACHINE MAKERS. 4780

GOODFELLOW & MATTHEWS,

(LATE B. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS.

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

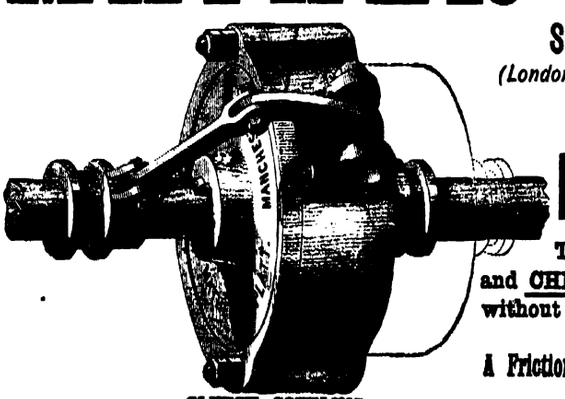
CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 5006

MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.



CLUTCH COUPLING.

— PATENT —

FRICTION CLUTCH.



CLUTCH AND PULLEY

These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.

LIBERAL TERMS TO THE TRADE.

PRICES ON APPLICATION.

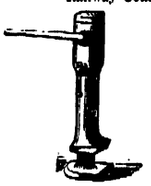
6001

TANGYES LIMITED

CORNWALL WORKS, BIRMINGHAM.

TANGYES' HYDRAULIC LIFTING JACK

Adopted by the British and many Foreign Governments, and most of the principal Railway Companies and Engineers in the World.



LIFTING JACK

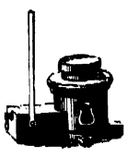


TRAVERSING JACK

This Jack is arranged so that one man can raise the specified weight.

Tested to	Height when down	Run out	Weight	Price Lifting	Price Traversing
3 tons	19 ins.	6 ins.	36 lbs.	£3 0	£6 0
4 ,,	23 ,,	10 ,,	57 ,,	4 0	7 0
6 ,,	24 ,,	10 ,,	68 ,,	4 10	8 0
8 ,,	26 ,,	11 ,,	76 ,,	5 10	9 0
10 ,,	27 ,,	12 ,,	80 ,,	6 0	9 10
12 ,,	27 ,,	12 ,,	96 ,,	6 10	10 0
15 ,,	28 ,,	12 ,,	104 ,,	7 0	11 0
20 ,,	28 ,,	12 ,,	132 ,,	8 0	12 0
30 ,,	29 ,,	12 ,,	174 ,,	10 0	16 0
40 ,,	29 ,,	11 ,,	206 ,,	12 0	19 0
50 ,,	29 ,,	11 ,,	264 ,,	14 0	25 0
60 ,,	29 ,,	10 ,,	304 ,,	16 0	27 0

TANGYES' HYDRAULIC SHIP JACK



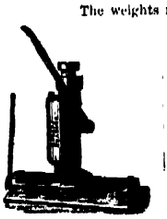
Tested to	Height when down	Run out	Cast-steel or Wro't-iron Cylinders
20 tons	12 ins.	6 ins.	£9 0
35 ,,	14 ,,	7 ,,	12 0
50 ,,	14 ,,	7 ,,	15 0
70 ,,	14 ,,	7 ,,	17 0
100 ,,	14 ,,	7 ,,	19 0
150 ,,	14 ,,	7 ,,	23 0
200 ,,	14 ,,	7 ,,	28 0

If with Safety Valve attached, 45/- extra.

TANGYES' HYDRAULIC LOCOMOTIVE JACK

In this Jack the cylinder and cistern are in one.

The weights named can readily be raised by one man.



Tested to	Height when down	Run out	Traverse	Price
12 tons	20 ins.	12 ins.	12 ins.	£9 0
15 ,,	20 ,,	10 ,,	16 ,,	12 0
20 ,,	20 ,,	10 ,,	22 ,,	13 10

TANGYES' HYDRAULIC CARRIAGE LIFTER

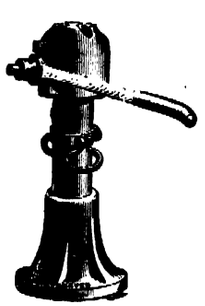
This Lifter is designed for raising the end of a Railway Carriage or Wagon to facilitate examination of axles, &c. The carriage can be raised about 2 feet in less than one minute by one man.



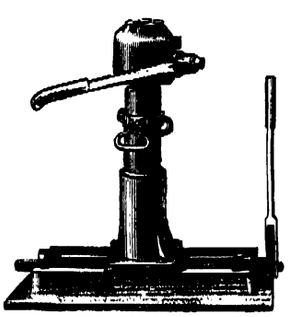
Tested to .....tons	2	4	6	8	10	12
Height when down, ins.	29	29	20	20	20	20
Run out ..... ,,	20	20	20	20	20	20
Weight ..... lbs.	84	90	100	112	146	160
Price ..... £	6	7	8	9	12	15

TANGYES'

AMERICAN HYDRAULIC LIFTING JACK



LIFTING JACK



TRAVERSING JACK

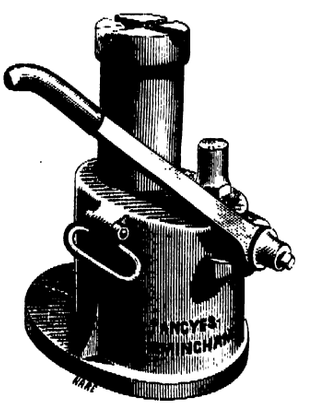
In lifting, it may happen that another stroke cannot be made, in which case the lever should be gently raised a little and pushed slowly down; by this means a stroke will be missed.

To lower—withdraw the lever from the shaft to miss the lug, and press it gently down.

Tested to	Run out	Price Lifting	Price Traversing
7 tons	12 ins.	£10	£13
10 ,,	12 ,,	12	15
15 ,,	12 ,,	15	18
20 ,,	12 ,,	18	21
30 ,,	12 ,,	21	26
45 ,,	12 ,,	25	32
60 ,,	12 ,,	30	37

TANGYES'

AMERICAN HYDRAULIC LOCO JACK



In lifting, it may happen that another stroke cannot be made, in which case the lever should be gently raised a little and pushed slowly down; by this means a stroke will be missed.

To lower—withdraw the lever from the shaft to miss the lug, and press it gently down.

Tested to	Ordinary Run out	Price	Telescopic Run out	Price
10 tons	9 ins.	£15	18 ins.	£20
15 ,,	9 ,,	17	18 ,,	24
20 ,,	12 ,,	20	24 ,,	28

[Copyright; Entered at Stationers' Hall.]

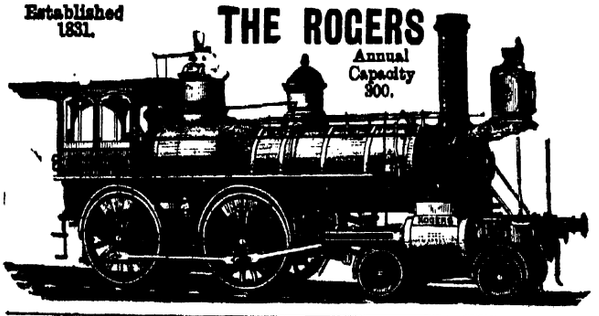
London - - TANGYE BROTHERS, 35, Queen Victoria St.
Newcastle - TANGYE BROTHERS, St. Nicholas Buildings.
Manchester - - TANGYE BROTHERS, St. Mary's Gate.
Glasgow - - - TANGYE BROTHERS, Argyle Street.

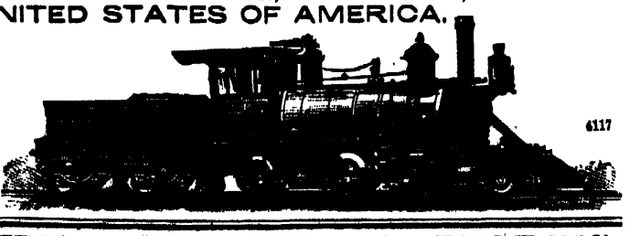
Established 1831.

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Annual Capacity 300.

BUILDERS OF LOCOMOTIVE ENGINES OF ALL GAUGES
And for every variety of service,
PATERSON, NEW JERSEY,
UNITED STATES OF AMERICA.



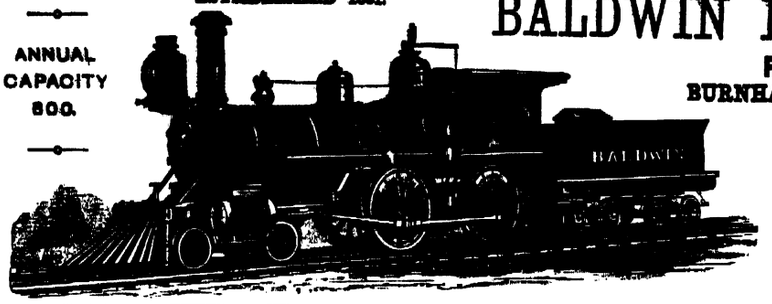


6117

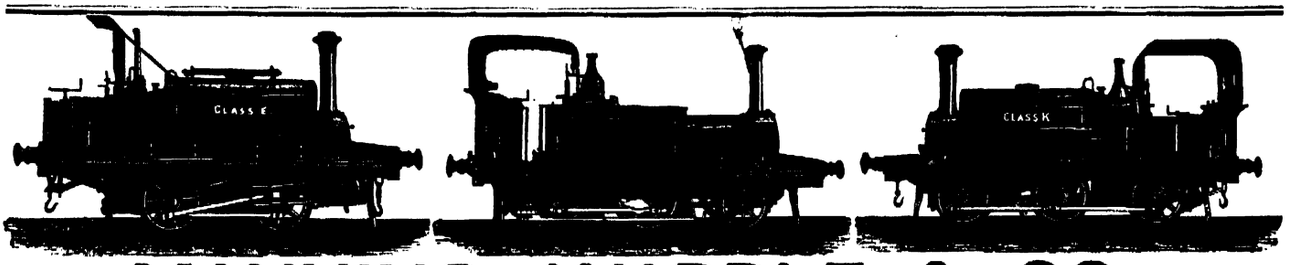
ESTABLISHED 1831.

ANNUAL CAPACITY 800.

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BURNHAM, PARRY, WILLIAMS & Co., Proprietors.
MANUFACTURERS OF
LOCOMOTIVE ENGINES,
Adapted to every variety of service, and built accurately to standard gauges and templates. Like parts of different engines of same class perfectly interchangeable.
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STEAM STREET CARS, &c.
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ALL WORK THOROUGHLY GUARANTEED. 1234



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BOYNE ENGINE WORKS, LEEDS,

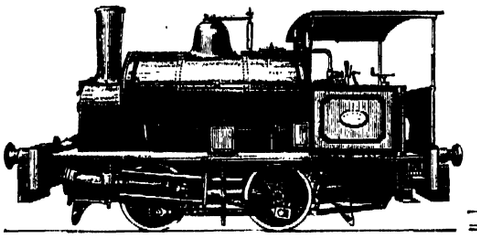
Have designed and constructed one hundred various types of Tank and other Locomotive Engines for upwards of thirty different widths of gauge, adapted where necessary for passing round sharp curves and ascending steep gradients, suitable for any climate, and for burning coal or wood, &c. : also for special duties required by Railway Companies, Contractors, Collieries, Iron Works, and Mines, Brick Works, Quarries, Gas Works, Ship Yards, Docks, Sugar Plantations, &c., &c. They are built accurately to standard gauges and templates in order that like parts of various classes of Engines will fit different Engines of the same type, and so that duplicates can be supplied on the shortest notice. The materials are the best of their respective kinds, and the workmanship cannot be excelled.
MANNING, WARDLE & Co., having designs and models of such a great variety of Engines, are enabled to execute orders for Locomotive Engines adapted to most requirements in a very short time.

Locomotive Tank Engines from 8 inches to 15 inches Cylinders on Four or Six Wheels all coupled, always in Stock or in Progress. 2496

SPECIFICATIONS, PHOTOS, AND PRICES, ON APPLICATION.

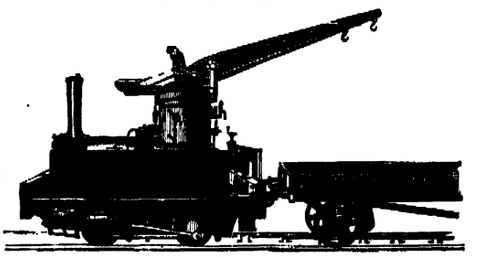
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NEWCASTLE-ON-TYNE,
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LOCOMOTIVE ENGINES
OF EVERY DESCRIPTION.
TRAMWAY LOCOMOTIVES.
MAKERS OF 5050
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TANK LOCOMOTIVE.



VARIOUS CLASSES IN PROGRESS.

PATENT CRANE AND LOCOMOTIVE.



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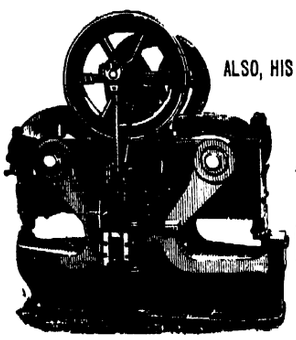
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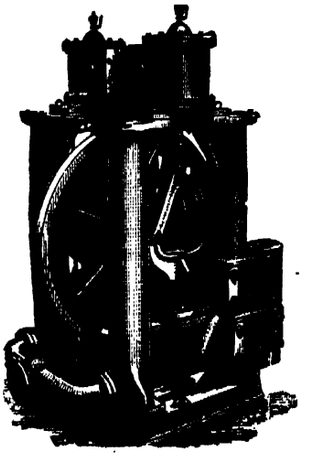


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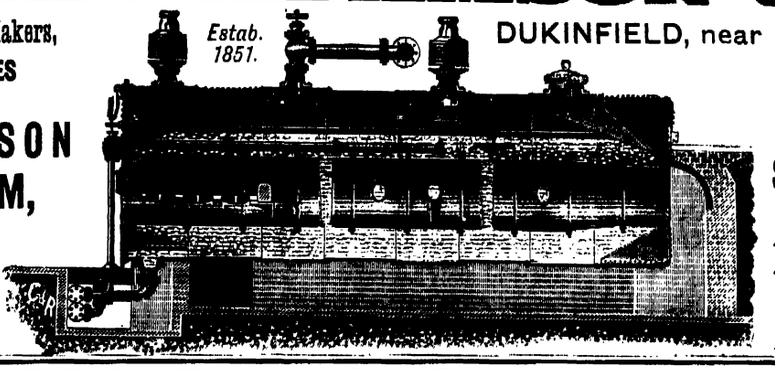
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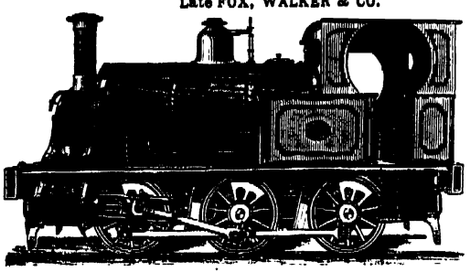
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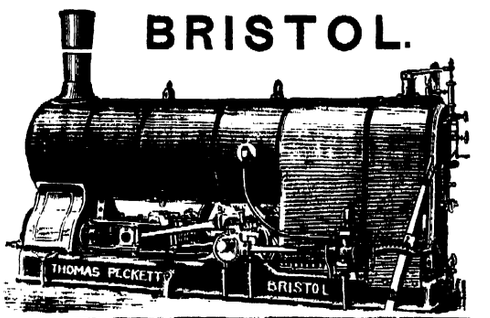
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ALWAYS IN STOCK.

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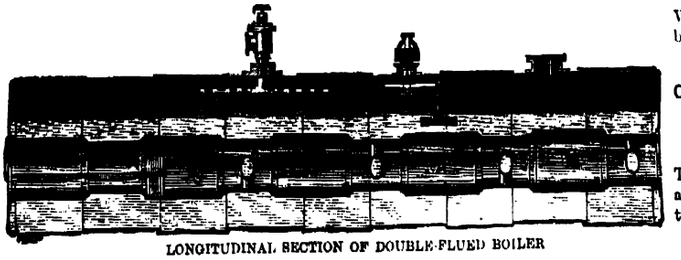
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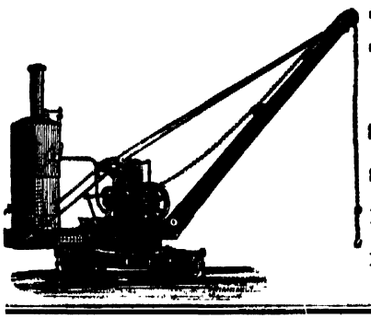
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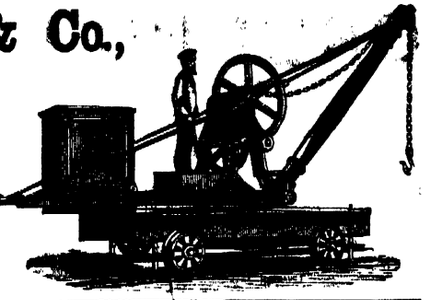


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3 × 1½	= 6 ,,	5 × 4½	= 23 ,,	7 × 3½	= 20 ,,	9½ × 4½	= 29 ,,	12 × 6	= 56 ,,
4 × 1½	= 7 ,,	6½ × 2	= 11 ,,	8 × 4	= 22 ,,	10 × 4½	= 32 ,,	14 × 6	= 60 ,,
4 × 3	= 12 ,,	6½ × 3½	= 16 ,,	8 × 5	= 29 ,,	10 × 5	= 36 ,,	16 × 6	= 62 ,,
4½ × 1½	= 8 ,,	6 × 5	= 29 ,,	8 × 6	= 34 ,,	10 × 6	= 56 ,,	17½ × 6½	= 82 ,,
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Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to 2". 5126

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8 × 4	3½ × 3½	2½ × 2½	
6 × 6	3 × 3	2 × 2	
6 × 3½	2½ × 2½	1½ × 1½	
5 × 3½	2 × 2	1 × 1	
4 × 3½	1½ × 1½		
4 × 4	1 × 1		

TEES.	CHANNELS.
5½ × 5½	12 × 8
4 × 4½	9½ × 3½
5 × 3	9½ × 3½
3 × 3	8 × 3½
2½ × 2½	5½ × 2½
2 × 2	4½ × 2½
1½ × 1½	2½ × 1½
1 × 1	1½ × 1



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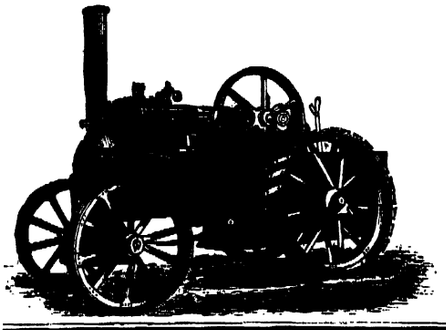
of the highest class & most approved construction & of

GUARANTEED ECONOMY OF PRODUCTION.

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JOHN FOWLER & CO., LEEDS, ENGLAND,

MANUFACTURERS OF



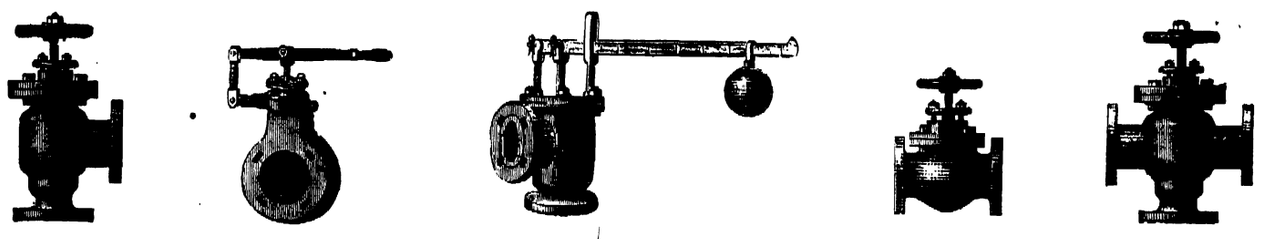
Steam Cultivating Machinery — Traction Engines — Patent Compound Yorkshire Semi-Portable and Fixed Engines — Semi-Portable Engines — Horizontal High-Speed Stationary Engines — Hauling, Winding, and Pumping Engines — Patent Automatic Expansion Valve Gear and Governor, for ensuring Economy, Regularity, and Safety —Boilers of all types, adapted for every kind of fuel and country—Steel Portable Railway, for Sugar, Cotton, and Indigo Plantations, Contractors' Works, Military Depots, Workshops, Mines, Timber Yards, Agricultural Holdings, &c.— Locomotives of various gauges. 3061

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Large Stock Kept of Engine and Boiler Mountings.

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JOHN HENDERSON PORTER, PATENTEE,

1 & 2, TUDOR STREET, LONDON, E.C., furnishes the necessary Plant.

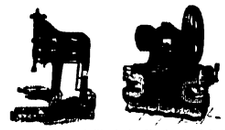
The PORTER-CLARK PROCESS

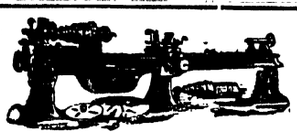
Removes the Carbonates of Lime, Magnesia, and Iron from **Hard Waters**, and thus, the **causes of Incrustation in Boilers and Pipes**. This Process is in use in Paper Mills, Breweries, Sugar Works, India-rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c. One Railway Company employs it for feed-water to the extent of **1,000,000 gallons** daily, and one of the London Water Companies at two of its Pumping Stations. It is also in use in County Asylums, Public and other Schools, and Private Mansions. The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich, are rendered soft and clear. 5226

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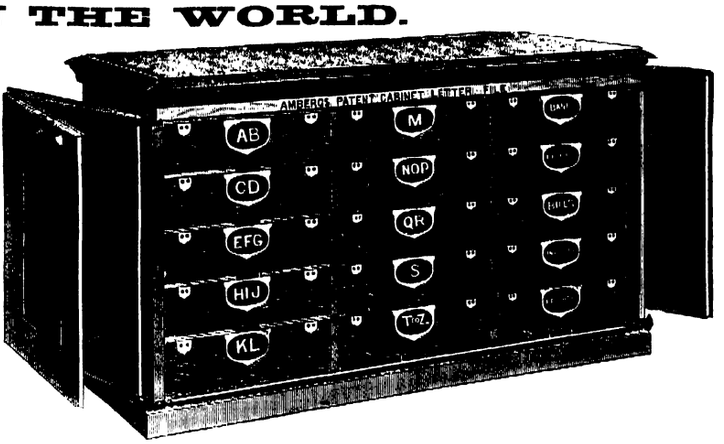
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Two	„ „	28 ft.	by	7 ft. 0 in.	„	80 lbs.
Two	„ „	28 ft.	by	7 ft. 0 in.	Steel	80 lbs.
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One	„ „	30 ft.	by	7 ft. 6 in.	Iron	70 lbs.
Six	„ „	30 ft.	by	7 ft. 0 in.	Steel	80 lbs.
One	„ „	26 ft.	by	7 ft. 6 in.	Iron	90 lbs.
One	„ „	22 ft.	by	6 ft. 0 in.	„	70 lbs.
One	„ „	18 ft.	by	6 ft. 0 in.	„	60 lbs.
One	One-flued „	30 ft.	by	7 ft. 0 in.	Steel	80 lbs.
One	„ „	28 ft.	by	6 ft. 6 in.	Iron	80 lbs.

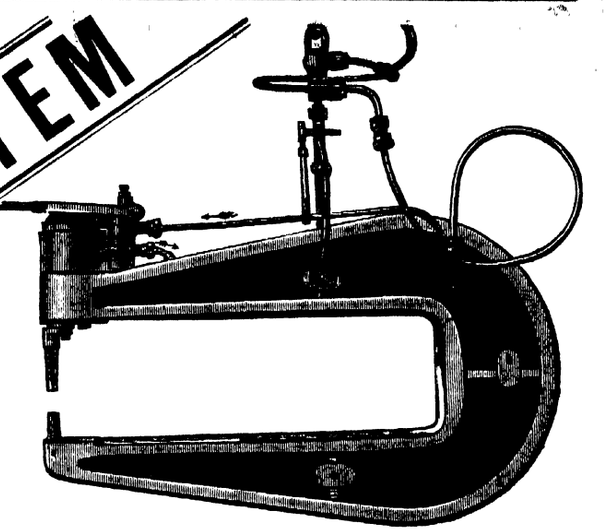
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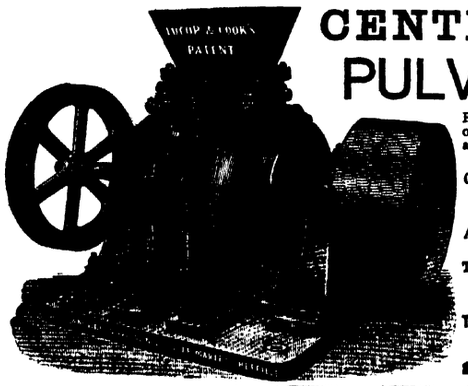
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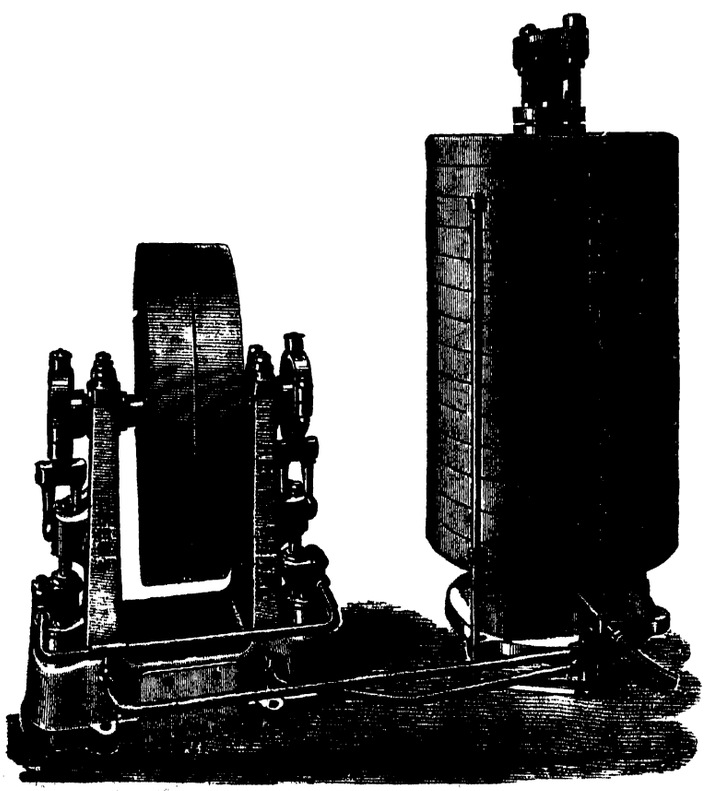
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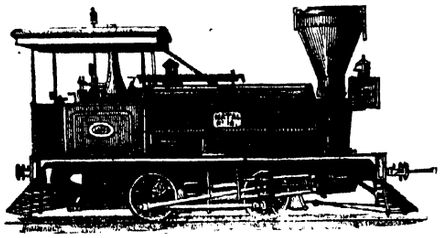
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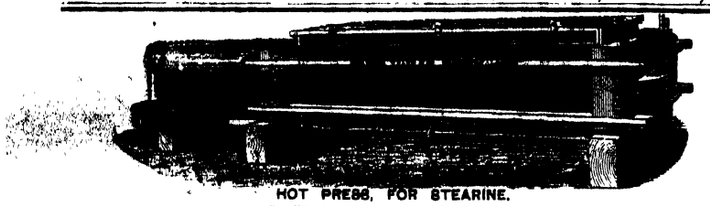
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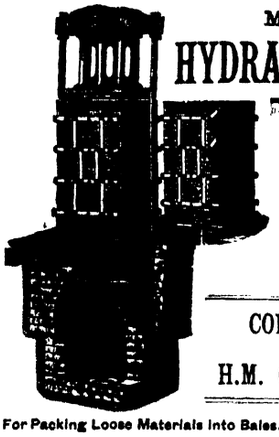
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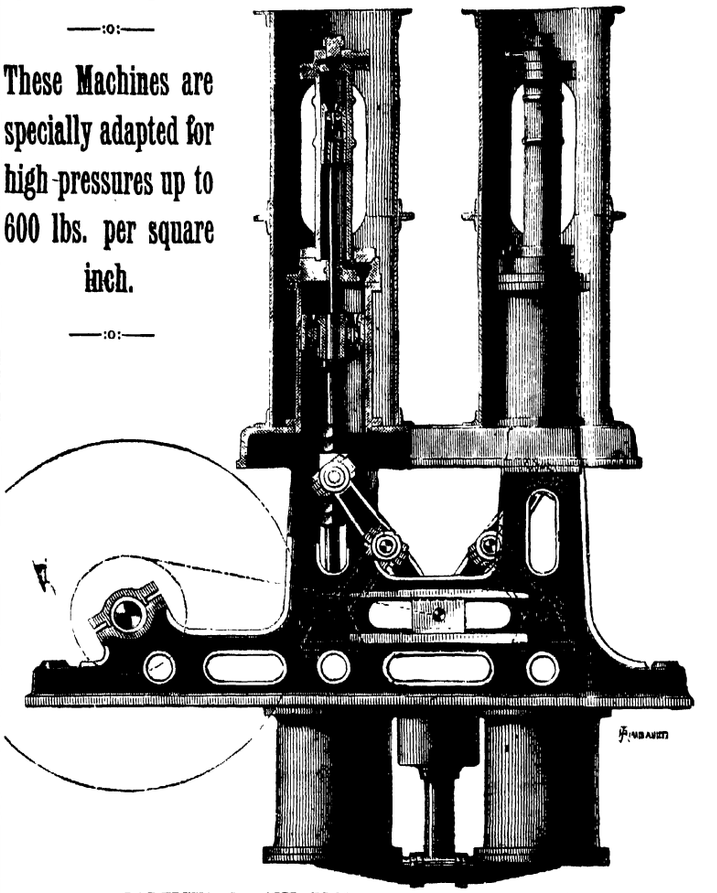


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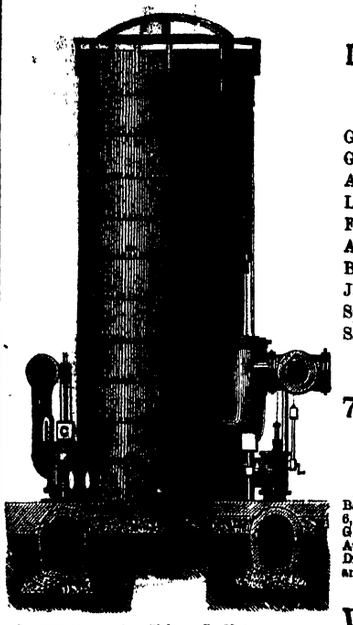
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Germany	99	... 26
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Luxembourg	16	... 3
France	110	... 36
America	228	... 73
Belgium	43	... 11
Japan	3	... 1
Spain	12	... 4
Saxony	3	... 1
Total...	795	... 243

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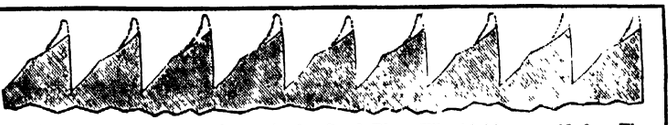


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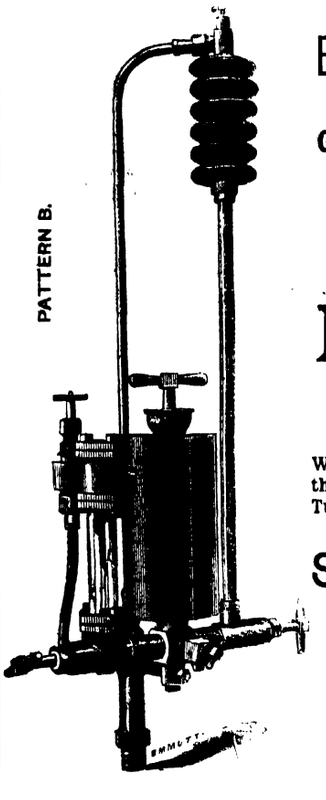
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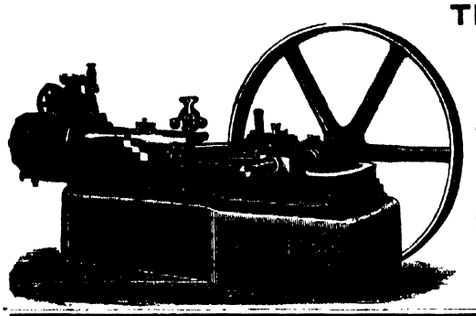
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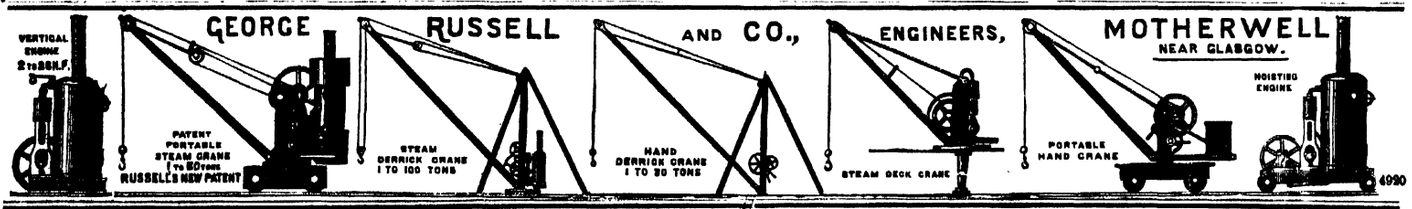
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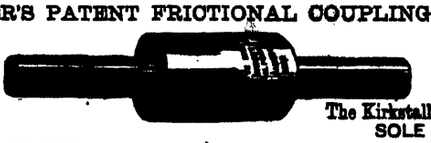
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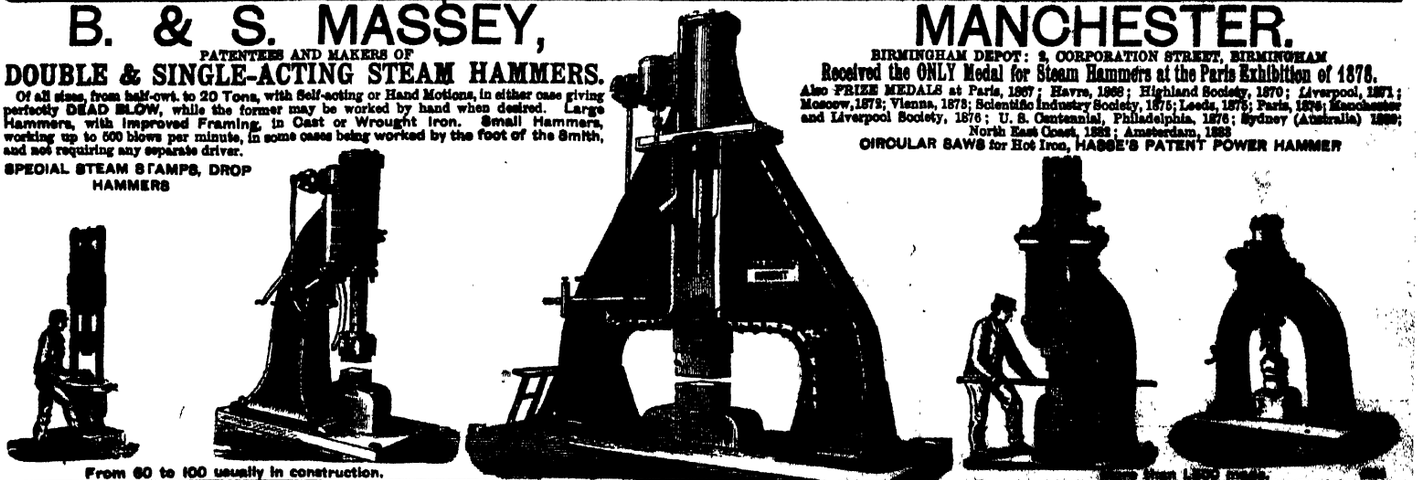
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VOL. XXXVIII.—No. 971.] *LONDON: FRIDAY, AUGUST 8, 1884.* [PRICE ...6d. BY POST...6½d.

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ENGINEERS. 4457

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HENRY J. COLES,

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NEWBURN STEEL WORKS,

NEWCASTLE-ON-TYNE.

SPRINGS, BUFFERS, STEEL CASTINGS, FORGINGS, TOOL STEEL, FILES SPRING STEEL, &c. SIEMENS STEEL BLOOMS AND BARS. 2703

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See Advertisement July 25, page 7.

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Switches, Crossings,

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Willan's Patent Compound ENGINES, for marine and general purposes. Stock sizes from 6 to 150 I. HP. Special patterns for Electric Lighting.—WILLAN & ROBINSON, Thames Ditton, Surrey. 5988

Iron Roofs, Sheds, Buildings, Houses, Best work, reduced prices. Dixon's special Corrugated Iron Roofs are the most economical for spans up to 45 ft. Catalogues, Designs, Estimates, on application. ISAAC DIXON, Windsor Ironworks, LIVERPOOL. 4833

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Tubes. MARINE, LOCO', STEAM, BORING, COLLIERY. LARGE TUBES LAP-WELDED TO 12in. DIAM.

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The Patent Corliss Engine And PATENT CORLISS GEAR ENGINE, with special Improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N.B. These engines are made Horizontal or Beam, Condensing, Non-Condensing, and Compound. Also makers of Rice Mills, and Paper Mills, and General Engineers. Machinery shipped or trucked direct from the premises. Makers of

Lightfoot's Patent Self-con- TAINED DRY AIR REFRIGERATOR, For Preserving Meat, Fish, &c., on Board Ship or on Shore. 3599

Dennis' Patent Straight Full- WAY HIGH-PRESSURE VALVES, for Steam, Water, Gas, &c. For list and terms, apply to T. H. P. DENNIS & CO., Chelmsford, London Office—Mansion House Buildings, E.C.

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The Only First Award for WOOD-WORKING MACHINERY granted to European Exhibitors at the SYDNEY INTERNATIONAL EXHIBITION, 1879-80, was awarded to

John M'Dowall & Sons,

Saw Mill Engineers and Wood-Working Machinists, Walkinshaw Foundry, Johnstone, near Glasgow.

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J. B. GUTHRIE, 70, Bishopsgate Street Within.

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LONDON AGENT FOR

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Gas Engines.

5054

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Field's Patent Boilers and TUBES.

LEWIS OLRICK & CO., London. 5046

See Illustrated Advertisement, page 27.

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Steam Hammers.—

Massey's Patent Hammers RECEIVED THE *ONLY* PRIZE MEDAL PARIS 1878.

More than 1500 made.

Drop Hammers Hasse's Patent Power Hammer.

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The "Differential" Pumping ENGINE.—DAVEY'S PATENT for Draining Mines; Water Supply of Towns; Irrigation; Supplying Docks; Pumping Sewage; and General Pumping Purposes.

HATHORN, DAVEY, & CO., LEEDS.

H., D., & Co. have Patterns of "Differential" Engines of all sizes from 5 to 500-horse power, and have facilities for supplying very powerful Engines and Pumps at a short notice. 4750

Locomotive Tank Engines designed and constructed by MANNING, WARDLE, AND COMPANY, Boyne Engine Works, Leeds. 2487

See their Illustrated Advertisement, page 43.

Locomotive Tank Engines, TRAMWAY ENGINES AND CARS. Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough. 5206

See Illustrated Advertisement, page 12.

Patent Spring Safety Valves.

THOMAS ADAMS,

WORKS OF THE "ANT AND BEE," WEST GORTON, MANCHESTER.

SEE LARGE ILLUSTRATED ADVERTISEMENT, JULY 18, PAGE 45. 4872

Stannah's Pendulum Pumps. For Prices see alternate weeks. 3228

Steel Hydraulic Cylinders.— HENRY BESSEMER & CO., Limited, SHEFFIELD.

See Advertisement last week, page 31. 3627

Tweddell's

Hydraulic Rivetting Machines

14, DELAHAY STREET, WESTMINSTER, LONDON, S.W. 4897

See Illustrated Advertisement last week, page 47.

L. Sterne & Co., Limited. ENGINEERS,

Sole Makers of

Clerk's Patent

Self-Starting Gas Engine.

HIGHEST AWARD,

BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881.

GOLD MEDAL,

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Strong's Patent Feed-water

Heaters and Purifiers,

WITH

STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels,

Emery Machines,

Spiral Springs.

The Crown Iron Works, GLASGOW.

The Crown Iron Works (Hollinwood), MANCHESTER.

10, Victoria Chambers, WESTMINSTER.

City Office and Show Rooms, 40, CANNON STREET, E.C.

10, Rue Laffitte, PARIS. 2588

Crystal Palace Company's SCHOOL OF PRACTICAL ENGINEERING.

The NEXT TERM OPENS on MONDAY, SEPTEMBER 8th. I.—Mechanical Course. II.—Civil Engineering Division. III.—Colonial Section.—Prospectus of the undersigned.

F. K. J. SHENTON, Supt. Educational Department. G 656

TENDERS.

THE DOCK COMPANY AT KINGSTON-UPON HULL.

PATENT SLIP NO. 1,
Adjoining the Works of Earle's Shipbuilding and Engineering Company, Limited.

The Directors of the Dock Company at Kingston-upon-Hull are willing to receive

Tenders from Parties desirous of LEASING and WORKING this SLIP, as from the 23rd instant.

Tenders, addressed to the undersigned, will be received up to the 15th instant; but the Directors do not bind themselves to accept the highest or any offer.

The conditions on which the Slip will be let, and the regulations under which it is worked, may be ascertained on application to the undersigned.

By order,
EDWARD H. GARBETT,
1st August, 1884. General Manager and Secretary. G 642

The Directors of the SHEFFIELD UNITED GAS LIGHT COMPANY invite

Tenders for Roofing, with

wrought iron girders supported on cast iron columns, and fitted with guttering, &c., for the EXTENSION of the ROOF of a COAL STORE and RETORT HOUSE, at their Effingham Street Station.

Plans and Specification may be had on application to the Company's Engineer, Mr. J. F. Kay.

Tenders, marked "Tender for Roofing," must be delivered to the undersigned not later than Thursday, the 21st instant.

Gas Company's Offices, Commercial Street, Sheffield, 1st August, 1884. HANBURY THOMAS, Manager. G 643

ALEXANDRIA WATER COMPANY, LIMITED, ALEXANDRIA, EGYPT.

CAST IRON PIPES.

The Directors of this Company are prepared to receive

Tenders for the Supply of

about 1,000 TONS of CAST IRON PIPES in accordance with the Specification, copies of which, and Forms of Tender, may be obtained from the Company's Secretary, Mr. F. SANDERS, 50, Parliament Street, Westminster, on payment of Five Shillings.

Tenders will be opened at Alexandria, on the 22nd of August, but the Company does not bind itself to accept the lowest or any Tender. G 597

EAST INDIAN RAILWAY COMPANY.

The East Indian Railway Company is prepared to receive

Tenders for the Supply and

DELIVERY of the
STEEL AND IRONWORK FOR THE CENTRAL CANTILEVER OF THE HOOGHLY BRIDGE,
in all about 1,400 Tons,
as per Specification and Drawings to be seen at these Offices.

Tenders are to be delivered in sealed envelopes, addressed to the undersigned, marked "Tender for Steel and Ironwork for the Central Cantilever of the Hooghly Bridge," not later than One o'clock p.m., on Thursday, the 4th day of September next.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
A. P. DUNSTAN, Secretary,
Nicholas Lane, London, E.C. 31st July, 1884. G 638

EAST INDIAN RAILWAY COMPANY.

The East Indian Railway Company is prepared to receive

Tenders for the Supply and

DELIVERY of
GALVANIZED STRAND WIRE FOR FENCING,
as per Specification to be seen at these Offices.

Tenders are to be delivered in sealed envelopes, addressed to the undersigned, marked "Tender for Galvanized Strand Wire for Fencing," not later than One o'clock p.m. on Thursday, the 4th day of September next.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board, G 603
Nicholas Lane, London, E.C. A. P. DUNSTAN, Secretary.
7th August, 1884.

TO CONTRACTORS.

CARDIFF CORPORATION WATERWORKS.
(SCHEME B., LLANISHEN SECTION.)
CONTRACT NO. 1.

The Waterworks Committee of the Cardiff Corporation are prepared to receive NEW

Tenders from Competent

PERSONS for the CONSTRUCTION of a large STORAGE RESERVOIR, including Embankments, Valve Well, Culverts, Gauge Basins, Overflow, Bye-Channel, Road, Fencing, and other Works, at Llanishen, near Cardiff.

Plans and Drawings may be seen on and after Monday, the 11th August next, at the Offices of the Engineer, Mr. J. A. B. Williams, Queen's Chambers, Queen Street, Cardiff, and printed copies of the Specification, Form of Tender, and Bill of Quantities may be obtained from the Engineer, on payment of Five Guineas, which will be returned after the receipt of a *bona fide* Tender.

Tenders must be enclosed in a sealed envelope, endorsed "Cardiff Corporation Waterworks, Tender for Llanishen Reservoir," and addressed to, and left with me, the undersigned, before Ten o'clock of the morning of Friday, the 22nd day of August next. G 604
Town Hall, Cardiff, 28th July, 1884. J. L. WHEATLEY, Town Clerk.

TO ENGINEERS.

The Guardians of the Poor of the St. George's Union desire to receive

Proposals and Tenders for the

ERECTION OF THREE FIRE ESCAPE BRIDGES, at their Infirmary in the Fulham Road.

A Plan and Particulars may be obtained on application to the Guardians' Architect, Mr. H. Saxon Snell, No. 22, Southampton Buildings, Chancery Lane, any day after the 11th instant. Tenders to be sealed, endorsed "Tender for Bridges," and addressed and delivered to me, at these Offices, on or before the 25th instant.

The Guardians do not bind themselves to accept the lowest or any Tender.

By order, THOMAS WORLOCK,
Clerk's Offices, Clerk to the Guardians.
60, South Audley Street, Grosvenor Square, W., 6th August, 1884. G 660

APPOINTMENTS OPEN.

Civil Service Commission

—Examination for ASSISTANT EXAMINERSHIPS in the Patent Office (21-26) 29th August. Salary £250 to £400. The date specified is the latest at which applications can be received. They must be made on forms to be obtained with particulars from the SECRETARY, Civil Service Commission, London, S.W. G 578

To Engineers.—A Resident

WORKS MANAGER WANTED, having experience in brewing, distilling, and colonial work.—Address, P. Q., care of Messrs. R. F. White & Son, 83, Fleet Street, E.C., stating qualifications, and salary expected. G 649

Foreman Wanted, for Gas

Holder and Boiler Works; must be an energetic, practical, and intelligent man, of steady habits, with good knowledge of piece work prices.—Apply, in own handwriting, stating age, salary and references, to G 648, Offices of Engineering, 35 and 36, Bedford Street, Strand, London, W.C. G 648

Draughtsman Wanted, must

be thoroughly experienced in wrought iron roofing work.—State age, experience and salary required, to G 641, Offices of Engineering, 35 and 36, Bedford Street, Strand, London, W.C. G 641

Draughtsman Wanted, age 21

to 25, quick, neat, and well up in getting out details and working drawings. Give references and wages. In London.—A. B., Offices of Engineering, 35 & 36, Bedford Street, Strand, London, W.C. G 655

Leading Smith Wanted, in a

moderate sized Engineer's Shop; general work; constant job for suitable man.—Address, G 662, Offices of Engineering, 35 and 36, Bedford Street, Strand, London, W.C. G 662

Lists of Berths Vacant or

WANTED. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5262

SITUATIONS WANTED.

Manager, Superintendent or

otherwise.—The Advertiser, just returned from abroad, where he had the entire charge of the Locomotive Dept. of a Railway, DESIRES an ENGAGEMENT. He is thoroughly conversant with machinery, and the control of men.—Address, C. B., 41, Maude Grove, Chelsea, S.W. G 639

Wanted, Situation as Manager

in a Steel Work, by a scientific and practical man, great experience in the responsible management of large works, good references, &c.—Apply, X. Y. Z., Offices of Engineering, 35 and 36, Bedford Street, Strand, London, W.C. G 650

Wanted, Situation as

DRAUGHTSMAN, by a Swiss who has absolved the Zürich College; has practised five years on the Continent, draws in good style, and speaks and writes four languages. Structural work preferred. First-class references.—Address, G 593, Offices of Engineering, 35 & 36, Bedford Street, London, W.C. G 593

Electrician. — An Electrical

Engineer, theoretical and practical experienced, WANTS a SITUATION as Electrician.—Address, B 4904, care of Rudolf Mosse, Cologne. G 598

A Young C.E. seeks Work on

a line of Railway in course of Construction, either to ASSIST ENGINEER or CONTRACTOR. Has already had experience in railway work. Excellent testimonials. Small salary.—Address, W. T. L. W. DENNIS, Esq., M.I.C.E., 3, Victoria Street, Westminster. G 658

Wanted, to Represent some

good Firm in Machinery Engineering or Metal Trade. Good Offices in the best part of the City of London, Milan, and Genoa, with facilities to introduce business abroad. Reference exchanged.—Address, CANZIANI, 84, Lombard Street, E.C. G 659

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Civil Engineer, 20 years' pro-

fessional and commercial experience, desires to JOIN a well-established connection, or would take up *bona fide* business having remunerative prospects.—Address, M. INST. C.E., Box 108, Post Office, Swansea. G 625

WANTED, &c.

Wanted, a New or First-class

Second-hand VERTICAL ENGINE, 18 in. or 20 in. cylinder, must have all latest improvements.—Address, G. R. TURNER, Vulcan Ironworks, Langley Mill, Notts. G 651

Wanted, Steam Engine

(Stationary), from 16 to 30 HP., either with or without suitable Boiler and Shafting; also Travelling Crane, capable of lifting from 2½ to 3½ tons.—Offers, with full particulars, to be addressed JOHN MACFARLANE, 98, Bath Street, Glasgow. G 647

Agents Wanted, to push First-

class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool. 5233

Lists of Machinery Wanted or

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FOR SALE.

For Sale, 12 in. Leather and

COTTON BELTING, of best description.—For orders to view, apply to W. BULL, Southboro', Tunbridge Wells. G 576

For Sale, Twelve Tramway

LOCOMOTIVES, 4 ft 8½ in. gauge, in good working order.—For particulars address THE ROUEN TRAMWAY COMPANY, Rouen, France. G 548

For Sale, 9 in. Double Cylin-

der PORTABLE ENGINE, by Clayton and Shuttleworth, in good condition; being replaced by larger engine.—Apply to STRACHAN & CO., Frome Hall Mills, Stroud, Gloucestershire. 5282

For Sale, Largest Stock in

England, Engineers' Machine Tools, Steam Hammers, Steam Engines, Wood-working Machinery, all sizes, best materials and workmanship, low prices; send for stock list.—SCOTT BROTHERS, Halifax.

For Sale, Thirty-four Vols. of

the PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS, ending with the issue of June, 1884; nearly nine years, complete.—Address, G 654, Offices of Engineering, 35 & 36, Bedford Street, Strand, London, W.C. G 654

For Sale, being superseded by

engines of higher power, a pair of High Pressure Condensing STEAM ENGINES. Cylinders, 26 in. diam., 3 ft. 6 in. stroke, with cold water pump for same.—Can be seen at work at the Manufactory of the LONDON PORTLAND CEMENT CO., Ltd., Northfleet, Kent, to whom enquiries may be addressed. G 534

For Sale, Steel Twin-Screw

STEAM LAUNCH (being in progress and nearly finished), 55 ft. long by 13 ft. 6 in. beam, 6 ft. 6 in. deep, draught 3 ft. 6 in.; compound non-condensing engines, 10 in. and 15 in. by 14 in. stroke; designed for light draught and high speed. Sold owing to owners requiring larger boat.—Apply, LOUDON BROTHERS, 111, Bothwell Street, Glasgow. G 630

TO CONTRACTORS, HARBOUR BOARDS, &c.

For Sale, at Wicklow Harbour

Works, an 8-ton Russell Self-Propelling Steam Derrick Crane, with 60 ft. jib.; 10-ton Cameron ditto, with 72 ft. jib; Priestman Steam Travelling Crane, for "B" size grab; two specially strong Priestman Grabs; Punching and Shearing Machine; Chaplins' Locomotive; several large Iron Skips; several tons 6 in. by 6 in. Angle and Tee-Iron; 40 tons Steel Rails; large quantity sound sawn Pitch Pine; three good Barges; one specially good rectangular Barge, on which Priestman Crane works.—Apply to JOHN JACKSON, Harbour Works, Wicklow Ireland; or 9, Victoria Chambers, Westminster. 5122

For Immediate Sale, at low

prices for cash.

SECOND-HAND.

LANCASHIRE BOILER, 18 ft. 3 in. by 7 ft. diameter.
CORNISH BOILER, 12 ft. by 4 ft. diameter.
VERTICAL CROSS TUBE BOILER, 7 ft. 6 in. by 3 ft. 3 in. diameter.
TANK LOCOMOTIVE, 4 wheels coupled, cylinders 10 in. by 20 in.
A New 9 HP. CHAPLIN'S LOCOMOTIVE.
5 ft. 6 in. FACE PLATE LATHE, by Whitworth.
RAIL STRAIGHTENING MACHINE, with engine attached, by Collier.
No. 6 ROOT'S BLOWERS, by Thwaites.
Two No. 4½ PATENT BLOWERS, by Ellis.
Two SCOTT WHEEL MOULDING MACHINES.
10-ton RAILWAY WEIGHING MACHINE.
STEAM WINCHES, from 5 in. to 7 in. cylinders.

For prices and full particulars of any of above apply to "PHILLIPS' MONTHLY MACHINERY REGISTER," Newport, Mon. 4904

On Sale, One Pair Vertical

ENGINES, indicating 520 horse-power; three BOILERS, 30 ft. by 7 ft.—All can be seen working at the LANCASHIRE COTTON SPINNING CO., Ltd., Heyside, near Oldham. G 497

To be Sold, 20 Ton

POWER-DRIVEN TRAVELLING CRANE, 53 ft. span, timber beams, trussed, and all accessories. To be seen in Nottingham.—Apply, LEE and HUNT, Arkwright Works, Nottingham. G 563

Boilers.—Two really First-

class GALLOWAY PATENT BOILERS, 26 ft. by 6 ft. 6 in., two flues into combustion chamber, with twenty-four tubes and two water pockets; excellent fittings; guaranteed for 65 lbs. pressure. One excellent POLLITT'S PATENT BOILER, 30 ft. by 7 ft., two flues and fittings; guaranteed for 60 lbs. pressure.—C. H. BERRISFORD, 12, Bank Street, Cross Street, Manchester. G 652

The Lowesmoor Engineering

BRIDGE, ROOF and BOILER WORKS, Worcester.

The above, covering 5568 yards, to be LET or SOLD. Large Contracts for Home and Colonial Governments, done for past ten years.

20 HP. Engine and Cornish Boiler and Plant, at valuation, includes complete Hydraulic, Rivetting, Punching, Planing, Drilling, and Turning Machines. Cranes, &c., &c.—Midland and Great Western Lines into Works, and Canal communication.—Apply to FRANCIS SPOONER, Hanwick, Worcester. G 644

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through death, a very old-established BRASS FOUNDRY and COPPERSMITHS' BUSINESS of the highest reputation, with first-class connection. To be disposed of at a low valuation—Apply, at first by letter, to A. B., care of Gordon & Gotch, Advertising Agents, 15, St. Bride Street, London. G 558

Finnigan's Patent Horizontal

BAND SAWING MACHINE, to cut 54 in. diam., with 6 ft. pulleys, complete with four saws. Used three years. £125. F.o.r. at Preston.—IRVIN and SELLERS, Preston. G 522

Hornbeam Plank, all thick-

nesses, dry; warranted English growth; very large stock; cogs cut to any pattern at moderate prices.—J. KEEN, 384, Waterloo Bridge Road, London, S.E. 5191

Gunpowder Machinery is a

specialty of JOHN HASTIE and CO., Kirkland Engine Works, GREENOCK. Also Patentees and Makers of the most economical Water Pressure Engines ever constructed. 2275

Boilers! Boilers!! Boilers!!!

The Largest Stock in London of Cornish or Vertical Boilers for Sale or Hire from 2 to 20 horse power.—F. BONE, South London Boiler Works, Long Lane, Borough. Boilers repaired by practical men only. 5142

16 HP. Portable Steam

ENGINE, high class, new, with or without link motion reversing gear, FOR SALE on advantageous terms. 8 HP. PORTABLE STEAM ENGINE, high class, new, FOR SALE, cheap for the quality, with a 6 ft. pan Mortar Mill and a 5 ft. by 2 ft. 6 in. Saw Table complete.—For price, or to view, apply to BARROWS and STEWART, Engineers, Banbury, Oxon. 503

Compound Surface Conden-

sing MARINE ENGINES FOR SALE; cylinders 10 in. and 20 in. diameter by 12 in. stroke, fitted with Payton and Wilson's patent circular balanced and double-ported slide valves, and link motion reversing gear.—Address ALEX. WILSON & CO., Vauxhall Iron Works, Wandsworth Road, London, S.W. 4966

40 HP. Nom. Semi-Portable

ENGINE and BOILER combined, 14 in. cylinders, 20 in. stroke, with reversing motion, pump, and injector; working pressure, 150 lb.; new; in stock; price, £625.—THOMAS PECKETT, late Fox, Walker & Co., Atlas Engine Works, Bristol. G 640

Loco. Tank Engine For Sale

or HIRE (Second-hand). Cylinders, 12 in. diam.; 18 in. stroke; four wheels coupled; photograph on application. New Locomotives in progress.—PECKETT, Atlas Engine Works, Bristol. G 645

Tank Locomotives, 4 or 6

wheels coupled. Specification and workmanship equal to Main Line Engines.—Apply to R. & W. HAWTHORN, Engineers, Newcastle-on-Tyne.

See Advertisement last week, page 43. 4954

Locomotive Tank Engines

always in stock or progress.—HUDSWELL, CLARKE and CO., Railway Foundry, Leeds, Sole Makers of RODGERS' PATENT WROUGHT IRON PULLEYS. See Illustrated Advertisement, page 36.

Locomotive Tank Engines for

Main Line Traffic, Short Line, Collieries, Contractors, Iron Works, Manufactories, &c., from a superior specification, equal to their first-class Railway Engines, and specially adapted to sharp curves and heavy gradients, may always be had at short notice from Messrs. BLACK, HAWTHORN, and Co, Locomotive, Marine, and Stationary Engine Works, Gateshead-on-Tyne 1594

Machine Tools for Sale.—

Ready for Delivery:—One powerful Treble Geared Lathe, 36 in. centre, with blocking up pieces to raise it up to 48 in. centres when required, face plate 7 ft. 6 in. diameter, two saddles, and will admit 22 ft. between centres, right-hand saddle fitted with screw-cutting gear, &c., weight 38 tons.

One 18 in. stroke Slotting Machine, will admit 5 ft. 9 in., quick return motion by elliptic gearing, ram balanced.

One 7 in. stroke Slotting Machine, will admit 3 ft. diameter.

Apply, WM. HOLDSWORTH, Machine Tool Maker, Leeds. G 504

Machine Tools for Sale.

Planing Machine, 14 ft. by 6 ft. 1 in. by 6 ft. 3 tool boxes.
" " 12 ft. by 4 ft. by 4 ft., 2 "
" " 8 ft. by 3 ft. by 3 ft., 1 "
" " 6 ft. by 2 ft. 6 in. by 2 ft. 6 in., 1 "
" " 4 ft. by 2 ft. by 2 ft., 1 "
Shaping Machine, 15 in. stroke, 6 ft. bed, 2 tables.
" " 8 in. stroke, 4 ft. bed, 1 table.
Slotting Machine, 8 in. and 12 in. stroke.
Radial Drilling Machine, 5 ft. arm, 2¼ in. spindle.
Steam Hammers, 2 and 5 cwt. (Massey's pattern).
Lathe, 16 in. centre, 20 ft. gap bed. G 657
Lathes, 12 in. centre, 16 ft. and 20 ft. gap beds.
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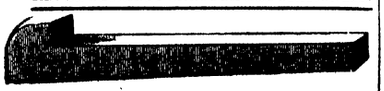
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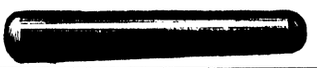
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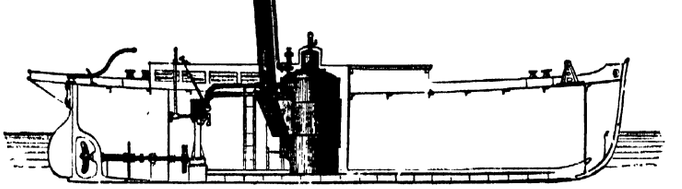
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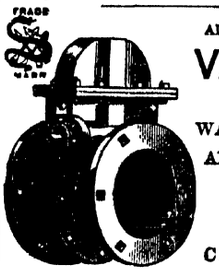
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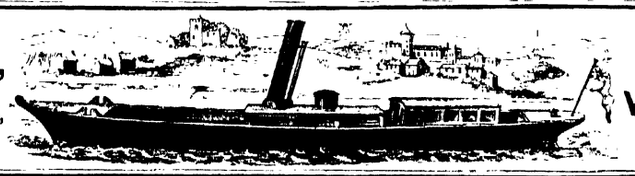
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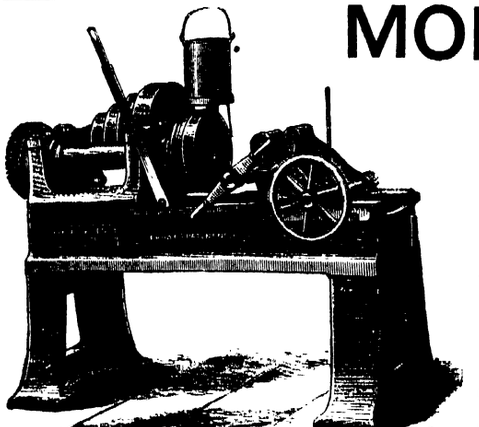
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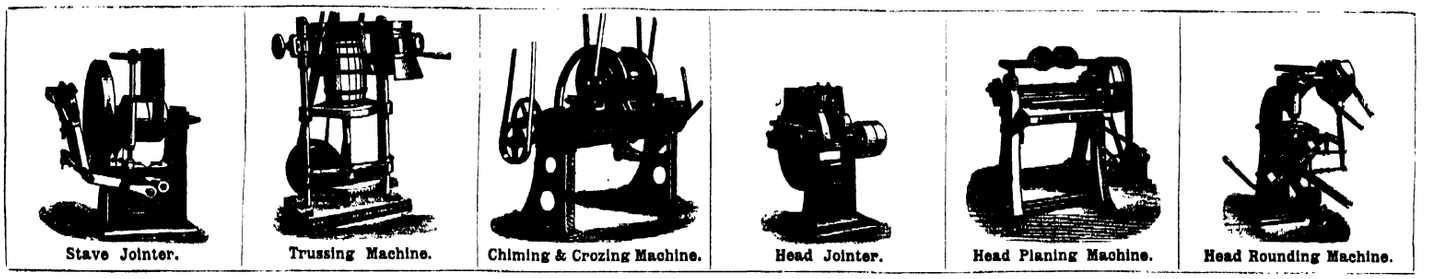
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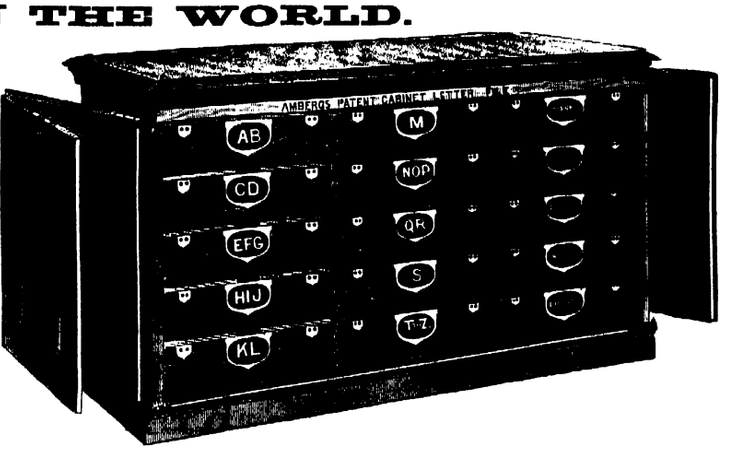
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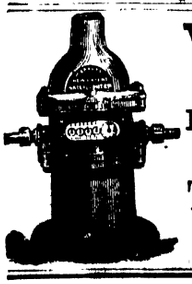
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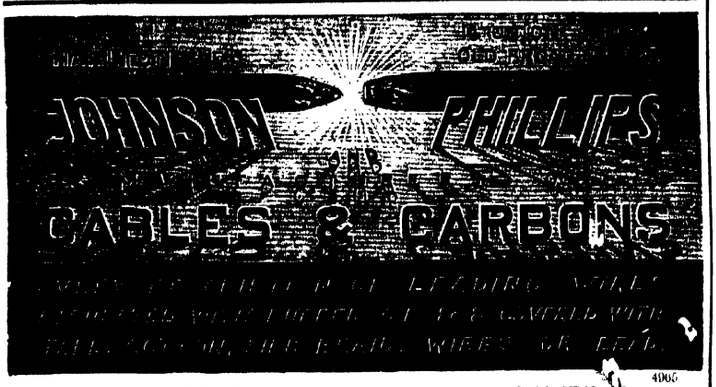
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THE MANCHESTER WATER METER CO., Ltd.

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ESTABLISHED 1860 4433



4005



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"NIAGARA WORKS,"

25Q, EAGLE WHARF ROAD,

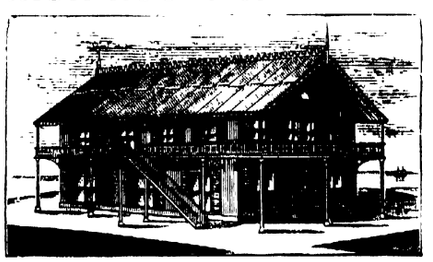
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Have in constant readiness a staff of competent DIVERS, and a large stock of Apparatus, which enables them to undertake on the shortest notice submarine operations of all kinds, requiring skilled and experienced men, such as repairing submerged Pumps, Dockgates, Locks, &c.

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THE MOST RELIABLE VALVE MANUFACTURED

Sizes from 2-in. to 48-in.

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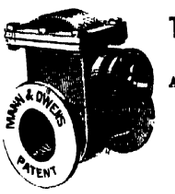
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BY USING OUR PHOSPHOR-TIN,

Phosphor-Bronze can be made Superior to any now in the Market,

AT 30 PER CENT. LESS COST.

Three cwt. of our tin will produce one ton of Phosphor-Bronze, thereby effecting a considerable saving in carriage, and enabling Manufacturers to use the same stock of Copper for all purposes.

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Is the CHEAPEST and BEST adapted material for producing PHOSPHOR BRONZE (only 15 to 20 lbs. being required per ton of metal) and all other COPPER ALLOYS, as well as Castings from pure Copper, Brass, German Silver, and Alloys of all kinds with or without admixture of Tin; also for re-casting old Metals and Filings.

NO WASTE OF METAL BY OXYDATION.

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For producing homogeneous Metal Castings. *Particulars on application to*

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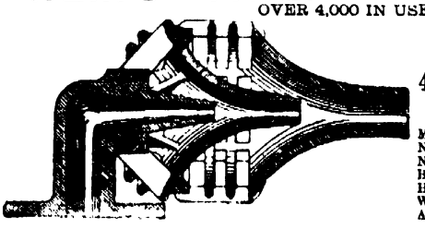
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Best and Cheapest Means of Preventing Unequal Expansion.

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OVER 4,000 IN USE.



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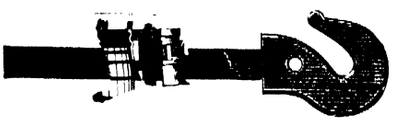
49, JAMAICA STREET,

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MENZIES & BLAGBURN, King Street, Newcastle-on-Tyne. Wm. REID & CO., 5, New London Street, London, E.C. A. & R. BROWN, Waterloo Road, Liverpool. R. HUGHES & CO., Fulton Street, ditto. W. S. VON ESSEN, Engineer, Hamburg, Agent for Scandinavia & Germany. 4670

CASK-M

t Machine



Apply—THE KIRKSTALL FORGE CO., near Leeds. 4036

"STANDARD" STEAM BOILING NOZZLE

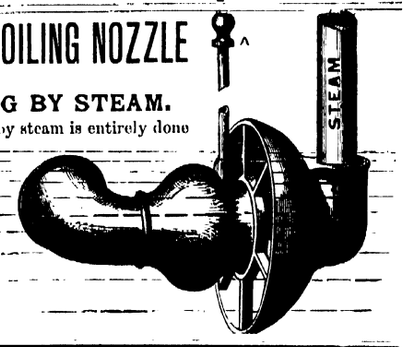
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STEEL CASTINGS

OF EVERY DESCRIPTION

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ORIGINAL PATENTEES AND SOLE MAKERS

IN IRON OR STEEL

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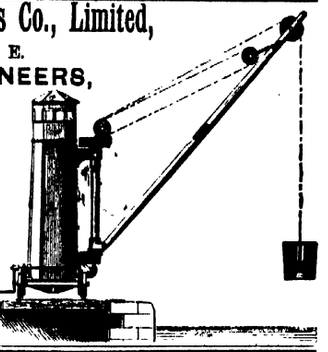
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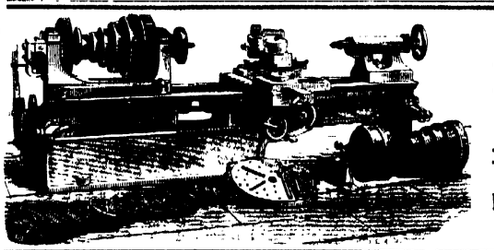
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Surface Condensers

FOR ENGINES,

REFRIGERATORS, BREWERS, &c.

Smallest and Best in the Market.

Made entirely of Sheet Copper, BRAZED TOGETHER, with Gun-Metal Fittings

Gallons per day.	Dimensions. Dia.	Height.
750	7 in. ×	14½ in.
1000	9½ in. ×	16 in.
2000	10½ in. ×	24 in.
3000	12½ in. ×	24 in.
4000	14 in. ×	26 in.
6000	14 in. ×	32 in.

This quantity is guaranteed perfectly cold and fit to drink at exit.

The Highest Testimonials and Price Lists ON APPLICATION TO

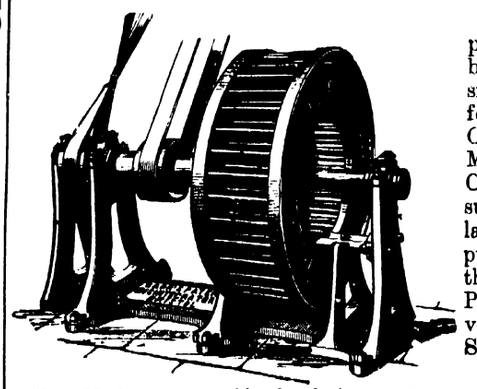
SUFFIELD & BROWN,
Coppersmiths & Sole Manufacturers,
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4084
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"CARR'S DISINTEGRATOR,"

Registered Trade Mark, No. 6380.

AWARDED BRONZE MEDAL, PARIS UNIVERSAL EXHIBITION, 1878.

CARR'S PATENT DISINTEGRATOR.



This Machine effectually pulverizes by the combined influences of percussion and of centrifugal force, Iron, Zinc, and other Ores; Asphalte, Artificial Manures, Phosphates, Fire Clay, and many other substances. It is also largely in use for the pulverization of Coal for the manufacture of Coke, Patent Fuel, &c.; and is very effective for mixing Sugar.

These Machines are capable of reducing to a fine granular powder from 50 to 200 tons per day (according to size) of any unfibrous material. Machines made to order from 18 inches diameter, to suit special requirements of purchasers; these small machines being specially adapted to the requirements of Chemical Manufacturers for Mixing and other purposes.

No Agents. All Machines will in future bear the Registered Trade Mark ("Carr's Disintegrator") in three places—viz. on Bedplate, and on outside Face of each Cage.

A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee, 2523

PHILIP TRIGGS, Albion Chambers, BRISTOL.

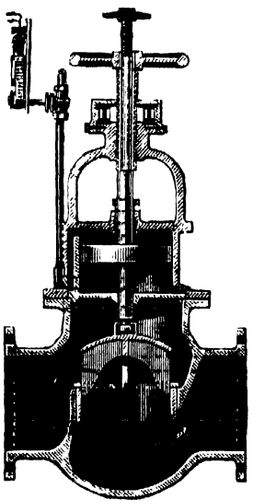
TATE'S PATENT

Electric Valve-Closing Apparatus

FOR STEAM ENGINES.

Medals Awarded AT THE INDUSTRIAL EXHIBITION, BRADFORD, 1882.

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THIS *APPARATUS* IS LARGELY USED ON STATIONARY ENGINES WITH THE GREATEST SUCCESS.

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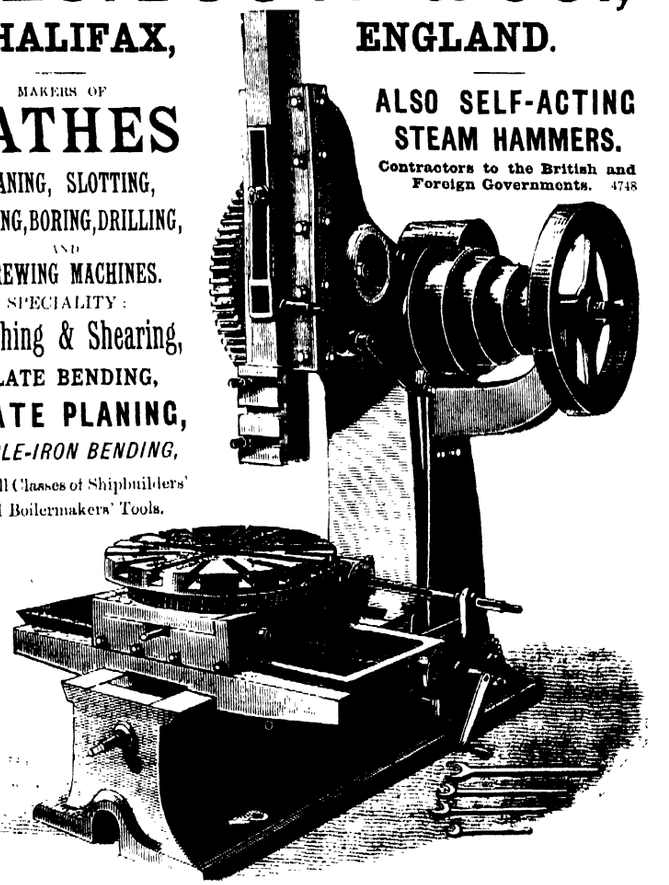
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And all Classes of Shipbuilders' and Boilermakers' Tools.

ALSO SELF-ACTING STEAM HAMMERS.

Contractors to the British and Foreign Governments. 4748



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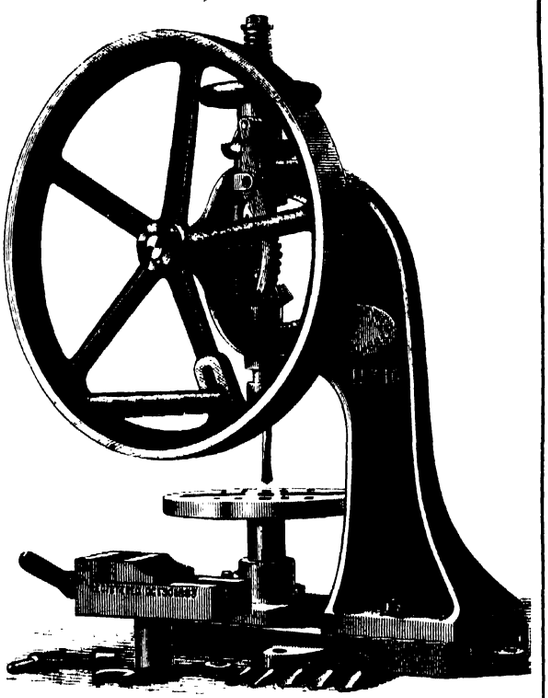
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Registered Self-Feeding Bench Drilling Machine

WITH REGISTERED VICE.

This Machine is suitable for Hand or Power. Prices on application.

SIX DRILLS AND A SET OF SPANNERS SENT WITH EACH MACHINE.

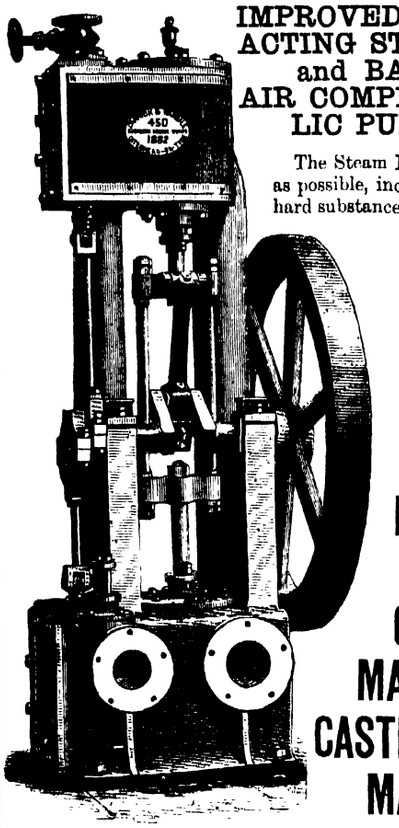


4128

No.	Height.	Weight.	Depth of Feed.	Diameter of Table.	Drills up to
210	2 ft. 3 in.	100 lbs.	2½ in.	9½ in.	¾ in.

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IMPROVED SINGLE & DOUBLE ACTING STEAM FEED, BILGE and BALLAST PUMPS, AIR COMPRESSORS, HYDRAULIC PUMPS & PRESSES.

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BRANDS	Ship	Boiler	Special	Extra Fine
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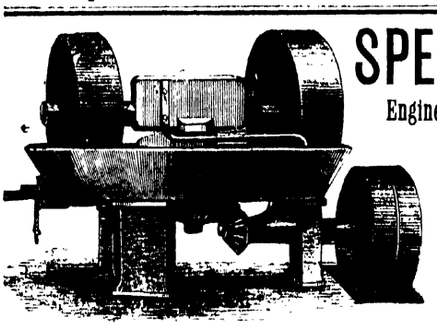
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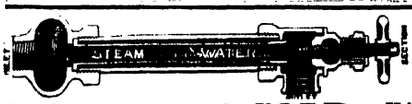
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STEAM TRAPS

OVER 13,000 SOLD. VAUGHAN'S PATENT WATER
SILVER MEDAL AWARDED. EJECTOR OR STEAM TRAP.
POSITIVELY THE ONLY RELIABLE APPARATUS EVER MADE.

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Satisfaction Guaranteed.	Steam Engine Piping.	Steam Hammer Pipes and Cylinders.
Simple. Cheap.	„ „ Cylinders.	Heating Pipes.
Saves broken joints, broken cylinders, broken pipes.	„ „ „ Jackets	Heating apparatuses of all kinds.
Absolutely reliable.	„ „ Valve Casings.	&c., &c., &c.
Unvarying.		

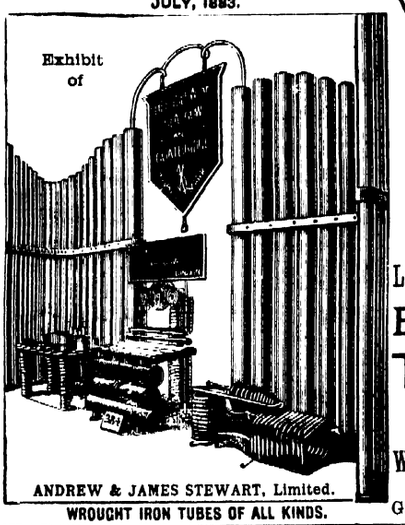
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CONTRACTORS TO H.M. GOVERNMENT,

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Address
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Lap-Welded
BOILER
TUBES
OF IRON & STEEL

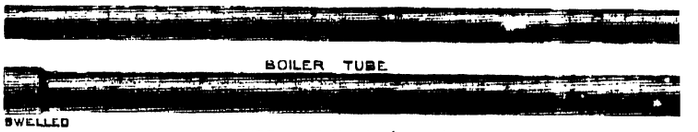
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FOR 5105
Gas, Steam, Water, &c., &c.

THE WELDLESS STEEL TUBE COMPY.

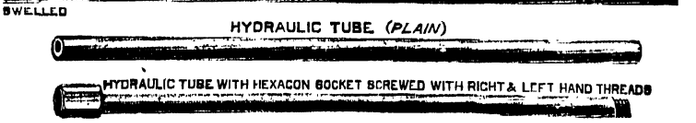
ICKNIELD PORT ROAD, BIRMINGHAM,

MANUFACTURERS OF

BOILER TUBE.



BOILER TUBE.



SWELLED

HYDRAULIC TUBE. (PLAIN)

HYDRAULIC TUBE WITH HEXAGON SOCKET SCREWED WITH RIGHT & LEFT HAND THREADS

PATENT WELDLESS STEEL TUBES

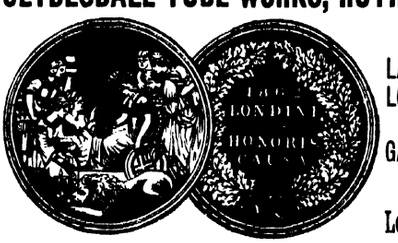
For Boilers, Hydraulic Presses, Ferrules, Boring Rods, Bushes, Shaftin Couplings, Spindles, Collars, and other uses.

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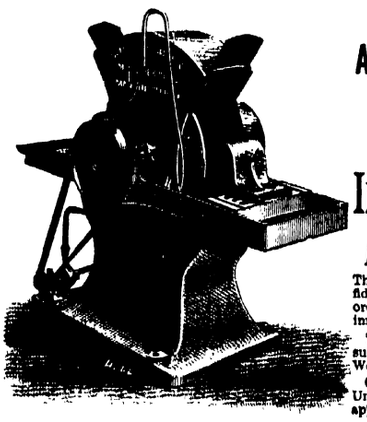
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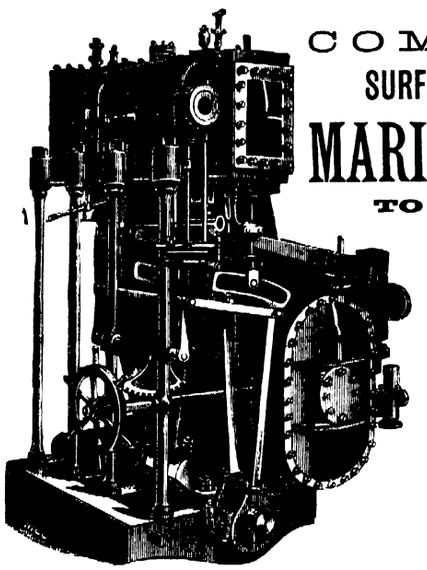
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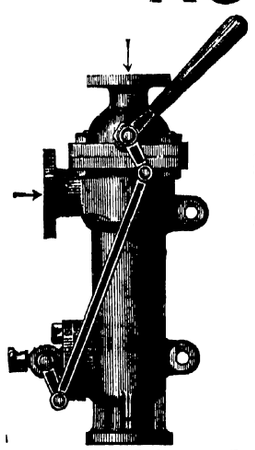
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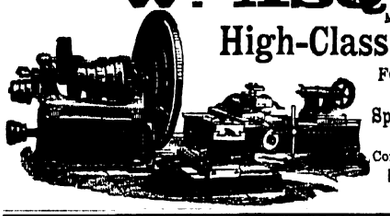
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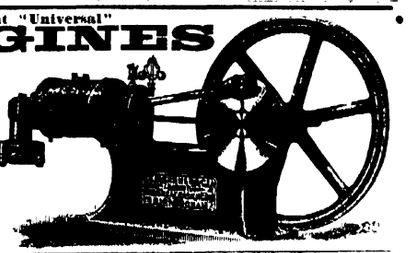
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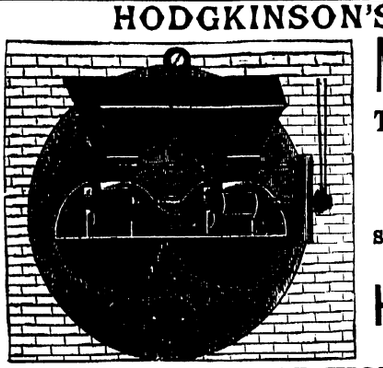
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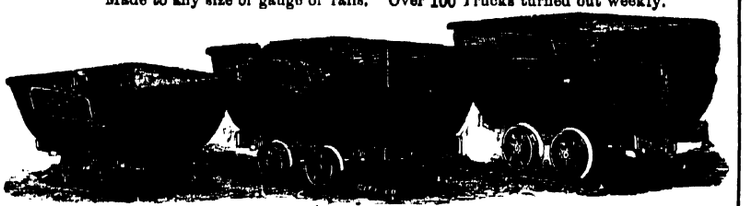
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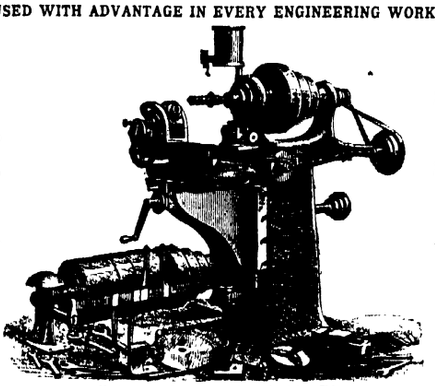
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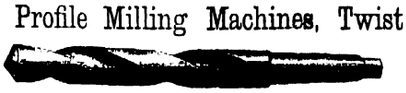
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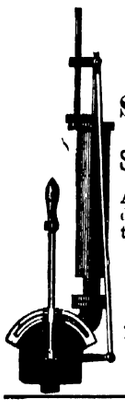
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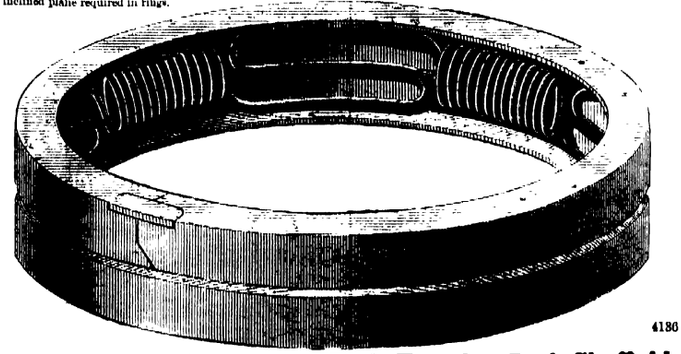
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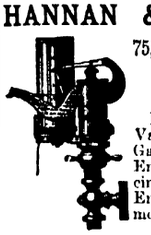
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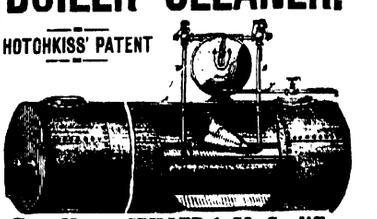
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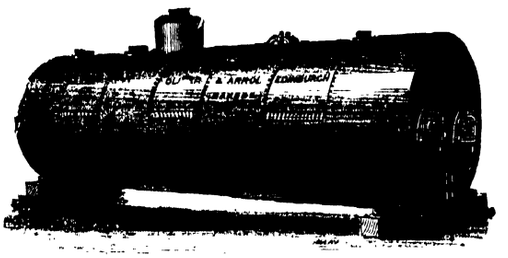
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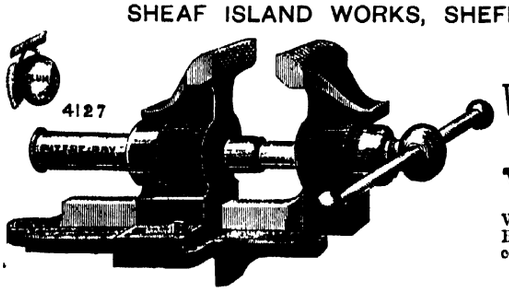
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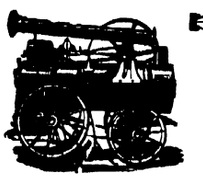
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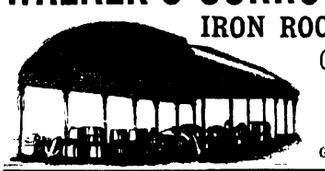
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INVENTORS AND SOLE MANUFACTURERS: 5082

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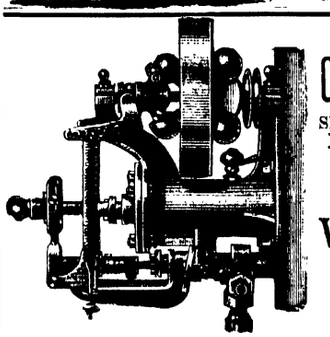
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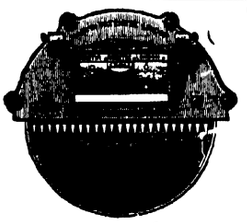
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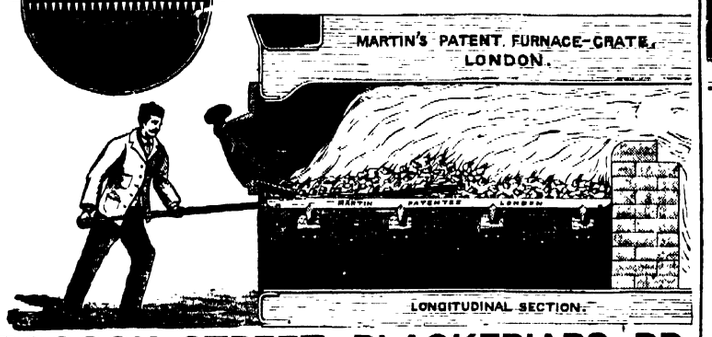
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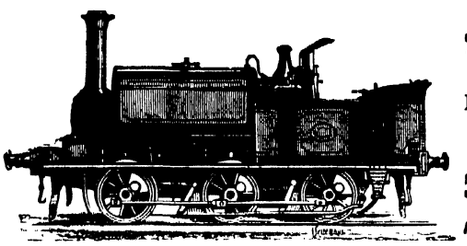
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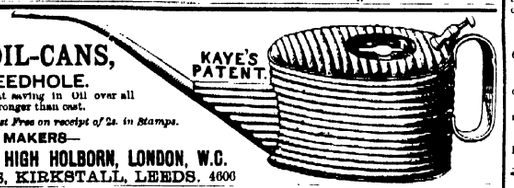
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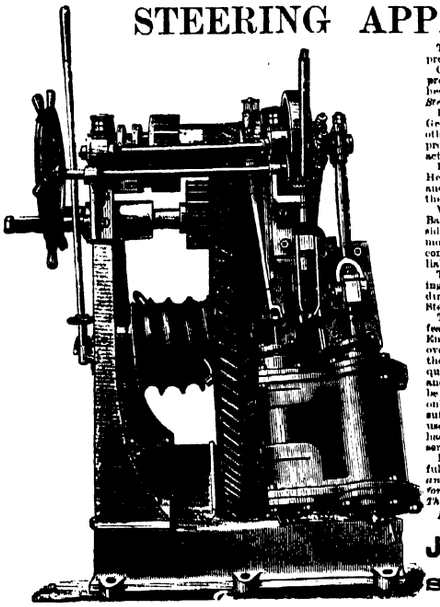
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This Machine is the strongest and most compact at present in the market.

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It will be observed that we have adopted the Double Helical Wheel system of gearing, in which backlash and noise are almost completely dispensed with, and they cannot be surpassed for strength and durability.

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The Gear is perfectly automatic, the Engine responding to the action of the Steersman instantly in either direction, so that as good a course can be steered by Steam as by Hand power.

The economical working is another conspicuous feature in this Machine, only 20 revolutions of the Engine being necessary to put the Rudder from "hard over" to "hard over," as compared with 120 to 180 in the Worm-and-Wheel type of Gears in use; consequently there is a great saving in Steam, and wear and tear are reduced to a minimum. This will also be found advantageous in steering a Compass Course, only half a revolution of the Engine either way being sufficient for the purpose, although we recommend the use of Hand power only at sea, which (in this Machine) has been proved to answer the purpose admirably, reserving the Steam power for rivers and narrow channels.

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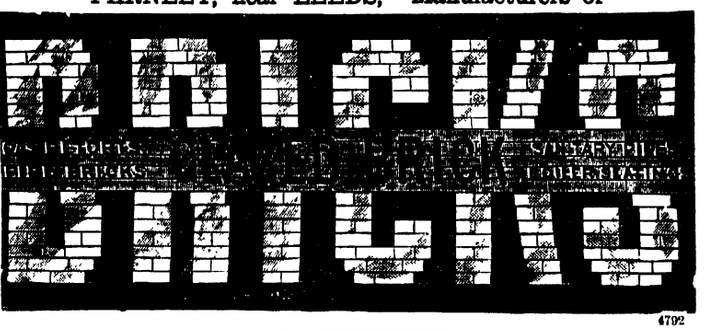
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Gas produced without fire or heat. For Lighting all places where Coal Gas is unobtainable

Sizes, 12 to 500 Lights and above.

Prices, 16 GUINEAS upwards.

Machine Muller à faire le gaz (dite Alpha).

Elle produit le gaz sans feu et sans chaleur. Elle sert à éclairer tous les endroits où l'on ne peut se procurer du gaz de charbon.

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Für 12 bis 500 Brenner.

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The Engine makes the Gas by which it is driven.

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FOR

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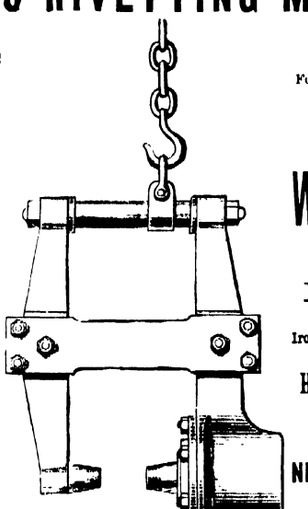
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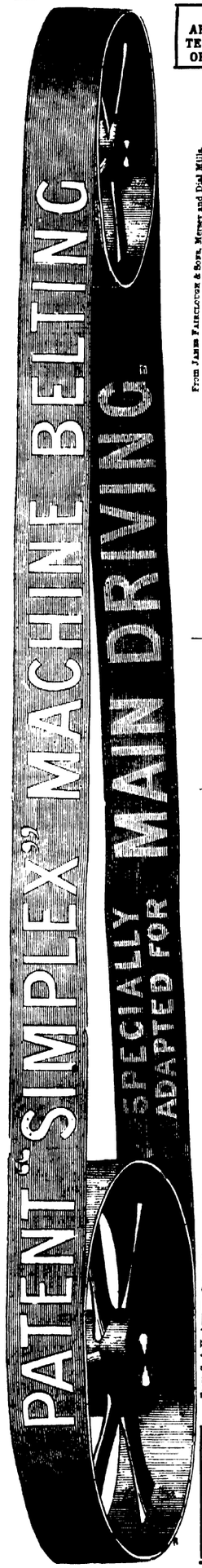
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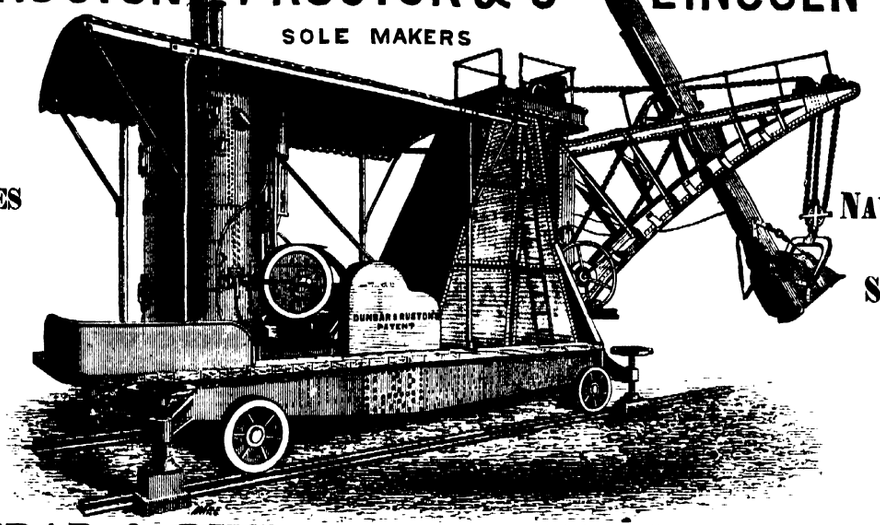
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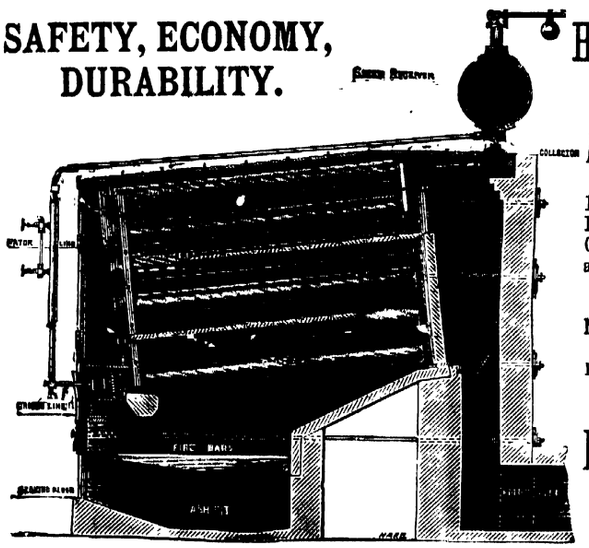
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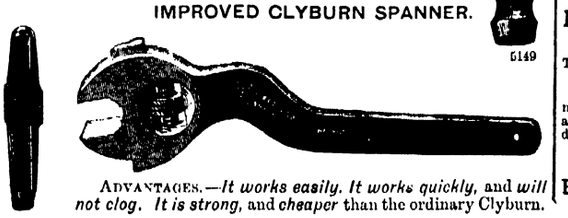
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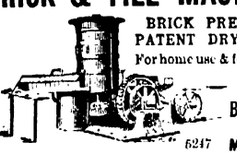
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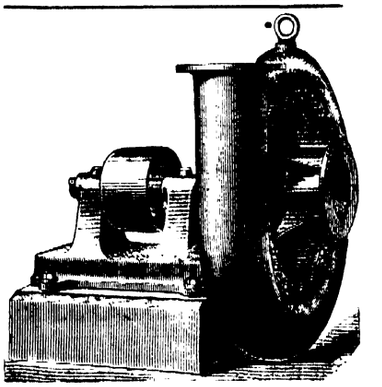
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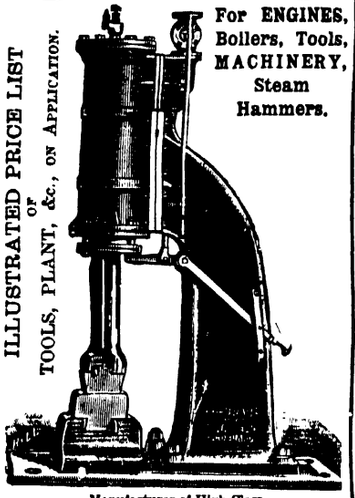
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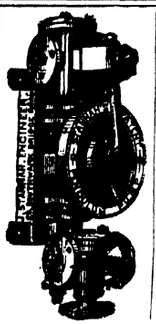
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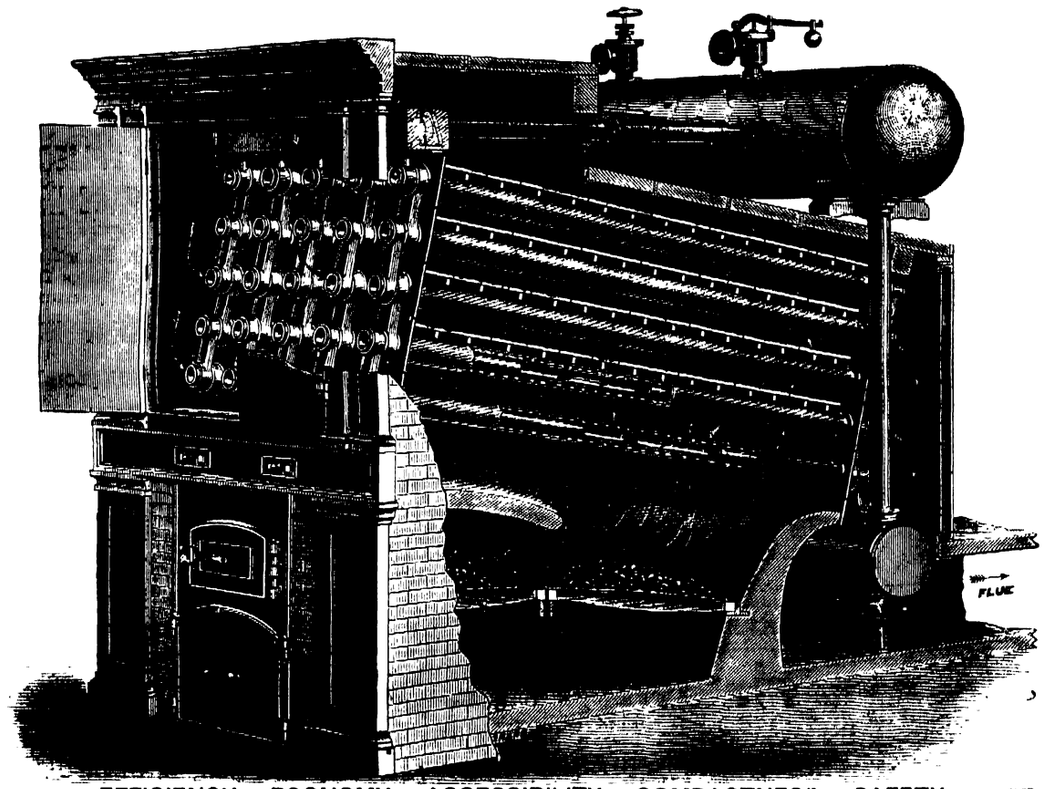


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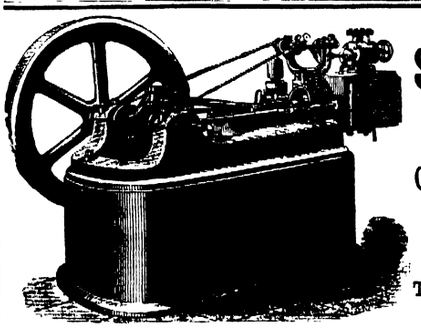
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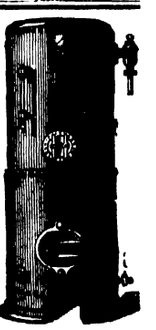
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LITERATURE.

How to Apply for a British Patent under the Patents Act, 1883; a Manual of the Amended Patent Law. By Thomas Wilkins. London: Charles Gilbert, 1884.

Hitherto books on patent law and practice have been of two classes; first, those written by barristers and eminent patent agents for the use of their own class, and second, those written by patent agents for circulation among intended patentees. It is seldom that these latter have any other purpose in view than to extend the authors' business connection, and those who consult them with the idea that they will be able to find in them clear instructions as to how to obtain a patent without employing an agent, are always disappointed. Whether the proverb which says that a man who is his own lawyer has a fool for his client, be applicable to patent matters or not, is a point which it is scarcely worth while to discuss at the present time. Many of the provisions of the new law were expressly drawn so as to admit of personal application on the part of intended patentees, and it is certain that now that the fees payable to obtain a patent are reduced to four pounds, many persons will grudge to pay an equal or greater sum for the services of a patent agent.

Mr. Wilkins's book belongs to neither of the two classes we have named. He is not a patent agent, but a patentee, and in laying his knowledge of the subject before his readers he has nothing to gain, but everything to lose, by ambiguity. His object is to explain the steps to be taken by an inventor to obtain protection for his ideas, and much of the advice he offers may be of service to those whose means give them the advantage of being able to employ skilled assistance. No patent agent can be an expert in all branches of science and manufacture, and hence he must often be dependent upon his client for his information. If the client have clear ideas as to the end to be served by a specification, and the requirements of the law, he will put the matter before his agent in a more intelligible form than if he is ignorant on these points, and the result will be to his advantage. Beginning at the first inception of an invention, the author lays down the course to be followed, warning the inventor of the dangers to be avoided, and explaining the principles by which his course is to be regulated. He first advises him, before applying for a patent and after reducing his idea to practical form on paper, to make a thorough search as to the novelty of his invention, and, to aid him in this, the work contains, amongst other valuable information, a list of places, at which works, published by the Patent Office authorities, are daily accessible to the public free of charge, and also a price list and key to the abridgments of specifications of inventions already published. The applicant should then, supposing that he is satisfied as to the novelty of his invention, apply for a patent. We would point out as one objection to this method of procedure that, should two independent inventors make the same invention at about the same time, he who first applies for a patent, if the patent is subsequently granted, has an exclusive right to the invention, and that, by making a search before his application, the inventor undergoes a chance of losing his invention. Now that the stamp duty on the provisional specification is reduced to one pound, it would probably be better to risk the loss of that than the invention. The description of what may be patented follows, and although quite accurate, might perhaps have been made clearer to persons not accustomed to thinking exactly, by means of a few illustrations. The author's ideas of "one invention only" do not appear to agree with those of the Patent Office examiners. This phrase is differently understood in different countries, and it is not yet certain what the English office will ultimately accept as the invention. Up to the present the examiners have had matters their own way, but it is impossible to say what modifications will be introduced when a few appeals have been carried to the law-officer.

Although the title of the work makes no allusion to foreign patents, yet a good deal is said as to obtaining protection in the United States and on the Continent. The patentee is advised that he should apply for other foreign patents within a few days of paying the United States final fee. It would, we think, be preferable to arrange the applications so that the patents afterwards granted in, say, France, Germany, and Belgium should bear the same date as the United States patent.

In giving the duties of the examiners, the author omits to state that they examine pending applications, and report whether two or more of those appear to them to comprise the same invention, and if so, give notice of this similarity to each applicant. After some very useful information relating to the procedure of applying for a patent, and to the drawing up, &c., of the specifications, the author concludes by giving most of the important forms and other documents likely to be required by an applicant, patentee, assignee, or licensee, including those having reference to notice of opposition to a grant of letters patent, application to amend specification, and opposition to amendment, assignments, licenses, compulsory licenses, renewals, and enlargement of time, &c., which are filled in and interpolated with other valuable information relating thereto.

Notwithstanding the few inaccuracies that we have pointed out, this little work will be of great service to all interested in patents. It is printed in large clear type, contains a sufficiently copious index, and should obtain a large circulation among the large class whom the new Patent Law is designed to benefit.

The Principles and Practice of Electric Lighting. By Alan A. Campbell Swinton. London: Longmans, Green, and Co.

The author of this work addresses himself to those who employ the electric light, or are likely to employ it, and to the general public who take an interest in new discoveries and inventions, and consequently his task is not one requiring any deep research or profound investigation. All that he professes to do is to furnish such information as shall enable a person of ordinary intelligence to obtain a good general acquaintance with the more prominent systems of electric lighting, so that he may be in a position to judge which is the proper one to adopt under certain conditions, and to appreciate the special excellencies and defects inherent in the various methods of utilising electricity for the purposes of illumination. Although this is not a very ambitious programme, yet it is one which fills a real want, for on this subject there is a decided scarcity of books which are both cheap and reliable. Between the electricians who can only speak in their own language, and those authors whose knowledge of the subject is very incomplete, the general public, who want a little assistance in discriminating between the statements of rival inventors, have hitherto found the hand-books issued for the guidance somewhat confusing.

Mr. Swinton spends but little space upon the theory of electricity or the history of the various discoveries in the science. Half a dozen pages bring him to the Gramme ring and the present era of electric lighting, and he never looks back again, but immediately turns to the practical side of the question, beginning with the system of units adopted at the Paris Congress, and the various instruments employed in their measurement, such as Ayrton and Perry's ammeter, Siemens' electric dynamometer, and Edison's meter. Prime movers have a chapter to themselves, descriptive of the various kinds, and more particularly of the considerations which guide their selection under different circumstances. The article on generators includes every one which has an actual commercial existence in this country and no others, and thus the memory of the reader is not uselessly burdened with facts whose interest is merely scientific. This rule seems to have been a little relaxed as regards the arc and semi-incandescence lamp, as a few are included which have dropped out of sight for the last year or two. Indeed it is a question if any semi-incandescence lamp now survives except the *lampe soleil*. Six forms of incandescence lamps are briefly described. We notice that the Lane-Fox lamp is said to have a filament of "French whisk," but we believe that the use of this material was abandoned by the Brush Company nearly two years ago. The electric lighting systems have a chapter to themselves, explanatory of the various arrangements in vogue, and of the many accessories in the way of switches, current regulators, governors, cut-outs, secondary generators, accumulators, and the like, and the work ends with a discussion of the cost of electric lighting, the figures being obtained from the installations at the British Museum, and at South Kensington. Also from Sir William Siemens' address to the Society of Arts, from Mr. Conrad W. Cooke's report to the corporation of Sheffield, from Mr. Gordon's tender to the corporation of Nottingham, and from Mr. Octavius E. Coope's letter to the *Times*. It would have been well, we think, if the author had supplemented these figures, which are favourable to electric lighting, with the information that the illumination at the British Museum and at South Kensington is decidedly unsatisfactory, and that the other schemes, except Mr. Coope's, were based upon a much longer period of burning than can usually be obtained.

It will thus be seen that Mr. Swinton fulfils the promise of his preface. He describes the very latest inventions in all departments of electric lighting, and does so in language that every one can understand with reasonable application; his book is entirely free from padding and from any prejudice in favour of particular manufacturers, and should meet with the appreciation of the class of readers to whom he addresses himself.

THE EBBW VALE IRON AND STEEL WORKS.

These works, of which we publish a general plan on the following page, and the industries allied to them, form one of the most extensive and important business enterprises in South Wales. They were commenced by Jeremiah Homfrey, who came into South Wales from Staffordshire. He was of the same family as the original owners of Perrydarren and Tredegar Works. In 1790 the Harfords became the proprietors, and in 1816 purchased from Featherstone and Monkhouse, the owners of Tredegar Works, the Sirhowy property. The Harfords, prior to coming to Ebbw Vale, were part owners of another iron works in conjunction with a Mr. Hill, who was the founder of the Blaenavon Works. Messrs. A. Darby and Co. acquired the property in 1844, and in 1848 annexed the adjoining Victoria Works. The latter had been commenced by the Monmouthshire Iron and Coal Company in 1836. Messrs. Darby and Co. subsequently added the Abersychan, Pontypool, Bundon, and Abercarn estates to the enterprise, and finally in 1864 the whole was converted into a limited company as it now exists. We believe that Mr. Darby, the principal partner in A. Darby and Co., was also the chief proprietor of the Coalbrookdale Iron Company. Previously to the opening of the tramroad to Newport in 1879, the pig iron was conveyed to port on mules.

A few figures relating to the extent and production of the various branches of the company have been prepared for the information of the members of the Institution of Mechanical Engineers who visit the works to-day, and from these we reprint the following data:

Mineral Properties.

		Acres.	Total.
Ebbw Vale	Freehold	2800	
,,	Leasehold	2200	
			5,000
Abersychan	Freehold	60	
,,	Leasehold	1750	
			1,810
Pontypool	Leasehold		2,500
Abercarn	Freehold	320	
	Leasehold	1300	
			1,620
			10,930

Collieries.

	Tons.	Output in 1883.
Ebbw Vale:		
Ebbw Vale	364,209	
Sirhowy	247,195	
Victoria	185,644	
Waunllwyd	258,154	
		1,055,202
Abersychan		256,215
Pontypool		174,604
		1,486,021

Coke made 1883.

	Tons.
Ebbw Vale	203,097
Pontypool	37,253
Abersychan	33,032
	273,382

The entire coking plant is equal to a production of 340,000 tons per annum.

Bricks Made 1883.

	No.
Ebbw Vale	5,433,644
Abersychan	524,075
	5,957,719

Iron and Steel Works.—Production 1883.
Pig Iron and Spiegeleisen.

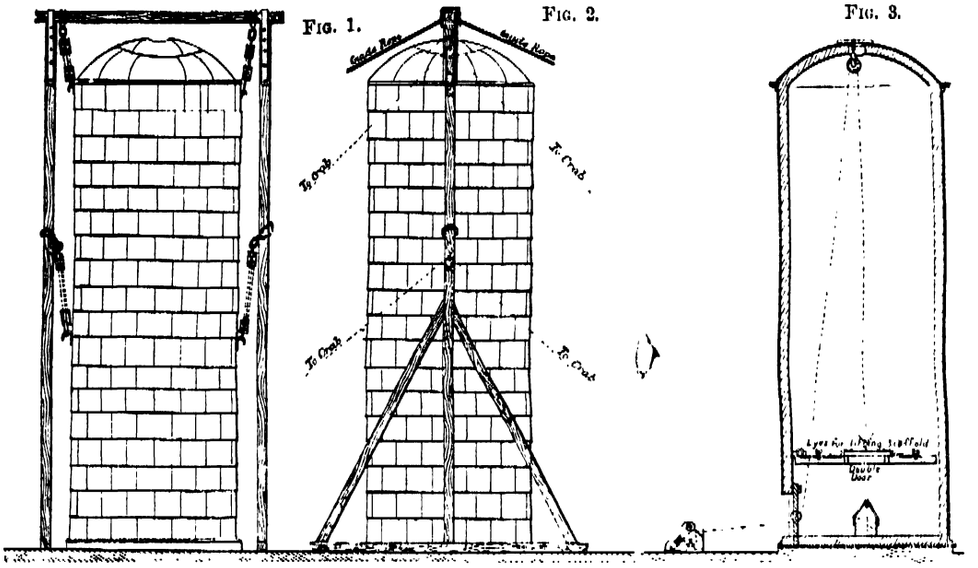
	Tons.
Ebbw Vale	161,313
Pontypool	24,984
Abersychan	26,115
	212,412

PLAN OF THE EBBW VALE IRON AND STEEL WORKS.

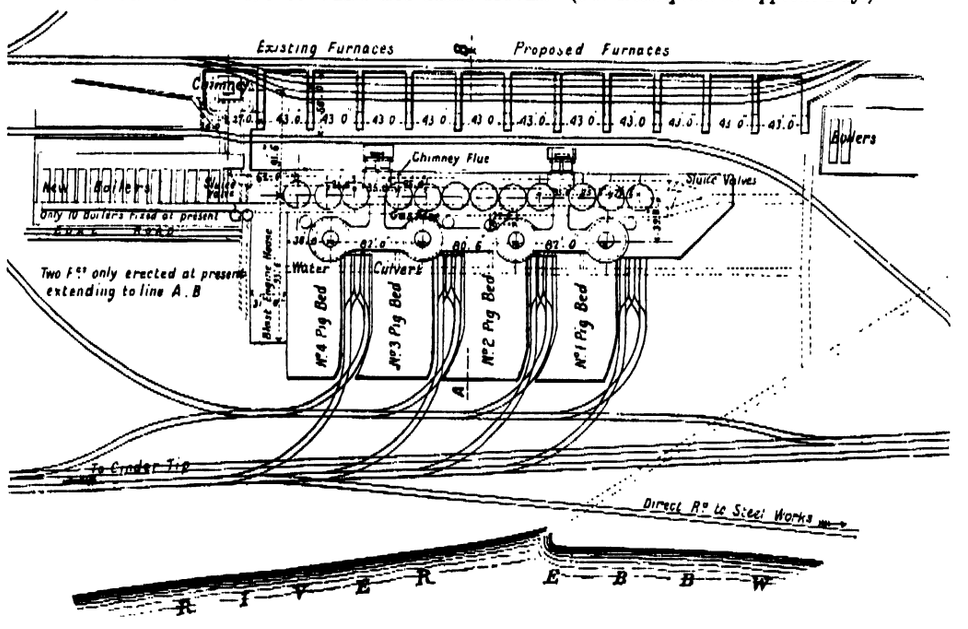

Bylchy Farm
Bylchy garn Ho
Morning Star Ho
Reservoir
Sluices
Old Shaft
Old Level (Coal)
Level (Coal)
Slip (Coal)
Old Pit
Old Works
Brassmeir Steel Works
Hydraulic Engine
Engine House
Engine House
Level (Coal)
Air Shaft
Level (Coal)
Level Adit
Weighing Machine
Weighing Machine
Goed Tyn-y-fyd
Water Pipe
Ebbw Vale Iron Works
Ebbw Vale Iron Works
Ebbw Vale Iron Works
Ebbw Vale Iron Works
Victoria Colliery
Victoria Colliery
Victoria
Blast Furnaces
Blast Furnaces
Engine House
Engine House
Engine House

&c., falling down on the men below. The bricks and clay are lifted in wooden tubs by means of a small steam winch. For lifting the scaffold the chain is taken off the tub and connected to the four chains on the scaffold. When the latter is lifted to the required height, four pins are put through staples on the scaffold, their ends resting on the brickwork. The checkered work and flame flue are built after the lining is completed.

At the opposite end of the blast furnaces is an engine-house containing a blowing engine of the ordinary beam type. The steam cylinder is 72 in., the blowing cylinder 144 in., and the stroke 12 ft.



MODES OF ERECTING COWPER'S HOT BLAST STOVES. (*For Description see opposite Page*).



THE EBBW VALE IRON AND STEEL WORKS: PLAN OF VICTORIA FURNACES.

The flywheel is 30 ft. in diameter, and weighs 90 tons. It makes twelve revolutions per minute. This engine was started about eighteen years ago, and on the second day of running the cast-iron crank broke. One of wrought iron was then substituted, and the engine ran very well until about five years ago, when the crankshaft broke short off in the journal at the crank end. A Whitworth fluid-pressed steel crankshaft and crank-pin were then fitted, and these are at present in use in conjunction with the former wrought-iron crank. The diameter of the crankshaft in the bearings at the crank end is 20 in., and the length 3 ft. the total length being 15 ft. 2 in. It is square where the flywheel is blocked and staked on. The steam pressure for this engine is 40 lb., and it delivers into the same blast main as the last described engine. The air valves are of the horizontal type with balance weights.

At the back of this engine-house is a range of four Cornish boilers 40 ft. long by 7 ft. diameter, having a 4 ft. flue and six Galloway tubes in each. They are all gas-fired, no provision being made for coal. Near these again, and convenient to the rails, on which the Bessemer ladle carriage is brought from the furnace, are two cupolas used for assisting the furnaces when enough iron is not got from them, and for working up pig made on Saturdays or Sundays. A steam lift with overhead cylinder raises the materials for these cupolas.

Ascending to the higher level on the hillside immediately at the rear, we find that a railway brings the coke close to the back of the furnaces. On the other side of this railway is the depôt where the ore and limestone are stored, these materials having been brought in by a line of rail placed about 35 ft. above the coke line, which is on the same level as the depôt floor. There are six compartments in the depôt, each 45 ft. wide and 35 ft. high. From the depôt floor to the charging platform there is a height of 16 ft., and the materials are raised by means of four direct-acting steam lifts with cylinders underneath. It should be mentioned that the depôt and landing at the back of the furnaces are entirely covered by a light iron roof.

Still higher on the hillside is a block of thirty-three drag ovens, which are said to have some slight improvements on the general form, the details of which we did not learn, and next to these is another block, thirty-four in number, of earlier construction. These ovens are about to have flues fitted to collect the waste gases for heating the boilers.

Descending to the lower ground again, we come to the boiler repairing shop which contains the necessary tools, and from thence a short walk brings us to the truck repairing and general carpenter's shop. Here the 3500 trucks owned by the company are kept in proper order, and other wood-working is carried on. There are one or two very good tools here, a horizontal single saw plank-cutting machine being the most prominent. The work is fed up by a table at a speed suited to the hardness of wood. The saw delivers itself by an arrangement in which the guides are placed at a slight angle. Here are also band saws, a circular bench saw, and other wood-working machines, all by Messrs. T. Robinson and Son, Limited, of Rochdale. The power for these tools is obtained from a single cylinder engine placed beneath the floor, and driving the shafting, also placed beneath the flooring, by means of cotton rope gearing.

From here we pass to the large smiths' shops, consisting of three bays of light iron roofing 134 ft. long and 123 ft. deep in all. Here are thirty-three fires, a small steam hammer, and a balling furnace. Adjoining the smithy is a fitting shop 176 ft. long by 40 ft. wide. In it are all necessary tools for keeping the engineering part of the establishment in repair. Rails are laid down the centre, upon which one of the travelling steam jib cranes, of which there are several on the works,

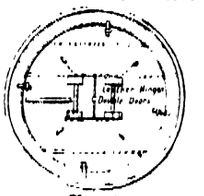


Fig. 4.

can be brought to the tools and shift the work in them. Near here again is the locomotive repairing shed, where the thirty-two locomotives owned by the company are brought when requiring attention.

Leaving this block of workshops, we proceed in a southerly direction towards Victoria, where the new furnaces are placed. The arrangement of this part of the works is shown by the separate plan which we give on the present page. About half way on the line the Bessemer steel works are situated, and these we will deal with now. We first pass into the shop containing the lathes which are used for turning the rolls. They are eight in number, and each will take rolls up to 12 tons in weight and 9 ft. in length. Overhead there is a steam travelling crane which will lift 20 tons. The shop engine is horizontal, the cylinder being 20 in. and the stroke 24 in. Further on we arrive at the steel works, in which are three pits, each with two converters placed opposite to each other. The first pit met with on entering is the most modern. Here are a pair of converters of the ordinary type, each capable of working 10 tons of metal. There are nineteen tuyeres to each, which are pierced with eight $\frac{1}{2}$ in. holes in place of the sixteen smaller holes used formerly, the larger holes being found to answer better. The converters are placed close to a building in which there is a line of rails, upon which the ladle is brought from the blast furnaces at a sufficient height to enable the metal to be run direct to the converters by means of swinging troughs. The pit is 17 ft. 6 in. radius, and has two side cranes for clearing away the ingots and shifting the moulds. The centre crane has a single ram of 21 in. diameter. The tipping gear is of the ordinary rack and pinion type, worked by a horizontal hydraulic cylinder. The converters are lined with silica bricks. The two other pits are of the old deep type, and have each two 8-ton converters.

The blowing engines for this plant are two in number, one by Messrs. D. Adamson and Co., and the other by Messrs. W. and J. Galloway and Sons. The former is of the vertical direct-acting type and comprises a pair of 40 in. steam cylinders, with 54 in. blast cylinders, by 5 ft. stroke. The steam pressure is 50 lb. and the pressure of blast 25 lb. A Buckley condenser is attached and is used when water is very plentiful. The Galloway engines are a pair of horizontal 36 in. steam cylinders, 48 in. blast cylinders, and stroke 5 ft. They are non-condensing, the exhaust steam being taken to heat the feed water. Both these engines deliver into the same blast main and take steam from the same boilers. Close by are three pairs of horizontal hydraulic pumping engines by Sir W. G. Armstrong and Co., for working the Bessemer plant and the rail mills. The steam cylinders are 18 in., with $4\frac{1}{2}$ in. rams, the stroke 2 ft., and the water pressure 450 lb.

In the rolling mills, beside the Bessemer plant,

there is a pair of horizontal blooming engines by Messrs. W. and G. Galloway and Sons geared 3 to 1. The cylinders are 36 in. in diameter and the stroke 4 ft. 6 in., steam pressure 50 lb. There is one of Messrs. Hathorn, Davey, and Co.'s separate condensers with a differential pump. This engine drives two trains of 36 in. rolls, one on each side. Further on is the rolling-mill train, 30 in. centres, which is driven by a pair of vertical engines geared 1½ to 1, cylinders 50 in. in diameter and 4 ft. stroke. From the finishing rolls the rails are taken to a swing saw by Messrs. Kitson and Co., of Leeds, and thence to the straightening presses, which consist of two double and one single press in the first tier, and two double and two single in the second. A small steam hammer is also placed here.

The heating furnaces are eight in number, and are gas-fired on the Siemens principle. They are of considerable depth, and are charged on each side. Hydraulic gear is used for pulling out. The gas producers are placed close to the stream, the gas being carried over a railway in a wrought-iron tube. The latter discharges into a culvert which distributes the gas to the furnaces. There are six blocks of producers with four fires in each block. The boilers running the steel works are thirty in number. Of these fifteen are quite now, and have been made by Messrs. D. Adamson and Co. They are 30 ft. long and 7 ft. in diameter, and have each one flue 3 ft. 10 in. in diameter, and two cross tubes. Six more of these boilers are on Galloway's plan, and are of the same length and diameter. Another series of nine are by the Coalbrookdale Company, and are 34 ft. long and 7 ft. in diameter, having each two flues 2 ft. 6 in. in diameter. The last nine are fired underneath; the others are internally fired, coal only being used.

Leaving the steel works we pass on to the Victoria furnaces, and on the way, we notice, away to the east of the line we travel on, two engine houses situated on the banks of the stream. These contain two pumping engines which are for taking back the water which has been used for boilers, condensers, water tuyeres, and, above all, for the coal-washing machinery. One is a Cornish pumping engine with a 60 in. steam cylinder, a 17 in. plunger, and a 6 ft. 7 in. stroke. The second engine has a 40 in. steam cylinder by 4 ft. stroke. It is geared four to one on the crankshaft and works two pumps with 12 in. barrels and 6 ft. stroke. The large pump discharges into a range of pipes 20 in. in diameter, by which the water is taken a height of about 225 ft., from intake to delivery, the distance being about three-quarters of a mile. The second engine serves a 12 in. main, which is placed beside the larger one. Both these mains discharge into an artificial open watercourse, which carries the water to a small reservoir above the Ebbw Vale furnaces, the latter being in that part of the works furthest up the valley. The advantage of this water-saving system has been strikingly manifested during the recent long spell of dry weather, all through which the Ebbw Vale Works had no lack of water.

We now arrive at the Victoria blast furnaces, of which there are two now at work. They are 60 ft. high, 20 ft. in diameter at boshes, 8 ft. at hearth, and 13 ft. 9 in. at top. They have seven tuyeres inserted at equal distances and a water frame for the tuyeres. A tuyere can also be placed in front if required. One furnace has a firebrick hearth and the other is rammed with dry ganister. Both have water blocks, and are rammed inside with dry ganister round the furnace. The furnaces are hooped with iron in the same way as those at the Ebbw Vale end. In addition to these two furnaces, provision has been made for two others which are about to be built. On the preceding page we give a plan, Fig. 6, of the complete arrangement, but up to the present time only that part on the left of the line A B is complete.

The blowing engines, two in number, are placed in a handsome engine-house at the end of the range. The engines are by Messrs. Kitson and Co., of Leeds, and are of the vertical type with steam cylinders 50 in. in diameter above, and air cylinders 100 in. in diameter below. The stroke is 5 ft. The steam pressure is 60 lb., and the blast 5 lb. There are piston steam valves and circular blast valves. In this engine-house there is room for two more engines of this type, the foundations for which are already laid.

Under an iron roof adjoining is a range of ten Adamson steel boilers 30 ft. long and 7 ft. in diameter, all of which are gas-fired. The flues are 3 ft. in diameter, and each boiler has six cross tubes. There are two Berryman feed-water heaters which take the exhaust steam from the engines. In this boiler shed are two of Messrs. Hathorn, Davey, and Co.'s horizontal pumps with differential gear for taking the tuyere water back to a reservoir, and next to these is a Cameron pump for feeding the boilers. All the arrangements in this part of the works are excellently designed and well carried out, substantial brick shelters being provided for the men, whilst the engine-house has more the appearance of a water company's pumping station than a building for housing a blowing engine. The depôt for these blast furnaces consists of seven bunkers, each 43 ft. wide, 45 ft. high, and 50 ft. deep. These are at the tapping level, all materials being lifted upon steam hoists by a pair of winding engines with 12-in. cylinders and 20-in. stroke, geared 5 to 1 with wire rope.

To the left of the blast furnaces is the foundry where rolls and all necessary castings for works are made. Castings up to 30 tons have been turned out at this foundry. Ascending the western slope of the valley a line of rails takes us to the coke ovens, of which there are seven blocks, or 180 in all. Six of these are on the Coppée principle, and supply heat by their waste gases to nine boilers, which are placed at the ends of the blocks. They supply steam for two coal-washing machines on the plunger principle, which are close by. They also provide steam for the engines required at the mouth of two pits close by, and also for a pumping engine which takes the coal washing water back to a tank on the top of the machine. Provision is made for adding three more of these boilers. It should be mentioned that there are three steam "pushers out" for discharging the Coppée ovens.

The bar mill is next reached on the return tour towards the offices. Here is a 12-in. train driven by an engine with cylinders 24 in. in diameter by 30 in. stroke, and an 8 in. guide mill having an engine with 21-in. cylinders by 20-in. stroke. Both these trains are to be driven by cotton rope. The flywheel pulleys are 14 ft. in diameter and 2 ft. wide, and have eight grooves. The driven pulley on the 8 in. train is 6 ft. 7 in. in diameter, whilst that on the 12 in. train is 7 ft. 7 in. The engine for the former mill will make 112 revolutions per minute, and the other 70 revolutions. Ropes 1¼ in. in diameter will be used and the distance between the centres of the pulleys will be 30 ft. Rope gearing for rolling mills is to a great extent a novelty in this country, although we understand that it has been adopted to some small extent in the North. In America, however, it is not uncommon. On the other side of these sheds is an 18 in. train for rolling fish-bars and large size iron and steel bars up to 3½ in. or 4 in. It is driven by a pair of horizontal engines made on the premises and geared 3 to 1 with 30 in. cylinders and 4 ft. 6 in. stroke. In this mill are seven boilers fired by the waste heat from the heating furnaces. These are each 24 ft. long by 7 ft. in diameter. They have two tubes each 2 ft. 6 in. in diameter, one furnace delivering into each flue.

From here we pass some old puddling furnaces and arrive at what are known as No. 4 steel rolling mills, where a new 36 in. blooming mill and pair of engines are now being erected. The engines are by Galloway and Son, and are geared 3 to 1. They are 36 in. in diameter by 4 ft. 6 in. stroke. This mill has helical pinions and the top rollers are balanced with hydraulic cylinders after the most approved style. Hydraulic power is supplied for passing the bloom and also for turning over. This fine train has been made on the premises and is an excellent example of machinery of this type. The horizontal guillotine shears have also been made on the works.

The mill train situated close to the preceding is worked by an old beam engine with a horizontal engine coupled. It is geared 2½ to 1. There are twelve boilers 24 ft. long by 7 ft. in diameter, which are heated by waste gases from the heating furnaces. They have two flues 2 ft. 6 in. in diameter, one furnace delivering into each flue. There are also fifteen coal-fired boilers of a similar type. From these mills we pass back to the offices and have completed the round of the Ebbw Vale Company's extensive works.

CANADIAN PACIFIC RAILWAY.

No. XVI.

MEDICINE HAT TO SUMMIT OF ROCKY MOUNTAINS.

AFTER leaving Medicine Hat, 660 miles west of Winnepeg, the railway runs between the two main confluents of the South Saskatchewan, which loses its name some fifty miles above the railway crossing, when the Bow and Belly Rivers run together and form the south branch of the great river. Both of these take their rise in the Rocky Mountains, and of the two the Bow is the largest and most important. To the north of this is a larger river than either, the Red Deer, which rising in the same great range, flows through a fine district and runs into the Saskatchewan 150 miles below Medicine Hat. The course of the line after crossing the main river is for some distance along the height of land between the Bow, some twenty miles to the south end, and the Red Deer fifty miles to the north. The land and the climate in this district are altogether different from Manitoba or Assiniboia; we are in a new province, Alberta, and it is an entirely different country, with different pursuits for the people, and an entirely different way of making their living. At a very much higher elevation and rapidly approaching the great snow-capped mountain range, which is the backbone of America, there is nevertheless a warmth and a moisture in the air different from anything previously experienced, whilst the climate is far more equable, colder in summer and warmer in winter than the plains behind and below us. The land, a good honest clay loam, is strong and productive, but more suitable for pasturage than tillage, and though many a good farm might and will be carved out of it, its cultivation will resemble more the farming of England than of Canada, and it will require more working and not be as productive under the plough as the rich light lands further east. This district, and a vast area it is, stretching from the Red Deer across the Bow Valley and to the south of the Belly River, is the ranche ground of Canada, and the great beef-growing country that will as certainly supply England in the future with a large proportion of her butcher's meat, as Manitoba will send her wheat, and provide her with bread. The peculiarity of the climate is the prevalence of what are called the Chinook winds, a stream of warm moist air blowing with tolerable regularity from the Pacific, and which tempers the atmosphere so that there is seldom any depth of snow in the winter, or any very severe cold weather to prevent cattle from remaining out of doors and unminded the year round. The lands here are not disposed of by the Government as they are further east, nor are they sold either to actual settlers or to companies, but leased at the uniform rate of 10 dols. per 1000 acres per annum, that is one halfpenny per annum per acre. By a return presented to the Houses at the session of 1883, there had been up to the end of the fiscal year no less than 78 applications for land, covering altogether 4,215,371 acres. Of the whole number up to that time only eight had been granted, and these were all twenty-one year leases and covered 734,171 acres, seven of them being for 100,000 acres each, and the eighth for the balance. The most important of, these ranche companies is the Cochrane Company whose location is on the Bow River north of Fort M'Leod. In 1882 this company purchased a herd of 6000 head of cattle from across the lines, at the rate of 25 dols. per head, and including in the purchase sixty Durham bulls at 300 dols. each. This acquisition made the stock on the Cochrane ranche equal to 40,000 head of cattle, their herd of thoroughbred bulls consisting of 100 Herefords, 36 polled Angus, and 65 Durham cattle. These animals range about the whole winter without any difficulty, and all the attention they require is afforded by a few "cow-boys" who, constantly in the saddle, keep the cattle from straying across the limits of the "farm." Twice a year they are "rounded up," or driven together to the enclosure, once in the spring for the purpose of branding the calves and again in the fall for the purpose of selecting those that are to be disposed of. The exportation of cattle from Canada to England commenced in 1878, and has now assumed an importance that is affecting the relations of the countries interested. To the end of 1883 the number of cattle exported from this country had reached 231,487, which at an average of 21*l.* sterling per head, including grass feed and store stock, which was the average price of last year's exportation, would amount to 4,860,807*l.* In 1874, only ten years since, the whole export of cattle from the Dominion amounted to 63 head. The next year the trade began by a party of Toronto gentlemen who got together a cargo of cattle, and sent them to England as an experiment. The venture proved remunerative beyond expectation. There was, however, considerable prejudice on the part of the

English consumers, and an immense deal of jealousy on the part of the English dealers and traders, and the prejudices of the one and the jealousies of the other, had to be and were lived down, and now there are twenty-seven cattle exporting firms doing business in the province of Ontario alone, and a capital of 1,500,000 dols. engaged in the business. In four years the live stock shipped from Montreal alone had increased to 17,101 head of cattle and 59,990 sheep, and from Quebec in addition there were 4000 cattle and 17,274 sheep. For the season of 1880:

Montreal shipped	35,416	cattle and	67,943	sheep.
Quebec ,,	9,894	,,	11,208	,,
Halifax ,,	4,150	,,	2,392	,,
	49,460		81,543	

Every one of these was Canadian bred, not one being imported from the United States. In 1881 for the first time a vessel was put on expressly for this cattle trade, and the European, an old Allan freight steamer, left Halifax in March with 755 head of cattle on her first trip, all Toronto cattle, sent off in three special trains, which took just a week on the road, 1180 miles. The shorter ocean run from Halifax is a great advantage in this trade, where the animals are liable to succumb from exhaustion if the passage is too long. The summer months are of course the best for the voyage, just as the winter months are ... suitable for the fresh meat trade, as the prices in the English market do not vary sufficiently to pay the extra cost and insurance of the winter transportation. The average cost of these animals in Toronto is put down at 5 cents per pound, or for a beast weighing 1600 lb., 16*l.* 9s. The freight to the shipping point and across the Atlantic averages about 1*l.* and 4*l.* respectively, and all the other charges bring up the price of a first-class beast to 23*l.*, whilst the average actually realised last season was 25*l.* for stall-fed animals. The proportion of beef made to the live weight is from 56 to 57 per cent., and at this price, 23*l.*, the beef is worth 6½d. per pound. The cattle so far shipped have been exclusively from the older provinces and principally from Ontario, none have, so far, gone from the Canadian ranches, but in a year or two these will be the majority, and the quantity that can be raised is simply determined by the means of disposing of them. A ranche is run at a very small expense. One of 5000 head can be run at a cost of 1 dol. per head per annum; with 10,000 head the expense will be from 75 cents to 80 cents, or halfpence, per head, and a ranche of 25,000 or over, need not cost over 2s. sterling per head. It requires to run a ranch of 5000 cattle about four men during the winter months and ten men during the summer. It is generally estimated that they require two horses for every hundred head, which gives to each man ten horses during the summer. There is nothing done on foot in this country, everything is done on horseback, and horseflesh is the cheapest muscle that can be found. A stock ranche is better off with ten men and a hundred horses than twenty-five men and fifty horses. Each horse is ridden till he is tired, then a fresh horse is taken till the cow-boy has gone through the number allotted to him, and then he begins over again with the first horse. Each ranche requires a trusty foremen, whose wages are about 200*l.* a year, "and all found." The ordinary herdsmen get about 30 dols. per month, say 72*l.* a year, and are found. These "cow-boys" are a rough, hardy, industrious set of men, and generally very trusty. There is no stabling or sheds, except for the horses. The cattle run wild just as the buffalo used to do. There is no cutting of hay for the winter's fodder. The cattle do their own mowing from one year's end to the other. In the Eastern States the farmer has the pitchfork in his hands for nine months in the year. On the ranches the cattle drift from 50 to 75 miles from their summer ranges; during a cold storm they move with it and keep going till they get into some ravine or behind a ledge, travelling in this way sometimes 25 miles in a heavy storm. But wherever they roam during the winter, when spring comes they are all found during the general round up, when they are driven back to their respective ranges, and where they are attended to by the herdsmen till winter sets in again. The "round up" is a regular organisation of all the interested parties, and the whole is under the command of a captain whom all obey. The cattle are separated according to the brands upon them, denoting their owners, and then started back to their own ranche, the calves being then branded and turned loose with the herd; the whole of this occupying about two months, during which the cowboys scour the country in all directions.

After following the high land between the Bow and the Red Deer rivers for some distance, the railway approaches the valley of the latter, and crosses its tortuous stream no less than eight times. The first of the bridges has two spans of 199 ft. each, the second, where there is an island in the river dividing it it into two channels, has a bridge over each consisting of one iron span of 215 ft. clear. The third crossing has again two spans of 199 ft., whilst the fourth has three spans of 155 ft. each.

The sixth locomotive division ends at Gleichen, 125 miles from Medicine Hat, 785 from Winnepeg, and 1214 from Port Arthur, where shops and conveniences are being erected for the maintenance of the rolling stocks on the sixth and seventh divisions. The country from this place to Calgary possesses more than ordinary attractions for those who travel for pleasure. The prairies are beautifully undulating; lakes, whose clear waters are filled with fish, appear at short intervals; large droves of antelopes are frequently seen, and the countless buffalo trails that traverse the prairie in every direction, clearly denote that the country was once a favourite grazing ground for these former monarchs of the plains. As the westward train passes through a low cut and reaches the level plain at a point about 150 miles from the base of the "Rockies," their dazzling snowy peaks come into full view, and travellers who have crossed by the other continental lines assert that no such beautiful scenery is to be found upon any of the others to compare with this upon the Canadian Pacific. At a distance of 54 miles from Gleichen and 840 from Winnepeg, the capital of the province of Alberta, Calgary is reached, which was the end of Langdon and Shepard's contract, and destined apparently to be the largest and most important town next to Winnepeg, between the Rocky Mountains and Lake Superior. It is already the centre of operations for the ranchemen, and the place where ultimately most of the cattle will be shipped. It will be the seat of Government of the province, and already banking accommodation is being provided, a want which has already commenced to be felt. The town dates from August 15, 1883, at which date the tracklayers reached the place, and the station grounds were laid out. A more beautiful place for a town could not be found. It is at the junction of the Elbow and the Bow rivers, and about 65 miles from the base of the Rockies; the waters of the rivers are so clear that the smallest object can be seen in them for 20 ft. from the surface. Nor is this clearness peculiar to the water only. The air is so clear that distances are most deceptive, and a hill supposed to be only two miles distant on the survey proved to be ten miles off. The surveyors employed on this district tell some most marvellous stories of the clearness of the atmosphere and the wonders of sound and sight in this beautiful place, as that a ¾ in. picket could be distinctly seen for six miles, and that words spoken at half a mile and a mile distance can be heard without an effort (see Klotz' Report to Minister of Interior, 1883, page 89). There is seldom a perfect calm on this prairie, the general direction of the wind being from the west, what the ranchemen term the "Japan current." The table land on which the present village stands is surmounted on the north and south by ranges of hills, or "buttes," as they are here termed, which ascend by a succession of terraces, on each of which there are plateaus of considerable width, and from which there is a superb view of the distant peaks and slopes of the Rocky Mountains, as well as the lovely Bow River up and down the valley. There has been some delay in getting this town site, which belongs to the Government, properly surveyed and the land placed in the market. Assurances are given that the rights of settlers shall be respected, in case they file their claims, but this is scarcely sufficient to justify the erection of expensive houses or places of business, though cheap buildings are going up with great rapidity, and a number of people prefer simply a tent or weather boarding to shelter them until they can secure their title to the land. Even the *Calgary Herald*, a very creditable sheet, is printed in a common tent, and some large stores carrying a heavy stock of goods are in the most primitive tabernacles. This is already a good business point, all the trading for an area of several hundred miles is done here, and all the leading ranches, not only on one side of the international line, but even from Montana, draw their supplies from this city of the future.

Calgary is most unexpectedly developing into a mineral district, and at several points round, veins of coal more resembling anthracite than any they yet found in Canada, have their outcrops so prominent that the settlers supply themselves by driving up to the bank and with a pick and shovel loading their wagons without any difficulty. At Devil's Head Creek, 60 miles west of Calgary, is a valuable seam of coal, the composition of which is as under:

Fixed carbon	81
Volatile combustible matter	10.75
Water	.75
Ash and residium	7.50

This mine is close to the Canadian Pacific Railway, and what is more remarkable, is associated with, and in close proximity to, a valuable vein of silver; it is situated on what is called the Cascade stream, and has been pronounced by Professor Selwyn and Dr. Dawson, of the Geological Survey, as the best hard coal that has yet been discovered in the Dominion.

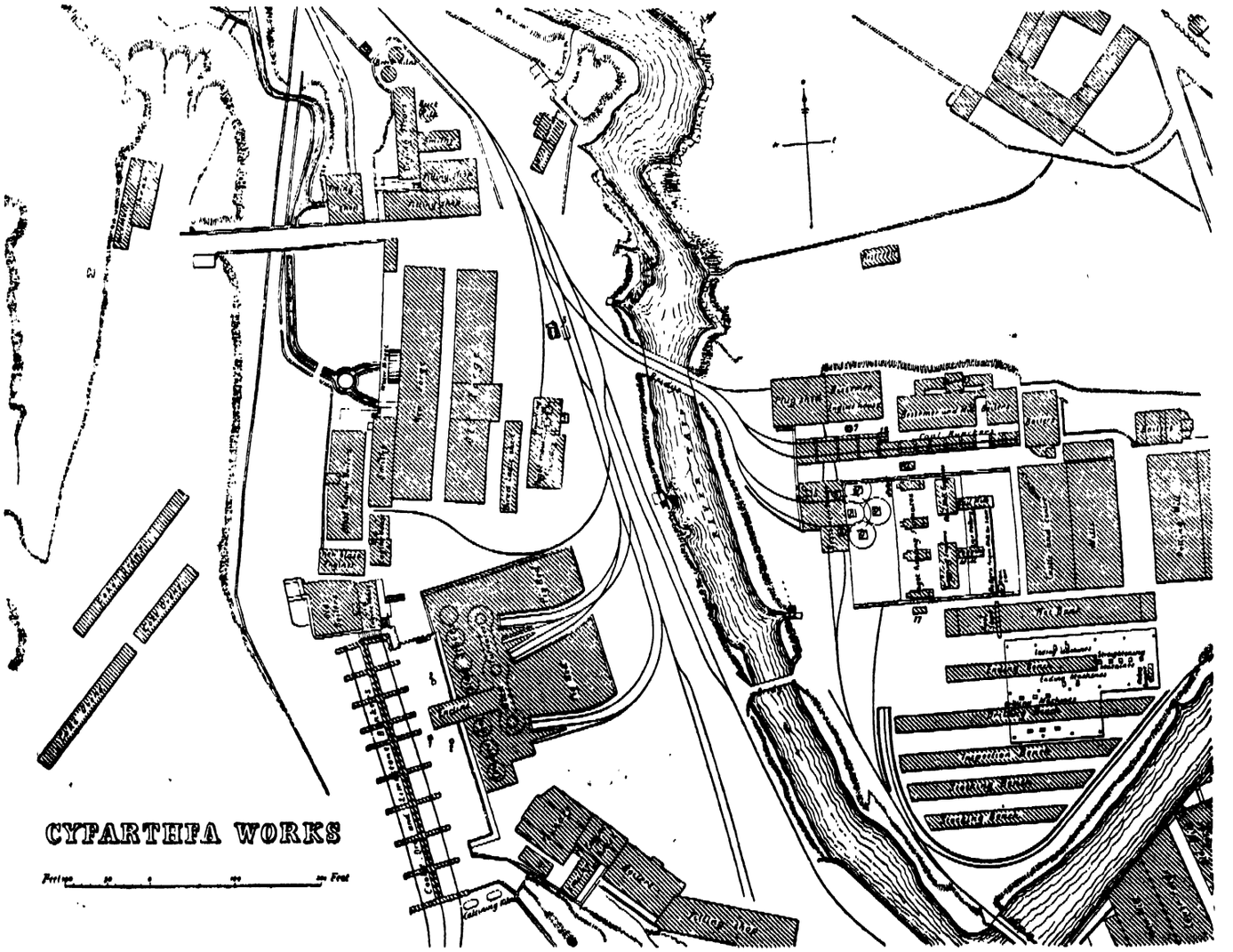
The seventh locomotive division ends at what is temporarily called the Twenty-seventh Siding. None of the stations between Calgary and the summit have yet been built or named, but this point will undoubtedly some day be a thriving and important place from the mineral wealth that is being developed all round it. The Bow River is a beautiful stream throughout, the water cold and clear and running six or seven miles an hour. Looking down the river there is a magnificent plain spread out as level as a billiard table, in places 30 miles in length and three or four miles wide, with the Bow River running through it like a silver ribbon, whilst the green slopes of the foot hills of the grand mountain range, make an excellent background to the scenery, over which the giant Rockies, with their snow-covered heads, look down like huge sentinels over the plains. After the monotony of the prairies the first glimpses of this mountain scenery are very grateful.

Leaving Calgary, up the valley of Bow River, the scenery to Morleyville, a distance of 42 miles, is simply magnificent. At this point we reach the foot of the hills, and in 22 miles further, at Padmore, 904 miles from Winnepeg, we are through the foot hills, pass the falls of the Bow River and the ruins of the now deserted Old Bow Fort. The scenery is beautiful beyond description, and the land is all good and productive. At this point there is a reserve of the Stony Indians, which numbers 400 lodges. These are undoubtedly the best Indians of the north-west. They live in houses and own large herds of cattle and horses, which keep fat all the winter, with the Rocky Mountains for a shelter. These Indians hunt the wild sheep and goats, the mountain deer, and the small fur animals of the parks in the mountains. The wild sheep are very much larger than the domestic variety, and a ram's head will often weigh over 60 lb. The Stonies are splendid riders and they often have races and matches with other Indians of the mountains, especially with the Kootenay Indians further south, Padmore is in the "Gap" of the Bow River Pass. where it is about a mile wide, and runs with a gradual slope 55 miles into the Rockies to Bath Creek. The line of the railway follows this creek four miles to Summit Creek, where a similar stream issuing from a sister lake near to it, runs to the Pacific. This Bow River Pass looks as if it were made for a railway, the work of construction through it being remarkably easy. The scenery is grand all through; at times the pass opens out into beautiful parks, with mountains resembling great castles 5000 ft. high, with almost perpendicular sides. It is generally cold at night, but the Chinook winds from the Pacific, and the hot morning sun, soon melt any snow away that may have fallen. It is no uncommon thing for the sun to be shining brightly in the pass, and the temperature to be warm and comfortable, whilst a heavy snowstorm is raging in the mountains above, and all the elemental disturbances of an Arctic winter going on.

There is great excitement just at present about the mineral discoveries in the neighbourhood of this pass, and evidence seems accumulating that the whole of this Rocky Mountain region is full no only of silver and the more precious metals, but of coal, both bituminous and anthracite, of great extent and easily workable. The rails were laid to this place in November last, to which time it was al

PLAN OF THE CYFARTHFA IRON WORKS.

(*For Description, see Page* 111 *ante.*)



REFERENCES.

1. Weigh table for blast furnace materials. 2. Cowper stove chimneys. 3. Weigh table. 4. Spiegel cupolas. 5. Spiegel lift. 6. Bessemer converters. 7. Hydraulic accumulator. Centre casting crane. 9. Ingot cranes. 10. Charging and drawing apparatus for ingot furnaces. 11. Balance weights for charging and drawing apparatus. 12. Ash lift.

but unknown, certainly no value attached to it. Three months afterwards, a town had sprung up like a mushroom in the mountains, at a place alongside of the railway, and which took the name of Silver City. It can already boast of a population of 600, with several hotels and boarding-houses, and all the appearances of a thriving place. There are 400 miners and prospecters already, and those who know seem to think that this is one of the greatest "strikes" that has yet been made. Shafts are being sunk and blasting going on in various directions, and in some of the shafts the rich gold-bearing quartz may be seen all the way down. One of the leading miners there, who has had experience in California, Colorado, and Mexico, declares this to be the richest in mineral resources of any district that he has yet seen. He valued some of the quartz at 40,000 dols. per ton, and he had already sold the tenth interest in his mine for 25,000 dols.

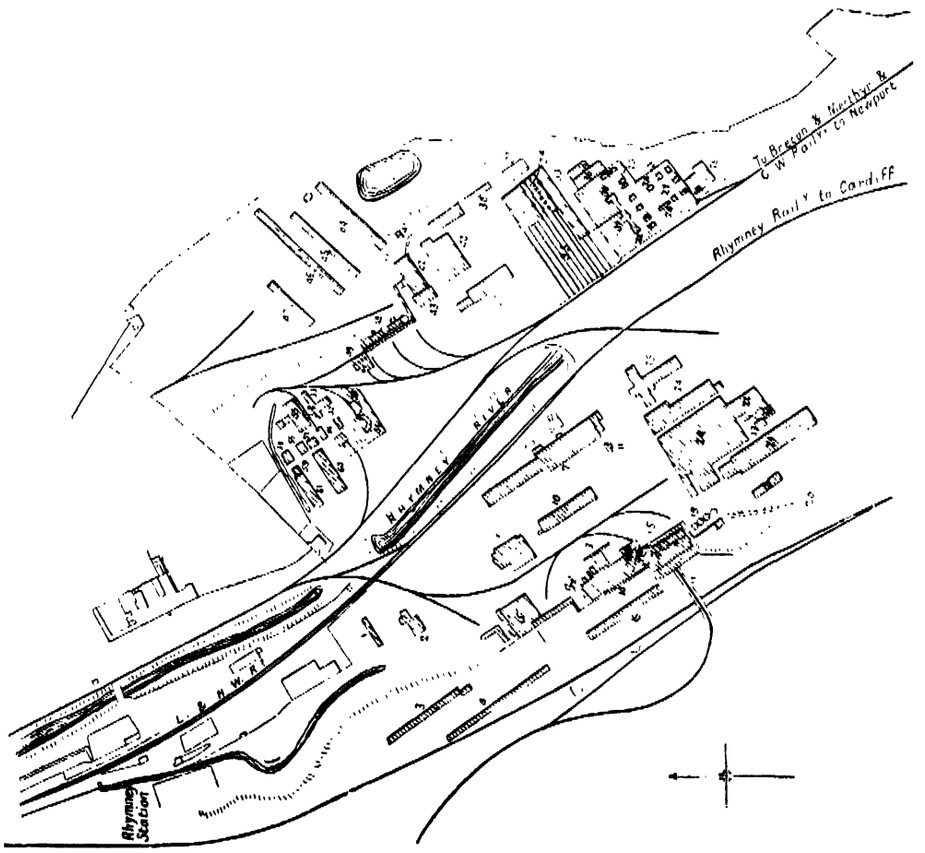
Father De Sinet, a devoted Jesuit missionary to the Indians of Oregon (mentioned by Governor Stevens in an address before the New York Geographical Society as "a man whose name is a tower of strength and faith"), thus speaks of the entire region in the vicinity of the eastern chain of the Rocky Mountains, which he calls "the ocean of prairies," extending from 30 to 60 miles along their base. "I have traversed the district for over 300 miles in length, where the innumerable rivers and streams drain from the Rocky Mountains into the North and South Saskatchewan. The country is capable of supporting an immense population, and the soil is favourable for the production of all the grains grown in more southern countries. Are these vast and extensive fields of hay for ever destined to be consumed by fire or perish in the autumnal snows? And these inexhaustible quarries —these abundant mines of coal, lead, sulphur, iron, copper, and silver—can it be that they are doomed for ever to be inactive? Not so. The day will come when the labouring hand will give them value, and a strong, active, and enterprising people are destined to fill this spacious void." Father De Sinet knew, as he often said, of wonderful veins of the precious metals which had been pointed out to him by his Indian guides, who almost worshipped him, but he deemed this knowledge an inevitable misery for the country, and had seen so much of the frightful results of the rowdy element that seemed inseparable from the pursuit of the precious metals in the Western States of the Union, that he died conscientiously refusing to give any information as to their whereabouts. No doubt this district just opened up and probably stretching north towards the Yellow Head Pass, is the vicinity referred to where the precious metals exist.

When the great work of settling and bringing into cultivation these north-west territories was entrusted by the Imperial Parliament of Great Britain to the Dominion of Canada, one of the most difficult problems to solve was the maintenance of friendly relations with the Indian tribes, and the avoidance of those terrible Indian wars, that have resulted in such a frightful series of misfortunes and deplorable massacres in the United States. The Hudson's Bay Company had been unusually successful in dealing with the Indians, but in their case there had been no actual dispossession of their landed rights, no interference with their nomadic propensities; the broad line of distinction of the piece of land that belongs to me, and upon which you have no right, was never presented to them, and in this point lay the extreme difficulty and delicacy. When the Indian mind is disturbed, it is apt to be more suspicious and jealous than the facts of the case justify. They were not unaware of the results of the settlement of the white men in the United States, of the demoralisation of their tribes by the introduction of the accursed firewater, and of all the misery and disintegration of their nationality that had accompanied the contact of the two races. Then came the victimising of the poor, half-intoxicated Indian, to cajole him out of his peltries, the impoverishment that universally followed their trading with the Americans; then the revenge taken by the Indians, the subsequent shooting down of every redskin as if he were a wolf or a dog, by the superior arms that were carried by the whites, and the ultimate driving off or extermination of the Indian races by the tide of settlement. In the north-west, mindful of what had taken place in the United States, when the mild rule of the Hudson's Bay Company was to be exchanged for the Government of Canada, the Indian mind was perplexed, and naturally feared a repetition of the southern experience. It was therefore a matter of the

should meet this question fairly and squarely in the outset, and they wisely resolved that before taking possession of the country and introducing settlement, and colonisation, they should make treaties with the Indians, provide for their immediate wants, and introduce a system of training that should ultimately afford them a means of support, without the indulgence of those nomadic propensities that were at once an injury and a menace to

PLAN OF THE RHYMNEY IRON WORKS.

(*For Description, see Page* 112 *ante*).



REFERENCES.

1. Carpenters', joiners', and painters' shops.
2. Saw mills.
3. Coke ovens.
4. " "
5. Foundry.
6. Offices.
7. Fitting shops.
8. Electric light engine-house.
9. Steam boilers.
10. Smiths' shop.
11. Mill office.
12. Blowing engines.
13. " "
14. Steam boilers.
15. Nos. 4, 5, and 6 blast furnaces.
16. Copped coke ovens.
17. Limestone bunkers.
18. Ore stock.
19. Whitwell stoves.
20. Steam boilers.
21. Puddling furnace and mills.
22. Steam boilers.
23. Crucible steel foundry.
24. Bute rail and fish-plate mills.
25. Rail shed.
26. Steam boilers.
27. Heating furnaces.
28. Steam hammers.
29. Heating furnaces.
30. Roughing reversing engines.
31. Finishing " "
32. Cogging mill engines.
33. Hot rail bank.
34. Rail presses.
35. Rail bank.
36. Steam boilers.
37. " "
38. " "
39. Boilermaker's shed.
40. Old iron mills.
41. Chimney.
42. Steam boilers.
43. Blowing Engines.
44. Coppée coke ovens
45. Coke ovens.
46. " "
47. " "
48. Nos. 7, 8, and 9, blast furnaces.
49. Bessemer iron cupolas.
50. No. 1 Bessemer pit.
51. No. 2 " "
52. Cupola house.
53. Gannister store.
54. Converter bottom stove.
55. Steam boilers.
56. Blowing engines.
57. Hydraulic "
58. Laboratory.
59. Fitting shop.
60. Gannister and brick store.
61. Colliery shops.

all white settlement. In 1870 the Parliament created the machinery of Government for Manitoba and the north-west territories, and contemporaneously with that, recognised so much of the Indian rights as was necessary to insure the peaceable possession of the country. Since then seven treaties have been concluded, the work of obtaining the goodwill of the Indians has been completed from Lake Superior to the Rocky Mountains, and no tribe now remains that has not been fairly dealt with, and their title legally extinguished throughout the whole of the fertile belt.

Treaty No. 1 was concluded with the Ojibbeways and Chippewas, or Salteaux as they now call themselves, August 3, 1871, for the southern half of Manitoba and Keewaten, these tribes, with the Ottawas, having migrated to this district many years since from the older provinces of Quebec and Ontario; and No. 2 with the Chippewas and Assiniboines for the rest of Manitoba and a large district beyond it. No. 3 was made with the Ojibbeways for the district round the Lake of the Woods, October 3, 1873, covering the whole ground through which the Dawson route and the Pacific Railway were constructed.

No. 4 was the Qu'Appelle treaty, September 15, 1874, covering 75,000 square miles belonging to the Cree and Salteaux tribes. No. 5 was the Lake Winnepeg treaty, which covers 100,000 square miles inhabited by the Chippewas, Swampy Crees, and others, dated September 24, 1875, whilst in 1876 and 1877 Nos. 6 and 7 covered the whole ground from the international line, bounded on the west by the Rocky Mountains, and extending north of Nos. 3 and 4 as far as the Peace River and Arthabasca Lake. The wise policy adopted by the Government with the Indians is now bearing fruit. Most of the bands have gone to their reserves, and it is hoped that next spring will see them all so settled, as the efforts of many of them to become agriculturalists have been crowned with success. They have learned that the mounted police is for the preservation of law and order, quite as much as a protection for them against the encroachments of the whites upon their property, as directed against them if they trespass on their neighbours', and the few incipient disputes that have occurred have invariably been settled with a rigid regard to justice whoever had been the wrongdoer. There is no fear of any outbreak on their part now, endangering the safety or comfort of the community, and they are gradually settling down as quiet, inoffensive tillers of the soil.

The rails were laid to the summit of the Rocky Mountains, 960 miles from Winnepeg, 1389 from Port Arthur, by the 27th of November, 1883, where for the present is the "end of the track." The elevation of this point above the sea level is 5300 ft., which is approached however from the east so gently that no gradient occurs of over 40 ft. to the mile on the whole line from Montreal, excepting in the upper five miles of the Bow River, where the rise is at the rate of 75 ft. per mile. By the route adopted there is a saving of about 100 miles in the total distance as compared with the original line laid down by the Government through the Yellow Head Pass, to the north of this Bow River Pass; nor is the line more difficult to build nor more heavily graded than on the longer line, whilst the natural resources of land and minerals leave very little to desire on the route that has been selected. As far as the local traffic is concerned the almost unexpected development of the coal and cattle traffic insures a large amount that is likely in the future to make this a very busy railway, and the traffic so far has far exceeded the expectations of those most sanguine on the subject. During 1882 the company carried on the central section, open only to Brandon at the beginning, and to Moose Jaw later on in the season, over 96 million feet of timber, 80 per cent. of which was from Rat Portage and Minneapolis, 652 carloads of cattle, 20 head to the car, 722 cars of horses, averaging 17 to the car; 37,361 barrels of flour, 50 per cent. of which was produced in the country, 377 carloads of shingles for roofing houses, and 30,000 cords of wood for fuel. During the season no less than 75,884 cars moved with loads on the track and most of the traffic is for long distances. The local traffic round Winnepeg proved from the beginning very much more extensive than could have been anticipated, taking into account the short time that has elapsed since permanent buildings began to be erected. In the first nine months, there were sent from the Winnepeg yard, 361 loaded cars for the east, 17,516 for the west, and 859 for the south, and there were received 8898 loaded cars from the east, 1059 from the west, and 18,994 from the south. About 40 per cent. may be added to these figures for the whole work of the year, and for 1883 these figures were about doubled, the gross earnings for 1883 having been 5,420,113 dols., or something over 1,003,000*l.* sterling, on a line the greater part of which was opened for business during the year.

THE DOWLAIS IRON WORKS.

These extensive works were founded nearly 140 years ago and are in many respects noteworthy as having been connected with several important epochs in the iron and steel industry of South Wales. Here the first steel rail ever made was rolled, the mill from which it was turned out being in active work at the present time. Dowlais is also historically interesting as having been connected with the earliest history of the locomotive.

The works,* which are scattered over a vast area of ground, are at present on the eve of many and great changes which will have the effect of transforming the whole aspect of the place, so that what might be said of to-day, will probably be incorrect a year or two hence. It is for this reason that we have given no plan of the works, although we publish general illustrations of the other three important establishments thrown open to the members of the Institution of Mechanical Engineers during their visit to Cardiff this week.

Commencing at the southern end of the premises we take the steel works first. There are three Bessemer pits, each of which has two 8-ton converters of the usual type with ordinary rack and pinion tipping arrangement. Those known as Nos. 2 and 3 are in use at present, and are being worked with 10-ton charges. The pits are served by the usual single ram hydraulic central crane and two balanced ingot cranes. The ladle with the metal is brought in from the furnaces at back of the the converters at a level somewhat above that of the pits. From thence it is raised to a higher level by a hydraulic lift. This brings it sufficiently high to enable the metal to be tapped out, and it is then run into the converters by swinging troughs in the usual way. A short line of rails runs at the back of the converters so that the ladle can be traversed from one to another. There are two cupolas at the back of each pit used for spiegel. They are placed sufficiently high for the spiegel to be tapped out at a level which will enable it to flow into the converters through the trough used for the charge from the furnace. The materials used for charging the cupolas are raised by a hydraulic lift. The converter bottoms are made and dried immediately at the back of the pits, the drying stoves

* A description of Dowlais works will also be found on page 122 of vol. xviii.

which have a line of rails running between them, being arranged so that the bottom goes in on a truck at one side and comes out at the other, close to the converter. A small crane is placed on the top of the stove for lifting the bottom on to the truck, and a special crane is provided for placing the bottoms in the converter. There are four cupolas for melting pig when required. Two hydraulic lifts are provided for working these.

For blowing the converters there is a pair of horizontal engines by Messrs. Hicks, Hargreaves, and Co., having 36 in. steam cylinders and 48 in. air cylinders, the stroke being 5 ft. These are the original engines erected in this part of the works for steel making, and in addition to them there is a pair of vertical engines by Messrs. D. Adamson and Co., with 40 in. steam cylinders, 54 in. air cylinders, and a stroke of 5 ft. The hydraulic machinery for both the Bessemer and Siemens plant is situated in the same building. It consists of four pairs of pumping engines, viz., a pair of 10 in. by 12 in., a pair of 12 in. by 24 in., a pair of 16 in. by 24 in., and a pair of 14 in. by 30 in. engines. Near them there is also a blowing engine of the beam type with a 36 in. steam cylinder and a 7 ft. stroke, which is used for blowing converters when they are being warmed. There are also three No. 7 Roots blowers for serving the cupolas. Steam is supplied by 19 single and double flue boilers, which are coal-fired and were made on the premises. There are six Siemens-Martin steel furnaces which will take respectively 6, 7, and 8-ton charges. Two of these furnaces are provided for each pit, the latter being arranged in the same way as with the Bessemer plant.

Between Nos. 2 and 3 pits is a small foundry, where castings are made direct from the furnaces. The ingots are taken hot from the moulds to the cogging mills, by means of iron trolleys which hold about six or eight ingots each, and are drawn by horses. The original cogging mill engine is by Messrs. Kitson and Co., of Leeds. It is geared four to one, and has two cylinders, each 30 in. in diameter by 4 ft. stroke. The steam pressure is 50 lb. The rolls are 36 in. between centres, the top rolls being movable. The blooms are sheared into lengths by a pair of horizontal sliding shears, and then lifted by a hydraulic crane on to bogies, to be taken by trucks to the rolling mill. The second cogging mill is placed at the extremity of the range of buildings comprised in this part of the steel works. The rolls are 36 in. in diameter, and have a movable top roll as before mentioned, and the arrangement generally is as described in the first train. They are driven by a double pair of compound horizontal tandem engines by Messrs. Kitson and Co., of Leeds. These are fitted with piston valves, and have cylinders 24 in. and 43 in. diameter, the stroke being 4 ft. They are geared 3 to 1, and run with a boiler pressure of 80 lb. The live rollers to this train are placed very close together, and are driven by a continuous train of spurwheel gearing. There are attached to this plant four heating furnaces fired by gas, and thirteen in which coal is used; most of these have steam boilers attached. For serving all the furnaces, four blocks of gas-producers, each block having 12 fires, are provided.

From the cogging mills we pass to the rail mills, which have a train with 25 in. centres. It is driven by a pair of horizontal engines by Messrs. Kitson and Co., with cylinders 48 in. in diameter by 4 ft. 6 in. stroke. The engines are coupled direct to the rolls. Here there are ten heating furnaces all coal-fired; the blooms are drawn from them by hydraulic power. From the mill train the rails are carried in the usual way to a swinging circular saw and then to the straightening presses. In this neighbourhood are eight rail-ending machines, driven by separate engines, for the purpose of cutting rails to exact lengths. In an adjoining shed are eight horizontal rail drills driven by a semi-portable engine.

A new rail mill is being laid down in this part of the works, and the engines, which are by Messrs. Kitson and Co., are partly erected. They have 60 in. cylinders and 5 ft. stroke, and will be coupled direct to a 25 in. train. These engines have piston valves, the axes of the valve, and of the main cylinder of each engine respectively lying in two planes inclined towards each other. The eccentrics are mounted on a length of shafting carried by brackets raised to the required height above the engine framing, this shaft being driven from the main shaft by helical spur gearing. The arrangement affords an excellent means of economising space. The reversing in this, as in the other engines, is effected by hydraulic power. In the centre of this mill there stands an old beam engine which ran the plant for many years.

Passing from the steel works to the furnaces, we find that in the principal part of the works there are now six in blast, whilst in the Ivor Iron Works, which belong to the establishment, there are four other furnaces, one having been blown out. These blast furnaces are of various sizes, between 50 ft. and 70 ft. The one known as No. 1 is of the cylindrical type, 65 ft. high, and is hooped with iron bands. The diameter of the bosh is 17 ft. 6 in., the hearth is 7 ft. 6 in. and the throat 12 ft. 6 in. There are attached to this furnace three Cowper stoves, 22 ft. in diameter and 60 ft. high, two serving the furnace whilst the third is being heated. Close to this, a new furnace of a similar style, and of the same diameter, but 10 ft. higher, is being erected. Another furnace, known as No. 9, is of the same dimensions as the first named, and has the blast heated by three Whitwell stoves, two being on blast whilst the third is being heated. Other furnaces of smaller dimensions and fitted with pipe stoves are also in blast. The blowing engines are placed in various buildings situated in this part of the premises. The first is of the ordinary beam type, having a steam cylinder 55 in. in diameter and a stroke of 13 ft., the air cylinder being 144 in. in diameter and 12 ft. stroke. It has a common slide valve with a cut-off valve working on a separate facing on the valve chest. Engines Nos. 2 and 3 are in another house close by. They are also of the beam type and work independently of each other. The steam cylinders are 60 in. in diameter with a stroke of 10 ft., the air cylinders being 132 in. in diameter and the stroke 9 ft. For these three engines a steam pressure of 50 lb. is used. No. 4 is an old low-pressure condensing beam engine with double-beat valves worked by tappet gear. The steam cylinder is 60 in., the air cylinder 96 in., and the stroke 8 ft. No. 5 is a compound non-condensing beam engine with cylinders 42 in. and 60 in. in diameter; the air cylinder is 144 in. The stroke is 10 ft., and the boiler pressure 50lb. No. 6 is a beam engine with a 45 in. steam cylinder and a 104 in. air cylinder, the stroke being 9 ft. These engines were not all at work on the occasion of our visit, but they all deliver into one main, the pressure of blast being about 3½ lb. They are principally driven by boilers fired by the waste gases from the furnaces and coke ovens, only comparatively a small quantity of coal being burnt for raising steam. On the high ground at the back of the furnaces the depôt is situated. The materials are raised the additional height of the more modern furnaces by steam hoists with directly connected overhead cylinders.

There are extensive ranges of coke ovens, of the ordinary South Wales type, situated on the high ground at the back of the furnaces, and in addition to these there are two blocks, each containing 36 Coppée ovens. These are served by two steam "pushers out" of the usual type.

The coal-washing machinery in this part of the works has recently been fitted up by Erence Coppée, of Brussels. It is run by a horizontal engine with a 30 in. cylinder and a stroke of 5 ft. We regret that we were unable to gain further information as to this machinery, and can only hope to give fuller details at a future time. We believe that the special feature about it is that bituminous coal and harder varieties can be treated at one operation.

The iron works to which we have made reference are situated to the north of the premises we have been describing. Here we understand there are four furnaces in blast, and one out. One of these furnaces is 65 ft. high, and is served by Whitwell stoves; the other stoves being of the old cast-iron pipe description. There are two blowing engines, one has a steam cylinder 52 in. in diameter, the air cylinder being 144 in., and the stroke 9 ft. The second is a horizontal engine, and has a steam cylinder 52 in. in diameter, an air cylinder 108 in., and a stroke of 9 ft. The boilers supplying steam are heated partly by the furnace gases. These furnaces are making iron for the rolling mills. Here are two puddling forges and one plate mill, together with guide and merchant bar mills. It should be mentioned, also, that puddling is carried on in the part of the works first described, where there are also two merchant bar mills. We have not attempted to give any details of the various engineering shops which are used for doing the work required on this large establishment. In fact, it seems a work of questionable utility putting on record much that is likely so soon to be altered or added to. At present, Dowlais is an establishment of boundless promises; how these promises have been carried out, we hope to be able to lay before our readers at some future date.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Pig Iron Market.—The pig iron warrant market was strong last Thursday, and a fair amount of business was done at better prices, the close being 1½d. per ton over that of the previous day. There were transactions in the morning at 41s. 5d. to 41s. 6½d. cash, also at 41s. 7d. up to 41s. 8½d. one month, the close being sellers at 41s. 7d. cash and 41s. 9d. one month, and buyers offering ½d. less per ton. Business was reported in the afternoon at 41s. 7d., 41s. 7½d., and down to 41s. 6½d. cash, also at 41s. 8½d., 41s. 9d., and back to 41s. 8½d. one month, with sellers at the close at 41s. 7d. and 41s. 9d. cash and one month respectively, and buyers at ½d. per ton lower. Friday's market was fairly steady, and the close was at the same rate as that of Thursday, being an advance of 3d. per ton over the week. Business was done during the forenoon at 41s. 6½d. and 41s. 7d. cash, also at 41s. 8½d. and 41s. 9d. one month, the close being sellers at 41s. 7d. cash and 41s. 9d. one month, and buyers offering ½d. under. In the afternoon transactions were reported at the same rates, there being no change. Monday was a *dies non* with the members of the "iron ring," owing to the occurrence of the Bank Holiday. On the resumption of business on Tuesday the market was flat, and on forenoon 'Change transactions were done at 41s. 6½d. down to 41s. 5½d. cash, also at 41s. 8½d. down to 41s. 7½d. one month, the market closing with sellers at 41s. 5½d. cash and 41s. 7½d. one month, and buyers at ½d. per ton under. Slightly lower prices were accepted at the forenoon market to-day, but they improved in the afternoon, the closing quotations being again 41s. 5d. cash and 41s. 7d. one month, with buyers near. The firmness which took place towards the end of last week seems to have been due chiefly, if not entirely, to the fact of some of the dealers covering a portion of their oversales, and owing to sellers being rather shy. Notwithstanding the very low prices now ruling, the outside public are still most unwilling to invest in warrants, as they do not consider them to be a good investment, in view of the fact that trade shows not the slightest sign of any improvement. Some of the shipments recently made to New York market, seem to have resulted in a loss to the importers. From Canada a few orders have lately been received, and from Germany the demand is very quiet. There are now 95 blast furnaces in actual operation, an additional one having been blown in at Clyde Iron Works. At this time twelvemonth, there were 115 furnaces blowing. The make of pig iron last month was about 17,000 tons less than that of July, 1883, the shipments were about 15,000 tons less on the month. Last week's shipments amounted to 9544 tons, as compared with 10,315 tons in the preceding week, and 13,722 tons in the corresponding week of last year. The United States took 1420 tons; Canada, 638 tons; India, 185 tons; Australia, &c., 550 tons; France, 265 tons; Germany, 1360 tons; Holland, 770 tons; Belgium, 100 tons; and other countries, lesser quantities, Russia again taking none. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood at 587,806 tons yesterday afternoon, as against 587,581 tons yesterday week, showing for the week a decrease of 275 tons.

Agricultural Implement Trials.—In connexion with the late show of the Highland and Agricultural Society of Scotland there was a competition of broadcast manure distributors on a farm near Edinburgh. Three machines were entered for competition, but only two of them were qualified—one by Messrs. Ben. Reid and Co., Aberdeen, and one by Messrs. Sheriff and Co., Dunbar. Neither of them seemed to come up to the standard of excellence fixed by the judges, who gave, however, very high commendation to Messrs. Reid and Co., whose machine had a more effective range of distribution than the other.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was again a small attendance on 'Change and the amount of business done was very limited. As was anticipated the Cleveland makers stocks showed a considerable increase and the tone of the market was depressed. No. 3 was quoted 36s. 6d. to 37s. per ton according to the position of the seller, and No. 4 forge was offered at 34s. 6d. to 35s. In the manufactured iron trade there is no alteration, and prices are nominally the same as those quoted last week. Where orders can be obtained they are readily booked at figures below those in lists. A large number of men in the northern towns continue out of employment owing to the slackness at the shipyards, and consequently at the mills and forges. The prospects of trade are so bad that no person is bold enough to predict a time when there is likely to be a permanent improvement. There is a general impression that months must elapse before new steamers are required or any fresh railways made.

The Steel Trade.—Messrs. Bolckow, Vaughan, and Co.'s great steel works at Eston, Middlesbrough, are still idle in consequence of the scarcity of orders. The steel-makers of the United Kingdom having entered into a combination to keep up prices they are sharing the contracts. Where the works are inoperative the men are condemning the action of the masters and are urging that

free and unfettered trading is the best thing for the public good. The men contend that the firms who can make the best and cheapest steel should secure orders so long as there are any in the market, and firms who are less favourably situated than others, and cannot compete except at a loss, should close their works.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

British Wagon Company, Limited.—The Directors have issued their 31st half-yearly report of the past half-year. The company's stock of wagons now stands at 8666. The balance standing to the credit of profit and loss account amounts to 2385*l.* 2s. 3d., out of this the directors proposed to pay a dividend of 6 per cent. per annum on the paid-up capital of the company, free of income tax, to place 500*l.* to the reserve fund, and to carry forward to the next half-year the balance of 105*l.* 4s. 2d.

The Scarborough and Whitby Railway.—An extraordinary general meeting of the shareholders of the Scarborough and Whitby Railway has been held at Scarborough to sanction the raising of additional capital. The Chairman (Mr. A. Marshall) presided, and after explaining that the Bill promoted in 1884 for an extension of Works had passed into law, moved a resolution sanctioning on the part of the shareholders the creation and issue of the whole, or any part of the new preference shares, authorised by the Scarborough and Whitby Railway Act, 1884, and the exercise of the borrowing powers by that Act conferred upon the company by the creation and issue of debenture stock or mortgages, as might be determined. The resolution proposed the raising of 160,000*l.* by the creation of preference stock, and the further exercise of their borrowing powers to the extent of 53,000*l.* Mr. John Fenwick seconded the motion, which was carried unanimously. The engineers (Messrs. C. Fox and Sons) reported on July 22 to the directors that the works of the railway had made most satisfactory progress since their last report. The contractors (Messrs. John Waddell and Sons) think that the railway will be ready for public traffic by the end of this year.

Hull Marine Engineers and the Shipowners.—A meeting of the steam shipowners interested in the Humber ports has been held, under the presidency of Mr. C. H. Wilson, M.P., when the final answer of the marine engineers was given to the proposal that they should consent to a reduction in their wages to the extent of 10 per cent. The men, we are informed, declined to discuss the question or to meet the owners, and it was determined to renew the proposal, and, in the event of the engineers remaining firm, to lay up the great bulk of the steamers, which, it is urged, are being run at a loss, owing to the great depression of trade.

NOTES FROM THE SOUTH-WEST.

London and South-Western Railway.—The new Surbiton and Guildford line will be completed at the end of this year, and its Leatherhead branch will be finished early in the spring. The Bournemouth direct railway, and the doubling works between Christchurch and Bournemouth, as well as the new junction lines there, are under construction. The Hurstbourne and Fullerton line, and the widening of the Andover and Redbridge railway, are well advanced, as well also as a new curve at Weybridge. Additional lines between Clapham Junction and Barnes are progressing, and the Fareham and Netley extension will be proceeded with in due course. The Staines curve and the Lymington extension and pier have been opened for traffic.

The Barry Dock Scheme.—On Thursday, the select committee of the House of Lords appointed to consider the Barry Dock and Railway's Bill decided that the Bill should proceed, except in two respects, viz., that the railway should cease at Hafod, and that there should be no running powers. Mr. Pember inquired if the promoters were to have the two junctions for which they applied, viz., one at Hafod and one at Treforest, and an affirmative reply was given.

Harbours of Refuge.—The report of the Select Committe on Harbours of Refuge was issued on Tuesday. After dealing generally with the question of the necessity of harbours of refuge, the report proceeds:—"In regard to the position of the coasts between Land's End and the Welsh coast, including the whole of the Bristol Channel, the Committee decline to determine between the relative advantages of St. Ives, Lundy Island, the Mumbles, and Swansea, but they found out that the general tenour of the evidence is of a character to show that at one of these places a harbour should be constructed without further delay."

The Forest of Dean.—There has been no change worth noting in the coal trade, the demand maintained having been of a sluggish character. At the same time, as far as data can be obtained, there is reason to believe that the output for the first six months has not fallen below the average of last year. The half-yearly returns of the Great Western Railway show that 93,000 tons of Forest coal were carried over that line during the half-year ending June 30, as against 78,000 tons during the corresponding half of last year. The furnaces at Cinderford iron works are as yet kept going; the stocks of pig iron are increasing largely. The tin-plate works of the district are in fair activity, and the Lydbrook Works, which have been closed for some time, have resumed operations.

Coal Winning at Llantwit Vardre.—A London company, which has for the last two years been driving a level for coal on Dryscol Farm, has just struck a splendid seam. Before reaching it 200 yards of solid rock was pierced.

Newport.—The steam coal trade has not undergone any material change. The tips at the Alexandra Dock have been well occupied. In the house coal market there has been no new feature. In the manufactured iron and kindred trades the works are, in some instances, fairly occupied. New orders are, however, stated to be slow in coming forward. The quantity of iron cleared last week was 5329 tons, viz., to New York, 1600 tons; to Sundswall, 690 tons; to Helmstadt, 895 tons; to Quebec, 1124 tons; and to Kurrachee, 1020 tons. Last week's coal clearances were 60,809 tons. From Bilbao there arrived 4558 tons of iron ore, and 1750 tons came to hand from other sources.

Falmouth Docks.—Falmouth graving dock, No. 2, was opened on Friday, the screw steamer Boskerma Bay being the first to enter, to repair damages after collision with the steamer Earl of Dumfries. This dock is now the longest in the English Channel, being 510 ft. long, with 22 ft. of water. It has been constructed at a cost of over 30,000*l.*, partly advanced by the Public Works Loan Commissioners.

FOREIGN AND COLONIAL NOTES.

A New South Australian Railway. The Mount Barker and Strathalbyn Railway, which is now approaching completion, commences at the Mount Barker Junction Station on the Adelaide and Nairne line, 31 miles from Adelaide, and runs in a southerly direction to Strathalbyn. It is 19½ miles in length, and connects the Victor Harbour tramway system with the Intercolonial and the other railways of South Australia. The country traversed necessitated numerous cuttings and embankments, steep gradients, and sharp curves. The largest cutting occurs at 13¾ miles from Mount Barker Junction. It is 30 ft. deep, and contains 25,500 cubic yards of excavation. The largest embankment is at 15¼ miles, is 27 ft. high, and contains 39,000 cubic yards. There are two bridges, one at 3¼ miles, over the Mount Barker Creek, and the other at 19½ miles, over the Angas. The former has one span of 40 ft., and the latter two spans of 48 ft. each. Iron-plate girders and masonry abutments, with ashlar copings, are used in both instances. The pier supporting the girders of the Angas bridge is formed of two cast-iron columns 2 ft. 3 in. in diameter, resting upon cement concrete foundations. Ample provision has been made for carrying off flood water by constructing several large culverts and numerous smaller ones. The largest flood openings occur at 18 miles, where there are seven of 11 ft. span each. Nearly 11 miles of the line are constructed on a ruling gradient of 1 in 45. The sharpest curves are 12 chains radius, and in the aggregate are three miles in length. The rails throughout are of steel, weigh 61 lb. per yard, and are laid to the 5 ft. 3 in. gauge.

Victorian Railways.—Damages to the amount of 7500*l.* have been awarded to contractors against the Victorian Railway Department for the non-supply of permanent way material.

Dock Accommodation at Port Adelaide.—A graving dock, proposed to be constructed at Port Adelaide, will be on the westerly side of the Dunnikier slip, within an area of about 6½ acres. The site is close to that recommended for the Government graving dock. The dock will be 550 ft. long, with a depth on the sill at low water of 22½ ft., and while in progress it will not interfere with the working of the present slip. It is contemplated to make the dock in two sections. One will be about 400 ft. long, which will be first made, and when finished the other portion—150 ft. long—can be made while the larger section is in use. The advantage of having the dock in two sections is that it will avoid the expense of pumping out the whole of the water for a moderate-sized vessel, which can be accommodated in the large section alone. The dock will be dug out dry if possible, in the way in which the Port Dock was excavated. It will be of composite construction, partly stone, iron, and wood. The work will be commenced almost at once, the plans being now in hand. The Dunnikier slip is still in working order, and has turned out a vessel of over 1300 tons register, but it is not equal to the large class of vessels which are now frequenting Port Adelaide.

An Electric Head Light.—An electric head light has been fitted experimentally to one of the engines of the Chicago, Milwaukee, and St. Paul Railroad. This application of the electric light is the invention of Mr. Wooley, of Indianapolis. Some days since his agent sought permission of the superintendent of the Chicago division of the Chicago, Milwaukee, and St. Paul Railroad to place one of his lights, with its engine, on one of the company's locomotives. The apparatus, which consists of a small 1½ horse-power rotary engine, and a box about 2 ft. square by 8 in. in thickness, containing the dynamo, &c., was placed upon the engine, directly in front of the cab on the left-hand side. The focus had been so adjusted as to cast the light a little to the right of the centre of the track. The light was exceedingly brilliant, and its power was estimated to equal 2000 candles.

New South Wales Coal.—The ship Port Jackson has arrived at Liverpool from Sydney, New South Wales, with a cargo of 3100 tons of Australian cannel for the Liverpool Gas Company. Although the fact has not hitherto been made public, it is understood that the company has previously received cargoes of this cannel, which is credited with great gas-producing qualities.

Metallurgy in Queensland.—A new process for the conversion of pig iron into steel, of which a Mr. Burgess claims to be the inventor, is being tested in Queensland. If the operation prove satisfactory, a company with a capital of 100,000*l.* will be floated, and extensive works will be established at Ipswich, where, it is stated, there is an abundance of iron ore.

Blast Furnaces in the United States.—The number of furnaces in blast in the United States at the commencement of July, was 279. The corresponding number of furnaces in blast at the commencement of July, 1883, was 343; at the commencement of July, 1882, 434; at the commencement of July, 1881, 437; at the commencement of July, 1880, 413; at the commencement of July, 1879, 277; and at the commencement of July, 1878, 248.

Wood Paving at Sydney.—A Bill is pending in the Parliament of New South Wales which proposes to authorise the Town Council of Sydney to expend 200,000*l.* in laying down wood pavement in that city.

The Population of Mexico.—A census of Mexico gives the population at 9,686,777. No state has a million, two states have less than 100,000, and several states have less than 200,000 inhabitants. But Señor Romero thinks that the population is really not far from 12,000,000. Eighty-two per cent. of the population lies south of the parallel of Tampico.

A Marsh under the Ocean.—Every south-east and southerly storm throws upon the south side beach of Long Island large masses of peat, lignitic branches, trunks of trees, fossilised leaves, and animal remains. The coast, it is said, after a heavy wind and surf, is strewn with these apparently unaccountable objects from Atlantieville to Water Island. The geologists state that the appearance of débris seems to be the result of the wave action of the surf upon the remains of a vast swamp, at present submerged beneath the Atlantic. After due calculations they have decided that this submarine swamp extends fifty miles longitudinally and half a mile latitudinally. Professor Newberry, of Columbia College, gives the following explanation of the existence of this marsh: "The coast is settling, and what had been swamped places on the land have been submerged by the waves. We find along the coast of New Jersey, Staten Island, and Long Island, evidences of subsidence going on at the present time, and that which was forest land and marsh land is now out at sea. In some places the peat beds which were marshes on the land have been submerged, and we find shell fish bored into the peat. I have plenty of specimens to show that the level of the land has changed, and we have also fresh evidence of that circumstance in the fact that stumps of trees of a large size are found along the coast at some distance in the water where they are only, perhaps, visible at low tide. They must have grown on comparatively dry ground."

The Duration of Rails.—The Great Central Belgian Railway Company has taken account since 1865 of the number of iron rails, and since 1869 of the number of steel rails, withdrawn from its lines, as well as their ages. With reference to iron rails, the figures given in the report show that the renewals are made gradually each year, starting from the first or the second year, and are nearly complete at the end of fifteen or twenty years. On the other hand, all the steel rails laid down since 1869 have shown, up to the close of 1881, only an insignificant proportion of renewal, and it was the same in 1882, except for the rails laid in 1869. These latter were 520 in number. One only had to be withdrawn before the 1st of January, 1882, on account of accidental fracture, 257; that is to say, 48.3 per cent., had to be replaced in 1882, because the wear had reached nearly ¼ in., a limit which the profile of the rails would not permit to be exceeded. These facts confirm the opinion which is entertained concerning steel rails; they wear away regularly, while iron rails perish by scaling off beneath the wheels before being worn out, and after a very variable number of years. It was not supposed, however, that the wear of the steel rails could be so uniform that one half of the rails laid at the same time would have to be replaced exactly the same year, to be followed probably very soon by the other half; but such is likely to be the case. Another result equally satisfactory is the length of time which these rails lasted, having regard to the circumstances. These rails, it is true, only lasted thirteen years, but under altogether exceptional conditions of wear and tear.

ELEVATED RAILROADS AT NEW YORK.—A statement has been issued showing that since September 30, 1878, the elevated railroads of New York have carried 444,098,105 passengers, yielding a revenue of 31,073,878.46 dols. For the eight months ending May 31, the record is 66,335,167 passengers and 4,624,592.06 dols.

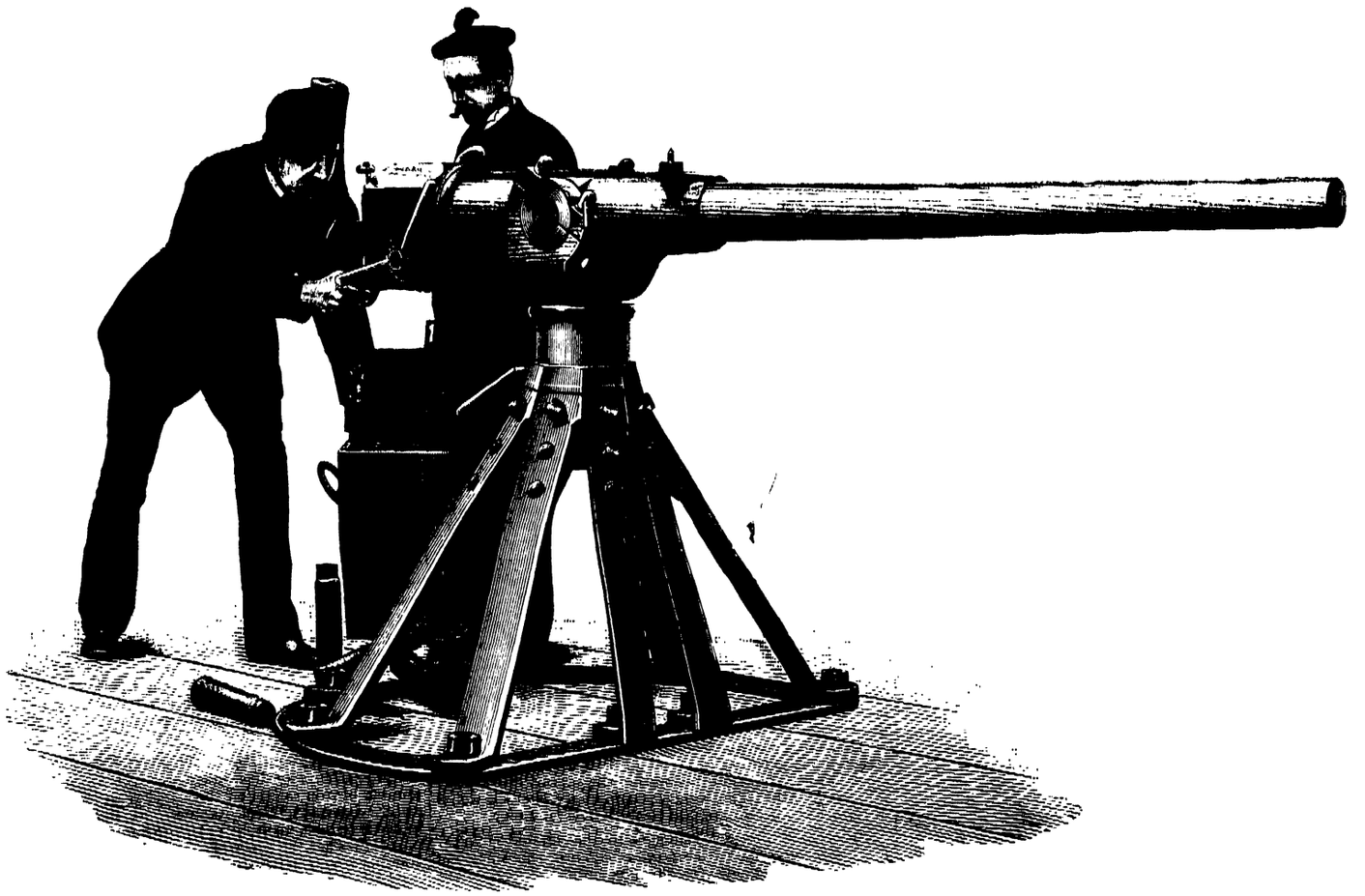
THE RIVERS POLLUTION ACT AT REDDISH.—The Reddish Local Board having obtained from the Local Government Board an order suspending the Rivers Pollution Act, 1876, have directed Mr. R. Vawser, C.E., Manchester, to prepare a plan for the drainage of the district, and the treatment of the sewage.

THE COLONIAL EXHIBITION.—The Victorian Mining Department has decided to send to the Colonial Exhibition, which is to be held in London in 1886, a scientific and economic mineral collection representing the geological features of Victoria. A collection which was sent to Amsterdam will be used as a nucleus.

THE LATE CHARLES MANBY.—We regret that pressure on our space compels us to postpone until next week our obituary notice of the late Charles Manby. We may mention that the interment took place at the Eastbourne Cemetery on Tuesday last, and that by the express desire of the widow and her son, the funeral was unattended by any of Charles Manby's old friends and colleagues.

SIX-POUNDER RAPID-FIRING GUN FOR THE BRITISH NAVY.

CONSTRUCTED AT THE HOTCHKISS ORDNANCE WORKS, PARIS.



The important order for single-barrel machine guns recently given by the British Government to Mr. Hotchkiss, is the result of the competitive trials carried out last year by the Ordnance Committee at Shoeburyness. The first Hotchkiss single-barrel machine gun was made in 1876, and this, which is now in the museum of the Hotchkiss Ordnance Works, is on the bolt principle, with an automatic feeding arrangement, exactly like the Hotchkiss revolving cannon of 1½ in. calibre, and fires the same ammunition.

After this gun was completed, a Russian inventor, Baranowsky, was killed by one of his guns, a few of which were in the Russian service during the last Russo-Turkish war. The Baranowsky gun was also on the bolt system, and the manner in which the accident took place, convinced Mr. Hotchkiss that nothing but a wedge action would give absolute security against similar mishaps in single-barrel machine guns. He therefore abandoned the idea of the bolt, and in 1879 commenced work on a wedge-action gun. In 1880 four such guns of 1.64 in. calibre were made and sold as yacht guns. Here the wedge was arranged to move horizontally, the movement of a side lever opened the wedge for loading, cocked the hammer and extracted the empty cartridge case; the loading was performed by hand. This, as well as the first-described gun, were mounted to be fired without recoil, and laid by means of a stock.

To work rapidly three men were required for the gun, viz., one to open and close the breech, one to load, and a third to sight and fire. Experience soon taught that the three men did not generally work in harmony, and the rapidity of fire was therefore not so great as required; thereupon Hotchkiss set about to alter the breech action, so that it might be worked easily by two men. The first gun of the present type, with a vertically sliding wedge, was made and tried in 1881; its calibre was 1.85 in. but later it was bored up to 2 in. and chambered to take the ammunition of the 2 in. revolving cannon. This gun is still in the hands of the Ordnance Committee at Shoeburyness.

In 1881, it was decided by the War Department to invite inventors to supply a new gun for the light armament of our Navy, and the following memorandum of conditions to guide manufacturers was issued by the War Office, dated December 29, 1881.

Quick Firing Rifled Breechloading Gun for Auxiliary

1. The gun to be a breechloader which will range with accuracy to 4000 yards.

2. The muzzle velocity of the projectile to be not less than 1800 f.s.

3. The projectile to be shell and steel shot of 6 lb. weight.

4. The projectiles and powder charges to be made up in one cartridge for simultaneous loading.

5. The service of the gun to be capable of being performed by three men.

6. The gun to be able to fire under the above conditions not less than twelve aimed rounds per minute.

7. The mounting to be suitable for either ship or boat service. An alternative mounting to be provided to enable the gun to be readily mounted for field service.

8. To be capable of readily delivering an all-round fire.

9. The recoil to be reduced to the lowest limits, and the gun to return after recoil to the firing position.

10. The gun to be provided with an easy removable shield, proof against the fire of the Martini-Henry rifle at 100 yards range.

11. The total weight of the gun and ship mounting not to exceed 10 cwt.

In the spring of 1883, three different guns constructed to fulfil, as nearly as possible, the above conditions, were delivered for trial by the following firms. Sir William Armstrong, Mitchell, and Co., Hotchkiss and Co., and Thorstein Nordenfelt.

The Armstrong gun was withdrawn from trial after the preliminary experiments, as it did not give the expected results, the Ordnance Committee recommending the Hotchkiss gun, after a series of very successful experiments at Shoeburyness. There being, however, some diversity of opinion in the Navy on the system of training the guns, the Admiralty decided to order, besides the Hotchkiss gun a certain number of Mr. Nordenfelt, who was to adopt the Hotchkiss non-recoil system of mounting, and to embody similar ballistical features in his gun, so that the ammunition could be fired from either system with exactly similar ballistical results. The exact shape of the pedestal for the guns is not yet decided, it will vary somewhat according to the construction of the ships and the places for the guns. The first 77 Hotchkiss guns ordered, are, according to the term of the contract, to be delivered by Hotchkiss and Co. by the beginning of April next.

The Hotchkiss guns are called "non-recoil" because they are generally mounted on fixed elastic pivots and have no perceptible recoil, although the guns in reality have a definite amount of movement at the departure of the projectile, sufficient to relieve the mountings of undue shock.

In all cases, except for the larger calibres for boat service and for the field, these guns are laid by means of a stock, or shoulder-piece, bearing against the left shoulder (as in the Hotchkiss revolving cannon) and a pistol-grip with trigger, which the gunner grasps with his right hand. He fires the moment his sights bear upon the object aimed at, by pulling the trigger, so that it will be seen that this gun has the general characteristics of the Hotchkiss mounting, viz.:

1. The gun is mounted on a pivot and trained direct by the shoulder without the aid of any elevating or directing mechanism; thus enabling it to be pointed easily and rapidly from moving and rolling vessels against swiftly moving objects.

2. The sighting and firing are effected by a single man, which is shown in perspective above, and in detail on the opposite page.

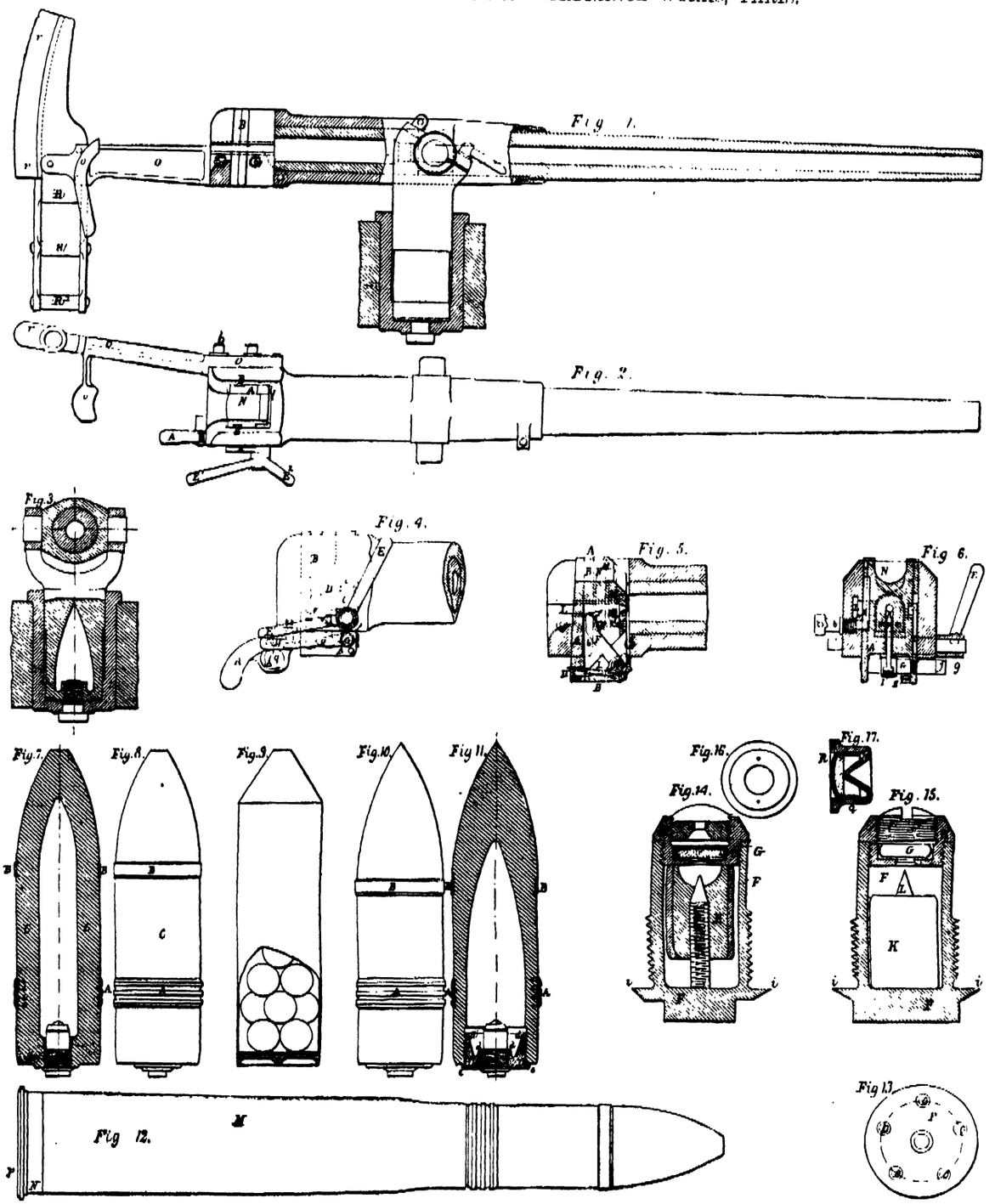
The gun is made of Whitworth's fluid-pressed steel, oil tempered. The body consists of a tube, and a jacket carrying the breech and the trunnions, so that the longitudinal and transverse strains are divided. The jacket is shrunk over the tube, and to prevent any slipping, they are locked together by a screwed collar, carrying the fore sight. The gun is exactly balanced in the trunnions.

Breech Action.—The breech action belongs to the class of guns with a breech-block sliding vertically through a mortice, and actuated by a lever, the movement of which opens the breech, extracts the fired cartridge case, and cocks the hammer for the next shot. The action is composed of the following parts, viz.: the wedge, with its stop-screw for limiting the run; crank and crank-handle, for moving the wedge up and down; firing-hammer and its rocking shaft; main-spring, trigger sear, trigger spring, and trigger, and the extractor.

Wedge.—The wedge A (Figs. 2 and 5) is square, with rounded corners; its face is normal to the bore, whilst its back surface is inclined. This wedge runs in guides B B (Fig. 1) on each side, and its run is limited by the stop-screw *b*, which serves at the same time to fix the stock. The wedge is moved up and down by means of the crank C, the pin *c* of which runs in a peculiarly shaped groove D (Fig. 4) in the wedge. This crank C is journalled in the right-hand cheek of the breech, and it carries on its stem the crank-handle E E¹, which serves to open the breech by pulling the top handle E, and to close the same by pulling

SIX-POUNDER RAPID-FIRING GUN FOR THE BRITISH NAVY.

CONSTRUCTED AT THE HOTCHKISS ORDNANCE WORKS, PARIS.



the bottom handle E^1. This arrangement makes the opening and closing of the breech very easy and rapid.

Firing Mechanism.—The firing mechanism is placed in the hollow of the wedge and consists of a hammer F (Fig. 5), the point of which penetrates the face of the wedge and strikes the cap in the base of the cartridge on pulling the trigger. This hammer F is mounted on a rocking shaft G, which is provided with an arm *g* on the outside of the wedge.

The crank-handle E E^1 carries a cocking cam *e*, which acts on the arm *g* of the rocking-shaft, and in this manner, by swinging the crank-handle downwards, the hammer is drawn backwards, or cocked, before the wedge descends to open the breech. There is a cock-notch on the hammer, and a trigger sear H (Fig. 5) catches on this cock-notch and holds the hammer back until released by pulling the trigger, which in turn actuates the trigger sear H.

The V shaped main-spring I acts direct upon the hammer, and by an ingenious arrangement both branches of it are made to work, the upper branch bearing against the heel of the hammer, whilst the lower one pulls on the opposite side, thus causing a nearly frictionless rotation of the hammer F and its axis, in the bearing.

Cartridge Extractor.—The extractor L is a prismatical piece of steel; it works in a recess on the interior left cheek of the breech and parallel to the bore of the gun; its further end forms the hook which acts on the head of the cartridge. On the same side as the hook, the extractor bears a stud *l*, which runs in a groove M on the left side of the wedge. On opening the breech the stud *l* of the extractor runs in the straight portion of the groove, which moves it backwards slowly, but as soon as the wedge is so far withdrawn that the opening N coincides with the chamber, the inclined portion of the groove acts upon the stud and causes the extractor to be moved back quickly, thus throwing the cartridge clean out of the gun

.....—The stock consists of the gun-metal part O, which is attached to the left side of the breech of the gun by the screw P and the stop-screw *b*. The stock can be removed by turning the screws P and *b* a quarter of a turn. The vertical portion of the stock, which bears against the shoulder is, of wood, and to prevent the shock of discharge being felt by the gunner, there is a stout india-rubber tube *r* attached to the back of the top branch. This forms a very elastic and effective buffer. The lower branch has three handles R, R^1, and R^2. The gunner grasps the handle convenient to him with the left hand whilst he bears his shoulder on the top branch and has the pistol-grip in his right, and so directs the gun.

To prevent the fired cartridge cases falling on the feet of the gunners when extracted, there is a deflector *o* attached to the gun-metal part of the stock behind the axis of the gun, against which the fired cases strike when ejected from the breech, and they drop down to the ground out of the way of the gunners.

Pistol-Grip.—The pistol-grip A is of gun-metal and is screwed on to the under side of the breech; it carries the trigger *q*, which in turn acts upon the trigger sear H in the wedge, when this is closed and the gun ready for fire.

The front sight is a plain roughened steel point, screwed into the locking collar on the gun. The rear sight is a tangent bar sight of gun-metal, with a sliding leaf, worked by a set screw for correct-

ing the deflection. It is moved up and down by a rack cut in the bar, and a pinion wheel, provided with a T handle. To set the sight permanently, if necessary, there is a clamp screw with milled head. The sight is graduated in yards.

The mechanism acts in the following manner, supposing the gun just to have been fired :

First Movement.—The breech is opened by pulling the handle E. The crank-pin *c* moves backward in the groove D, part of which is concentric to the axis of the crank, and does not yet move the wedge; during this time the cocking cam *e* acts on the arm *g* of the rocking shaft, and cocks the firing hammer F. As soon as the crank-pin *c* runs in the portion of the groove D, which is inclined against the axis of the crank, the wedge is caused to move downwards, and the extractor stud *l*' being engaged in the straight part of the extracting groove M, a slight but powerful backward motion of the extractor takes place, until the wedge is drawn down so far that the opening N nearly coincides with the chamber; then the sharply inclined portion of the extracting groove acts on the stud and causes the extractor to jerk backwards and throw the fired cartridge case out of the gun. By this time the wedge is stopped by the stop-screw *b*.

Now the gun is ready to be loaded.

Second Movement.—A cartridge is run into the chamber so far until it is stopped by the rim catching against the extractor hook; now the lower crank-handle E' is pulled, the wedge begins to move upwards, and the inclined part of the opening N on the face of the wedge, acting on the cartridge, forces it further into the chamber; by the time the wedge is entirely closed its face bears tight up against the head of the cartridge, and the crank C has passed the vertical position and rests against the body of the gun, so that the wedge is blocked by the action of its weight, and the reaction of the crank-handle E on the discharge of the gun. When the breech is closed the cocking cam *e* on the crank-handle is in position to allow the arm *g*, and with it the firing-hammer, to act, and the gun is ready for fire.

Third Movement.—On pulling the trigger the top branch of it acts upon the trigger sear H, presses this down, and so releases the hammer, which flies forward under the action of the main-spring, strikes the primer in the cartridge, and discharges the gun.

The gun is worked by two men, one to load and one to operate the breech and fire. The rapidity of fire, with careful aiming, was found to be, at Shoeburyness, about thirteen rounds per minute.

Ammunition.—The ammunition consists of a centre-fire metallic cartridge of special construction, holding in each one the powder, the projectile, and the primer, arranged in a similar manner to the metallic ammunition generally used for small arms (Fig. 12).

Three different types of projectiles are used with the Hotchkiss guns, viz.:

a. Common shell.
b. Steel shell.
c. Canister shot.

Cartridge Case.—The metallic cartridge case consists of a drawn brass tube M, slightly conical. It is reinforced at the base by an inside and outside cup of the same metal. The head P, of iron, is dipped whilst hot in boiling linseed oil to prevent rust, and fastened to the body with brass rivets *o o*, which pass through it, and through the base and reinforcing cups, thus holding the whole solidly together. The advantage of this construction having three thicknesses of metal at the base is: that if one or the other part of the base should have unseen defects there can be no danger of leakage, as the others have sufficient strength to resist the pressure.

The primer consists of a small brass case (Fig. 17), shaped to form the anvil; it is closed at the bottom end by a cap R holding the fulminate. The primer is forced into a hole which penetrates the head and the base of the cartridge, and it projects through into the inside. The reinforcing cups are pushed up around the primer cavity, so as to form a gas-check around the primer, and so hold it tight and prevent leakage.

Common Shell.—The shell differs from these projectiles commonly used, in the fact of the fuze being placed in the base instead of in the point. This arrangement gives greater strength to the point of the shell, and obviates missfires of the bursting charge, caused by the fuzes placed in the point getting damaged and broken when the projectile strikes. The shell is of cast iron, cylindro-ogival in shape, about 4 calibres in length, and it receives its rotation by the lands of the poly-groove rifling cutting their way into the soft guiding band A, which is placed at about one calibre's distance from the base of the projectile. At the front end there is a narrow centring band B, which does not take the rifling.

The guiding bands are of soft brass, contracted over the body C of the projectile. Under the rear band there are a number of grooves *c c* (Fig. 7) turned into the body, and the band is moulded into these grooves, thus leaving a small cannelured surface to take the rifling, and reducing to a minimum the strain and friction caused by the projectile passing through the bore.

The projectiles are turned smooth all over and are made with the greatest care and exactness.

Steel Shell.—This projectile is necessary so as to obtain the full perforative power of the gun, as hardened steel projectiles alone can cope successfully with modern steel or compound armour plates. The steel shell is pointed, and is fitted with the Hotchkiss base percussion fuze. It is made of special steel, of great longitudinal strength, to obtain a maximum of perforating power, and small transversal resistance, so as to enable it to explode with a relatively small charge of ordinary gunpowder. It is hardened; the hardening gradually dying away towards the base. To further facilitate the proper bursting and breaking up of this projectile it is bored equally large at the base as it is in the powder chamber, and the bore is closed by a threaded gas-check base D (Fig. 11), or fuze receiver, of extremely soft steel, into which the fuze is screwed.

To prevent this base being blown out of the body, and again to prevent the fuze being blown out of the base on ignition of the bursting charge, it is shaped so as to provide inwardly extending walls *d d*' forming a gas-check both around the fuze and in the powder chamber. Thus the internal pressure causes the whole to be held securely together and gas escape prevented, so that the bursting of the shell is made certain, even when striking very thin plates, wood, or any other object.

The gas-check base, or fuze receiver D, is provided with a projecting flange *e*, bearing against the base of the shell, which serves to close the chamber of the same effectually, by means of the external pressure on the base of the projectile when the gun is discharged, thus making premature explosions in the bore impossible.

The Base Percussion Fuze.—This fuze consists of three principal parts, viz.: The fuze case, the plunger carrying the firing-pin, and the detonating cap (Fig. 14).

The fuze case F is of gun-metal, and carries the detonating composition G in the screw-cap H, which closes the end of the case. The base of the fuze is provided with a projecting flange *i*, brought up to a thin edge and acting as a gas-check when the fuze is screwed into the base of the projectile, because the pressure of the powder gas in the bore of the gun tends to force this flange against the base, and so make an absolutely gas-tight joint.

The plunger K is composed of a body of lead, cast into a cylindrical case of hard brass, and of the central firing-pin L made of hard brass wire and roughened so as to give sufficient hold to the surrounding lead, in order to prevent any accidental displacement. The rear end of the firing-pin projects beyond the bottom of the plunger K, whilst its front end is sunk a little below the surface. The entire length of this compound part being so calculated that when it is inserted in the fuze case and the screw cap H is in its place, the point of the firing-pin L cannot touch the primer G, and it can only displace itself by the shock of the discharge, when in consequence of its inertia its slides back on the firing pin down to the bottom of the case. The point then stands above the body of the plunger, ready to be projected against the detonating cap by its momentum, as soon as the flight of the projectile is retarded on striking.

The Operation of the Fuze is thus:—On the discharge of the gun, the plunger K, through its inertia, slides backwards on the firing-pin L. The lead, being a soft substance, is compressed by the shock and closes tightly on to the firing-pin again, leaving the point projecting in front. The plunger is now disengaged, and free to move forward in the line of its axis. When the flight of the projectile is suddenly retarded by its striking any object, the plunger again, in consequence of its momentum, is driven forwards, and the firing-pin strikes the detonating composition G in the front of the fuze, and ignites the bursting charge in the projectile.

This base fuze is absolutely safe during transport and all the manipulations of the projectile, as it requires the shock of the discharge to prepare it to act, and the sudden retardation in the flight of the projectile to set it off.

Canister Shot.—The canister does not much differ from that generally used with other guns. It consists of a drawn brass case, closed at both ends, and filled with hardened leaden bullets. The front end is coned off to facilitate rapid loading. The base of the canister by means of the annular projection of soft lead, which closes the bottom, is made to form a gas-check in the bore of the gun (Fig. 9).

Principal Weights, Dimensions, &c.

Gun.

Calibre	57 mm.	2.244 in.
Length of bore	2280 ,,	7 ft. 5.7 in.
Do. in calibres ...	40	
Rifling: Number of grooves	24	
Rifling: Width of lands	2 mm.	0.078 in.
Rifling: Depth of grooves	0.4 ,,	0.0157 ,,
Rifling: Twist, increasing	1 to 6 deg.	
Length of gun	2450 mm.	8 ft. 1.6 in.
Do. including stock	3000 ,,	9 ft. 10.1 in.
Weight of gun do. ...	370 kil.	7.03 cwt.
Weight of pivot	115 ,,	2.18 ,,
Weight of elastic pedestal...	320 ,,	6.08 ,,

Ammunition.

Weight of common shell, charged and fuzed ...	2.720 kil.	6 lb.
Bursting charge	85 gr.	2.97 oz.
Weight of steel shell ...	2.720 kil.	6 lb.
Bursting charge	115 gr.	4.02 oz.
Weight of canister shot ...	3.400 kil.	7 lb. 7 oz.
Length of projectile ...	220 mm.	8.66 in.
Total length of cartridge with projectile	481 ,,	22.9 in.
Total weight of complete cartridge	4.23 kil.	9 lb. 5.2 oz.
Charge of powder	850 gr.	29.75 oz.
Initial velocity of the projectile	560 met.	1849 ft.
Total muzzle energy of the projectile	43.48 met. tns	140.4 ft. tns.

RAILWAY FERRIES.

We illustrate, by a two-page plate, the general arrangement of two railway ferries, the Korsör and the Nyborg, recently completed for carrying trains over the Great Belt and keeping the communication open, throughout the winter, between Zealand and Jutland, thereby not only maintaining a continuous traffic, but effecting a considerable saving in time by avoiding the necessity of transferring freight from the train to the boats and *vice versâ*. The vessels, which are each capable of carrying seventeen loaded wagons, or thirteen passenger carriages, were constructed by the Kockums Mekaniska Werkstad, Aktie Bölag, Malmo, Sweden. We shall reserve our description of these interesting vessels until the publication of further details.

CONTINUOUS BRAKE FAILURES.

To the Editor of Engineering.

Sir,—In your issue of July 25, p. 85, details are given of a collision at Swansea caused by the leaking off of the "two-minute" brake. On July 4th a Midland train ran into the buffer stops at Leeds from the same cause, and on Saturday last, another case similar in every way, took place. The brake was applied and worked well, then it "leaked off," and *before* another store of vacuum could be obtained, the train ran into the buffer stops; this case has therefore added another instance of the inefficiency of leaking-off brakes. Buffer stops have been run into at Portskewet, Liverpool, Northampton, Leeds, Bradford, Leeds, Swansea, and now Leeds for the third time.

Yours faithfully,
Clement E. Stretton.

40, Saxe-Coburg-street, Leicester.

DISTILLING CONDENSERS.

To the Editor of Engineering.

Sir,—Having observed in one of your late issues an advertisement claiming to produce 23 tons of distilled water for 1 ton of coal, and not being in a position to thoroughly investigate the operation at the Health Exhibition (which would require at least two or three days to get a fair result), I should be glad of any information respecting this subject, it being contrary to my experience.

During the last eight years I have been an engineer in large ships, which have been fitted with distilling condensers, and have found that although the condensers were perfectly clean, and of the most approved type, I have thought myself fortunate when I obtained 8 tons of water for a ton of coal, making from 20 to 24 tons per day, and of course having to clean boilers after about 15 days distilling. This is not from one ship only, but having investigated the logs of about 30 ships, I find the mean to be 7 to 8 tons of water per ton of coal, all the ships being fitted with Normandy's condensers, and in the tropics, where the circulation has to be accelerated, 7½ tons of water is a fair average, using the hot water for feeding the boiler. I believe that it is quite possible to get 12 or 13 tons with an ordinary boiler, but beyond that, considering 9½ lb. of water per pound of coal a fair evaporation, I am inclined to mistrust.

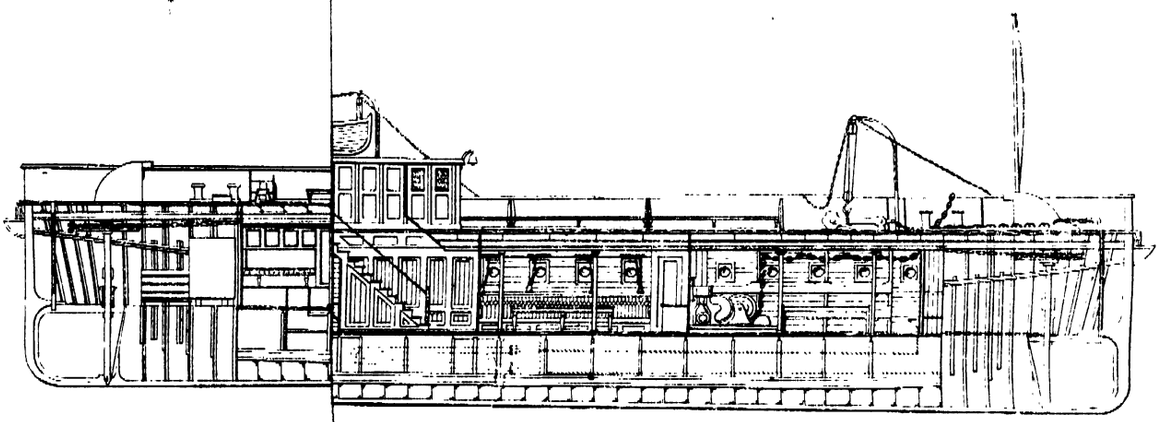
Perhaps some of your readers will favour me with their experience on this matter.

Spes.

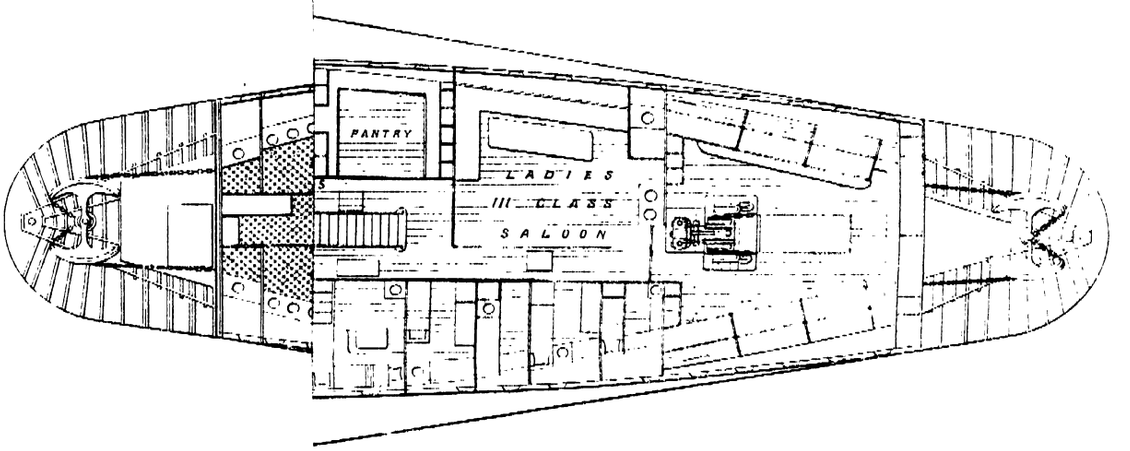
Gas in Paris.—The revenue acquired by the Parisian Company for Lighting and Heating by Gas in the first half of this year, was 1,439,638*l*., showing an increase of 41,097*l*., or 2.90 per cent., as compared with the corresponding period of 1883.

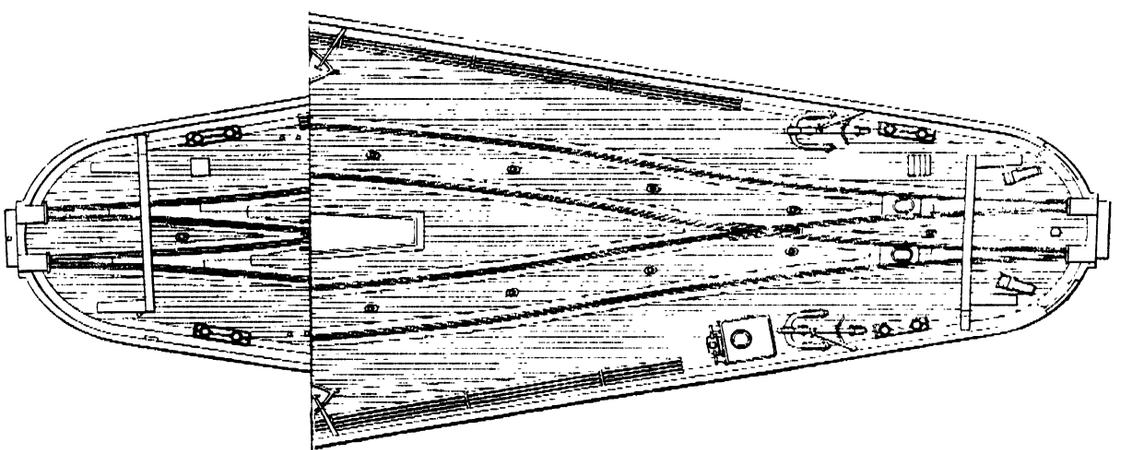
The Victorian Coast.—By the instruction of the Victorian Commissioner of Trades and Customs, Mr. Wilson, the engineer of ports and harbours, has drawn up a report in reference to more effective signalling off the Victorian coast. He suggests that 5000*l*. worth of "sound rockets," similar to those used at Flamborough Head in England, should be obtained, and that the Agent-General should procure for use at the channel stations three of the best fog-signal horns of such power and capacity that the supply of compressed air can be maintained by two men working an air pump. The recommendation will, it is understood, be adopted.

MALMO, SWEDEN.



2.





AGENTS FOR "ENGINEERING."

BELGIUM: P. Bailly, 12, Rue du Parchemin, Brussels.
BERLIN: Messrs. A. Asher and Co., 5, Unter den Linden.
CALCUTTA: G. C. Hay and Co.
EDINBURGH: John Menzies and Co., 12, Hanover-street.
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ENGINEERING.

FRIDAY, AUGUST 8, 1884.

THE MANCHESTER SHIP CANAL.

WE cannot better express the feeling with which the decision of the Committee of the House of Commons on the Manchester Ship Canal Bill was received, than by quoting from a Liverpool daily paper, the London correspondent of which writes:

"The decision of the Select Committee in throwout the Manchester Ship Canal Bill has created a widespread surprise. I happened to know some of the leading counsel on both sides, and, though differing on other points, they in private conversation agreed on this, that the Committee was sure to pass the Bill. It is curious to recall the fact communicated to you at the time that just before the decision in the Lords was given, both sides were agreed in the anticipation that they would throw out the Bill. It is the reverse that has happened in both cases, completing the most remarkable history of a private Bill comprehended in two sessions. Last year the Commons passed the Bill, and the Lords threw it out; this year it is the Lords who pass the Bill, and the Commons throw it out. Between the two it has been a costly game for somebody. It is reported that the promoters of the measure have spent 120,000*l.* in preliminary expenses."

It is further noticeable that the Committee which passed the Bill in the House of Commons last year unanimously, was a very strong one, and expressed their opinion as to the importance of the measure to Lancashire; they went fully into the question as did the Committee in the House of Lords this session, spending thirty and forty-one days respectively in considering it; whereas the Committee of the House of Lords last year had not the estuary part of the case before them, and although they curtailed the inquiry and declined to pass the Bill, certainly they gave the promoters every encouragement to come again.

This year the Commons Committee, which rejected the Bill, sat for twenty days only, and we certainly think the promoters and the public generally have some reason for desiring information as to the specific grounds upon which the Bill was passed by the House of Commons at one time, and rejected subsequently. When such large interests are involved, and the expenditure of a quarter of a million of money, in promoting and opposing the measure, has been incurred, some explanation is surely due in the interests not only of the people who find the money, but of the public generally, or the whole system of Private Bill legislation would seem to be greatly at fault, and to require reformation.

Before leaving the question of the Mersey we desire to call our readers' attention more particularly to the sea entrances. As stated by us on the 20th of last month, the water on the Sandy Hook bar at the entrance to New York has shoaled from 25 ft. to 23 ft., and forthwith a memorial was forwarded to Congress and a Bill introduced into the House of Representatives directing that proposals should be invited for deepening the channel 5 ft., and widening it not less than 500 ft. We hope that if the attention which has been called to the unsatisfactory and dangerous state of the entrances to the Mersey fails to rouse the people of Liverpool, at any rate outside influence may be brought to bear, and that some higher authority may be induced to move in the matter.

Undoubtedly the magnitude of the works necessary on the Mersey would be far greater than would have been found sufficient elsewhere; but, on the other hand, the trade which would be benefitted is far greater also. In 1855 the tonnage paying dues at Liverpool was 4,000,000 tons as compared with 290,000 tons on the Tees, and in 1882, 8,100,000 tons, as compared with 1,500,000 tons on the Tees. The Commissioners of the Tees have conferred immense benefits on the trading community by keeping the necessity of improving the navigation distinctly before them, and Parliament has granted to them the collection of dues and the power to spend the money so derived. The works have been done economically owing to the abundance of ironstone slag, a material in itself of about the same specific gravity as Runcorn sandstone, and if a breakwater can be formed of slag on the east coast, why not of sandstone on the west? The necessity of improving the sea channels has been frequently mooted both outside the councils of the Mersey Dock and Harbour Board, and also at the meetings of that body.

During the latter part of 1881 and the following year, Mr. Russell Aitken, C.E., was in correspondence with the chairman of the Marine Committee of the Board, and laid before him a proposal for removing the bar at the mouth of the harbour.

Of late years this bar has had no more than 9 ft. of water at low water ordinary spring tide, and Mr. Aitken proposes to dredge and maintain a channel 30 ft. deep at all times of the tide between Liverpool and the sea. As will be seen on the longitudinal section, which we published on page 364 of our thirty-seventh volume, this would entail the formation of a channel 2800 yards long through the bar, and also two shorter channels through banks above. Mr. Aitken fixes the width of his 30 ft. channel at 300 yards with slopes of 1 in 60. He estimates the quantity of material to be shifted at 9,000,000 cubic yards, and the cost 320,000*l.*, and further that the channel could be maintained by the removal of 500,000 cubic yards annually at a cost of 12,500*l.* We quite agree with Mr. Aitken that there is great need of improvement to the sea channels, but we cannot concur in the method proposed, for we feel satisfied that as narrowing proved abortive both on the bar and in the upper estuary so would dredging unless combined with training. If the currents were capable of maintaining a deeper channel they would in time form such a channel through sandbanks, and as this is not formed it follows that there is not power to maintain it, and it would silt so rapidly as to defy any efforts made to keep it open. It is when a bar is formed by hard material such as rock or even clay, that dredging a channel proves effective.

In our opinion the east coast should be studied where we see the natural groin, Spurn Point, jutting out into the Humber, and which by narrowing the entrance to the estuary affords at the same time an anchorage at the back and a deep channel round it; and again a very similar result followed the placing of an artificial groin, viz., the South Gare Breakwater at the entrance to the Tees. Probably if the mouth of the Mersey was treated on the same principle the same result would follow.

The Mersey Conservators have no power to raise or expend money, they cannot initiate improvements, and can only exert their authority to prevent changes being made, which they judge would be objectionable or dangerous. We have seen the acting conservator recommending improvements, both above and below Liverpool in his official reports of 1879 and 1880; but nothing resulting from these suggestions, no public inquiry has been instituted or information sought for.

The Mersey Dock and Harbour Board receives the dues, and here, as elsewhere, the power of the purse predominates. This Board, which, owing to the qualifications demanded of its members, and the mode of election, is composed, with one exception, of Liverpool men, and although it presides over the destinies of a navigation of national, even of universal, importance, it has for its first care and concern the management and development of the Liverpool Dock Estate. On this immense sums of money have been lavished, but with the exception of lighting, buoying, and removing wrecks, nothing is done for the navigation, and prior to the formation of the Upper Mersey Navigation Commission the lighting and buoying of the estuary above, was done at the cost of the Bridgwater Trustees, although dues were paid to Liverpool by craft proceeding to the up-river ports.

It thus seems as if the Liverpool Board were still *de facto*, as they formerly claimed to be *de jure*, conservators of the Mersey, and the question ought to be looked into and decided, whether they will act for the public in the matter of improving the navigation as a whole, or whether they should be called upon to make way for a new authority established on a broader basis and likely to possess more extended ideas of their duty.

The neglect with which the Upper Mersey has been treated, was shown in 1876 when the Upper Mersey Commissioners came into existence in spite of the opposition of Liverpool. In his evidence on the ship canal inquiry, the chairman of the Mersey Dock and Harbour Board asserted that no responsibility for the condition of the sea channels rested with the Board.

The time seems now to have arrived when a commission should be created to embrace the positions occupied by the Mersey Conservators, the Upper Mersey Commissioners and the Mersey Dock and Harbour Board, so far as regards the conservancy duties from the bar to Warrington, with power to levy dues on all vessels entering the port, and that the Dock Board rates should be confined to the docks and surrounding premises. The Mersey Dock and Harbour Board would then be in the same position as the London Dock companies with reference to the Thames Conservancy, the Hull Dock Company to the Humber Conservancy, the railway companies and the owners of docks on the Tyne and Tees to the Commissioners of those estuaries. It may be urged that the docks on these last named estuaries are the property of private companies, whereas the Mersey Dock and Harbour Board is a public trust whose members receive no direct pecuniary benefit from the estate, that therein lies the reason for investing them with conservancy powers, and if their estate was situated at the upper end of the estuary there would be

more reason for allowing them to continue to occupy the position, providing they were willing to undertake and fulfil it for the benefit of the district generally. As it is, their interest is antagonistic to the development of the upper ports, and their desire naturally is that that all the merchandise required by the dense manufacturing population inhabiting South Lancashire, Cheshire, and West Yorkshire, should pay dues to them; they can scarcely be expected to willingly assist in providing facilities for conveying it past Liverpool.

Many persons will no doubt exclaim at the difficulties which are patent in carrying out such an improvement as we foreshadow on the Mersey, but the position of Liverpool must be looked at on a map, not of the county, but of the British Isles and of the Continent of Europe. Then it will be seen that although the bar lies ten miles below New Brighton, if still it were found necessary to extend works so far, they would to a great extent be sheltered by the sandbanks to seaward or further by Wales and Anglesea on the south and south-west, by Lancashire on the north-east. Even on the north and west the Isle of Man and Ireland intervene between the site and the waves of the Atlantic Ocean, whereas on the east coast, and on the coast of Holland, works have been constructed with success to stem the unobstructed fury of the German Ocean.

At present the threefold jurisdiction established for the conservancy of the Mersey, results in absence of effort, as is usually the case when responsibility is divided. Glasgow is situated at the head of the estuary of the Clyde, where energy, skill, and large sums of money have been freely spent for many years in improving the navigation to Glasgow, and, but recently, in the construction of docks. The situation of Liverpool is different, and so have been the aims of the authorities.

We venture to say that had London been on the Mersey instead of on the Thames, the present state of affairs would not have been allowed to exist without diligent inquiry at the hands of Parliament. Of late years we have had commission after commission sitting in reference to the Thames with a view to the improvement of the navigation, the drainage, disposal of sewage, &c., and during this session on the ownership of the banks and the rights of the public on the river generally. A Cabinet minister was sufficiently interested in this matter to offer himself for examintion as a witness, but no public inquiry has been held with regard to the Mersey since the Conservancy Act was passed in 1842.

Meanwhile enormous changes have been made in the mercantile marine as well as in the trade of the port of Liverpool, and in the conduct of trade generally, time is an object of much greater importance, and delay in entering or leaving a port, is far more objectionable. The public expect to step on board a steam liner in dock on the arrival of a train at a fixed time, and to proceed to sea without delay, but at Liverpool the American liners haul off to mid-channel, and even the little boats plying to the Isle of Man are unable to cross the bar at dead low water. Moreover, during this period the depth of water on the bar has become considerably less, while, owing to the general adoption of steam for propelling, or towing in, and out of, harbours, a deeper channel is preferable, even if obtained at the sacrifice of width formerly necessary for beating out under sail.

There is another important question to be considered, which is the advantage accruing to the nation and the Government, for with an improved entrance, Liverpool might be used with confidence as a naval station and harbour of refuge. With the existing depths of water, a fleet could not issue forth to meet its adversaries except at high tide, and a disabled man-of-war could not run for safety or get access to a graving dock, except during a few hours of the twenty-four, and meanwhile she might sink, or fall into the hands of the enemy. Liverpool is practically undefended from the land, and although we should certainly expect a good account to be given of any hostile fleet before they got into the Irish Sea, still it would be a matter of importance in the naval defence of the west coast, to have an unobstructed harbour, accessible at all times of the tide for the heaviest description of war vessels, and in which floating batteries might lay for the protection of commerce, and be able to sally forth to meet an adversary at any hour.

The mercantile marine would also greatly benefit, for at present, with the exception of Holyhead, which is not suitable for the largest vessels, there is no harbour of refuge on the west coast of Great Britain, between the Clyde and Milford Haven. To the harbour itself the advantage accruing from protecting works would be immense. By far the greater number of the dock entrances are on the lee side, and the position of the Canada Dock entrance was found to be so exposed, that, although the more recently constructed docks have been extended far below, their entrance is fixed close to the Canada Dock gates, and even these cannot be opened in heavy weather. The danger from the sea is not increased, but the difficulty of working the ships using two large systems of docks through what is practically the same outlet, must be considerable. Under the protection of the training works or breakwater, the river would become tranquilised, and not only would greater freedom for docking vessels be obtained, but the area of anchorage ground, which is already found to be too restricted for the requirements of the port, would be enlarged. We think, therefore, in the interests of the empire, as well as of the manufacturing districts of the north-west of England, a full and exhaustive inquiry should be set on foot as to the present condition and mean of improving the Mersey.

In America, France, and most other countries, the works themselves would be carried out by the Government. Englishmen prefer to leave such matters to private enterprise, but we think that the interest which has been aroused by the proposal to make a ship canal to Manchester, affords a fitting opportunity for directing public attention to the still larger subject which has lain dormant, and is well worthy of the deepest attention, not merely of individuals, but of the Government of the country.

INEFFICIENT BRAKES.

The failures and defects of vacuum brakes continue, and that more lives are not lost is certainly marvellous. In our issue of the 25th of July we noticed a collision between a Midland train and the buffer stops at Swansea, by which injury was inflicted on fifteen people, the cause being the failure of the "leak off" Clayton automatic vacuum brake. We have now to record a similar collision with the buffer-stops at Wellington Station, Leeds, on the 2nd inst. from the same cause. The train was well filled with passengers, many of whom sustained blows and bruises. This is not the first time such an event has occurred at Leeds, and looking to the list of other places, including Portskewet, Northampton, Liverpool, Bradford, and Swansea, where similar accidents have resulted, it is by no means likely to be the last. As often previously explained, by its unfortunate principle, this form of brake is rendered quite untrustworthy for a second or third application, and drivers are thus always in danger of being led into a trap, particularly when approaching junctions and termini.

When twenty-five people were killed on the Sheffield Railway at Penistone, Sir Edward Watkin was inclined to think that Providence had been a little hard on his railway by not arranging for the engine to run "only 60 yards further." It is to be hoped that on the numerous occasions when passengers do escape on this line, Sir Edward is properly thankful, though should he continue to tempt Providence by adhering to the use of a vacuum brake, he may soon have to make more excuses, and express regrets for a further addition to the many lives which have already been sacrificed on the Manchester and Sheffield Railway. In our issue of the 25th ult. we also drew attention to a breakaway at Worksop on the same line, and a narrow escape of a subsequent collision, which would never have been possible had the train been fitted with an automatic brake. A further illustration of the necessity for such appliances on Sir Edward Watkin's railway was afforded on Bank Holiday. As a heavily-laden excursion train of more than twenty carriages, from Sheffield for Grimsby, was approaching Great Coates Station, about three miles from Grimsby, a man was observed standing on the footboard of a carriage, gesticulating and shouting. It was also observed that the fifth vehicle from the end of the train was oscillating violently. Fortunately, the driver was able to be signalled by the officials at the station, and the train was brought to a stand after running several hundred yards, having carried off a gate-post and part of Great Coates platform, and torn away one side of the carriage, with injuries to several people. The primary cause, as at Penistone, was the breaking of an axle, by which part of the train was thrown off the line. The results were fortunately more favourable than those at Penistone, but had the driver not received timely warning of the mishap which luckily occurred when passing a roadside station, it is quite possible that five carriages filled with their pleasure-bent freight, might have met the fate that has befallen others under very similar circumstances. Had an automatic brake been in use, it would in all probability have been self-applied when the axle broke, and all anxiety would have been at an end.

Imagine this vehicle with the cracked axle, in the front of the train—which would have been the condition of things a few hours afterwards on the return journey—and that the axle had broken on a heavy falling gradient; it is quite possible to have had a recurrence of that most fatal calamity which took place on September 13, 1882, at Hugstetten on the Baden State Railway. In this latter case the front part of a heavily laden excursion train left the line, on a falling gradient, and was overrun by the remainder of the train, killing 63 people, and seriously injuring 72 others. **It is significant that the Baden State have since adopted the Westinghouse brake, and are fitting it to their stock, but from Sir Edward Watkin's remarks at the South-Eastern meeting, commented upon in our last number, it would take many more lives than those sacrificed at Hugstetten before he would voluntarily consent to adopt the same brake on the railways he controls with such autocratic self-will. If the shareholders of these lines have not lost all control of their affairs we shall probably hear of their making a movement with a view to recovering some independence of action. Meanwhile we hold it to be our duty to the public to watch narrowly, and report carefully, the dangerous failures of non-automatic brakes upon our railways, and to counteract, as far as possible, the efforts of Sir Edward Watkin to uphold and perpetuate a dangerous system, in defiance of the recommendations of the Board of Trade.**

THE TEXTILE TRADES EXHIBITION.

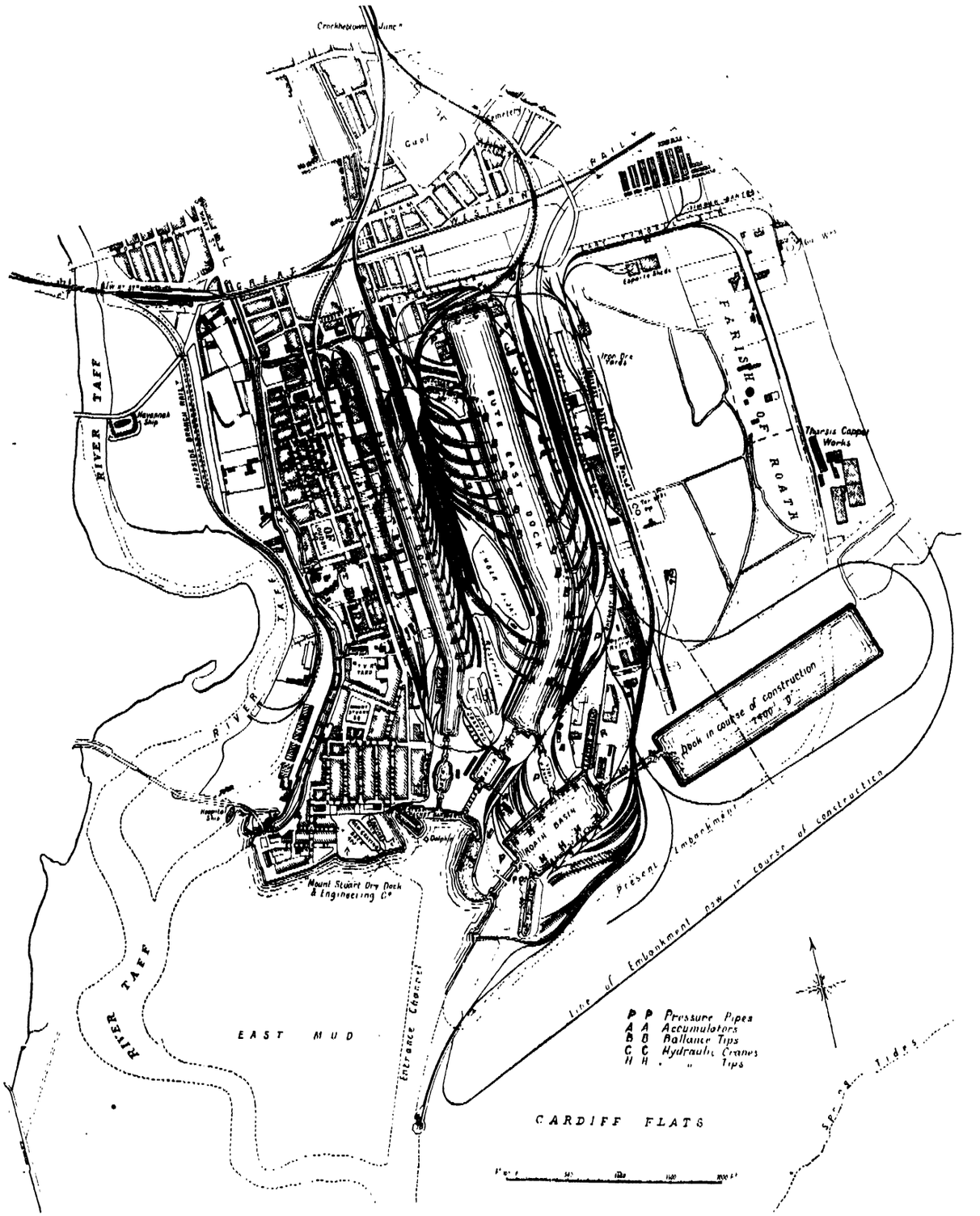
An exhibition of machinery and products connected with the textile trades was opened at the Agricultural Hall last Monday, and is to remain on view until September 20th. It is difficult to understand what is the object of the promoters is holding an exhibition of this kind in London, where little or nothing is known about the subject; and we should have thought that the result of a similar attempt at the Crystal Palace three years ago would have effectually prevented a renewal of the experiment. At that time there was a considerable response from the manufacturers, and the show, although very partial in its character, was, so far as it went, interesting, and did really represent many phases of the textile trades. The result, however, was not successful, and scarcely any of the former exhibitors are to be found at Islington; indeed, of all the textile industries, the cotton trade is the only one that is to be seen on any scale whatever. Spinning machinery is exhibited by Mr. Samuel Brooks, of West Gorton, Manchester, in the form of two ring and traveller frames, and these are the only examples in the building. Messrs. Farmer and Sons, of Salford, make a considerable display of first-class finishing machinery, and other machines of the same class are shown by Messrs. J. H. Riley and Co., of Bury. The show of looms is most meagre; Mr. Robert Hall, of Bury, whose machines are to be counted by thousands in Lancashire, being represented by a single fustian loom, and other well-known makers being content with the same modest number.

At the time of writing, several of the firms whose names appear in the catalogue have not put in an appearance, while the line shafting by which the greater part of the machines are to be, driven has not been started. We shall therefore reserve our notice of the textile machines for a future issue, in the hope that something may appear which will justify the assumption of the title. At the present there is neither silk nor flax-working machinery, and very little that pertains to wool, while the cotton manufacture is represented by a few details of the process, and with two or three exceptions, no machinists of note are exhibiting. In this notice we turn to a few of the other exhibits, which have a more extended application.

Messrs. Musgrave and Sons, of Bolton, show two

PLAN OF THE BUTE DOCKS, CARDIFF.

(*For Description, see Page* 135.)



of their starting engines, which are designed for turning large engines over the centres, or for the purpose of rotating them slowly when it is required to do so for the purpose of putting on straps, ropes, &c. The special feature of them is that they come automatically out of gear with the main engine the moment it gets under way from its own steam, and hence no accident can arise from the negligence of the man in charge. In the first form of starting gear, the main shaft of the starting engine has keyed upon it a pinion, which gears into a pinion carried by a lever pivotted loosely upon the shaft itself. This lever can stand in two positions. In the first the pinion gears into a toothed circle on the flywheel of the main engine, forcing it downwards. Should the engine start by its own steam, it carries the pinion with it until the lever assumes an inclined position, when the pinion is out of gear, and a catch falls in to keep it so. In the second form of starting engine the driving pinion is attached to its shaft by a scroll key, so that when the flywheel overruns it, it screws itself along its shaft, and slides out of gear, the last part of its motion being assisted by a weighted lever which falls over the centre, and carries the pinion completely clear of the wheel. Another form of turning engine is shown by Messrs. Hick, Hargreaves, and Co., of Bolton, but as we hope to illustrate it in our next issue we shall reserve our description of it till then.

There is a very considerable show of cotton belting by Mr. Maurice Gandy and others. Mr. Wilson Cobbett, of 60, Queen Victoria-street, E.C., shows the Scandinavian cotton belt, which is woven solid in a loom at one operation, and is not produced by folding cloth upon itself. It is claimed for it that as there are no stitches in it, it is more durable than if sewn. Cotton ropes, which are now widely used in mill driving, are exhibited by Messrs. J. and J. E. Milne, of King-street, Oldham, who have a stand with samples of all sizes, from spindle banding up to main driving ropes.

Messrs. Frank Pearn and Co., of West Gorton, Manchester, have a large selection of their well-known pumps. In the way of novelties they are showing a ballast pump and a blowing engine. The former has a 9 in. steam cylinder, a 9 in. water cylinder, and 15 in. stroke. The steam valve is worked by a special steam cylinder which has its valve operated from the pump piston rod. The blowing engine is constructed on a similar plan, and has a 36 in. air cylinder, a 16 in. steam cylinder, and 24 in stroke. It is in-

tended to compress up to 6 lb. or 7 lb. on the square inch, and is to be applied to ventilating a ship's stokehold, on Green's system. We hope to illustrate both the blowing engine and the system itself shortly. Steam for this exhibit is furnished by two "Hyde Duplex" vertical boilers, manufactured by Messrs. Tinker, Shenton and Co., of Hyde. They are 10 ft. high and 4 ft. 6 in. in diameter, and are capital specimens of boilerwork. The furnace communicates by a short vertical flue with a horizontal cylindrical flue terminating in the lower part of a combustion chamber, from which a number of horizontal tubes run to an external firebox. A very high efficiency is claimed for these boilers.

Two mechanical stokers are exhibited, one by Messrs. Hodgkinson and Co., of Odsell-lane, Manchester, and the other by Mr. James Procter, of Hammerton-street, Burnley. The former distributes the coal over the fire in a continuous rain by means of a revolving fan rotating about 200 times a minute, and the latter feeds by means of a ram and a shovel.

Messrs. W. Buckley and Co., of Sheffield, have a large exhibit of their well-known pistons, and near to them is the stand of Messrs. Hudswell, Clarke, and Co., Leeds, who have supplied the whole of the pulleys for the electric light department of the Health Exhibition.

THE INSTITUTION OF MECHANICAL ENGINEERS.

The summer meeting of the Institution of Mechanical Engineers commenced on Tuesday last at Cardiff, under the presidency of Mr. I. Lowthian Bell. The proceedings were opened with a meeting for the reading and discussion of papers at the Cardiff Public Hall, Crockherbtown, when the members were welcomed to Cardiff by the mayor, Mr. Robert Bird. The President having replied on behalf of the Institution, the minutes of the special and ordinary meetings in May last were read and confirmed, and a list of fifty-three new members elected at the present meeting, was read by the secretary.

This routine business having been disposed of, the President proceeded to deliver his address. Mr. Bell nominally took iron for his text, but his address really covered a far wider ground than the progress of our iron manufacture only, and it was in all respects an admirable one. We shall not attempt to give an abstract of Mr. Bell's remarks here, as we publish his valuable address *in extenso* on another page, and it is one which deserves to be read and carefully read—in its entirety. The especially important part of the address is that containing Mr. Bell's views on the comparative cost of labour in this country and abroad, and this is a portion which we believe will be widely discussed not only here, but also by our Continental competitors. Mr. Bell's remarks were cordially received by the meeting, and at their conclusion a vote of thanks for the address—proposed by the mayor and seconded and supported by Mrs James Colquhoun, of Tredegar, Mr. Jeremiah Head, and Mr. E. H. Carbutt—was heartily accorded.

Dock Accommodation and Coal Shipping at Cardiff.

The next business was the reading of a paper by Mr. John McConnochie, of Cardiff, "On Recent Extensions of Dock Accommodation and Coal-Shipping Machinery at the Bute Docks, Cardiff." This was an interesting descriptive paper, and may be regarded as an appendix to that on a similar subject read by the author on the occasion of the last visit of the Institution to Cardiff in 1874. As we commence the publication of Mr. McConnochie's present paper on page 140 of the present issue, it will be unnecessary to abstract it here.

This paper was followed by but a very brief discussion. The first speaker was Mr. B. Walker, of Leeds, who remarked that until he had heard Mr. McConnochie's paper, he had always supposed that the movable hydraulic crane had originated with Mr. Westmacott, but he now found that it had first been suggested by Mr. McConnochie. This type of crane he considered an exceedingly useful one, and his firm had now 80 of such cranes in hand, 53 of them being of one pattern, and being intended for the new docks at Tilbury. In many cases such cranes, he added, were actually cheaper than fixed cranes, and they were vastly more useful. The anti-breakage arrangement described in Mr. McConnochie's paper he considered a very ingenious and valuable one; it greatly reduced the labour in the ship. On the whole, however, he considered that our coal-shipping appliances were by no means perfect, and that a good deal more would yet be done to facilitate the performance of such work.

Mr. Joseph Tomlinson, Jun., who spoke next, remarked that he was for a long time connected with Cardiff; and from what he had seen of its growth, and taking into consideration the continuously increasing demand for Welsh coal, he did not consider that the dock accommodation which was being provided was at all too great. He believed that seven millions of tons of coal now being shipped annually would be increased to fifteen millions of tons, instead of6 millions, as prognosticated by Mr. McConnochie.

Mr. McConnochie then replied to the remarks which had been made, and explained that the idea of using movable hydraulic cranes was not entirely his. He had suggested such cranes to Sir W. G. Armstrong and Co., but had been told that they could not be made on account of the difficulty attendant upon the construction of the supply pipes. He had, however, come across a Nasmyth steam pile-driver with jointed steam pipes, and he had suggested that the hydraulic pipes for the movable cranes could be made the same way. His suggestion was adopted and the movable hydraulic cranes were the result. The anti-breakage arrangement he had been led to employ to reduce the quantity of dust-coal in a cargo. In conclusion he offered to give any further explanations when the members visited the docks in the afternoon. On the motion of the President a vote of thanks was then accorded to Mr. McConnochie for his paper.

Locomotive Running Shed; Taff Vale Railway.

The next paper read was one by Mr. Charles Hurry Riches, of Cardiff, entitled a "Description of the New Locomotive Running Shed of the Taff Vale Railway, at Cathays, Cardiff." This paper we shall also publish *in extenso*; but meanwhile we may give an abstract of its contents.

The author commenced by stating that the increase in the traffic of the Taff Vale Railway had necessitated the removal of the engine shed to a more eligible site at Cathays. The new building will accommodate sixty large tender engines, and is 383 ft. long inside the walls. It comprises two spans of 67 ft. each, divided by a centre wall, supported by arches on brick pillars. There are ten roads in all, and midway in the length of the shed is a steam traverser, 40 ft. long, working across all the lines of rails. The length of the shed is divided into six tiers of berths. The main pits are 3 ft. 6 in. deep, and extend throughout the entire length of the shed, except under the traverser. There are drains at intervals of 46 ft. 10 in., and in every alternate space between the pits there is a water main with hydrants at 37 ft. 6 in.

At the south end are the workshops and offices, covered by a continuation of the same roofs. The coppersmiths' shop is 19 ft. 6 in. wide, and adjoining this come the boiler shop and smiths' shop, entering the main shed near the longitudinal centre wall. In the eastern space is the machine shop. There are also waiting rooms and mess-rooms covered by a lean-to roof. Outside the shed at at the northern or outlet end, the ten roads lead to separate drop pits, each of which has a water jet so arranged that it can be set at any angle to throw water into the pan without the use of a flexible hose. Adjoining the drop pits are two double fire furnaces for lighting the engines, and there is a third by the doors of the traverser. The coal stage has a double platform with a road for the wagons in the centre, and a road on the outside of each platform for the engines. The platforms are each 133 ft. long, and each is fitted with three coal cranes and nine tumbler buckets. Between the cranes are tanks for dried sand, and near to them is a sand drying kiln with three furnaces and 406 square feet of drying platform. Seven thousand gallons of water are pumped per hour from a well into a cast-iron tank upon a stone building.

The main girders of the turntable are semi-elliptic inverted, of rivetted plate, and of treble T section. The centre pivot is a round pin, supported by a cast-iron cone in two parts, which rest upon the centre foundation stone. Between the top of the cast-iron cone and the point of the pin, there is inserted a case hardened washer of double convex section to reduce the friction. The ends of the table are carried round the race upon four cast-iron wheels shod with crucible steel tyres 2 ft. 1½ in. in diameter. The race is of ordinary double-headed steel rails, and the table works without any toothed gearing. The main frames of the traverser are composed of eighteen pairs of double-headed steel rails laid transversely, and joined together by angle iron and wrought-iron plates, both diagonally and transversely, with cast-iron distance pieces intervening, thus forming a broad shallow box girder, upon which are laid the bridge rails that carry the locomotive. It is driven by an engine with a pair of 8 in. cylinders.

In addition to the account of the shed the paper contained descriptions of a flange lubricator and a jet for washing the rails. The former is composed of three small vessels, one at either side and one in the centre of the leading end of the engine. The middle vessel is a closed tank, and is connected with both the others, and with the tender tank. Water is admitted to it by a float up to a certain level. In each of the side vessels is a small syphon the top of which is at a certain height above the ordinary water level in the centre vessel, and no water will flow down the syphon until the water level is raised above it. When the engine is running round a curve the centrifugal force causes the water to flow towards the outside of the curve, over the top of the syphon, and down on to the flange of the leading wheel. This continues until the engine leaves the curve, when the water resumes a uniform level in the three vessels. The jet for washing the rails is taken from the boiler.

Mr. Riches' paper was followed by a brief conversational discussion, in the course of which Mr. Haswell, of the North-Eastern Railway, advocated running shells with turntables as affording greater facilities for getting out any engine required, than those having a central transverse traverser as employed by Mr. Riches. In the engine shed of the North-Eastern line at Gateshead, from 90 to 100 engines can be housed, this shed having five turntables and there being several ways of getting out the engines in the event of a table being disabled. Mr. Barton Wright considered that polygonal sheds with turntables were, perhaps, the most convenient, but he had known all the engines in such a shed locked up by the failure of the table. Mr. E. H. Carbutt pointed out that the traffic on the Taff Vale line was of a special character, the trains being despatched in groups and several engines being required in rapid succession. The shed designed by Mr. Riches was especially suitable for such conditions.

Mr. C. Hurry Riches, in replying to these remarks, stated that the traverser arrangement he had adopted had been found to give every convenience, and in practice the engines could be got out very rapidly. If a failure of the traverser occurred there would be no difficulty in getting engines across the gap by temporary expedients. In designing the shed he had considered it an important matter to provide for the "day in" engines to be placed close to the workshops so as to facilitate the execution of repairs.

Mr. Joseph Tomlinson, Jun., observed that in forty years' railway experience he had only known one case in which a shed turntable had been blocked by an engine getting into the pit. In practice turntables could be readily kept from breaking down, by doing the necessary repairs before the breakdown happened. As regarded Mr. Riches' shed, the fact was that money not being available for erecting both a repairing shed and a running shed, Mr. Riches had put up a shed which served both purposes. No doubt later on, when the money was available, the running shed accommodation would be increased, and the part of the present shed next the workshops would be wholly devoted to repairs.

After some brief remarks from Mr. Bell a hearty vote of thanks was accorded to Mr. Riches for his paper.

The Amalgamation of Silver Ores.

The third and last paper read on Tuesday was a "Description of the Francke 'Tina' or Vat Process for the Amalgamation of Silver Ores," by Mr. Edgar P. Rathbone, of London. This process was invented by Herr Francke, and is based on the same principles as the system described by Alonzo Barba in 1640, and known in the States as the Washoe process. It is applicable to rich but refractory silver ores, such as are found at the Huan-

chaca and Guadalupe mines in Potosi. The ore is dressed by hand into four grades, viz., (1) very rich, with 6 per cent. of silver, (2) rich, with 1 per cent. of silver, (3) ordinary, with ½ per cent. of silver, and (4) waste. The first quality is sent to England to be smelted, and the second and third are treated at the local works. They are stamped dry, without water, until they will pass through sieves of 40 holes per lineal inch, and are then roasted in double-bedded furnaces, with one hearth above the other. These furnaces cost 100*l.* each at Huanchaca, and are capable of roasting 2 to 2½ tons in twenty-four hours, at a cost of 28s. for fuel. The ores are roasted with 8 per cent. of salt, costing 2s. 2d. per 100 lb. They are only partly chlorinised in roasting, and their complete chlorinisation is effected subsequently during the process of amalgamation. All the sulphide ores of Bolivia contain sufficient copper to form the quantity of cuprous chloride requisite for the first stages of roasting, in order to render the silver thoroughly amenable to subsequent amalgamation.

The roasted ore is stored in bins behind the grinding and amalgamating vats, locally known as "tinas," and which constitute a prominent feature of the Francke process. They are large wooden vats, 6 ft. to 10 ft. in diameter, and 5 ft. deep, and will treat 2½ tons at a time. At the bottom there are copper plates 3 in. thick, and 10 square feet in area, and other plates, with ribs slightly inclined to the horizontal, are affixed to the sides to promote a more thorough mixing. Within the vat, and working on the top of the copper plates, is a heavy copper stirrer or muller, rotating at forty-five revolutions per minute. It may have four projecting radial arms, or be composed of one single bell-shaped piece without arms. Each vat requires 2½ to 3 horse-power to work it.

Each tina is charged to one-fifth of its depth with water, and with 6 to 7 cwt. of common salt, the amount varying from 150 lb. to 300 lb. per ton of ore. The mixture is boiled by steam, and the stamped and roasted ore introduced. At the end of half an hour 1 cwt. of mercury is added, and further additions are made as the process proceeds. The stirring is kept up from eight to twelve hours, and at the end of the time the amalgam is run out, washed, and put into hydraulic presses to squeeze out the superfluous mercury. A thick pulpy mass is left behind, composed mainly of silver, and known locally as a "piña." These piñas are freed from the remaining mercury in a subliming furnace, and the silver run into bars. The actual quantity of mercury used is based on practical experience. With ores assaying 150 to 175 ounces per ton, three quantities of 75 lb. each are used. When treating earthy chlorides assaying 20 to 30 ounces to the ton, 36 lb. of mercury is added to 2½ tons of ore at three different stages of the process. The rationale of the process seems to be that the chlorinisation of the ores is only partially effected during the roasting, so as to prevent the formation of injurious salts, and is completed in the vats in which chloride of copper is formed progressively as required by the grinding away of the copper plates. This chloride subsequently becomes incorporated with the boiling brine, and is considered to quicken the action of the mercury upon the silver.

At the conclusion of Mr. Rathbone's paper, there was read by the secretary a long letter criticising it from Mr. Frecheville, the Government Inspector of Metalliferous Mines at Truro. We regret that our space will not permit us to give an abstract of this letter here. Mr. T. R. Crampton next referred to the statements made in the paper, as to the difficulties of crushing the ore fine, and as to the wear of sieves. Sieves no doubt did wear and get out of shape rapidly, but it was easy to get over this difficulty, and to grind the ore as fine as was desired. Mr. Frecheville, in his criticism on Mr. Rathbone's paper, had spoken of the use of a draught of air to keep the dust off the bearings, but this draught could be applied another way. He (Mr. Crampton) had seen hard quartz successfully and cheaply ground by percussion in a disintegrator, the material flying off from the arms of the disintegrator being delivered into a depositing chamber where the coarser particles were deposited, while the finer product was discharged with the escaping air, the current being caused by the disintegrator acting as a fan. The coarser deposited material was raised by a Jacob's ladder, and again delivered into the disintegrator. It was a great advantage to have the material in a fine state for such processes as were described in the paper. He added that for upwards of four years an arrangement of the kind he had described had been in use at the shell foundry, Woolwich Arsenal, for grinding coal for use as a parting in the moulds, and dust of an almost impalpable fineness was obtained by it without trouble.

The only other speaker on the paper was Mr. P. F. Nursey, who stated that some years ago he had been connected with a gold mining enterprise in North Devon, and that in that case the quartz had been crushed with edge runners and passed with a stream of water through sieves. These sieves had 6400 meshes per square inch, and they stood well. Eventually the scheme was abandoned, it not being a financial success.

At the termination of the meeting the members adjourned to luncheon, to which they were kindly invited by the Local Committee. When luncheon was over, they proceeded to examine the docks, the hydraulic machinery described in Mr. McConnochie's paper, Mr. C. Hurry Riches' running sheds at Cathays, and the various works thrown open, while in the evening they became the guests of the Marquis of Bute, who entertained them most hospitably at a dinner in the Cardiff Drill Hall. In the absence of the marquis the dinner was presided over by the Hon. Mr. Dudley Ryder, one of the trustees of the late Marquis of Bute.

We append some particulars of the Bute Docks, and shall in our next issue refer to the other excursions, want of space compelling us to postpone our notice of these visits till next week.

The Bute Docks.

In our account of the last visit of the Institution of Mechanical Engineers to Cardiff,* just ten years ago, we gave some particulars of the Bute Docks as they then existed, which were taken from the able paper of Mr. McConnochie, the engineer to the docks. In the following number we published a general plan of the port, in which the arrangement of the docks and those at Penarth, were very fully shown. Since that date many changes have occurred, and even more important ones are in progress, as may be gathered from a comparison of the plan we now publish on page 133 with that of ten years ago to which we have made reference. That the changes and additions to the accommodation of the port have not been made with any undue haste the following figures, which we take from a publication issued by Messrs. Daniel Owen and Co., of Cardiff, would tend to show. In the year 1871 the number of houses in Cardiff was 8156 and the population 59,494. In 1881 the number of houses had increased to 12,137 and the population to 85,378, whilst in 1883 there were 15,080 houses, and the population was estimated at 96,000.

From the "annual statement of the navigation and shipping of the United Kingdom," prepared by the Board of Trade, it would appear that in 1882 4,455,201 tons register of shipping cleared from the port of Cardiff in 1882, the corresponding figures for Liverpool and London being 6,487,764 tons and 5,178,217 tons respectively. In the same year Newport cleared 1,565,855 tons; Swansea, 1,304,401 tons; Bristol, 621,342 tons; and Gloucester, 238,613 tons. It would appear then that the aggregate of the four large Bristol Channel ports is considerably less than that of Cardiff.

At the time of the last visit of the Institution of Mechanical Engineers to this port—viz., 1874—the coal exports to foreign ports for the year amounted to 2,942,149 tons; the corresponding figures for Newcastle being 3,192,822 tons. In 1882 Cardiff was credited with 5,799,919 tons, whilst the Newcastle exports of coal to abroad were only 4,291,312 tons. It is perhaps hardly necessary to remark that the figures must not be taken as conclusive evidence of the relative importance of the two ports as coal centres, even when allowance is made for the fact that Cardiff stands alone, whilst the port of Newcastle does not comprise the whole of the Tyne ports.

Just now the self-congratulation of the Cardiff folks has received a slight check from the passing of the Barry Dock Bill through the House of Lords, and local pessimists are loud in their lamentations upon the coming desolation of the port. Probably, however, before the Barry Docks can offer quayage enough to accommodate all the ships that now flock to the Bute Docks, Cardiff will have had time to have accumulated a very comfortable reserve, to aid her to fight the battle of competition.

The following are the particulars of the Bute Docks as they at present exist, according to the figures furnished us by the courtesy of the officials. We may first state, however, that the area of the docks is 78 acres, and they are in direct communication with the Midland, London and North-Western, Great Western, and local railways.

West Dock.

Entrance to basin ... 45 ft. wide
Basin (area 1½ acres) 300 ft. long; 200 ft. wide
Lock ... ... 152 ,, 36 ,,
Dock (area 18 acres) 4000 ,, 200 ,,
Quayage ... ... 8800 ,,
Depth of water in dock ... ... 19 ft. and 13 ft.
Viz.: 1550 ft. by 19 ft. deep
2450 ,, 13 ,,
Depth of water on sill, spring tides, 28 ft. 8½ in.
,, ,, ,, neap tides, 18 ft. 8½ in.

There are 13 staiths for the shipment of coal.
The ballast cranes (three in number) are capable of discharging 100 tons per hour.
Cranes (four in number) to lift 10 tons.
Graving dock, 245 ft. long, 40 ft. width of entrance, 12 ft. deep.

East Dock.

Sea lock ... ... 220 ft. long; 55 ft. wide.
Basin (area 2¼ acres) 380 ,, 250 ,,
Inner lock ... ... 200 ,, 49 ,,
Dock (area 44 acres) 4300 ,, 300 ft. and 500 ft. wide.
Viz.: 1000 ft. long by 300 ft. wide.
3300 ,, ,, 500 ,,
Quayage ... ... 9360 ft. long.
Depth of water in dock ... ... 25 ft.
Depth of water on sill of sea lock, spring tides... ... ... 31 ft. 8½ in.
Depth of water on sill of sea lock, neap tides ... ... 21 ,, 8½ ,,

There are 20 staiths for the shipment of coal, with the latest improvements in hydraulic machinery.
There are two ballast cranes capable of discharging 100 tons per hour.
Shear legs to lift 60 tons.
Hydraulic cranes (23 in number) to lift from 2 to 20 tons.
Two hand cranes to lift 2 and 4 tons.
Graving dock, 400 ft. long; 48 ft. width of entrance; 17 ft. deep.
Graving dock, 420 ft. long; 50 ft. width of entrance; 19 ft. deep.
Note.—Vessels can enter East Dock *viâ* Roath Basin.

Roath Basin.

Entrance lock ... ... 350 ft. long, 80 ft. wide.
Dock (area 12 acres) ... 1000 ,, 550 ,, in centre.
Quayage ... ... 2700 ft. long.
Depth of water on sill, spring tides, 19 ft. 8½ in.
,, ,, neap ,, 25 in. 8½ in.
Eight staiths for the shipment of coal, with the latest improvements in hydraulic machinery.
Two hydraulic cranes to lift two tons.
Graving dock, 600 ft. long; entrance, 60 ft. wide.
Depth of water, spring tides, 23 ft.
,, ,, neap ,, 13 ,,

Entrance Channel.

Graving dock ... ... 320 ft. long; 45 ft. width of entrance.
Depth high water, spring tides, 19 ft. 8½ in.
,, ,, neap ,, 9 ft. 8½ in.
Gridiron ... ... 350 ft. long.
Depth high water, spring tides, 23 ft.
,, ,, neap ,, 13 ft.
Steam-packet harbour, with bridge and floating pontoon:
Depth high water, spring tides, 33 ft. 3 in.
,, ,, neap ,, 23 ft. 3 in.
Steam crane, to lift 6 tons.
Pier head crane, to lift 4 tons.
Channel coal staith, worked by hydraulic power:
Depth high water, spring tides, 28 ft.
,, ,, neap ,, 18 ft.
Low water pier, with floating pontoon and hydraulic lift:
Hydraulic crane, to lift 10 tons.
Depth at high water, spring tides. 43 ft. 8½ in.
,, low ,, ,, ,, 5 ft. 8 in.
,, high ,, neap ,, 33 ft. 8½ in.
,, low ,, ,, ,, 15 ft. 0 in.

There are extensive grain warehouses, with hydraulic appliances for discharging from vessels and for delivery from the warehouses; and also commodious wharves and depôts for the stocking of iron, iron ore, wood, and other goods.

The hydraulic coal-shipping machinery of recent date is fully described in the paper of Mr. John McConnochie, which appears in another part of this paper.

The New Dock.

An important addition to the Bute Docks is now in course of construction on the south-east shore. This is to be known as the Roath Dock and will communicate with the existing Roath Basin, which

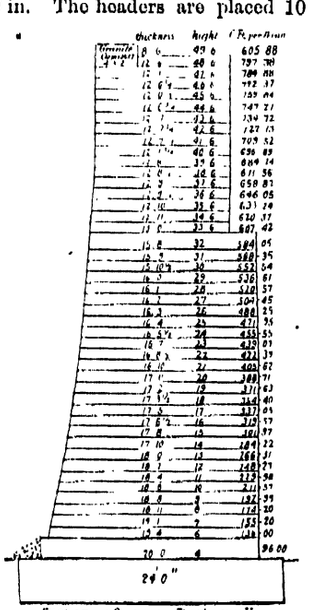
* See Engineering, vol. xviii., p. 108.

has an entrance direct from the Bristol Channel, and also one communicating with the Bute East Dock. The position is clearly shown by the plan on page 133. The whole of the work for this fine example of engineering is being carried out from the plans of Mr. John McConnochie, the engineer to the Marquis of Bute, the proprietor of the docks. The work is being executed by Messrs. T. Nelson and Co., of Carlisle, contractors.

The length of the new dock is to be 2400 ft. and the width 600 ft., which will give an area of approximately 35 acres. The entrance lock—one of the finest in the country—is 600 ft. long and 80 ft. wide, whilst the depth from the top to the sill, will be 43 ft. 6 in. The bottom of the dock is 3 ft. below the sill level. The depth of water on the sill at high water ordinary spring tides will be 35 ft. 8 in., and 10 ft. less at neaps. There are to be three pairs of gates of unusually massive proportions. The foundations of the lock are on the red marl, above which is a bed of cement concrete 3 ft. 6 in. to 4 ft. thick. The hollow quoins, the pointing sill, roller path, sluice pier stones and covers, and sluice valve stones are all of Cornish granite. To every gate there are two sets of stop grooves of Forest of Dean stone, having a depth of bed of 4 ft. These are carried through the invert and walls. The main portion of the lock between the gates has a solid ashlar invert 4 ft. in depth of bed.

The thickness of the lock wall at the round head is 32 ft. for a height of 22 ft. stepping in from that to the top, where it is 15 ft. The thickness of the gate chambers is 25 ft. 6 in., stepping in in a similar manner. For a length of 50 ft. behind each hollow quoin, the walls are carried up 32 ft. thick to the coping, giving room for the sluice valves, closing chambers, and heel post anchors all in the solid masonry. The remainder of the lock wall has a thickness of 20 ft. at bottom and 10 ft. at the coping. The sluices are elaborately designed and well thought out. They consist of two main sluices, 6 ft. by 4 ft., on both sides of each gate. There are five inlets and four outlets. These are also faced with West of England granite.

The junction of the wall and invert is formed in a very efficient manner with a heavy skewback 5 ft. by 4 ft. 6 in. in section. This is also Forest of Dean stone. The gate platforms front and back are also of the same stone. They are respectively 3 ft. and 5 ft. in depth of bed. The other portions of the lock walls, as well as all the remainder of the dock walls, are built of Pennant stone from the Marquis of Bute's quarries, at present worked by Messrs. T. Nelson and Co., the contractors. The face work is principally formed of large-sized stone, snecked up with stone of the same kind. This is neatly squared up and dressed down to a true line on the face. It is of a uniform blue colour, and contrasts pleasantly with the Forest of Dean stone. The average depth of bed of ashlar is 2 ft. 9 in. The headers are placed 10 ft. apart



Section of new Dock wall.

with a depth of bed from 4 ft. to 6 ft. The granite coping covering the whole of the walls, is 4 ft. by 2 ft. in section. The lock will be spanned by a hydraulic swing bridge by Messrs. Sir W. G. Armstrong and Co., for the purpose of carrying the various lines of railway over the lock to the east and lower parts of the Roath Basin and new dock.

The masonry of the dock wall is 24 ft. thick at bottom, 50 ft. 6 in. high, and finishes with a breadth of 12 ft. 6 in. at top. The coping is similar to that of the lock. The walls are battered 5 ft. with a radius of 209.523 ft., and to the original surface of ground — a height of 33 ft. 6 in.—are backed by 2 ft. of concrete. There is a concrete toe in front of the foundation of the wall of an area in section of about 4 ft. by 5 ft.; the subjoined engraving gives a section of the wall. At the four corners of the dock in the curves are sets of granite steps, which present a very neat appearance.

There will be, when complete, about 250,000 cubic yards of masonry in the lock and dock walls, independently of the solid ashlar and lock.

The excavation for this large work will necessitate the removal of about two and a half million cubic yards of earth. The depth of excavation runs from 30 ft. to 40 ft, From the surface for a depth of about 18 ft. the material is a description of silt and blue clay; below that it is red marl. About one-third of the area of the dock will be on land, at present being reclaimed from the foreshore. In fact, nearly the whole of the land on which the dock will stand has been at one time or another reclaimed.

At the time of our visit we were informed that nearly 100,000 cubic yards of masonry had been built, and this part of the work was evidently proceeding with great rapidity. There were sixteen steam cranes at work in various parts. The masonry is, as will be seen from the figures quoted, of unusually massive construction, and is exceptionally well put together.

Up to the present time, roughly speaking, nearly half the excavation has been completed. This work has been done by five powerful steam navvies by Messrs. Ruston, Proctor, and Co., of Lincoln. Attending on these, are eighteen locomotives, some with 16 in. cylinders, considerable power being required for the heavy inclines. About forty miles of rails have been laid down on the work, and there are nearly 500 wagons and 300 trucks employed. There are five steam cranes lifting the excavated material from the foundations for the dock walls. There are eight portable engines for pumping and mortar grinding, &c., and eight mortar mills. All the earth excavated is being deposited on the foreshore, at once forming a dam and reclaiming about 600 ft. outside of the dock walls in addition to the area of the dock itself.

The Cardiff Junction Dry Dock and Engineering Company.

The dry dock of this company is situated between the West Bute Dock, and the basin to the East Bute Dock, and forms a junction between the two. The position is shown on the plan of the Bute Docks, which we publish on page 133. In addition to the dock, the company have two other establishments in the neighbourhood, viz., an engine-fitting shop and foundry, and a large boiler-making shop. The two entrances are closed by caissons, the one at the south-east end carrying a line of rails; pulsometers are used for pumping out these caissons. The length of this dock is 420 ft., the width 76 ft., and the entrances are 50 ft. A depth of water of 18 ft. on the blocks can be obtained at all times. Surrounding the dock are the various shops required for the repairing work.

Passing to the north-east side we come first to the plate and angle furnaces. These are placed in front of the slabs, which are under a light iron roof, that also covers the rolls, steam punching and shearing machines, countersinking and drilling machines, a plate planing machine, and a machine for bending the garboard strakes of vessels. Next to this is the smithy, which has six fires, blown by a Root's blower and duplex engine by Messrs. Thwaites and Carbutt. There is a small steam hammer in this shop.

The pumping engine used for emptying the dock is placed in a building in the centre of the premises. It is of the horizontal compound condensing type, the cylinders being 22 in. and 40 in., by 30 in. stroke. There is a jet condenser, and the air pump works from the end of the crankshaft. This engine is geared 3 to 1 to a pair of centrifugal pumps of the ordinary type used for work of this description. They are 4 ft. 3 in. in diameter, and work in one well. In the same engine-house there is also a direct-acting beam pumping engine with a 16 in. cylinder and a pair of 19 in. bucket pumps having 4 ft. stroke. This is used for keeping the dock dry. With these appliances the dock can be emptied in two hours. The engines are driven by a pair of return-tube boilers 10.3 ft. in diameter and 11 ft. long, each containing two furnaces. The working pressure is 70 lb. The engines and boilers have been made by Messrs. Parfitt and Jenkins, of Cardiff. Next to the pumping engines is a machine shop containing lathes, planing and shaping machines, drills, and in fact all the tools necessary for carrying on ship repair work. The principal of these is a treble-geared surfacing and screw-cutting lathe by Messrs. Hethrington and Co., of Manchester, which will take between centres, a shaft 32 ft. long. It has a sliding bed, the leading screw being inside, and is worked by gearing passing beneath the foundation. There is a gap which opens 12 ft., and will take work 6 ft. in diameter. The bed of this lathe is of unusually solid proportions. Belonging to this department there is a portable cylinder boring machine, suitable for boring out the cylinders of vessels in position.

Adjoining the last-mentioned shop is the wood-working machinery, and on the opposite side of the dock are the carpenters' shops, stores, offices, &c. The north-east side is served by a steam crane, and at night the yard is lit by electric light. A line of rails connecting with the main system runs into the yard.

The Tubal Cain Engine Works, which also belong to this company, are situated at the northern end of the Bute Docks. The principal building consists of the machine and erecting shop, at the end of which are the smiths' and copper-smiths' shops. The machine and erecting shop is served by an overhead travelling crane which commands the whole length of the building. The plant includes all tools necessary for turning out engines for steamships and other marine work. At the time of our visit two pairs of screw engines of the ordinary compound type, one 120 and the other 100 horse-power, were being erected. In this shop several of the locomotive engines used on the Bute Docks were constructed, and some of the hydraulic engines and coal tips were also supplied by this firm. The foundry to this establishment is about 240 ft. long and 40 ft. wide; here propellers, engine beds, cylinders, and other heavy castings are made. Two large swing cranes which take from one to another, command the whole floor. There are two cupolas supplied with blast by a Root's blower. A line of rails connecting with the main system runs into the yard, passing under a gantry and travelling crane; pattern shops and necessary offices complete the works.

The third establishment of this company is situated on the west side of the public graving dock which opens on to the northern corner of the Roath Basin. It is known as the Roath Dock repairing works, and consists principally of a large boiler shop. There are eight smiths' fires, plate furnaces, rolls, punching and shearing machines, a plate planing machine, drills, and all necessary tools of this nature, including a steam rivetter. In this yard all the heavy welding jobs are done, such as repairing broken stern frames, keels, &c. The railway runs into the yard and shop, the latter having an overhead steam travelling crane. One or two small steamers have been built here, as well as three pairs of lock gates for the Bute Docks, one leaf of these being 65 tons in weight.

It may be mentioned that the public graving dock is 580 ft. long and 60 ft. wide at the entrance. The depth of water at spring tides is 23 ft.

Petroleum Fuel for Locomotives.

On the meeting being resumed on Wednesday morning the first paper read was one by Mr. Thomas Urquhart, of Borisoglebsk, Russia, "On the Use of Petroleum Refuse as Fuel in Locomotive Engines." This was an excellent paper on an interesting subject* and gave rise to a well-maintained discussion. In his paper Mr. Urquhart stated that the first experiments on the use of petroleum for fuel on locomotives, were made in 1874 by the author on the Grazi and Tsaritsin Railway, South Russia, but at that time the great cost of the fuel prevented its extended use. Naphtha refuse has a theoretical evaporative power of 16.2 lb. of water, and anthracite of 12.2 lb. at 120 lb. pressure per square inch, hence petroleum has, weight

* Articles on this subject will be found on pages 578 and 600 of vol. xxxv. of Engineering.

for weight, 33 per cent. higher evaporative value than anthracite. In locomotive practice a mean evaporation of 7 lb. to 7½ lb. of water per pound of anthracite is generally obtained, thus showing 60 per cent. of efficiency. But with petroleum, the author said, an evaporation of 12.25 lb. is practically obtained, giving 75 per cent. efficiency, and hence the practical evaporative value of petroleum must be taken at 63 to 75 per cent. higher than that of anthracite.

The form of spray injectors, which had been found by the writer to give the best results, was illustrated by diagrams. A combustion chamber is constructed with firebrick inside it, which, when heated, acts as a regenerator, retaining the ignited gases long enough to secure their thorough admixture with air. In certain instances the incoming air at the forward ash-pan damper, was heated by passing through a narrow channel in the brickwork. All the locomotive sprays were worked with steam, but in a tyre-heating furnace the author uses an air blast from a Roots blower. In this the cost of fuel is only one-third of what it was with bituminous coal, and the work done per day has increased 25 per cent. Four spray nozzles are arranged tangentially to the tyre, and there is a circulation of flame all round.

To get up steam in a petroleum-fed locomotive, it is temporarily connected to a shunting locomotive or stationary boiler, to obtain steam for the blower and the spray jet. Steam can be raised to 45 lb. in 20 minutes, and to 120 lb. in 55 minutes. If the water be already hot, the full pressure is obtained in 25 minutes. In lighting up, the spray nozzle is first cleared of water by the steam jet, and at the same time the blower in the chimney is started for a few seconds, to draw the gas, if any, out of the smokebox. A piece of cotton waste, or a handful of lighted shavings, is put in the combustion chamber, and the spray turned on; the oil immediately ignites without an explosion, and then its quantity can be augmented at pleasure. When the fuel is turned off, as in descending a long incline, the ash-pan doors are closed, and also the revolving air damper in the chimney, to retain the heat. When the fuel is turned on again, the box is hot enough to light it.

There are 72 locomotives running with petroleum under the author's care; 10 of them are passenger engines, 17 are eight-wheel coupled goods engines, and 45 are six-wheel coupled. The length of line over which they run is 291 miles, from Tsaritzin to Burnack; and there are four main storage reservoirs, each holding 2050 tons. At each shed there is a distributing reservoir provided with a gauge-glass and a scale.

The paper ends with a number of tables. The first gives the specific gravity and weight of petroleum refuse at different temperatures. The second is the record of 17 trips, giving a mean consumption of 39.15 lb. per train mile. The third gives the results of comparative trials of different kinds of fuel in summer and winter. In comparison with anthracite, the saving in favour of petroleum was 55 per cent. in cost, and 41 per cent. in weight. With bituminous coal there was a difference of 49 per cent. as to weight, and 61 per cent. as to cost. The fourth table is the record of 19 trials in summer, and shows a consumption of 32.08 lb. per train mile. Other tables give the consumption for each month in the year. In conclusion, the author said that although it was scarcely possible that petroleum firing will ever be of use for locomotives in England on ordinary railways, yet its employment on underground lines would be an enormous boon.

In the discussion which followed Mr. Urquhart's paper the first speaker was Mr. Joseph Tomlinson, Jun., who directed attention to the difference between the relative comparative values of petroleum and anthracite as given in the earlier part of the paper with the saving effected in actual practice with locomotives as recorded in the latter portion of the communication, the advantage possessed by the liquid fuel in the latter case being much smaller than in the former. Considering how largely Mr. Urquhart has used the liquid fuel he (Mr. Tomlinson) wondered that he had not constructed a special locomotive boiler for its use, while with regard to Mr. Urquhart's suggestion that the petroleum fuel was well fitted for use on underground lines, he considered that it would never do to use it on the Metropolitan Railway, on account of the danger attending its storage and other considerations. He added that at present there was practically no smoke made on the Metropolitan line, the engine chimneys being entirely free from any soot deposit and only dust being discharged.

Mr. William Boyd, of Newcastle, who spoke next, remarked that he had no experience in working locomotives with liquid fuel, but he had supplied the machinery of some steamers for service on the Caspian Sea which were fitted up for using such fuel. A diagram showing the arrangement adopted in this case was exhibited. The boiler shown had two furnaces and the petroleum fuel was brought to it from a storage tank by a pipe passing across the front just below the firehole doors. From this pipe branches, fitted with cocks, conveyed it to two brass arms—one to each furnace. These arms had double passages formed in them, the upper passage in each arm receiving the petroleum refuse, while to the lower steam was admitted. At the end of each arm, facing the centre of the furnace, were two jets directed at an angle of about 45 deg., so that the steam discharged from one met the liquid fuel discharged from the other, and injected it into the furnace. The furnace had an ordinary grate, provision being made for closing the ash-pit by a damper. A lump of greasy waste placed on the grate served to ignite the jet. The arrangement described had been fitted to five vessels, and the only special point about the boilers was that the tubes were longer than usual in proportion to their diameters. In the first boilers the tubes were made 3¼ in. in diameter and 7 ft. long, but in the latest they had been made 2¾ in. in diameter and 9 ft. long. He (Mr. Boyd) had been struck by the value (20s. and 21s. per ton) placed on the petroleum fuel by Mr. Urquhart. On the Caspian the value was very much less. He regretted that he had not any accurate data as to the evaporative performance of the boilers to which he had referred, but it appeared that the consumption of the petroleum was about 2½ lb. per indicated horse-power per hour. Judging from the reports he had received, however, he believed that, owing to its excessive cheapness, it was carelessly used. Mr. Boyd also referred to the Tables given in Mr. Urquhart's paper, and directed attention to the enormous difference between the consumption of fuel in the summer and winter months; he wished to know if this was a normal result. Finally he observed that petroleum fuel gave the power of raising steam very rapidly, more rapidly in fact than was desirable in the case of ordinary marine boilers.

Mr. G. B. Rennie remarked that the system of burning petroleum described in the paper closely resembled one which his firm had tried some twelve or fourteen years ago. They had then used it on their workshop boiler, and the results of the experiment—running one month with coal and another month with the liquid fuel—showed an advantage in favour of the latter. The price of the petroleum, however, increased, and its use was then abandoned. His firm had also fitted the injecting apparatus to a steamer sent out for service on the Tigris, where it had been used, but the difficulty of getting clean oil and the consequent clogging of the jet led to its abandonment.

Mr. Tartt, the superintendent engineer of the company for whom the steamer referred to by Mr. Rennie had been constructed, next read an interesting statement of the results which had been obtained with liquid fuel in this case. We cannot give Mr. Tartt's figures, but we may say that the economical results were decidedly in favour of the liquid fuel. It was, however, at one time found very difficult to obtain steady supplies of this fuel of suitable quality, and hence its use was abandoned. In the earlier experiments the fuel was injected on some bricks laid loosely on the bars, and covered with ashes, and it was found that dense smoke was evolved, and that there was a strong smell of unburnt petroleum. In a subsequent trial the bridges were built up to the crowns of the furnaces, interstices being left between the bricks for the gases to pass through. In this case there were also evidences of incomplete combustion until the bricks got thoroughly hot, when a clear, bright flame was obtained.

Mr. T. R. Crampton, who spoke next, had no doubt that petroleum refuse could be successfully burnt; the only question as to its employment here was one of cost. When such fuel was experimented with some years ago, it was found that owing to the limited supply here, its employment at once led to increase of cost. With reference to the mode of burning such fuel described in the paper, he thought that it would be improved if the air required was taken in with the steam and fuel, and proper means provided for regulating its supply. With proper arrangements perfectly constant results should be obtained. He added that it was desirable to know how the smokebox temperatures were affected by the use of petroleum fuel; he anticipated that with this fuel the temperature would be lower.

Mr. F. C. Marshall, of Newcastle, stated that his firm (Messrs. R. and W. Hawthorn) had also fitted up a marine boiler for using petroleum fuel, the arrangement being very like that described by Mr. Boyd. He had found it desirable to use very long tubes, and had made them even longer than Mr. Boyd had done, they being 2½ in. in diameter with a length of 10 ft. Even with these proportions the flame came out at the ends. The question of properly adjusting the supply of air was a most important one, and he agreed with Mr. Crampton as to the desirability of the air being taken in with the steam and fuel. In the boiler to which he had referred the want of more air was very evident, much smoke being formed. This evolution of dense smoke was a subject of complaint on the Volga in the case of steamers using liquid fuel. He was not able to give any data as to the performance of the boiler he had mentioned, but the engineer stated that when using petroleum steam was kept up much more easily than when burning wood. Referring to the remarks of Mr. Boyd as to petroleum fuel giving the power of getting up steam in a marine boiler more rapidly than is desirable, Mr. Marshall observed that it was a pity that we had not yet been able to produce a marine boiler in which there was an efficient circulation while steam was being got up. He believed that the time would come when many steamers trading in the Mediterranean, would find it preferable to obtain liquid fuel from some of the Black Sea ports rather than coal from England. The question of smokebox temperatures required more attention than it had generally received; he would like to see a chimney dispensed with and the products of combustion passing off at a temperature little above that of the steam in the boiler.

Referring to the different arrangements which had been described Mr. Jeremiah Head pointed out that in the locomotive fireboxes described by Mr. Urquhart, there were large masses of brickwork which were absent in the marine boiler furnaces mentioned by other speakers. This would account for some difference in the results as far as the attainment of complete combustion is concerned. There was no doubt that an accumulator of heat was much wanted with liquid fuel, while it also appeared important that both the fuel prior to injection, and the air required to support combustion, should be preliminarily heated. He doubted if the steam used for injection was decomposed; he rather thought it probable that it passed into the smokebox as steam.

Mr. P. F. Nursey observed that in 1878 he was present on board a steamer fitted up for burning liquid fuel, when it was tried between London and Gravesend. The results were satisfactory as far as the combustion of the petroleum refuse was concerned, but it was subsequently found that no regular supply of the required fuel could be obtained at a moderate price, and the intention of regularly working the steamer with such fuel was abandoned. He added that some years ago he had been interested in the introduction of petroleum into steam boilers for the purpose of preventing priming, according to the system patented by a Danish engineer. The plan had been tried very successfully, amongst other cases, on the steamer Ida, belonging to the London, Brighton, and South Coast Railway Company, and trading between Newhaven and Dieppe. The boilers of the vessel primed so badly that it was proposed to take them out; but by the employment of the petroleum this fault was cured. The petroleum was injected with the feed, a small quantity being put in at the commencement, and again about the middle, of each trip. It was found that not only did this use of petroleum prevent priming, but also that it did away with hard incrustation in the boiler, and rendered unnecessary any lubrication in the engine cylinders.

Mr. Bedson remarked that his firm, being manufacturers of charcoal iron, had at one time a large quantity of charcoal dust to get rid of, and that they had utilised it by mixing it with refuse petroleum and burning it, but the price of petroleum advanced and its use was discontinued. Mr. W. S. Tomkins pointed out that the locomotive boilers shown in Mr. Urquhart's diagrams could only be regarded as make-

shifts, or adaptations of existing boilers; he believed that when Mr. Urquhart designed special boilers for petroleum fuel, it would be found that the construction could be much simplified, the present expensive copper firebox being done away with and other changes made. Mr. Boyd, he added, had referred to the difference between the fuel consumption in the summer and winter months during Mr. Urquhart's trials; this, he said, was always so in Russia, the consumption in water being largely increased by the inclemency of the weather, &c.

Mr. Cardew, of the Indian State Railways, next spoke as to the use of petroleum as a disincrustant in locomotive boilers. On the Indian State lines they had exceptionally bad water to deal with, this water containing a large proportion of sulphates; so much so that the boilers had to be washed out after every 100 miles run. With a view of obtaining the deposition of the solids in the form of dust, the introduction of Rangoon oil had been tried, but at first the result was to cause excessive priming and to produce leaky tubes, &c., so much so that when an engine using it went out they never quite knew when it would get back again. Eventually, however, they found that by using very minute quantities of the oil they got the desired result without these inconveniences, and the practice ultimately arrived at was simply to paint the interior of the tender tank with kerosine each time the boiler was washed out. The application of kerosine as an anti-incrustator had been made on several Indian railways, but he believed that on some it had been given up as being too ticklish to manage.

Mr. Druitt Halpin observed that he had for years successfully used petroleum as an anti-incrustator in boilers supplied with worse water than that found in the Punjaub (with the character of which he was acquainted). The boilers in which he had used it were of the Lancashire type, 7 ft. in diameter by 30 ft. long, and from a pint to one and a half pints of petroleum was used per boiler per week, the petroleum being put in the boilers through the safety valves on Monday mornings.

The President, in bringing the discussion to a close (the author not being present), remarked that he agreed with the statements in the paper as to the heating power of petroleum, but the latter, of course, varied much in quality. If we were to employ petroleum in place of coal for firing boilers in this country the effect would be a rise in the price, which would in turn render its use prohibitive. He agreed also with the desirability of carefully adjusting the air supply so as to obtain the best results, imperfect combustion being a serious cause of loss. With regard to a remark made by Mr. F. C. Marshall, he observed that as the rate of transmission of heat through the heating surfaces of a boiler fell off as rapidly as the difference of temperature on the two sides of a plate was diminished, it would never be possible practically to even approximately fulfil the conditions which Mr. Marshall aimed at, the additional heating surface required to approximate to this result being such as to render it impracticable. A speaker had referred to the firebricks in the furnace as forming a "regenerator;" this was incorrect, as the bricks trapped no heat which would otherwise be lost, they merely acted as equalisers of temperature. With regard to the differences which appeared in Mr. Urquhart's paper between the relative evaporative powers of petroleum and anthracite and their relative economic powers as fuel in locomotives, he pointed out that in the latter case, the result was affected by the heat absorbed in generating the steam used in injecting the fuel, and other losses. The admission of this steam to the furnace might also become a source of loss. Of course if the steam was decomposed heat would be absorbed, and if its elements recombined before leaving the furnace this heat would be restored and the total effect of the two operations would be *nil*; if, however, the recombination did not take place a loss would ensue. In conclusion he proposed a vote of thanks to Mr. Urquhart for his paper—a vote which was heartily carried.

The Corrosion of Marine Boilers.

The second and last paper read on Wednesday was one entitled "On the Causes and Remedies of Corrosion in Marine Boilers," by Mr. J. Harry Hallett, of Cardiff. This was a short but very suggestive and practical paper, which we intend to print *in extenso* as soon as we can prepare the necessary diagrams. Meanwhile we may give an abstract of its contents.

The writer said that steel boilers were equally liable to corrosion with iron ones. Severe corrosion was often found concealed by a very slight scale, upon the removal of which the plate proved to be covered with a black substance, probably a black oxide of iron. The principal causes of corrosion might be discussed under the two heads of defective design and defective management. The most frequent fault of design was the want of sufficient space to allow a thorough examination of the interior. The tubes were often placed too far out in the wings, and the manholes were too small. They should always be fitted in the wings, if the size of the boiler would allow, and one at the bottom of the back end was to be recommended. The steam space stays should always come over the tubes and not over the spaces between them, as if they did they interfered with the use of the scaling tool.

Double-ended boilers are especially liable to suffer from racking strains, due to the difference of temperature between the upper and lower parts. One method of reducing this difference was to lead the feed-pipe along the level of the upper tubes, so as to warm the water before it was discharged at the bottom of the boiler. The scum pipe should be fitted with a pan shaped like an inverted saucer, and placed just above the level of the water for the scum to collect under. When the engines are standing, the water should be pumped to the top of the gauge glass, and blown off down to the bottom two or three times. In a voyage of seventy-two days with several stoppages, the author kept the boilers in excellent condition by the above plan. The mode of treatment adopted by the writer for new boilers is to have them washed out before filling, then to run them up with water to the normal height, and throw in a bucketful of common soda. Then steam is raised to 30 lb., and the scum cock is opened for a little. The donkey pump is washed out by being made to deliver overboard at first, and the feed water overflowing from the hotwell is allowed to run into the bilge for a time. When boilers put out of work they should be blown out from the bottom and kept thoroughly dry.

Corrosion in the upper parts of the boilers is principally caused by the introduction of grease from the engines, and good effects follow from discarding the use of lubricants in the cylinders. Various remedies have been tried for preventing corrosion, such as air extractors, circulating tubes, and zinc. The writer had found Mr. Hannay's "electrogen" very effective, as far as he has experimented with it. It consists of a ball of zinc cast upon a copper bar, and then hammered to make it more impervious to the action af the water. On each end of the copper bar a wire is soldered, and the two wires are again soldered to the different parts of the boiler, so as to obtain metallic contact. Boilers which had shown a tendency to corrosion looked quite healthy in a very short time after these appliances had been fitted to them. Marine boilers do not often suffer from external corrosion, but the author had met with bad results from the bridge being built up to the backs of the combustion chambers. He considered that when a vessel was laid up it was a good plan to pump the boiler full to the very top of the dome, or to empty it thoroughly, put it in a stove of burning coke, and close it up.

Mr. Hallett's paper gave rise to an excellent discussion, the first speaker being J. R. Fothergill, who differed from many of the author's conclusions. Mr. Fothergill first referred to the erratic character of corrosion and to the evidence collated by the Admiralty Committee on Boilers. Defective circulation, he remarked, was more a fault of old boilers than new ones, but in the latter corrosion was met with in places where the circulation was good. He considered that the best preventative was to keep a slight scale on the surface. From many experiments, also, he believed that the presence of air was an important factor in the case, and this had been shown by suspending strips of iron in an air pump and feed pump, when that in the air pump (where the water was freed of air) was untouched and that exposed in the feed pump was seriously corroded. Air also increases the formation of a greasy mud which will not adhere to the plates, and prevents the formation of a protective scale. He believed that if the feed water was thoroughly freed from air and oil there would be very little corrosion. Referring to some remarks in Mr. Hallett's paper, that in a boiler only partially emptied instead of being completely blown out, the bottom water became heavily charged with solids, he stated that these could only be solids in suspension, and he considered there could be no sensible difference in the quantity of solids in solution in different parts of a boiler. He was an advocate for admitting the feed near the water level, so that any air it contained might be at once liberated into the steam space and not have to work its way up through a large body of water. He had found that corroded places could be best treated by carefully washing them with soda and then coating them with a wash of Portland cement. This would generally prevent further mischief. Mr. Hallett had spoken in his paper of doing without lubricants; did he—he asked—also prevent oil working in through the stuffing-boxes. Instead of emptying boilers as Mr. Hallett advised, he considered it better to let boilers stand full of water until cold and then to run the water off. The reputation of many mineral oils was, he considered, exaggerated, particularly when used in connection with steam at high pressures; he was at present engaged in investigating this subject, and he would, if the members were agreeable, at some future time lay his results before the Institution.

The next speaker referred especially to the electrical aspect of the question, and advocated the use of amalgamated, in place of plain zinc in boilers, so as to get practically the action of pure zinc, which was not commercially obtainable. It might be also desirable to connect the zinc by wires to various parts of the boiler so as to obtain a better electrical connection than now always existed. A block of amalgamated zinc so connected would be considered to do all that the electrogen referred to by Mr. Hallett could do, and the more so if the zinc was used in connection with a copper plate forming a galvanic couple.

Mr. Jacobs next mentioned the case of a vessel built about four years ago, which made at first a five months' trip, during which her boiler was not opened. On her return it was found that some stays had been reduced by corrosion from 1⅛ in. to ⅝ in. in diameter, and that there were also seriously corroded patches on the plates. It was at first feared that the boiler was ruined, but the stays were renewed, the corroded places washed with petroleum and coated with a wash of Portland cement, and the feed was altered so as to deliver near the water level. The result was to stop the mischief and the boiler was now working.

Mr. F. C. Marshall thought that in face of the very conflicting evidence collated by the Admiralty Committee, it would be of much interest to know what conclusions the Admiralty had arrived at, and what were the details of their present practice with regard to the prevention of corrosion, in their boilers. He suggested that one of the members connected with the Admiralty should be invited to contribute a supplement to Mr. Hallett's paper. As an instance of one of the causes of corrosion, he proceeded to describe the case of a double-ended boiler made by his firm, in which about 100 tubes failed from pitting after being a very short time in use. In this case it had been the habit to only partially empty the boiler, and it was found that the pitting took place on the under side of the tubes at the ends which, owing to the trim of the vessel, were lowest. Tracing the matter out, it was found that the manner in which the boiler had been treated had led to moisture being left on the tubes, this moisture draining down and dripping off the tubes at the spots where the corrosion occurred. In another case, the sides of a furnace were extensively corroded just along the level of the firebars—neither above nor below—and it had occurred to him that the plates at this point might, owing to the presence of the firebars, be in a different electrical condition to what it was elsewhere. Both the boilers above referred to were of iron, and so far he had found less corrosion with steel than with iron. He considered that there could be no question as to the desirability of excluding air from boilers. In conclusion, he remarked that many foreign engineers successfully introduced small quantities of petroleum into their boilers to prevent priming.

Replying to the remarks of the various speakers, Mr. Hallett stated that he had expected an energetic discussion of his communication. In his experience he had found that corrosion can be prevented by taking the courses recommended in his paper. As to the inquiry about lubrication, he

simply did away with all lubricators on the cylinders and valve chests, but of course some of the oil applied to the piston rods and valve spindles found its way into the cylinders. This, however, was not sufficient in quantity to do any harm. In the case of the s.s. Blue Jacket, no lubricant had been employed, and the cylinders, which had been shown to the members during their visit to the docks on Tuesday, were as polished as glass. In one case, where he had met with pitting in the line of the firebars and also on the tube-plate, he had the holes cleaned out and filled up with red lead, and no further corrosion had occurred, the boiler being now in excellent order. The boiler to which the electrogen had been applied had a light uniform scale throughout, and was in excellent condition.

A hearty vote of thanks having been accorded to Mr. Hallett for his paper, the meeting next proceeded to pass similar votes to those who have so liberally contributed to the success of the Cardiff meeting, including the mayor and corporation, the local committee, and its executive officers, the owners of the works so freely thrown open, and the railway companies who have given many special facilities. We may say here that nothing could be better than the manner in which the arrangements for the meeting were made by the local committee and its energetic honorary secretary, Mr. C. Hurry Riches. The members on all hands have met with a heartiness of welcome which, we are certain, will be long pleasurably remembered.

At the conclusion of the Wednesday morning's meeting the members were again entertained at luncheon by the local committee, and then proceeded to visit various works in Cardiff, or to take part in the four alternative excursions to collieries, namely, the Great Western, the Lewis's Merthyr, the Cymmer, and the Llwynypia Collieries, while in the evening a large number visited the Windsor Gardens, Penarth, at the invitation of Lord Windsor.

Want of space prevents us from noticing more than two of the day's excursions—the visit to the Taff Vale Railway Company's repairing shops and the Mount Stuart Dry Docks.

The Taff Vale Railway Company's Repairing Shops.

The locomotive and repairing shops of this company are situated at West Yard, close to the Bute Docks. Having been constructed piece by piece as the growth of the company and the introduction of more modern appliances demanded additions, they have not that symmetry of arrangement that is so noticeable a feature in the recently completed running sheds of the company. The latter are fully described in the paper of Mr. Charles Hurry Riches, which is referred to elsewhere. The locomotive shops are, however, conveniently arranged and contain all the appliances requisite forturning out a high-class locomotive. This is proved by the fine engine that Mr. C. Hurry Riches, the engineer to the company, has recently designed and which we believe was used for the first time in taking the visitors of the Institution on the various excursions over the Taff Vale line.

In passing from the offices of these works, we first come to the paint shops, where there is a steam apparatus for rapidly drying the work in cold or damp weather, and which is said to be found very efficient. The fire-extinguishing arrangements here are very complete. Steam ejecting apparatus is placed in front of the paint store, by means of which, any oil or inflammable material which may take fire, may be driven out if not extinguished.

Passing from the paint shop we noticed in the yard a portable hydraulic fire engine. This belongs to Penarth Docks, of which the Taff Vale Company are the lessees. The engine is arranged to couple on to any part of the hydraulic mains laid down in the docks, and with a pressure of 700 lb. will throw 700 gallons of water per minute to a height of 150 ft. The carriage has an iron frame, and can be drawn by horses or by hand. It should be mentioned that in this repairing yard there are 6 in. mains running all round, which have hydrants at every 50 ft. Extincteurs and hose cupboards are placed at intervals throughout the premises.

The erecting shop is placed in the middle of the yard, and contains eleven pits. In addition to this there is room for four boilers which may have their mountings fitted on at the same time. Under a lean-to roof there is convenience for fitting seven other boilers, so that eleven boilers can be prepared, and eleven engines can be erected at the same time. The pits run across the shop and there are traversers at each end running the entire length. There is also a portable gantry which can be placed over any pit as required. It is run by an endless band on the shafting in the shops. The heating here is by steam, small radiating stoves of a neat pattern being provided.

From the erecting sheds we pass to the machine shop, where there are all the necessary machine tools, such as cylinder boring machines, lathes, and other appliances of a like nature. In the adjoining store we noticed Richter's patent oil economiser and filter, a simple apparatus, but one which saves a deal of unpleasantness and waste. Another feature we noticed in this part of the works was the solid iron shutters which come down and shut in all open fireplaces at the time the establishment is closed. A special apparatus in this part of the works is a boiler tube drawing apparatus, which has now been in use for some time and was designed by Mr. Riches. It consists of a wrought-iron frame in which a crosshead slides. The latter has attached to it a clip, by which the end of the tube is firmly held. A pair of dies are fixed in the machine; these have a slight taper, the smaller end being of somewhat less diameter than the diameter of the tube. The brass boiler tube is forcibly drawn through the dies and the effect is that although the diameter is decreased, the tube is made longer and the gauge of metal slightly increased. The machine is used for working up old tubes that have become defective at the ends, and undoubtedly forms a better means of repair than the ordinary way of cutting and piecing the tubes.

Around the yard are other machine shops with necessary tools for turning out locomotive and hydraulic work. A good deal of the latter class of machinery is made here for use at Penarth Dock and harbour, for hydraulic cranes and lifts, coal machinery, &c. We also noticed a Tweddell's hydraulic rivetter with a compound accumulator, also a stationary pump by Messrs. Merryweather and Sons for fire-extinguishing purposes. In the yard there was also a gas apparatus for heating tyres. This consisted of two pipes, each bent to a semicircle and pierced with holes. They form a couple of atmospheric burners the size of the wheel, and are connected to the gas main by flexible tubing. A suitable hollow shield or casing is provided for retaining the heat.

In the boiler shop there are six fires and a three-tier rivet furnace, by which thirty rivets can be heated per minute easily. The boiler shop is served by an overhead crane running over the hydraulic rivetters. The latter will take 7 ft. in the gap so that a whole boiler can be rivetted. It will also take work 20 in. wide, in order that it may be used for girders.

In the smiths' shops there are fourteen fires and the usual appliances. There are two small steam hammers 10 cwt. and 15 cwt. respectively. There are also two of Allen's steam strikers, which are said to be found of great service. There is a spring oliver, but this has been to a great extent superseded by the steam striker.

In the spring shop there is a machine for punching, shearing, and nibbing spring leaves, and other tools of the usual description.

Mount Stuart Dry Dock and Engineering Company.

The port of Cardiff is especially well provided with ship repairing yards, many of which are important establishments, well organised, and possessing plant necessary for successfully dealing with ship and marine engine repairs of the heaviest description. Most of these yards are situated within the precincts of the Bute Docks, but the company we are now dealing with has entrances on to the Bristol Channel, which are, however, situated close to the gates of the Bute Docks. In this yard are two graving docks, one of which has been but recently completed. The premises are shown on the plan of the Bute Docks, which will be found on page 133. The older, or No. 1 dock, is 324 ft. long, 70 ft. wide, and has gates 45 ft. wide. The depth of water at ordinary spring tides on sill and keel blocks, is 20 ft. No. 2 dock is 420 ft. long and 100 ft. wide. The entrance gates are 52 ft. wide, and the depth of water on sill and keel blocks at ordinary springs, is 26 ft. In this dock, two vessels, each of 360 ft. length, can be placed alongside each other, it being customary to give them a slight list towards the dock wall, and only shore them on one side. In the event of having to provide for a ship of greater length, the centre keel blocks would be used. There is rather an unusual feature about this dock. It opens on to the tidal water of the Channel, and in order to enable ships to be afloat if necessary, internal gates are provided so that the water can be retained. These gates are high enough to give 20 ft. of water above the keel blocks. We understand that these dry docks are the only ones between Swansea and Cardiff which open directly on to the Bristol Channel, others having entrances out of loading docks. Another advantage this company possesses in their present site, is that ships requiring only internalrepairs can be comfortably berthed on the mud alongside the boundary wall of the premises.

The various buildings surrounding the two dry docks contain all the plant necessary for heavy marine repairs. Entering the gates from the road we find on the right a machine shop containing various tools. A large lathe which will take work 8 ft. in diameter was on the occasion of our visit engaged in turning a marine engine crankshaft. A radial drill was boring a propeller 17 ft. 6 in. in diameter which was for the s.s. Nedjed. Another propeller weighing 10 tons, and 18 ft. 6 in. in diameter, had also recently been bored. Another tool here seen is a shaft lathe, which will take work 24 ft. between centres, and there are besides various tools, such as drilling machines, planing machines (one with a bed 16 ft. long and 4 ft. between frames), &c. There is a travelling overhead crane. We noticed several steam winches in course of construction here.

A second machine shop contains a lathe with a 26 ft. bed. By shifting the latter a pit is exposed which enables work 10 ft. in diameter to be chucked. There are also several other machine tools of the ordinary description, as well as brass-finishing machines. From the latter shop the visitor goes to the sawmill, which contains frame, circular, and band saws, besides other wood-working machinery. There are two foundries in this yard, one set apart for lighter work where firebars are the chief production, 9 to 10 tons being sometimes turned out in a week; the main foundry is adjoining. It has three cupolas, and is capable of turning out castings up to 20 tons. Next to this is a brass foundry with four furnaces. The boiler yard and smithy are at the back of these buildings. There are seven fires and two large ground fires capable of heating large forgings such as keels, stern frames, or sterns of vessels, accidents to which afford a good deal of work at times. Here are made iron and steel boilers, some up to 36 tons weight having been turned out. There are also plate rolls, steam punching and shearing machines, plate blocks, plate and angle iron furnaces, and all the necessary plant of this description, including a steam rivetter. The general smithy has ten fires. A small steam hammer is placed here. Pattern makers and joiners' shops, coppersmiths' and plumbing shops, and a block and mast-making shed, together with a rigging shop, complete the establishment. A line of rails runs into the yard from the Bute Dock system.

With the proceedings of yesterday and the subsequent days we shall deal next week, when we shall also give notices of the four collieries above named, and of some of the works at Cardiff kindly thrown open to the inspection of the members.

NOTES FROM THE UNITED STATES.

Philadelphia, July 25, 1884.

Another disappointing week has passed to the manufacturers of crude iron, who were confident that the middle of July would bring into the market the host of buyers who were practically without stock. Not a single important transaction took place in this market in pig iron. Inferior stuff is being pushed at as low as 16 dols. to 17 dols. for forge, with standard and special brands at 17 dols. to 18 dols., while inferior grades of No. 2 and No. 1 foundry are sold in small lots at 18 dols. and 19 dols. respectively, with standard and special makes at 19 dols. and 20 dols. to 21 dols. respectively. Founders and mill owners are afraid to buy a sixty-day supply, as is usual at this season, lest a further break in prices should take place. Only an occasional furnace has its output for the next sixty or ninety days sold. Several offers have been made to secure contracts for ninety days, but the best offer would not cover cost. There are 130 anthracite furnaces idle, and there is very little prospect for resumption. The mills have nearly all started up, but the amount of business placed is trifling. The iron trade generally is in a backward condition, the only activity being in plate, sheet, and structural iron.

The business placed in this market this week will foot up about 4000 tons, which consists of nearly 2000 tons of structural iron in large and small lots, and nearly that much of plate iron. The sheet manufacturers are meeting with an encouraging demand, and quote refined sheets at from 3½ cents to 4 cents. Galvanised is selling at from 50 to 60 per cent. discount from circular rates. Bloom sheets 5½ cents to 6 cents. The Western Pennsylvania pipe mills are well off for orders. One 12,000 ton order for steel rails was placed at mill for 28 dols., the lowest price known. A good deal of rail-making capacity is temporarily idle, ostensibly for repairs. Some eastern rail-makers predict that they will drive two or three of the western mills out of the market. There is some sharp competition ahead, and nothing but a very general suspension in the rail works for two or three months, will remove the difficulties which threaten that branch of trade. The nominal price for large lots is now 29 dols. Bessemer is quoted at 10 dols. at tidewater. For old rails 19 dols. is asked, but buyers offer only 18 dols. The supply is greater than the demand. Quotations for Scotch irons are as follows: Clyde, 20 dols.; Eglinton, 19.50 dols.; Glengarnock, 20.50 dols.; Carnbrae, 20.50 dols.; Langloan and Shotts, 21.50 dols.; and Gartsherrie, 21 dols. These prices are all to arrive, from 50 cents to 1 dol. more is asked at yard. The plate mills throughout Pennsylvania are in good shape, and better than they have been in since last April. A large amount of business has unexpectedly presented itself. A great deal of bridge building is going on, and the structural iron manufacturers are somewhat elated at the business in hand and that to come. Nail makers are cutting each other's rates in a way which has hurt trade rather than stimulated it. The Pittsburgh manufacturers are complaining of the backwardness of trade, half of their pig iron capacity is idle. The mills throughout the Ohio Valley, at Cincinnati, Ironton, Mortsmouth, and Covington have started up under fair prospects, but there is great danger of crowding the market, and the business requires careful handling. The coal trade is looming up, and the anthracite production for the balance of the year will be satisfactory.

COAL SHIPPING AT CARDIFF DOCKS.

*On Recent Extensions of Dock Accommodation and Coal Shipping Machinery at the Bute Docks, Cardiff.**

By Mr. John McConnochie, of Cardiff.

On the occasion of the former summer meeting of the Institution held in Cardiff in 1874, the author had the pleasure of giving a paper on the Bute Docks and the mechanical appliances for shipping coal, in which he described the origin, growth, and existing extent of the dock accommodation at Cardiff, the balance tips and hydraulic tips and anti-breakage cranes in use for the shipping of coal, with the hydraulic hauling engine and portable hydraulic crane, and also the motive power for working the hydraulic machinery. Without repeating, therefore, the particulars then given, the object of the present paper is to describe briefly the further progress and improvements that have been effected during the ten years which have elapsed since that time.

A general plan of the whole of the docks is given in the map of Cardiff on page 133.

Roath Dock.—In 1882 an Act was obtained for the new Roath Dock now in course of construction, which is to be entered from the Roath basin through a lock 600 ft. long by 80 ft. wide, with three pairs of wrought-iron gates, similar to the gates in the sea lock of the Roath Basin. The gates are being constructed by Sir William G. Armstrong, Mitchell, and Co.

The dock is to be 2400 ft. long by 600 ft. wide, having an area of 33 acres. The depth from coping to sill is 43 ft. 6 in., and the bottom of the dock is 3 ft. below the sill level. The depth of water on the sill at high water is 35 ft. 8 in. at ordinary spring tides, and 10 ft. less at ordinary neap tides. The construction of this dock was formally inaugurated by the Marquis of Bute on January 30, 1882, and the work is to be completed in October, 1885, the contractors being Messrs. Nelson and Co., of Carlisle. It is intended to devote the whole of the north side and east end of the dock to the shipment of coal, and the south side to the import and export trade of timber, iron, iron ore, and general merchandise. On the north side will be erected appliances of the most approved kind for the shipment of coal.

Coal Shipping Machinery.—The first hydraulic machines at Cardiff for tipping coal direct from trucks into the vessels were four put up for the Great Western Railway as far back as 1857 by Sir William G. Armstrong and Co. They were fixed hoists, differing but little from those now in use, except that in two of them the lift was only 15 ft. and in the other two 22 ft. The increasing size of vessels has necessitated a corresponding increase in the height of lift of the coal hoists; and the last two hoists erected at Cardiff in 1880 have a range of 27 ft. These, curiously enough, were for the Great Western Railway, to replace the two with 15 ft. lift erected in 1857, which were found to have too short a lift. They are on the east side of the Bute East Dock.

Since 1874 the additional machinery for shipping coal is as follows:

a. One hydraulic tip has been erected on the west side of the East Dock by Messrs. Brown Brothers and Co., of Edinburgh.

b. Tips Nos. 1 and 3 on the west side of the East Dock have been converted from balance to hydraulic tips, the machinery being supplied by Messrs. Parfitt and Jenkins, of Cardiff, and erected by the workmen of the Bute Trustees.

c. Two hydraulic tips have been erected on the east bank of the River Taff, and are connected with the Great Western Railway by a branch from the main line near Cardiff station.

d. One movable hydraulic crane, capable of lifting 25 tons, has been erected on the east side of the Roath Basin, between Nos. 1 and 2 tips.

Movable Hydraulic Crane.—The employment of steamers instead of sailing vessels for carrying coal necessitates a much quicker despatch; and the increasing length and number of hatchways in the steamers has for some time made it most desirable to be able to load into two hatchways at least at the same time. With fixed machines this has been found impossible, except in rare cases, because the positions of the hatchways vary so much. It therefore became a question as to the possibility of using movable machines; and it was with a view of practically trying this that the movable crane tip at the Roath Basin has been put up. Fixed cranes have of course been in use for some years at other ports for shipping coal direct from the truck; but it has hitherto not been practicable to make such cranes movable, owing to the cradle or platform on which the truck is lifted requiring a pit or gap in the line of rails for its reception. This special seating for the cradle rendered it necessary that the crane should always pick up and deposit the wagons at one point. It is obvious that these arbitrary fixed points of picking up and depositing the wagons on the lines are not applicable to movable tips, inasmuch as it is absolutely necessary that the lines of rails should be parallel with the quay, and be continuous without break or gap, so as to be common to the tip in any position in which it may be placed along the dock wall.

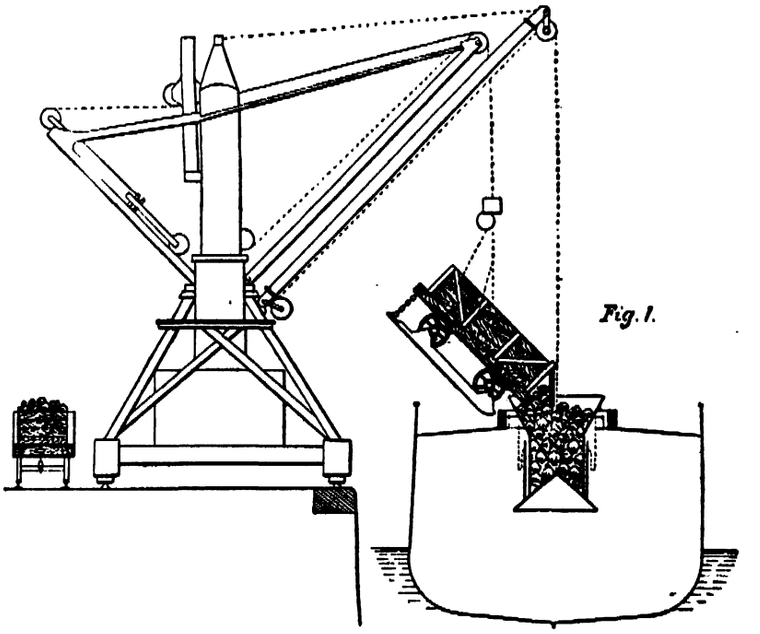


Fig. 1.

This problem has been solved in a very ingenious and efficient manner by Mr. Westmacott's coaling cradle, which must be looked upon as the key to the successful application of movable coal-shipping appliances. It may be described as a light platform suspended by chains, which takes its seat on an ordinary line of rails in any position. It is suspended on what may be called an anti-friction swivel, which enables a man to turn a cradle with a loaded wagon on it, thereby dispensing with turntables. There are no tipping chains to hook on and off every time a wagon is shipped, as is the case with coaling cradles of the usual construction: the tipping chains in this case pass through the centre of the swivel attachment, and are permanently connected with the cradle.

The crane itself, as shown in Fig. 1, consists of a nearly square wrought-iron pedestal or base, tapering upwards, and is carried on four wheels, one near each corner, running on rails of 24 ft. gauge laid parallel to the quay wall. These wheels, however, are used only for travelling on; the whole of the weight when working is taken by four hydraulic jacks, one at each corner, which effectually prevents any movement of the crane.

Rising out of the top of the pedestal, and revolving in bearings at the top and bottom of it, is the pillar, consisting of two flat plate-girders, between which is placed the hydraulic cylinder for lifting. The chain from this cylinder passes over the jib head, and both ends are attached to the cradle. The jib is attached at the lower end to the front of the pillar, just above the pedestal; and at the outer end by stays to the top of the pillar. At the back of the pillar is fixed a second hydraulic cylinder, which effects the tipping of the wagon by making a bight in the tipping chain that passes over the jib head to the cradle. The tipping chain is always kept taut by a third hydraulic cylinder, placed on an inclined frame which is fixed to the pillar at the back in the same way as the jib is in front. Thus the tipping cylinder proper needs to have a short range only. The inclined cylinder and its frame act as a counterweight, for balancing in some measure the load hanging from the jib head.

The turning of the pillar and jib is effected by a pair of hydraulic cylinders, one on each side of the pillar, fixed to the base of the pedestal, which itself remains stationary. The chain from these cylinders passes round a drum at the foot of the pillar.

All the motions are controlled with the greatest ease by one man in a valve-house on the side of the pedestal. There are two of these houses on opposite sides of the machine, so that he can use whichever is most convenient for enabling him to see into the vessel. The pressure water is conveyed to the crane by movable and jointed pipes which can be attached to hydrants placed at convenient distances on the hydraulic mains along the quay wall.

There is an auxiliary or anti-breakage crane, designed by Mr. Hunter, of the Bute Works, on the side next the dock, the foot of the jib being carried from the pedestal, and the top by means of a chain from the top of the pillar. By an arrangement of a hopper resting on the dock (Figs. 2 and 3), with telescopic throat which is closed by a conical bottom or valve held up by the auxiliary crane, the first few wagonfuls of coal can be lowered quietly to the bottom of the hold, and a conical heap formed for the following coal to fall on, as is done at the hoists, so as to lessen the breakage of the coal. When the anti-breakage crane is not in use, it can be swung to one side, clear out of the way.

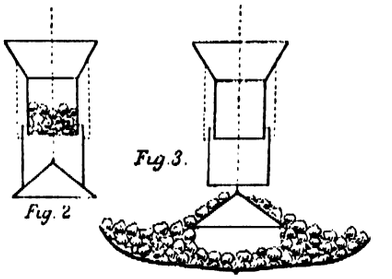


Fig. 2.

Fig. 3.

It is found in actual work that a wagon can be shipped in from 2½ to 3 minutes. The crane was designed and constructed by Sir William G. Armstrong, Mitchell, and Co., and is similar to their well-known and largely adopted movable hydraulic cranes for cargo and ballast work. These cranes were first introduced at the suggestion of the writer about fourteen years ago at the Atlantic Wharf of the Bute East Dock, to supersede fixed cranes. The introduction of the movable crane resulted in such an increased amount of work and despatch to steamers, that all the dock companies very soon recognised the importance of adopting cranes of this type. At the Royal Albert Docks, London, there are about ninety of these cranes.

The number of tips for shipping coal at the Bute Docks is now as follows:

13 balance tips at the West Dock.
12 ,, ,, ,, East Dock.
8 hydraulic tips at the East Dock and entrance basin.
1 hydraulic tip in the entrance channel for loading in the tideway.
8 hydraulic tips at the Roath Basin.

42 total number of tips.
One movable hydraulic crane capable of lifting 25 tons.

* Paper read before the Institution of Mechanical Engineers at the Cardiff meeting.

Each tip is capable of shipping 1000 tons of coal per working day; the total shipping capacity of the Bute Docks is therefore equal to nearly 12,000,000 tons of coal per annum. In some instances as much as 200 tons of coal have been shipped per hour at the hydraulic tips; and it is now not uncommon for a steam collier of 2000 tons burthen to enter the basin at high water of one day, discharge her ballast, receive her outward cargo, and leave at high water the following day, the entire operation having occupied less than 24 hours.

The principal portion of the trade carried on in the Bute Docks is the export of coal and iron, which amounted to 2,750,000 tons in the year 1873, and 6,916,000 tons in 1883. The import trade of iron ore, timber, and general merchandise, amounted to 630,000 tons in 1873, and in 1883 to 1,299,000 tons.

Railways.—The mineral traffic of the West Dock is supplied exclusively by the Taff Vale Railway from Merthyr, Dowlais, and the Aberdare and Rhondda Valleys. The traffic to the East Dock is supplied jointly by the Taff Vale, the Rhymney, and the Great Western Railways; the last of which is the means of communication with the great coalfield now being opened in the centre of Glamorganshire in the Ogmore district. The London and North-Western and Midland Railways have also access to the docks by their connection with the above railways. A general plan of these several railways communicating with the port is shown in the map.

Sidings.—A very large extent of siding accommodation is required for working the coal shipping trade; for owing to the fluctuations of the trade, loaded wagons have to be stored in the sidings at times when the supply exceeds the demand. The extent of main lines and sidings provided and maintained by the Bute Trustees in connection with the docks amounts to 70 miles in length, namely, 25 miles of main line and 45 miles of sidings, the whole of which is fully occupied. In addition to this the Taff Vale Railway has constructed a large system of sidings seven miles in length, above Crockherbtown Junction.

(*To be continued.*)

INSTITUTION OF MECHANICAL ENGINEERS.

Address of the President, I. LOWTHIAN BELL, F.R.S., *delivered at the Cardiff Meeting*, 1884.

BEFORE deciding on the choice of a subject upon which I should say something to you upon the present occasion, I naturally turned my attention to the very able addresses which have been delivered by my distinguished predecessors in this chair. In the list—and that not the least comprehensive and interesting of the number—is one by Sir Frederick Bramwell. Among the various important services rendered by the mechanical engineer, he claims that of having brought into existence the civil engineer, to whose profession the world is so much indebted.

The object of my search was to select a subject which would afford me some hope of justifying, partially at all events, your having invited me to occupy a position which has been filled by some of the ablest mechanical engineers of the day. I will not enlarge upon the misgivings with which I approached the task, more than to assure you that they have added greatly to the difficulty of thanking you in commensurate terms for the high honour you have conferred upon me.

I propose addressing you on a metal—iron—of which it is not too much to say that it constitutes a condition precedent to the very existence of both the engineering sciences already referred to. This and the circumstance of our meeting in one of the oldest seats of the British iron trade will, I trust, reconcile you to the selection I have made for the subject of my discourse. To myself it is one which particularly recommends itself, less from my long association with it than from its affording me an opportunity of acknowledging how immensely the manufacture of iron is indebted for its marvellous progress in recent years to the assistance it has received from the hands of the mechanical engineer.

The Dowlais Iron Company, with their accustomed liberality and kindness, will open their works for your inspection. In that renowned establishment you will find a blowing engine delivering its blast from a cylinder 12 ft. in diameter, with a stroke of the same length. You will also have an opportunity of beholding a rail-mill engine on the Ramsbottom direct-action principle, the largest of its kind in the world. Now it is no exaggeration to say that the existence of such pieces of machinery as these, would have been a physical impossibility for many years after the beginning of the present century. Of the sober truth of this statement you may judge when I mention that I was informed many years ago by the late manager of the celebrated Wallsend Colliery, of the difficulty he experienced upon one occasion in obtaining a steam-engine cylinder of about 2 ft. in diameter. At that time (about the beginning of the present century) there was not an iron foundry on the Tyne capable of casting, nor a tool in the northern counties fit for boring it. Ultimately a more enterprising firm in Scotland was persuaded to undertake the work on being permitted to cast it in two pieces, and, in addition, on being allowed to fill up with tram rails the sloop which conveyed it to Wallsend.

When a spectator finds himself in the midst of such triumphs of mechanical engineering as are now to be found in every well-appointed iron work, he must be apt to associate the manufacture of iron with the presence of vast mechanical force. Nevertheless there is no metal capable of being separated from the mineral containing it by simpler means than the one we are considering. Our ancestors supplied their wants by forming a small heap of ore and charcoal on an exposed hillside. There unassisted Nature performed the office of a blowing engine; and with one stone for the hammer, and another for the anvil, as much iron was obtained as served for a people who largely depended on the chase for their subsistence.

We have no record of the date at which we, in this country, emerged from the state of being dependent for the iron we required on such primitive forges as those just mentioned. We do know, however, that for many centuries, probably until the fifteenth, piles of rough masonry, the inside of which occupied a space of six or eight cubic feet, blown by the simplest form of bellows, performed the duty now demanding the help of the powerful and complicated machinery so familiar to every one in this meeting.

The advance, thanks to the mechanical engineer, in the construction of the engines employed in our iron works, has been so rapid that there are to be found still in use examples of very antiquated modes of manufacturing the metal, which have survived the changes by which they are surrounded. I had an opportunity of examining a case in point a short time ago, in a blast furnace built towards the end of the last century, on the great road over Mont Cenis. At the period of its erection that road was probably a mule track; at any rate, I have myself performed less difficult journeys than that which I took by this road, over Alpine passes which were inaccessible by wheels. Every one knows what a revolution has been effected in the means of carrying traffic over and through the great natural difficulties presented by the rocky summit of this mountain. The mule has given place to the locomotive, the circuitous path cut in the face of lofty precipices has been abandoned, and a tunnel, designed by the civil engineers and pierced by their mechanical brethren, now permits the passage of tons where perhaps ounces were previously carried, and this at twenty times the speed of former times. Thus alongside this achievement of modern enterprise, you have the blast furnace in its most ancient form, using charcoal for its fuel, burnt by a current of air induced by streams of water falling down hollowed stems of trees. I visited another equally primitive establishment in the Smoky Mountains of North Carolina. There wrought iron was being made in a Catalan fire, blown, like the blast furnace in Savoy, by the so-called *trompe*, the bloom being afterwards drawn out under a hammer very different in principle from that designed by my friend James Nasmyth.

Besides the acknowledgment of the immense services rendered by mechanical science to the art of making iron, which this brief retrospect of its progress has enabled me to make, I have other motives in selecting that metal as the subject of the present address. The Bessemer process has revolutionised the process of obtaining it in its malleable form. The product is purer, and therefore better, while the cost of conversion is less than that obtained by means of the puddling furnace.

The metalloids which it is the object of both processes to remove, and which are known to injure the quality of the products, are silicon, sulphur, and phosphorus. To illustrate the superior efficiency possessed by the Bessemer converter in separating these three substances, I give the composition of Middlesbrough pig iron, followed by the average composition of the heads of ten iron rails and twenty steel rails manufactured from Cleveland ironstone. The former were rolled from No. 2 stabbed-down bars, and the latter from steel ingots made by the so-called basic process. These modes of treatment involve two heatings in the mill for the iron rail-head, whereas one only sufficed for that made of steel.

	Middlesbrough Pig.	Iron Rail-head.	Steel Rail.
Silicon ...	1.750	0.159	0.065
Sulphur ...	0.100	0.041	0.095
Phosphorus..	1.500	0.324	0.054
	3.350	0.524	0.214

These figures indicate that there remains in the iron rail nearly one and a half times more of the noxious elements than in the steel rail. When the puddling is conducted with extraordinary care, the removal of the foreign matter is no doubt better performed than in the example just given. Thus, a sample of Low Moor cold blast pig iron, used for the celebrated bars made there, was ascertained to contain:

Silicon, 1.380. Sulphur, 0.075. Phosphorus, 0.620 per cent.

This expensive metal is refined and then puddled in small heats. After being flattened under the hammer, it is broken so as to select the best of the iron, which is then piled; and after one, or often more, heatings, it is drawn into a billet or slab, from which the finished iron is rolled. It is only right to say that unrefined Middlesbrough pig, when puddled in a revolving furnace, gives also a very pure iron. The content of the three metalloids in these two kinds of iron, and their strength, as certified by Mr. Kirkcaldy, were as follows:

	Silicon.	Sulphur.	Phosphorus.	Breaking Weight.	Extension Per Cent.
				tons.	
Low Moor	0.016	0.010	0.067	22.771	29.68
Middlesbrough ...	0.012	0.025	0.085	22.227	29.68

There is however an inconvenience connected with the manufacture of malleable iron, comparatively unknown in steel, which occasionally gives much trouble. The cinder or silicate of iron formed during the process sometimes gets sealed up in the iron, and gives rise to the formation of cavities in the manufactured article. The worst case of all is when the cavity, in the case of a boiler-plate, does not manifest itself until it is exposed to the heat of the fire when in use.

So far as the three above-mentioned substances are concerned, the quantity in which they are present cannot be said to constitute the difference between malleable iron and steel; for we have in one specimen of iron more of them, and in two others less, than in the example given of the composition of steel. So far as our knowledge goes at present, both iron and steel would gain by the entire absence of all three.

The substance which really distinguishes steel from iron is carbon; at the same time, as is well known, examples of malleable iron entirely devoid of this element are rarely if ever met with. Thus Bowling and Low Moor and other well-known brands of iron, puddled as they are with so much care, rarely contain under half-a-tenth per cent., and frequently much more. In the manufacture of Bessemer steel, it is found advantageous to blow the metal until the bath, so far as the metalloids are concerned, becomes malleable iron. This may be seen from an analysis in a case where the pig iron used was that made on the West Coast of England. The blown iron contained—

	Per cent.
Carbon...	0.10
Silicon	0.03
Sulphur	0.04
Phosphorus	0.06
Total	0.23

Now there is evidently nothing, so far as relates to these four substances, to lead us to infer that this malleable iron—for such in point of composition it really is—would not possess all the qualities which render this metal so useful in the arts. As is well known however, this is far from being the case; and to render the blown iron sufficiently malleable to resist the tearing action of rolling, manganiferous pig iron requires to be added.

Recent investigations have led chemists to ascribe, among other causes, the want of malleability—or red-shortness, as it is termed—in heated iron to the presence of oxygen gas in some form or another. Three specimens made at the Monkbridge Works, one of them red-short, were recently sent to me for examination, and their composition entirely confirmed the soundness of this opinion. On analysis, the two samples which were free from this defect, contained only 0.750 and 0.704 per cent. respectively of oxygen, while the one complained of gave 1.384 per cent.

The addition of a substance containing a readily oxidisable metal, such as spiegel iron or ferro-manganese, carries off this superabundant oxygen, at the same time that it restores sufficient carbon to give us steel of any desired degree of hardness or softness, down to what in the matter of carbon must be regarded as malleable iron.

We have now to choose between what chemically may be considered as the same substance, but made in two different ways—in the one case obtained by means of the puddling furnace, and in the other by the use of the converter.

By the former method we produce a metal interspersed with cinder, which gives rise to unsoundness, or, when exposed to great wear, causes lamination, so familar to every one in the case of iron rails. By the latter we have a metal free from both these defects, and to which carbon enough can be readily united to form a true steel, capable of enduring twice the tensile strain of the best iron, and, under the same wear and tear, lasting twice as long as an iron rail.

The superiority of quality in the product does not by any means exhaust the advantages possessed by what is often known as the pneumatic over the puddling process. Dissimilar as the two modes of procedure are in appearance, there is in principle not much difference between the two systems. In the puddling furnace the workman, by very severe labour, exposes the liquid iron to the joint oxidising influence of the bath of cinder and of the atmospheric air. The combustion of the metalloids under such conditions is so slow, and the radiation and other cooling influences, being extended over a much longer time, are so great, that 20 cwts. of coal are consumed for each ton of puddled iron made. In the Bessemer converter, on the contrary, the mechanical action of the workman is replaced by the passage of the air up and through the molten mass of pig iron. Fresh surfaces of metal are, by this mode of treatment, brought so rapidly in contact with renewed supplies of oxygen, that the operation on eight or ten tons is completed in one-sixth of the time required in puddling four or five hundredweights. Very little heat is wasted in the manner so conspicuous in the puddling process; so that the great heat evolved by the combustion of the metalloids, along with that contained in the pig iron as it comes direct from the blast furnace, suffices for the operation. Thus the only fuel consumed is that required for the blowing engine; and the expense of labour is so much reduced in amount that the ton of ingots ready for the mill, including the manganese, costs about fifteen shillings less than the same weight of puddled bar made from the same quality of pig iron as that used in the Bessemer converter.

It is now twenty-seven years since this pneumatic process was described by its distinguished inventor; and, with the manifest advantages just referred to in economy of production and in the nature of the product, it may appear surprising that so much puddled iron still continues to be manufactured. This delay in the substitution of a cheaper and better article for one both dearer in price and inferior in quality, is due to a variety of causes, some real and others more or less of an imaginary character. First and foremost, it was, as might be ex-

pected, many years before an entirely new branch of industry was able to compete in economy of production, with a process which was invented by Henry Cort now exactly one hundred years ago. Immediately this point was approached the greater durability of the material for rails having in the mean time been demonstrated, railway companies rapidly abandoned the use of iron rails and had recourse to steel. About the period at which we have now arrived in this brief history of the trade, the great superiority of iron over wood as a material for shipbuilding—which, by the way, it took about a quarter of a century to prove—became generally accepted; so that the consumption of the metal for railway purposes diminished, that for naval construction took its place. It may well be asked how long, in a structure like a ship, where not only strength but lightness is so important, will the inferior metal continue to be preferred to the superior? A partial answer to this question is found in the fact that, for reasons into which space forbids my entering, the cost of rolling steel ingots into plates was for a long time disproportionately high, in comparison with that of converting ingots into rails. The effect of this difference was that, while steel rails were selling at as low a price as those of iron, plates of steel were often 6*l.* a ton dearer than those of iron. This difference at the present moment does not exceed 50*s.* or 60*s.*; and as a steel ship of the same strength as one of iron, is much the lighter of the two the occupation of the puddler in connection with naval architecture bids fair to follow the example already afforded by railways.

Again, the introduction of steel into the construction of locomotive engines, and the rolling stock generally of railroads, was very properly a work of time. Fears were expressed, and open assertions were made, as to changes taking place in the molecular structure of objects exposed to violent percussion, which by sudden rupture might be the cause of disastrous consequences. These fears have been shown to be almost, if not entirely, groundless; and the use of the new material, produced either in the Bessemer converter or in the open hearth designed by our late lamented Past-President Sir William Siemens, is gradually being extended to many purposes besides those for railways, in which great strength and durability are needed. No doubt, by many workers in iron, strong objections are still entertained to the abandonment of a material to the manipulation of which they have been accustomed all their lives. Nor am I prepared to deny that this is not always the result of mere prejudice; for strongly as analyses may point to an almost perfect identity in composition between iron in its malleable form made by the two methods, pneumatic and puddling, we must bear in mind how very small a difference in the quantity of foreign matter may greatly affect the quality of the iron containing it. It is possible that this may happen in the case of steel, and yet the defect be remedied by a slight modification in the way of dealing with the metal, in the process of fashioning it into the article required. This however will be quite enough to delay its being readily accepted by individual workmen, who, although employing iron in small quantities, consume in the aggregate considerable weights of the metal. This delay will no doubt prolong the existence of the puddling furnace among us; but as the nicer details of the pneumatic method become better understood by the manufacturer, and the minuter peculiarities of the product more thoroughly known to the smith, the necessity for the violent exertion of the puddler will probably in a great measure, if not totally, come to an end.

Bearing in mind the immense strides which the art of producing iron has made in the last twenty-five years, the consumer may be tempted to inquire as to the prospects of seeing further improvements introduced into the quality, as well as into the cost, of the product.

As regards the first of these two questions, it may be difficult to predict what can be done by alloying other metals with iron. Something has been tried in this direction; but no marked success, so far as I know, has attended any of the attempts hitherto made. From time to time great hopes—sometimes indeed great achievements—are announced; but there the matter seems to end. On the other hand, past experience as to the effect of those substances taken up by the metal during its passage through the blast furnace, does not justify the expectation that any further diminution in the quantity of silicon, sulphur, or phosphorus, beyond that already attained, can very materially add to its strength; while we know that an addition of any of them has a contrary effect.

A word or two on the second question: namely, the existence of a process which carries with it any likelihood of proving more economical than that of the joint action of the blast furnace and the converter.

In proceeding to consider this branch of the subject, we may eliminate any possible saving to be secured by a cheaper mode of working the minerals; firstly, because it is not probable that any great reduction of expense can be effected in quarrying limestone or in mining coal or ore; and secondly, because under any circumstances it is only from diminution in the quantity employed that economy from this source can be hoped for, the saving in mining being common to all processes.

At first sight undoubtedly the blast furnace presents an objection, which, however, in my opinion, has had undue weight attached to it. Not only, is it alleged, do we obtain a product contaminated by substances which admittedly injure its quality, but we also unite with it carbon, which, along with the other elements just alluded to, it is the province of the subsequent operation, be it puddling or converting, to remove. To avoid this circuitous mode of operating, the ancient so-called direct process has been revived; and from no one in recent years has the subject received greater or more intelligent attention than it did at the hands of Sir William Siemens.

It would be impossible, upon such an occasion as the present, to describe in detail all the objections to the process in question. To obtain a rough bloom, unfit, without a previous heating and hammering or rolling, for the manufacture of a finished bar or plate, more than 25 per cent. of the iron contained in the ore is oxidised. The blast furnace, on the contrary, gives practically in the pig all the metal of the mineral operated on. It is true a portion of the iron is wasted during the process of conversion; but the waste thus incurred is less than one-third of that which happens in the most successful direct process I have heard of. In the item of labour, I am satisfied, by comparing it with cognate operations, that the united wages paid at the blast furnace and the Bessemer converter, are considerably less than what would be expended over the direct process alone. If to the expense of obtaining the rough bloom you have to add in one case a second hammering, or in the other case fusion in an open hearth furnace, the possibility of competing with the combined action of the blast furnace and converter is *pro tanto* diminished.

In reference to the operations connected with the smelting process itself, there is no branch of the manufacture of iron in which, during the last fifty years, such great amelioration has been accomplished. By means of excellent machinery, by heating the blast as high probably as it will be found practicable, or probably advantageous, to raise it, and by a great increase in the dimensions of the furnace, I am tempted to say that we have arrived at a point when further improvement of any moment can scarcely be hoped for. We waste none of the iron contained in the ore; no more limestone is employed than that found necessary to remove the sulphur and to flux the earthy constituents of the minerals employed; and the fuel employed is not one quarter of what Neilson declared it was in Scotland, when he discovered the value of the hot blast. This inventor contented himself with blowing in air having a temperature of 300 deg. or 600 deg. F. It is frequently used now at 1400 deg., and we have been urged to heat it still higher; but, for reasons I have given on former occasions, and which I cannot repeat now, I greatly question whether any great benefit would be derived from a change, which moreover it would be found difficult to maintain steadily. The only other item in the cost of smelting iron is the labour; and this, by proper appliances and mechanical arrangements, has been so reduced in amount, that I have estimated that each ton of matter handled during the operation, in a properly appointed work, costs not more than 1½*d.*

In reading the addresses of your former Presidents, I observed upon some occasions that advice for future conduct has been added to an examination of the benefits conferred on mankind by the mechanical engineers of this and other countries. Nothing can be more appropriate, either to the individual or to the nation, than a periodical stock-taking, as it were, of the progress which has been made at home and abroad. With this view, no doubt, Mr. Cowper pointed out from the chair in 1880 how the British had been outstripped in the manufacture of certain objects; and reminded you that, forgetful of how much had been achieved by previous exertions, England was failing in the enterprise and energy necessary to keep her in advance of all other nations in arts and manufactures.

That the British people for many years occupied the distinguished position Mr. Cowper is so naturally anxious for them to retain will not, I dare say, be denied by any of our honourable rivals in the industrial race, in which some half-dozen nations are engaged with ourselves. In such comparisons as that drawn by my predecessor we must not overlook the vast differences in the circumstances of the two periods he contrasts with each other. Industrial science, as we now understand it, dates from the commencement of the present century; in point of fact, from Watt's grand invention of the steam engine, properly so called.

Denser population, comparative immunity from the social disturbances attending the wars which unhappily marked the end of the last and beginning of the present century, extended commerce favoured by our insular position, and the possession of well-explored coalfields, conferred upon the United Kingdom advantages not enjoyed by other European nations.

Recent years have greatly changed the aspect of affairs both at home and abroad. Want of space and of employment have perhaps promoted emigration from our shores to a greater extent than from those of other countries; and, in consequence, the increase of population on the Continent may, relatively, have exceeded our own. For seventy years, with few and short exceptions, peace has been maintained in Europe; railways have brought inland provinces nearer the coast, and large Continental coalfields have been discovered and developed. With our example before them, it would, under these circumstances, have been a matter of astonishment if other nations had not followed our lead; and with populations, many of them, to say the least of it, as well educated as our own, and gifted with an intelligence certainly not inferior to that of the inhabitants of Great Britain, can it be wondered at that some of the victories in industrial supremacy should have been achieved outside the boundaries of these islands?

The services, however, which our own country has rendered to every branch of industry, scientific as well as practical, have been generously acknowledged by other nations. We on our side can well afford to recognise and feel grateful for the numerous and important contributions to the world's advancement and happiness made by foreign enterprise, in the United States as well as in Europe.

Upon more occasions than one, not only in the addresses which have been delivered by some of your Past-Presidents, but in the public press, the iron trade of Great Britain has been reminded of the competition offered by other nations in neutral markets, as well as in certain articles required for consumption in the United Kingdom. Intimations have also not been wanting that this was a consequence of superior skill exercised by Germany and Belgium in particular, in arts where hitherto our own country had rendered no mean service.

After what I have just said in reference to foreign competition, I am not going to permit my patriotism to submit any statement of the relative importance of what has been done here and elsewhere towards raising the manufacture of iron and steel to its present high state of excellence. This would be best ascertained by individual research, or by an appeal to those foreign competitors by whom the very existence of the British iron manufacture, according to some authorities, is threatened.

A few years ago an answer to such an inquiry, so far as Germany is concerned, was given by the iron manufacturers of that country; for at that time, in consequence of evidence tendered before a Government commission, a duty was levied of 10*s.* per ton on pig iron and 25*s.* on steel rails imported into the Zollverein, to rescue the German iron trade from the absolute ruin which importations from Great Britain were alleged to be sure to effect.

Notwithstanding these representations, these same ironmasters, then making much of their pig iron from the same Spanish ore as that used in England or Wales, with much higher transport charges to pay, were found underselling us in considerable orders for steel rails. The supposed answer to this apparent anomaly was that, protected by the cost for carriage from this country, added to the heavy import duty, a sufficiently profitable trade could be carried on in rails for home consumption, to support a considerable loss on any foreign transaction entered into after meeting the home demand—a loss which was preferred to that accruing from a partial stoppage of their works.

Since the period in question, the introduction of the basic process has materially improved the relative position of the German steel rail makers. Pig iron suitable for the acid process, as it is now termed, cost in Westphalia about 30*s.* per ton more than the phosphoric metal obtained from the Liassic ironstone, now so largely worked in Germany and in France. In Great Britain, the difference between the two kinds of iron was only about one-third of this amount. If, for the purpose of illustration, we assume 10*s.* to be the additional cost of conversion entailed by the basic process, a Middlesbrough steel rail manufacturer is left pretty much in the same position as he occupied under the acid system, while his German competitor has gained an advantage of about 20*s.* per ton by the change.

Omitting the actual cost of working the minerals, as this may be greatly affected by the nature of the veins or beds in which they occur, there are two circumstances which operate, generally speaking, in favour of the foreign manufacturer—viz., the price of labour, and the dues paid to the owner of the soil for permission to work coal, ore, and limestone.

With regard to the last-named item, the lowest amount chargeable as royalty against a ton of steel rails in Great Britain may be taken at 5*s.*, whereas in Germany and France it is under 1*s.*, and in Belgium it varies from 1*s.* 6*d.* to 6*s.* On the other hand, the cost of conveying the raw materials to the point where they are manufactured is, generally speaking, less heavy in Great Britain than it is in any of the three Continental countries referred to.

With the cost of labour and of royalty dues operating adversely to the manufacturer in our own country, and the cost of carriage on the minerals in his favour, the balance of the advantages is such that in many smelting works in Germany, France, and Luxemburg, a ton of pig iron, fit for making malleable iron or steel rails by the basic process, can be made somewhat cheaper, certainly quite as cheaply, as a similar quality of iron can be produced at Middlesbrough.

The point at which we have now arrived in considering the question before us, is whether there is any difference of skill evinced in dealing with the minerals in the blast furnace, and in converting the pig iron thus obtained into rails or other objects, in which the Continental manufacturers are competing with us, not only in neutral markets, but in certain articles of rolled steel and iron for consumption on British soil.

Superiority of skill in the manufacture of iron means less waste of metal, a smaller consumption of fuel, and arrangements of such a character that the same amount of work is done with a lesser expenditure of labour. Measured by these standards, which are easily ascertained, I have arrived at the conclusion, after several years of careful examination in almost every country where iron is made, that if the manufacturers of this kingdom are not in advance of their foreign competitors, most assuredly they are not behind them.

There is a fourth and not an unimportant question, viz., the quality of the product. This, as all iron manufacturers well know, is dependent partly on the quality of the raw materials employed, and partly on the amount of labour usefully expended on their manufacture. To this inquiry my answer, *ceteris paribus*, would be in the precise terms given in the previous paragraph. Give a workman, be he English, Belgian, French, or German, pig iron and coal of the same description, and give all equally good machinery for dealing with the materials; ask then the consumer to pay for the manufactured article a price corresponding with the pains taken in producing it; and I believe that he will receive for his money the object he requires of equal quality, in whichever of the four countries it may have been made.

I have spoken of the expenditure of labour in the sense of its amount; let us consider it shortly in the sense of its

price. This term, of course, is by no means confined to the daily earnings of the individual. Were British miners and iron workers to be measured by this standard, British iron would speedily be superseded by that of foreign manufacture; because in many departments the workmen with us are paid 20 to 40 per cent. higher wages than are given on the Continent of Europe. Dearer labour has, no doubt, led to the adoption of means for its economy in our own country; but it is, I believe, universally admitted abroad, that our more highly paid and therefore better fed men, are capable of performing, and actually in most instances do perform, more work than is done by the workmen of almost any other nation. This, as regards iron works, is certainly my own opinion, founded on the number of men required for the same amount of duty in each case. Notwithstanding this greater efficiency of our own labouring population, the wages they are paid exceed the comparative amount of work performed to such an extent, that in many instances its average cost cannot be taken at less than 25 per cent. higher than with Continental nations.

It would not be an easy matter to speak precisely with regard to the average intrinsic value of mining labour. It affects the cost of pig iron, owing to the great variety of the conditions under which it is applied to seams and veins essentially different in their nature. Suffice it to say, that there are certain of the best situated places, in which, according to my calculations, pig iron, fit for forge purposes or for the basic process of making steel, can be made something like 2 or 3 per cent. cheaper than the same iron in the Middlesbrough district. Such a difference would, of course, be insufficient to cover transport from inland works abroad to sea-going vessels, and freight to this country. We may therefore safely assume that no nation can enter into competition with the Middlesbrough furnaces so far as our own domestic consumption is concerned. The same observation is applicable to steel rails of any ordinary sections, when sold, as they have been of late at 4*l.* 12s. 6d. or 4*l.* 15s. per ton. When, however, we have to deal with tram rails, or iron and steel in any form worth 8*l.* or more per ton, the extra cost being largely made up of labour, the Continental advantage of 25 per cent. begins to tell heavily against our own manufacturers. This view is being daily confirmed by actual experience; for steel tram rails, iron girders, together with spring steel and axles and tyres also of steel, are being imported by some of our large railway companies and house builders. The change of circumstances in connection with the basic process above referred to will also, I think, enable the German manufacturer, even in rails of ordinary sections, to compete with us on something like equal terms in markets to which the cost of sea-freight is the same from both countries.

In the North of England we hear of what are now generally known under the name of labour difficulties, more in connection with iron shipbuilding than in almost any other branch of manufactures. In the year 1880 I received from two large establishments a statement of the average earnings for that year. The chief men worked 313 days, during which they were paid rates varying from 8s. 9d. to 12s. 10½d. per day. So far as the information I have been able to collect enables me to form an opinion, the workmen in the English shipyards, all told, receive about double the wages paid abroad; but it would appear that for this extra pay they perform, as has been mentioned in connection with the men in the iron works, more duty. As with the ironworkers, the extra work however is considerably less than the equivalent of the extra pay, according to foreign rates of wages.

Favoured by the differences in the price of labour, there has been recently established in Norway a shipbuilding yard, where vessels, as well as the steam engines they require, are constructed out of iron supplied from the north-eastern ports of England. The establishment in question, begun only a year or two ago, now employs 800 hands. Mr. Raylton Dixon, whose practical knowledge of the trade is so well known, informs me that the actual cost of labour for a given amount of work in the locality in question, is 25 per cent. less than he pays at Middlesbrough. This, after paying 10s. per ton freight on the plates from England to Norway, enables the Norwegian builder to construct the hull of the vessel for 15s. per ton of iron employed less than is paid in England—an amount equal on a ship of 1500 tons deadweight capacity to 525*l.*

It is self-evident that, if such a margin as that just named has to continue, we must prepare ourselves for seeing a great increase in the number of vessels built by means of foreign labour, even if they are afterwards navigated under the British flag. It is moreover not improbable that the plates used in their construction may be brought from German or Belgian iron works; and this is inferred from the same reason which enables the ironmasters of these two countries to furnish our engineers and architects with railway material and iron girders—viz., cheaper labour.

From various sources I have computed that the skilled workmen engaged in the manufacture of ship plates in England, earn on an average between three and four times as much as the same class of men do in Germany. According to the last return in my possession, the daily wages in a large plate-mill in the county of Durham were as follows:

	s.	d.
Head shinglers	22	9
Puddle rollers	15	1
Plate-mill furnacemen	16	1
Head plate rollers	41	1
,, shearmen	34	9

Notwithstanding these high rates, it is a remarkable fact that at the present moment, owing to the large production, the wages per ton in the finishing mill alone are not higher in the English than in the German work with which it is compared. As soon, however, as the foreign houses commence to roll plates on the large scale which obtains in this country, there will be a considerable reduction in the cost of production with the former. It may therefore come to pass that the Norwegian shipbuilding may go on increasing, but that the consumption of English iron in connection therewith may proceed in an opposite direction.

I have been induced to give a certain amount of prominence upon the present occasion to the labour question, after reading the observations of Mr. Thomas Hawksley, one of your former Presidents, who has himself had abundant opportunity in his lengthened experience of studying the question in all its aspects. Mr. Hawksley, in his address delivered seven years ago, agrees as a general proposition with what has just been said on the higher cost of British labour. I have endeavoured to show specifically to what extent the manufacture of iron and the building of iron ships are affected by the condition of things referred to by my predecessor.

To avoid what he calls the "ruinous disadvantage when the English capitalist is brought by the exigencies of his business into immediate competition with the foreign capitalist employer," the English workman is cautioned by Mr. Hawksley against falling into the error, "that he is entitled to share in his employer's success."

It will be observed that this advice is in direct opposition to the course of conduct adopted by the coalowners and ironmasters of the North of England, who have agreed with their workmen on a scale of wages regulated by the ascertained selling price of their produce. This of itself cannot be accepted as a proof of the soundness of the plan itself, nor of the unsoundness of the doctrine quoted above, and laid down for the acceptance of the men. As a fact, however, and it is difficult to see how it could be otherwise, a sliding scale has for many years past been more or less in force in the northern counties, as well as elsewhere; because, when trade was active and prices high, labour was in demand, and it, like any other commodity, rose in price. Instead of the purchaser and seller of this commodity having to meet to make a fresh bargain at every fluctuation in price—which entailed delay and frequently interruption to work, under the form of strikes, not confined to this country—a self-adjusting scale has been adopted.

Speaking from some lengthened experience with the system, it appears to me, and I think, to many of my colleagues in these two industries, that its introduction has been satisfactory to both sides. It may and will happen that differences of opinion arise between the two parties on the nature of the scale to be adopted; but these differences are more likely to be reconciled when discussed from time to time with forbearance and good temper by those concerned, probably chosen for their presumed fitness for the office.

It is, however, of the utmost importance that the whole industrial community should be able thoroughly to appreciate the circumstances by which they are surrounded. The employer is speedily warned of his position; for if he falls behind in the matters of price or of quality, his goods remain unsold if too dear, or if inferior in quality they decline in value; but this does not apply equally to the workman.

In the markets of the world, the capitalist has to meet competition from whatever quarter it may proceed; and legislation, introduced forty years ago, and in the introduction of which the employers of this country took a conspicuous part, opened the markets at their own doors to the manufacturers of every nation. This same legislation however, let in cheap food, and has so equalised the price of all the necessaries of life, that the British workman is able to live as cheaply as his Continental competitor, and to hold his own against all comers in economy of production, as he hitherto has done in the quality of the product of his hands.

Before concluding my remarks I am wishful to call to your attention the enormous extent of ground covered directly and indirectly by the work of the Mechanical Engineers in this country. No estimate of this kind can pretend to be more than the roughest approximation; and perhaps the quantity of coal burnt in various processes and manufactures may serve as well as any other measure for the object in question.

About twenty years ago an attempt was made in a Government inquiry to assign to the various sources of consumption their proportion of the coal raised. In the first column of figures in the annexed Table, these proportions are set against each branch of trade. The second column has these numbers applied to the coal wrought in 1882, being the last return issued by Her Majesty's Inspector of Mines. The quantities thus obtained are then divided in a somewhat arbitrary way. In some of the items, such as railways, the whole quantity may be set down as being employed for mechanical power, while in some of the others the coal is used partly for the development of power and partly for processes in which heat is required as an agent. Such an example is found in the coal consumed in textile industries; but even here it is no exaggeration to say that but for the spinning and weaving machinery, in fact, but for the works of the mechanical engineer, the manufacture of textile fabrics, as well as many others, would have occupied a very insignificant position in the industries of the world. I have, however, in the rough way already intimated, divided the whole quantity of coal raised under two columns headed M and H (mechanical and heating); the one headed H containing the quantities more or less independent of any influence exercised by the use of machinery, and the other headed M those affecting, directly or indirectly, the use of mechanical appliances. Iron and steel making is here considered as directly influenced by the use of machinery.

Table Showing the Purposes to which the Coal Raised in Great Britain in the Year 1882 was Applied.

Heads of Consumption.	Out of 1000 tons Raised there was Used in	Total Coal Worked, and Used as below.	Rate of Division. m.	Rate of Division. h.	M.	H.
		tons.			tons.	tons.
Paper making and tanning ..	6	939,000	½	½	469,500	469,500
Smelting copper, lead, tin, and zinc	8	1,252,000	1/10	9/10	125,200	1,126,800
Water works ..	14	2,191,000	1	..	2,191,000	
Breweries and distilleries ..	18	2,817,000	1/10	9/10	281,700	2,535,300
Chemical manufactories ..	19	2,973,000	1/10	9/10	297,300	2,675,700
Railways	20	3,130,000	1	..	3,130,000	
Steam navigation	30	4,695,000	1	..	4,695,000	
Clay, glass, and lime kilns ..	31	4,851,500	1/10	9/10	485,150	4,366,350
Textile fabrics ..	42	6,573,000	1/10	9/10	3,943,800	2,629,200
Gas works	60	9,390,000	..	1	..	9,390,000
Mining operations	67	10,485,500	1	..	10,485,500	
Coal exported ..	92	14,398,000	1/10	9/10	7,199,000	7,199,000
Steam engines ..	121	18,936,000	1	..	18,936,000	
Domestic use ..	172	26,918,000	..	1	..	26,918,000
Iron and steel works	300	46,950,000	1	..	46,950,000	
	1000	156,499,000			99,189,100	57,309,800

By this mode of computation it would appear that there is consumed for mechanical purposes, or for industries which are wholly dependent on machinery, about 63 per cent. of all the coal raised in Great Britain. The account is no doubt susceptible of considerable modifications in either direction; but one fact will, I think, remain undisputed, viz., that a very large proportion of our fuel is applied for purposes directly connected with the profession of the mechanical engineer.

With so large an amount of work to undertake, it is not surprising that, for purposes of mutual instruction, the creation of so important a body as the Institution of Mechanical Engineers should have been found a necessity, or that so great an amount of success should have resulted from its deliberations. For once your President, without the risk of being misunderstood, may congratulate the younger members of this body on having an opportunity afforded to them of listening to the counsel of the most distinguished and the most experienced men in a profession, so largely dependent on experience for the full measure of its success.

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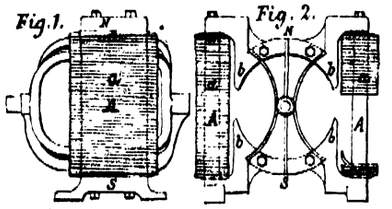
NUMBER OF APPLICATIONS FOR PATENTS.

	1884	1883	1883
July 29th	62	..	5
,, 30th	41	19	7
,, 31st	43	32	—
Aug. 1st	40	17	14
,, 2nd	30	16	10
,, 3rd	..	18	12
,, 4th	..	20	6
Total for week	225	122	54
Total from January 1st to Aug. 4th (inclusive) ..	10,911	8829	1827

5061. Apparatus for Getting Coal, &c., without the Use of Explosives: W. F. Hall and W. Low, Haswell Colliery, Durham. [4*d.* 12 *Figs.*] This refers to apparatus described in Specification 3370 of 1883, consisting essentially of a wedge, screw, and levers combined and operating together. A compound bar consisting of two parallel bars fitted with two sliding blocks is inserted in a bore hole. At the front end of the compound bar, between its two parts, is fixed a wedge, the point of which is directed outward so that it can enter between the front ends of the blocks, and a second wedge has its point directed inward so that it can enter between the back ends of the blocks. The outer wedge is operated by a bar fitting into a sliding block attached to the inner end of a screw passing through a nut provided with flanges by which it is prevented from endwise movement in a bearing piece connecting the outer ends of the parallel bars. The nut is rotated by worm gearing, the outer wedge being forced inwards, and the inner wedge drawn outwards, thus causing the sliding blocks to separate. Slight modifications are illustrated and described. (October 24, 1883).

5470. Dynamo-Electric Machines: H. H. Lake, London. (*T. J. McTighe and J. T. McConnell, Pittsburgh, Penn., U.S.A.*) [6*d.* 9 *Figs.*]—The soft iron cores A, oblong in section, are parallel to one another and are similarly wound and connected in circuit. The cores are connected to form the down-

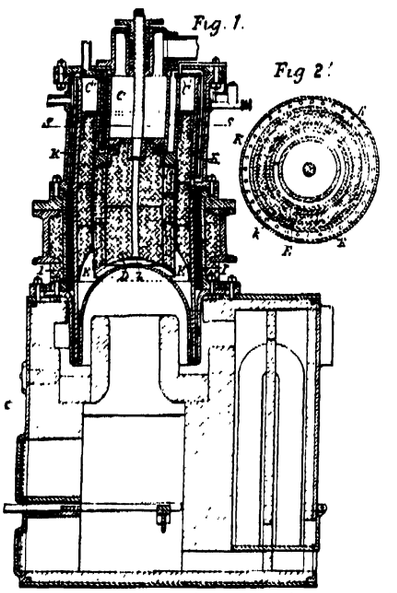
wardly dipping pole-piece N and the upwardly extending pole-piece S. The adjacent faces of the pieces form a portion of a circle for the reception of the armature, and the circular extensions *b* are formed with their outer faces parallel with the faces of the coils *a*. In order to secure the commutator to the armature shaft, the shaft has a shoulder and a screw thread; two metallic rings having on their adjacent faces recesses fitted with insulating rings with convex projecting surfaces are fitted upon the shaft. The convex surfaces of the insulating rings are radially grooved, there being as many grooves as there are to be segments in the commutator. The segments are cut from a copper strip



having a wedge shape in cross section and are milled at the ends to form semicircular rabbets fitting the convex surfaces of the insulating rings and projecting tongues fitting the radial grooves therein. A nut on the armature shaft secures the segments and rings between itself and the shoulder on the shaft. A lock nut may be applied to the nut. No insulating strips are needed, but if employed they are stamped with semicircular recesses at the ends. When the insulating rings are large, the metal rings may be dispensed with. In order to connect the armature coils to the segments, each segment is milled out at the side or middle of the inner end and a metallic strip is firmly attached by rivetting or otherwise, the end of the strip taking the place of the projecting tongue. The other ends of the strips are attached to L-shaped chucks, the outer arm of which has a slit and is screw-threaded to receive a compressing sleeve. The armature conductors are brought into the slit laterally to avoid bending, and the sleeve screwed up, no soldering being required. (November 20, [illegible]

5493. Chimney Cowls and Ventilators: F. Leslie, London. [6*d*. 2 *Figs.*]—A flue pipe has at its upper end a series of truncated conical shells mounted one above the other; the lowest being fitted as a collar around the pipe and the remainder being supported [illegible] equidistant radial partitions. An annular [illegible] in the centre somewhat larger than at t[illegible] uppermost truncated cone is fixed level with the uppermost cone. A horizontal plate is fixed slightly above the annular plate and may have a domed top. (November 22, 1883).

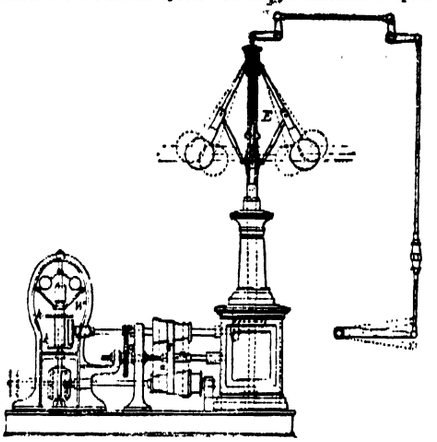
5626. Hot Air Engines, &c.: S. Wilcox, Brooklyn, U.S.A. [1*s*. 4*d*. 25 *Figs.*]—The upper part of the interior cylinder C is formed with an annular water space, and the lower portion is made of sheet iron filled with a non-conductor, and with a space below for the circulation of air. The outer cylinder C¹ surrounds the cylinder C and is formed with an annular water space. The working piston D is connected by a single piston rod, crosshead, and links to the end of a beam, the other end of which is connected to the rod of a similar piston, the apparatus being duplicated. The beam is secured to a rocking shaft having on one side an inclined arm connected by a link to a crank. Fig. 2 is a section on line *x x*, Fig. 1. The annular



charging piston E is connected by two rods to one end of a beam (the other end being connected to the annular piston of the other cylinder) turning loosely on the rocking shaft. The heater B is dome-shaped on its under and inner side and cylindrical on its outer side, and with a strong and wide flange by which it is bolted to the expanded base of the outer cylinder C¹, the annular space between the dome and cylindrical portion serving to highly heat the air. The heater is braced by six webs cast in one therewith and firmly connecting the dome and the cylindrical portions. A casting extends down in the six spaces so formed and fits on the webs, the main portion of the air having thus to traverse the entire depth of the heater. When, by the rise of the piston E, a large proportion of the air is transferred into the bottom space, it is expanded and acts on the under face of the piston D. On the descent of the piston E, a large portion of the air moves to the top of the engine and its pressure is reduced and the working piston descends. The beam, to which the piston E is attached, is connected through a "Stevenson" link to eccentrics. The regenerator I is composed of metallic plates set on edge, and is situated in the annular space exterior to the cylinder C¹, and in communication with the hot-air space, as shown, and through a cooler with the relatively cold-air space above the piston E. The cooler is formed with thin metallic tubes *k* traversing the annular water space around the cylinder C¹. The engine is regulated by means of a centrifugal governor acting through a supplementary cylinder on the link motion, and so varying the motion of the piston E. The space over the working cylinder is subjected to a pressure equal to the lowest pressure below the piston by means of a force pump, the admission of air to which is varied by a special valve according to the leakage. The packing for the piston rods consists of a number of rings of leather, U-shaped in cross-section, and filled with rings of india-rubber, the whole being gently pressed down by a gland. The packing of the working piston is known as the "Dunbar" packing. The air to support the combustion of the furnace is drawn in through the ∩-shaped pipes S, which are exposed to the hot gases escaping from the furnace. Means for lubricating the parts and indicating the quantity of water required in the cooler, the temperature and pressure, friction gear for communicating the power, and modifications of the parts, are also described and illustrated. This contains fifty claims. (December 4, 1883).

5642. Apparatus for Mining Coal: W. R. Lake, London. (*B. F. Asper, Pittsburgh, Penn., U.S.A.*) [10 *Figs.*]—This comprises (1) a series of reciprocating picks, the strokes of which are produced by the contraction of powerful springs which are distended by means of a motor shaft carrying tappet arms; (2) mechanism for feeding the picks forward as the channelling progresses, comprising a combination of right and left hand screws, one of which is attached to the main frame whilst the other is attached to the pick frame and telescoped within the former so that it will reciprocate with the frame while being caused to rotate with the outer screw; (3) means whereby the picks may be adjusted relatively to accommodate themselves to any condition of obliquity; (4) means for giving the carriage a lateral feeding movement on its base, such movement being obtained by a suitable intermediate bearing from the motor shaft, causing the picks to travel laterally the width of the channel being cut, such travel being continuously to and fro; (5) cleaning chains which clean out and empty the channel as the work proceeds, the chains being arranged to feed forward and laterally with the respective picks; and (6) devices whereby the machines may be adjusted to any inclination. (December 4, 1883).

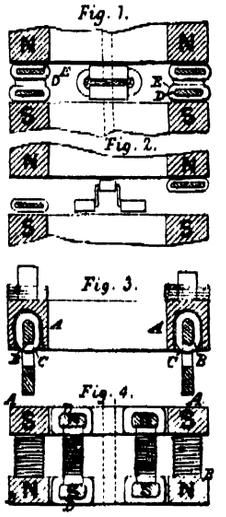
5664. Governing Steam Steam Engines: W. Knowles, Bolton. [6*d*. 4 *Figs.*]—The speed of the main governor is varied by means of a supplementary governor. Referring to the illustration, which clearly shows the construction of the governor, when the engine is at its normal speed with a certain load and pressure, the balls of the centrifugal governor E revolve in such a plane that the lever H is in its proper position for regulating the admission of steam, the driving strap S being also in a central position on the conical pulleys, and the supplementary governor W at its normal speed. Should an alteration of speed



occur, the governor E moves the lever H so as to vary the steam supply or cut-off, and the governor W brings one or other of the discs *k* to bear on the disc *l*, and to rotate it and its shaft in one or the other direction; by this movement the nut *d* is turned, moving a fork *a* in one direction or the other, and so shifting the strap *s* along the conical pulleys, and altering the speed of the governors E. A similar arrangement applied to a horizontal steam engine fitted with a Corliss valve gear is illustrated and described. (December 7, 1883).

5697. Lighting and Extinguishing or Raising and Lowering Illuminating Flames: G. P. Ganster, Reading, Berks, U.S.A. [6*d*. 8 *Figs.*]—Clock mechanism wound by hand or other suitable mechanism is provided with means for automatically raising or lowering the gas at certain predetermined times. A cluster of lights is employed in each lamp; the mechanism ignites all the burners at nightfall; it extinguishes all but one, say, at midnight; and it extinguishes the remaining one in the morning. (December 11, 1883).

5736. Dynamo-Electric Machines: P. W. Willans, Thames Ditton. [4*d*. 4 *Figs.*]—The machine is formed with



one or more circular magnet poles or poles of the same polarity arranged in a circle. Coil of insulated wire wound round iron wire cores are revolved in front of one or between two such poles. Fig. 1 shows the coils E of insulated conductor, embracing the iron wire ring D and revolving between two opposite circular poles N N, S S. Only those parts of each coil cut the lines of force from the magnet pole to the core as will cause one continuous current to be induced, the other parts cuting as few lines of force as possible. Fig. 2 shows an arrangement with a single iron core of zig-zag form. Fig. 3 shows the coils C mounted on a ring B, and revolving in a recess in a circular pole A. The ring B may be of opposite polarity to the pole A. Fig. 4 shows two cylindrical poles A B, within which are the cylindrical poles on which the coils D are mounted, the inner and outer poles being of opposite polarity as indicated by the letters N S. Provisional protection only. (December 13, 1883).

5752. Stern Frame for Screw Steamers: C. J. D. Christie, Tynemouth, North. [4*d*. 1 *Fig.*]—The forward post is curved aft from the "boss" (through which the propeller shaft projects) towards the rudder-post at the keel and towards the "transon" or rudder trunk (merging into the rudder post) at upper part. (December 15, 1883).

5754. Manufacture of Cast Metal Pipes, &c: W. R. Lake, London. (*F. Shickle, St. Louis, Missouri, U.S.A.*) [1*s*. 6*d*. 67 *Figs.*]—This invention relates (1) to apparatus for forming cores, &c., and moulds for pipes and similar castings; (2) to the method of lining a mould consisting in placing the lining material in a tubular form in the mould flask and then compressing the material against the flask, the flask being arranged vertically and the sand being applied thereto throughout its height before being compressed, the compression being effected by moving the compressor upward; (3) to a similar method of coating a core bar; (4) to a moulding pit; (5) to the relative position of the pit wall and the flasks when suspended in the pit; (6) to that part of the moulding apparatus which forms the bell of the pipe, and (7) to the means employed in moulding the coating upon the core bar socket. This specification extends to twenty-two pages of description, and contains forty-nine claims, and is too long for satisfactory abridgment. (December 15, 1883).

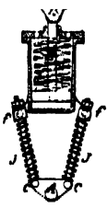
5778. Printing Types: H. J. Allison, (*L. B. Benton, Milwaukee, Wisc., U.S.A.*) [6*d*. 1 *Fig.*]—Each character body is made of a width running wise which shall be an exact multiple of a certain fixed unit of measure, and each space of a width either equal to or a multiple of that unit. (December 18, 1883).

5780. Type-Writing Machines: W. R. Lake, London. (*J. B. Hammond, New York, U.S.A.*) [1*s*. 6*d*. 36 *Figs.*]—The object is "to provide simpler, more efficient, and more responsive mechanism, the friction of which is reduced to a minimum, and to improve the several parts concerned in performing the several functions incident to a type-writing machine in such a manner that the co-operation of these parts shall be harmonious." This contains twenty-eight pages of descriptive matter and fifty-three claims, and cannot be abstracted within our limits. (December 18, 1883).

5801. Cleaning Seed and Grain: J. Anderson, London. (*Lyall, Gray, and Co., Calcutta*). [1*s*. 10 *Figs.*]—The machine comprises a sieve for separating the large lumps, an elevator for raising the grain on to an inclined board, where it is submitted to the action of rubbers, and a second sieve where the rubbed grain meets with a blast of air. (December 18, 1883).

5859. Augers, &c.: A. G. Brookes, London. (*J. Swan, Seymour, Conn., U.S.A.*) [6*d*. 10 *Figs.*]—The object is to produce a machine capable at one operation of milling the floor lip and shaping the inner wall of the cutting spur of an auger or auger bit. The bit is held in a rest and operated upon by a rotating milling tool having its periphery toothed to mill the inner side of the cutting spur and leave it concaved and circular. The floor lip of the bit is cut at an inclination, and the inner face of its cutting spur is concaved at one and the same operation. (December 26, 1883).

5925. Spring Hinges for Doors: J. S. Stevens and C. G. Major, London. [6*d*. 14 *Figs.*]—This refers to hinges of the kind described in Specification 5281 of 1883, the heel of the door being fitted with a shoe and pivot provided with two arms. Referring to the illustration, the door pivot A is fixed to the heel of the door and is provided with two arms C to which the rods, surrounded by the spiral spring *j*, are pivotted. The rods pass through



two lugs on the cylinder, which are fitted with knuckle joints and fastened by lock nuts. The cylinder is placed with its closed end toward the pivot A, the rod E pointing towards and being pivotted to the back of the box at G. The rod is surrounded by a spring J. The buffer or check action, by means of a liquid, is as explained in the before-mentioned specification. Other arrangements are described. (December 29, 1883).

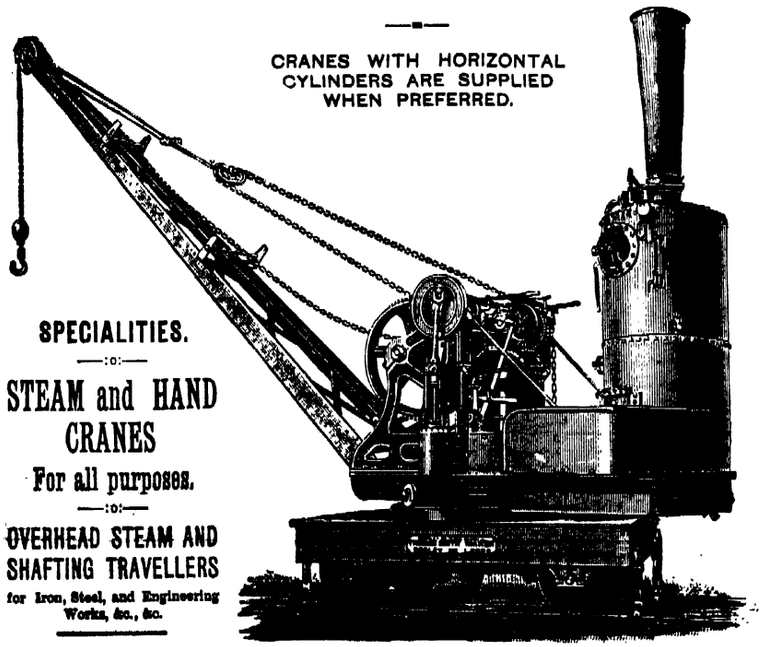
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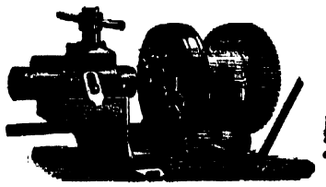
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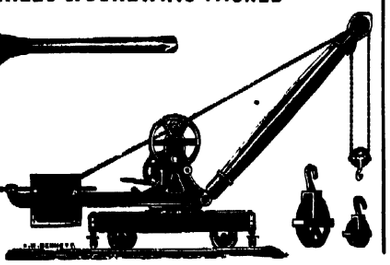




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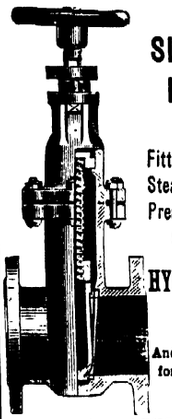


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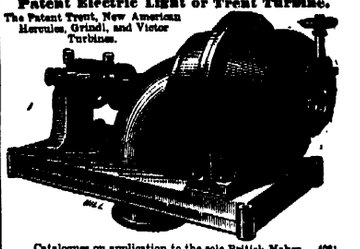
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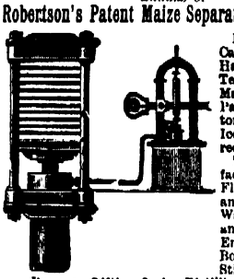
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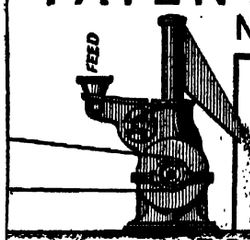
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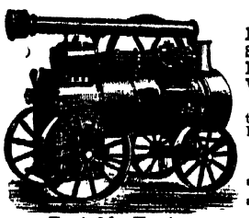
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ENGINES AND BOILERS SUITABLE FOR MILLS, FACTORIES, ELECTRIC LIGHT INSTALLATIONS, &c., &c.



Portable Engine.
Single Cylinder, 4 to 12 HP. nominal
Double " 8 to 30 HP. "

Portable and Semi-Portable Engines, Semi-Fixed Engines and Boilers, Horizontal Engines, Vertical Engines and Boilers,

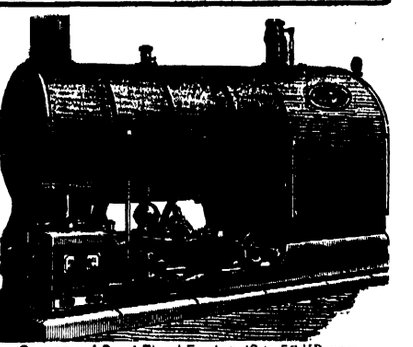
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Compound Semi-Fixed Engine, 12 to 50 HP. nom.

TUBES AND **FITTINGS.**

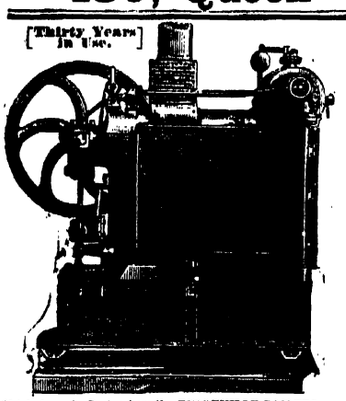
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Clyde Rivet Works Co.,
GLASGOW.
BEST RIVETS, SPIKES, WOOD SCREWS, SCREW BOLTS, NUTS. 5072

Important Fact as to Belting.

AT the Bath and West of England Show, held at Maidstone, from the 2nd to the 6th June, various belts were in use on the Machinery in motion there. On the 4th, about noon, the rain came on, and continued up to the close of the Show on the 6th. *During the whole of the rain, out in the open,* one of GANDY'S PATENT AMERICAN COTTON BELTS *continued to do its work satisfactorily,* driving a set of Messrs. TAYLOR & NEATE'S, of Rochester, 12 in. three throw Slurry Pumps. This was the only Belt that continued to work in the rain. All the Leather and Rubber Belts *had to be taken off, owing to their inability to drive in wet weather.* This fact alone speaks volumes. How long will it take to convince Englishmen (the Americans are already convinced) that the "GANDY" BELT is the **CHAMPION** Belt of the **WORLD?** 5149

130, Queen Victoria Street, London, and Baltimore, U.S.A.



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Grands Magasins du Louvre (in the Basement)	- - -	900 HP.
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Hôtel du Crédit Lyonnais	do. - - -	320 HP.
Eden Théâtre	do. - - -	140 HP.
Grands Magasins du Printemps	do. - - -	800 HP.
Grand Hôtel	do. - - -	100 HP.

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Gold Medal and Legion d'Honneur—Paris, 1878. Diploma of Honour—Nice, 1884.

BELLEVILLE'S INEXPLOSIBLE PATENTED PORTABLE ENGINE AND BOILER

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SEMI-METALLIC ANTI-FRICTION PASTE FOR STUFFING BOXES, AND ANTI-FRICTION GREASE FOR STEAM COCKS, &c.

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Non-evaporative at 600°.
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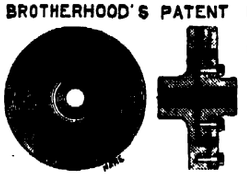
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Free from Acid.
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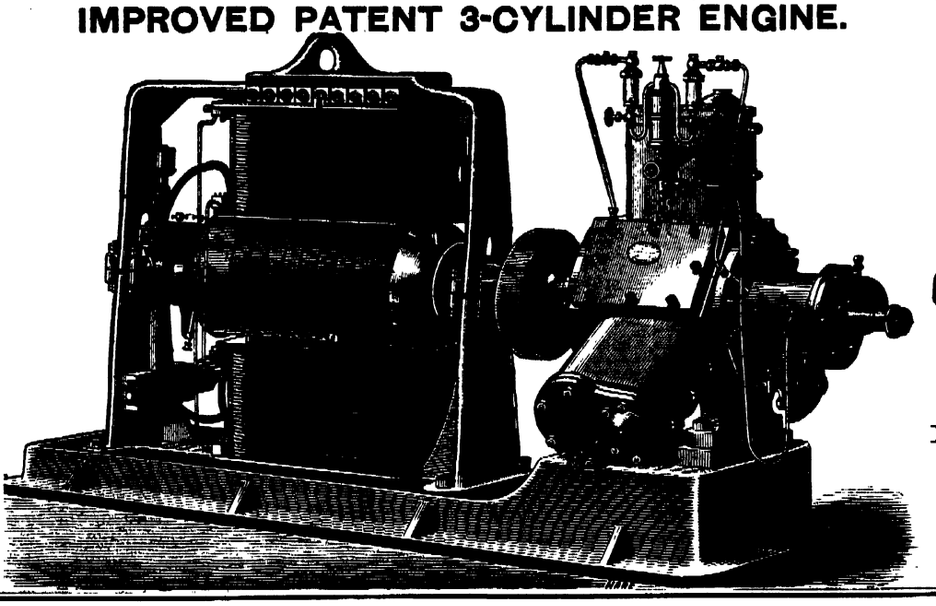


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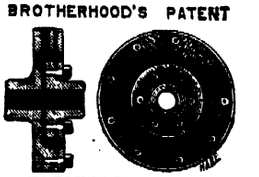
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IMPROVED PATENT 3-CYLINDER ENGINE.



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FANS,
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HIGH-SPEED
MACHINERY.

5204



Uptake arrangement.

FIELD'S PATENT BOILERS AND TUBES.

1540 OF THESE BOILERS ARE NOW IN USE. They are the lightest and most economical in the market. We can show several 50 HP. Boilers occupying a floor space of only 6 ft. 6 in. square, which are evaporating 10.93 lbs. of water per lb. of coal, after eight years' hard work.

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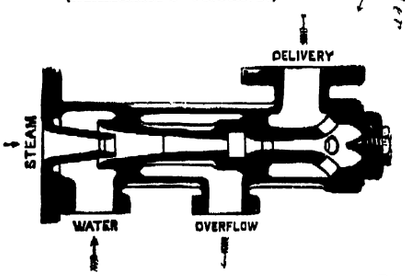
Gresham's Patent Improved Giffard's Injectors

FOR SUPPLYING STATIONARY, LOCOMOTIVE, AGRICULTURAL OR MARINE BOILERS WITH WATER

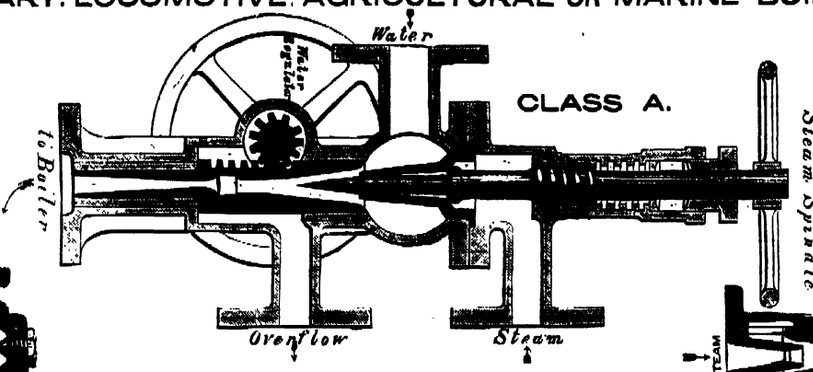
CLASS C 2.

Combining and Receiving Cones removable without breaking pipe joints.

(GRESHAM'S PATENT.)



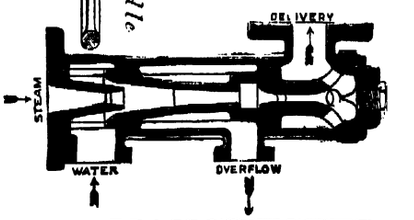
CLASS A.



CLASS G

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The above and every other class of Injector, Ejector, and Elevator in stock and in progress; also Brass Fittings for Locomotive and other Boilers.

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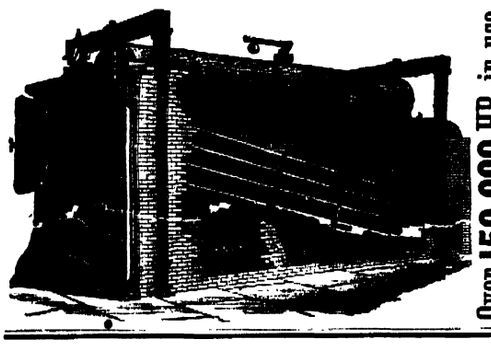
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CONTRACTORS BY APPOINTMENT TO HER MAJESTY'S WAR DEPARTMENT.

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The SIMPLEST, SAFEST and BEST, and also the CHEAPEST Automatic Safety Apparatus for Turning Main Engines.

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HALL'S PATENT

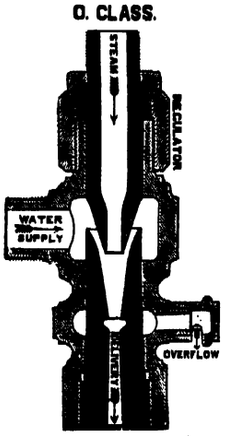
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ONE MOTION ONLY—SIMPLY TURN ON STEAM.

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STATIONARY.

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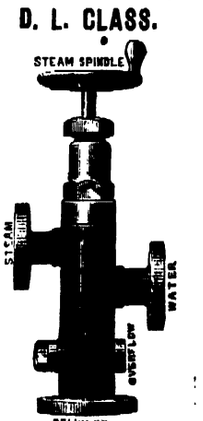
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Your Injector works beautifully. I will do all I can to recommend them to any party who is in want of a perfect Boiler Feeder, as I feel satisfied that they are the best, cheapest, and simplest Feeder that has ever been employed for supplying water to Boilers. GEO. W. H. FRASER, BURNBANK ENGINE WORKS, 40, SEAMORE ST.

ASHTON, NEAR WIGAN, June 22nd, 1883.

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Lifting and Forcing.
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STANDARD PATTERNS FOR

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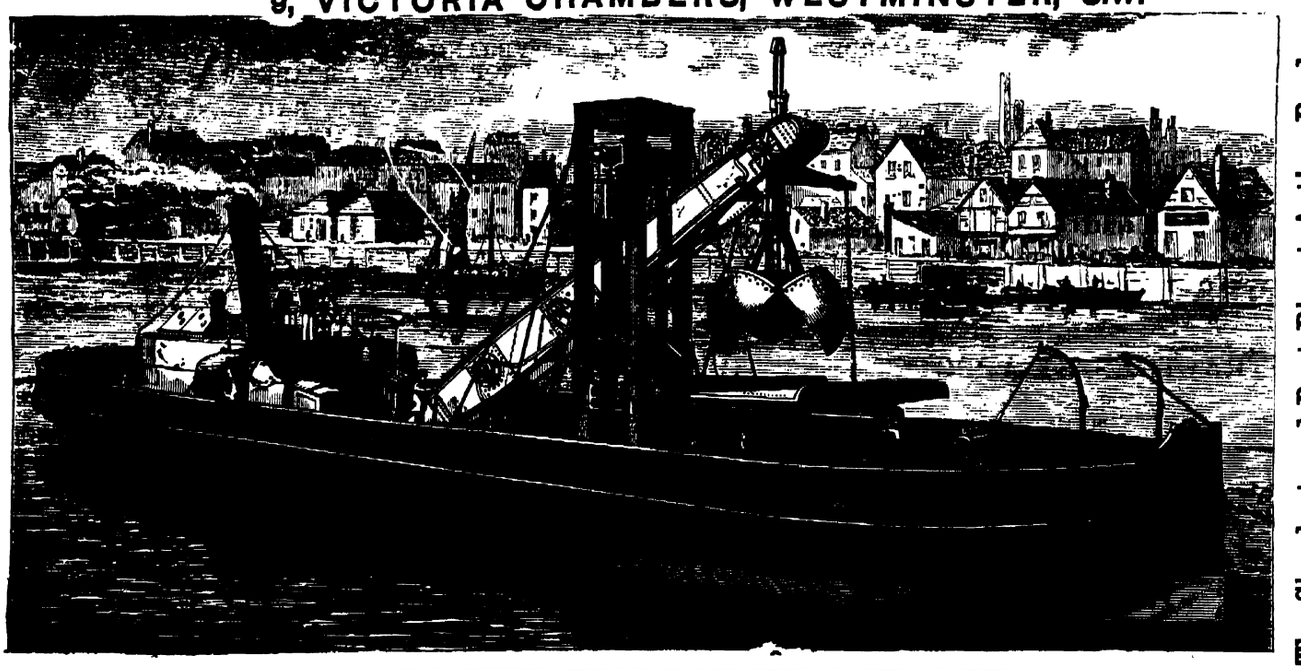
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These Dredgers can be made to work to any depth not exceeding 35 ft., and to dredge in any material from 100 to 1,000 tons per hour.

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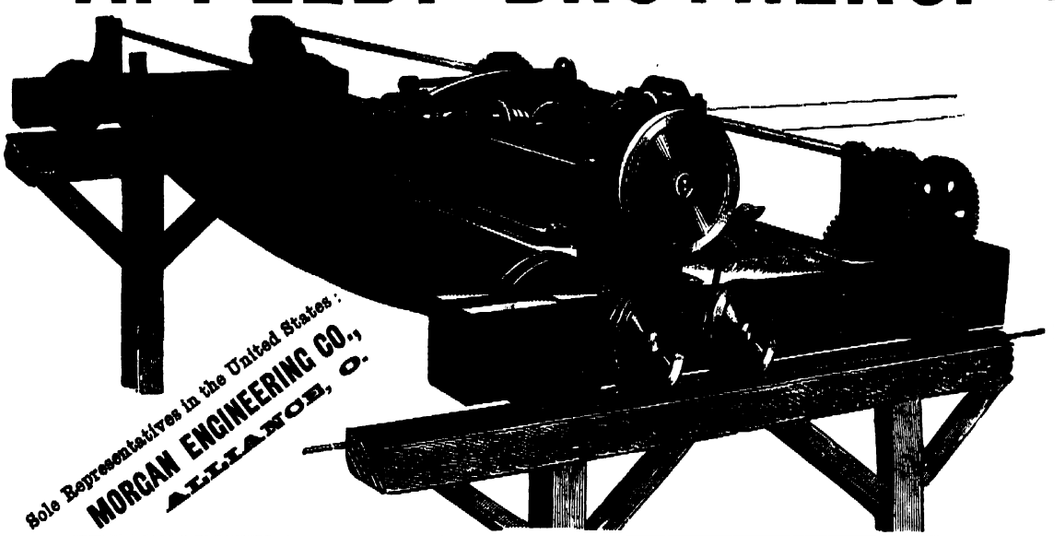
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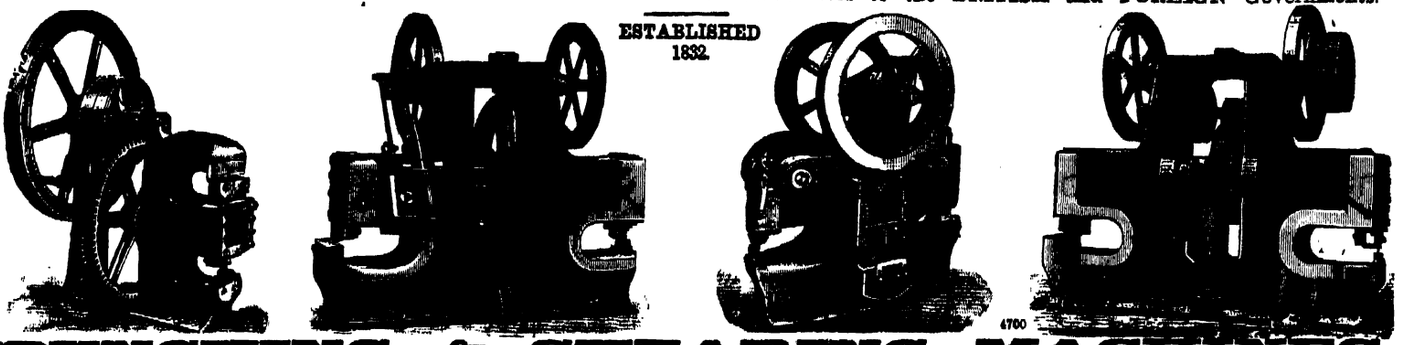
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4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1882, 1



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 4794

THE

MANGANESE BRONZE & BRASS COMPANY

(LIMITED),

Sole Manufacturers of Parsons' Patent "Manganese Bronze and Parsons' White Brass.

MANGANESE BRONZE.

No. 1.—In Ingots, Slabs, Forgings, Rolled Rods, Plates, Sheets, &c. Can be rolled and forged hot, and rolled drawn and worked cold. Tensile strength—Annealed 30 tons, Cold Rolled and Drawn 40 to 50 tons per square inch. No. 2.—For special purposes. Has double the strength of gun metal. No. 3.—For Propellers and strong castings of all kinds. Is 50 per cent. stronger than gun metal, and can be cast with facility. No. 4.—For all parts of Engines and Machines subjected to friction, especially such as work under heat. No. 5.—Special Bearing Metal—Wears three times as long as gun metal.

PARSONS' WHITE BRASS.

No. 1.—In Ingots, Bearings, &c. Wears four or five times as long as gun metal. No. 2.—For Filling—In Ingots. For filling Main Bearings, Crank pin Brasses, Side Blocks, &c., of Marine and Land Engines Is used by the principal Steam Ship Companies and Engineers. Experience proves it superior to all other White metals. 4058

For further Particulars and Prices apply to P. R. PARSONS, Manager, ST. GEORGE'S WHARF, DEPTFORD, LONDON, S.E.

WALKER BROS., ENGINEERS AND BOILER MAKERS, Pagefield Iron Works, WIGAN,

MANUFACTURERS OF LOCOMOTIVES.

WALKERS' PATENT

AIR-COMPRESSING ENGINES

For COLLIERIES, STEEL WORKS, &c., and as supplied to HER MAJESTY'S GOVERNMENT for INDIA

WALKERS' PATENT GUIBAL VENTILATING FANS,

For Mines, Collieries, Tunnels, Sewers, &c. Diameters from the smallest size up to 50ft. With Simple or Compound Condensing Engines.

MAKERS OF THE GUIBAL, SCHIELE (his latest Patent), AND WADDLE FANS.

STEAM HAMMERS, Patterns up to 20 tons. FORGE and ROLLING MILL PLANT. WINDING, HAULING, and PUMPING ENGINES. IMPROVED FEED PUMPS for BOILERS.

STEAM CAPSTANS, Patterns for lifting up to 60 tons. OVERHEAD TRAVELLERS AND OTHER CRANES.

HORIZONTAL AND VERTICAL, STATIONARY, AND LOCOMOTIVE BOILERS.

Iron and Steel Forgings. Horizontal and Vertical Engines, Condensing and Non-Condensing. Roofs, Girders, Bridges, Pit Cages, &c., and all kinds of Iron and Steel Work.

WALKER'S Patent, as adapted to Bessemer Blowing Engines, is now in successful operation at the following Steel Works, and is about to be applied to other Engines for similar purposes :—

Messrs. BOLCKOW, VAUGHAN and CO., Eston, Middlesbro'.
,, The DOWLAIS IRON CO., Dowlais.
,, CHARLES CAMMELL and CO., Cyclops Works, Sheffield.
,, The DARLINGTON IRON and STEEL CO., Darlington.
,, The WEARDALE IRON and STEEL CO., near Durham.

And to 150 other Engines for a variety of purposes throughout the country.

The advantages afforded by the application of the Patented Valves to Bessemer Engines, are a greater endurance than has yet been attained by valves worked automatically (eccentrics, &c., for the valves not being required), and an almost perfect expulsion of the whole of the compressed air from the cylinders.

RANSOMES & RAPIER,

5, Westminster Chambers, London, & Waterside Ironworks, Ipswich,

MAKERS OF ALL KINDS OF RAILWAY PLANT

INCLUDING

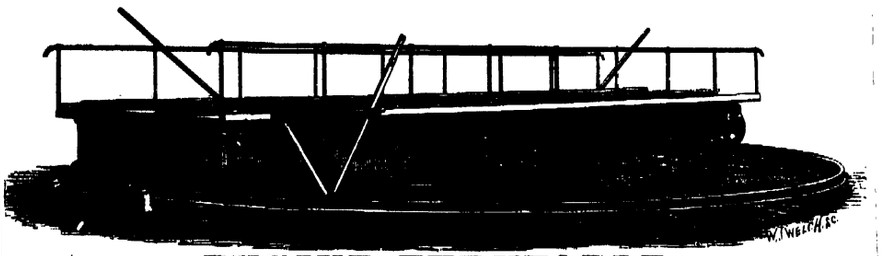
SWITCHES,

CROSSINGS,

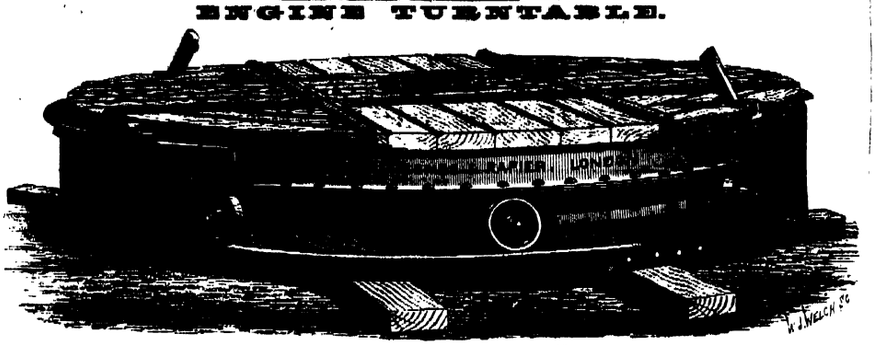
Engine Turntables,

CARRIAGE TURNTABLES,

TRAVERSERS.



ENGINE TURNTABLE.



CARRIAGE TURNTABLE.

INCLUDING

SIGNALS

HYDRANTS,

PUMPS

TANKS,

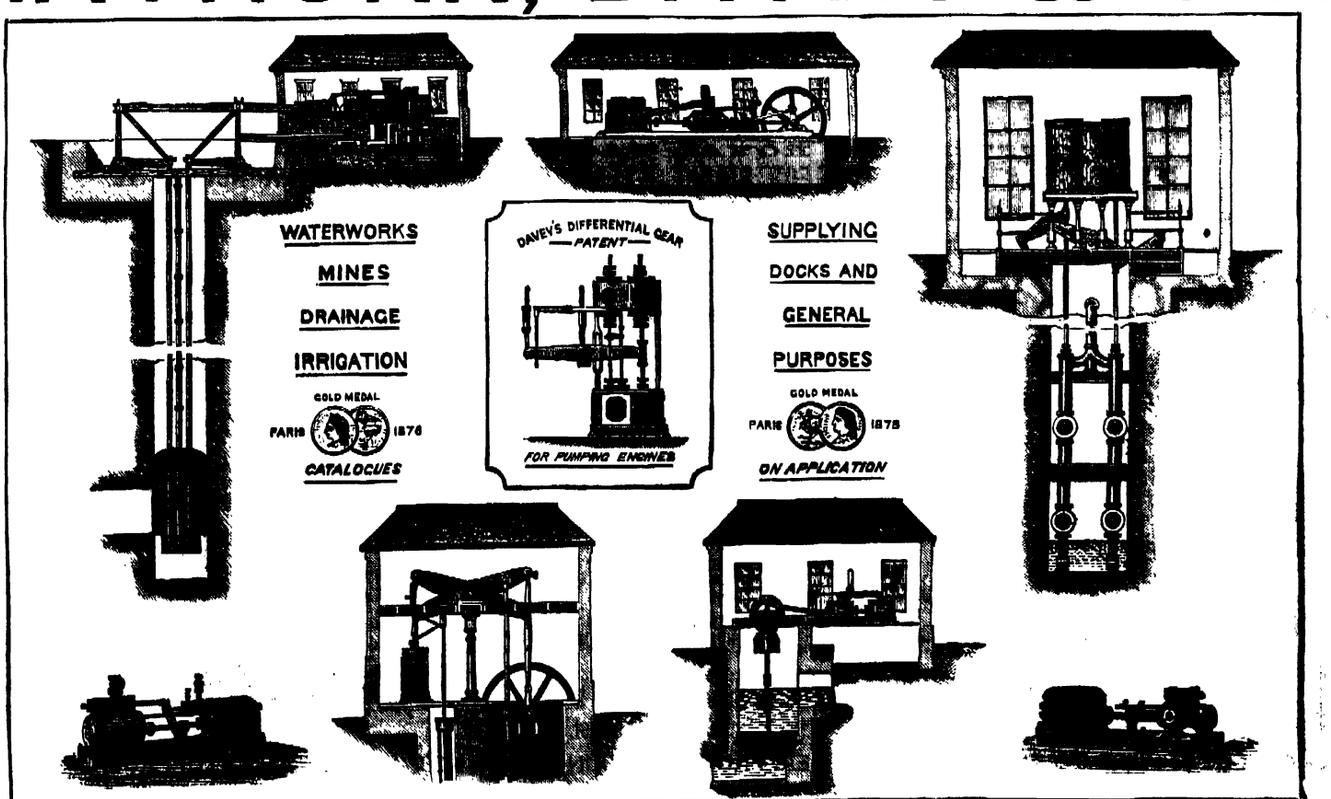
WATER CRANES

ALSO ALL KINDS OF

STEAM AND HAND CRANES

Prices and Illustrations on application to **RANSOMES & RAPIER**, 5, Westminster Chambers, London.

HATHORN, DAVEY & CO.



4973

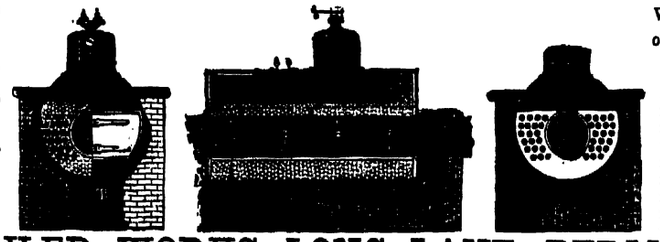
SUN FOUNDRY, LEEDS.

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breeze, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft.	long,	5ft. 0in.	diameter,	20-horse power.
10ft.	,,	5ft. 6in.	,,	30 ,,
12ft.	,,	6ft. 0in.	,,	40 ,,
13ft.	,,	6ft. 6in.	,,	50 ,,
14ft.	,,	7ft. 0in.	,,	60 ,,
15ft.	,,	7ft. 6in.	,,	70 ,,
16ft.	,,	8ft. 0in.	,,	80 ,,
17ft.	,,	8ft. 0in.	,,	90 ,,
18ft.	,,	8ft. 0in.		100 ,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

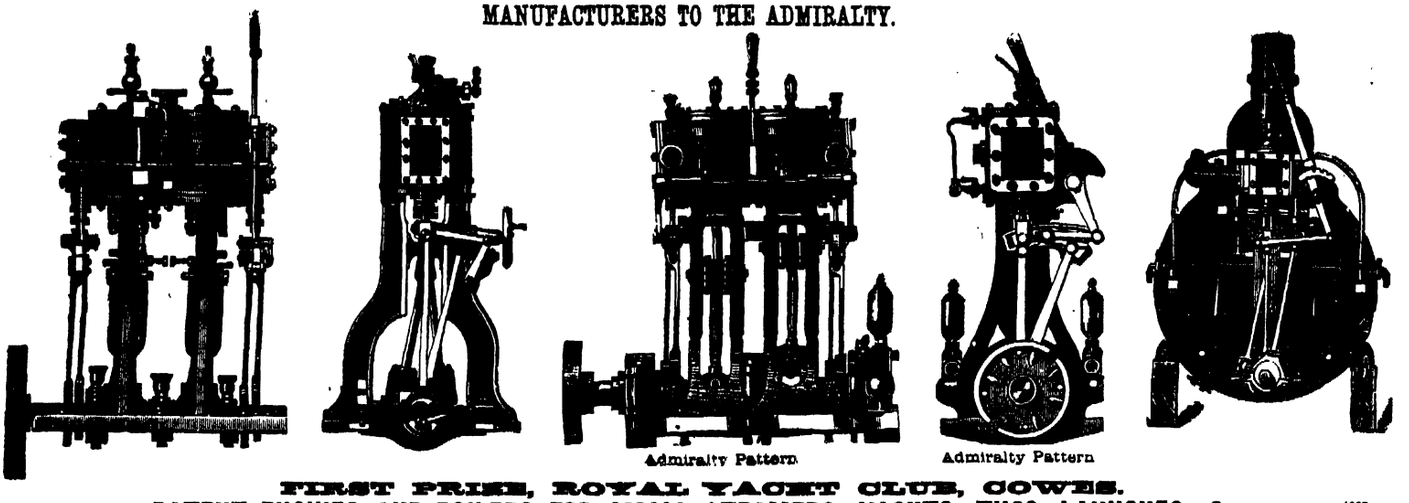
BRASS & COPPER TUBES

SEAMLESS & BRAZED, FOR BOILERS, SURFACE CONDENSERS &c
BRASS & COPPER WIRE, SHEETS &c. 4857

BIRMINGHAM BATTERY & METAL CO., BIRMINGHAM.

PLENTY & SON, EAGLE IRONWORKS, NEWBURY, BERKS.

MANUFACTURERS TO THE ADMIRALTY.



Admiralty Pattern. Admiralty Pattern

FIRST PRIZE, ROYAL YACHT CLUB, COWES.

PATENT ENGINES AND BOILERS FOR SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &c. 4927

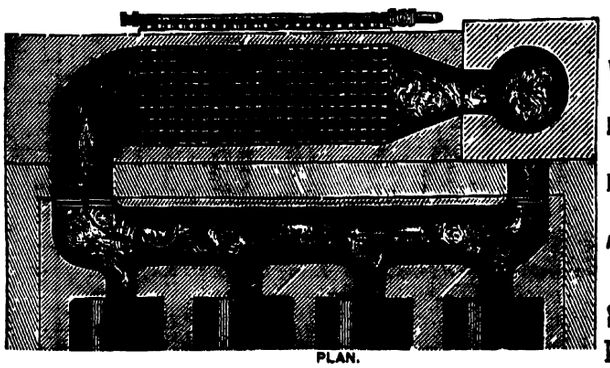
Simple, High-pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works.

Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(For Utilising the WASTE HEAT from STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION



PLAN.

SPECIAL ADVANTAGES.

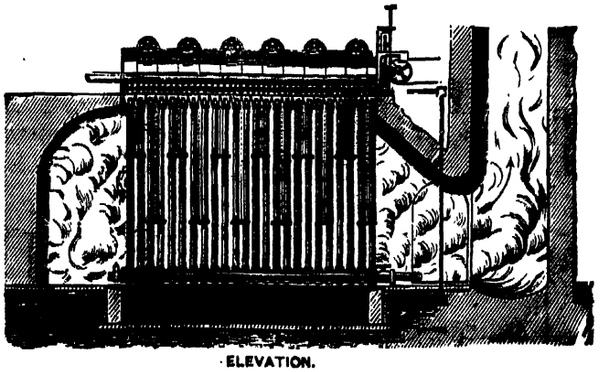
Vertical Pipe Castings. Guaranteed sound and perfectly true.

New Patent Spiral Scrapers The most effectual removers of *soot*.

Patent Reversing Gear. Never sticks or gets out of order.

ALREADY IN OPERATION TO HUNDREDS OF STEAM BOILERS.

Saves from 20 to 25 per cent. of the fuel.



ELEVATION.

N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and abroad.

PRICES, TESTIMONIALS, AND FURTHER PARTICULARS ON APPLICATION TO 4420

ARTHUR LOWCOCK, (PATENTEE & SOLE MAKER) Coleham Foundry, Shrewsbury, England.



From Photo. of ROOF, 80 ft. span (in IRON and STEEL), recently erected by MOREWOOD & CO., suitable for Railway Stations, Sheds, and general purposes.

Roofs and Building
IN IRON AND STEEL.

MOREWOOD & CO.
WOODFORD IRONWORKS,
SOHO, BIRMINGHAM
LONDON OFFICES—158, LEADENHALL STREET, E.C.

CORRUGATED AND GALVANISED SHEET
LION WORKS, BIRMINGHAM
Manufacturers of every description of Roofs and Buildings in Iron & STEEL for Forges, Rolling Mills, Railway Stations, Goods Sheds, Yards, Docks, Stores, and General Purposes.
Special Curved Corrugated Iron Roofs without Framing for moderate Spa
WROUGHT IRON WATER TANKS, any size.
ANNEALING AND GALVANIZING POTS.
Corrugated Iron & STEEL Sheets & Fastenings, &
Ridges, Gutters, and Tanks, Galvanized or Painted.
Wrought-Iron Lattice and Plate Girders. Railway, Road and Foot Bridg
DESIGNS AND ESTIMATES ON APPLICATION. 490

Paris, 1878.—GOLD MEDALS AWARDED.—Melbourne, 1881.

WM. JESSOP & SONS, LIMITED
BRIGHTSIDE WORKS, SHEFFIELD,
MANUFACTURERS OF
EVERY DESCRIPTION OF TOOL STEEL & STEEL CASTINGS,
Cast, Shear, German, Spring, Blister & Sheet Steel for all purposes
Files of First Quality.—Steel Lagging Plates for Cylinders.—Steel Boiler & Ship Plates & Forgings of all kinds.
DEPOTS:—Manchester, Paris, Dusseldorf, St. Petersburg, New York, Boston, Philadelphia, Cincinnati, St. Louis Chicago, San Francisco, Baltimore, Providence, Montreal.
LONDON OFFICE: MESSRS. CORNES, CALVERT & CO., 30, WALBROOK, E.C. 5187

DAVY BROTHERS, LIMITED,
SHEFFIELD,
MANUFACTURERS OF
STEAM HAMMERS
From 1 Cwt. to 50 Tons, for every kind of work,
Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.
BESSEMER STEEL WORKS PLANT,
FORGE AND ROLLING MILL MACHINERY,
Steam Engines for Mills, Ironworks, Collieries, &c.
SINGLE AND DOUBLE FLUED BOILERS.

STAND 15, TEXTILE EXHIBITION, AGRICULTURAL HALL, LONDON.

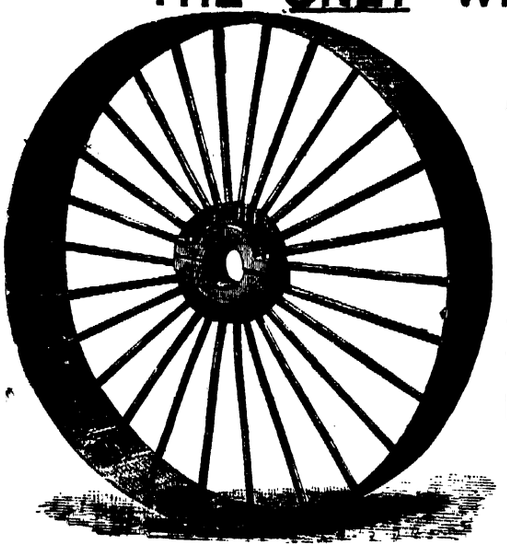
RODGERS' PATENT
WROUGHT IRON PULLEYS

WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.

THE ONLY WROUGHT IRON PULLEY MADE.

SPLIT OR SOLID.

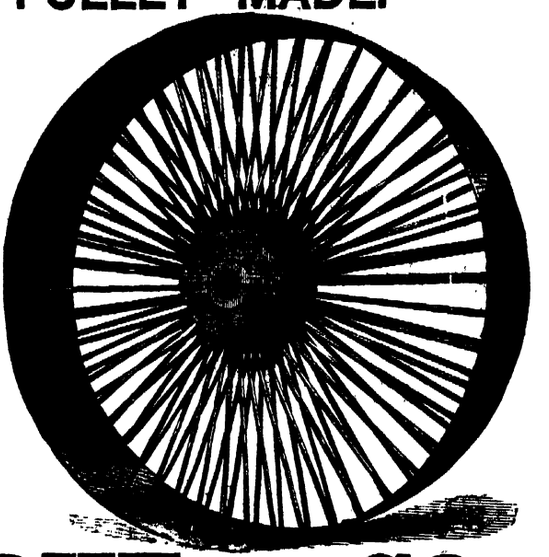
All Sizes up to 24 feet Diameter.



40,000
IN USE.

The Best Pulley in the World

USED SOLELY FOR
DRIVING THE ELECTRIC LIGHT
AT THE
HEALTH EXHIBITION,
SOUTH KENSINGTON.



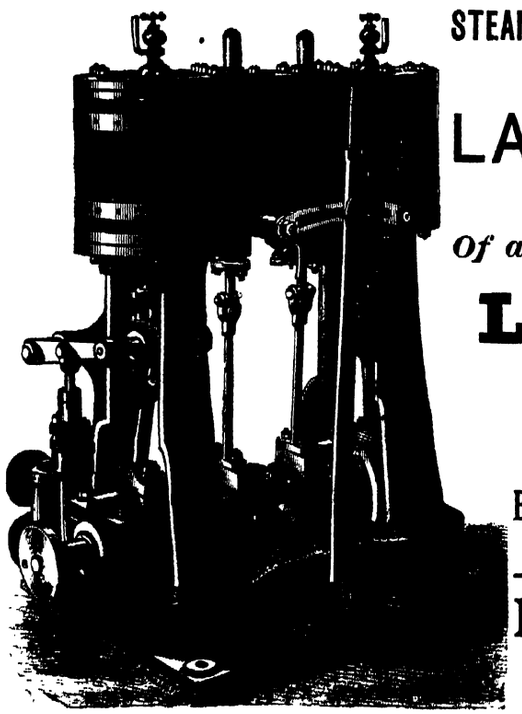
SOLE MAKERS:

HUDSWELL, CLARKE & CO.,
RAILWAY FOUNDRY, LEEDS.

—SOLE AGENTS—

France—C. BORISSOW, Rue a Fiens, 9ter, Lille.
Russia—S. G. MARTIN, Galerny No. 12, Quartier 8, St. Petersburg.
Austria—J. EGLI, I, Berz Freiung 7, Vienna.
Saxony—W. W. DERHAM, Leipzig.
Belgium—D. GRANDY, Rue de l'Abattoir 30, Gand.
Italy—A. SINGTON & CO., Manchester and Milan.
Holland—VAN RIETSCHOTEN EN HOUWENS, Rotterdam.
Portugal—ALFD. HARRISON, Rua Nova St. Domingos 95, Oporto.
Dominion of Canada—T. J. CHURCH, 672, Craig St. Montreal.
Lancashire & District—F. B. WELCH & CO., Market St., Manchester.
North of England—SNOWBALL & CO., Side, Newcastle-on-Tyne.
W. of England—Townsend & Young, Arch House, John St., Bristol.
Glasgow and District—ROBERTSON & Co., 9, Old Sneddon St, Paisley.
South of Ireland—JAS. F. ROBERTS, 72, Francis Street, Dublin
4925

MATTHEW PAUL & CO.,
MAKERS OF
STEAM AND HAND WINDLASSES,

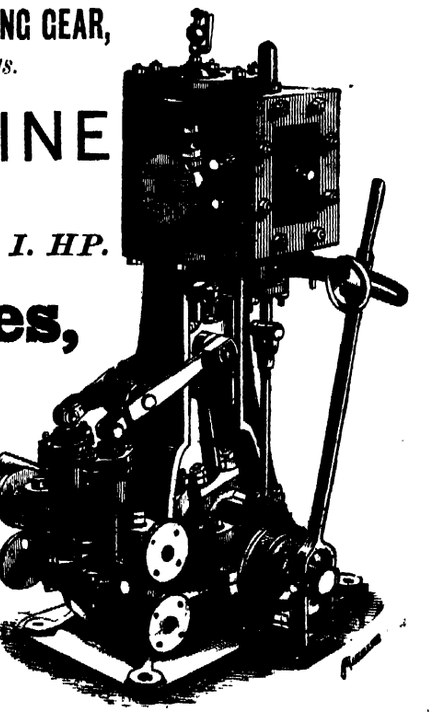


STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,
And every Description of Ship Fittings.

LAND AND MARINE ENGINES
Of all Sorts and Sizes up to 1,000 I. HP.

Launch Engines,
WITH
Patent Valve Motion.

Builders of LAUNCHES, BARGES, & YACHTS
UP TO 100 FEET LONG.

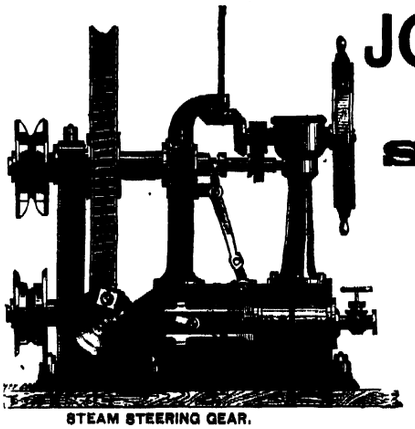
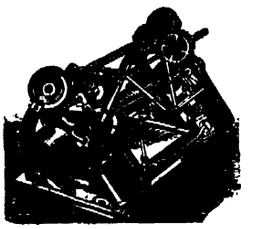
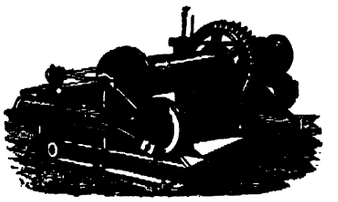


LEVENFORD WORKS,
DUMBARTON.

In the above the reversing is accomplished with single eccentric for each cylinder, and the numerous complications and working joints of link motion are dispensed with, while all the properties of same are retained, and the steam and exhaust openings at ends of stroke are the same always, whether in full gear or not.

FOR MINING, LEATHER
ENGINEERING, INDIA-RUBBER
AND GENERAL MECHANICAL PURPOSES GUTTA-PERCHA
GEO. ANGUS & Co. NEWCASTLE-ON-TYNE 18, BILLITER STREET, LONDON. LIVERPOOL. And BUTE DOCKS, CARDIFF.
5101

JOHN H. WILSON & CO.,
ENGINEERS AND BOILER MAKERS, &c.
SANDHILLS, LIVERPOOL.


STEAM STEERING GEAR.

VERTICAL STEAM WINCH.

HORIZONTAL STEAM WINCH. 4662

MANUFACTURERS OF STEAM CRANES, OVERHEAD TRAVELLERS, STEAM PUMPS, &c.

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

BELL'S Asbestos Works, Southwark. S.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.
Steam Pressure.....110 lbs. | Vacuum.....29 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 27 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,
D. HENDERSON, Chief Engineer, S.S. "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department,
Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,
MR. J. BELL. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts,
Admiralty, Whitehall, 20th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core.....square. | Elastic core.....round.

To MR. JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 60 per cent.; ¼ in., 100 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

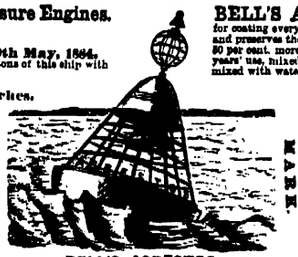
Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

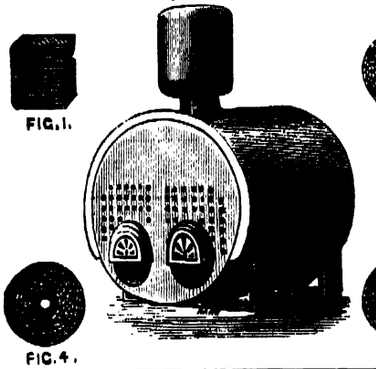
To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,
THOMAS WINTER, Colliery Engineer.


TRADE MARK.

BELL'S ASBESTOS.

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depôts and not through agents or factors.


FIG. 1.
FIG. 2
FIG. 4.
FIG. 3.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates.. .. .. .. 186 deg.
Covering. .. .. .. 94 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 28th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly,

"W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,
Gunnislake, Tavistock, 8th April, 1884.

MR. JOHN BELL, Southwark, S.E.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,
W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ⅛ in. to 3 in. wide, and any thickness from 1-16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and ¼ millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts.
Admiralty, Whitehall, S.W., 17th May, 1884.

SIR,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT.

MR. JOHN BELL. Director of Navy Contracts.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REG'D.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

4943

OR THE DEPOTS—

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

READING IRON WORKS, LIMITED.

HORIZONTAL CONDENSING - ENGINES	VERTICAL - - - - BOILERS
COMPOUND CONDENSING - ENGINES	CORNISH OR SINGLE FLUE - BOILERS
BOTH CLASSES NON-CONDENSING ENGINES	LANCASHIRE OR DOUBLE FLUE BOILERS
VERTICAL, to 12 Horse-Power - ENGINES	MULTITUBULAR - - - BOILERS
AUTOMATIC EXPANSION - - ENGINES	SEMI-PORTABLE - - - BOILERS
PORTABLE, HIGHEST CLASS - ENGINES	And VERTICAL - - - BOILERS
SEMI-PORTABLE - - - ENGINES	In COMBINATION with VERTICAL ENGINES
TRACTION - - - - ENGINES	

FOR CATALOGUES AND INFORMATION APPLY TO 4781

THE READING IRON WORKS, LIMITED, READING, BERKS.

THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

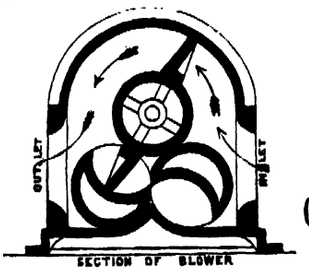
Baker's Patent Rotary Pressure Blower and Gas Exhauster

—:o:—

BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

—:o:—

HALL'S PATENT STONE BREAKER.

—:o:—

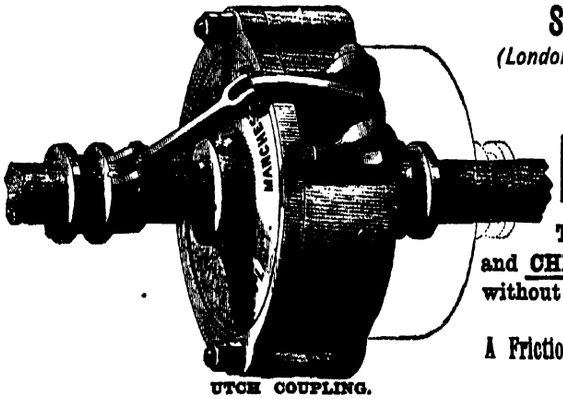
General Machinery of Every Description.

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4688

MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.



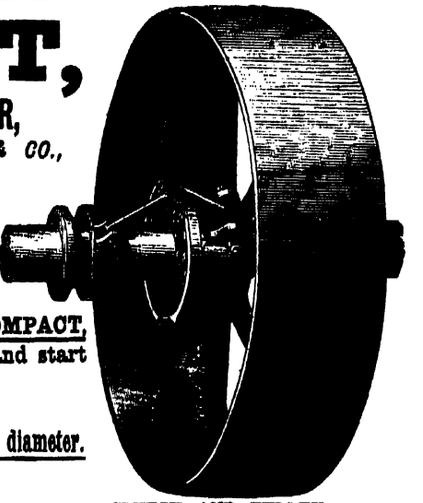
UTCH COUPLING.

— PATENT —

FRICTION CLUTCH.

These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.


CLUTCH AND PULLEY

LIBERAL TERMS TO THE TRADE.

PRICES ON APPLICATION.

5269

GOODFELLOW & MATTHEWS,

(LATE B. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 5004

Highest and only First-Class Award at the Calcutta International Exhibition, 1883-4.

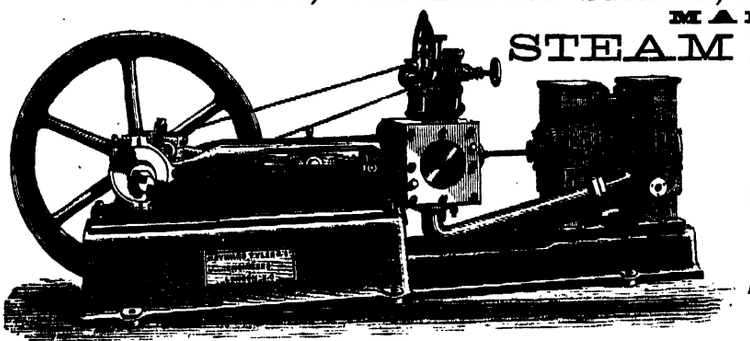
TRAMWAYS DICK, KERR & CO., TRAMWAYS



Over 150 miles of Line now laid in England on the above systems.
BUILDERS OF TRAMWAY LOCOMOTIVES AND TRAMWAY CARS. 5023
Estimates, Specifications, and Drawings on application to HEAD OFFICE: 101, LEADENHALL STREET, LONDON, E.C.
WORKS: BRITANNIA ENGINEERING WORKS, KILMARNOCK.

W. ROWLANDSON,
132, Boundary St.,
LIVERPOOL,
— MAKER OF —
OIL MILL MACHINERY
On the old system, or the ANGLO-AMERICAN,
OIL BOILING PLANT,
Machine Moulded Wheels,
PULLEYS, SHAFTING,
ELEVATORS,
ENDLESS BAND CONVEYERS,
AND ALL KINDS OF MILLWRIGHT AND ENGINEERS' WORK. 5278

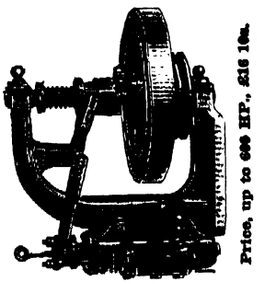
HAYWARD TYLER & CO.,
84 & 85, WHITECROSS STREET, LONDON,
MAKERS OF
STEAM ENGINES



The BRAMAH ENGINES, High Pressure, 3 to 10 HP.
Ditto, Condensing
(for Chemical Works, &c., where low pressure steam is used).
The TUBE GIRDER ENGINES, High Pressure, 6 to 60 HP.
Ditto, Condensing.
The STANDARD HORIZONTAL ENGINES, High Press., 6 to 60 HP.
Ditto, Condensing.
4930

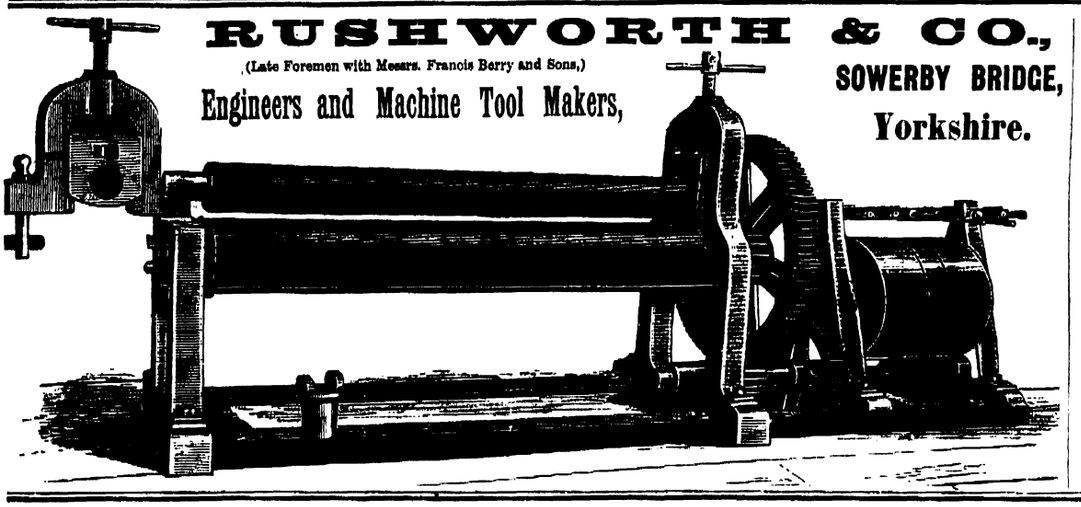
COMPOUND CONDENSING ENGINES, 30 to 300 HP., with Rider's Patent Automatic Expansion, controlled only by the Governor.

BLAIR'S IMPROVED MARINE
ENGINE GOVERNOR
SENSITIVE & RELIABLE.



Price, up to 600 HP., £16 16s.
Has been supplied to numbers of Screw Steamers.
For further particulars apply to 5222
GEORGE BLAIR, 38, Queen St., Glasgow.

RUSHWORTH & CO.,
(Late Foremen with Messrs. Francis Berry and Sons,)
Engineers and Machine Tool Makers,
SOWERBY BRIDGE,
Yorkshire.

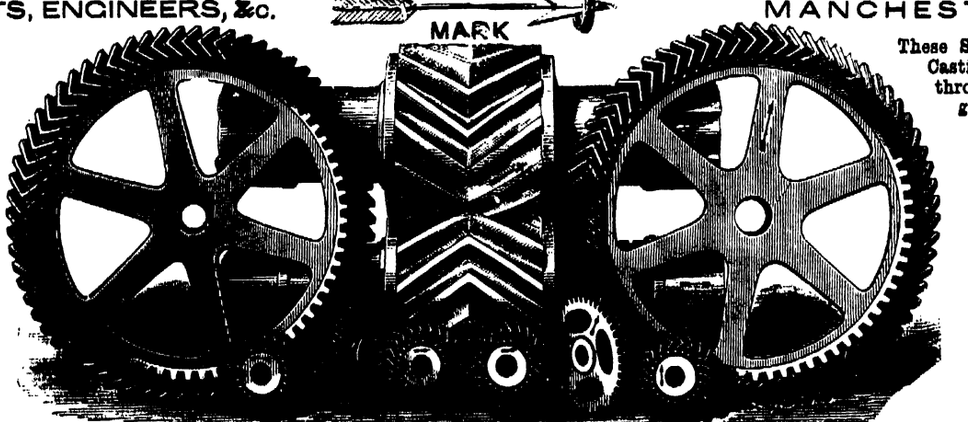


MAKERS OF
Improved Lathes, Planing, Slotting, Shaping, Drilling, Screwing, Punching & Shearing
MACHINES,
PLATE BENDING ROLLS,
Special Angle & T Iron Bending Machines,
SPECIAL MULTIPLE PUNCHING AND SHEARING MACHINES FOR GAS HOLDER AND TANK MAKERS,
Steam Hammers, Geared and Steam Rivetting Machines, &c.,
PLATE EDGE PLANING
MACHINES 5163
For Boiler Makers and Ship Builders.

P. R. JACKSON & COMPANY,
STEEL AND IRONFOUNDERS
MILLWRIGHTS, ENGINEERS, &c.
TRADE MARK
SALFORD ROLLING MILLS,
MANCHESTER.

MANUFACTURERS OF
JACKSON'S
Machine-Moulded
Spur, Bevel, AND Worm Wheel
CASTINGS.

PULLEYS
EITHER FOR
Straps or Ropes,
Spur or Bevel
Mortice Wheels
with Machine
cut Cogs.



These Steel or Iron Wheel Castings can be obtained through almost any Engineer, Millwright, or Machinery Merchant.
Care should be taken to specify
"P. R. Jackson & Co.'s MACHINE-MOULDED WHEELS."
And each Wheel should bear the above TRADE MARK.

Fly Spur Wheels Rope or Strap Pulleys to 30 ft. diameter, bored, turned and key-grooved by Machinery, and erected when required.
MAKERS OF RAMSBOTTOM'S PISTONS & PISTON PACKING RINGS, in Iron, Steel, or Brass. More than 28,000 of these Pistons are at work. 4330

WATER PURIFICATION

JOHN HENDERSON PORTER, PATENTEE,
1 & 2, TUDOR STREET, LONDON, E.C., furnishes the necessary Plant.

The PORTER-CLARK PROCESS

Removes the Carbonates of Lime, Magnesia, and Iron from **Hard Waters**, and thus, the **causes of Incrustation in Boilers and Pipes.** This Process is in use in Paper Mills, Breweries, Sugar Works, India-rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c. One Railway Company employs it for feed-water to the extent of **1,000,000 gallons** daily, and one of the London Water Companies at two of its Pumping Stations. It is also in use in County Asylums, Public and other Schools, and Private Mansions. The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich, are rendered soft and clear. 5226

DESCRIPTIVE CIRCULAR ON APPLICATION.

THOMAS TURTON & SONS,

MANUFACTURERS OF RAILWAY SPRINGS AND BUFFERS,

Files and Cast Steel of Superior Quality, Spring Steel, Shear Steel, &c. 4927

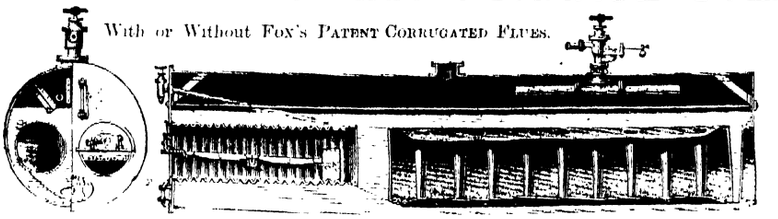
SHEAF WORKS, AND SPRING WORKS, SHEFFIELD.

LONDON OFFICES, 90, CANNON STREET, CITY. PARIS DEPOT, 12, RUE DES ARCHIVES. BOSTON, U.S., 40, KILBY STREET.

PENMAN'S IMPROVED DUPLEX FURNACE STEAM BOILER.

PENMAN & Co.,
CALEDONIAN IRON WORKS,
377, DALMARNOCK RD.,
GLASGOW.

With or Without FOX'S PATENT CORRUGATED FLUES.



MAKERS OF
ALL CLASSES OF
STEAM BOILERS
FOR HOME & ABROAD.

LONDON OFFICE: 7, FENCHURCH STREET, E.C.

THE ABOVE POSSESS THE FOLLOWING IMPORTANT ADVANTAGES OVER THE ORDINARY DOUBLE-FLUED BOILER:—
1.—EQUAL EXPANSION. 2. PERFECT CIRCULATION OF WATER. 3.—THOROUGH COMBUSTION OF SMOKE. 4.—ECONOMY OF FUEL.
Makers of the most Effective, Simplest, and Cheapest SMOKE CONSUMING APPARATUS yet introduced. 4082

SHAFTING

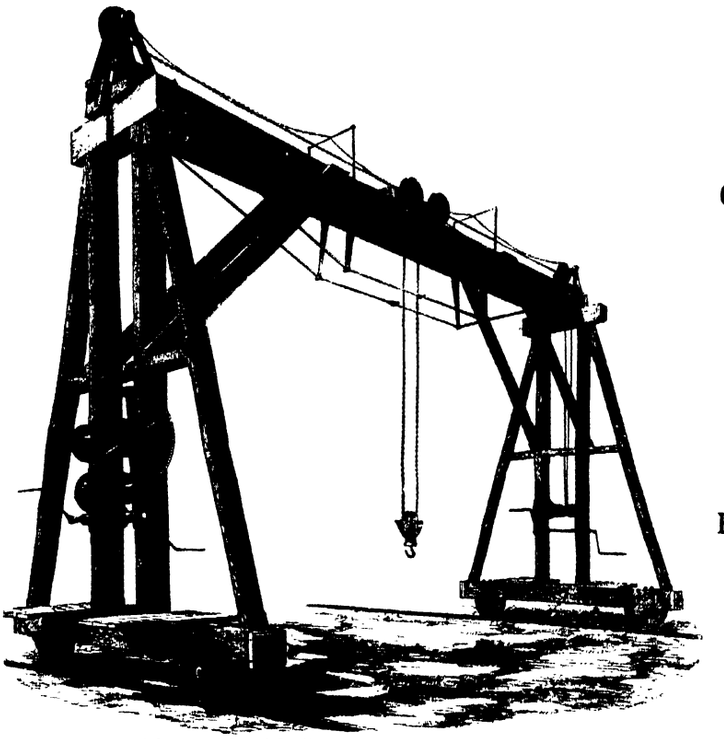
Turned true and bright to Whitworth's Gauges, any length, from 2 in. to 3 in. diameter, **14s.** per cwt. at Nottingham. Also Couplings, Pulleys, Plummer Blocks, Hangers, Machine-made Spur, Bevel, and Mitre Wheels, Friction Gearing, &c.

H. HIND & SON, NOTTINGHAM, AND 62, BLACKFRIARS ROAD, LONDON, S.E. 4157

STOTHERT AND PITT, LIMITED, BATH.

HAND-POWER AND STEAM OVERHEAD TRAVELLERS.

STEAM CRANES.
WAREHOUSE CRANES.
WINDING ENGINES.
INCLINE GEARING.
PUMPING ENGINES.
CONCRETE MIXERS.
TURNTABLES.
TRAVERSERS.

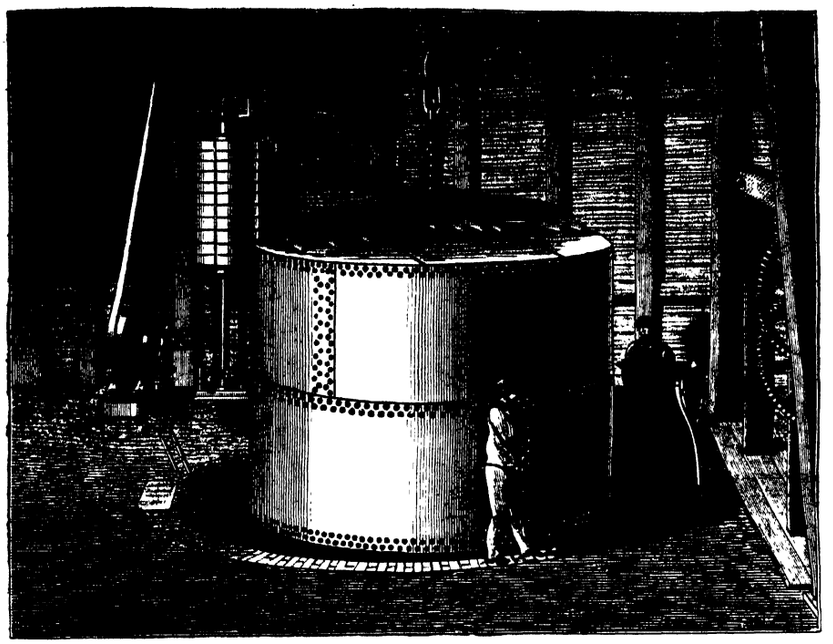


FOUNDRY CRANES.
QUARRY CRANES.
WATER WHEELS.
TURBINES.
WATER CRANES.
HYDRAULIC PRESSES.
STEAM CAPSTANS.
LEATHER MACHINERY.

Fig. 134. Engraved from a 4-Ton "Wellington" Crane, supplied to the Royal Albert Docks. 4639

LONDON OFFICE: 30, WALBROOK, E.C.

HYDRAULIC RIVETTERS



OF THE MOST RECENT TYPES.

Punching, Shearing, Bending, Forging, Hoisting,

AND OTHER HIGH-PRESSURE

HYDRAULIC MACHINERY

Please Note Change of Address:

ANDERSON & CALLWEY

Hydraulic Labour-Saving Machine Makers,

CREMORNE WORKS, 4085

CHELSEA, LONDON, S.W.

RACOSINE OIL

THE RUSSIAN NATURAL LUBRICATING OIL. Gold Medal, Paris, 1878.

Pure Hydro-carbon, free from acid. Body superior to Olive or Lard Oil | Never gums or clogs. Never freezes or thickens.

No. V 2s. 6d. PER CAL.

RAGOSINE & CO.,

7, IDOL LANE, LONDON, E.C.,

And Love Lane, Quayside, Newcastle-on-Tyne.

Works—BALACHNA and CONSTANTINOW, RUSSIA.

Price Lists and full particulars on application 4779

No. VIII 2s. 0d. PER CAL.



PATTERN C.

THE EMPIRE LUBRICATOR COMPANY,

EMPIRE WORKS,

GREAT BRIDGEWATER STREET,

MANCHESTER.

MANUFACTURERS OF

GRANDISON'S

EMPIRE LUBRICATOR

Which shows each drop of oil passing into the steam through the medium of a Glass Tube, and is the BEST APPARATUS now known for Lubrication of

STEAM ENGINES,

LAND OR MARINE.

Lubricators sent on approval to any part of the kingdom and references given to users in all parts of the inhabited world.

FURTHER PARTICULARS ON APPLICATION. 4763

A. S. CATTELL & Co.

17 & 18 Bear Alley, FARRINGDON St. LONDON, E.C.

ENGRAVERS TO "ENGINEERING"

BLOCKS PRODUCED FOR LETTER-PRESS PRINTING BY

ZINCO TYPOGRAPHY

ALL THE WORK IN TWO HOURS, NO LOSS OF WORK ENGRAVING

ELECTRO & STEREOTYPERS

4677

HANSON'S SPECIALITIES

Steam Pumps, Steam Engines, Steam Winches, Steam Dryers, Steam Traps, Steam Reducing Valves, Steam Purifying Apparatus for Boilers, Water Engines and Hoists for Warehouses.

WILLIAM HANSON,

QUEBEC WORKS, BRADFORD.

LONDON OFFICE: 37, WALBROOK. 5270

(See Illustrated Advertisement July 18th, page 11.)

TAYLOR & CHALLEN,
ENGINEERS,
BIRMINGHAM.

SOLE MAKERS OF
WITHINSHAW'S PATENT
Feed Water
HEATER.
The most powerful invented.
Great Saving in Boilers, Coals, and Labour.
LARGE HEATING SURFACE
Solid Drawn Brass Tubes.
Free Expansion.
No Scurf adheres to the Tubes.
4837
List on application.



MATHER'S PAN MILL



For Red Lead, Putty, Crushing Lumps, &c.

What Users of Machine say:

Messrs. Gwynne & Co., London: "Are satisfied with it." Hayward Bros. & Co., London: "It saves time, &c." Mr H. Mobbs, Northampton: "I am satisfied with it." Mr. W. Allchin, Northampton: "It is most useful." Messrs. Clayton & Shuttleworth, Lincoln: "We like it very much." Messrs. Tangye Bros., Birmingham: "Work is better than hand." Messrs. Foster & Co., Lincoln: "We think it well worth the money." 5104
Price with handle £1 18s. As above sketch, £2 2s.
G. R. MATHER, Wellingborough, England.

W. R. PALMER,
LIMITED,
BAGOT STREET FOUNDRY,
BIRMINGHAM.
Manufacturers of
MALLEABLE IRON CASTINGS.
Guaranteed true to Pattern, of best Qualities, and at *Low* Rates.
Castings for the Bicycle and Tricycle Trades. 4188



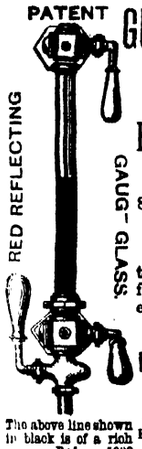
GOLD MEDAL, PARIS, 1878.

GAUGE GLASSES
AND
ENAMELS
For Iron, Cast-iron, Copper, &c.

PATENT
GUILBERT MARTIN
Patentee and Manufacturer of the
PATENT
RED REFLECTING
GAUGE GLASS,
Showing through the water a Broad Red Line.

N.B.—All Glasses are of the finest quality, and manufactured expressly to resist extreme pressure.

DEPÔT:
1 & 2, FALCON STREET,
Aldersgate Street,
LONDON, E.C.
Represented by
E. M. HAMBURGER.



The above line shown in black is of a rich Red. 5002

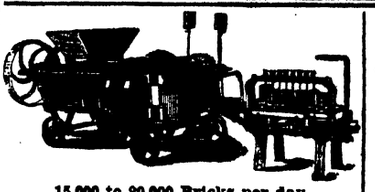
EDWARD HAYES, Engineer, STONY STRATFORD.
(LONDON OFFICE: 12, GREAT ST. HELENS, E.C.)

STEAM LAUNCHES
Speed from 10 to 25 miles per hour.



MACHINERY constructed for Boats Built Abroad.
Engines and Boilers kept in Stock.

BUILDER OF STEAM TUGS AND LAUNCHES.
Speciality in Small STEAM TUGS for towing Barges and Lighters. 5103



15,000 to 20,000 Bricks per day.

E. PAGE & CO.,
Victoria & Bedford Ironworks,
BEDFORD.
Illustrated and Priced Catalogues Free, in English, French, Spanish, or German, on application. 4718

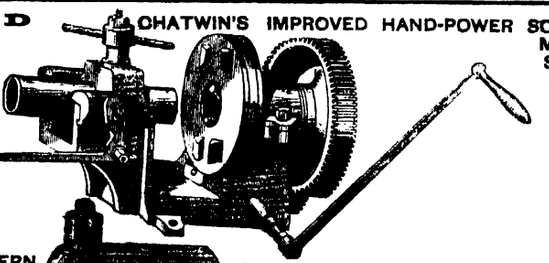


10,000 Bricks per day.

SPECIAL TOOL STEEL
FOR ALL PURPOSES.
BESSEMER AND SIEMENS STEEL FORGINGS AND SHAFTING.
SPECIAL TOUGH MINERS' DRILL STEEL
CRUCIBLE CAST STEEL TRAM CAR WHEELS AND AXLES. 5000
ASKHAM BROS. & WILSON, Ltd., SHEFFIELD.

AWARDED
A
Gold & Silver Medal
AND
Two 1st Class Certificates at
Calcutta Exhibition, 1884.

CHATWIN'S IMPROVED HAND-POWER SCREWING MACHINE, SCREWING AT ONCE OVER.



WHITWORTH PATTERN GUIDE STOCKS AND DIES.

PATTERN STOCKS AND DIES.



ENGINEERS' ANGULAR



BUDDING SPANNER.

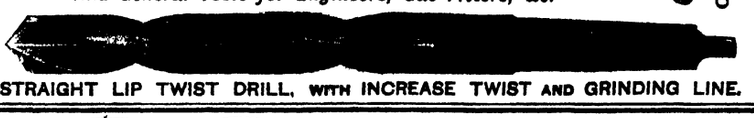
THOMAS CHATWIN,
GT. TINDAL STREET, BIRMINGHAM,
MANUFACTURER OF
STOCKS, DIES, AND TAPS,
PATENT HAND-POWER SCREWING MACHINES, TWIST DRILLS,
STANDARD CYLINDRICAL GAUGES, RIMERS,
CLYBURN, BUDDING, AND OTHER SPANNERS,
RATCHET BRACES, TUBE CUTTERS, TUBE WRENCHES, TUBE VICES,
And General Tools for Engineers, Gas Fitters, &c. 4824



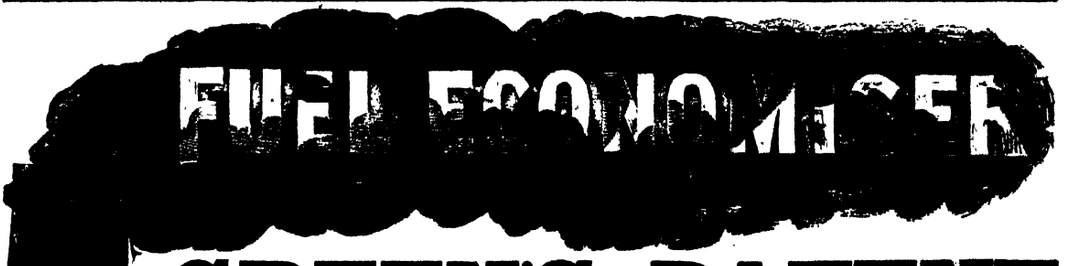
CLYBURN SPANNER



PATENT SOLID DIE STOCK FOR GAS TUBES SCREWING AT ONCE OVER.



STRAIGHT LIP TWIST DRILL, WITH INCREASE TWIST AND GRINDING LINE.

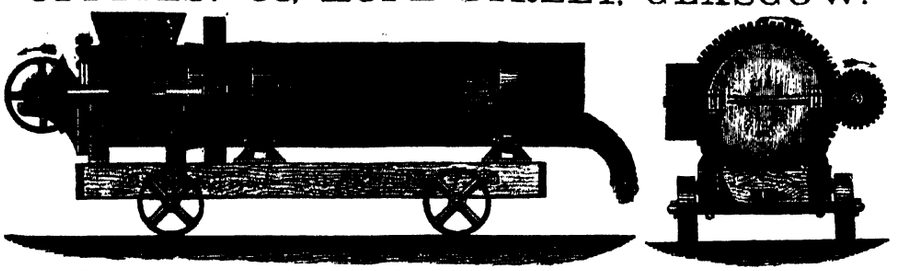


GREEN'S PATENT
Has been awarded the GOLD MEDAL at the CALCUTTA EXHIBITION, in addition to TWELVE MEDALS previously given at other Exhibitions. 5061
ST. ANN'S SQUARE, MANCHESTER. WORKS: WAKEFIELD.

BUTTERS BROS., Contractors' Engineers,

PERCY CRANE & ENGINE WORKS, LAMBHILL STREET.

OFFICES: 93, HOPE STREET, GLASGOW.



"Patent Concrete Mixer," capable of mixing 80 to 100 cubic yards per day of 9 hours.

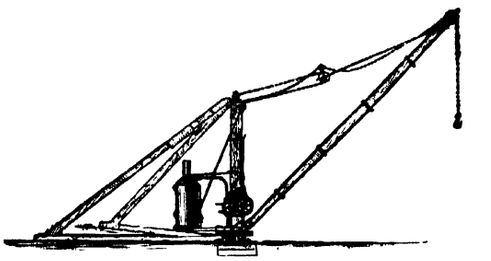
PRICE £90, AS SHEWN.

BUTTERS' CELEBRATED

SCOTCH DERRICK CRANES,

AS SUPPLIED TO

Forth Bridge Works; Sir Thos. Tancred; Arrol & Co., Contractors; New Bute Docks, Cardiff; Messrs. T Nelson & Co., Contractors; and principal Contractors in England, Ireland, and Scotland.



STOCK SIZES to Lift 1½, 2, 3, 5, or 7 Tons, 50 ft. Jibs. 5008

MADE UP TO 30 TONS.

LIGHT FORGINGS.

BRAKE WORK.

WAGON IRONWORK.

GLASGOW HYDRAULIC FORGE CO., LIMITED, Sentinel Works, Polmadie, Glasgow, and Canal Road, King's Cross, London. 5135

INTERNATIONAL HEALTH EXHIBITION.

CENTRIFUGAL PUMPING MACHINERY

FOR IRRIGATION,

Suitable for India, Egypt, and Elsewhere.

SIMPSON AND COMPANY, of PIMLICO, LONDON, have on EXHIBITION, close to the Water Companies' Pavilion, a CENTRIFUGAL PUMP capable of delivering 10,000 Tons of Water per Hour.

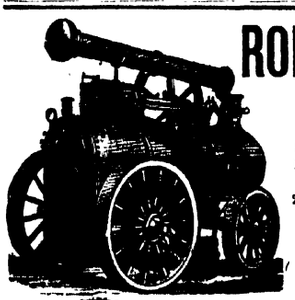
BRIDGE FOUNDATION CYLINDERS.

THE STOCKTON FORGE CO.,

STOCKTON-ON-TEES.

Make a Speciality of this work, turning out over 100 tons per week; also large quantities of Railway Chairs. 4809

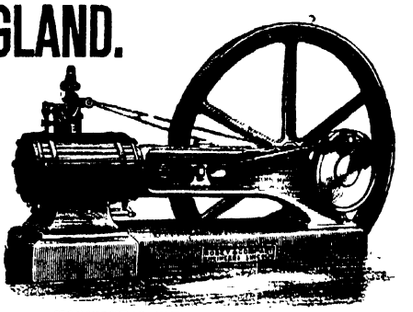
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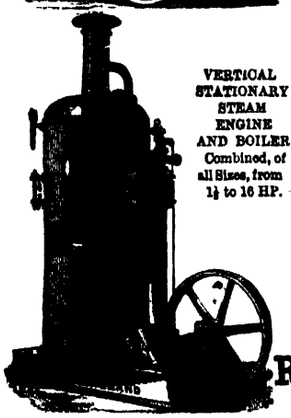
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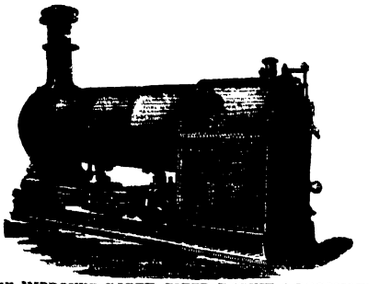
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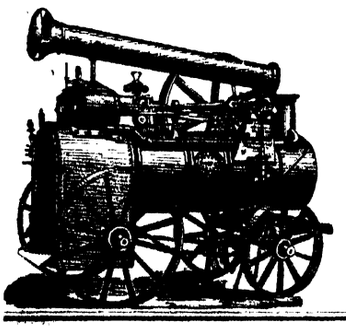
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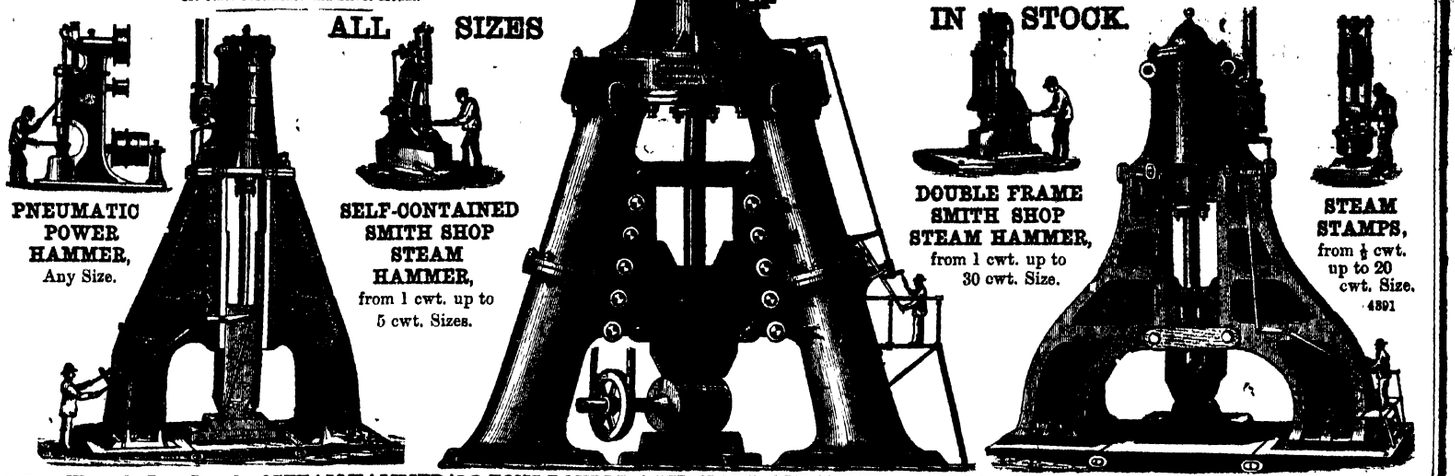
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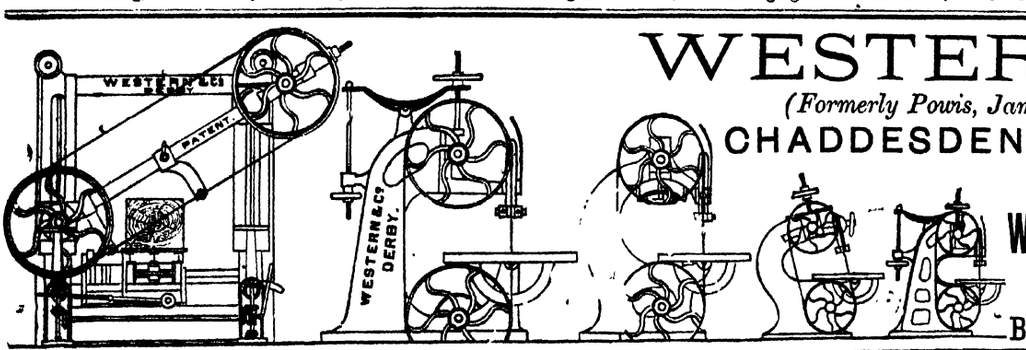
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An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.

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See Illustrated Advertisement last week, page 12.

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See Advertisement, page 33 3627

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Clerk's Patent Self-Starting Gas Engine.
HIGHEST AWARD,
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Patron:
HER MAJESTY THE QUEEN.

President:
H.R.H. THE PRINCE OF WALES, K.G.

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The NEXT TERM OPENS on MONDAY, SEPTEMBER 8th. I.—Mechanical Course. II.—Civil Engineering Division. III.—Colonial Section.—Prospectus of the undersigned.

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Supt. Educational Department.

The Mason College, BIRMINGHAM,

SESSION 1884—1885.

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All departments of the College are open to both sexes on the same terms. Special arrangements are made for the convenience of ladies.

Syllabuses containing full information as to Admission of Students, Courses of Instruction, Fees, Entrance and other Scholarships, &c., will be forwarded on application to GEO. H. MORLEY, Secretary. G 676

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EAST INDIAN RAILWAY COMPANY.

The East Indian Railway Company is prepared to receive

Tenders for the Supply and

DELIVERY of GALVANIZED STRAND WIRE FOR FENCING, as per Specification to be seen at those Offices.

Tenders are to be delivered in sealed envelopes, addressed to the undersigned, marked "Tender for Galvanized Strand Wire for Fencing," not later than One o'clock p.m. on Thursday, the 4th day of September next.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board, G 663
Nicholas Lane, London, E.C. A. P. DUNSTAN,
7th August, 1884. Secretary.

TENDERS FOR GASHOLDER.

The Directors of the PRESTON GAS COMPANY are prepared to receive

Tenders for the Erection of a

TELESCOPIC GASHOLDER, about 150 ft. diam. Sealed Tenders, endorsed "Tender for Gasholder," and addressed to the Chairman of the Company, must be delivered on or before Wednesday, the 10th September next. Plans and Specifications may be seen at the Office of the undersigned on and after the 14th inst. G 671

Gas Office, Preston, HENRY GREEN,
8th August, 1884. Engineer.

THE SOUTHERN MAHRATTA RAILWAY COMPANY, LIMITED.

The Board of Directors of the Southern Mahratta Railway Company, Limited, are prepared to receive

Tenders for the Supply of

IRON UNDERFRAMES, UNDERFRAME and BODY IRONWORK and FITTINGS for First, Second, and Third Class Carriages, Composite Carriages, Horse Boxes, and Brake Vans, as per Specification and Drawings to be seen at this Office. Tenders are to be delivered in sealed envelopes, addressed to the Secretary, marked "Tender for Underframes, &c.," not later than Twelve o'clock, at noon, on Wednesday, the 17th September, 1884.

The Company is not bound to accept the lowest or any Tender.

By order of the Board,
Secretary's Office, EDW. Z. THORNTON,
31, Lombard Street, E.C., Secretary.
8th August, 1884. G 666

TO ENGINEERS, IRONFOUNDERS, &c.

SOMERSET EAST, SOUTH AFRICA, WATER SUPPLY.

The Municipal Council of Somerset East, Cape Colony, require

Tenders for the Supply and

DELIVERY in England of about 400 tons of straight PIPES (9 in. to 3 in. diameter), and special CASTINGS, and of a number of Sluice and Air Valves, Hydrants, and Fittings.

The Specification and Drawing may be seen at the Standard Bank of South Africa, Clement's Lane, E.C., between Eleven and Two, on and after Monday, August 18th, and copies of the Specification and Form of Tender can be obtained there on payment of Half-a-Guinea.

Tenders, which must be endorsed on the outside "Tender for Pipes, &c., Somerset East," and addressed to ROBERT STEWART, Esq., Standard Bank of South Africa, Clement's Lane, E.C., must be delivered not later than noon on September 6th, 1884.

Mr. Stewart has power to accept Tenders, and enter into Contracts on behalf of the Municipal Council.

Tenders for the Pipes and Specials, or for the Valves and Fittings, will be considered, as well as Tenders for the whole of the work.

Intimation of the acceptance of any Tender will be given not later than October 1st, 1884.

The lowest or any Tender will not necessarily be accepted. G 634

APPOINTMENTS OPEN.

Civil Service Commission —PRELIMINARY EXAMINATION.

ASSISTANT to Surveyor's Office of Works (21-30), 5th September. Technical training and qualifications necessary.

The date specified is the latest at which applications can be received. They must be made on Forms to be obtained, with particulars, from the SECRETARY, Civil Service Commission, London, S.W. G 686

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WANTED, for Harbour Works in South America, the SERVICES of a GENTLEMAN who has had experience on similar works. A knowledge of either Portuguese, Spanish, or French indispensable.—Apply, in the first instance, stating qualifications, &c., to M. P., care of Messrs. A. H. BAILY & Co., 15, Nicholas Lane, City, E.C. G 682

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be thoroughly experienced in first-class Boiler Work in all its branches, and practically acquainted with modern formulæ.—Apply, giving full particulars, to Messrs. FRASER & FRASER, Bromley-by-Bow, London, E. G 679

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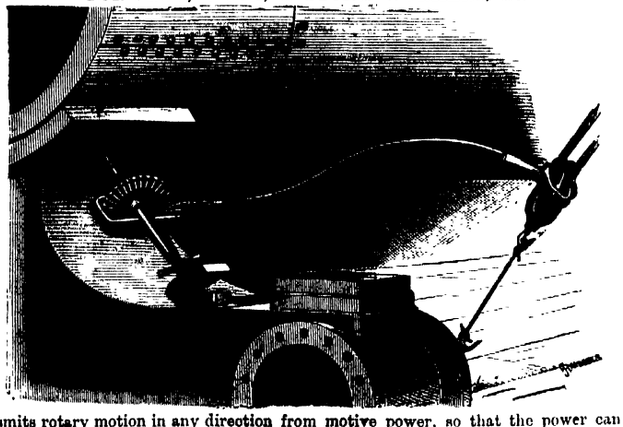
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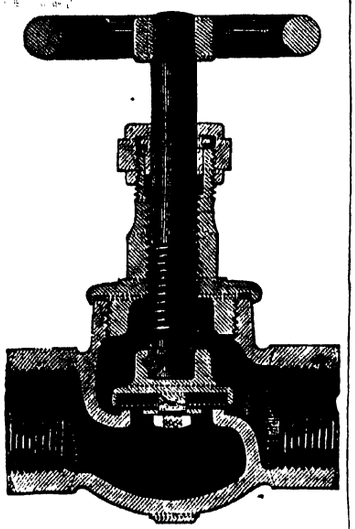
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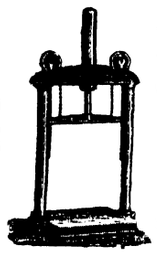
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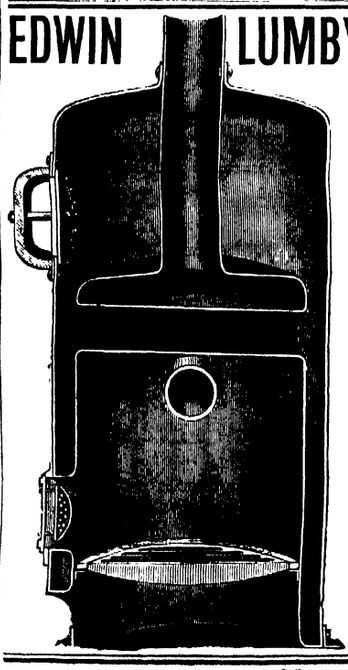
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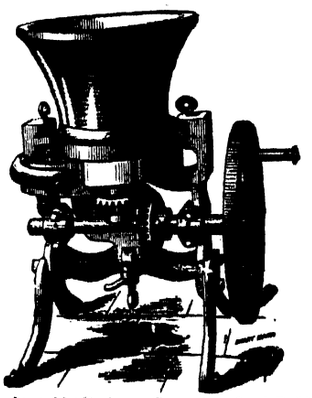
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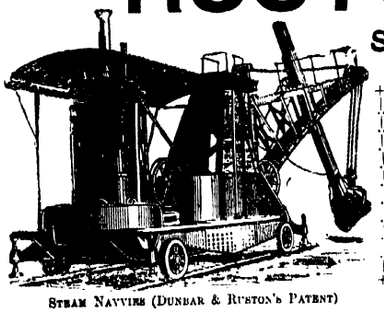
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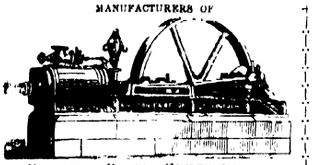
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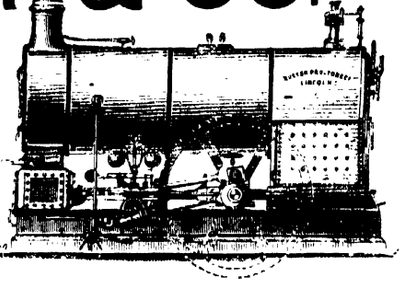
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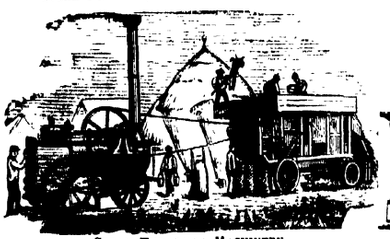
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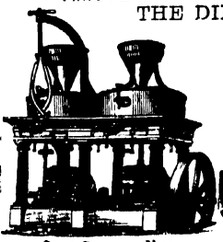
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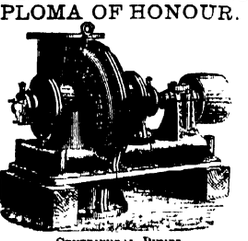
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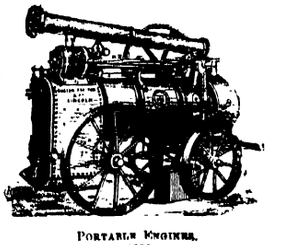
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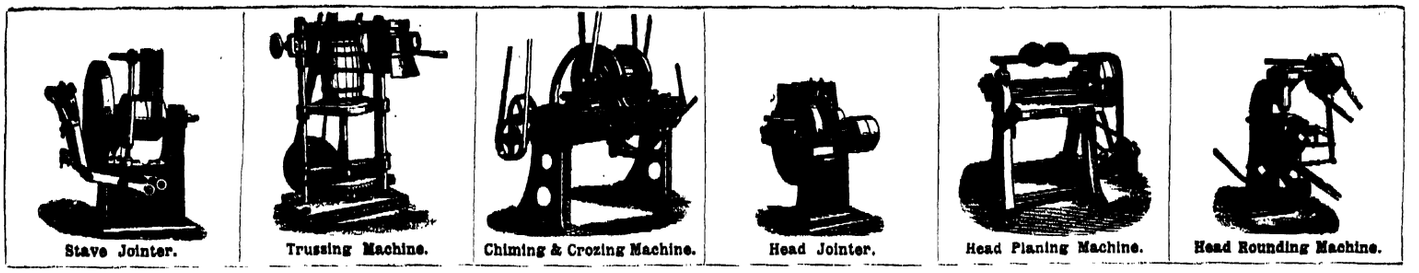
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Stave Jointer. Trussing Machine. Chiming & Crozing Machine. Head Jointer. Head Planing Machine. Head Rounding Machine.

FOR WHICH A GOLD MEDAL HAS JUST BEEN AWARDED AT THE FISHERIES EXHIBITION.

A. RANSOME & CO., STANLEY WORKS, CHELSEA.

CAUTION.—The notorious success of A. RANSOME & Co.'s Cask and Barrel Machines having caused them to be copied by other Engineers, Purchasers are advised to ascertain that any Cooperage Machines they may be offered do not infringe any of A. R. & Co.'s Patents. 1668

GEO. RICHARDS & CO.



Note.—We have no connection with any Firm of Agents in Manchester trading under a somewhat similar name. All communications relating to Richards' Patent Wood-cutting Machines should be addressed to us,

ATLANTIC WORKS, BROADHEATH, NEAR MANCHESTER

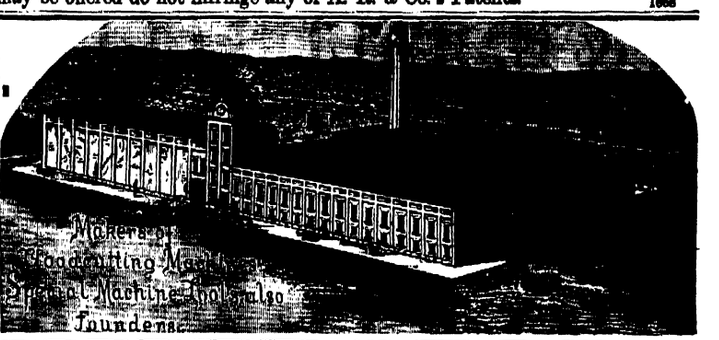
WOOD-CUTTING MACHINERY

OF HIGHEST CLASS AND OF ALL DESCRIPTIONS.

4977

London Show Rooms & Offices: 23 & 24, Whitecross St., E.C.

Continental Agents: SMITH & COVENTRY, 10, Rue Alibert, Paris.



WOOD-CUTTING MACHINERY OF ALL KINDS.

5148

PARTICULARS AND PRICES ON APPLICATION.

HAROLD SANDS, EAGLE WORKS, POPHAM ST., LEENSIDE, NOTTINGHAM.

JAMES GOODWIN & Co.,

Ironfounders, Bridge Builders, Engineers, & Boiler Makers,

MOTHERWELL NEAR GLASGOW.

MAKERS OF
Cast Iron Chairs,
Cast Iron Sleepers,
COLUMNS, TANKS,
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SOLE MAKERS OF
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Stone Breakers.

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Foundries also at
Ardrossan, Ayrshire,
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Johnstone, Renfrewshire.



VIADUCT AT HIGH BLANTYRE, CALEDONIAN RAILWAY. LENGTH, 730 FEET. ERECTED 1882.

5274

MAKERS OF IRON ROOFING AND GENERAL STRUCTURAL WORK.

BRIDGE FOUNDATION CYLINDERS.

THE STOCKTON FORGE CO.,
STOCKTON-ON-TEES.

Make a Speciality of this work, turning out over 100 tons per week; also large quantities of Railway Chairs. 4909





SCOTT WEST IRON WORKS, **BROS.,** MOUNT HALIFAX.





Have the largest Stock in England of Self-Acting Slide and Screw Cutting Lathes, Radial Wall, Vertical, and Bench Drilling Machines. Shaping, Screwing, Slotting Punching and Shearing and Plate Bending Machines, Steam Hammers, Horizontal and Vertical Engines and Wood-working Machinery.

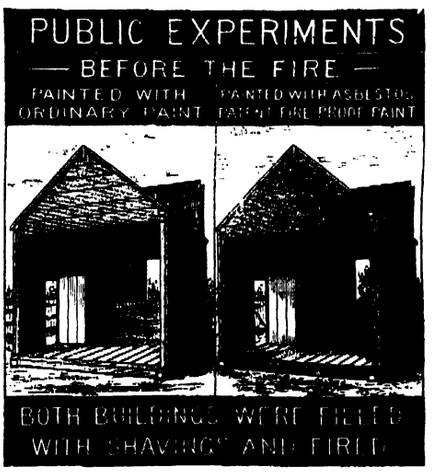
ILLUSTRATED LISTS ON APPLICATION. QUOTATIONS FOR SPECIAL TOOLS. 4905

ASBESTOS (Patents No 2114 & 3357) FIRE-PROOF PAINT

THIS is the ONLY PAINT which has successfully stood the test of PUBLIC EXPERIMENTS.

Similar trials to demonstrate that Woodwork coated with it will offer an effectual resistance to flames were made, with results equally successful to those shown in the engravings, on the following occasions:—

LONDON (Crystal Palace)—Before the Lord Mayor and distinguished company, January, 1882.
LONDON (Whitehall Place)—Before the Chairman of the Metropolitan Board of Works, Government Officials, Architects, etc., August, 1882.
LONDON (Alexandra Palace)—August, 1882.
LONDON (International Fisheries Exhibition)—By invitation of the Executive Committee of the Exhibition three times, February and March, 1883. Witnessed by H.R.H. the Prince of Wales, the Speaker and Members of both Houses of Parliament, and over 100 Representatives of the Press.
STOCKHOLM—In the presence of the King of Sweden, Prince Karl and Suite; also Captain Halsten, Chief of Fire Brigade; Representatives of the Army, Admiralty, State Railways, and Municipal Authorities, May, 1883.
AMSTERDAM—Before the Minister of State and Municipal Authorities, August, 1883.
And at various times before the Lord Provosts and Magistrates of Edinburgh and Glasgow, and the Mayors and Corporations of Manchester, Liverpool, Birmingham, Stratford-on-Avon, and other towns.



From **THE TIMES**, January 16, 1882.

"These results are highly satisfactory, and fully demonstrate the value of the Asbestos Paint as a fire-resisting medium in respect of its application to theatrical stages and effects, or, in fact, to any other structures or their fittings."

THE TIMES, in referring, on February 3, 1883, to the late Great International Fisheries Exhibition, said:—

"This is a precaution which the fear of fire renders evidently necessary, but the Exhibition buildings will, of course, be carefully watched and guarded, and *will, moreover, be thoroughly coated by the United Asbestos Company with their non-inflammable paint, a composition which, as was shown yesterday, to those who visited the ground, enables a common wooden shed to resist the efforts of flaming shavings and petroleum.*"

From the **STANDARD**, May 19th, 1884.

"The natural antagonism between fire and water was exemplified on Saturday morning in a more usual phase. Fortunately, owing to the difficulty of igniting the Asbestos-painted walls, the fire was put out by the aid of a portable engine in five minutes from its discovery. It is not desirable to have any repetition of such tests of the fire-proof qualifications of the Paint; but it is satisfactory to know it has in this instance kept its character free from reproach."

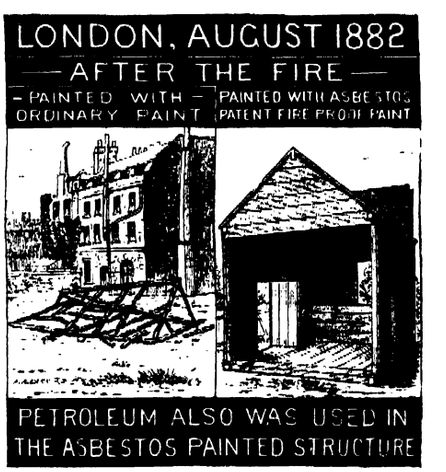
From the **DAILY CHRONICLE**, May 19th, 1884.

"FIRE AT THE HEALTH EXHIBITION.—On Saturday morning a fire broke out at one of the exhibitor's stands in the central annexe which runs parallel with the gallery in which the opening ceremony took place. The fire, which was confined to the stand where it originated, was speedily extinguished, the uninflammable Paint with which the wooden walls of the building are coated effectually barring the progress of the flames."

From the **DAILY TELEGRAPH**, May 19th, 1884.

"FIRE AT THE HEALTH EXHIBITION.—Early on Saturday morning a fire broke out at one of the exhibitor's stands in the central annexe of the Health Exhibition. The fire, which was confined to the stand where it originated, was speedily extinguished."

N.B.—The Paint attacked by the fire had been exposed to the wear and tear of over six months.



HUNDREDS OF EQUALLY FAVOURABLE PRESS NOTICES

—— IMPORTANT TESTIMONIALS. ——

INTERNATIONAL FISHERIES EXHIBITION, S. Kensington, London, S.W., 19th November, 1883.

Dear Sirs,—With further reference to your letter of the 10th inst., I beg to inform you that I have duly laid the same before my Committee, and I am directed by them to express to you their entire satisfaction with the way in which your paint has stood the exposure to the weather, and the wear and tear of six months, though happily the qualities which you claim for it, and which the Committee have every reason to believe exist from the tests which they witnessed previous to the opening of the Exhibition, were not called into requisition.—I am, dear Sirs, yours faithfully,
E. CUNLIFFE OWEN, Secretary.
Messrs. the United Asbestos Company, Limited.

From H.M. INSPECTOR OF EXPLOSIVES, Home Office, May 26th, 1882:—

"I have no doubt that the Patent Fire-proof Paint will be of great value in preventing the spread of fire in wooden buildings."

From the SECRETARY OF STATE FOR INDIA, Sept. 19th, 1882:—

"I have to inform you that the samples of Paint which you have sent in have been satisfactorily tested."

ROYAL ITALIAN OPERA, Covent Garden, London, May 19th, 1884.

Dear Sir,—In answer to your inquiries, I beg to say that I have read the accounts in various newspapers of the late fire at the Stadt Theatre in Vienna, and the lamentable result. I have also observed in one of the accounts that certain fire-resisting liquids were in use at the Theatre, but proved to be of no avail; I have therefore thought it right to make a further test of the Fireproof Asbestos Paint supplied by your Company to this Theatre in the beginning of 1882 with which all woodwork in the vicinity of the stage was painted. With this view I had a piece of wood detached—this was partially covered with Asbestos Paint only. I had the wood placed in a hot furnace with a fierce fire, and left there for some minutes. The result was that the bare portion of the wood was consumed immediately, but the painted part remained comparatively uninjured. I observed that a similar result was the case at the recent fire at the Health Exhibition, where the Asbestos Paint appears to have entirely stopped the progress of the fire. It appears from the various accounts that none of your material was used at the Vienna Theatre, and I should be glad to learn from you that such is the case.—I am, dear Sirs, yours very faithfully, (Signed) ERNEST GYE, Managing Director.
The United Asbestos Company, Limited, 161, Queen Victoria Street, E.C.
N.B.—This Company's Paint was not used on any part of the Stadt Theatre.

CRYSTAL PALACE CO., Crystal Palace, S.E., 18th June, 1884.

Dear Sirs,—In answer to your letter of the 22nd ultimo, I have to state that the Asbestos Patent Fire-proof Paint applied by your Company two-and-a-half years ago to the woodwork of the Great Stage of the Crystal Palace is, to all appearances, as good and sound as when first put on; and although, fortunately, it has not been put to a practical test, I have reason to believe, from experiments which have been made, that the Paint has not lost any of its fire-resisting qualities.—Yours faithfully,
WM. GARDINER, Secretary.
The United Asbestos Company, Limited.

Amongst the numerous buildings which have been wholly or partially protected with this Paint we may mention—

GREAT INTERNATIONAL FISHERIES EXHIBITION BUILDINGS (over 70 tons of paint were used on these buildings, and they were insured at a reduction of 50 per cent. in consequence).
HOUSES OF PARLIAMENT, Westminster. RESIDENCE OF H.R.H. PRINCE OF WALES, Sandringham.
THE BRITISH MUSEUM. THE SOUTH KENSINGTON MUSEUM.
HAMPTON COURT PALACE. ROYAL ITALIAN OPERA, Covent Garden.
STAGE OF SHAKESPEARE MEMORIAL THEATRE, Stratford-on-Avon.
THE BOROUGH LUNATIC ASYLUM, Birmingham. CURZON HALL STABLES, Birmingham.
CANVAS SCREENS at the CRYSTAL PALACE, Sydenham. ALHAMBRA THEATRE ROYAL.
WALKER'S AMMUNITION SHEDS, Birmingham.

SPECIALLY RECOMMENDED FOR WOODEN BUILDINGS

Of every description, especially Cotton Mills, Factories, Warehouses, and for fire-proofing the underside of floors, stairs, hoists, &c., which, as a rule, carry the flames. Timber should be dry when the Paint is applied, and outside work done, if possible, in fine weather, so that the Paint may dry and set hard, which it does very quickly. The Paint is in all cases sent out *ready for use*, with necessary instructions, and can be applied by ordinary workmen.

PRICE **38s.** per cwt., grey or stone colour; other colours, 45s. per cwt., f.o.b. London, Hull, Liverpool, Bristol, or Glasgow, in 5 cwt. lots. Packages cost price. Cash or London reference should accompany foreign orders.

IMPORTANT.—This Company was the first to make and introduce Asbestos Fire-proof Paints to the public. The process of manufacture was patented, but as in the case of all valuable inventions, compositions, similar in name but greatly inferior in quality and value, are being foisted on the public, and as instances have recently come under our notice where loss and disappointment have resulted therefrom, buyers who want the genuine article should, particularly when ordering through merchants, specify our brand.

ASBESTOS OIL PAINTS

For Ironwork, Bridges, Stations, and General Outside PAINTING, are invaluable. They have been proved to withstand the action of foul atmospheres, sulphur, gases, smoke, steam, &c., better than any paint known, and after lengthened trials in exposed positions are now specified for general outside painting by the leading Railway Companies. Being 25 per cent. lighter, these Paints are no dearer than ordinary paints.

See next issue for particulars of our **ITALIAN ASBESTOS MILLBOARD** and **ITALIAN ASBESTOS** and **INDIARUBBER WOVEN SHEETING, TAPE** and **RINGS** for Joints of all kinds. Italian Asbestos Patent Woven HP. Gland Packing. New Italian Asbestos Rolled Cloth Packing, with Indiarubber Core (strongly recommended), and every description of Asbestos Goods.

SPECIFY UNITED ASBESTOS COMPANY'S "SALAMANDER" BRAND.

"SALAMANDER." NEW ILLUSTRATED CATALOGUE ON APPLICATION. "SALAMANDER."

The UNITED ASBESTOS Co., LIMITED,

161, QUEEN VICTORIA STREET, LONDON, E.C.

4725

— DEPOTS: —

MANCHESTER: 85, CORPORATION STREET. | **LIVERPOOL:** 47, SOUTH JOHN STREET. | **BIRMINGHAM:** CLEMENT STREET. | **GLASGOW:** 52, ST. ENOCH SQUARE.

FLAX HOSE PIPE.

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RICHARDS & Co.,

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ARE THE

Original and Sole Makers

OF THE

CELEBRATED

Vaucher Hose

Owing to inferior makes having been STAMPED with the word Vaucher in imitation of our Hose, we have registered a

NEW TRADE MARK,

And hereby call attention to the fact that the

GENUINE VAUCHER

will in future be

Stamped every 30 ft.

with our stamp, thus—

VAUCHER'S

PATENT.

AND WE WARN OUR FRIENDS AGAINST IMITATIONS.

RICHARDS

AND CO.,

Aberdeen and Montrose.

LONDON WAREHOUSE: 5259

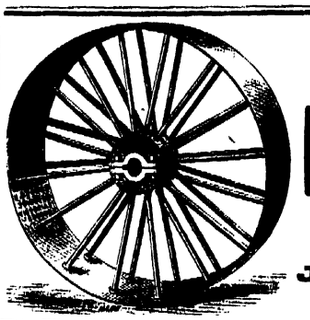
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GLASGOW RUBBER WORKS, GLASGOW.

Branches { GLASGOW—55, ROBERTSON STREET.
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LIVERPOOL—27, WATER STREET. 5031
SUNDERLAND—6, Tavistock Place, Borough Rd.



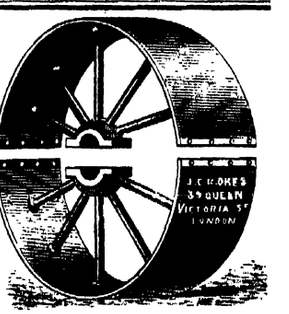
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LEATHER BELTING.



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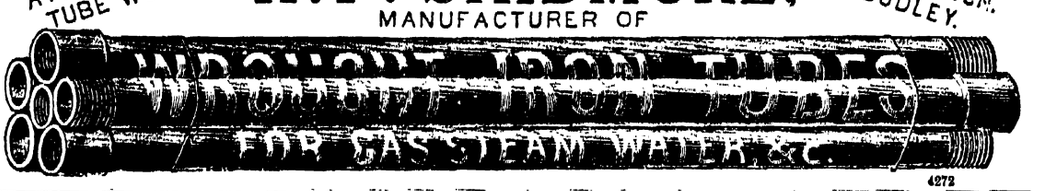
AND ALL OTHER MECHANICAL LEATHER. 4905

PARK ROAD LEATHER WORKS, BINGLEY, YORKSHIRE.

ATLAS TUBE WORKS. NEAR DUDLEY. NETHERTON.

H. P. SKIDMORE,

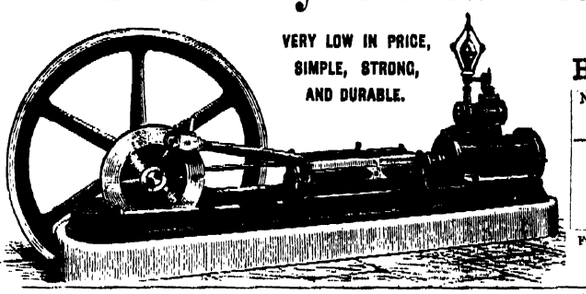
MANUFACTURER OF



4272

The Machinery and Hardware Company, Limited

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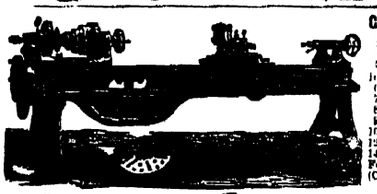
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Horizontal High Pressure Steam Engines

Nominal HP.	Cylinder and Stroke.	Diam. of Fly Wheel.	Price.	Nominal HP.	Cylinder and Stroke.	Diam. of Fly Wheel.	Price.
	in. in.	ft. in.	£ s.		in. in.	ft. in.	£ s.
4	6 by 12	3 6	31 10	14	12 by 24	7 0	89 10
5	7 ,, 14	4 6	40 0	20	14 ,, 28	8 6	115 10
7	8 ,, 16	5 0	47 10	24	15 ,, 30	8 6	142 0
9	9 ,, 18	5 0	58 0	28	16 ,, 30	8 7	173 10
12	10 ,, 20	6 0	68 10	32	18 ,, 36	8 9	194 10

Full sized Cylinders with long strokes. Direct-Acting High-Speed Porter's Governors, Pumps, Fly-wheel, and out end Pedestal complete, all finished in first-class style. Prices f.o.r. Manchester.

TO BE SEEN IN OUR SHOW ROOMS AT ABOVE ADDRESS.



GOOD CHEAP LATHES.

Centre.	Bed.	Class B. Sliding & Screw-cutting.	Sliding, Surfacing & Screw-cutting.
In.	ft.	£ s.	£ s.
6	6	27 10	33 0
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8	9	39 10	45 0
9	10	48 10	55 0
10	12	63 10	70 10
12	20	107 0	122 0
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For Prices First-class Lathes (Class A), highly finished, see General Catalogue.





CORNISH BOILERS, One Flue.

2 hp	4	6	8	10	12	14	16	20	25	30	35 hp
£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
21 0	32 0	46 0	58 0	65 0	78 0	87 0	92 0	109 0	137 0	188 0	228 0





4-Jaw'd Chucks with steel Saws

Dia.	Price.
In.	£ s. d.
8	3 17 0
10	4 8 0
12	4 16 0
14	5 10 0
16	6 12 0
18	7 14 0
20	8 10 6
24	11 0 0
28	13 5 0
30	14 5 0
36	18 5 0



CIRCULAR SAW BENCHES, With Rising and Falling Tables.

Table inches.	Will take Saw diam.	Price. £ s. d.
48 by 24	24 in.	16 10 0
50 ,, 28	30 in.	20 0 0
62 ,, 32	36 in.	25 10 0
72 ,, 36	42 in.	32 10 0

Cheap Drilling Machines.

Admit

26 in. dia. Double Gear.. £27 10

30 in. ,, ,, ,, .. £33 10

36 in. ,, ,, ,, .. £42 0

Other sizes quoted on application.

VERTICAL CROSS TUBE BOILERS.

1 hp	2	3	4	5	6	8	10	12	14	15	16	18	20 hp
£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
15 0	22 0	26 10	31 0	35 0	45 0	50 10	63 10	76 0	83 0	88 0	99 0	107 0	115 0

PRICE LISTS and COMPLETE CATALOGUES on application. The various sizes of these Lathes, Drilling Machines, Chucks, Saw Benches, and a few sizes of the Engines are invariably

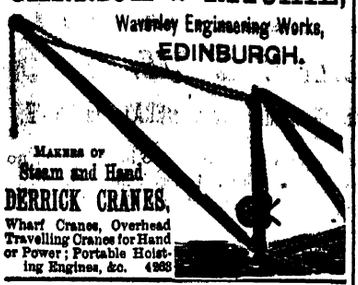
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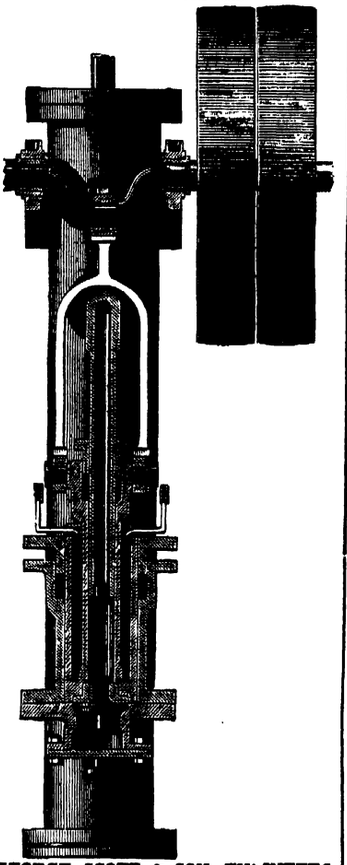
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MAKERS OF
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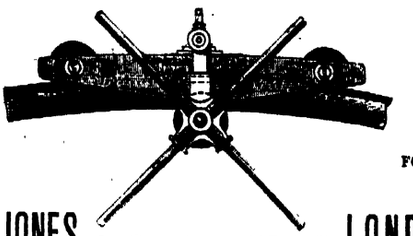
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FOR ALL PURPOSES.



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PRICE LISTS ON APPLICATION.



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MAKERS OF ALL KINDS OF MACHINE TOOLS FOR ENGINEERS, SHIPBUILDERS, &c.
Specialities: Screwing Machines, Taps, and Hand Screwing Apparatus.
Sole Makers in this Country during the currency of the Patent of DUDGEON'S TUBE EXPANDERS. 4469

The Cheapest CONTINUOUS CURRENT DYNAMOS in the Market

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6 Lamps of 20 C.P. .. .. .. Price £10 (No. 05).
20 " " .. .. .. " £30 (No. 2).
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GERARD & CO., Limited, 82, Hatton Garden, E.C.
AGENTS WANTED. 4030

MAWLAM'S PATENT RAILWAY TRUCK COUPLER.

Prize Medals at the Alexandra Palace Industrial Exhibition, 1880, and Peterborough Exhibition, 1882.

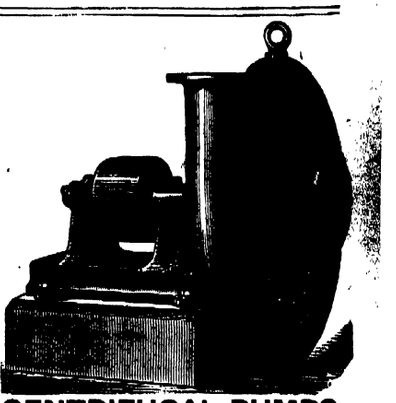


For coupling and uncoupling Railway Trucks without the workman using it being required to go between the Trucks. It necessitates *no alteration whatever in the existing Coupling Chains.* By its means one or both of the Coupling Chains may be attached, and the Chains when uncoupled may also be *hooked backon to their own hooks* if required. *Some hundreds now in use by the N.E.R. Co., & other Railway Companies.*

By its use the work is more rapidly accomplished and without the danger to life which (in fly shunting especially) is incurred when the Coupler is not used.

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CENTRIFUGAL PUMPS AND PUMPING ENGINES,

For Docks, Circulating Purposes, Salvage Work, &c.

The cheapest and most Efficient Pump in the Market From Nowest and most Improved Patterns.

SPECIALITIES: Centrifugal Pumps, Baking Machinery, Leather Dressing Machinery, Hydraulic Presses and Pumps, Hydraulic Cranes, Accumulators, Hydraulic Rivetters, Lifts of all kinds.

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ECONOMICAL SPECIALITÉ.

PATENT MACHINE GROUND
(Equal to Milled).

BRIGHT STEEL,
Hardened or soft, to finished Dimensions for Engine and Machine parts, Pieces and Plates, square, flat, or bevelled.

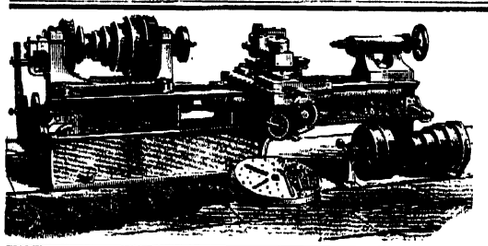
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BRIGHT DISCS
For Milling Cutters, Screwing, Stamping, and Forging Dies.

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MACHINE GROUND SHEAR BLADES AND KNIVES,
For Wood, Paper, Cardboard, Metals, and Tobacco Cutting Machines.

ORDINARY AND SPECIAL TOOL STEELS.
PATENT ROLLED ROUND BARS.
BESSEMER AND SIEMENS' QUALITIES AND TEMP
SHEAR, BLISTER AND SPRING STEEL. 5193
FILES, SAWS, EDGE AND ENGINEERS' TOOLS.



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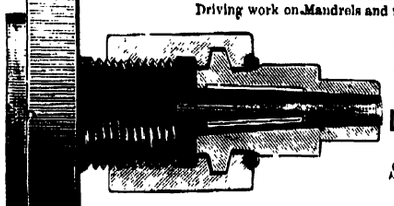
SMITH & WILSHAW,
HALIFAX, ENGLAND
Makers of all kinds of
Improved Self-Acting, Sliding, and Screw Cutting Lathes,
For Foot or Power. 5220

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MANUFACTURER OF
CORNISH, LANCASHIRE & VERTICAL BOILERS
IN IRON OR STEEL.
WROUGHT IRON AND STEEL BUOYS OF EVERY DESCRIPTION.
Tar Stills, Steam Pans, Jacket Pans, Shoots, Hoppers, TANKS, CISTERNS, *&c.*
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BELLAMY'S PATENT TUBULAR BOILER,
Unsurpassed for quick Steaming and Economy of Fuel. Also
BELLAMY'S PATENT HEATING BOILER,
SPECIALLY ADAPTED FOR HORTICULTURISTS. 4922

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THIS MANDREL is bolted to a Lathe Face Plate, and the work, such as pulleys, can be secured on it and removed when finished, without carrying the Mandrel.
Driving work on Mandrels and the consequent breakages are avoided.



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EXPANDING MANDRELS
have been in extensive use for Two years, applied to
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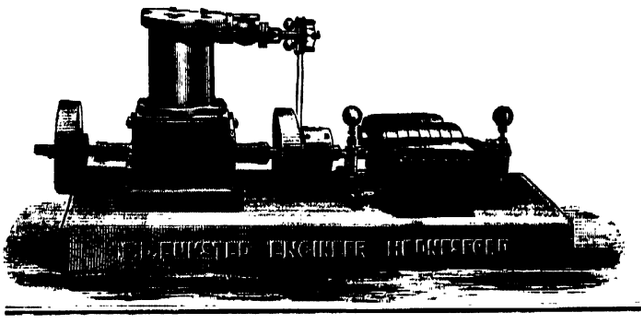
NUMBER ONE

THE LANCASTER STEAM TRAPS

WILL BE EXHIBITED AT THE ABOVE STAND AT
Textile Trades Exhibition,
AGRICULTURAL HALL, LONDON.

LANCASTER & TONGE, 4235
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SINGLE OR DOUBLE. SILENT & STEADY.

SPECIAL TOOLS having been made for these ENGINES they are MODERATE in PRICE.

1200 REVOLUTIONS per Minute. Perfect System of Lubrication—no lubricators, no attention. Half-pint of Oil is sufficient for Two Days' Supply. Forged Steel Crank and Phosphor Bronze Working Parts throughout. MADE IN FOUR SIZES.

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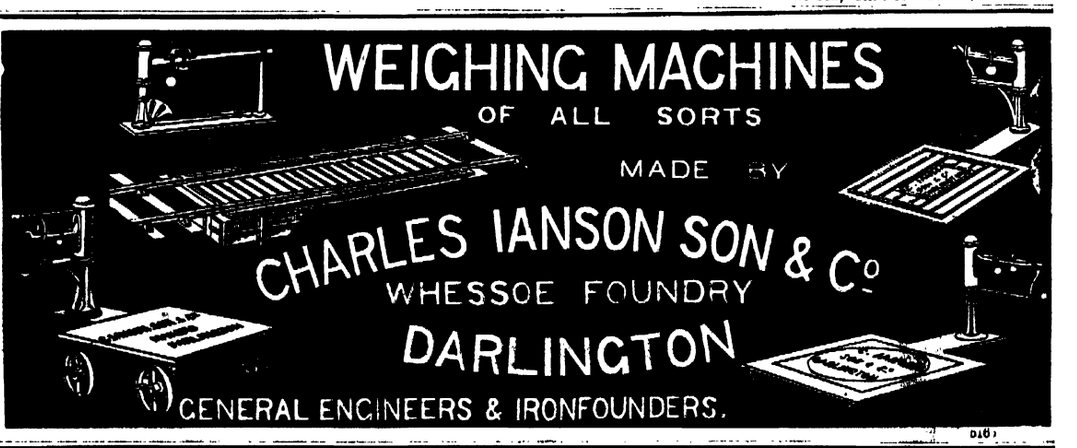
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FAN-BLOWERS AND EXHAUSTERS.
ALL SIZES in STOCK.
To Blow from 3 to 100 Smiths' Fires, and to melt from 8 cwts. to 10 tons Metal per hour. 5070
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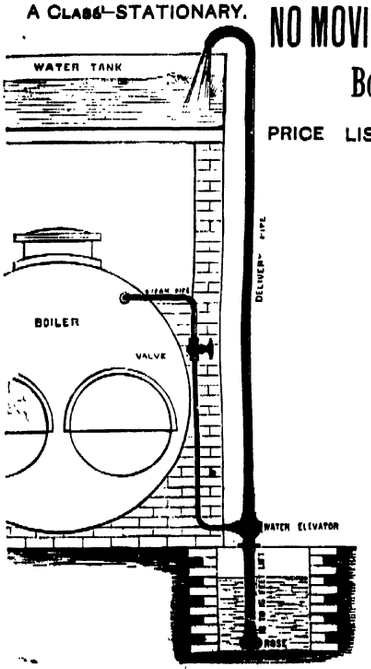
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With a very low consumption of Steam. Up to 80 ft. elevation.

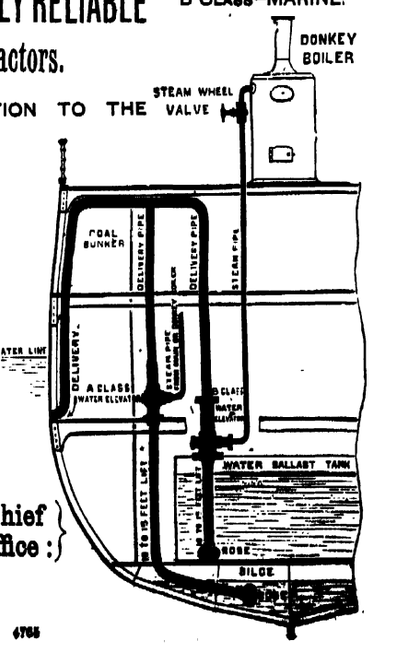
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A	1¼ in.— ¾ in.	1000	£4 10 0
A	1½ in.— 1 in.	2000	£7 10 0
A	2 in.— 1¼ in.	3000	£9 10 0
B	2 in.— 1½ in.	3000	£12 10 0
B	2½ in.— 1½ in.	4000	£14 0 0
B	3 in.— 1½ in.	6500	£17 10 0
B	4 in.— 2 in.	10000	£22 10 0
B	5 in.— 2½ in.	20000	£27 0 0
B	6 in.— 3 in.	30000	£32 0 0

Approximate.

FAIRBURN & HALL {Chief Office:}

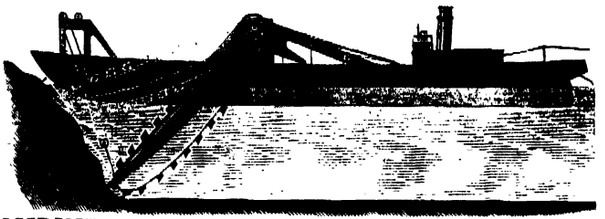
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DREDGERS to dredge in front, in centre, or at sides.

DREDGERS for abroad shipped in pieces, or made for steaming to any part of the world.



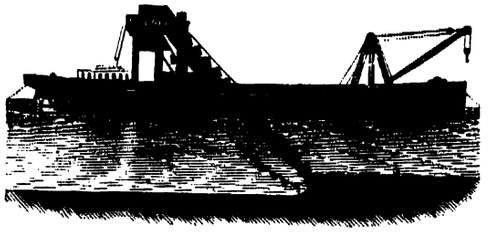
DREDGERS for River Bar, Dock, Canal or Harbour.

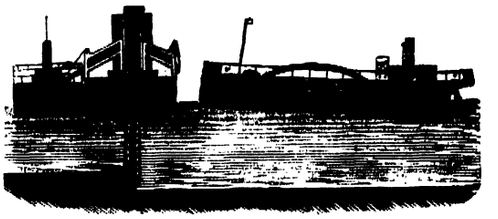
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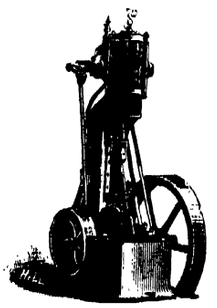
BRADFORD.

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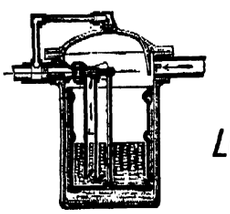
LONDON OFFICE: 37, WALBROOK.

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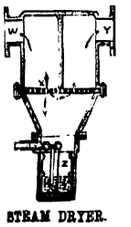
CATALOGUES ON APPLICATION.



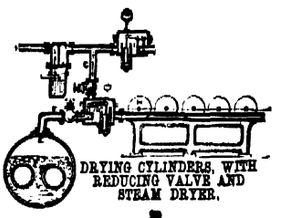
VERTICAL STEAM ENGINE.



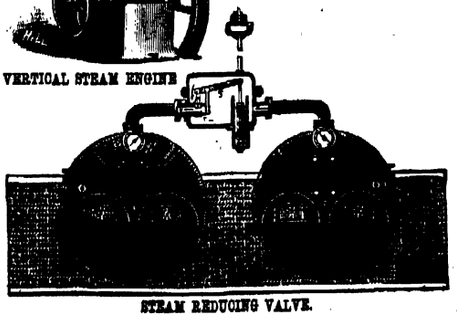
STEAM TRAP.



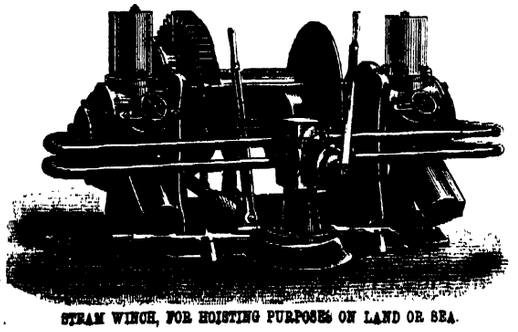
STEAM DRYER.



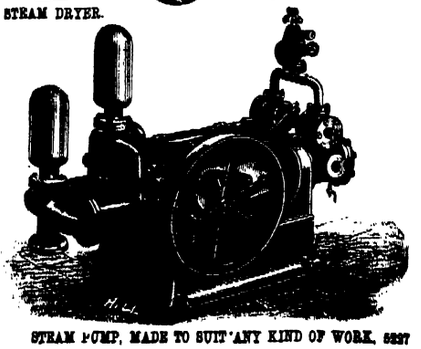
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Tug Steamer, 80 ft. by 11 ft. by 6 ft. 6 in. 80 I. HP. Constructed 1884.



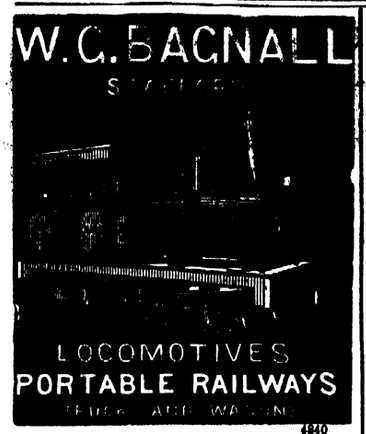
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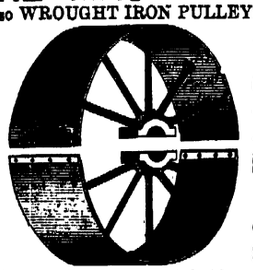
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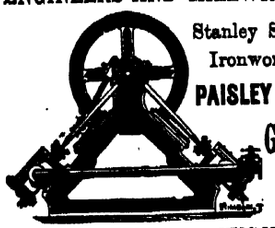
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Steam Engines of every description to drive one or more of the above machines, fitted with One, Two, or Three Cylinders.
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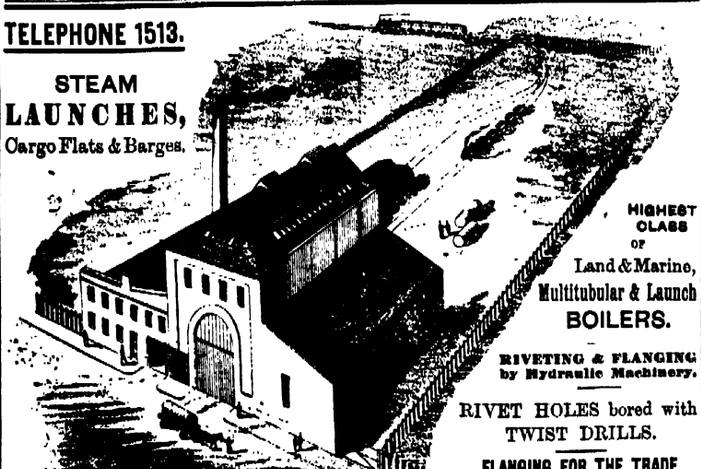
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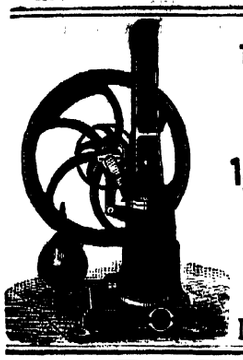


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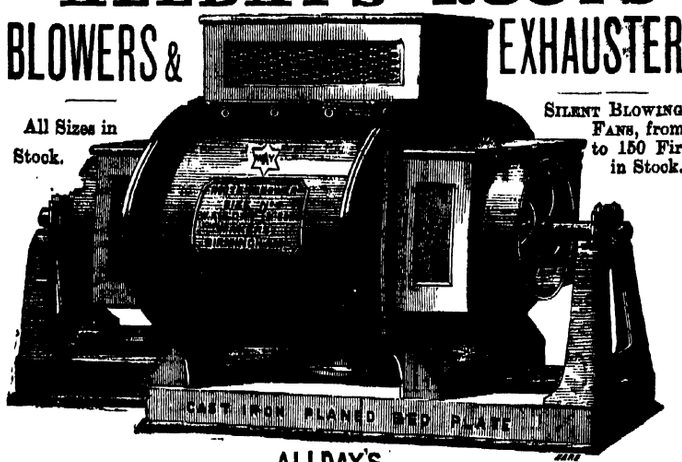
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RANKIN & BLACKMORE,

ENGINEERS, GREENOCK,

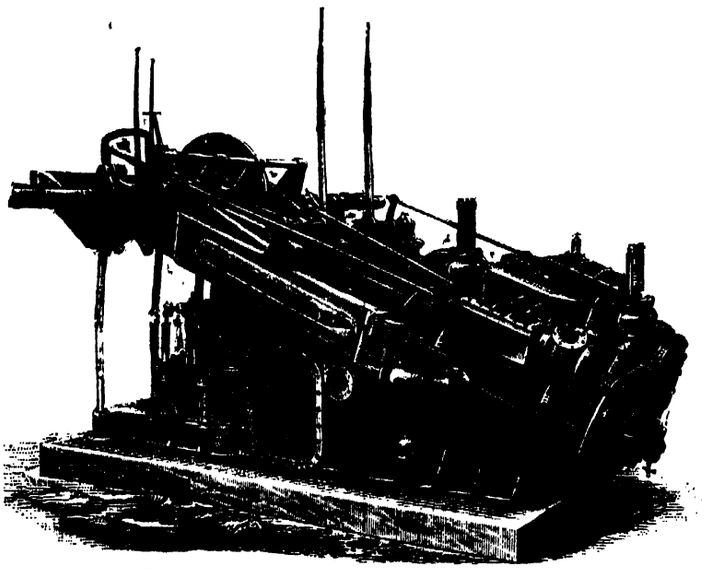
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AND

4-Cylinder Disconnecting Triple-Expansion Engines,

FOR PADDLE AND TWIN-SCREW STEAMERS.



The principal advantages claimed for these Engines, as compared with the ordinary 4-cylinder Compound and 6 or 8-cylinder Triple-Expansion Engines, are—

SIMPLICITY OF CONSTRUCTION, ECONOMY OF FUEL, ACCESSIBILITY OF WORKING PARTS, SUPERIOR EFFICIENCY, AND LESS TEAR AND WEAR.

FULL PARTICULARS AND PRICES ON APPLICATION.

For Illustration of 4-cylinder Twin-Screw Engines, see Engineering of this day fortnight. 5239

ARROL'S PATENT [illegible]

HYDRAULIC RIVETTING MACHINES

FOR

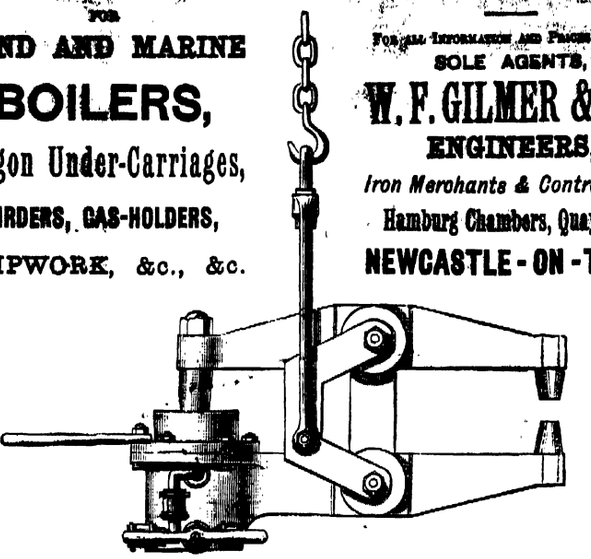
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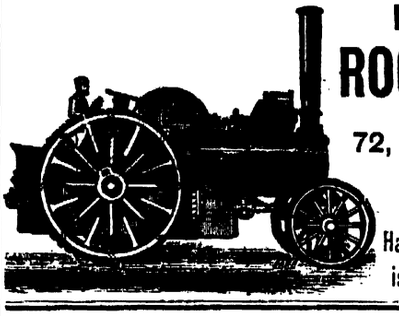
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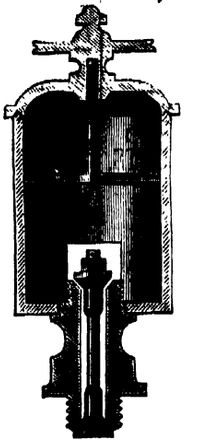
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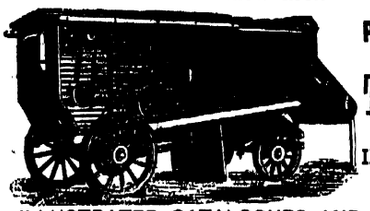
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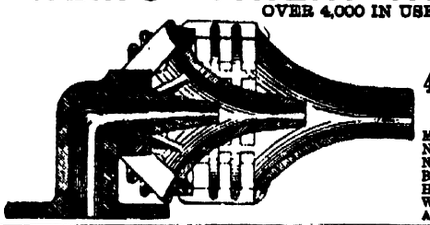
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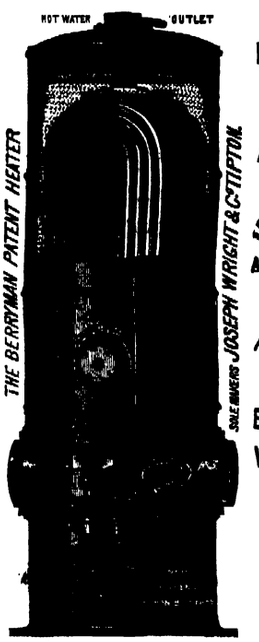
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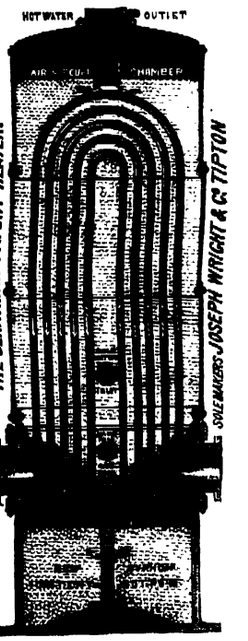
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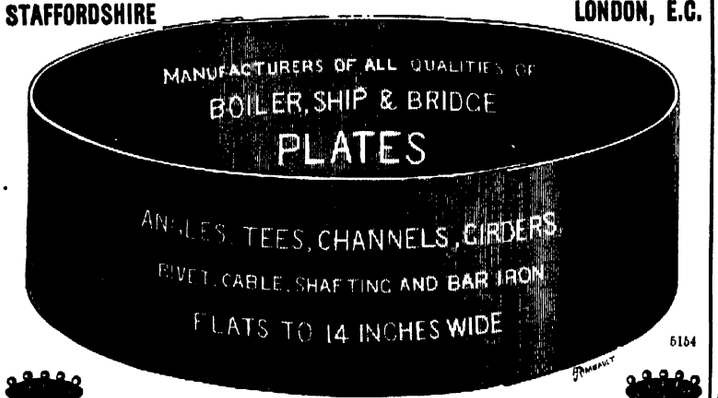
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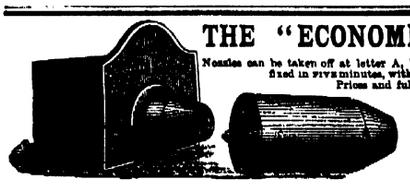
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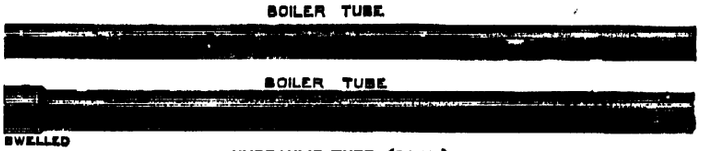
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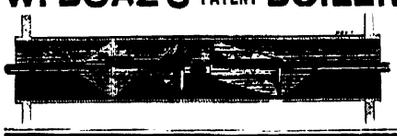
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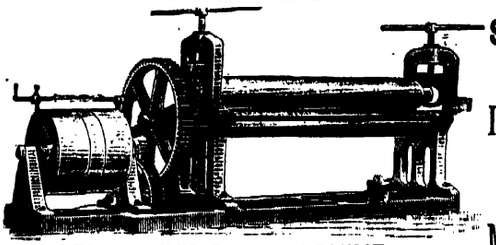


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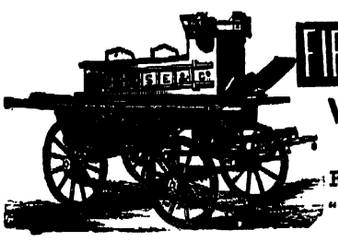
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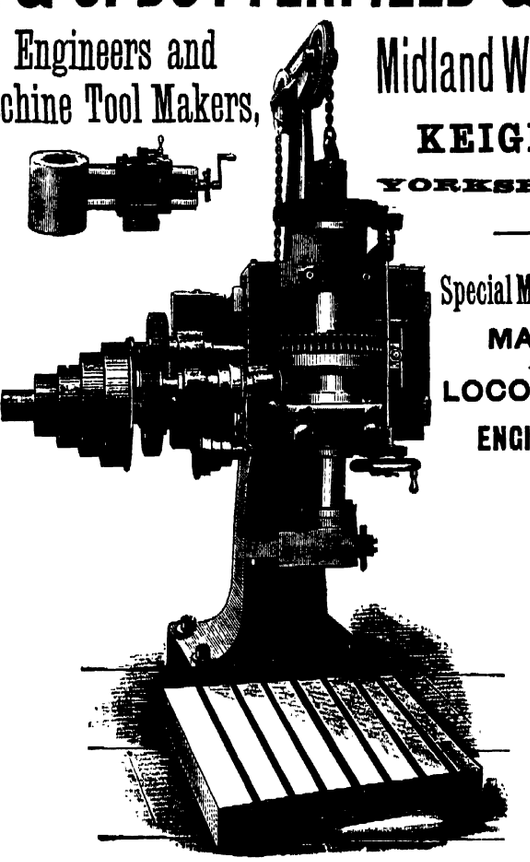


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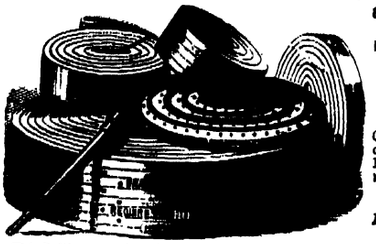
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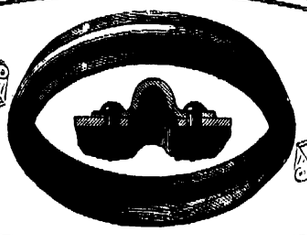
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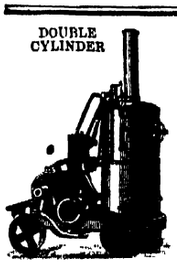
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I am, yours faithfully, T. A. BROCK, Secretary.

To W. M. MELVILLE, Esq. Port Adelaide Dock Company, Limited

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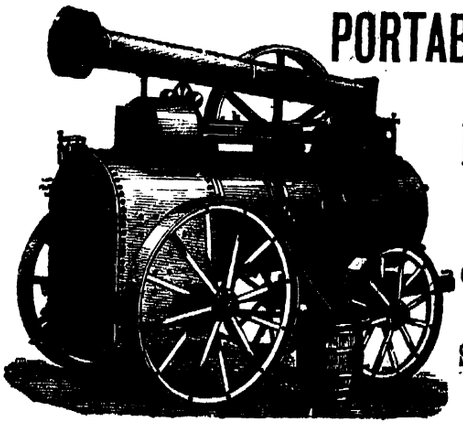
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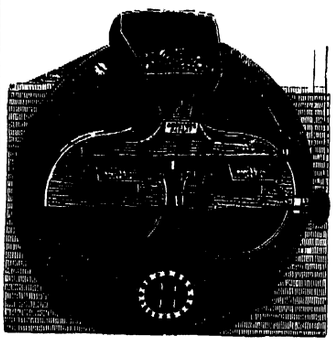
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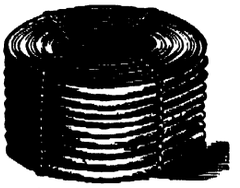
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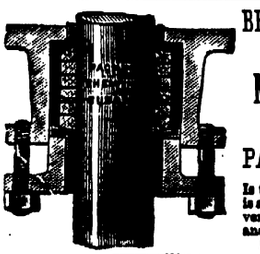
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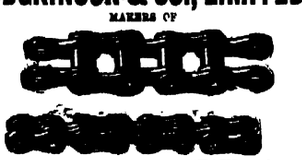
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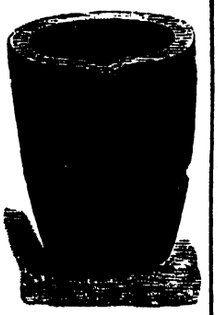
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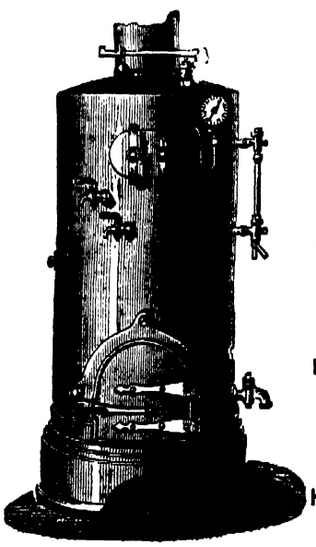
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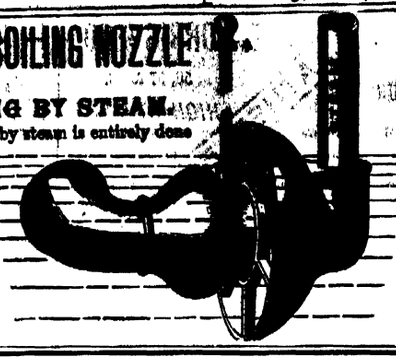
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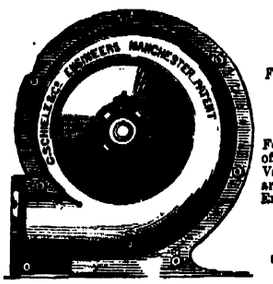
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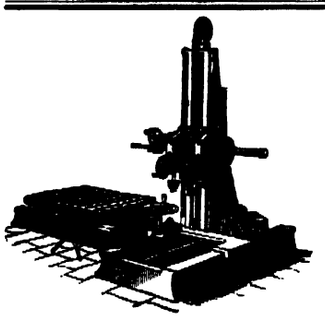
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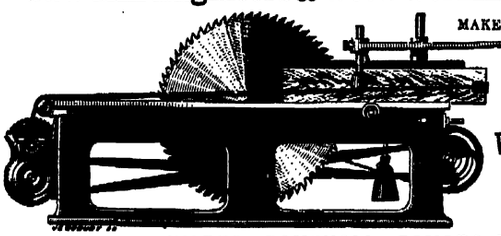
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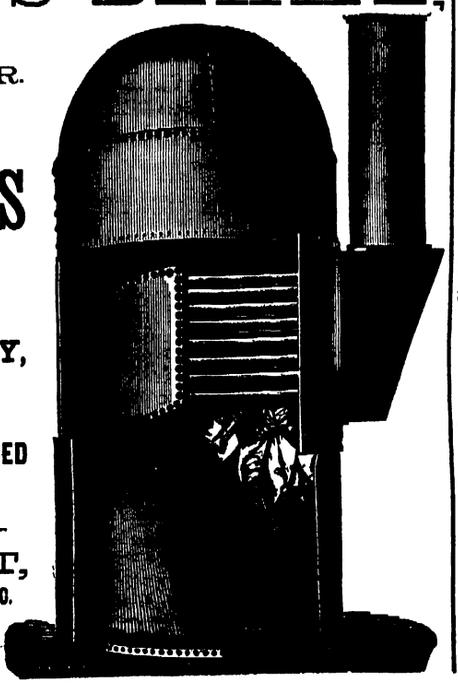
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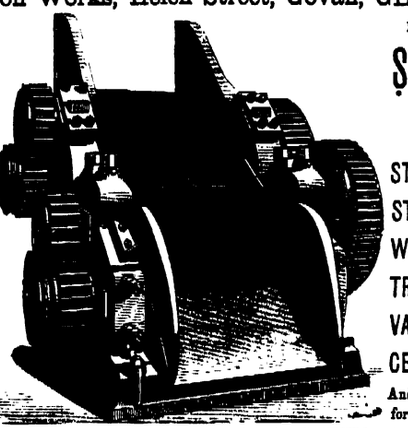
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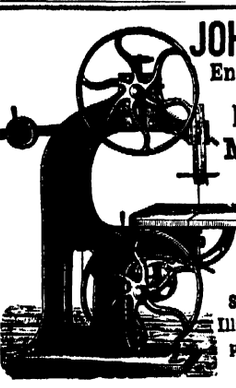


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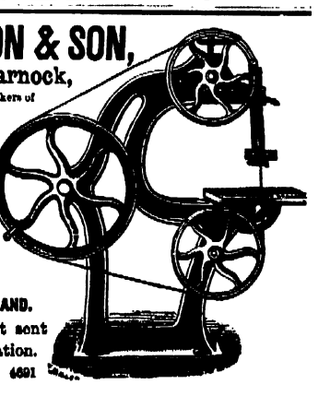
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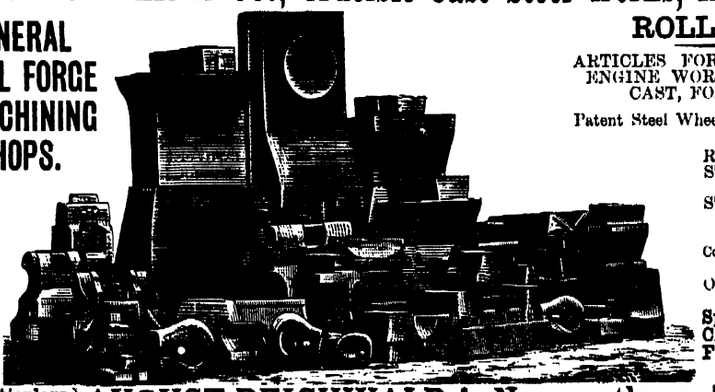
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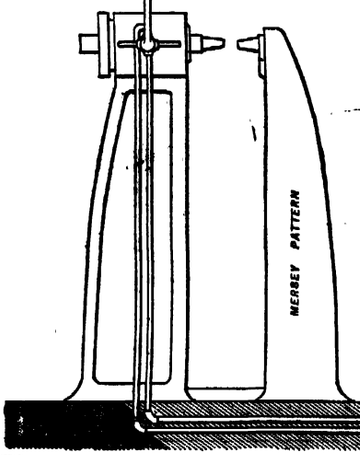
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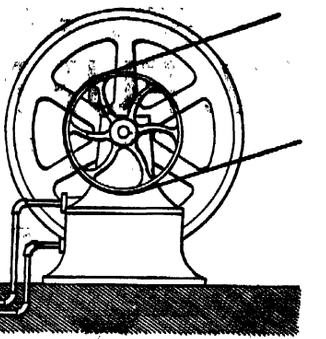
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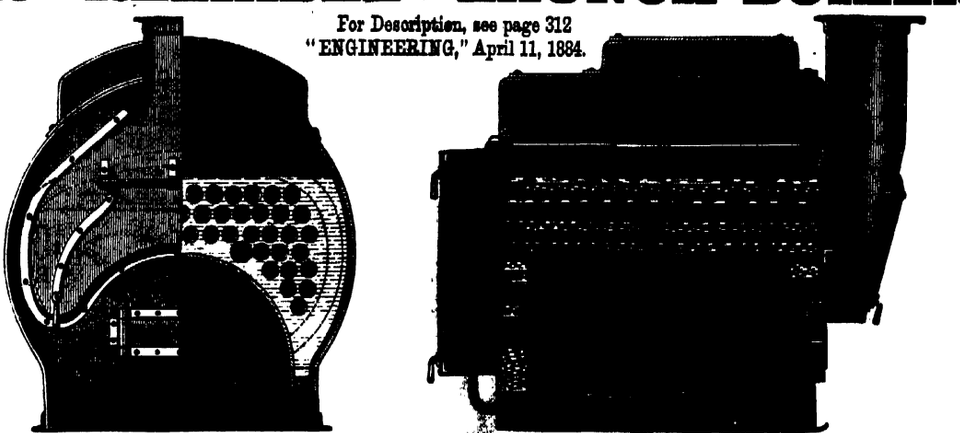
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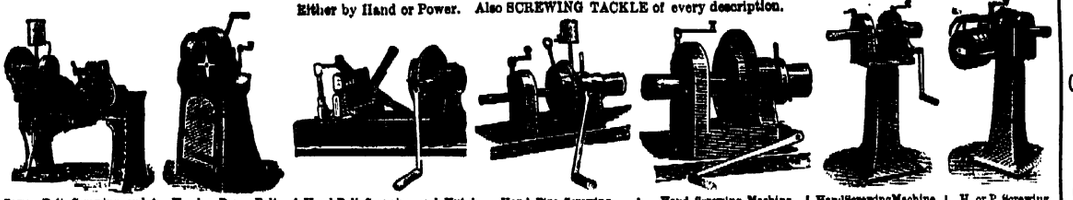
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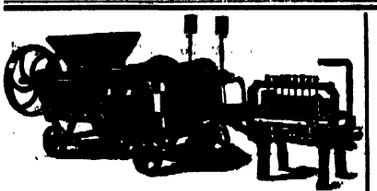
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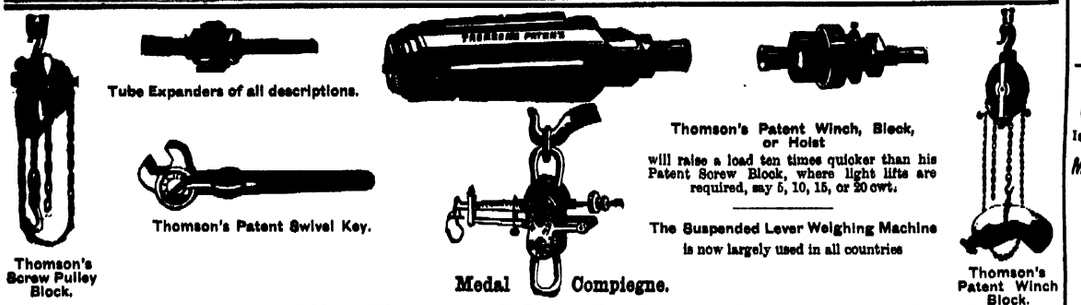
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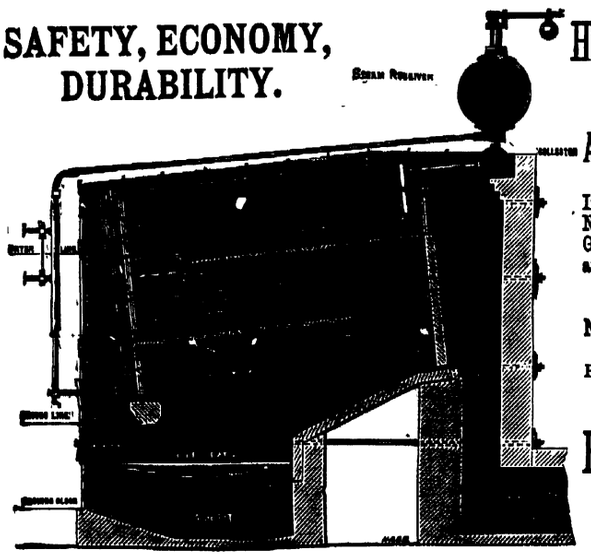


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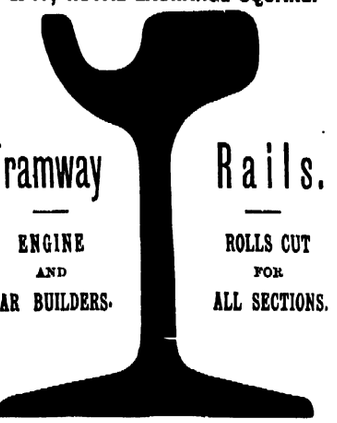
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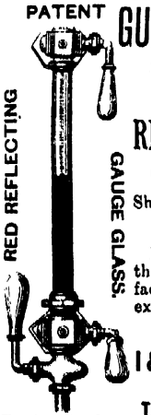
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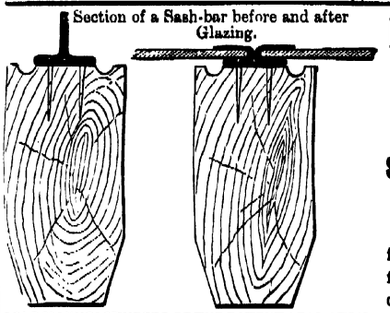
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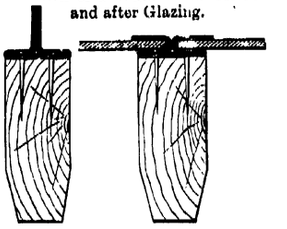
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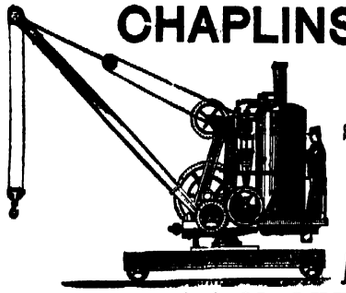


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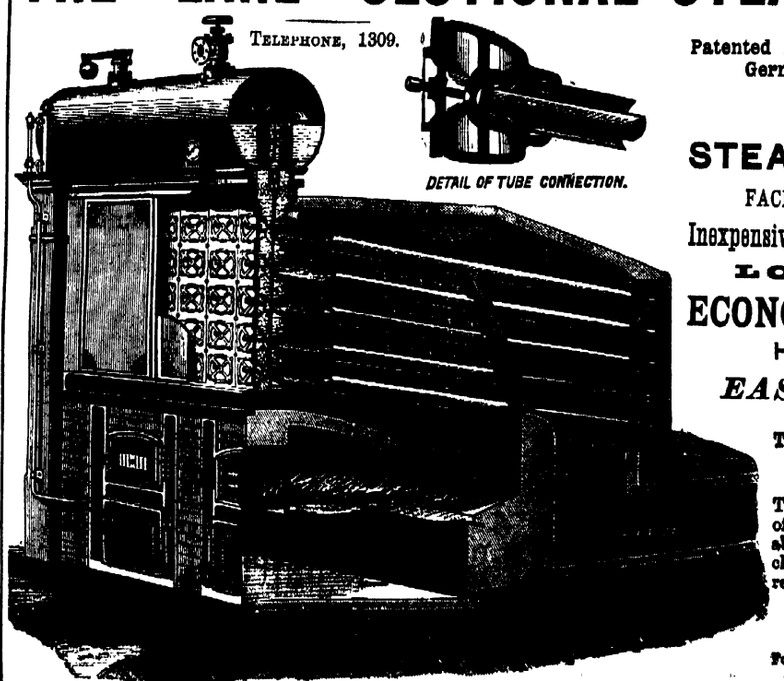
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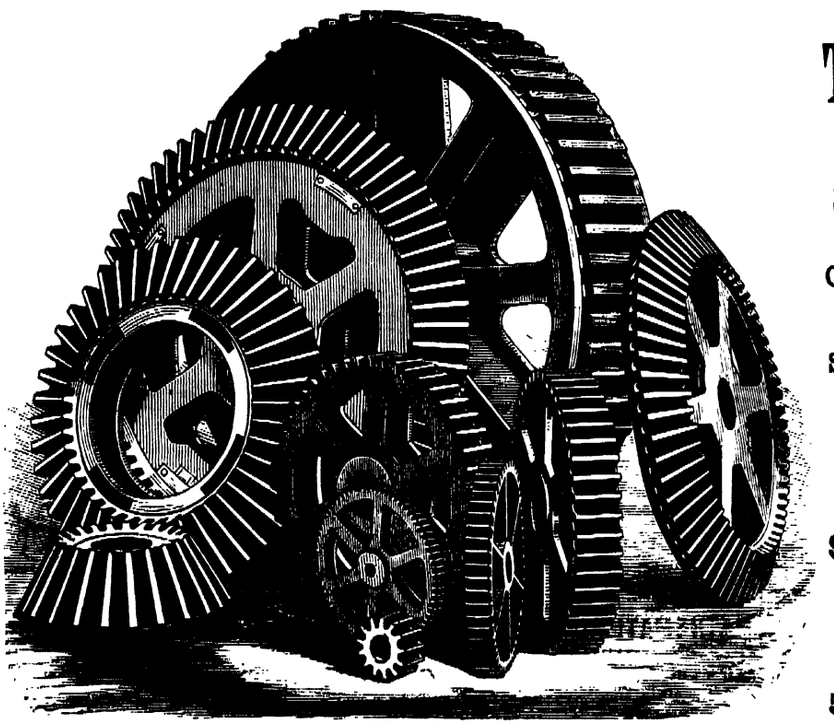
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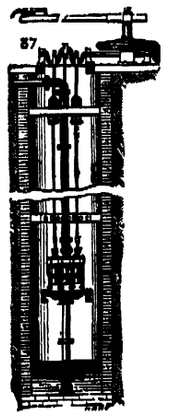
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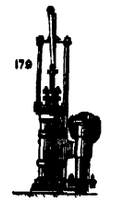
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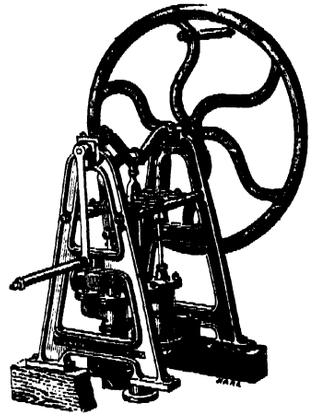
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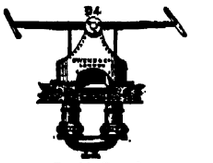
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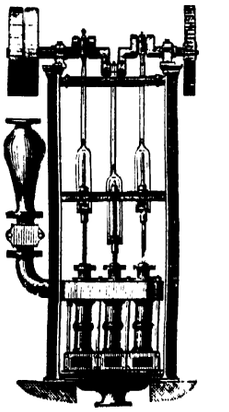
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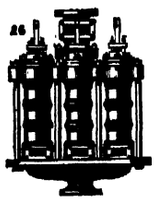
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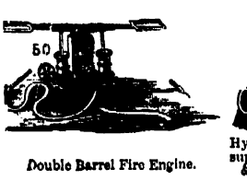
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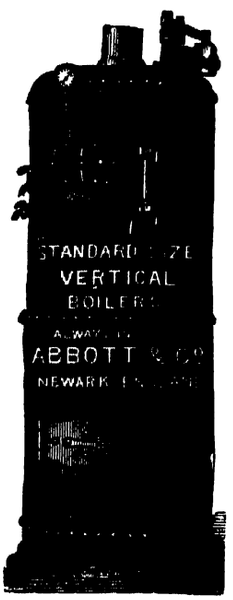


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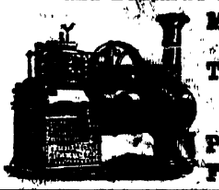
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AN Advertisement having been inserted in sundry papers by Messrs. F. REDDAWAY & Co., setting forth that Mr. GANDY has been ordered to pay their costs, about £5,000, in reference to the action brought by him against them, Mr. GANDY Gives Notice that as yet no costs have been paid to Messrs. F. REDDAWAY & Co. by him, that the decision referred to is now under Appeal, and that the amount of costs named is grossly exaggerated, and it is premature to say by whom the costs will ultimately have to be paid.

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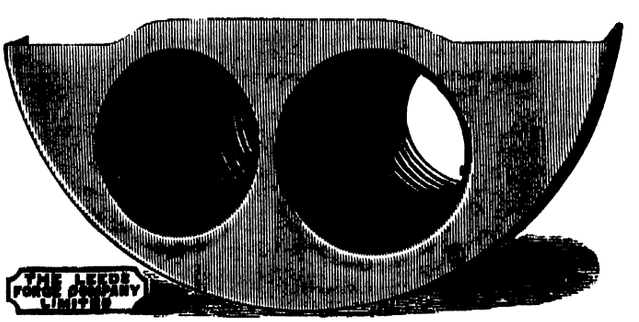
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THE INSTITUTION OF MECHANICAL ENGINEERS.

In dealing in our last issue with the meeting of the Institution of Mechanical Engineers at Cardiff, during the past week, we gave a full account of the proceedings at the two meetings for the reading and discussion of papers held on Tuesday and Wednesday, the 5th and 6th inst., and we also gave notes on several of the works, &c., thrown open to members. We have now to describe some of the other works visited, and to describe the specially arranged excursions which form such an important feature in these summer gatherings.

The Wallsend Slipway and Engineering Company.

These works, which were specially set down for being visited on the 5th inst., form a branch of the well-known establishment on the Tyne, and are situated on the public graving dock referred to last week. They also face the new Roath Dock now in course of construction, of which particulars are given in our notice on page 135 *ante*. The works are entirely new, and indeed, at the present time, are hardly completed, although they are sufficiently advanced to undertake any work that may be required.

Entering at the principal gates, we pass into the lofty main building, which comprises the erecting and machine shop. It is 150 ft. long and 67 ft. wide, and is covered with Holt's patent roof. In this department are several very fine new tools. Amongst them is a large lathe, treble-geared, surfacing and screw-cutting, by Messrs. Smith, Beacock, and Tannett, of Leeds, which at the time of our visit was being erected. This has been especially designed for turning up heavy crank-shafts, but can be used for any heavy general work. There is a pedestal with a compound slide rest for turning work of large diameter, the gap allowing of pieces up to 10 ft. being chucked. A shaft 20 ft. long can be taken between centres. A second screw-cutting and surfacing lathe by the same makers will take a shaft 26 ft. long. There are also other smaller lathes for lighter work. A large radial drill will work over a radius of 7 ft. This machine has been specially arranged for boring work of large diameter, such as propellers, &c. A pit is provided for work of greater length than usual. There are also smaller drills of the same type; both of these are by Messrs. Campbells and Hunter. A planing machine, by Messrs. Sharp, Stewart, and Co., is a fine tool; it is on Sellars' patent, with diagonal worm. There is also a slotting machine and a screwing machine by the same makers. The latter is also on Sellars' patent, and will screw up to 3 in. diameter. There is also a shaping machine by Messrs. Campbells and Hunter, besides several other tools suitable for the class of work in view. The shafting for driving these machine tools is cold-rolled shafting supplied by the Kirkstall Forge Company, and the pulleys are on Mackie's patent. The shop is commanded by an overhead travelling crane of 25 tons capacity, by Messrs. J. Booth and Brothers, of Rodley; it is driven by a square shaft 150 ft. long. This crane also runs over the railway siding which passes across the end of the shop. All the machinery, including the crane, is driven by a 16 horse-power Otto gas engine of the new pattern lately introduced by Messrs. Crossley Brothers. The gas is supplied by two Dowson gas producers, one of which only is worked at a time, the other being held in reserve. Each producer is capable of generating gas for 120 indicated horse-power. The usual scrubbers and a gas-holder of 1500 cubic feet capacity are provided.

Above the smaller machine tools is a gallery set apart for pattern and wood-working generally. The bench vices are on a somewhat novel principle. In this shop the boilermaking and iron ship repairing plant is placed at present as a temporary measure. A building of similar dimensions to the one we are now treating of will be erected adjoining for this purpose as soon as the company obtain possession of the ground, which will be in January next. The plant consists of plate planers, rolls, punching and shearing machines, and other gear suitable for dealing with heavy marine work. In the yard there is in course of erection a plate furnace which will heat a plate 16 ft. by 8 ft., and a beam bending machine is also placed here.

On the western side of the yard is a building 113 ft. long by 45 ft. wide, and somewhat similar to that we have described; this forms the foundry. One cupola is already built, and arrangements are made for erecting a second. A Roots blower, placed in the other building, is used for giving the required blast. Castings of the largest size will be made here, the plant being specially designed for large propellers. A large drying stove 24 ft. square is built against the foundry. The brass foundry, which has three fires, is in the same building. At present half the area of this shop is occupied by the smiths, but when the premises are completed there will be a separate smithy.

All gas, water, and air pipes are laid in a culvert, so as to be easily accessible. This establishment was opened for work on the 1st of July last, and may now be said to be in fair order. The place is well arranged for dealing with ship repairs of all kinds. The excellent modern tools and favourable position will render this latest invasion from the north a formidable rival to the existing yards.

The Tyneside Engine Works.

These works were also visited on the 5th inst. They form a part of a group that is placed round the public graving dock of the Bute Docks, and which it will be seen, by reference to the plan published on page 133 of our last number, leads from the northern corner of the Roath Basin. This dock is 580 ft. long, 60 ft. wide at entrance, and has at springs 23 ft. of water over keel blocks.

Passing in through the offices we come first to the erecting shop, a fine lofty building served by an overhead travelling crane which will lift 10 tons. At the back of the shop is a treble-geared surfacing and screw-cutting lathe with a sliding bed. It will take a long shaft between centres, and will turn such work as pistons and pieces of this nature up to 6 ft. in diameter. At the time of our visit to these works there were being erected two pairs of compound tandem engines intended for the Bristol Corporation.

Next to the erecting shop is the boiler-house, which contains two large vertical boilers, and from thence we pass to the machine shop, which is fitted with lathes, planing, shaping, slotting, and drilling machines, and all the usual tools for ship-repairing work. The most noticeable of these is a heavy crankshaft lathe. Above the machine shop is a fitters' gallery with fitting benches and light machines. Next to this is the coppersmiths' shop and a brass foundry with four fires and the usual appliances.

In another building there are two floors upstairs, which comprise the pattern shop and carpenters' shop fitted with the usual tools and wood-working machinery. Below is a boat-building shop. At the other end of this range of buildings is the smiths' shop with eight fires served by a Roots blower. There is also a small steam hammer.

At right angles to the latter building is a lofty boiler shop, which is covered by two spans of iron roofing placed on strong iron columns. These are to support a travelling crane which is being erected and which will lift up to 35 tons. For the boiler-making plant some hydraulic machinery is now being constructed by Messrs. Fielding and Platt. There are also two heavy and two light steam punching and shearing machines. There are ten boilermakers' fires and a large sunken fire, which is used for welding up stern frames or heavy work of this description. There is also in this shop one of Allen's steam strikers, which is found very useful in drawing down tools and such work. There are countersinking machines, rolls, beam bending machinery, and other tools necessary to complete the boilermakers' plant. On the opposite side of the yard there is a plate furnace which will take a plate 17 ft. by 8 ft., beside which is an angle iron furnace for heating frames, &c., and in front are the plate levelling blocks.

This is a modern establishment, the tools being new and of recent design. The buildings are lofty, light, and most substantially built. A line of rails in connection with the main systems runs into the works. This company has recently built on these premises three small screw tug vessels which were launched sideways into the dry dock. A notable case of repairs recently executed by this company was that of the iron s.s. Moliere. This vessel got high and dry on the rocks at the Foreland, a bad spot in the Bristol Channel. The bottom was patched up and the rocks were blasted away in order that the vessel might be floated off. She was towed up to the dry dock and a new cellular bottom was put into her almost all along up to the turn of the bilge. The work was completed in twenty-eight days from the time the vessel entered the dock.

The s.s. "Blue Jacket."

Before leaving the morning meeting on Tuesday, the 6th inst., the attention of the members was directed to the s.s. Blue Jacket, this being the vessel to the boilers of which had been fitted Mr. Hannay's electrogen described in Mr. J. H. Hallett's paper on "Corrosion in Marine Boilers," read before the Institution on the 6th inst. In order to facilitate the discussion of his paper on the subsequent day, Mr. Hallett, who is the consulting engineer to the owners, had arranged that on the Tuesday afternoon one of the boilers of the Blue Jacket should be opened and available for the inspection of any member desiring to examine it. The boiler had not, we believe, been cleaned in any way, and it was found to be in admirable condition, and coated only with a light uniform scale. The engines of the Blue Jacket had also been running without any lubricant being introduced in the cylinders, and the high-pressure cylinder was opened for the inspection of the members, the bore showing a perfect surface. The Blue Jacket is the property of Messrs. Hallett and Co., of Cardiff, and was built by Messrs. J. L. Thomson and Sons, of North Sands, Sunderland. Her chief dimensions and particulars are as follows: Length between perpendiculars, 282 ft.; breadth, 36 ft. 8 in.; depth, 24 ft.; capacity, 3100 tons; rig, schooner; iron lower masts; short full poop for cabin; long bridge and top-gallant forecastle; iron main, forecastle, and upper bridge decks; and wooden upper deck. She is provided with four large winches and a donkey boiler, Cochrane's patent, of extra large size. She is also fitted with Laing's patent helical wheel, steam steering gear, and direct-acting steam windlass. The hull is well subdivided by bulkheads, and provision is made for water ballast in the fore and main holds and peaks. The engines were built by Mr. John Dickinson, of Sunderland. They are of the compound surface condensing type, with cylinders 35 in. and 66 in. in diameter, and 42 in. stroke. They are fitted with steam starting, reversing, and turning gears, Dickinson's patent built crankshafts, and Durham's patent governor. Steam is supplied by two multitubular boilers, fitted with hydrokineters, and working at a pressure of 80 lb.

Excursions to Collieries.

As we mentioned last week, the afternoon of Wednesday was chiefly devoted to four alternative excursions to collieries, a number of works in Cardiff being, however, also thrown open. The four collieries to which visits were made were the Great Western Colliery, Lewis' Merthyr Colliery, the Cymmer Colliery, and the Llwynypia Colliery, all situated on the Taff Vale Railway in the neighbourhood of Pontypridd, passing which a glimpse was obtained of the one-arch stone bridge of 140 ft. span erected in 1755 by William Edwards, the self-taught architect. On the way to Pontypridd also were seen in passing the ancient Castle Coch (which has been recently restored by the Marquis of Bute, to whom it belongs, and which has a large vineyard annexed to it), and the Nantgarw Pottery, celebrated for the now rare china formerly produced there.

Of the four collieries above named, we subjoin some particulars.

The Great Western Colliery.

This colliery is situated about one mile from Pontypridd. It consists of three pits, one of which, however, is only used for pumping. The Hetting pit is 400 yards deep, being sunk to the 6 ft. seam. It is now, however, working the 4 ft. seam, which consists of steam coal. The winding engines situated at the head of the pit are of the ordinary horizontal type, with double beat valves. The cylinders are 40 in. in diameter and the stroke is 6 ft. They are fitted with Stevens's automatic expansion gear, which gives a considerable economy in steam, a consideration of more importance in this instance than is usually the case at collieries, as here the small coal is used for coking. The drum is 16 ft. in diameter, of ordinary construction, and has a flat rope. The shaft is 16 ft. in diameter, and is fitted with rail guides for the cages. The working faces average about a thousand yards distant from the pit. The roads are straight, and gradients easy. The haulage is by compressed air, an engine being placed at each end of the

plane, as the inclination is not sufficient for the trains to carry the ropes back. The air-compressing engines are a fine modern pair by Messrs. D. Adamson and Co., of Dukinfield, and are placed in a building adjoining the winding engine. They are of the ordinary horizontal type excepting that they have a special valve with convex face working on a hollow cylinder face. The steam cylinders are 40 in. in diameter, and the stroke is 6 ft. The air cylinders are 42 in. in diameter, and have Walker's patent inlet and outlet valves, which are fitted with a spring buffer arrangement. The steam pressure is 50 lb., and the air is compressed to 45 lb. to 50 lb. per square inch, the engine stopping automatically when the steam pressure is reached in the air receiver. The air is carried down the pit by a 12 in. wrought-iron main, and is distributed by smaller pipes. There are four air engines for haulage, and one pump on Cameron's patent for draining the dip workings. The hauling engines are on what is known as Stevens's patent and have been supplied by the Uskside Company, of Newport; one engine has a pair of 14 in. cylinders with 18 in. stroke, the diameter of the drums being 5 ft. There are three other of these engines, each having a pair of cylinders 8 in. in diameter with 12 in. stroke, the drums being 3 ft. in diameter. Steel wire rope $\frac{5}{8}$ in. and $\frac{3}{4}$ in. is used. The larger engine will bring 12 trams, each holding about 22 cwt. of coal, at about twelve miles per hour, quick hauling being the rule in this pit. Electric signals are used.

The No. 2 pit is working what is known as the red coal, which is a seam of high quality steam coal. This pit is 430 yards deep. The winding engine is of ordinary horizontal type, with steam cylinders 30 in. in diameter by 4 ft. stroke. The drum is 11 ft. in diameter and has a flat rope. The shaft is oval, its greater diameter being 14 ft. 4 in., and the smaller diameter 10 ft. 6 in. The haulage in this seam is by horses, the workings being near the pit. The workings in both seams are ventilated by one Guibal fan 40 ft. in diameter, which is worked direct from a horizontal engine having a cylinder 36 in. in diameter and 3 ft. stroke, the fan making fifty-two revolutions per minute. The No. 1, or Hettie pit, is the downcast, and the No. 2 the upcast shaft. The present fan, however, will shortly be superseded by a new Schiele fan, to be driven by a horizontal engine, having a 32 in. cylinder by 3 ft. stroke. This machinery is in place, and will soon be ready for work. Steam for these engines is supplied by four sets of boilers, sixteen in all. Four of these are fired by the waste gases from the Coppée coke ovens. These boilers are mostly of the Lancashire type, but there are three or four egg-end boilers. The latter are 50 ft. long, and the former 30 ft. long by 7 ft. in diameter. All deliver into one steam main, the pressure being 50 lb.

The coke ovens are placed to the east of the pits. There are five blocks of Coppée ovens and eight blocks of ordinary ovens. There is one steam pusher out. These are the only collieries we met with which worked Coppée ovens. These ovens are well adapted for coking a hard dry coal, which in any case does not, of course, produce such a high quality coke as the bituminous coals. The coal used for coking at this colliery is of a slightly bituminous nature, and in the Coppée ovens produces a very good coke, although the colour is, of course, not equal to that produced under more favourable circumstances. It is a fact worth noting that in the iron works which produce coke for their own use efforts are being made to introduce the Coppée ovens as much as possible, and it is said that if the coke is watered as soon as withdrawn a fair colour can be obtained.

It will be seen that steam coal only is worked at this colliery. Of this the average output is 1200 tons per day. The coal used for coking is washed by one of Sheppard's three-bosh machines, which is turning out 200 tons per day.

The Lewis Merthyr Colliery.

This colliery is situated at Hafod, in the Rhondda Valley, and is the property of the Lewis Merthyr Navigation Coal Company, Mr. William Thomas Rees being the engineering manager. There are three pits in working, two on the 4 ft. steam coal seam and one on the No. 3 Rhondda seam of bituminous coal. The Birtie Pit is one of those working the 4 ft. seam at a depth of 360 yards, and has a pair of winding engines by Messrs. John Fowler and Co., of Leeds, of the usual horizontal type with double beat valves. They have 42 in. cylinders and 7 ft. stroke and work a spiral drum varying from 15 ft. to 30 ft. in diameter. These engines are fitted with steam and hand brake and steam reversing gear. The pulley frame is of wrought iron. Round rope is naturally used with the spiral drum, and two trams are carried on the cage, which is single-decked and 13 ft. long.

In this pit there is no mechanical haulage under ground, as the main levels are not more than 700 yards long. The area of the takings is very large, and comprises about 2000 acres of steam coal. In addition to the 4 ft. seam, the 9 ft. seam, the 2 ft. 9 in. seam, the 6 ft. seam, and the red vein, have all been proved workable; the 4 ft. is only being worked at present. This pit is ventilated by a Schiele fan which is placed in a building close to the winding engine; it is driven by a belt from an engine with 24 in. cylinder, a duplicate engine being held in reserve and ready to couple on at any time according to the ordinary practice. The engine makes fifty-five to sixty revolutions a minute. The driving pulley is 17 ft. in diameter, and the fan pulley is 6 ft. 2 in. in diameter. The fan itself is 13 ft. 6 in. in diameter. The water gauge on the fan drift registers an average of about 2.2 in. The average output of the Bertie pit is 1100 tons per day, but the machinery is capable of handling from 1400 to 1500 hundred tons a day.

From the Bertie we pass to the Hafod pit, which is situated on the other side of the Rhondda, and connects with the Bertie pit. The winding engine here is of the ordinary horizontal type, and has a pair of 30 in. cylinders, the stroke being 6 ft. The drum is 12 ft. in diameter, round rope being used, and one tram is raised at a time. The depth of the pit is practically the same as the Bertie, and the veins are the same, but the 4 ft. seam only is worked. Horses are employed for haulage here, the distances not being considered sufficiently great to make it desirable to use power. The ventilation of this pit is obtained by means of a Waddle fan 40 ft. in diameter, which is driven by an engine with a 30 in. cylinder. It is estimated to be capable of delivering 150,000 cubic feet of air per minute. The output at the Hafod pit averages about 680 tons per day.

The Coedcae pit is situated about 130 yards higher up the valley on the Bertie side, and is working the No. 3 seam of bituminous coal. The winding engines are of the usual type seen in these parts, and have 24 in. cylinders and 4 ft. stroke. The drum is 12 ft. in diameter, and a flat rope is used. The depth of the pit is 120 yards. The haulage here is on the tail rope system, the distance being exactly one mile. The engines, which are underground, are placed with the boilers close to the upcast shaft. They have two 14 in. cylinders and a stroke of 16 in. The old system of ventilating this pit by furnace is in use, the men working with naked lights. The average output at the Coedcae pit is 280 tons per day.

The coal-washing machinery is situated close to the last-named pit. It is of the plunger type on Sheppard's patent, and is capable of dealing with 200 tons per day of twelve hours. It is worked by a horizontal engine with a pair of 12 in. cylinders. The coke ovens are situated near the coal-washing machinery. There are 111 in all, and are of the ordinary South Wales type, and are drawn by a hand winch at present, although steam gear is about to be fitted. There are eight steam boilers 6 ft. 6 in. in diameter and 36 ft. long, having two tubes in each, which are heated by the waste gases from the ovens, assisted occasionally by a little coal.

Cymmer Collieries.

These collieries are the property of Messrs. George Insole and Son, the manager being Mr. Thomas Griffiths. They have been established about sixty years. Nine years ago they sunk to the steam coal measures, prior to that house coal only being produced. They are sixteen miles from Cardiff on the Rhondda branch of the Taff Vale Railway close to the Porth Station. There are three pits; two, which communicate with each other, are for steam coal, and the remaining one, situated about half a mile away, produces an excellent bituminous coal for domestic purposes. Both the steam coal pits and the bituminous coal pit have separate outlets communicating with the Taff Vale Railway. The two steam coal pits are 400 yards deep, and both have been sunk to the 9 ft. seam, which is the fourth seam of the steam coal series of South Wales, and underlies the celebrated 4 ft. seam. Three seams are at present worked at these pits, viz., the 2 ft. 9 in. seam, 4 ft. seam, and the 9 ft. seam, forming an aggregate thickness of 20 ft. of coal. The long wall system of working is adopted throughout, the average output for the present year being 1300 tons per day of steam coal alone, the bulk of which is from the 4 ft. seam. The diameter of the downcast shaft is 16 ft. and that of the upcast 13 ft. The shafts are lined with brick from top to bottom, and have been fitted with substantial wrought-iron head gear on the Terris principle. The height of the head gear on the downcast shaft is 75 ft., and on the upcast shaft 60 ft. The diameter of the downcast pulleys is 17 ft., and flat ropes are used in that shaft. The diameter of the pulley of the upcast shaft is 12 ft., and round ropes are here used.

For the downcast shaft there are a pair of large horizontal winding engines of exceptionally substantial construction by Messrs. Harvey and Co., of Hayle, Cornwall. They have 42 in. cylinders by 6 ft. 6 in. stroke. The winding drums are 17 ft. in diameter at first lift. The engines have been fitted with an automatic expansion gearing, which has had the effect of enabling seven boilers to do the work which formerly required eight.

The boilers for the whole works consist of ten Galloway and two egg-ended boilers. Six of the Galloway boilers are fitted up with Bennis's patent mechanical stoker. We are informed that the beneficial results from this apparatus are that a saving in fuel of 15 per cent. is obtained, and that the quantity of water evaporated per hour is 30 galls. more per boiler than with the same amount of fuel with ordinary hand firing. Two of the Galloway boilers have also been fitted up with Messrs. J. Williams and Son's patent blower. With this apparatus a current of air is blown in at the bridge in order to effect the complete combustion of the gases. The saving in fuel attributed to this arrangement is 12 per cent., in addition to which there is the advantage of practically no smoke. These boilers are not fitted with the mechanical stoker, but at the same time 5 gallons per hour more water is evaporated with the blowing arrangement than with the boilers with the mechanical stokers; that is to say, the evaporative efficiency of the boilers with the blower is greater, although the best economy of fuel is obtained by the mechanical stokers. At the same time, taking only a monetary view of the question, the blowers are more economical than the stokers when cost of maintenance of both systems is allowed for. It should be mentioned that the fuel used is ordinary slack known in this district as small coal. Mr. T. Griffiths, the manager of these collieries, has paid a great deal of attention to this subject, and the above facts are given as the results of his experience.

A heapstead consisting of a slate roof on iron framing resting on cast-iron pillars has been erected. It is 144 ft. long by 44 ft. wide. Here the coals are weighed and screened. Fisher's patent banking apparatus has been fitted for loading and unloading the pit cages. The advantages of this apparatus are that an additional 200 tons of coal per day can be handled in the same time with the same number of men. The apparatus consists of two 12-in. vertical oscillating steam cylinders with piston rods fastened to the rails at one end, while connecting levers are at the other ends of the rails. Steam is admitted underneath the pistons only and elevates the rails so that the trams run by gravitation into the cage. This apparatus, as applied at the Cymmer Colliery, was fully illustrated by us on page 10 of our thirty-fourth volume.

Underneath the heapstead a coal-washing machine is placed. It is one of Sheppard's patent and is on the plunger type. It is a four-bosh machine capable of washing 200 tons per day. Adjoining the heapstead there is a pair of horizontal engines, with 23 in. cylinders, which work this washing machine. Adjoining these engines there are a pair of rolls for crushing the No. 3 Rhondda coal as it is brought from the pit. This coal, after being crushed, is raised by an elevator and then dropped into a pair of Carr's disintegrators, where the steam small has been delivered straight from the washing machine. Both coals are well mixed and pulverised in the disintegrator. From this coal is conveyed into a large hopper and thence to the coke ovens. These are in two blocks and comprise 84 ovens in all. They are of the ordinary drag-oven type.

The mechanical haulage in the new pit, which we have been principally dealing with up to the present, is on the endless rope system, one pair of

horizontal engines with cylinders 20 in. in diameter and 3 ft. 6 in. stroke being used. The engines are geared 6 to 1, and have two pairs of grooved drums. The main drums are 10 ft. in diameter and the counter drums 5 ft. in diameter. The engines are on the surface and the ropes are carried down the pit and along three separate districts, viz., the north, south, and south-east districts, from whence all the coal is conveyed to the pit bottom from different points. The diameter of the ropes is ⅞ in. The system adopted is that generally known as the bogie system, in which coals are conveyed in sets of eight trams. The mode of attaching the trams to the rope is by the ordinary right and left-handed screw tongs, which are dropped into two gudgeons on the bogie and then attached to the rope, the speed of the rope being 2½ miles per hour. The hauling engine has been so arranged that the different sides of the pit can be worked either separately or together.

To work the old pit there is a pair of 28 in. cylinder horizontal winding engines, with 4 ft. stroke, and an 11 ft. drum. Round ropes are adopted. This colliery is ventilated by a Waddle fan, 45 ft. in diameter, which is driven by a horizontal engine with 32 in. cylinder by 4 ft. stroke. The total volume of air delivered per minute is 250,000 cubic feet. The water gauge on the separation doors underground registers 2 in., and the water gauge on the fan drift on the surface 3 in.

In connection with the colliery there is a small gas works which contains a feature of interest. A "blower" of gas is conveyed up the shaft by pipes and is forced into the purifiers attached to the gas works by a steam injector. The gas made is forced down the pit by another injector and is there burnt for use. A receiver is placed at the pit bottom to separate from the gas the water resulting from the condensation of the injector steam. The workshops in connection with the premises are built in one line near the coke ovens. They comprise a smithy and a fitters' shop, with necessary machine tools and engine. There is also a granary for storing horse feed. A sawmill, a joiner's shop, a saddlery, and a general store, complete this part of the works.

The Llwynypia Colliery.

This colliery is the property of the Glamorgan Coal Company, and is under the management of Mr. W. W. Hood. It is situated about the centre of the Rhondda Valley, and is the furthest from Cardiff of the four collieries on the list of excursions arranged for the 6th inst. It consists or three pits, one of which supplies coal from the bituminous or No. 3 seam, whilst the other two are sunk to the lower steam coal measures. The No. 3 seam is about 100 yards from the surface and is 3 ft. thick. It affords an excellent coking and house coal. This pit is worked by a pair of diagonal winding engines having cylinders 15 in. in diameter. This bituminous coal is worked by a kind of pillar and stall working peculiar to this seam, and so far as we are aware known only in South Wales. The steam coal seams are of different thicknesses, varying from 4 ft. to 6 ft. 9 in.

The No. 2 shaft which works this coal is sunk to a depth of 372 yards. It is worked by a winding engine of the ordinary horizontal type with double-beat Cornish valves; the cylinders are 34 in. in diameter and the stroke 5 ft. 6 in. The drum is spiral, the smallest diameter being 15 ft. and the largest 25 ft. The cages are double-decked, and draw two trams per lift, the total weight of coal, tram, and cage being about 5½ tons.

The pit known as No. 6 is the up-cast shaft for all the seams. It is 403 yards deep and has recently been fitted with a pair of winding engines to win the steam coal measures, which lie at a lower level than those of No. 2 pit. The cylinders of these engines are 30 in. in diameter, and have a 5 ft. stroke. They work with steam at 60 lb., which is a higher pressure than is generally used for these purposes. The diameter of the drum is 14 ft.

The ventilation is obtained by means of a Schiele fan 15 ft. in diameter, which is driven by a direct-acting horizontal engine having cylinders 21 in. in diameter, the stroke being also 21 in. Steam is cut off at a quarter-stroke. The fan runs at a speed of from 140 to 145 revolutions per minute, at which rate it passes a total quantity of 200,000 cubic feet of air per minute with a water gauge of 1.5 in.

The underground haulage is carried on upon the compressed air system. In No. 6 pit there are two hauling engines, which are placed near the bottom of the shaft. They are supplied with air by a pair of air-compressing engines having steam cylinders 26 in. in diameter and air cylinders 24 in. in diameter. At the bottom of No. 2 shaft there are also two pairs of hauling engines, having cylinders 18 in. in diameter and 3 ft. stroke. These are used for working several planes by the main and tail rope systems of haulage. As the planes are very undulating and in many parts have heavy gradients, no other system could be applied with advantage. There is, however, an endless rope system of haulage for working the sidings at the bottom of the pit and arranging the number of trams for the engine journey. This is said to answer remarkably well and dispenses with the necessity for at least five horses. The steam coal measures are worked on the long wall system.

There are about 320 coke ovens of the ordinary South Wales type at this colliery. These ovens, which are 12 ft. long by 6 ft. wide and 5½ ft. high, turn out an average of one ton of coke per oven a day, each oven being drawn twice a week. The first batch in the week is charged to give three tons of coke, whilst the second batch yields four tons. In this way the necessity for working on Sunday is overcome and the required seven tons of coke a week is obtained from each oven. The ovens are charged at the top and the charges are watered in the ovens. Steam travelling crabs are used for drawing the charges from the ovens, and the coal is drawn to the ovens from the pit-bank by a system of endless rope haulage. At the part of the works furthest up the valley there are the ordinary colliery workshops and wagon sheds, where the company keep in repair all their own wagons. There is also a small brick works attached to the premises where the bricks are made, which are here used for arching underground in order to save timbering. The total quantity of coal drawn from the three shafts is about 1600 tons per day.

There are two other collieries, situated in the Ely and Ogmore valleys, which are the property of the Glamorgan Coal Company and are worked in connection with the Llwynypia Colliery. They have been working principally the upper measures so far, but the steam coal measures are being gradually won, the company having recently struck the 6 ft. seam of smokeless steam coal at the Ely Valley Colliery. The quality is said to be of the best, and has a fine clift top, so that clean coal of large size can be turned out. This will no doubt be of great benefit to the district, as the seam will be rapidly developed and will give employment to a large number of additional workmen, who are likely to be well cared for by their employers if we may judge from what we saw at Llwynypia, where there were pleasing evidences of the welfare of the employés of the colliery being considered by those in authority. Coking is extensively carried on at the two collieries last-named as well as at the principal establishment, the production of superior descriptions of coke being made a special feature with this company. For some time it was known as the "Glamorgan Patent Foundry Coke," but it was found necessary for special reasons to alter the name to "Hood's Foundry Coke," under which title it is now sold.

The Bute Shipbuilding, Engineering, and Dry Dock Company (Limited).

These works were amongst those visited on the afternoon of the 6th inst., by members who did not take part in the excursions to the collieries. The premises of this company are situated between the River Taff and the Glamorganshire Canal; the latter not very many years ago, before the Bute Docks were built, constituting the port of Cardiff. The yard is fitted with all necessary machinery for shipbuilding and ship repairs. On entering the premises there will be noticed on the left the forge where heavy work, such as stern frames, keel bars, and rudder frames are made or repaired. In front of this are the boilers and shop engine and on the opposite side are the stores and offices. By the side of the forge is a building comprising the fitters' shop, the blacksmiths' shop, boilermakers' shed, and plumbers' shop. The smiths' shop has 22 fires and two steam hammers besides the other usual appliances. Here in addition to smaller work the large forgings are finished. The fitters' shop has also the requisite tools for turning out large marine engines. Beyond this range of shops are the pattern-makers' shop, and a foundry where 23 to 30 tons of castings can be turned out per week.

In the centre of the yard are the joiners' and carpenters' shops, below which boat-building is carried on; another part of the lower floor being used as a store. In front of this there is the shipyard plant. This consists of the usual plate and angle furnaces with bending blocks, beyond which is the space for the body board. There are two steam punching and shearing machines, horizontal punching machine, and a beam bending machine. There is also a locomotive steam crane by Messrs. J. Jessop and Son, of Leicester, which will lift 7½ tons. In this yard, there is at present a screw steamer on the stocks nearly completed. She is built entirely of Landore steel. Her dimensions are 240 ft. long by 33 ft. beam and 18 ft. deep. She has a long raised quarter-deck, bridge-house, and top-gallant forecastle; her dead-weight capacity will be 2000 tons. There is also just commenced a caisson 78 ft. long, 16 ft. wide, and 20 ft. deep. This will be used to divide the company's new dry dock into two parts, so that vessels needing heavy repairs may be placed at the far end of the dock and kept dry until complete, whilst the other part of the dock is being used for other vessels which require only painting or short repairs. The iron gates for this new dock were also built here. This company recently launched two hopper barges, which were built for the Marquis of Bute, each of 300 tons dead-weight capacity.

The new graving dock to which we have made reference is now in course of construction. The length is 580 ft., and it connects with the southern corner of the Roath Basin. The position is shown on the plan of the Bute Docks published on page 133 of our last week's issue.

Penarth Docks and Tidal Harbour.

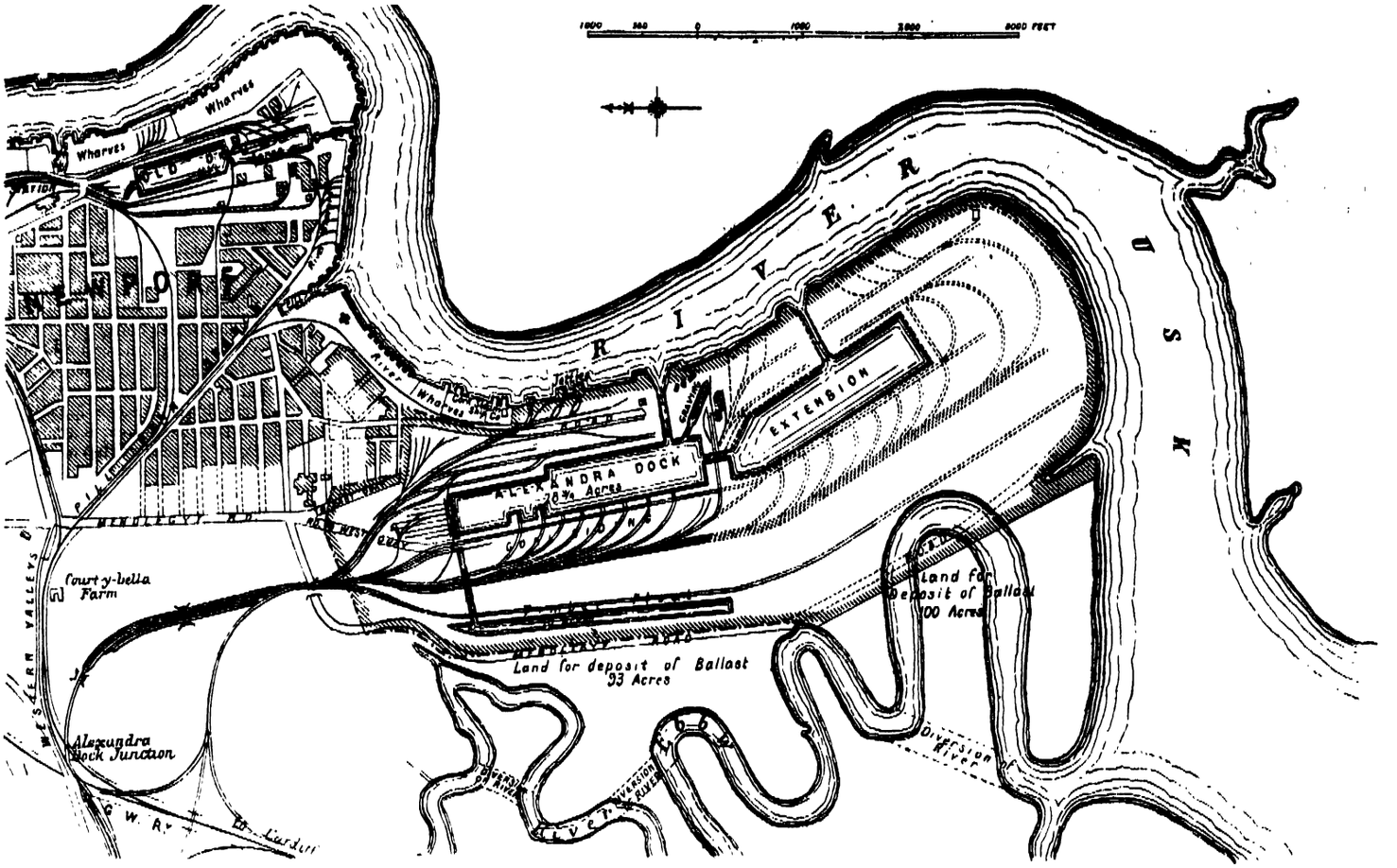
The excursions to the collieries and visits to works at Cardiff on the afternoon of the 6th inst. were followed by an inspection of the docks and ship slipway at Penarth. On the occasion of the former visit of the Institution of Mechanical Engineers to Cardiff in 1874 we published a map (*vide* page 120 of our eighteenth volume) which showed clearly the arrangement of the Penarth Docks and their position relatively to those at Cardiff. To this map a reference may now be advantageously made. The Penarth Dock and Basin are situated in a line with each other on the south-west side of the mouth of the River Ely which here joins the Severn. The entrance to the basin opens into the Severn slightly to the south of the mouth of the River Ely. In addition to the dock and basin there is also a tidal harbour at Penarth formed by the lower part of the River Ely, this harbour being provided with staiths for the shipment of coal along its north-east side. The Penarth Dock and Harbour works were designed by Sir John Hawkshaw, and were carried out under his supervision and that of Mr. Samuel Dobson. From a description of these docks and harbour works, prepared for the information of the visitors by Mr. T. Hurry Riches, the honorary local secretary, we quote the following particulars:

"*Penarth Dock.*—The dimensions of the dock are as follows: Length, 2100 ft.; width, 370 ft.; area, 17½ acres. The basin is 400 ft. long by 330 ft. wide, and its area is 3 acres. The lock is 270 ft. long, and 60 ft. wide. The sea entrance also is 60 ft. in width. On the sill of the sea-gates and the lock-gates the depth of water is 35 ft. at spring tides, and 25 ft. at neap tides; giving a depth of 4 ft. lower than the Bute East Dock, and 7 ft. lower than the Bute West Dock sill. The new dock is not so large as the Bute East Dock, but the greater size of its basin gives it a manifest advantage as to the number and size of vessels which could be locked in or out in a given period. Being a tidal dock also, whil the existing Cardiff Docks are all filled by fresh water, the Penarth Dock will be able at high water to throw all its gates open from dock to sea, and allow immediate ingress and egress of ships, thus preventing the delay so often complained of in the shipment of minerals from this port. In addition to these considerations, it may be stated that owing to the depth of water in this dock it will be able to accommodate a larger class of ships than this or any other port in the Channel has hitherto been able to receive.

"There are ten coal drops now constructed along the side of the dock, and two more along the basin. These are all on the south side. They are estimated to ship 150 tons per hour each. All of these drops are on the high level, so that the machinery is self-acting, being worked by gravitation, thus saving the expense of employing artifical motive power; but they are also fitted with hydraulic

THE ALEXANDRA DOCKS, NEWPORT.

(*For Description see opposite Page.*)



power, so as to tip at a higher level when required. Two of the drops in the dock and two in the basin are what are called double drops, that is to say, the loading of coal into the same vessel is intended to be effected by means of two drops at the same time, and vessels loading at these double drops will be loaded at the rate of 300 tons per hour. The railway siding arrangements connected with them possess a feature deserving notice. The roads by which the loaded coal wagons are to approach the drop incline downwards towards the drop, while those by which the empty coal wagons are to retire from the drop fall outward, so that the wagons will in each case be impelled by their own gravitation in the direction in which they are to go. In this as in every other detail of the work advantage has been taken to the fullest extent of every natural feature and existing circumstance, so that the minerals may be shipped with the greatest speed and facility, and at the minimum of expense.

"On the opposite side of the dock from the coal drops are seven hydraulic ballast and iron ore cranes, three of which are portable, and a 10-ton lifting crane, and two steam cranes, with the necessary sidings for working them. Two of these cranes have been so placed that they will work into the same vessel at the same time. This double arrangement and the double coal drops have been specially provided to give despatch to steamers. The remainder of that side of the dock is as yet unappropriated, and may be applied to the purposes of an import trade, or, should it be found necessary, more coal drops could be erected, to be worked by hydraulic power. Very powerful hydraulic machinery has been provided, by which are worked the ballast cranes, ore cranes, and the cranes at the coal drops for lifting small coal from the decks of the vessels, as well as the machinery for opening and closing the gates, the sluice machines, capstans, fender chain machines, &c. There are about 28 miles of sidings connected upon this dock, for storing wagons for the convenience of merchants.

"*Penarth Tidal Harbour.*—Length measuring along the centre of the river, 13,000 ft.; frontage on Cardiff side, 12,000 ft.; on Penarth side, 12,700 ft.; total frontage, 24,700 ft. Average width at water line at high water for first reach of river, 600 ft.; length, 4000 ft.; area, 55 acres. Average width at water line in same reach when depth of water is 15 ft., 280 ft.; area, 26 acres. Number of staiths for the shipment of coal, ten; room for six more; each staith capable of shipping 150 tons an hour. Depth of water in the berths at high water at ordinary spring tides, 30 ft.; and at ordinary neap tides 20 ft. Vessels up to 800 tons burthen take the ground, and are loaded with safety and despatch in this harbour. The maximum run of the tide is at the rate of about two knots an hour. Three cranes for unloading ballast and iron ore, each capable of unloading 50 tons an hour."

The proceedings on the 6th inst., after the inspection of the Penarth Docks, were brought to a very pleasant conclusion by a visit to the Windsor Gardens, Penarth, on the invitation of Lord Windsor, these gardens affording a magnificent view over the Bristol Channel.

The Dowlais and Cyfarthfa Iron Works.

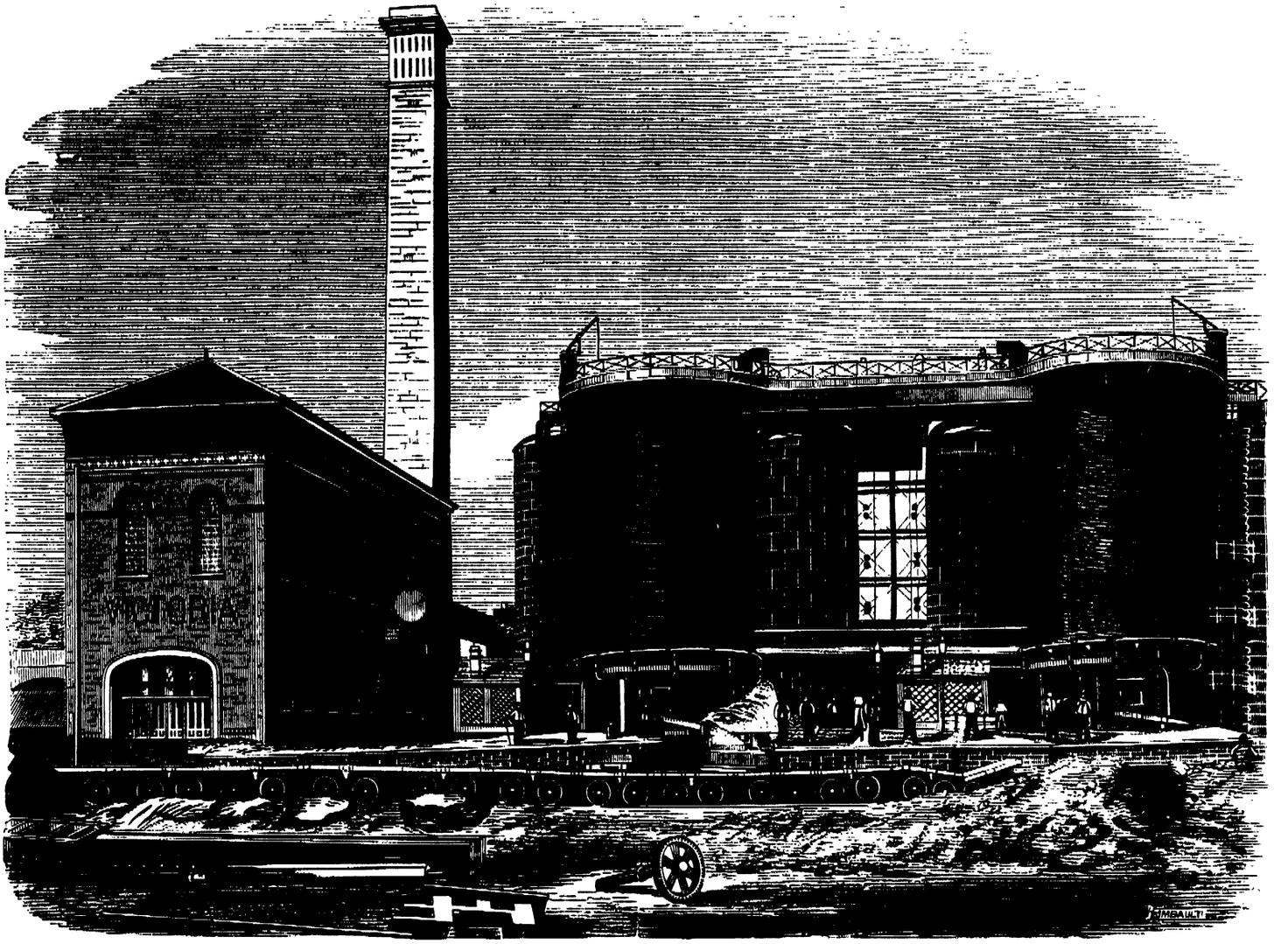
Thursday, the 7th inst., was devoted to an excursion to the Dowlais Iron Works, and to those at Cyfarthfa, the members being conveyed by a special train from the Rhymney Railway Station at Cardiff. Of both the works named we have already published descriptions, our account of Dowlais appearing on page 125 of our last issue, and that of Cyfarthfa on page 111 of our last number but one; we also on page 124 of our last number published a general plan of the Cyfarthfa Works. Under these circumstances it is unnecessary that we should enter here into any detailed account of either of these works, but we cannot pass without special comment the enormous changes which have been made in these establishments since they were visited by the members of the Institution of Mechanical Engineers in 1874. Even at that date the manufacture of steel had attained very large proportions at Dowlais, but it had by no means supplanted iron to the extent to which it now does, while at Cyfarthfa the production of steel was not even thought about. Now there is ample evidence that the day of Welsh iron-making has practically past, and that in the future it must give way almost entirely to the production of steel. That the owners of works like Dowlais and Cyfarthfa fully recognise this fact is clearly shown by the manner in which their plants are being entirely remodelled to meet the altered conditions, and every credit is due to them for the thoroughness with which they are taking up the manufacture of steel.

At Dowlais, after inspecting the works and coke ovens, the visitors were most hospitably entertained at luncheon by Mr. George T. Clark, the chair, in the unavoidable absence of Mr. Clark himself, being taken by Mr. Edward P. Martin, the able manager of the works. After luncheon the members re-entered the special train, which conveyed them to Cyfarthfa, where they were received by Mr. Crawshay, and by the manager, Mr. William Jones, under whose guidance they made a survey of the works. As we explained in our notice of Cyfarthfa the week before last, the steel department is not yet at work, but the plant is very nearly complete, and it was examined with great interest. From Cyfarthfa the members were conveyed by the special train back to Cardiff, where in the evening they took part in a conversazione kindly given by the Mayor at the Free Library and Museum.

The Rhymney and Ebbw Vale Iron Works.

Friday, the 8th inst., was devoted to an excursion embracing visits to the Rhymney and the Ebbw Vale Iron Works, the Abercarn Tin Works, and the Newport Docks. Leaving Cardiff by special train the members were first taken to Rhymney, where they were received by Mr. David Evans, under whose guidance and that of Mr. J. R. Williams, the resident engineer, the tour of the works was made, especial interest being shown in the Bessemer department and steel rail mill, the plant of which reflects great credit on all concerned in its arrangement. Inasmuch as we gave a description of the Rhymney Works on page 112 of our last number but one, and a plan on page 125 of our last issue, it will

THE VICTORIA BLAST FURNACES; EBBW VALE IRON WORKS.



be unnecessary that we should enter into an account of them here.

From Rhymney the special train conveyed the visitors to the Ebbw Vale Iron and Steel Works, a description of which appeared on page 119 of our last number, and where they were met by Mr. Calvert B. Holland, the general manager. Accompanying the notice just referred to, we gave on pages 120 and 121 *ante* a general plan of the whole works, and a plan to a larger scale of the new Victoria furnaces. This latter plan we this week supplement on the present page, by a perspective view of two of the furnaces just named, which will assist in explaining their design and arrangement. The works of the Ebbw Vale Iron and Steel Company cover an enormous area, and the survey of them under a broiling sun certainly did not diminish the visitors' appreciation of the luncheon which the company had hospitably provided for them in the market hall at Ebbw Vale.

The Abercarn Tin Works.

Leaving Ebbw Vale, the party next proceeded by the special train to Abercarn, where the Abercarn Tin Works were visited, the Crumlin Viaduct being seen *en route*. The works at Abercarn are extensive, and we regret that the demands upon our space prevent us from giving a detailed account of them. The production of tin plates is one of those manufactures of which the various stages can be readily followed by the visitor to such works as those at Abercarn, and it thus possesses an interest which in more complicated manufactures is often wanting. The rolling and re-rolling of the plates, the pickling, cleaning, and dipping—first in boiling palm oil and subsequently in the baths of molten tin—are all consecutive processes, the relation of which to each other can be readily understood, and which, moreover, derive a special interest from the great manual dexterity shown in the rapid handling of the materials. An inspection of the sulphuric acid works and a visit to offices where provision had been thoughtfully made by the proprietor, Mr. Daniel Whitehouse, for liberally replacing the losses by evaporation which the members had suffered during the inspection of the rolling mills, brought the visit to Abercarn to a conclusion.

The Newport Docks, &c.

On their arrival at Newport, the members were conveyed by the special train direct to the docks, a short stoppage being made, however, to enable an examination to be made of Wood's safety railway chair, which is in use on the dock lines. Of this chair we may have something to say hereafter.

Of the Newport Docks we give on page 148 a general plan, which will explain clearly their arrangement and positions with regard to the River Usk, which joins the Severn at this point. The River Usk is navigable for vessels of the largest size up to Newport Bridge, a mile and a half above the Old Dock entrance, where it has a width of 900 ft. and a depth at spring tides of 40 ft. The Old Dock has an area of 11½ acres and a length of 1753 ft., while the depth of water in it is 25 ft. It is entered through a lock 220 ft. long by 61 ft. wide and having depths of water on the sill at entrance gates as follows: at extraordinary springs 36 ft.; at average springs 31 ft.; at average neaps 20 ft., and at lowest neaps 15 ft.

Of the Alexandra Dock, some particulars for the use of the members were kindly supplied by the engineer, Mr. William Stopford Smyth, and from these the following account has been prepared: The dock was opened in April, 1875, Mr. James Abernethy and Mr. Alexander Bassett being the engineers. It is 2500 ft. long, 500 ft. wide, and has an area of 28¾ acres, while the area of land appropriated for quays, yards, warehouses, &c., is 200 acres, there being also an additional area of 93 acres set apart for the deposit of ballast free of charge. The entrance lock is 350 ft. long, and 65 ft. wide, with 36 ft. of water on the outer sill at average spring tides and 25¾ ft. at average neap tides. The width of the trumpet-mouthed entrance is 300 ft. There are three pairs of timber working gates, and one pair of iron sea gates, all worked by hydraulic power. The inner sill is 8 ft. above the outer sill, and the ordinary level of water in the dock is 30 ft. above the dock sill. There are three Siemens electric lights at the entrance, each 34 ft. high and of 6000 candle-power, worked by two 8 horse-power Otto gas engines. Vessels are thus enabled to enter the dock as freely by night as by day.

The Alexandra graving dock is entered from the wet dock. Its length is 532 ft. from gates to head of dock, and 515 ft. on the blocks, while the width is 74 ft. between the copings. The gates are 50 ft. wide, with 20 ft. of water on the sill. The dock is emptied by a culvert discharging into the river. Alongside the dry dock are the fitting and repairing shops, and the foundry, with the necessary machinery for all kinds of repairs to vessels and engines. A timber float of 10 acres area and 8 ft. depth is connected with the wet dock by a canal.

The railways and sidings immediately in connection with the dock are twenty-seven miles in length. The coal sidings are laid out on the gravitation principle, so that the loaded wagons run down from the high-level sidings to the quay, where they are weighed, and are then taken by the hydraulic capstans to the hydraulic hoists, raised to the required height, tipped by hydraulic power, and transferred to railway viaducts which cross the quay and lead them by gravitation to the sidings for empties. The lines for loaded wagons from the

high-level sidings to the quay are laid in sets of twos and threes, to allow wagons with different kinds of coal to be tipped in rotation, thus insuring the due mixture of coal, as may be required.

There are eight hydraulic coal hoists with their accompanying sorting sidings, weighbridges, viaducts, and sidings for empties. Vessels are discharged by hydraulic cranes of from two to three tons power. Of these there are seven movable and six fixed. There are also five steam cranes of from two to ten tons power. The hydraulic power for the gates, hoists, capstans, and cranes is furnished by three steam pumping engines of 210 horse-power collectively, with seven boilers and three accumulators. Two of the accumulators are 17 in. in diameter and 17 ft. lift; the third is 20 in. in diameter and 23½ ft. lift. The traffic is worked by thirteen locomotives. A powerful steam hopper barge, fitted with Priestman's crane and bucket, removes the silt in the dock and acts as a tug-boat.

For the extension, or South Dock, 213 acres of land have been acquired, with 100 acres adjoining for ballast purposes.

From 700 to 800 men are engaged about the dock, including the officials and the men loading and discharging the vessels. The principal exports are coal and steel; the imports are iron ore, pig iron, timber, pitwood, and sleepers. The coal shipped in 1876 was somewhat less than half a million tons; in 1883 it exceeded 1¾ million tons; while the total exports and imports in 1883 amounted to nearly 2,400,000 tons. The number of vessels that entered the dock in 1883 was 1848, of nearly 1,100,000 net register tonnage.

In addition to the docks, the Cambrian Foundry and Engineering Works, Messrs. Mordey, Carney, and Co.'s Shipbuilding Works and Dry Docks (of which we give a short account below), and the Emlyn Foundry and Machinery Stores were thrown open to the inspection of the members, but unfortunately little time was available for visiting them, a change having been rendered necessary in the programme for the latter part of the day's proceedings. As originally arranged, the members visiting Newport were to have dined at the Drill Hall there, by invitation of Sir George Elliot, but on Wednesday a telegram was received by the local committee from Sir George, stating in somewhat curt terms that he would be unable to be at Newport on the Friday, and that therefore his invitation of the members to dinner on that evening must be regarded as cancelled. This telegram was read at the termination of the meeting for the reading of papers on Wednesday, and the local committee at once convened a special meeting to deal with the changes in their programme, necessitated by Sir George Elliot's extraordinary behaviour. The result of a very brief conference was the announcement that the local committee had taken upon themselves the duties of host discarded by Sir George, and that they had with great liberality promptly made arrangements for inviting the members to dine at Cardiff on the Friday evening instead of at Newport. In the course of the Wednesday afternoon the news of the change in the programme reached Mr. E. H. Carbutt, the member for the Monmouth boroughs, and he at once telegraphed the local committee that he would most willingly take Sir George Elliot's place and entertain the members at Newport as originally proposed. Unfortunately the local committee were unable to accept Mr. Carbutt's cordial invitation, they having already entered into arrangements for the Cardiff dinner, but later in the day the Patent Nut and Bolt Company, of Newport, hospitably persuaded the committee to accept them as the hosts of the Cardiff dinner, they taking over all the arrangements which the committee had already made. Thus as finally arranged the members became on Friday evening the guests at Cardiff of the Patent Nut and Bolt Company, representing Newport, the chair being taken by Mr. Grice, of the company just named, who was supported by his colleague, Mr. Keen. What at first appeared a disagreeable incident thus only served to bring into greater prominence the unbounded hospitality of our Welsh friends and to prove the cordiality of the reception which they accorded to the Institution.

Messrs. Mordey, Carney, and Co.'s Works, Newport.

The dry dock and engineering works of Messrs. Mordey, Carney, and Co., Limited, are situated on the west side of the River Usk and cover an area of about five acres. They contain two dry docks of 225 ft. and 285 ft. long respectively. These are now being considerably lengthened and are having additions made for the better accommodation of the large class of vessels now frequenting this port. When the alterations are finished the length of the docks will be 300 ft. and 350 ft. respectively, and the draught of water will be between 12 ft. to 22 ft. at neap and spring tides respectively. In connection with the docks there are the usual shops and buildings required for steamship repairs. These consist of fitting shops with good modern tools, coppersmiths' and brassworkers' shops, and a large boiler and smiths' shop containing a number of forges. The shipbuilding machinery is placed under a range of sheds close by, and beyond this is another large smiths' shop containing 20 forges. It is commanded by cranes suitable for lifting heavy smiths' work, such as stern frames and other pieces of a like nature which may require welding. There are also saw mills, joiners' shops, a blockmakers' shop, and sail and rigging lofts. On the dock side there is a large stationary crane and also a travelling crane suitable for lifting propellers and other heavy weights. Five railway sidings run into these works. Three lie close to the docks and prove very convenient in cases of ships discharging ballast or taking in cargo, &c., when it is necessary to stiffen the vessel before she proceeds out of dock. Outside the entrance of the docks there is a large stage where vessels up to 300 ft. can lie in safety when internal repairs or alterations can be carried out. This stage is often used for sailing ships when discharging ballast.

Messrs. Mordey, Carney, and Co. have built on these premises several iron vessels and a number of smaller ones of wood. They have building berths in the yard capable of laying down steamers 300 ft. long. There are two berths in what is known as the old yard and three in the new yard. The position is well adapted for building, as there are very good launching facilities, and the shops are conveniently placed to the berths. The firm also construct their own marine engines. We understand that a gridiron 300 ft. long is shortly to be erected on the Ebbw Vale Pill, which is on the north side of the company's property.

The Severn Tunnel.

Saturday, the 9th inst., the last day of the meeting, was devoted to a visit to the Severn Tunnel works, on the invitation of the contractor, Mr. T. A. Walker. Arriving at Portskewett by special train from Cardiff the visitors were received by Mr. Walker and the members of his staff and by Mr. A. G. Luke, who for the past four years has been the resident engineer on the work, representing Sir John Hawkshaw, the consulting engineer. At a temporary station erected for the purpose a change was made from the special train to a train of ballast wagons fitted up with seats, this train conveying the members to the beginning of the workings on the Monmouthshire side. Walking through the gradually deepening cutting the visitors reached the land portion of the tunnel on that side. With the exception of a short length this portion of the tunnel is excavated to its full size, and by far the greater part of it has received the brick lining. It will be remembered that towards the end of 1879 a land spring discharging some 360,000 gallons per hour was struck by the land portion of the tunnel at a short distance from the Monmouthshire shore, this leading to the flooding and long stoppage of the works. On this spring being eventually temporarily mastered, a pair of dams were constructed across the tunnel about 100 ft. apart, these shutting off the spring from the remainder of the workings, and being fitted with sluices by means of which the discharge to the pumps could be controlled. These dams are still in position, rendering the tunnel discontinuous at this point, although, as our readers are aware, it is now some three years since it was opened through from bank to bank underneath the river. The total length of the tunnel is about 4½ miles, of which about half is actually under the River Severn.

On reaching the first dam, those of the party who had traversed the whole of the shore portion of the tunnel were raised to the surface at the adjoining shaft, and after inspecting the pumping engines at work and in process of erection, descended another shaft to examine the subaqueous portion of the work. Of the early history of the Severn Tunnel we gave an account on page 47 of our thirty-third volume, when we also published a plan and section showing the position of the tunnel and the nature of the geological formations through which it passes. Of the progress made during the past two years and a half, and of the present condition of the works, we should now have given a detailed account were it not that in a very early issue we propose to publish an able paper descriptive of the whole undertaking, which has been prepared by Mr. J. Clarke Hawkshaw for reading before Section G of the British Association at their approaching Canadian meeting. This paper it would be scarcely fair to anticipate, and we shall therefore content ourselves for the present by stating a few general particulars. The quantity of water now being raised at the pumping station adjoining the dams is 11,000 gallons per minute, the pumping being done by three Cornish and two Bull engines, while two more large Cornish engines have just been erected by Messrs. Harvey and Co., of Hayle. The seven engines will have an aggregate pumping capacity of about 55,000 gallons per minute. At present a curved heading is being driven on one side of the dams to connect the two parts on the tunnel, and by means of this heading the spring between the dams will be tapped and the inflow overpowered by the pumps so as to enable the dams to be removed and this short length of tunnel to be completed.

At the lunch, at which the visitors were hospitably entertained after their survey of the works, Mr. Walker made a brief speech in which he succinctly and humorously described some of the chief difficulties which it had been necessary to overcome in bringing the works to their present stage. How serious these difficulties have been and with what indomitable pluck and energy they have been surmounted by Mr. Walker and his staff, we hope some day to put fully on record, meanwhile we think that none who took part in the visit last Saturday would fail to give the Severn Tunnel Works a very high position amongst the most important engineering undertakings of the present century. Before taking leave of these works, also, it is only just that we should mention the ample evidences which exist of Mr. Walker's care to provide in every way for the welfare of those working under him. In the neighbourhood of the chief pumping station above mentioned there has been created a village of well-built cottages, each with a good garden, while a good recreation ground is provided together with reading and coffee rooms and two hospitals, one for fever patients and the other for general cases.

With the visit to the Severn Tunnel, the current summer meeting of the Institution of Mechanical Engineers came to a close, and we venture to think that never has such a gathering been more successful. Received with the utmost cordiality, met on all hands with lavish hospitality, and favoured by most brilliant summer weather, all who took part in the Cardiff meeting will long look back to it with pleasure. From first to last the arrangements were admirable, and they were carried out with a punctuality, and absence of all hitches, which reflected the very greatest credit upon Mr. T. Hurry Riches—the honorary local secretary—and the secretary of the Institution, Mr. Alfred Bache.

QUEEN CHARLOTTE'S ISLANDS.

Extending from China and Japan like stepping-stones in the great Pacific Ocean, the Kurile Islands, the exact number of which is unknown, lead from the densely-peopled regions of Cathay to the southern extremity of the peninsula of Kamtschatka, in latitude 50 deg., and east longitude 160 deg., and from thence still trending in the same north-east direction, the coast of Asia is laved by the Behrens Sea till, amidst fogs and everlasting desolation, this terminates in the straits which lead to the Arctic Ocean. Between this coast and the bleak mountain range, which runs parallel to it, a variety of fur-bearing animals, the marten, the fiery fox, the sable, and the precious ermine, have ever found a congenial home, and are here distinguished for the peculiar excellence of their peltry, which is seldom equalled in other localities; whilst along the whole range of the Kurile Islands and the Kamtschatka shore, the sea otter, the seal, and other marine inhabitants have for ages been hunted, and have drawn to these isolated regions the hardy fur trader, to barter with the nomadic natives, who find employment and profit in the capture of the different animals. China has always been the best market for the richest and the finest furs, and the Russians have come next in their eagerness to obtain those rare varieties that are principally

brought from the Kamtschatka peninsula. The caprice of fashion in the employment of fur as an article of dress or ornament, has perhaps been a stronger inducement to its possession than the necessities of climate, and all of Tartar or Sclavonic descent are supposed to inherit the taste for rare and expensive furs. Hence the rich dark shades of the sable and the snowy white of the ermine have ever been in the greatest request; the same now as when they were emblazoned in heraldry, and marked the rank of the proud crusader.

Stretching from the southern point of the Kamtschatka peninsula, and almost at right angles to the Kuriles, another strangely similar group of islands extends in a long curve for 600 miles between the continents of Asia and America, with marvellous regularity like giant boundary stones, to fence off the colder influences of the Behrens Sea from the warmer Pacific waters. Although the straits between the two continents, ten degrees further north, are only 50 miles in width, and even this distance broken up into easy reaches by islands in the middle, the long chain of the Aleutian, or Fox Islands, would seem to have been in the past, as they are to-day, the principal means of communication between Asia and America for the roving Indian tribes, common to both sides of the Pacific, and they have certainly been the route by which the natives of British Columbia have been enabled to cross from their original Asiatic homes.

In 1725, just before his death, Peter the Great commissioned Vitus Behrens, a Danish navigator, to ascertain the eastern boundary of Asia, and on the 10th of August, 1728, a century and a half since, he anchored in the straits which now bear his name, under the lee of an island, which in honour of the day he named St. Lawrence. A few years later he was again commissioned to extend his investigations, and in this trip he discovered the Aleutian Islands, which he so named from *Aleut*, the Russian for a bold, steep rock. But fogs and tempests beset him; on the nearest of these islands to the Asiatic coast, his vessel was wrecked, and on the 8th of December, 1741, amidst ice and fog, and every discomfort, he lay down, on the desolate shore of Behrens Island, to die of a broken heart. Like Magelhaens, the first European who entered, and who gave its appellation to the Pacific Ocean, Behrens left the straits, the discovery of which immortalised his name, to die upon an obscure island, which he himself, first of white men, had made known to the world. Exactly half a century after him, in 1778, Captain Cook cast his anchor in Behrens Straits, in St. Lawrence's Bay, close to the island previously discovered, which he also thus named from the day he discovered it, and from thence he carefully mapped out the American coast and the Aleutian range of islands. Through this survey, the enormous quantity of sea otters that frequented the shores of these islands, and the great varieties of foxes (from which the Eastern group was named) that abounded on the land, including the black fox, the most highly valued fur in Russia, became known. The announcement was as if a new gold mine had been discovered; vessels and traders from all quarters rushed into the new business, and in 1791 there were no less than twenty-one fully equipped vessels plying along the coast, and selling their peltry in the market of Canton.

From the discoveries of Behrens, Russia, by right of priority, claimed both sides of the strait between the two continents, and the intervening range of islands. The Queen Charlotte group, considerably south of the Aleutian, was supposed to have been included in this claim, and in Malte Brun's Geography of 1851 even, their ownership is assigned to Russia; but this geographical blunder is only one of too many that have been made in British American interests in the Pacific, and in this instance led to no difficulty. To protect and monopolise the fur trade, Russia incorporated a company with the exclusive privilege of trading for peltry in the Aleutian archipelago, and the main land adjoining. This privilege was extended by the Emperor Alexander to the whole of Russian America, supposed to contain 390,000 square miles. These rights were subsequently leased to the Hudson's Bay Company, but the Russian Fur Company's charter expired in 1863, and four years afterwards the Americans purchased from the Russian Government the whole of their territorial rights, since which time Alaska, including the Aleutian Islands, has been part of the United States, and the Queen Charlotte Islands have been recognised as belonging to the Dominion of Canada.

These islands were so named by Dixon, their first explorer, in 1787, probably after the name of his ship, but they had been seen and marked on maps under different names before this. They consist of a group, situated between latitude N. 51 deg. 55 min. and 54 deg. 20 min., and longitude W. 131 deg. to 138 deg. The most southerly point is Cape St. James, which is like the curved point of a wedge, gradually thickening to its northern base, where Graham's Island is 75 miles across in an east and west direction. From north to south is 175 miles long, and the area of the whole is about 6000 square miles. The eastern shore of the group is roughly parallel with the coast of British Columbia, from which it is distant from 40 to 90 miles, and its general shape is triangular, not unlike England (exclusive of Wales or Scotland) only reversed, with its broad base to the north, and Berwick represented by Cape St. James in the south. Vessels approaching British Columbia from the east may either pass to the north of these islands, to the south of them, between Queen Charlotte and Vancouver Islands, or to the south of Vancouver altogether. The largest and most northerly of the islands is Graham's Island, which may be 60 miles in average breadth, and 75 from north to south. Running through this island in a north and south direction, and dividing it into two nearly equal areas, is a range of mountains from 2000 to 3000 feet in height, of volcanic origin, but apparently long since quiescent, called the Seymour Mountains; the southern point of which, on Skidegate Channel, which separates Graham's Island from the others, is called Steep Point; and to the east of this, running at the base of the mountains, is a deep, narrow fiord or long arm, which extends into the island for five miles. A number of these deep bays or fiords present themselves in the island, and Masset Harbour, on the north side, runs inland for 20 miles, and at a moderate expense could be converted into one of the best roadsteads in the Pacific. A Hudson's Bay fort has been established on Masset Harbour, and a steamer periodically visits this, with other stations on the mainland, to bring their supplies and take away the peltry that has been collected.

Separated from this, by the narrow but navigable Skidegate Channel to the south, is Moresby Island, the second in point of size, and similar in its character to the portion of Graham's Island, east of the mountains. Skidegate Channel runs from its eastern outlet, towards British Columbia, in an easy south-west curve for about 12 miles, between these two islands, to an expansion in its waters called Alliford Bay. In this bay, Leading Island divides the channel, the main portion of which runs due west to the Pacific, between Maude Island, the third in point of size, and Lena Island, to the north of it. To the north of this, in Grahame Island, is Anchor Cove, and a little to the west of it is Shallow Cove, in both of which may be seen the abandoned works of the Queen Charlotte Island Mining Company.

The existence of anthracite coal on these islands has been known for many years, and some time since a number of gentlemen in Victoria, Vancouver's Island, formed themselves into a company under the above title, for the purpose of working these deposits. To the east of the basaltic range of the Seymour Mountains, lying in a nearly vertical direction, may be seen along the south shore of Graham's Island, the shales and associated rocks of the coal formation, and these mountains appear to be the western limit of a large coal basin, which, running north and south through the island, crosses the channel, and bending east runs to the coast on Moresby Island, where the outcrop is seen on the Pacific at Cumshewas Harbour. This coal has been traced for a long distance, and samples of similar quality have been brought from Masset Harbour, which is 57 miles north-west of the opening made by the company at Cowgitz. Between Cowgitz and Massett there is said to be spread out eastward, towards the coast, a level country, well suited for agriculture, bounded on the west by the Seymour Mountains, and under this it would seem probable that the coal basin extends in the form of a north and south trough, prolonged into Moresby Island, of a total length of about 84 miles. It is reported by the Indians, that a well-marked seam of coal occurs about 14 miles south of Skidegate Channel, in a south-east direction from Cowgitz, which agrees with the general strike of the seam as ascertained by the workings on Graham's Island.

Running into Shallow Bay, of Skidegate Channel, is a stream which has its source in the Seymour range, called Hooper's Creek, and from the bed of this, about a mile from salt water, and 448 ft. above it, the company drove an adit level. This tunnel was driven in a north-west direction, through the nearly perpendicular measures of black shale, so intermixed with nodules of clay-band ironstone, that these would probably constitute one-fourth of the entire mass to the seam of coal. This proved to be an excellent anthracite, similar in fracture and appearance to the Pennsylvania measures, and which yielded on analysis 86 per cent. of fixed carbon. When first struck the vein was from 2 ft. to 3 ft. in thickness, but it soon increased to 6 ft., and so continued for 60 ft. or 70 ft. forward, when it became more impure and mixed with the shale and ironstone. The tunnel was continued some distance further in this mixed material, when the coal disappeared, the whole indicating that they were working in a line of dislocation or fault, which could give no satisfactory results. A second and then a third adit were driven lower down the stream, and lower in the series of rocks, but, judging from the débris remaining on the surface, the seam of coal was not recovered at either place. About 9 chains across the measures another opening was made by a shaft sunk in the seam, and from this a great quantity of very good coal was obtained. The top of the shaft was 540 ft. above the sea, and an adit to unwater it was commenced 193 ft. lower down in the series to intersect it, but for some unexplained reason the junction between the two was never completed. A second and a third shaft near this appear to have been sunk, but abandoned, and an adit was also commenced; but the mineral obtained was a black carbonaceous shale, with only a thin filament of coal, and in two other places veins of impure coal 7 ft. and 9 ft. in thickness respectively were intersected. The workings were evidently all in a locality where the upheaval of the mountain range by volcanic action had disturbed the measures, and the ground was full of faults and irregularities.

In 1873, after the abandonment of the works, the company employed Mr. James Deans, formerly of the Geological Survey, to make an exploration of the country, which was a difficult task, from the heavy forest growth which covers the whole surface, but he succeeded in tracing the seams for three or four miles by the exposures in the streams and creeks, and he found that in this distance, whatever variation there might be in their quality or thickness, they were at least continuous. The strata throughout preserved their nearly vertical position, backed to the north-west by lofty escarpments of the volcanic rock. On Slaty Creek, four miles from Anchor Cove Wharf, to which point his explorations extended, near the base of the coal-bearing black shales, and close to the edge of the volcanic upheaval, the Indians have a quarry about 4 ft. deep, 4 or 5 yards wide, and 80 or 90 yards long, in the same seam of carboniferous shale as that obtained in the adits and shafts sunk by the mining company. This mineral the Haidars carve very beautifully into grotesque images, tobacco pipes, and musical instruments resembling flutes, to all of which they impart a high polish. This rock was examined by Dr. Harrington, of M'Gill College, who found it to be a hydrated silicate of alumina and iron, with 3 or 4 per cent. of carbonaceous matter, which was the cause, no doubt, of its susceptibility to the polishing process of the Indians, who carry on a large trade on the neighbouring mainland in their carvings and other productions.

(To be continued.)

Catalpa Ties.—The catalpa is already in use in the south-west of the United States, to some extent for railway ties. It is a wood of rapid growth, and yet has shown remarkable durability. In an address before an agricultural society in Ohio, General Harrison, of Indiana, mentioned a catalpa foot-log over a small stream in the Wabash country which had been in use for 100 years, and was still sound, showing no sign of decay.

A Guatemala Railway.—A line has just been opened from Guatemala, the capital of the republic of that name, to the port of San José de Guatemala on the Pacific Ocean. The length of this line is 68¾ miles. It bears the name of the Central American Pacific Railway, and the capital required for its construction was furnished by North American financiers. Great constructive difficulties had to be overcome in the establishment of the line, and an outlay of about 800,000*l.* has been altogether made upon it. The government of the republic of Guatemala guarantees a subsidy of 25,000*l.* per annum for a term of 25 years.

DETAILS OF BESSEMER BLOWING ENGINE FOR THE HEFT STEEL WORKS.

CONSTRUCTED BY MESSRS. BREITFELD AND DANEK, ENGINEERS, PRAGUE; FROM THE DESIGNS OF PROFESSOR RIEDLER, MÜNICH.

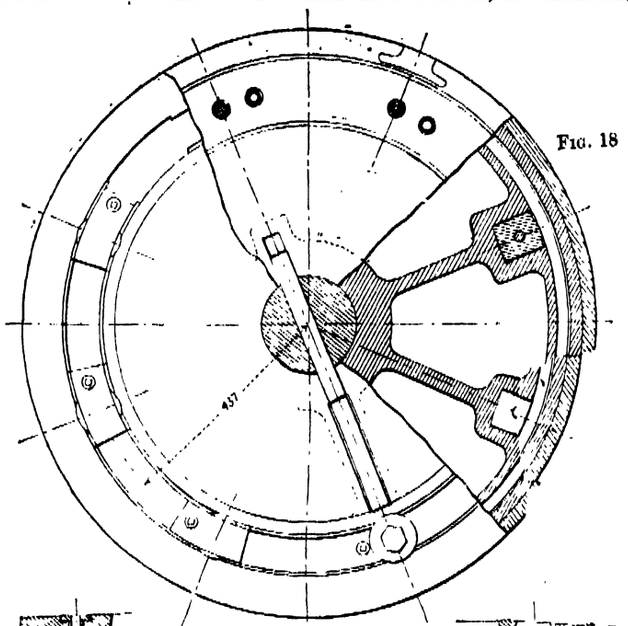


Fig. 18

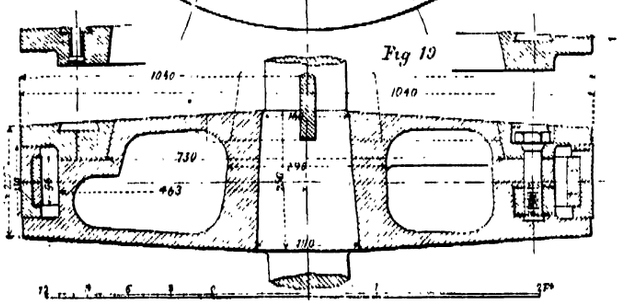


Fig 19

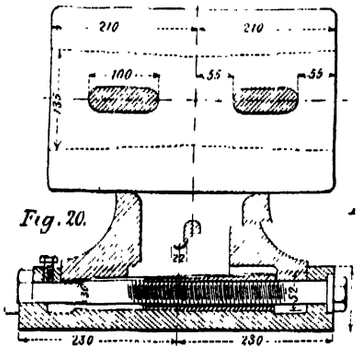


Fig. 20.

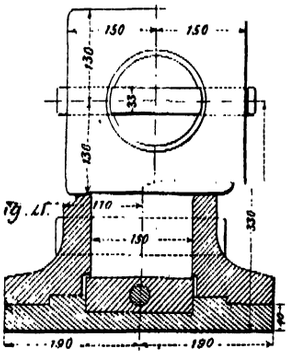


Fig. 21.

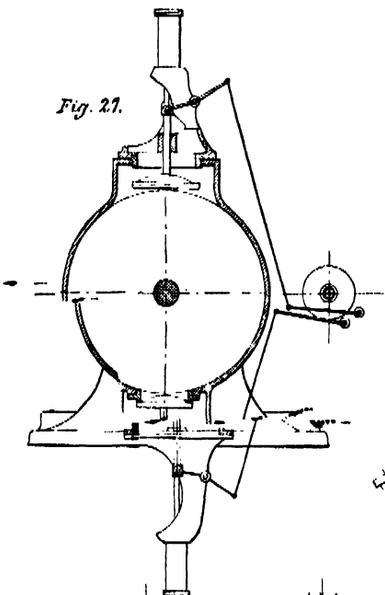


Fig. 27.

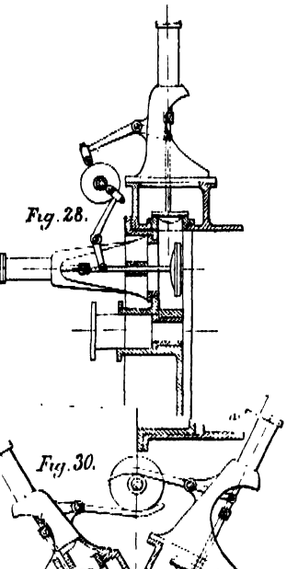


Fig. 28.

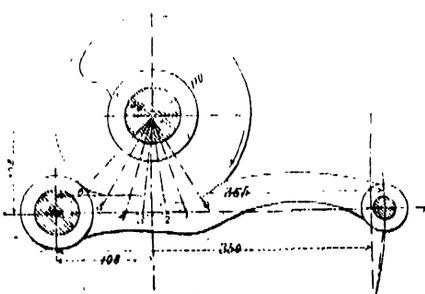


Fig 23

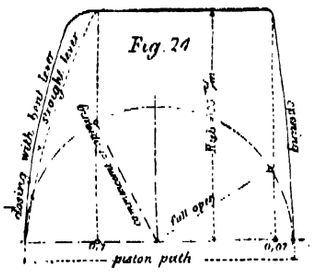


Fig. 24

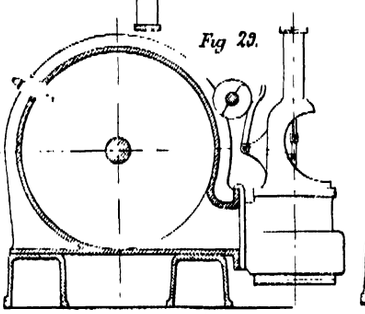


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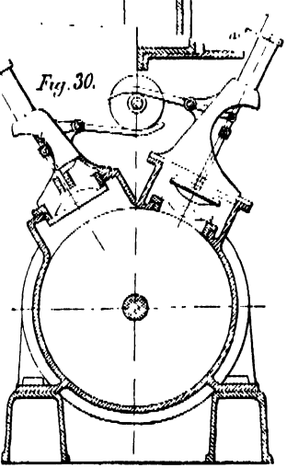
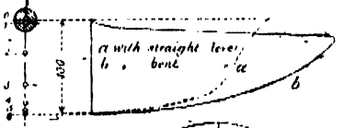


Fig. 30.



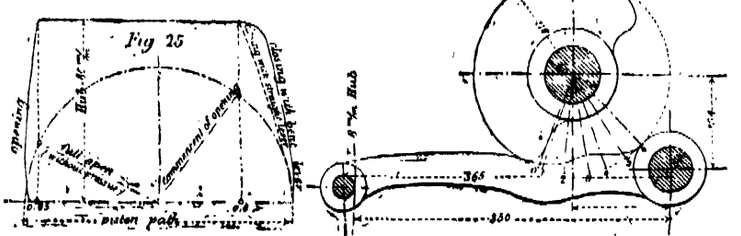


Fig. 26

Fig 25

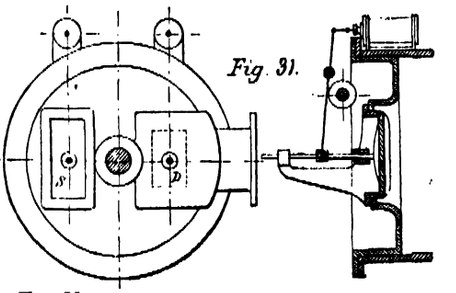


Fig. 31.

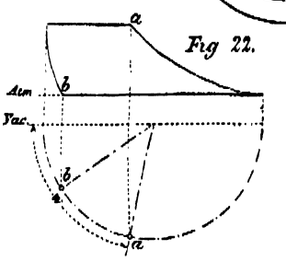


Fig 22.

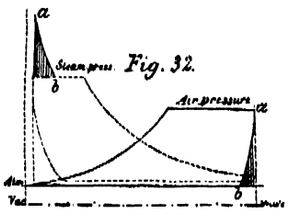


Fig. 32.

BESSEMER BLOWING ENGINE.

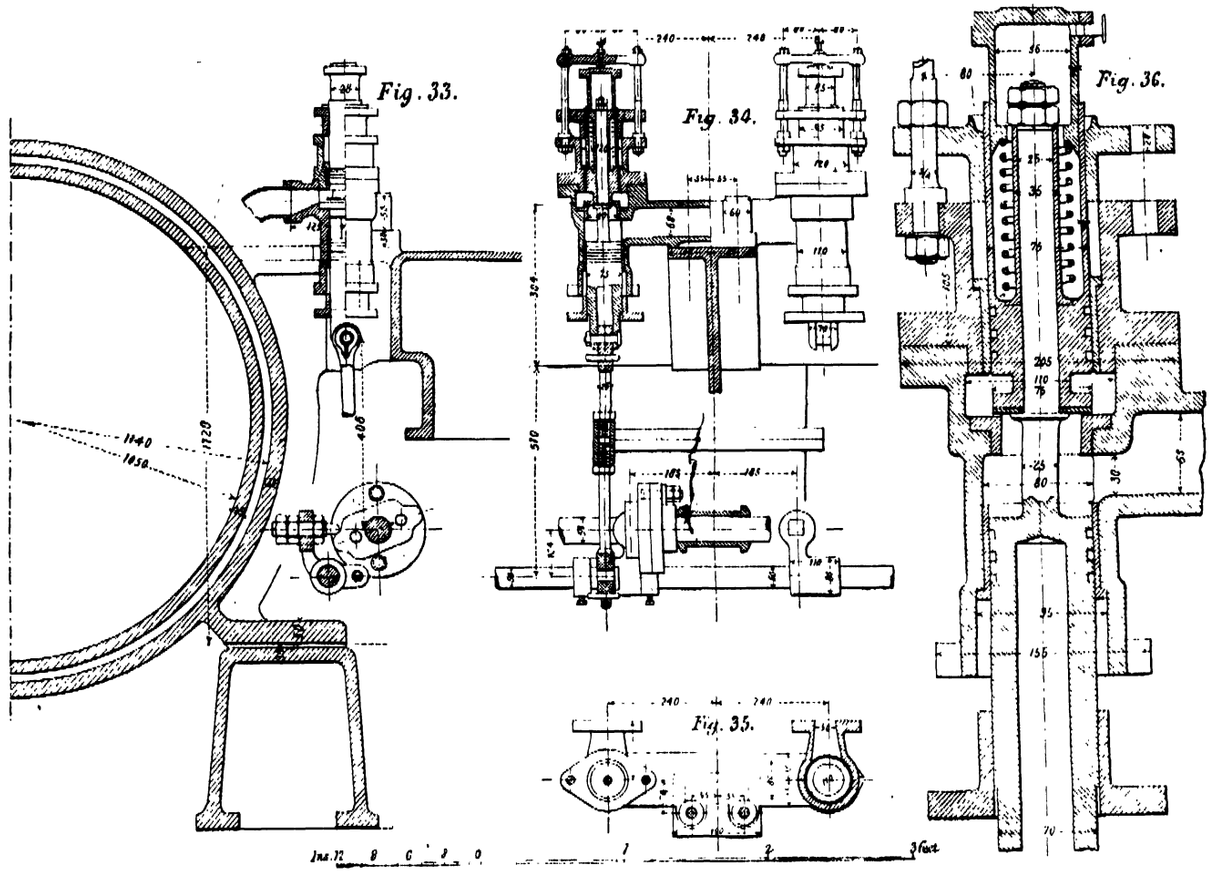
(Continued from page 105).

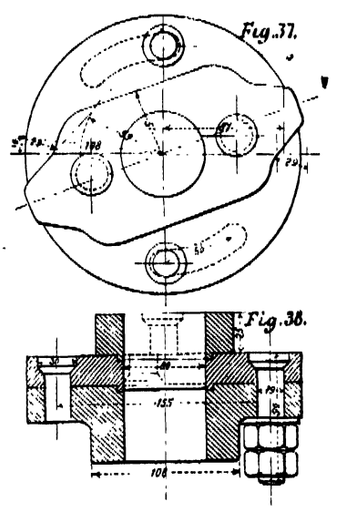
In continuing our description of the blowing engines at the Heft Steel Works we will first devote our attention to the details of the blowing cylinders and their accessories, and defer the description of the steam cylinders for another occasion.

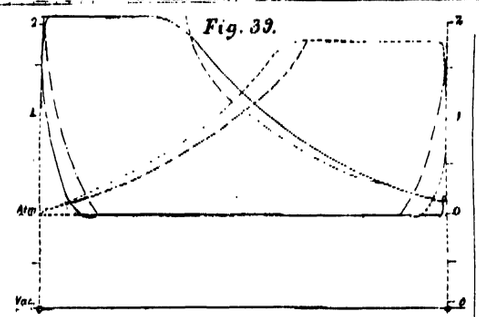
As we already previously mentioned, the horizontal arrangement of the blowing cylinders was made necessary by local conditions, and the designer does not think it necessary, in cylinders of such moderate dimensions as 3 ft. 5½ in. diameter, to resort to any but ordinary precautions against the oval wearing of the cylinders; large adjustable guides, and the piston body with sufficient play in the cylinder so as to insure t at only the piston rings can possibly receive any wear, being all he considers requisite. The piston and guide blocks are illustrated in Figs. 18 to 21. The piston, as will be seen, is of the ordinary pattern of cast-iron piston body with a junk ring held down by countersunk bolts, secured in their position by dovetailed slides (see Fig. 19). The rings are of the Mather and Platt patterns, overlapping the piston body $\frac{1}{16}$ in. all round.

DETAILS OF BESSEMER BLOWING ENGINE FOR THE HEFT STEEL WORKS.

CONSTRUCTED BY MESSRS. BREITFELD AND DANEK, ENGINEERS, PRAGUE; FROM THE DESIGNS OF PROFESSOR RIEDLER, MÜNICH.







The piston is secured to the conical collar of the steel rod, of 6 in. diameter, by half countersunk keys, recesses for the projecting part of the key being provided in the stuffing-box. The cylinder is bored to a larger diameter for $\frac{1}{16}$ in. at each end of the stroke, but in addition recesses are provided at both ends of the lower half of the cylinder in case any hard substance should accidentally enter. The piston rods pass right through the cylinders and are guided at both ends by cast-iron guide blocks of the pattern shown in Figs. 20 and 21, which are fitted with vertical adjustment to take up wear. For the purpose of keeping the cylinder itself sufficiently cool for the satisfactory working of the lubricant, olive oil is used, which is forced against the upper cylinder faces by a little force pump, the cylinder is provided with a water jacket, see Figs. 1 and 2, the cold water entering the jacket at the top at *a*, and leaving it at the bottom at *b*, the outlet being in communication with the injection pipe to the condenser.

The most important question to decide in relation to the details was the construction of the blowing cylinder valves. Rubber valves the designer did not consider advisable on account of their rapid wear with high temperature blast, while the more generally adopted arrangement of a large number of small metal valves fixed in the cylinder cover, both for suction and delivery, with from one-seventh to one-fifth area for suction, and one-fifteenth to one-tenth area for delivery, works noisily, even with lifts of from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. and in consequence of the severe beat, soon wears the faces and valves. Where these valves have apparently worked for a long time satisfactorily, Professor Riedler is of opinion that they have, in most cases, been very wasteful, inasmuch as they were not tight. Entirely self-acting valves were, therefore, not considered a satisfactory arrangement, and piston valves with definite movement, imparted by cams or eccentrics, next received consideration, but inasmuch as these valves are difficult to keep tight, and chiefly because they can only be set accurately for opening and closing for one fixed air pressure, their use was not considered advisable. Diagram Fig. 22 will serve to illustrate the impossibility of adjusting the definitely moved valve to various pressures, where if the piston valve opens the delivery at *a*, it must remain open during the path *w*, and close at the moment of change of stroke, to open again for suction at *b*, that is, after the air contained in the clearance space has expanded down to atmospheric pressure.

Returning again to ordinary seat valves with automatic action, the chief difficulty is found to be, to give the valves so great an area as to reduce the lift to such an amount that the valves will close noiselessly, and will not beat themselves to pieces. The necessary area of opening of valves for air compression cylinders is, according to Professor Riedler, only about one-tenth to one-seventh the piston area for suction, and one-fifteenth to one-twelfth for delivery valves, and if made greater it is found in practice that frequently some of the valves remain entirely inactive. The above proportion are always readily obtainable and the only difficulty is at the moment of closing, and it is to this point that Professor Riedler has devoted his special attention. That it is better to have all the required opening through one large valve rather than a number of small valves, is undeniable, since the friction of the air is necessarily increased by an increase in surface, and a single valve having only one seat, and opening one-fourth its diameter, would be the most successful valve to use, and it fulfils all requirements admirably until it comes to the moment of closing; when, left to itself, it must necessarily suddenly and heavily strike upon its seat. Professor Riedler adopted this form of valve, and added to it an arrangement which steps in just previous to the moment of closing and gradually reduces the lift of the valve until only about $\frac{1}{16}$ in. lift remains, which is closed noiselessly and without injury to the seat or valve by the change in pressure. The details of this arrangement will be clearly understood on reference to Figs. 12 and 13, the former showing a section of a suction, and the latter of a delivery valve. The attachment of these valves to each end of the cylinder is clearly shown in Fig. 2, and a section through a pair of them in Fig. 14.

To reduce the weight of the valves with their attachments, they are keyed to hollow valve rods of large diameter, giving ample guide surfaces. The rods are extended below the valve box and have each a piston attached to them, moving in a small vertical air cylinder with an adjustable air outlet. A powerful spring below the piston rod balances completely the weight of the valve and its attachments, and the springs can be so accurately adjusted that the valves open fully and freely, and remain so until the moment the cam gradually depresses the lever, and so reduces the lift of the valve. The cams, details of which are shown in Figs. 15 and 16, are not keyed directly to the shaft, but are adjustable on discs provided with slotted holes, so that they can be most accurately set. Diagrams showing the action of the cams on the valves are given in Figs. 23 to 26, the effect of using straight levers for the cams to act upon, being also illustrated, but in the Heft Steel Works Professor Riedler has preferred to use thelevers with curved outlines, so as to avoid even a sudden change at the beginning of closing, see diagrams, Figs. 24 and 25. The valves are, moreover, not only placed under the

influence of positive motion at the moment of closing, but the cams and levers have been so proportioned that a gradual opening of the valves takes place, avoiding sudden shocks; the amount of retardation is also shown in the diagrams already referred to. Valves and valve seats are made of cast iron, the suction valves being faced with leather, and the delivery valves with copper rings, attached as shown in Figs. 12, 13, and 14. During more than a year's regular work, this arrangement has acted most satisfactorily, and no repairs or alterations have become necessary; the valves are easily accessible by only slackening four bolts on each cover, and can be withdrawn, examined, and replaced in a very short time, and without interfering in the least with the cam and lever arrangement. The designer, however, considers that if more time had been allowed for the careful working out of details previous to the putting in hand of the main castings, more perfect arrangements of valve might have been found, placing the working gear in a more accessible position, and reducing the somewhat large clearance which these blowing cylinders have. As specimens of what Professor Riedler would like to have done under more favourable conditions, we give the small diagrams, Figs. 27 to 31, showing the valve gears either above or at the side of the cylinders, admitting of simpler valve box castings and less clearance spaces, which the designer asserts, with the above described large valves in place of a number of small valves, might be reduced to as low as one per cent.

To compensate as much as possible the combined evil effects of the large clearance in these blowing cylinders, the designer has introduced a by-pass valve, which allows the compressed air on the suction side to escape to the delivery side at the moment of compression. This valve serves two purposes, first of all it obviates the direct loss on the suction side due to re-expansion of the compressed air, and, secondly, it relieves the strain which would otherwise be thrown on the crankshaft of the engine, in addition to the steam pressure at that moment. This amount is represented in diagram Fig. 32, by the dotted lines, and is, as will be noticed, very considerable, and none the less injurious to the crankshafts and bearings of the engines, because it only acts during a very short period; indeed Professor Riedler is of opinion that not unfrequently this compression, if not taken into account in calculating the pressure on the crank-pin, may have led to serious breakages. The valve or rather valves which are designed to effect this pass-over of the compressed air, are illustrated in Figs. 33 to 36; two valves are used, because the sudden opening and precise closing of the passage for the compressed air are difficult to obtain, and in consequence of wear, more difficult to maintain with one valve only than with two. With the present arrangement, one valve being opened some time before, and the other closed some convenient time after the exact moment for release of pressure, an escape only takes place while they are both simultaneously open, and a safeguard is provided against leakage during the remaining long part of stroke. The valves are worked by cams, as shown in Figs. 33 and 34, and are direct spring loaded valves with long piston guides and stuffing-boxes. The designer considers that due to some special reason, these valves and passages, as constructed for the Heft blowing engines, are of inadequate dimensions to fully answer all requirements, but they have in other respects been very successful, and he expects that they will come into very general use for blowing cylinders. Indicator diagrams, Fig. 37, taken from the blowing cylinder while running at twenty revolutions per minute, show how far the desired result is obtained.

CONTINUOUS BRAKES.

To the Editor of Engineering.

Sir,—I have read your article on the Penistone Railway accident in your issue of July 25, and I believe I am right in stating that the London and North-Western Railway Company are doing away with the chain brake, and are adopting the same brake which you so strongly condemn, viz., a non-automatic vacuum brake. If this is the case, ought not the public to expect that after so many serious failures with this brake a great company like the North-Western, being the second largest in the kingdom, might adopt something better?

After the failure of their chain brake one might have supposed they would be more careful in choosing another.

Yours truly,
A. G. R.

Chester, August 8, 1884.

LIQUID FUEL.

To the Editor of Engineering.

Sir,—In your report of my remarks on Mr. Urquhart's paper on "Petroleum Fuel for Locomotives," read at the meeting of the Institution of Mechanical Engineers at Cardiff last week, the date of my experience of the use of liquid fuel on a steamer on the Thames is given as 1878. This is an error, as the date should be 1868. The error probably originated with myself, but I would ask you to kindly give this correction insertion, as soon after that date the liquid fuel question waned and practically died out in this country, owing mainly to the impossibility of obtaining supplies of that fuel at other than prohibitory prices. It may interest your readers if I add that the steamship I referred to was the Retriever of 500 tons burden, and having engines of 90 horse-power nominal. The petroleum furnace was that of Mr. Edward Dorsett, the coal-burning furnace of the Retriever having been altered to work it. In Dorsett's system the creosote was first vaporised in a generator resembling a small vertical boiler, and the vapour afterwards burned in jets in the furnace. The firebars were removed, and the ashpit was filled up with perforated firebricks, upon which the coil carrying the jets rested. Good steam pressure was maintained, an increase in speed was noted, and a great economy in fuel was effected at the then price of creosote. The system however had to be abandoned for the reason I have previously stated.

Yours truly,
Perry F. Nursey.

161, Fleet-street, E.C., August 12, 1884.

ROYAL CORNWALL POLYTECHNIC SOCIETY.

To the Editor of Engineering.

Sir,—Replying to the anonymous letter in your issue of 1st inst., respecting our exhibits at the show of the above Society, it would have been more candid, and only just and fair on the part of the writer if he had told the whole truth respecting the medal awarded to us, which we have no difficulty in showing that he has not done. The statement in our catalogue is, that "the Society's special gold medal was awarded for the gas engine, gas producer, and feed pump." Referring to the President's speech in making known the awards, we make the following extract, which is verbatim: "The judges thought it right to award them three silver medals—one for a gas engine, one for a gas producer (which is worthy of all attention), and also one for a feeding pump. But a gold medal has been awarded instead of the three silver medals. I think it right to mention this in order that the honour due to them for the excellence of those three particular engines should not be lost sight of."

The first intention was undoubtedly to give a silver medal for each article, but on reconsideration, the judges felt they were worthy of something better than that, and awarded the Jubilee gold medal. We have shown what the judges' first intention was—we have shown, too, that on reconsideration they decided this recognition was not sufficient, and consequently that they awarded the gold medal for these three articles expressly named, and we think your readers will come to the conclusion that if their President was wrong in what he stated, the writer should have taken exception to his speech at the time, or should have called all the judges together afterwards to deliver a third verdict upon the question at issue. There is another reason for your correspondent's captiousness which he does not avow.

We do not intend to pursue this correspondence, as after all, the matter is of exceedingly small importance, and we should have not taken this trouble except in the interests of truth.

We are, Sir, yours respectfully,
Richd. Tangye, Chairman.

Tangyes Limited, Birmingham, August 12, 1884.

THE MECHANICAL EQUIVALENT OF HEAT.

To the Editor of Engineering.

Sir,—In reply to the last letter of "H.'s" on the above subject, the following method of considering his difficulty may remove it. It will show him the different amounts of work *done* during descents from the same height, in different times.

Now, if we allow a weight to fall freely and to acquire its natural acceleration, on the arrestment of the weight the total conservation of energy acquired during the descent may be expended in producing pressure only.

Let the same weight do work during its descent, less pressure is experienced on its arrestment, a portion of that natural and due to the descent has been expended in doing work; and when the falling weight does greater work, and still greater, *during* its descent, less, and still less, pressure is experienced on its arrestment, until the pressure becomes *nil*, and *all* the energy of descent is consumed in doing work, or, finally, in balancing counterweight or pressure.

I should have thought that the very fact of one weight pulling different lesser weights up when connected to them by a cord passed over a pulley, would have enabled him to have reasoned to the case of a weight descending against different gaseous and heat pressures.

Yours faithfully,
G. Pinnington.

23, Chichester-street, Chester, August 11, 1884.

THE LATE MR. CHARLES MANBY.

To the Editor of Engineering.

Sir,—The short paragraph in your number of August 8th on the subject of the late Mr. Manby is calculated to convey a wrong impression, which I hope you will allow me, as his stepson and executor, to correct.

The funeral of Mr. Manby was carried out in *exact accordance* with his often-expressed wishes. He had the greatest dislike to anything in the shape of display or a large number of followers on such occasions. Therefore, though sorry to disappoint his many acquaintances, we felt *bound* to carry out his wishes so far as lay in our power.

I explained this fully to Mr. Forrest, the secretary of the Institution of Civil Engineers, in order to avoid any possibility of Mr. Manby's many acquaintances feeling hurt at the non-issue of invitations to the funeral, and I am surprised that Mr. Forrest did not make a point of communicating the facts of the case to the engineering journals.

I am, Sir, yours faithfully,
A. R. Hoon.

The Greys, Eastbourne, August 13, 1884.

[We willingly publish Mr. Hood's letter, but in justice to Mr. Forrest we must point out that the correspondence on the subject between members of the late Mr. Manby's family and the secretary of the Institution of Civil Engineers, completely justified the paragraph which appeared in our last issue, and which afforded the explanation required, on behalf of the numerous old and tried friends of Mr. Manby, to account for their absence at this funeral.—Ed. E.]

NOTES FROM THE SOUTH-WEST.

The Severn Tunnel.—The Directors of the Great Western Railway report that satisfactory progress has been made with the works of the Severn Tunnel. During the last six months 1350 yards have been completed, and 450 yards arched. Out of a total length of 7664 yards, about 5050 yards of permanent tunnel have now been completed, and a further length of 2050 yards has been arched. In anticipation of the completion of the tunnel, arrangements have been made for doubling the Bristol and South Wales Union Railway, from the junction of the tunnel railway to the main line near Bristol. The contract for the work has been let with a view to its completion contemporaneously with the tunnel.

Cardiff.—Business in steam coal has again been quiet. There is not much demand outside contracts. Prices remain, however, without much alteration. The patent fuel market continues to display a more healthy condition, and prices show an advance of 3d. per ton. The house coal trade remains quiet. In the iron ore market there is not any material change. Last week's clearances comprised 106,773 tons of coal, 1089 tons of patent fuel, and 741 tons of iron. From Bilbao there arrived 5532 tons of iron ore, and 1068 tons came to hand from other sources.

Great Western Extensions.—During the past half-year a loop line to Weston-super-Mare, about four miles in length, and an extension of the Bridport Railway to the harbour at Bridport, a distance of two miles, have been opened for traffic. The construction of the Bodmin line has been commenced.

South Wales Coal and Iron.—The shipments of coal and iron for July from the South Wales ports were large. From Cardiff the shipments of coal were, with one exception, the largest yet recorded in any one month. The largest record was made in May, when the shipments reached nearly 660,000 tons of coal to foreign parts. The exports of coal last month were: Cardiff, 639,460 tons; Newport, 145,811 tons; Swansea, 71,862 tons; Llanelly, 6585 tons. The shipments of coal for July, 1883, were: Cardiff, 538,373 tons; Newport, 131,602 tons; Swansea, 84,013 tons; Llanelly, 3792 tons. The coastwise shipments last month were:—Cardiff, 91,546 tons; Newport, 77,484 tons; Swansea, 62,518 tons; Llanelly, 14,728 tons. The shipments coastwise for July, 1883, were: Cardiff, 99,024 tons; Newport, 92,807 tons; Swansea, 67,436 tons; Llanelly, 12,539 tons. The shipments of iron were: Cardiff, 10,012 tons; Newport, 13,791 tons; Swansea, 512 tons. From Cardiff were also shipped last month 2734 tons of coke; from Newport, 48 tons; and from Swansea, 65 tons. There were also shipped from Cardiff 20,069 tons of patent fuel, and from Swansea, 34,301 tons. The return, as a whole, indicates an increased demand for coal and iron in foreign markets, but a decrease in the demand for coal in the home market.

New Works on the Great Western.—A vote of the proprietors of the Great Western Railway Company has been taken for the following expenditure: Doubling Bristol and South Wales Union Railway, on account, 50,000*l.*; Slough to Taplow, widening line, 5000*l.*; Reading to Didcot, widening line, on account, 10,000*l.*; Exe Valley Railway, 10,000*l.*; additional platforms at Paddington and sidings at West London Junction, 15,000*l.*; sidings and works at sundry stations, 30,000*l.*; locking gear, Pembrey to New Milford, 10,000*l.*; Plymouth, lengthening graving dock, 10,003*l.*; West Kirby extension, joint line, on account, 20,000*l.*; Quaker's Yard to Merthyr, joint line, on account, 20,000*l.*; subscription to Newent Railway Company, 50,000*l.*; subscription to Ross and Ledbury Railway Company, 50,000*l.*; total, 280,000*l.*

Newport.—There has not been quite so much activity in steam coal. The house coal market continues quiet. The arrivals of iron ore have been up to the average. The manufactured iron and kindred trades continue quiet, and substantial orders are far from numerous. Last week's coal clearances amounted to 49,877 tons. There were received from Bilbao 6340 tons of iron ore, and 4800 tons came to hand from other sources.

Rhymney Railway.—The works on the authorised lines between Quaker's Yard and Cyfarthfa are being prosecuted with vigour, and the directors expect that they will be able to carry over them the whole of the traffic of Messrs. Crawshay Brothers by January 1, 1885.

The Forest of Dean.—There are indications of a slightly increased activity in the Forest coal trade. There is a fair demand for the Coleford "high deep" for steam purposes. There is no change to report in the iron trade of the district.

Briton Ferry.—On Monday the Vernon Iron and Tinplate Works, which were purchased a few weeks since by Mr. E. E. Morgan, were restarted. The starting of the

machinery was witnessed by a large number of spectators.

Rhondda and Swansea Bay Railway.—The engineers of Messrs. S. H. Yockney and Son, report that during the past six months the contractor has made steady progress with the works, and the new railway in the Avon Valley, from Cwmavon to Cymmer, is, with a few exceptions, ready to receive the permanent way, which is being delivered. This portion of the main line will probably be ready to open for goods and mineral traffic in the course of the coming autumn. With the exception of some short lengths at the junctions, the permanent way of the Port Talbot branch has been re-laid and ballasted from the port to Oakwood Colliery, a distance of four miles, and the mineral traffic is being worked over it, pending completion, under a temporary arrangement with the freighters. This traffic is considerable. The formation of the Swansea extension line is in progress, and the shaft of the Neath River Tunnel requires to be sunk but a short depth further before the driving of the tunnel itself can be proceeded with.

Newport Gas Company.—A new tank and gasholder at Crindau are nearly completed, and the directors have entered into contracts for the erection of a retort-house, purifying house, engine-house, and other buildings, which are satisfactorily proceeding.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Falling off in the Coal Trade.—The return just issued of the coal sent from the Yorkshire collieries to Hull shows a marked falling off, which on the whole was pretty evenly divided between the collieries in both South and West Yorkshire. The quantity forwarded last month by the whole of the Yorkshire collieries was 104,560 tons, or a decline of more than 33,000 tons when compared with the month of July, 1883. The tonnage of the past seven months was 7,164,810, a decrease of 26,000 tons as compared with 1883.

York Gas Company.—At the half-yearly meeting of the York United Gas Light Company the report was adopted. It was resolved to declare a dividend of 5s. per share upon the old shares, and 3s. 6d. per share on the new shares. The directors were then re-elected, and it was resolved that their remuneration should be increased from 600*l.* to 900 guineas per annum. A resolution authorising the directors to raise a sum of money not exceeding 20,000*l.* by loan was adopted.

North Central Wagon Company, Rotherham.—The report of the directors of the above company for the past half-year, to be submitted to the next meeting of proprietors, shows a balance of 4338*l.* 3s. 9d. available for dividend, and the directors recommend that a dividend at the rate of 6 per cent. per annum for the half-year, free of income tax, be declared, the sum of 500*l.* carried to the reserve fund, and the balance of 124*l.* 13s. 10d. carried to next half-year.

The North-Eastern Railway and the Hull and Barnsley.—At the half-yearly meeting of the North Eastern Railway Company, held at York, Mr. John Dent-Dent, the chairman, referred to the Hull and Barnsley Railway and Dock (Money) Bill, and expressed himself as somewhat startled at the course which the authorities of the House of Commons had taken with respect to the Bill. Mr. Reinhardt, of Scarborough, complained of the selfish policy of the company in opposing the Hull and Barnsley Company, and Mr. Maxstead, of Hull, called attention to the decreased tonnage of Hull as compared with Goole and Grimsby, and urged a reduction of rates for the third port. The chairman thought the matter was more a question for the traffic manager.

THE PANAMA CANAL.—Considerable deliveries of plant have still to be made in connection with the Panama Canal works. Among this plant may be mentioned 1500 trucks, 28 locomotives, 23 dredgers, 3 hopper barges, 25 portable steam engines, 20 steam navvies, &c. Altogether plant has been ordered to the aggregate value of 1,400,000*l.* The aggregate quantity of earth which has to be removed to render the canal available for navigation is 120,000,000 cubic metres. Two-thirds of the earth thus to be excavated will be removed in a dry state, and the balance of one-third will be dredged.

HERTFORD CORPORATION TOWN WATER WORKS.—The "Abyssinian" tube well for the entire supply of the town of Hertford, has been completed by the contractors, Messrs. Le Grand and Sutcliff, with most satisfactory results. The size of the tube well is 7¼ in., and at 81 ft. the chalk springs are so abundant, that the yield is over 100 gallons per minute, or about 150,000 gallons per day. The pumping, when necessary, can be continued night and day with a very small amount of attention, as the motor is a powerful water-wheel worked by the River Lee. The contrast between the clear and sparkling water from the Artesian spring and the turbid water of the river is very marked. This well affords a further illustration of the fact stated by Mr. Robert Sutcliff at the recent Water Supply Conference held at the Health Exhibition, that it frequently happens there is abundance of good water to be found on the banks of the river that is no longer itself fit for supplying water for dietetic puposes. The total saving of the expense of filtration is also a very important item, which might to some extent recompense the London water companies for the expense of obtaining their supplies from sources that need no outlay on this head. The total cost of the tube well, including cast-iron connections to pumps, was under 150*l.*, so that town supplies on this system cannot be considered extravagant.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig Iron Market.—Last Thursday's market was firm, and transactions were reported on forenoon 'Change at 41s. 6d. to 41s. 7d. cash, also at 41s. 8d. to 41s. 9d. one month, the close being buyers at the top prices, and sellers wanting ½d. more per ton. The prices in the afternoon ranged up to 41s. 8d. cash and 41s. 10d. one month, and the market closed nominally at those rates. The tone of the market was less firm on the following day, business being done during the forenoon at 41s. 8d. down to 41s. 6½d. cash, also at 41s. 9d. and 41s. 8½d. one month, the close being sellers at 41s. 6½d. cash and 41s. 8½d. one month, with buyers offering ½d. per ton under. Transactions were reported in the afternoon at 41s. 6d. and 41s. 5½d. cash, also at 41s. 7½d. and 41s. 7d. one month, with sellers at the close asking 41s. 5½d. and 41s. 7½d. cash and one month respectively, and buyers at ½d. less per ton. The market was steady on Monday, and transactions were reported during the forenoon at 41s. 5d. and 41s. 5½d. cash, the market closing with sellers at 41s. 5½d. cash and 41s. 7½d. one month, and buyers near. Business was transacted in the afternoon at 41s. 6d. and 41s. 5½d. cash, also at 41s. 7½d. one month, the top quotations being asked by sellers at the close, with buyers offering ½d. lower per ton. Flatness was the rule in yesterday's market, business being reported in the forenoon at 41s. 5d. to 41s. 4d. cash, also at 41s. 7d. down to 41s. 6d. one month, with sellers at the close at 41s. 4½d. cash and 41s. 6½d. one month, and buyers at ½d. per ton lower. An advance was made in the afternoon to 41s. 5d. cash and 41s. 7d. one month, which buyers were offering at the close, with sellers at ½d. higher per ton. Business was done this forenoon at 41s. 5½d. and 41s. 6d. cash, also at 41s. 7d. to 41s. 8d. one month, the close being buyers at the top prices and sellers asking ½d. per ton more. In the afternoon 41s. 7d. cash and 41s. 9d. one month were reached, and the market closed with sellers at those quotations and buyers near. The advance in the quotations towards the end of last week seems to have been due in great measure to the fact that a number of "bears" were continuing to cover their over-sales, which they were almost compelled to do by reports having been circulated as to large contracts having been closed for new shipping on the Clyde, to the extent, it was said, of 50,000 tons at least, and that there were inquiries regarding something like other 50,000 tons. But when it became generally known, or believed, that the reports were greatly exaggerated the tone of the pig-iron market fell away in a somewhat marked manner. Trade in the iron-consuming branches of business is exceedingly unsatisfactory, and the foreign demand for pig iron is still far from being encouraging, the reports from the Continent and the United States showing no improvement. There have certainly been some large buying operations within the past week or ten days, but they have been almost entirely of a speculative character, for so soon as the buying ceases the market inclines to settle down. Some of the ironfounders are consuming considerable quantities of pig iron, but the makers of malleable iron are very short of orders in nearly all cases. There are still 95 blast furnaces in actual operation, as compared with 114 at this time last year. The shipments of pig iron for last week amounted to 9727 tons, as compared with 9544 tons in the preceding week and 14,054 tons in the corresponding week of 1883. They include 1300 tons to the United States, 1099 tons to Canada, 275 tons to Australia, &c., 200 tons to Italy, 1540 tons to Germany, 959 tons to Holland, 100 tons to Belgium, 150 tons to Spain and Portugal, 150 tons to China and Japan, and lesser quantities to other countries. The stock of pig iron in Messrs. Connal and Co's. public warrant stores stood at 586,836 tons yesterday afternoon, as against 587,306 tons yesterday week, the decrease for the week being 470 tons.

Japanese Students for Glasgow University.—News has recently been received in Glasgow stating that fourteen Japanese had arrived in Chicago, nine of whom intend to enter the University of Glasgow. That institution has already educated a number of Japanese students, more especially in natural philosophy and engineering; and it is pleasing to learn that it is attracting an increased number of them. It is expected that the young subjects of the Mikado will also apply themselves to acquiring a practical knowledge of some of the important industries carried on in and around Glasgow. A better place could not have been selected for giving these students a practical training.

Strikes on the Clyde.—After being out on strike for a considerable number of weeks, a large party of the rivetters and holders-on employed by Messrs. Russell and Co., shipbuilders, Greenock and Port-Glasgow, have returned to their work within the past few days, on the employers' terms as to wages. On Monday fortnight a large number of the same class of workmen employed by Messrs. Barclay, Curle, and Co., also came out on strike in consequence of a dispute regarding the rates of payment for the work on which they were engaged. In the course of last week, however, they returned to their work, having arrived at an amicable arrangement with their employers.

The Smoke Nuisance in Glasgow.—At a meeting of the Town Council of Glasgow, held last Monday, in answer to a series of questions put by one of the members, the chief constable stated that the number of observations of chimney stacks made by the police in Glasgow during the year 1883 was 1312; that immediately after each observation a notice was served on the proprietor of the particular works or premises that such an observation had been made; that in 132 cases reports were made to the Procurator-Fiscal; that in 70 of those cases no proceedings were taken; and that in 25 cases the parties were tried and acquitted, while in 37 cases the parties were convicted.

Steel Company of Scotland.—At a meeting of the directors of the Steel Company of Scotland held in Glasgow to-day, it was agreed to recommend (subject to audit) the payment of a dividend for the past six months at the rate of 7½ per cent. per annum, free of income tax, after writing off for depreciation the sum of 17,000*l.*, adding 2,000*l.* to the reserve fund (which now amounts to 15,000*l.*), and carrying forward to next year about 2400*l.* Considering the state of depression under which the steel trade has for some time been labouring, such a dividend is very gratifying. The dividend for the corresponding six months of last year was 7 per cent.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was again only a moderate attendance on 'Change, and there was a dull market. No. 3 Cleveland pig was quoted at 36s. 6d. per ton. With only two-thirds of the blast furnaces of the North of England in operation and stocks increasing, it is not surprising that there were reports in circulation that sales of pig iron had been made recently at prices below those of the combination figures. It was stated, although it was not believed in well informed circles, that a large firm of makers in Cleveland had disposed of 10,000 tons of pig iron to a Glasgow buyer at 36s. per ton. It is anticipated that owing to the local holidays this month, when the finished iron works will be laid idle for several days, the stocks of pig makers will be very considerably increased. There is a general opinion that pig iron will be lower in price before there can be any improvement in trade, and many people think that before the year closes combinations and restrictive arrangements will be abandoned, and the weakest will be left to go to the wall. Trade is certainly very bad at present.

Engineering and Shipbuilding.—The northern rivers are now very dull for want of work. Most of the shipyards are idle and in many of the engineering shops there is very little doing. Some of the bridge builders are, however, rather exceptionally busy and there is a fair amount of locomotive building in hand. On Saturday Messrs. Richardson, Duck, and Co., South Stockton, launched a fine iron screw steamer for Messrs. William Johnston and Co., of Liverpool. She is engined by Messrs. Blair and Co., of Stockton, and will be 460 nominal horse-power.

The Steel Trade.—Last week the first charge was put into one of the new steel furnaces which have been erected by the Weardale Iron and Coal Company at Tudhoe Iron Works, Spennymoor, for the manufacture of Siemens steel. This is satisfactory news to the Spennymoor people. A different state of affairs unfortunately exists at Middlesbrough. Messrs. Bolckow, Vaughan, and Co.'s great steel works at Eston, Middlesbrough, have been idle for a fortnight, and there is no probability of their being started for some time. These works can produce about 5000 tons of rails per week. It is stated that if Bolckow, Vaughan, and Co., had had the good fortune to secure the whole of the steel rail orders which have been given out this year they would not have been sufficient to have kept their gigantic works in full operation.

The Salt Trade.—A new company has been formed to sink for salt at Haverton Mill, Middlesbrough. On behalf of this company Mr. Vyvyan, of Whitehaven, has been intrusted with the boring operations. Mr. Vyvyan is the engineer who carried on the sinking operations for Messrs. Bell Brothers and for Messrs. Allhusen.

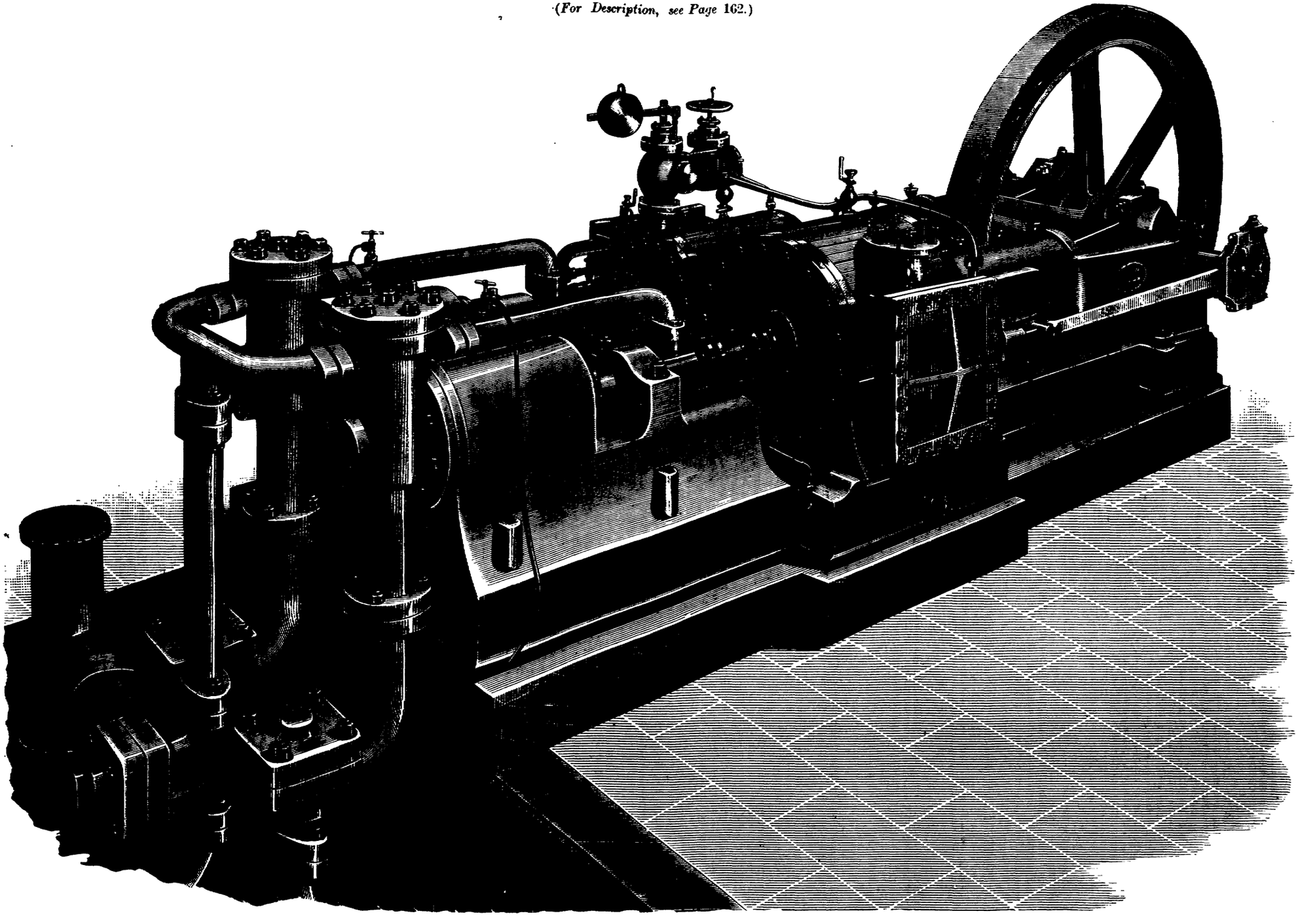
The Coal and Coke Trades.—There is no alteration in the coal and coke trades.

QUEENSLAND RAILWAYS.—Three branch lines have been recently opened in Queensland. These are the South Brisbane branch, which leaves the Main Southern and Western line, near Sherwood, and passing through the agricultural districts of Yeerongpilly and Boggo, comes to a terminus near the Dry Dock, South Brisbane; the first section of the Killarney branch, which leaves the main line at Warwick, both of which traverse agricultural country; and the first section of the Brisbane Valley branch line. On both sections of the Logen, railway work has been considerably delayed by rains which have fallen in those districts of late. On the first sections bridgework has been making good progress where the timber is available, but the earthwork has not been resumed since the rains. About 45 per cent. of the sleepers, and about half the ballast required, are now ready on various parts of the line. On the second section a fair amount of bridgework has been done, but very little earthwork has been executed. The bridge over Log Creek has been begun, and piles are driven for two sets of flood openings, both on the Beenleigh branch. The ironwork required for the bridges is now on the ground, and some of the cylinders for the Logan Bridge have been received and forwarded by steamer to the site. The second section of the Killarney branch is now in progress; clearing has begun, and contracts are let for some of the cuttings, and for half the ballast. On the Bundaberg line, which is now opened to Mount Parry, some small works are still in progress. Tenders have been received for the Kilkivan branch, but as none of these were considered eligible, fresh tenders are now invited, and plans are on exhibition in Sydney, Melbourne, and Adelaide, as well as in Brisbane.

COMPOUND ACCUMULATOR PUMPING ENGINES FOR BUENOS AYRES GREAT SOUTHERN RAILWAY COMPANY.

CONSTRUCTED BY MESSRS. TANNETT, WALKER, AND CO., ENGINEERS, LEEDS.

(*For Description, see Page* 162.)



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The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

ENGINEERING.

FRIDAY, AUGUST 15, 1884.

THE BOARD OF TRADE AND THE SOUTH-WESTERN RAILWAY.

AFFAIRS on the South-Western Railway appear to be in a bad way: indeed, to judge by the report of Colonel Rich on the Downton accident, and its accompanying letter addressed to the company from the Board of Trade which have just been published, they could not be much worse. A perusal of these documents gives rise to very unpleasant feelings, for whereas in most so-called railway accidents, whether arising from individual neglect, stupidity, or some unpreventible cause, there is generally a feeling of hope for the future, it would seem that upon the South-Western Railway there exists a most deplorable state of things, the only remedy for which, in the opinion of the Board of Trade, consists in a "complete reform in the management and in the working of the railway, a thorough examination of the system and stock, and that the drivers, stock, and various parts of their line and trains should be classified." Had such recommendations been given to some third-rate railway company in Ireland, perhaps no particular notice would have been taken of it, but that it should be found necessary to administer censure so grave to one of the best known railways running into London, frequently conveying Her Majesty, and which has for years paid a good dividend, is in the highest degree discreditable, and we fear it must be confessed that the expressions, severe as they are, have been fully deserved.

The story of the accident itself is soon told. It seems the Salisbury and Wimborne branch of the South-Western Railway is a single line, which has been opened for traffic for more than eighteen years, and is still laid with rails which weigh only 70 lb. to the yard, and which are fixed in chairs weighing but 24 lb. each. Upon this the inspector remarks that "a railway with so light a permanent way would not be allowed to be opened for traffic at the present time." On the afternoon of the 3rd of June, a close-coupled train, consisting of two engines and tenders, and eight passenger vehicles, left Salisbury five minutes late, and having stopped at Downton proceeded on a falling gradient of 1 in 78 towards Breamore. When about 1¼ mile from Downton, however, part of the train left the rails and ran over the bank, about 6 ft. high, into a wet ditch, with the result that five people were killed and forty-one more were seriously injured. The pilot engine and tender kept the line, as did also the train engine, but the tender of the latter and all the vehicles left the rails. The two engines and the front brake vans ran on for a distance of 501 yards, and stopped in safety, but the remainder of the train turned over and was almost entirely wrecked after running 217 yards. All the carriages and vans had two pairs of wheels, with a wheel base of 10 ft. 6 in.; they weighed from 6 to 7¼ tons each, and measured about 21 ft. from buffer to buffer, and their age varied from twenty to twenty-four years each. The falling gradient of 1 in 78 is a mile in length, there is then a quarter of a mile level ground, and the place where the train left the rails was on a curve of about 30 chains radius. And what is the conclusion arrived at by the Government inspector? He says: "I have no hesitation in stating that the accident was caused by the train having been run at too great speed over a weak road. The train having two engines and eight short vehicles, with short wheel bases, was not calculated to run steadily at great speed over a line of such gradients and curves;" and, further, "I have no doubt that it was the force and the weight of the engines that first displaced the permanent way." This is not at all unlikely, though we may mention that Mr. Adams, the locomotive superintendent of the South-Western Railway, attributes the cause of the train running off the line to the breaking of the coupling between the front brake van and the vehicle behind it. It should be mentioned that the only reason for having two engines on the train was to enable the pilot engine to get to Verwood that it might bring back a goods train; the single line not being worked by a train staff as usual, but by telegraph.

It is not, however, the accident at Downton alone which has brought upon the South-Western Company such remarkable censure as that we have referred to. The Government inspector draws particular attention to the fact that there have been three cases of passenger trains leaving the rails on this line, since September last. The first, at Portsmouth, which was due to the bad construction of a coach; the second, at Brockhurst, caused by "a train made up of inferior rolling stock being run at express speed along an old and very light permanent way," while Colonel Rich remarks there is "no room to doubt that a great deal of reform in the management and improvement in the working of this railway is required." Upon the subject of brake power Colonel Rich is somewhat vague. We are told that if the Downton train had been fitted with a good continuous brake the driver might have checked the speed and oscillation without endangering the safety of the train. This may be true, but it appears as though the object of the drivers was to run quickly, since both of them kept steam on all the way down the incline of 1 in 78 and until the accident took place. It was certainly possible to have run at a safe speed without steam, and by the use of the steam brakes with which the engines and tenders were fitted, but as a matter of fact, the train ultimately broke away, and therefore a brake which was simply continuous and not automatic would have been as useless as was that in the subsequent accident at Penistone.

In a recent article we drew attention to the remarkable similarity between the accidents at Downton and Penistone, and now that the circumstances and surroundings of the former are better known, the resemblance is rendered all the more striking. At Penistone, as at Downton, the accident occurred on an embankment; the train left the line at a curve at high speed after running down a heavy gradient; the engine and one vehicle kept to the embankment and ran on for over 500 yards although off the rails; the remainder of the train broke away, and uncontrolled ran down the bank, killing and injuring various passengers after running over 200 yards. In almost every particular the two cases are nearly identical. That the cause of the train running off the line at Downton was due to the weakness of the permanent way, while that at Penistone was owing to the breaking of a crank axle, is not so much to the point. Both trains did leave the line and separated into several portions, and as we have before pointed out, this is, from various causes, one of the most common forms of railway casualties, and will no doubt continue to be so.

It by no means follows, however, that such a mishap should result in such wholesale loss of life and injury to passengers and stock. It has been demonstrated repeatedly that where such an event occurs, and the train is provided with an automatic brake, absolute, or, at least, comparative safety is the result; whereas when a train is equipped with a non-automatic brake, or is not fitted with any continuous brake at all, there is an unlimited capacity for a terrible amount of mischief. An automatic brake is specially designed to meet such contingencies, whereas a non-automatic brake is so constructed as to render it impossible to do so. The train at Downton does not appear to have been fitted with any brake, while the Penistone train was furnished throughout with the Smith vacuum brake; but instead of this fact constituting an element of difference, it in reality only adds to the resemblance, for both trains were on an equality in respect of brake power so soon as the real emergency arose. We are careful again to point this out, since it is the crucial feature in the difference between efficient and inefficient continuous brakes, and numerous accidents have made it abundantly clear to ordinary practical and unprejudiced minds.

In an article on the Downton and Penistone accidents which appeared in the *Times* of the 12th inst., our contemporary referred to a letter which appeared in its columns from Mr. J. W. Grover. This gentleman, pointing to the Penistone accident, advocated a flexible wheel base as a necessity for meeting curves, and the *Times* appears inclined to adopt the suggestion as a remedy for preventing these disasters. It may be as well to consider this idea with a view to being assured that the real point is not lost sight of. We have ourselves no objection in principle to the adoption of the flexible wheel base, but since it applies only to the carriages we fail to see how it could have prevented the catastrophe at Penistone, which primarily arose from a broken crank axle on the engine, which in consequence left the line; or at Downton, where the line was spread by the engines owing to a defective permanent way. The Manchester engine, moreover, having a four-wheel bogie in front, had a wheel base which was flexible so far as possible, but this did not prevent the engine and tender wheels from leaving the line, and we have no hesitation in saying that no amount of flexibility in the wheel base of the carriages, will avail to keep the train on the line when the engine destroys the permanent way and, as usually happens, the carriages break asunder. Easy riding may, and will no doubt, result from a flexible wheel base, whether of bogie or other type. There will probably be also a reduction in the friction and cost of hauling, but there is no getting away from the fact that when all else has failed, the only effective appliance which science has provided for meeting such emergencies as those with which we have been dealing, is an automatic brake complying with the Board of Trade conditions. Indeed it is open to question whether carriages, either on the bogie or flexible wheel base principle, are not more unsafe when they are off the line, than those which are

more rigidly fixed to their wheels. The great point, however, is that when any part of a train is made to leave the rails, from whatever cause and under whatever circumstances, a controlling power, automatically, or otherwise applied, should be brought into action and remain in force, both with the object of bringing the train to a stand in the shortest possible distance, and also by holding back and binding the carriages together enable them to keep in line, and thus prolong the stop until they come to a stand in safety, and this is equally important whether on an embankment or in a cutting. We hold it to be our duty to repeat, and the public should grasp the fact, that the only means of accomplishing a result so desirable and yet so easily attainable, is by the use of an automatic brake which fulfils the conditions laid down by the Board of Trade.

THE IRONFOUNDERS' SOCIETY.

The seventy-fourth annual report of the Ironfounders' Society records some progress during the year 1883, but not sufficient for any display of exuberance of delight, for its payments to out-of-work members exceed those of 1882. Whether improved methods of casting lessen the demand for this kind of labour, or whether the actual production is less in proportion than formerly, does not appear, but the one fact that stands out prominent in the pages of the report is that the donation benefit is really draining the Society dry.

The report for 1883 consists of 152 pages, and 62 pages of introductory matter, tables, summaries, and the like. The branch reports occupy 72 pages, and the abstract, lists of admission, exclusions, and obituary, 45 pages, the remainder being devoted to miscellaneous matters, of interest to the members. The total number of branches at the close of the year was 109, an increase of one only. The total number of members was 11,197, an increase of 469, after allowing for deaths and exclusions. The number of members admitted was 943, and 10 were reinstated. The number of exclusions was 331, and of deaths 153, the net gain being 469 as before stated. The total net income for the year was 35,433*l.* 11s. The principal sources of income were: Contributions, 27,762*l.* 14s. 2d.; entrance fees and proposition money, 1171*l.* 18s. 7d.; fines, 367*l.* 18s. 10d.; reports, cards, rules, and emblems, 575*l.* 16s. 8d.; levies, 648*l.* 15s. 7d. Auxiliary levy, 4019*l.* 14s. 6d.; bank interest, 374*l.* 5s. 9d.; acknowledgment money from honorary and other members, 121*l.* 19s. 2d.; moneys returned—railway fares, sick, donations, and other benefits—278*l.* 19s. 7d.; surpluses, &c., 11*l.* 7s. 10d. The net income for the year was less than in 1882.

The total expenditure amounted to 30,233*l.* 18s. 6d., which amount exceeded that of 1882 by 2196*l.* 0s. 3d. Of this amount the following was paid in benefits:

	£	s.	d.
Out-of-work benefit, travelling relief, and fares	11,540	19	10
Sick benefit, doctors' certificates and expenses	6,877	0	8
Superannuation allowance ...	5,166	2	7
Accident benefit	731	10	1
Funerals (members and their wives)	2,020	0	0
Grants from the benevolent fund	95	10	0
Strike pay (auxiliary fund) ...	473	16	5
Total	26,904	19	7

The payments to out-of-work members are more than in 1882 by about 1000*l.*, but less than in any other year since 1875. Still, it means 10 per cent., or nearly so, of the members out of work, a fearful tax on those in work all the year round. There is also an increase of 379*l.* 8s. 4d. in the superannuation allowance, which increase is likely to grow instead of lessen. The expenditure for strikes is nearly double that of 1882, but the sum is not a large one; indeed the Society, as a rule, is tolerably free from labour disputes.

The other expenditure, for management, &c., may be summarised as follows:

	£	s.	d.
Salaries:			
Central office and 109 branch secretaries	1084	15	2
,, ,, presidents	105	0	2
,, ,, treasurers	47	1	3
,, ,, auditors...	97	11	4
Stewards, check, cash, and trade ...	142	16	5
Delegations, executive, council, and committees	326	19	10
Printing and stationery, including emblems, reports, rules, books, &c. ...	1005	9	10
Postages, parcels, telegrams, money orders, &c.	190	10	3
Banking expenses and loss of time ...	24	14	10
Sundry goods for office and branches ...	78	3	9
Rent, fuel, gas, insurances, rates and taxes, &c.	411	13	9
Law costs and charges		13	4
Appeal committee and treasurer's bond ...	9	6	6
Total	3473	16	5

The remainder consists of cash returned and loans repaid, 69*l.* 6s. 5d.; special audit and repairs, 4*l.* 14s. 8d.; and cost of Mr. Guile's memorial (late general secretary), 71*l.* 1s. 2d. From the total under the head of management expenses must be deducted 575*l.* 16s. 8d. cash received for reports, rules, cards, emblems, &c., leaving a total outlay of 2898*l.* for the whole of the Society, about a penny-farthing per member per week for the year.

The general office accounts show an income of 2618*l.* 14s. 2d., including balance from 1882. The expenditure shows cost of office, secretary, and assistant, 247*l.* 1[illegible]; executive committee, chairman, and auditors, 49*l.* 19s. 6d.; rent, taxes, fuel, gas, &c., 74*l.* 13s. 1d.; delegations, 35*l.* 13s. 9d.; and delegates revising the rules, day sittings, 186*l.* 5s. 8d. The remainder was general expenditure.

The cash balance at the close of the year was 26,030*l.* 9s. 10d.; at the close of 1882 it was 21,130*l.* 17s. 5d., showing a clear net gain of 4899*l.* 12s. 5d. The arrears owing are not given, as they are not reckoned as assets. Some information is given in the report as to the production of pig iron in the United Kingdom and in the United States, during the last four years; and also in another table the ma[illegible] Scotch and Cleveland pig iron, the prices, shipments, and stocks, the number of blast furnaces, &c. These statistics are a new feature in the report, and deserve to be extended and amplified. The secretary also reprints the Provident Nominations and Small Intestacies Act, 1883, for the information of the members.

The amounts paid for donation, superannuation, sick, funeral, and accident benefits for the last thirty-six years, are as follows:

	£	s.	d.
Donation (out-of-work) benefit	551,133	13	10
Superannuation allowance ...	66,803	11	0
Sick benefit	145,089	11	10
Funeral benefit (members and their wives)	43,095	5	4
Accident benefit	29,343	11	1
Total (including omitted farthings)	835,465	13	3

The first has amounted to 8*d.* per member per week; the second 1d., and sick benefit 2½d. per week. The others are ½d. and a ¼d. respectively. The above are exclusive of sums paid away for strikes. This records the work done by one of the oldest trade unions in the country.

THE WEATHER OF JULY, 1884.

The weather of July has been different in different parts of the British Isles. There has been a continuance of wet, and where rain has not fallen the sky has been overcast, and the atmosphere murky and muggy. These conditions were unfavourable to the growing wheat crop which needed drying breezes and bright sunshine. The moisture was, however, suitable to the root crops. The eastern and central districts had certainly the best weather, while the southern and western experienced continued and excessive rain. The mean atmospheric pressure and temperature at extreme positions, to which the Isle of Man is central, were as follows:

Positions.	Mean Pressure.	Difference from Normal.	Mean Temperature.	Difference from Normal.
	in.	in.	deg.	deg.
North ..	29.83	nil.	55	above 1
South ..	.96	below 0.06	61	below 2
West ..	.82	,, .11	59	above 1
East ..	.91	,, .01	62	,, 2
Central ..	.88	,, .04	59	nil.

The distribution of rain, in frequency and amount, may be roughly estimated from the following results:

Places.	Rainy Days.	Amount.	Difference from Normal.
		in.	in.
Sumburgh	18	1.42	below 0.64
Scilly	24	4.78	above 2.82
Valencia	26	6.93	,, 3.34
Yarmouth	12	2.76	below 0.06

The daily general directions of the wind currents give a resultant from S.S.W., whereas the normal resultant for the month is W. The general tendency of the air having been from S.S.W., accounts for the frequent and heavy rain in the south-west of England and over Ireland, while the east of England and Scotland had even less than the seasonable quantity, and on comparatively few days. There was more than double the usual rainfall at Scilly and Valencia.

The mean distribution of atmospheric pressure was in accordance with the resultant of the winds, having been less than the normal values in the west and in the south, while it was normal in the north and east. Pressure on the whole was remarkably uniform, and, with few exceptions, the winds were light and variable. Pressure reached 30.2 in. on several days, and the least height of the barometer was 29.2 in., while a cyclonic disturbance was passing east-north-eastward to the north of Scotland on the 17th. The mean temperature on the whole was about normal, but in the south there was a defect of 2 deg., while the east had an excess of the same amount. The highest temperature, 88 deg., occurred at Greenwich on the 4th; the lowest, 35 deg. at Wick on the 20th. Rainfalls exceeding 1 in. in twenty-four hours were measured at Wick on the 6th, 1.14; at York on the 11th, 1.63; at Valencia on the 14th, 1.75. On the 6th, at 3 P.M., a thunderstorm occurred at Kew accompanied by unusually heavy rain, the self-recording gauge registering a fall of 0.88 in. in forty minutes.

The 1st to the 7th was a period of dry heat and bright sky. The 8th to the 14th had moderate heat, overcast sky, and excessive rain. The 15th to the 21st experienced chilly nights and damp days; the 22nd to the 31st was cloudy, showery, and unsettled. These varying conditions were attended by a remarkable series of severe thunderstorms, nearly all confined to Great Britain; from the 2nd to the 6th, 9th to the 16th, 19th, 24th, to the 27th, no day escaped without one or more. An estimate of clear days gives eleven to the east and central districts and only four to all other districts; while overcast, dull, and gloomy weather varied in prevalence between eighteen in the north and eight in the central district. Fog and haze were more than usually prevalent. The duration of bright sunshine, estimated in percentage of its possible duration during the four weeks ending the 28th, was only 33 for these islands generally; 38 for east England, 37 for south-west England, 35 for the Channel Isles, 34 for south England, 33 for south Ireland, 32 for north and west Scotland, and 31 for north Ireland and north-east England, and about 30 for east Scotland, north-west and central England.

Wheat cutting had not yet commenced anywhere, and promised to be late. It may be added that from the mean of 63 years, wheat cutting commences August the 6th; but the amplitude is large, having been as early as July the 15th, and as late as September the 4th. According to the same series of years, the mean date when harvest finishes is September the 14th, and here again the amplitude is large, having ended as early as August 21st and as late as November 11th.

MR. CHARLES MANBY, F.R.S.

In recording the death of Mr. Charles Manby, which occurred on the 31st ult., we are carried back in thought through the whole series of engineering achievements which, more than anything else, distinguish this century from all that have preceded it. The marine engine, the iron ship, the modern iron manufacture, and the locomotive, occupied, at one time or another, his attention, and generally in the early and most difficult phases of their construction. But honourable and useful as his career may have been when acting as a private engineer, or serving the interests of powerful manufacturing companies, his reputation rests to a far greater extent on the result of his labours on behalf of the Institution of Civil Engineers. In the year 1839 he became the secretary to that body, and since then he has never ceased to display a profound regard for its welfare. For eighteen years he was the paid secretary, and during that interval a most notable change was worked in the body which he served, and the appreciation in which it was held by the public. At the commencement it was hardly acknowledged among the scientific societies of the country, while at the end it was the

centre and focus to which all members of the profession spread over the entire globe, looked as the visible embodiment of the science which they practised, and statesmen and nobles were proud to be present at its gatherings. Much of this was doubtless due to the same causes which so enormously increased the material resources of the country during that period, but still immense credit must be given to Mr. Manby's exertions. His skill in languages and his Continental experience, put him in correspondence with all the foreign scientific men who visited this country, and while rendering much service to them he was able to further the interests of the Institution. He was a member of the Scientific Commission appointed by M. Lesseps to consider the projected Suez Canal, and was joint secretary with M. Barthelemy St. Hilaire, until the affair took a commercial aspect, when he resigned. He arranged the successful reception accorded to Marshall Soult, when he came to attend the coronation of the present Queen, and so effectively did he accomplish his task that he received an autograph letter from Louis Phillipe acknowledging his courtesy. He was much concerned in the preliminary work of the great Exhibition of 1851, and he it was who propounded the idea of the guarantee fund, which rendered the execution possible; indeed there is scarcely any great movement of his time in which he did not take part, winning honour for himself and esteem for the body he so ably represented.

Mr. Manby was born in 1804, and was partly educated at St. Servan, in France, with the view of adopting a military career. The battle of Waterloo, however, inaugurated a peace which was expected to put an end to the profession of arms, and he was consequently apprenticed to his father's firm at the Horsely Iron Works in Staffordshire, and at the expiration of his indentures, he went to work at the East and West India Docks. There he came under the notice of Rennie and Telford, and for a time he was in Telford's office. Mr. Aaron Manby, his father, patented the oscillating marine engine, and he made the drawings and helped to construct the first engine, which was tried in a small boat belonging to Mr. Charles Wye Williams. In 1820 there was built the first vessel entirely constructed of iron, the Aaron Manby, and Mr. Charles Manby went to sea in her as engineer, under the command of Captain (now Admiral Sir Charles) Napier. The first voyage was from London to Paris, where the cargo was landed without transhipment.

We next find Mr. Manby in Paris, superintending the erection of gas works for the firm of Manby, Wilson, and Henry. After that he became the manager of the Charenton Iron Works, where he built steamboats both for the Government and private users, and turned out plant for the manufacture of iron, an industry which greatly benefitted by his ingenuity and skill. From there he went to Creusôt, where he remodelled much of the machinery. Before he had been there very long the French Government appointed him chief engineer to the State tobacco factories, and consequently he returned to Paris. At the end of 1829 he became connected with the Beaufort Iron Works, South Wales, where he stayed until 1835, at the same time practising as a consulting engineer in the neighbourhood. For a short time he was connected with the Ebbw Vale Iron Works, and with the Bristol works of Messrs. Harfords, Davies, and Co., and then he came to London, and commenced practising as a civil engineer, making the warming and ventilating of buildings his speciality. In 1839, Messrs. Simpson and Bramah approached him with the proposition that he should become secretary to the Institution of Civil Engineers. He first acted in that capacity on March 5th of the same year; on May 28th he was formally proposed for the office, and on June 21st he was elected. After eighteen years' service he resigned the active duties of the position, retaining, however, the place of honorary secretary. His leave-taking was the occasion of a very cordial demonstration of the esteem in which he was held by the members and his personal friends. Four hundred and seventeen of them joined together in presenting him with a service of plate and purse of 2000*l*. These were conveyed to him at a special meeting on May 23, 1857, by George Robert Stephenson, the then President, who in a short speech said that Mr. Manby's presence had infused a new spirit into the Institution, and had resulted in increased numbers, better papers, and in the improved Transactions, which had become the text-book of the profession.

After Mr. Manby's resignation he represented the firm of Messrs. Robert Stephenson and Co., both in London and abroad, and his former position devolved upon Mr. Forrest, the present courteous and able secretary, under whose care the progress instituted by his predecessor has been maintained, and much that was scarcely in embryo when he left, is now bearing abundant fruit. Mr. Manby was still on the Council of the Institution, and worked so loyally for its interests that, at the end of another twenty years the gratitude of the members found expression in a second testimonial, amounting this time to more than 4000*l*.

At his death, Mr. Manby was a Fellow of the Royal Society, a Fellow of the Geographical Society, a Knight of the Legion of Honour, a Knight of the Order of St. Maurice and St. Lazarus, Italy, a Knight of the Danebrog, Denmark, an officer of the Rose of Brazil, and a Knight Commander of the Order of the Wasa of Sweden and Norway. He was also lieutenant-colonel of the Engineers and Railway Volunteer Corps, a body which he projected in 1860, and which was enrolled in 1865.

INTERNATIONAL FORESTRY EXHIBITION IN EDINBURGH.

Tea-Preparing Machinery.

Amongst the machinery in motion at the International Forestry Exhibition at Edinburgh, the various exhibits of Messrs. John Greig and Co., tea machinery manufacturers, Regent Works, Edinburgh, hold a very prominent place, and a special interest attaches to them, from the fact that Mr. John Greig, Jun., the principal partner of the firm, was engaged for some fourteen years, as general manager and engineer of estates in India and Assam. The first in series of these appliances is the leaf-cutting machine. It embodies a mechanical arrangement whereby there is secured a rapid cutting of either large or small succulent leaf, and either in the green or the withered condition. It is also very suitable for cutting or equalising the tea when in a half-rolled state, or for cutting the "nibs" separately from the other coarser leaf, thereby enhancing the value of the tea thus treated, from the circumstance that little or no rubbing over sieves is required, an operation which removes the natural "bloom" of the leaf, and which has hitherto been employed to equalise the tea after it becomes dry and crisp. The machine in question will cut perfectly and fast enough to keep two of the largest rolling machines going, and it can be driven easily either by hand or by steam power.

Next comes the Greig link-and-lever tea-rolling machine, which comprises a skilful arrangement for rolling the cut leaves in strong canvas bags, 3 ft. 9 in. long by 14 in. in diameter, which revolve horizontally between a ribbed central drum and the sides of the machine. The results of a couple of seasons' working with one of these machines on a Darjeeling tea estate show most conclusively that this method is much more effective and rapid than hand rolling. Mr. Greig also shows a machine for drying tea after it has been rolled and for withering fresh tea leaf, so that the tedious operation of drying by spreading the leaf in thin layers in the open air or in a hot chamber, may be wholly superseded. It consists essentially of a revolving horizontal drum, having four compartments which can readily be charged from a hopper above. The periphery is formed of wire gauze. The machine is made to draw in either cool, warm, or hot air at pleasure, according to the material which has to be dried; the leaves being kept constantly in motion so as to expose them thoroughly to the desiccating action of the air.

Lastly, Mr. Greig has on exhibition an improved sifting machine which is devised for subjecting the tea to a rapid circular motion, which results in faster sifting, and in giving a much less percentage of broken "nibs" than a sieve of the same area having a reciprocating motion. The tea comes down from sieve to sieve in a fine thin shower; the "nibs" in passing through the meshes remain their full length, the same as with the China sieve. Five classes of tea may be sifted out by the machine. On the top sieve lies the rough tea; on No. 2 lies the souchong; on No. 3, pekoe and souchong; on No. 4, pekoe and broken pekoe, and from it falls the tea dust. Mr. Greig's stall is a source of very great attraction when any of his machines are in operation. There is no doubt that they all display much inventive originality, in addition to which they combine simplicity and cheapness, while they economise both space and motive power.

Transplanting Machines.

In various parts of the Exhibition, especially in the open grounds occupied by nurserymen exhibitors and others, there are shown a number of tree-transplanting machines, several of which show much ingenuity, and are doubtless effective in actual use. Special mention may be made of those exhibited by Messrs. John Greig and Sons, Fountainbridge, Edinburgh; by Messrs. James Dickson and Sons, Chester; and by Mr. Nathaniel Ahlbottn, Leith.

Forestry and other Edge Tools.

At Stand No. 171, in the main building, Messrs. Alex. Mathieson and Son, of the Saracen Tool Works, Glasgow, show a very extensive collection of edge tools and wood-working machines. Amongst the latter there are two small foot lathes, which are exceedingly well made and are very handy. There are also a hand mortising machine, two combined hand mortising and boring machines, two mortising machines, one of which has a boring attachment, an enlarged hand mortising machine, with boring attachment, and attachment for wheel naves, and a combined double-spindle power boring and hand mortising machine. There are likewise of a couple of small band sawing machines—one designed for hand power and the other for steam or water power. In both instances the tables are made to cant. The other exhibits of Messrs. Mathieson and Son are exceedingly numerous and varied, but they may generally be classed under the head of edge tools, and are fitted for almost every kind of operation in connection with wood-working. To many persons visiting the Exhibition, it will doubtless be matter of surprise that the manufacture of such tools is prosecuted so extensively and so successfully in Glasgow, the said manufacture being generally regarded as a sort of monopoly of the capital of Hallamshire, where steel-working dates back for many generations.

Close by, at the stand of Messrs. Robert Sorby and Sons, we have ample evidence of what a first-class Sheffield house can do in the manufacture of tools used in forestry, the collection being alike varied and extensive. Chief amongst Messrs. Sorby and Sons' exhibits are the axes, which are of most extraordinary variety as to size and shape. Not the least attractive of them is one of the Gladstone pattern. In another part of the Exhibition there is shown an axe that has actually been used by the Prime Minister of wood-cutting renown. Axes are also shown of patterns known as the Novar, the Buccleuch, the Lochabers, the Kent, the Roxburgh, the Argyle, the Scotch, the Mexican, the Kentucky and long Kentucky, the Stirling, the Lothian, the American, Merrick's, the Yorkshire, and Yorkshire felling, the marking, the hedging, the carter's, the Cullen priming, &c. As regards the extreme in size reached by some of these axes, we may mention that the Yorkshire felling axe blade is about 20 in. in length. One blade of the Yorkshire pattern is shown at Messrs. Sorby's stand which within the three years ending May, 1884, was used in felling 40,000 ft. of timber, chiefly oak, near Barnsley, and it still looks as if it had felling capacity for many more thousands of cubic feet. In the same collection of tools used in forestry there is likewise a large display of different forms and sizes of bill-hooks and pruning-hooks, many of which receive special names. Augers, saws, and other edge tools complete this most excellent collection of Sheffield exhibits.

Messrs. Taylor Brothers, another well-known Sheffield firm, show a large assortment of saws, which they seem to make their speciality of manufacture, although they likewise exhibit files, together with machine, cleaning, and moulding irons, and chaff knives, sugar-cane knives, &c. The saws are of great interest. A number of them are varieties of perforated saws. It is claimed for them that half the amount of filing is saved, and the expansion which is caused to the saw (by friction) is reduced by the air rushing through the perforations and so cooling it. The perforations also form receptacles for grease for lubricating the blade. Running in straight lines backwards from the teeth, and in series of three, four, or more, even up to ten, they serve as a guide to the filer, thereby enabling him to keep the teeth of uniform size. Liability to fracture

at the roots of the teeth is also done away with, as the perforation answers the same purpose as a hole drilled at the end of a crack to prevent it extending; and it enables a better and more uniform temper to be given to the teeth. Some of the claims set up in favour of perforated saws may possibly be rather overdrawn, but there is no doubt as to the great saving which the perforations effect in sharpening.

The adjoining stand is occupied by Messrs. Spear and Jackson, of the Etna Works, Sheffield, whose collection of manufactures embraces some excellent specimens of picks, felling and other axes, mattocks, spades, and other tools for draining, planting, &c., all of which are made of solid steel, and are axe-tempered. Saws and sawmill fittings likewise form a prominent feature in the collection. Ever since the Great Exhibition of 1851, in connection with which a Council Medal was awarded to the firm, Messrs. Spear and Jackson have taken a leading position with their wares at international and colonial exhibitions.

Messrs. T. and R. Fleming and Co., Glasgow, show largely in foresters' tools, draining tools, models of cottages (in corrugated iron), a shooting lodge, farm steading, sheds, and bridges. They also exhibit a model of a silo pit, the counterpart of one made for the Duke of Argyll at Roseneath, on the Clyde. These are all well worthy of a leisurely inspection.

Examples of corrugated sheet iron roofing and models of other structures in iron are to be seen in various parts of the Exhibition, but it is scarcely necessary that we should specify them in detail. As a solitary example we would simply mention a model of a forester's house made of vitrified iron by Messrs. Thomson and Company, Derby. Not only will the material in question possess great durability, but in warm climates it will have the effect of keeping the interior of the structure cool. One of the miscellaneous exhibits (Class X.) is a series of wooden models of the dynamite cartridges made by Nobel's Explosives Company for blasting tree stumps. From its extraordinary efficiency in doing such work, that explosive will no doubt come more and more into favour amongst foresters and persons engaged in clearing estates. The exhibitor in this instance is Mr. Robert Hamilton, St. James's-square, Edinburgh. There are also some examples of very efficient glazing for the roofs of conservatories and similar structures.

For such an exhibition as that under notice there ought certainly to have been a much more complete display of forestry tools used in the colonies and foreign countries. Such a display would have possessed much interest to scientific and practical men. Even as it is, much instruction may be gained by a study of the native implements shown here and there in the Exhibition. For example, there are the tools which are sent along with the specimens of wood by his Highness the Maharajah of Johor, from the Singapore Straits Settlements. These native tools are perhaps not more than a dozen in number, the principal of which is known as the "billyong," of which there are various forms and sizes. The Malay, axes known by that name, generally are very simple in structure and small in size. In some instances these tools can be used either as axes or adzes, the blade being easily removable from its socket, in which it is secured by narrow strips of rattan or cane, the use of which in tying involves a great amount of skill and art on the part of the Malay. The chisels and gouges go under the generic name of "pahat," in which there are several species. One of the forestry tools is known as a "kapak," a very simple axe, not much more than a sharp-edged steel-faced wedge, measuring about 6 in. long by 3 in. at the face.

The Japanese forestry implements and wood-working tools are also very simple in form and make, but unlike those of the Straits Settlements. They include hatchets, axes, chisels, and gouges, nearly all of which are bounded by straight lines of contour. One of the axes has a very narrow blade of about 9 in. long, and in all cases the blades of the axes have three or five grooved lines running parallel to each other and lengthwise of the blade. There are various forms of bladed tools called "sickles," the upper border of which is a convex curve, while the cutting edge is straight. These are very light tools. Bladed and pronged hoes are shown, and the saws are most uncouth tools, being very broad relatively to their length; indeed, one of the blades which is only about 22 in. long is 12 in. wide at the outer end. The teeth are always directed towards the handles, as the Japanese artisan saws by drawing the tool towards himself.

In the Indian collection of exhibits there are very few tools or implements that are used in forestry or wood-working by the natives. Two of the Forestry Conservators of Assam make a little show in that direction—but it is very little; and in one or two other instances they receive a slight countenance from other conservators. In the collection sent by the Government of Gambia, the visitor may see a native adze, an axe, a plough or hoe, and a plough handle. Almost the only other instance in which we can find any tools or implements, such as we are speaking of, is in the collection of exhibits sent by the Commissioners of Woods and Forests. Of course they are generally of a modern character. They are draining tools, stripping tools, ground work tools, and tools for felling timber.

As the position which teakwood has taken, and is likely yet to take, in connection with our great shipbuilding industry, is a very important question in the eyes of the promoters of the Exhibition, and of many of the large consumers of that material of construction, we propose in our next article to lay before our readers some important facts regarding the cultivation, commercial statistics, and industrial applications of that most valuable timber.

THE TEXTILE TRADES EXHIBITION.

After ten days' delay the Exhibition is at last beginning to assume a working appearance, and most of the machines have either commenced running or are on the point of doing so. The whole affair is still, and will continue to be, miserably disappointing as an illustration of the textile trades, but many of the exhibits are interesting in themselves. Foremost among these is the stand of Mr. Samuel Brooks, of Manchester. It contains a weft spinning frame, a twist frame, a thread doubling frame, and a drawing frame, and is the sole representative of the process of spinning in the whole hall. Mr. Brooks is an ardent advocate of ring spinning, and consequently his machines are all on the ring and traveller principle. The most interesting of them is the weft frame, because hitherto ring throstles have been most largely used for twist yarn, the softness required for weft not being attainable by them. The most noticeable features in this frame are the arrangement of the rollers, the method by which they are weighted, the fixing of the clearers, the spindle, the shaping or copping motion, and the doffing motion. The rollers are placed so that the roving is delivered to the thread eye tangentially to the point where the nip takes place, and does not lie upon the roller. By this plan it commences to twist immediately it emerges from between the rollers, and thus it gains strength at the moment it is subjected to the drag of the traveller. From the position of the rollers the ordinary method of weighting by a vertical link with a suspended weight is no longer possible. The link is therefore taken down in a direction parallel to a line drawn through the centre of the rollers, and is connected to a bent lever carrying a weight at its further end. The top clearer is round, and rests between the front and middle roller, being held in position by Walker's adjustable fixing. The spindle is a modification of the well-known Rabbeth type, and carries a small wooden pirn upon which the cop is built, first with a correctly formed "cop-bottom," and then with a parallel body. There is an independent thread board to each spindle, but the whole can be turned back simultaneously for doffing by a shaft running the length of the frame. The doubling frame is of the type used by the Scotch thread manufacturers with the bottom roller running in the water trough, and calls for no special mention.

The most interesting exhibit on the stand is Hill and Brown's winding frame. Cotton yarn is ordinarily used in cop, in hank, and on bobbins or spools, and this machine is designed to introduce another form, which shall have the advantage of a bobbin without its weight and without the expense and constant breakage which bobbins entail. The yarn is wound upon a paper tube about a ¼ in. in diameter, and is built into exactly the same form it would occupy if wound between the flanges of a bobbin. This is effected by means of a very rapid traverse which carries the yarn from side to side, crossing and recrossing, so that the whole is firmly knit together and cannot rove over at the side. The thread guide consists of two cams fixed on a revolving shaft. These cams are placed face to face, and a narrow cam path is left between the two in which the yarn lies. The new flangeless bobbin is suitable for use in the warping frame, in knitting and lace machines, and for the retail sale of sewing and crochet cotton, and promises to effect a very considerable saving, both for spinners, especially ring spinners, and for manufacturers.

There is one woolcombing machine, exhibited by Messrs. Heilmann-Ducommun and Steinlen, of Mulhouse, Alsace. It is noticeable for the thorough combing of the fibre which it effects. The broken sliver is held in a gill-box, and its end lies over a roller with a large number of combs projecting from its surface. Above this is a small roller with grooves planed in it from end to end, so that it can run in contact with the lower roller, and yet not injure the combs which enter the grooves. The small roller holds the end of the sliver down on to the combs until all the short fibres have been removed. A pair of jaws then advance and close upon the end of the combed fibres, drawing them forward through the gill-box, and joining them to the combed sliver which runs to the coiler.

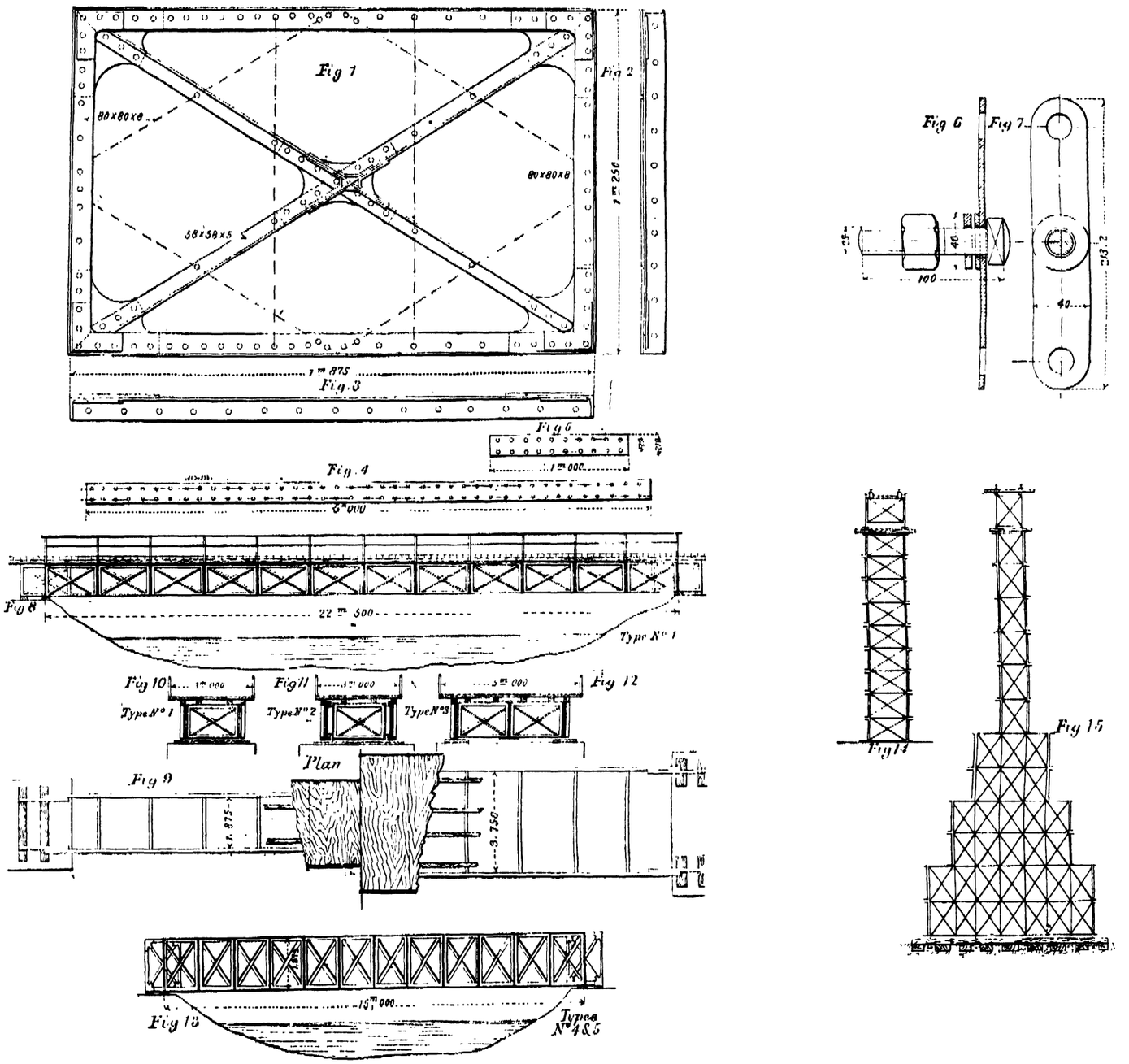
The show of looms is decidedly small. Messrs. Cryer and Co., of Dukinfield, show a 40-in. reed space loom with a loose reed. Mr. H. Livesey, of Blackburn, has a similar exhibit weaving stout shirtings. The largest display in this class of machinery is made by Mr. T. Sagar, of Burnley, who has three looms, one of which is fitted with Clayton and Richmond's positive dobby arranged for twenty shafts. The pattern is produced by a chain of pegged lags, and the healds are raised and depressed positively by eccentrics upon a constantly running shaft. Each eccentric can be secured to the shaft by a catch which is under the control of the selecting apparatus, and can be put in or out of gear when it is either at the top or the bottom of its stroke. The advantages of the arrangement are that neither springs nor weights are used to lower the healds, and consequently that the loom is never out of balance, and that the eccentrics give a uniform even motion which does not strain the warp. A single fustian loom by Mr. Robert Hall, of Bury, completes the list in this department.

There are a considerable number of miscellaneous exhibits among the dyeing and finishing machinery. Messrs. James Farmer and Sons, of Salford, show one of their doubling, creasing, and measuring machines in which the novelty consists in the length of the fabric being stamped upon it at intervals of five yards. By this arrangement an automatic check is established upon the man who reads the length off the measuring dial, and a record is created by which the length, of cloth remaining in a cut roll may always be learned without the necessity of measuring it from end to end. The cloth passes round a roller of known circumference, say one yard, lying in close contact with it, so that the two move at the same surface speed. The counting mechanism is driven from the axis of this roller, and so is the printing device. This consists of twenty types fastened at intervals along a pitch chain, which is stretched over two horizontal wheels in such a position that as the types pass round one of the wheels they come against the cloth on the measuring roller, and impress it. As the fabric is to be printed every five yards it is necessary that one type should pass for every five revolutions of the measuring cylinder, and that when it and the cloth are in contact, the two should move at the same speed, so that there may be no rubbing action between them. To gain this effect the pitch chain is driven through the agency of a starwheel having ten notches. A stud and ring wheel driven by a train of gear from the measuring roller, actuates this starwheel, turning it one-tenth of a revolution each time an impression is to be made, and holding it stationary at all other times. Ink is conveyed to the types by a pad fixed round a hollow wheel into the interior of which the coloured fluid is fed. The whole of the printing mechanism can be slidden to and from the centre of the table to accommodate various widths of cloth.

The same firm also show one of Farmer and Lalance's washing, soaping, and dyeing machines, in which a thorough impregnation or washing of the cloth, is effected in a limited space and in a short time. The fabric is passed successively round rollers having perforated or reticulated surfaces. These rollers are immersed in tanks and are in communication, through their axes, with a pump. This pump forces the dyeing or bleaching liquor

COTTRAU'S SYSTEM OF PORTABLE BRIDGES.

(*For Description, see Page* 163.)



into one set of rollers, and through the perforations, and the cloth by which they are covered, into the tank. The suction side of the pump is connected to another set of rollers, and draws the liquor into them through the cloth, and thus a constant circulation is kept up, passing through the cloth first in one direction and then in the other. Thus every thread is thoroughly exposed to the action of the liquor, and the action is rapidly effected with a small quantity of dye or bleach material, while the fabrics are not pulled out of shape. The same stand contains a seven-cylinder drying machine with copper cylinders, each 22½ in. in diameter, and 45 in. on the working face, driven by a 5 in. double-cylinder diagonal steam engine.

Messrs. Edwin Boden and Co., of Worsley Mills, Manchester, show a very neat machine for washing and dyeing hanks of yarn. The water or dye liquor is contained in a rectangular beck or vat. Crossways over the top of this vat there are arranged twenty rollers of porcelain of nearly square section, and upon them the hanks are threaded, with the greater part of the length hanging in the liquor. The axes of the rollers are all geared together with spurwheels, so that the contiguous sides of adjacent hanks run in the same directions. All the rollers are carried at one end in a movable frame, and when the hanks are ready for removal, this frame is raised bodily by a hydraulic ram, lifting the other ends of the rollers out of the open bearings in which they run, and elevating them until the hanks can be conveniently drawn over their ends. The frame is counterweighted, and the lifting power required is not great. The machine is driven by open and crossed belts so that the motion can be reversed from to time to keep the yarn straight, and the handles of the striking gear, and the taps of the hydraulic ram, are carried round to the front, so that the workman has every part under his command without leaving his place. It is stated that 1000 lb. weight of yarn can be dyed in the machine in ten hours.

Mr. James Robertshaw, of Simpson-street, Rochdale-road, Manchester, shows an apparatus having a similar purpose. In this case the lifting of the roller frame is effected by racks and pinions instead of by a hydraulic cylinder, and as the weight can be approximately balanced, this simpler means should answer as well as the more complicated one. The rollers are arranged in two groups, which are lifted separately, so that one set can be filled while the other set are at work. In the middle of the tank is a wringing appliance consisting of two large hooks arranged in the same axial line with their points separated by such a distance that a hank can be readily slipped over them both. One of the hooks has a square shank, capable of sliding endwise against the pull of a weight. The other has a round spindle and is driven by a friction clutch, the hold of which can be determined by a weight sliding along a lever. The wet hank is placed over the two hooks and the clutch is dropped into gear, and the further hook put into rotation. The hank is thus wrung, much in the same way that a laundry-maid wrings linen, until it is so tight that the friction clip slips. The weighted lever is then raised, the hook is thrown out of gear and rotates the opposite way as the hank untwists itself, the hank is removed, and a fresh one inserted, and the same process repeated. By this arrangement every hank is subjected to exactly the same pressure, and when this has been fixed by a competent workman, this process may be left in the hands of a boy. At the stand is a hank sizing and wringing machine with only one roller. In this there is no friction clutch, but the same result is obtained by fixing the strap guide in such a position that the belt comes on to the fixed pulley only such a distance

THE BUTE WORKS, CARDIFF; CAISSONS OF GRAVING DOCK.

(*For Description, see opposite Page.*)

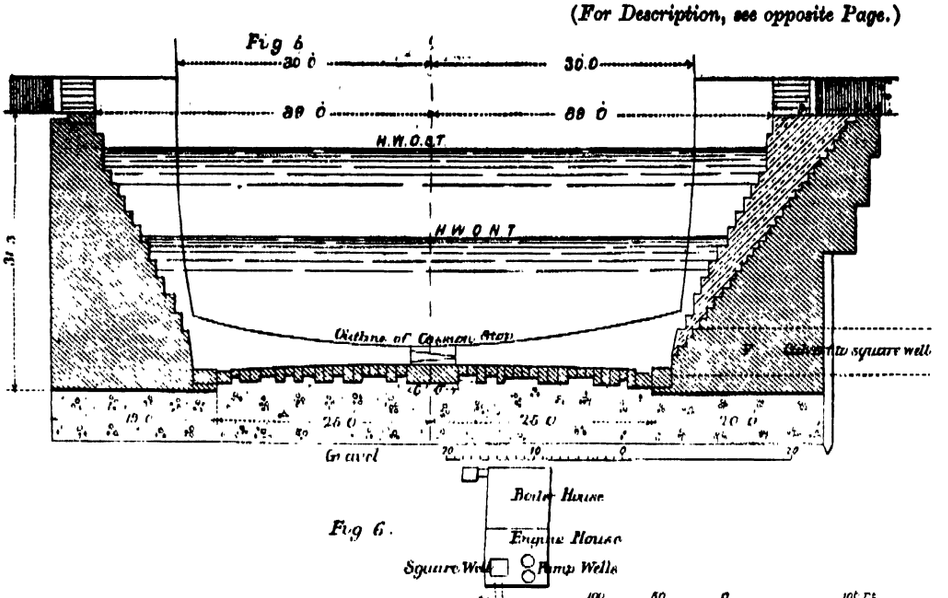
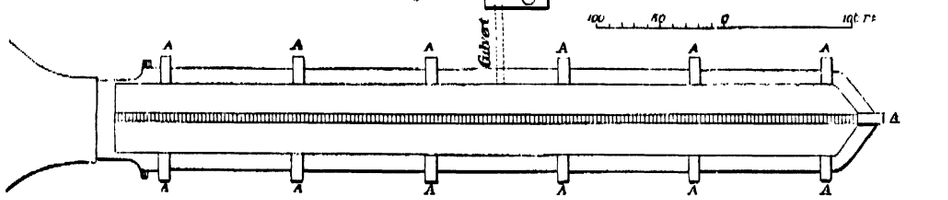
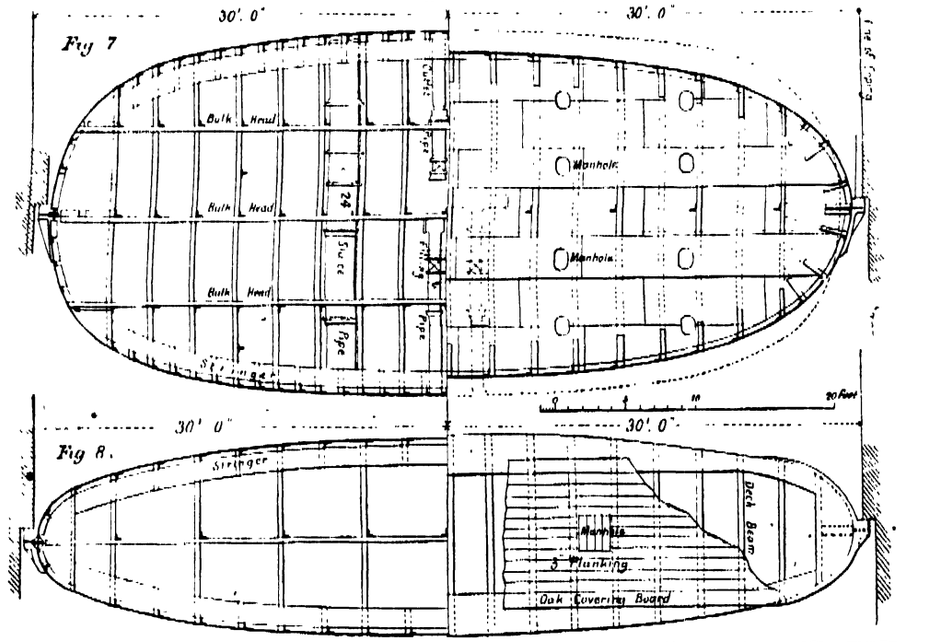
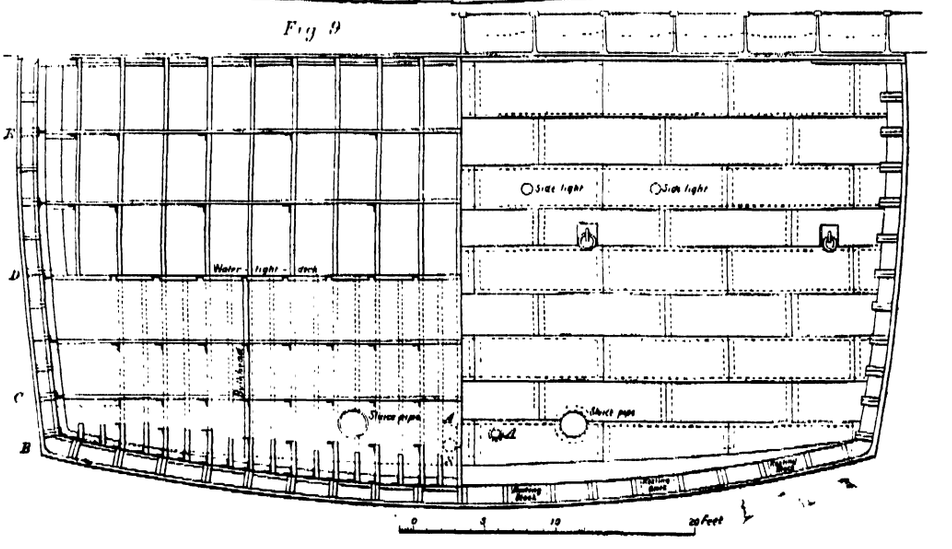
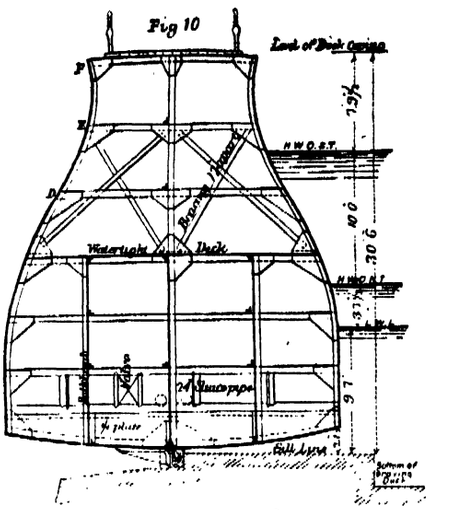


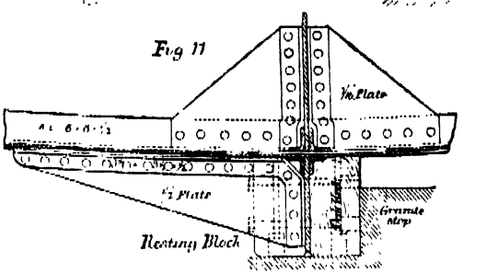
Fig 6.

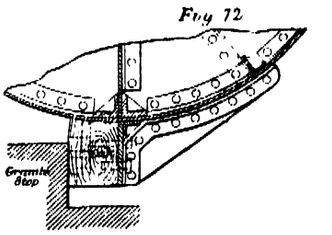












and built to the order Mr. E. M. Langworthy, of Florencia, River Plate. Her leading dimensions and particulars are: Length, 185 ft.; breadth, 28 ft. 3 in.; depth of hold, 12 ft. 8 in.; class 100 A 1 Lloyd's, under special survey. She is rigged as a three-masted brigantine, and has been designed with exceedingly large hatches for the shipment of machinery to be used in the owner's new colony.

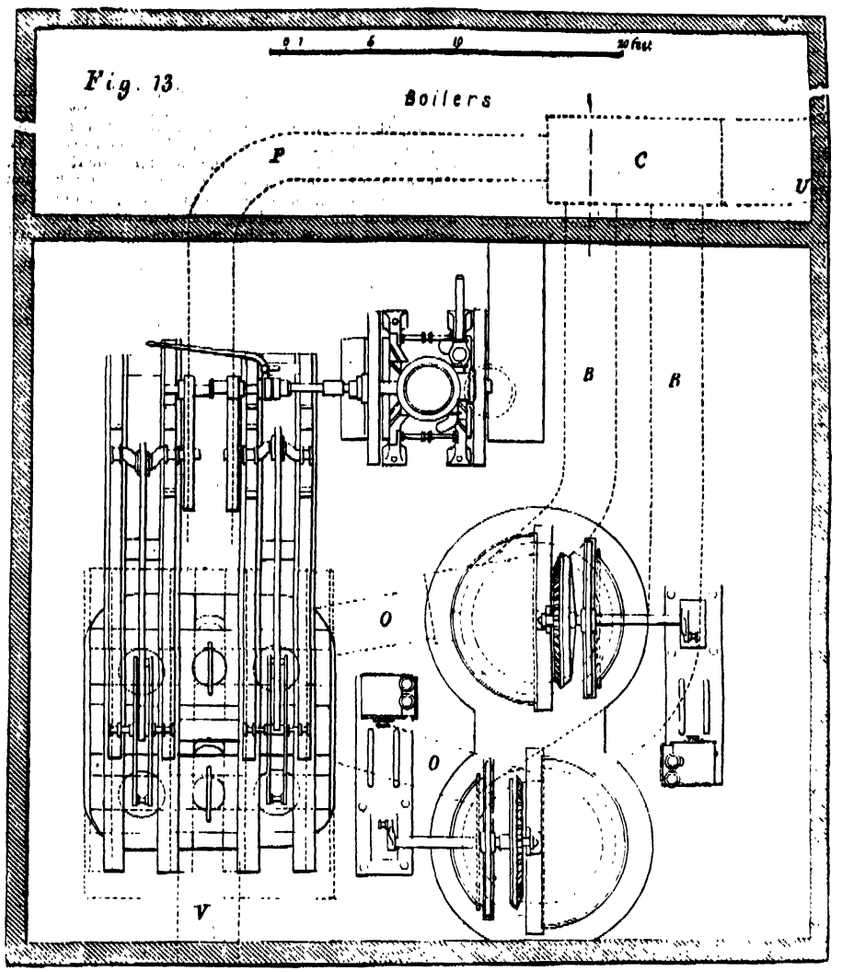
French Steel Rails.—The Denain and Anzin Company has obtained a Portuguese order for 11,000 tons of steel rails. The contract price is stated to be 5*l.* 16*s.* per ton.

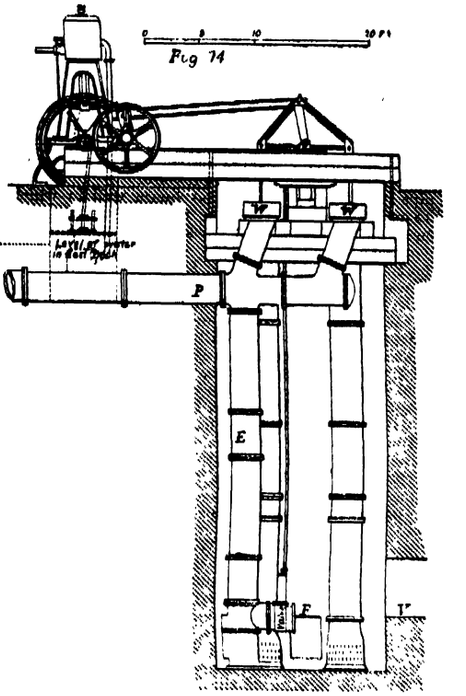
Western Australia.—Mr. A. Hordern has telegraphed from London to his Perth agent, Mr. A. Forrest, notifying that the contract for the construction of a railway between Beverley and Albany has been signed. Mr. Hordern leaves London for Perth immediately.

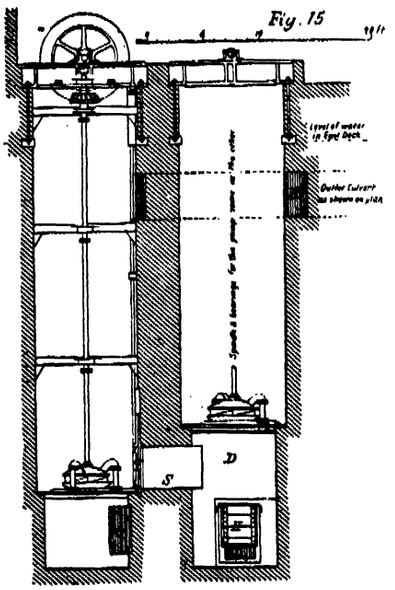
American Mechanical Industry.—The Westinghouse Machine Company has recently shipped to the Government of New South Wales one of its 160 horse-power automatic engines to be used in electric lighting. An order for two steam elevators, one for freight and the other for passengers, has been placed with Messrs. Eaton and Prince, of Chicago. The Vulcan Iron Works, of Chicago, have recently turned out a steam dredger for digging ditches. The novelty in its construction consists of an endless belt, forming the bottom of a series of revolving buckets.

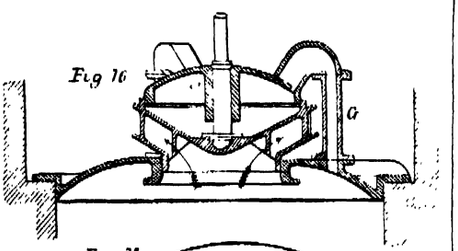
Nova Scotian Coal and Iron.—The amount of coal raised in Nova Scotian mines in 1883, was 1,422,553 tons, being an increase of 56,000 tons over the production of 1882, and of nearly 300,000 tons over that of 1881. The amount of coal exported to the United States last year was 102,755 tons, being an increase of 3453 tons over the exports of 1882. The largest shipments are to Quebec. New Brunswick is the market next in importance, while considerable quantities of coal also go to Newfoundland, Prince Edward Island, and the West Indies. It is stated that 300,000*l.* was paid out by several coal-mining companies of Nova Scotia last year, and that altogether the number of persons employed in and about the mines and in transporting coal by land and sea is about 10,000. The production of iron last year in Nova Scotia was 52,410 tons an increase of 10,000 tons over the previous year.

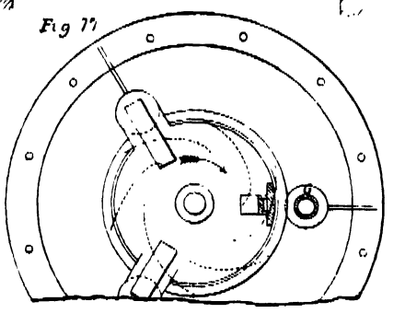
PUMPING ENGINES AT THE BUTE DOCKS, CARDIFF.











COAL SHIPPING AT CARDIFF DOCKS.

*On Recent Extensions of Dock Accommodation and Coal Shipping Machinery at the Bute Docks, Cardiff.**

By Mr. JOHN MCCONNOCHIE, of Cardiff.

(*Concluded from page* 141.)

Graving Docks.—The provisions for the examination and repair of vessels entering the port consists of eight graving docks.

1. *Public Graving Dock.*—The commercial graving dock, constructed by the Bute Trustees, is available for use by the public on payment of dockage rates as at Liverpool.

This graving dock R (see plan on p. 133 *ante*), shown in section and plan in Figs. 5 and 6, is 600 ft. long, 78 ft. wide at the bottom, with an entrance 60 ft. wide from the Roath Basin, the depth of water on the sill at high water of ordinary spring tides being 23 ft. 9 in. The bottom of the graving dock is 2 ft. 6 in. below the sill, and is laid with a line of cast-iron blocks 4 ft. apart throughout its entire length, the upper edge of these blocks being on the level of the sill. Access to the dock is gained by the steps at A A, Fig. 6, in which also are slides for passing down materials required for the repair of vessels.

Caisson.—The entrance is fitted with a wrought-iron boat-shaped caisson, shown in Figs. 7, 8, and 9. It is 60 ft. long, 26 ft. in greatest width, and 13 ft. in least width at the centre, and 30 ft. 6 in. in depth; and is constructed of angle-iron frames, columns, and beams, and skin plates, with oak stems and keel, Figs. 10, 11, and 12, and fir deck planking. It is divided by a water-tight deck and by bulkheads into sixteen compartments communicating with one another by means of small slide valves, for water ballast arrangements. To give the necessary displacement for any required flotation level, the water ballast is admitted to the four central compartments (from which it flows to the others) by two 9 in. cast-iron inlet pipes A A, or is discharged through the outlet pipe B, Fig. 9, each of which is fitted with a brass-faced valve worked from the deck. A small steam pump is fixed on the water-tight deck for the purpose of discharging the water ballast, in case of the depth of water on the sill being reduced whilst the caisson is afloat. The 24 in. cast-iron sluice pipes, fitted with valves worked from the deck, are fixed in a caisson for filling the graving dock. In addition to the water ballast, there are about 120 tons of iron ballast in the caisson, which, with the weight of the caisson itself, including the cast-iron pipes, pumps, &c., amounting to 152 tons, is equal to the displacement at the lowest water level at which it requires to be floated. The details of this caisson required careful consideration to provide by water ballast for a variation of 13 ft. between the high water of high spring tides and the high water of neap tides; and the author is indebted to the valuable assistance of Sir Edward J. Reed, K.C.B., M.P., in the arrangement of these details.

Pumps.—The pumping machinery for discharging the water from the graving dock is shown in Figs. 13 to 17, and consists of two centrifugal pumps, each working in a separate circular well, and driven by a high-pressure horizontal engine; and four lift pumps, all fixed in one square well, and driven by a direct-acting condensing engine. The water from the graving dock flows through a culvert V into the square well, whence it passes by separate culverts O O into the circular wells; and there is also a culvert S fitted with a sluice T between the two circular wells. The water from the whole of the pumps flows through the culverts B B and P, to the tank or well C under the boiler-house floor, from which it is conveyed by a 5 ft. culvert U to the East Dock. When the pumps are started, the sluice T between the two circular wells is closed, and each pump acts independently until the water level in the graving dock is so reduced that the lift of the pumps is equal to about 15 ft.; the sluice T is then opened, and the water discharged by the lower pump passes into the well, below the level of the higher pump at D. When this takes place, the self-acting flap H closes, and prevents the return of this water to the dock. The water discharged by the lower pump is thus passed through both pumps, and they divide the lift between them.

Centrifugal Pumps.—The construction of the centrifugal pumps is shown in Figs. 14 to 17. The cover shown over the revolving fan is for the purpose of removing the great pressure of the water from a large part of the upper surface of the fan; and as the water pressure has access to the underside of the fan, this pressure, instead of increasing the weight of the bearings, tends to support the fan, and takes away almost the whole pressure due to the weight of the fan and spindle on the bearings. Although the joint between this cover and the fan is nearly water-tight, it cannot be made perfectly so without too much friction; and the little leakage with takes place is removed to the underside of the pump through the three hollow standards or supports G, Figs. 16 and 17. The space between the cover and revolving fan is thus always kept free of water; and the fan and spindle bearings are relieved from water pressure and friction that would

* Paper read before the Institution of Mechanical Engineers at the Cardiff meeting.

otherwise absorb much power in overcoming them. The revolving fans are 4 ft. 2 in. in diameter, and when driven at their usual speed of about 200 revolutions per minute, they discharge about 3000 cubic feet of water in that time.

Lift Pumps.—The lift pumps, Fig. 14, are each 29½ in. in diameter, and 48 in. length of stroke. Their general speed is about fourteen strokes per minute, at which rate each pump discharges about 250 cubic feet, equal to 1000 cubic feet discharged per minute by the four pumps together. The engine which works the lift pumps works also two force pumps auxiliary to the force pumps for the service of the hydraulic machinery. Steam for these engines is supplied by three high-pressure boilers, working at 70 lb. to 75 lb. pressure, and by one low-pressure boiler, working at 10 lb. to 20 lb. pressure.

A pipe E, with a valve F, in the square well in which the lift pumps are fixed, is for the purpose of filling the graving dock from the East Dock when desired. The whole of the pumping machinery has been supplied by Messrs. R. Moreland and Son, of London.

2. The second graving dock is at the head of the Bute West Dock, constructed by Messrs. Charles Hill and Sons; it is 230 ft. long, with an entrance 40 ft. wide, and 12½ ft. depth of water over the sill. Vessels can here be docked at all times, irrespective of tides.

3 and 4. Two graving docks have also been constructed by Hills' Dry Dock and Engineering Company at the north-west side of the Bute East Dock. One is 408 ft. in length, with an entrance of 48 ft. in width, and 18½ ft. depth of water over the sill. The other is 400 ft. in length, with an entrance of 40 ft. in width, and 18½ ft. depth of water over the sill. Vessels can be docked in both docks at all times, irrespective of tides. The docks are pumped out by a pair of centrifugal pumps, with suction and delivery pipes of 18 in. bore and revolving discs of 4 ft. in diameter, made by Messrs. W. H. Allen and Co., of Lambeth. Each pump is intended to discharge 6000 gallons of water per minute; the two together have discharged on trial 18,000 gallons per minute, emptying the dock in two hours. Each is driven by its own engine, having an inverted cylinder of 15 in. diameter and 12 in. stroke, and working at an average speed of 180 revolutions per minute, with 60 lb. steam, cut off at three-eighths of the stroke. Either engine can work either pump, and can pump out either of the docks. The pumps have to discharge the water from the dry docks into the basin, the maximum height of lift being 22 ft. They are charged by means of a steam ejector, which exhausts the pipes and pumps in about one minute, thereby dispensing with a foot-valve; a self-acting flap-valve on the delivery side is alone required.

5. One graving dock, with an entrance from the basin of Bute East Dock at one end, and another entrance from Bute West Dock at the other end, has been constructed by the Cardiff Junction Dry Dock and Engineering Company. It is 420 ft. in length between the caissons, and 77 ft. in width at top of coping, with 18 ft. depth of water on the blocks; the entrances are 50 ft. in width, and the depth of water over the sill 20 ft. Vessels can be docked at all times, irrespective of tides; and this dock is available in case of need as an additional entrance to the West Dock through the East Basin. The water is let into the dock from both ends, through two sluices in each caisson; and the dock can be filled by these sluices in thirty minutes.

Caissons.—The caissons are fitted in grooves formed in the masonry, and are lowered and held down in their places by water ballast run in through inlet valves; the sinking occupies three minutes. For the purpose of raising the caisson, which has to lift about 5 ft. in order to clear the sloping side grooves, the water is pumped out by two pulsometers, which are fitted inside the caisson and are supplied with steam from the main boilers, the steam pipes being connected by flexible hose; the time occupied in lifting is six minutes.

Centrifugal Pumps.—The whole of the water from the graving dock is pumped up to a level not less than 1 ft. above the dock coping, and is returned to the Bute Docks. The pumping machinery was designed and constructed by Messrs. Parfitt and Jenkins, of Cardiff. There is one pump well only constructed of stone, and 9 ft. in diameter. In this well is fitted a vertical shaft, on which are two centrifugal pumps, each precisely the same in design and dimensions. The bottom one is fixed 2 ft. below the dock bottom, and the upper one 14 ft. above, leaving about 14 ft. head on the top pump, when working. The pumps make 210 revolutions per minute, and are driven by a pair of horizontal compound condensing engines, geared to the pumps by mortice bevel wheels. The engine cylinders are 22 in. and 40 in. in diameter, with 30 in. stroke, making seventy revolutions per minute, or one-third the speed of the pumps; pressure of steam from 65 lb. to 70 lb. per square inch.

Bucket Pumps.—Besides the main centrifugal pumps there are a pair of drain pumps, used for pumping out any leakage from the caissons into the dock. They are a pair of ordinary bucket pumps, 19 in. in diameter and 4 ft. stroke, worked direct by a high-pressure beam engine having a 16 in. cylinder, and the pump rods are hung off the extended ends of the beam. This engine makes about sixteen revolutions per minute, and when pumping out the dock works in conjunction with the main centrifugal pumps.

The engines are supplied with steam by two boilers of the marine type, having brick flues at the back, instead of the ordinary combustion chambers. The boilers are 10 ft. 3 in. in diameter and 11 ft. 3 in. long.

The dock when full contains about 16,000 tons of water, and the time occupied in pumping it dry is 2¼ hours. When docking an ordinary sized steamer the time occupied is about two hours.

6 and 7. Two docks, each entered from the west side of the entrance channel to the Bute Docks, belong to the Mountstuart Shipbuilding Graving Docks and Engineering Company. One dock is 324 ft. in length, with an entrance of 45 ft. in width, and depth of high water over sill of 19 ft. 9 in. at ordinary spring tides and 10 ft. less at ordinary neap tides. The other dock is 420 ft. in length, with an entrance of 52 ft. in width, depth of high water over sill 26 ft. at ordinary spring tides and 10 ft. less at ordinary neap tides.

8. A graving dock, with an entrance from the Roath Basin, is now being constructed by the Bute Shipbuilding, Engineering, and Dry Dock Company. It is 660 ft. long, 87 ft. wide at top, and 28½ ft. deep, with an entrance 55 ft. in width, depth of high water over sill 25 ft. at ordinary spring tides, and 10 ft. less at ordinary neap tides. Most vessels can enter or leave at any time, as the ordinary working level of the Roath Basin gives about 18 ft. of water over the sill. Provision has been made for dividing the dock into two by a caisson, which can be placed in any one of three recesses, either at the middle of the length or at 50 ft. on either side of the middle; the inner division can be used for a vessel requiring to stay a longer time in dock, and the outer for vessels staying a shorter time. The dock may be filled either direct from the tideway or from the Roath Basin. It will be emptied by two centrifugal pumps of 4 ft. diameter, on vertical shafts, each in a separate well. Two horizontal non-condensing engines are provided, one for each pump, the cylinders being 16 in. in diameter with 3 ft. stroke, to work with 80 lb. pressure of steam. A small separate pump with an engine is also provided for getting rid of any leakage water without running the large pumps. These pumps are designed to empty the dock in about four hours, the quantity of water to be discharged being about 929,000 cubic feet.

Gridiron.—On the east side of the entrance channel to the Bute Docks a gridiron has been constructed by the Bute Trustees, of which the length is 350 ft., and the width 30 ft.; the depth of water at high water is 23 ft. at ordinary spring tides, and 13 ft. at ordinary neap tides.

STANDARDS OF LENGTH.

*Standards of Length and their Subdivision.**

By George M. Bond, Hartford, Conn.

(*Continued from page* 84.)

After having thus briefly considered the subject of the "evolution" of a standard, and the conditions under which it must continue in order to be worthy of being called a standard, we will now attempt to show some of the methods adopted for comparing these yard or meter bars, and explain some of the principles upon which the accuracy of the comparison depends.

We have already partly described the way in which the end meter is compared or transferred to a line measure by the reflection of a fine point of platinum, without actually touching the ends of the standard bar. We may now notice how two standard end measure bars may be compared, using a method by which the differences, if any, are greatly magnified, and are thus very readily determined.

A most ingenious application of the laws of the reflection of light was made by Joseph Saxton for comparison of end-measure bars, and for which, in recognition of its value to science, he was, in 1837, awarded the John Scott Legacy Medal, his invention being the reflecting comparator. It depends upon the magnified distance of the path of a reflected ray of light, caused by the rotation of a mirror placed vertically, and delicately pivotted, the spindle of the mirror being connected with a sliding bar by a fine watch fusee chain wound around the barrel of the mirror spindle. At the end of the sliding bar, to which this chain is attached, contact is made with the end of the standard to be compared, the other end of the standard being firmly abutted against an immovable stop.

By first placing the standard bar in position, care being taken to have the bar supported at the "neutral points," and exactly in line, so that the centres of the opposite ends of the standard are against the contact surfaces of both the stationary and the sliding stops—and which, by the way, is one of the most difficult features of the experiment—a ray of light is brought to bear upon the mirror, and the reflection of a circular scale is observed through a small telescope, mounted just above this divided arc. This circular scale may be placed at any convenient distance from the mirror, say 15 ft. or 20 ft.

It is evident that a very slight motion of the sliding bar G (Fig. 1), will cause a ray of light, reflected from the mirror M, to which its motion is imparted through the small chain and drum, to move with a much greater velocity at the distance of the large circular scale R S, and, as the angle of incidence is equal to the angle of reflection, a motion of the mirror through an arc of 5 deg. would cause a motion of the reflected ray of 10 deg., as we may readily understand by taking the geometrical proof in illustration.

A polished surface is placed so that the light strikes it "squarely," or, in other words, at no angle whatever; it will evidently be reflected directly back to its source, Fig. 2. Now, suppose it is rotated into a position, as indicated in

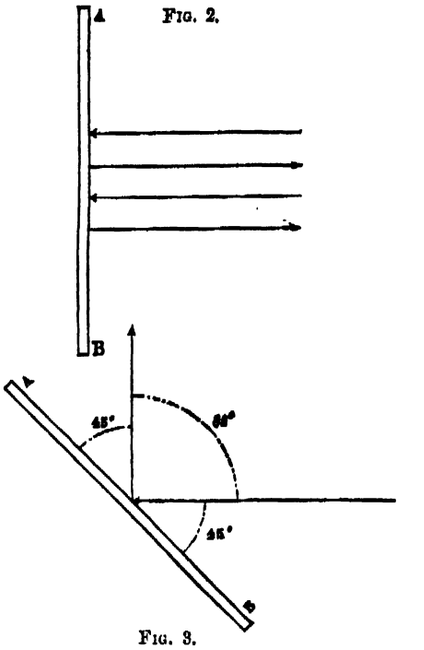


Fig. 2.

Fig. 3, which is just 45 deg. as compared with its original position, the light still coming from the same direction; it now strikes it at an angle of 45 deg., and as light is always reflected at the same angle as that at which it strikes a polished surface, its new path will be again 45 deg. from the plane of the mirror; but, as will be seen, it is twice 45 deg. with respect to its incident path, and is thus reflected at an angle of 90 deg.

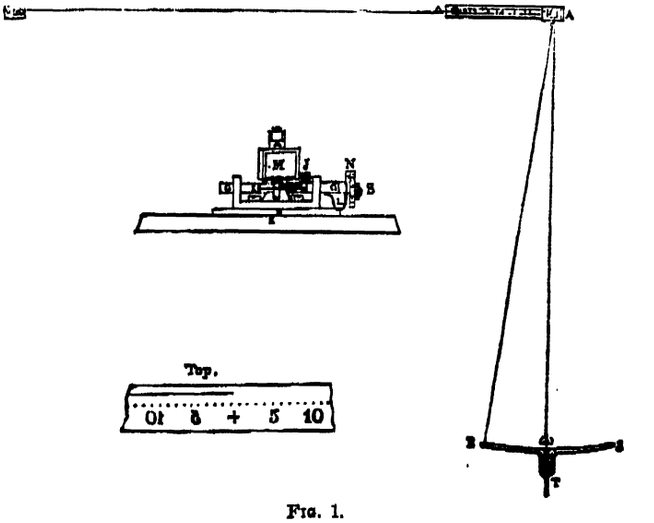


Fig. 1.

We can readily see how extremely delicate or sensitive to the slightest change of position this reflected ray becomes. As light may be said to have no weight, and consequently no momentum or inertia, it will quickly and certainly indicate the slightest change in length of a standard end measure bar.

By calculating the length of the relative "lever arms" we can easily determine the magnifying capacity of such an instrument of precision. For instance, supposing the drum on the spindle to which the rotating mirror is attached, is ¼ in. in diameter, and that the length of the radius of the large circular scale is 20 ft., we have, using the double angle in this relation, the distance moved by

* A lecture delivered before the Franklin Institute, February 21, 1884.

the sliding bar touching the standard, as compared with the arc passed over by the reflected ray at the distance of 20 ft. from the mirror, and reducing to the same unit, as $\frac{1}{8} \times \frac{1}{12} \times \frac{1}{20} = \frac{1}{1920}$ is to 1, or as 1 is to 3840, hence a motion, or variation of $\frac{1}{1000}$ in. at the point of contact would be 3.84 in. at the scale.

By placing a metallic bar in a closed tube, the ends merely projecting through this tube, and filling the tube with ice water, and then with water of a known higher temperature, and comparing the lengths of the same bar under these varying conditions, the amount of expansion for each degree can be determined; this will give us what is called the coefficient of expansion, to which reference has already been made.

The comparator in use by the United States Coast Survey at Washington, designated as the Saxton yard dividing comparator, is one designed by Mr. Saxton while in charge of the construction of standard balances, weights, and measures of length, to be presented to the different States, to insure uniformity throughout the country.

A short description of this comparator may be quoted from a paper read by Professor W. A. Rogers before the American Academy of Arts and Sciences, April 14, 1880, "On the Present State of the Question of Standards of Length," and from which, also, much that is of interest in regard to our subject-matter for this evening, has been obtained. To any one wishing to pursue the subject further, the paper entire, and the references contained at the end, will be of very great assistance.

"The Saxton comparator consists of a brass bedplate, having V-shaped ways running the entire length. A slide carrying a microscope slides freely over these ways.

"A series of brass posts form a part of this bed, through which pass steel screws, having conical ends, which have been tempered and polished. There are stops for the yard and for its subdivision into feet, and of 1 ft. into inches. There are also stops for the meter and for its subdivision into decimeters, and of one decimeter into centimeters . . . The end stops for the yard and for the meter were, many years ago, set to correspond with 'bronze No. 11,' at 58 deg. nearly for the yard, and with the iron meter at 68 deg. nearly. . . . The standards which have been distributed since 1856 have been transferred from these distances at the temperature at which they are standard.

"The yard in actual use at the Bureau of Weights and Measures, therefore, may be defined to be the distance between two steel stops attached to the bed of the Saxton comparator, which corresponds to the length of bronze No. 11, at 58 deg. nearly, and the meter may be defined to be the distance between two steel stops of the Saxton comparator, which corresponds to the length of the iron meter, corrected for the difference between its length at 32 deg. and at 68 deg., nearly. Recent comparisons indicate that these temperatures should be diminished, by a trifling amount, for the present distances between the stops both for the yard and for the meter."

Engravings representing the Saxton yard dividing comparator and also the Saxton reflecting comparator here shown, were obtained through the kindness of Professor J. E. Hilgard, Chief United States Coast Survey, by whom every facility was afforded me for examining the methods of comparison. The courtesy of Mr. Blair, assistant in charge, has aided me greatly in thus being able to illustrate the instruments now in use at the office of the Coast Survey.

Another form of a comparator, which has proved to be successful in the use of the means "for the end sought," in the comparison and investigation of standards of length, is that known as the Rogers-Bond universal comparator, which was constructed, from plans proposed by Professor Rogers, by the Pratt and Whitney Company, of Hartford, Conn., for their use in practically establishing standard gauge dimensions. A duplicate comparator of this form was also made by them for Professor Rogers for his professional work at Cambridge, and for the transfers and comparisons of standards used by the Pratt and Whitney Company as a basis of these standard sizes.

The comparator at Cambridge is also used by Professor Rogers in determining the coefficients of expansion of the various materials used in the construction of standard yard and meter bars, and also for obtaining the relation between the length of the Imperial yard and the "Mètre des Archives." The solution of this latter interesting and difficult problem is fully given in a memoir by Professor Rogers, presented May 9th, 1883, before the American Academy of Arts and Sciences, entitled "Studies in Metrology," and to which reference may be had.

The special features of the universal comparator are, as its name implies, the variety of the methods employed and the range of work that can be done in comparing standards; each independent method, when carefully carried out, producing similar results which serve to check or prove the comparisons. It includes a method for investigating the sub-divisions of the standard by comparing each part of the total length with a constant or invariable quantity of distance.

By the aid of the plan and elevation of this form of comparator (Fig. 4), the aim being to exhibit principles rather than a picture of the instrument, we may be able to describe in a few words the main features of its construction.

A heavy cast-iron base A is mounted upon stone capped brick piers, giving a permanent foundation to the apparatus. Upon this base, and reaching from end to end, are two heavy steel tubes, B and C, 3 in. in diameter, ground perfectly straight, and being "true" when placed in the centres of a lathe, the object being to get a straight line motion of the microscope plate D, which slides freely on these true cylinders.

Flexure of these cylindrical guides is provided for, by lever supports at the neutral points n and n^1. Fitted closely to these guides, and outside of the range of motion of the microscope plate D, are two stops E and F, one at each end, as shown in the figure. These stops are arranged to be adjusted at any desired position along the guides, and are securely held by clamping on the under side by the handles G and H.

These stops are each provided with a pair of electro-magnets, I and J, the poles of which do not come in contact with the armature seen at either end of the microscope plate. Contact is made at K and L, which are hardened steel surfaces, tempered and polished, and placed as nearly as possible in the centre of the plate and of the stops.

The magnets are intended to overcome the unequal pressure due to ordinary contact, a rack and pinion being used to move the plate. The magnets are used to lock the microscope plate at each end of its traverse between the stops. The use made of this sliding microscope plate and the stops we shall see presently.

Beyond the main base just described, and supported also on brick piers, is an auxiliary cast-iron frame N, which is provided with lateral and vertical motion within limits of zero and 8 in. and 10 in. respectively, for rough or approximate adjustment, and upon the top of this frame are

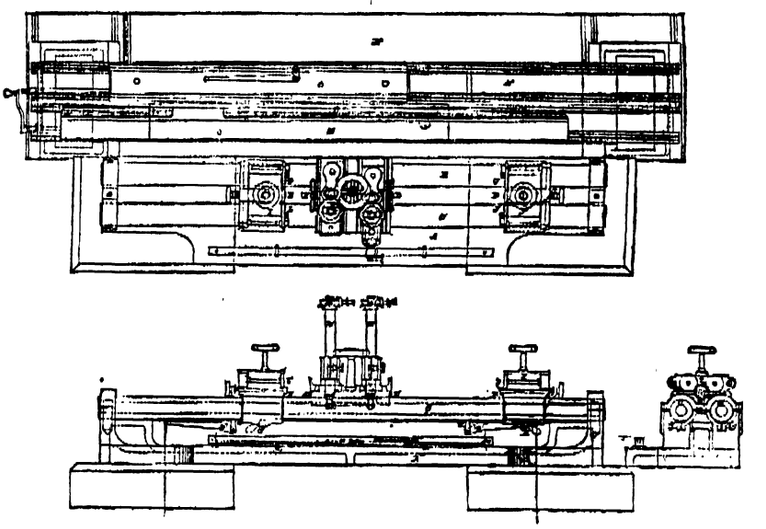


FIG. 4.

two carriages O and O', which slide from end to end, a distance of about 40 in. Upon these sliding carriages are placed tables T and T', provided with means for minute adjustment, for motion lengthwise, sidewise, and for leveling, thus permitting the adjustment of a standard yard bar quickly, and without the necessity of its being touched with the hands after being placed upon the table until the work of comparison is completed.

Before describing the operations necessary for a series of comparisons, it may be well to explain the peculiar fitness, for purposes of this kind, of the microscopes M and M' used in this connection.

The tubes are 12 in. long and 1½ in. in diameter; the eye-piece micrometers m_1 and m_2 were made by Joseph Zentmayer, of this city, whose skill as an optician is too well known to require further proof of their excellence. The objectives were made by the late Mr. R. B. Tolles, of Boston, and are each fitted with his illuminating prism.

In order to use a microscope upon lines ruled on polished surfaces, or on any opaque material, some means for obtaining sufficient light must be employed to see them distinctly, without the use of reflectors, which are often a source of error in standard work.

In no other form of objective does this requirement seem better fulfilled than that invented and made by Mr. Tolles. The objectives are each fitted with a prism of perfectly clear glass, placed just above the lower lens, and one end of the prism passes through the side of the objective. The inner end of this prism is bevelled (Fig. 5), forming such an angle of the end surface to the axis of the prism, that light is refracted perpendicularly upon the surface of the bar, lines less than $\frac{1}{10000}$ in. in width being easily seen and separated with a 1 in. objective. It may be said to "carry its own lantern," and with light so thrown, just where it is most needed, the bottom of the cut or furrow of a line cut by a diamond edge, as fine as that just stated ($\frac{1}{10000}$ in.), as well as the edges of the furrow, can readily be seen.

This method of illumination has proved to be invaluable in the work of comparing line measure standards, especially so in the case of bars having the lines ruled on polished gold surfaces at the bottom of wells sunk one-half the depth of the bar, these wells being not over $\frac{1}{8}$ in. in diameter, as in the case of bronze 1, and also of the bar now before you.

The first operation in the use of this form of comparator is to level the main base A, then, sliding the microscope D from end to end of the steel tubular guides, having the microscope adjusted so as to be in focus upon the surface of mercury held in a shallow trough, over which the microscope passes, the curvature due to flexure of the guides is determined, and may be compensated for by counterweights at the neutral points of support n and n^1.

In order to test this right line path of the microscope plate horizontally, the method of the "stops" is employed, or, another method, which is that of tracing a fine line the entire length of a standard bar upon its upper surface, and reversing the bar, tracing another line very near the first and at an equal distance apart at each end; then if this distance is uniform between the two lines the entire length, it is safe to assume that the path of the plate is a straight line horizontally, and at the middle, the amount of curvature, if any, and also if regular, is readily determined. This method has been used by Professor Rogers with marked success.

The "stop measure" is to compare a line measure, or an end measure bar, on each side of the centre line of motion of the microscope plate, using *one* microscope, and comparing this fixed length with the constant quantity before referred to, which is the distance between the stops. Should the path be a curved one, the distance between the defining lines upon the bar will appear greater on one side than on the other in proportion to the amount of curvature existing. The length of the standard being the chords of circles of different radii, but by comparison with the stops seems really to be different in length at each position, caused by the different distance, through a larger arc passed over by the microscope. By means of the proportion of similar triangles, the lengths of the radii may be very accurately determined. By placing different standards on one side of the line of the stops, they may be, by being compared with a constant quantity, compared also with each other.

(To be continued.)

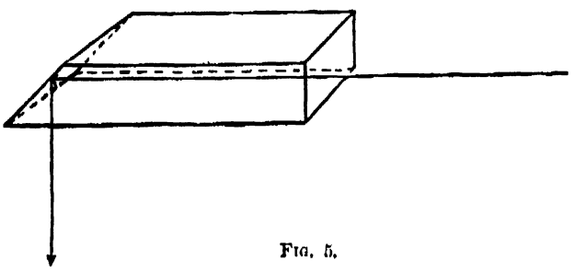


FIG. 5.

FOREIGN AND COLONIAL NOTES.

New Australian Lighthouse.—A new lighthouse on Cliffy Island near Wilson's Promontory, is expected to be ready for use in a short time. The light will be a red flashing light, and will be visible about fifteen nautical miles.

American Telegraphy.—There were 42,917 telegraph offices in the United States in 1882. The number of telegrams forwarded during the year was 40,581,177.

New South Wales Railways.—The tender of Messrs A. Johnson and Co., has been accepted for the construction of a railway from Burgendore to Michelago. The amount of the contract is 497,706*l.*

Canadian Pacific Railway.—This great line is expected to be completed eastward to Montreal by the summer of 1885. Work is being rapidly pushed forward in the Rocky Mountains. The Canadian Pacific Company is

offering every inducement and facility for the building of good elevators of not less than 10,000 bushels capacity with steam appliances for cleaning, &c.

Auckland.—Auckland, which has kept rapidly advancing while there has been dulness and stagnation in the south of New Zealand, is still extending by the erection of new houses all around. Tramways are being laid down in all the principal streets. Considerable progress has been made at Point Calliope in the harbour, in the preparation of a site for a dock, which is to have 33 ft. of water on the sill.

The King Country (N.Z.).—For some months past a survey of the King Country in New Zealand has been going on, with the sanction of the native owners, who are satisfied that arrangements will be made for their permanent benefit. Surveys have also been made for the construction of a trunk railway to connect Auckland with Wellington, thus opening up the whole of the interior of the North Island. Mr. Mitchelson, the Minister of Public Works, has traversed the country, and is prepared to lay a report upon the subject before the New Zealand Parliament.

The San Francisco Mail Service.—Correspondence in reference to the San Francisco mail service has been presented to the New Zealand Parliament. The New Zealand authorities on several occasions complained of the inward San Francisco mails being two or three days late, and they have urged that arrangements should be made to have them conveyed by faster steamers between Liverpool and New York. Nothing, however, seems to have been definitely settled upon the subject.

Railways in Manitoba.—In view of the great importance to the interests of the Canadian Pacific Railway Company that railways facilities should be extended to the fertile districts of Southern Manitoba, at the earliest moment, the Canadian Pacific directors recommend to the shareholders the leasing of the Manitoba South-Western Colonisation Railway, at a rental, which will cover the interest, on bonds of that railway, to be issued at the rate of 12,000 dols. per mile. Fifty-two miles of the line are in operation, and it is proposed to extend it 100 miles further when the necessary financial arrangements can be made.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF SPECIFICATIONS PUBLISHED DURING THE WEEK ENDING AUGUST 9, 1884.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

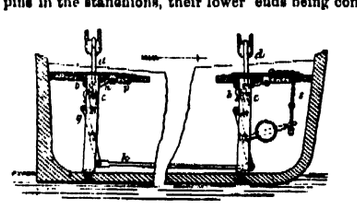
Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

Copies of Specifications may be obtained at 88, Cursitor-street, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, and addressed to MR. H. READER LACK.

NUMBER OF APPLICATIONS FOR PATENTS.

	1884	1883	1883
Aug. 5th	53	..	9
,, 6th	46	1	9
,, 7th	39	18	—
,, 8th	38	15	4
,, 9th	41	16	6
,, 10th	—	10	10
,, 11th	36	18	12
Total for week	248	78	50
Total from January 1st to Aug. 11th (inclusive) ..	11,159	3907	1877

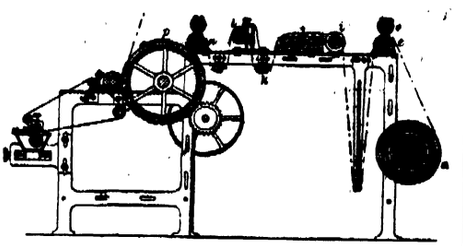
5510. Automatic Detaching and Safety Attaching Gear for Ships' Boats: J. Dixon, M. Waddle, and E. Dawson, Blythe, and E. Marshall, North Shields. [6d. 4 *Figs.*]—The principal feature of this invention is the safety locking gear for preventing attaching of one end of a boat without the other. Referring to the illustration, the hooks B hang the boat in the long shackles D of the lower tackle blocks, through transverse slots in the "thwarts." These hooks work on fulcrums C, and are connected by short links to levers G working on fulcrum pins in the stanchions, their lower ends being connected



by a rod running along the bottom of the boat. One of the levers G carries a weight constantly tending to open the hooks which are kept closed by the weight of the boat. When the hooks B are open, studs on them engage with the curved jaws of the locking levers N, which are balanced by weights P, and prevent either of the hooks B being closed until the shackles D are inserted in both ends at once, when they press down the locking levers, and the hooks are free to close, being turned upward by pulling the chain S. A slight modification is also described. (November 24, 1883).

5757. Lithographic Printing Machines: A. Paton, Leeds. [6d. 8 *Figs.*]—An intermittent motion, variable at pleasure, is communicated to the director roller to vary the extent to which it is turned at each stroke, so as to give more or less ink to the vibrating feed roller. The pressure of the vibrating roller against the director roller can be delicately adjusted by means of a double-jawed lever carrying it and a collar screw. The bearings of the inking roller are hinged to the framing, and are provided with padded adjusting screws. The feed table of the machine is provided with guides adjustable in slots and having horns projecting over the edge of the paper. The sliding bars which carry the feed guides are connected by a lever and spring. (December 17, 1883).

5823. Printing Machinery: G. W. Osborn and Jno. W. Yates, London. [6d. 2 *Figs.*]—This relates to that class of machinery used for printing continuous sheets of paper with more than one colour. As will be seen from the illustration, the paper after leaving the reel *a* passes upward and between the two drawing rollers *e*, the upper roller *e* working in slotted guides, so that its whole weight bears on the paper. It then passes down-



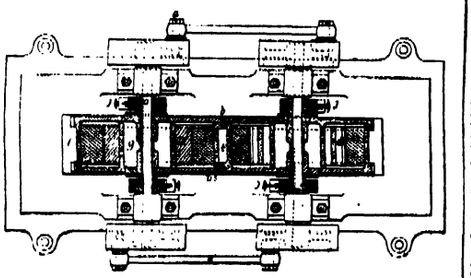
ward and beneath a horizontal compensating roller capable of movement in a vertical plane and proceeds upwards and over the flanged guiding roller *i* to the trough-like guide *j*, under the tightening bar *k*, over the vertically adjustable roller *l*, under the tightening bar *m* to the feed roller *n*, and printing cylinder *p*. The lower feed roller *n* is geared with the printing cylinder so as to run at the same surface speed. (December 18, 1883).

5828. Winches, &c.: W. Clarke, Gateshead-on-Tyne. [6d. 2 *Figs.*]—A disc loose on the engine shaft carries two or more pinions gearing into a pinion fixed to the shaft and also into an internally toothed wheel fixed to the lifting barrel. A brake is fitted around the loose disc which by means of a sliding clutch can be made to revolve with the shaft. By means of the brake and clutch the winch can be made to lift at various speeds and lower at will. (December 20, 1883).

5836. Springs for Carriages: R. Croall, Edinburgh. [6d. 2 *Figs.*]—Three-quarter elliptic springs with cross spring and shackle couplings are applied to the front of the carriage as well as to the back. The upper parts of the springs are connected to the axle bed by bolts, and the cross spring is fastened to the parts to which the shafts or splinter bar are connected. (December 21, 1883).

5833. Converting Continuous Rotary Motion into Step-by-Step Rotary Motion: C. D. Abel, London. (*A. Kaiser, Freeburg, Switz.*). [6d. 7 *Figs.*]—A toothed wheel receiving continuous rotary motion is connected to a starwheel by a circular spring. The starwheel is held by a spring pawl, and as the toothed wheel revolves, teeth thereon raise the pawl, and the star wheel turns until again stopped by the pawl. (December 21, 1883).

5865. Dynamo-Electric Machines: E. C. Warburton, Manchester, and L. J. Crossley, Halifax. [6d. 2 *Figs.*]—The armature and field magnets are rotated, one within the other, in opposite directions. Referring to the illustration, the two parallel shafts *a* are connected together by means of a toothed wheel *b* keyed on one shaft and gearing into a similar wheel free to revolve loosely on the second shaft. Magnets *c c* or arma-



tures *d d* are secured to barrels *f* on the spurwheels. The second shaft is driven from the first by means of cranks *e* and connecting rods, and has keyed on it a wheel b^2 gearing into a similar wheel loose on the other shaft. Magnets and armatures are also secured to barrels on these latter wheels. The brushes *j j* fitted to the frame of the machine bear on the commutator. (December 26, 1883).

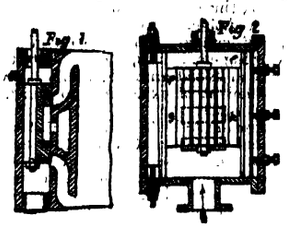
5866. Printing Presses: W. R. Lake, London. (*T. S. Nowell, Boston, U.S.A.*) [6d. 7 *Figs.*]—The platen is adapted to enter the interior of a box with one of the sides of the box interposed between the platen and the type bed. An adjustable table mounted on the platen is adapted to serve as a support for the box and gauge its position relatively to the type forme being adjustable vertically and transversely. A type bed is arranged to be reciprocated towards and from the stationary platen, and one or more board-guiding and supporting gauges adjustably secured to the platen and adapted to receive a board or wooden blank to be printed upon, fed thereto in a horizontal direction. The details of the machine are fully described and illustrated. (December 26, 1883).

5870. Automatic Drain-Flushing Apparatus: W. Ross, Glasgow. [6d. 1 *Fig.*]—The valve is operated by means of a float in a tank. The valve is of the type known as the Ross paragon valve. The lever is connected to a vertical spindle fitted with a sucker and surrounded by a hollow spindle carrying the float, the arrangement being similar to that used in the above-named valve. (December 27, 1883).

5895. Repeating Firearms: W. R. Lake, London. (*A. Larsen and C. E. Winterroe, Liège, Belgium*) [6d. 15 *Figs.*]—The object is to provide mechanism adapted to be easily and rapidly operated by means of a single motion. The magazine is in the form of a tube below the barrel of the firearm, the cartridges being fed by a spiral spring. (December 29, 1883).

5938. Coating Metal Plates with Tin, &c.: E. Morewood, Llanelly. [9d. 4 *Figs.*]—The plate whilst travelling out from the coating vessel is acted on first by the washing rollers and then by other rollers whereby the coating of molten metal is reduced and finished. (December 31, 1883).

5945. Slide Valve for Steam Engines: H. Howaldt, Diedrichsdorf, Prussia. [6d. 3 *Figs.*]—The slide valve is trapezoidal in cross-section, and works between the slide face of the cylinder and the steam chest cover, and it can be adjusted by means of an adjustable plate, so that it works steam-tight, and with a minimum of friction. Referring to the illustration, the pressure of the steam upon the broader side of the valve tends to force it too tightly between the convergent faces of the cover B and the slide face, and to prevent this an adjustable plate or strip



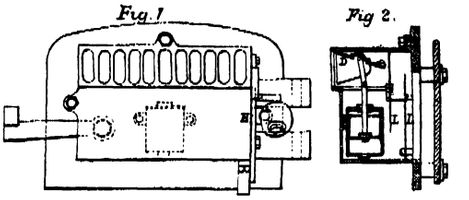
f extends along the smaller side *g*. An adjustable strip may also be arranged to bear on the broad side A of the valve. The mode of adjusting the strips is clearly indicated. To counterbalance the pressure on the face of the valve, it may be formed with a groove on its back. (December 31, 1883).

5953. Self-Feeding Eyeletting Machine: C. Whitfield, Kettering. [6d. 7 *Figs.*]—An interior projection or flange prevents overcrowding or glutting of the eyelets within the box. The friction between the revolving base and the eyelets carries them into a suitable position for escaping into the shoot from which they pass to the dies. (December 31, 1883).

5963. Refrigerators: C. M. Sombart, Magdeburg, Germany. (*B. Mosbius, Chehuahua, Mexico*). [6d. 8 *Figs.*]—The refrigerators consist chiefly of two bags of cotton yarn like that employed for wicks. The bags are woven in one piece with spherical bottoms, one being placed within the other. The bottle or article to be cooled is placed within the inner bag, the space between the bags may be filled with a freezing mixture, and the whole is then moistened with water, the vaporisation of which cools the contents of the bottle. (December 31, 1883).

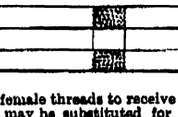
5966. Effecting Intermittent Action of Fog and other Signals: F. W. Durham and J. D. Churchill, London. [6d.]—A steam cylinder with an automatically moved slide is combined with a cataract cylinder having the communication for liquid between its ends regulated by adjustable valves. (December 31, 1883).

5977. Regulating the Supply of Air to Furnaces: W. C. Gale, Lower Tooting. [6d. 6 *Figs.*]—The admission of air to the furnace through the furnace door is controlled by means of flaps which close the air inlets as they turn downward. The descent of the flaps is controlled by the slow admission of mercury into a float, to which the flaps are connected. Referring to the illustrations, the furnace door is provided with a chamber at the back to which air is admitted through gratings. Inside the chamber is a hinged flap D, and below the flap is a cylindrical vessel containing



mercury. The flap is connected by a link and rod passing through a hole in the cover of the vessel to a float within the vessel, the bottom of which is fitted with a valve opening downwards and allows the mercury to pass out when the vessel is raised. When the furnace door is opened, the weighted arm H causes the flap D to be raised, and on closing the door again the flap tends to descend, the descent being controlled by the rate at which the mercury can enter a small hole in the vessel. L L are baffle plates fixed into the chamber. The whole apparatus being inclosed in the chamber is protected and is not exposed. (December 31, 1883).

5981. Printers' Quoins: J. C. W. Featherstonhaugh, London. [6d. 2 *Figs.*]—This comprises a right-handed and a left-handed male screw with an intermediate enlargement and two cheeks or plates with parallel sides, the plates being formed



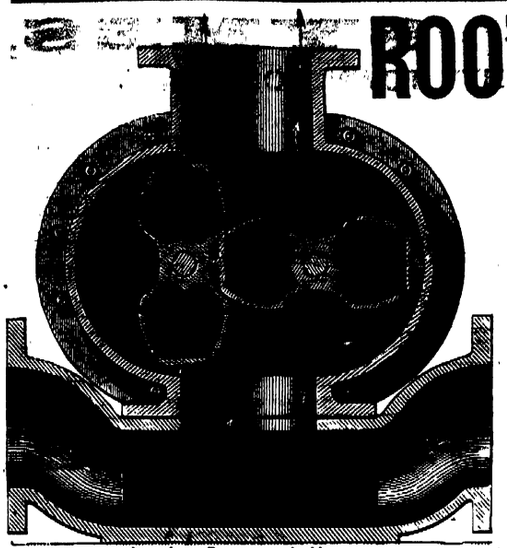
respectively with female threads to receive the right and left male screws. A swivel may be substituted for one of the male and female screws. The illustration clearly shows the construction of the quoin or locking-up apparatus. (December 31, 1883).

5992. Apparatus for Lighting Gas by Electricity, &c.: C. L. Clarke, Manchester. [6d. 7 *Figs.*]—The electrostatic generating device is constructed in cylindrical form, and comprises an outer cylinder of ebonite supporting armatures or inductors of metal foil, an inner cylinder of like material supporting carriers of metal foil, contact springs whereby the charges induced on the carriers are redistributed, and means whereby one cylinder may be rotated with reference to the other either with or without a drying chamber filled with a suitable fabric impregnated with chloride of calcium. (December 31, 1883).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

THE ÆOLUS WATERSPRAY VENTILATOR.—The Æolus waterspray ventilator which was fixed eighteen months ago in the physicians' consulting-room of the London Hospital has given such satisfaction to the medical staff that another installation of the same system in the throat consulting room has been resolved on. The work is now in hand.



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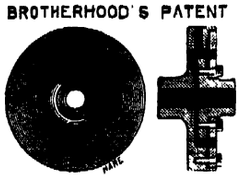
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BROTHERHOOD'S PATENT

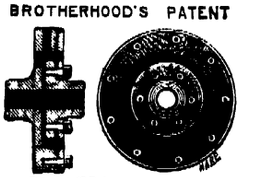


FLEXIBLE COUPLING

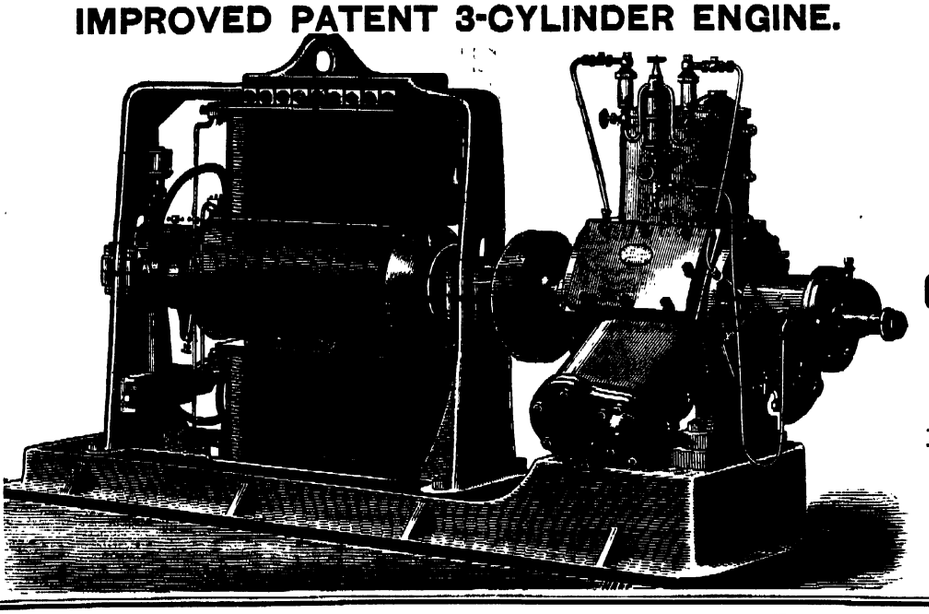
PETER BROTHERHOOD,

MECHANICAL ENGINEER,
BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.
IMPROVED PATENT 3-CYLINDER ENGINE.

BROTHERHOOD'S PATENT



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IMPROVED CENTRIFUGAL PUMPING ENGINE



FOR
DRAINAGE WORKS,
IRRIGATION WORKS,
AND
SEWAGE WORKS.

Direct Acting, with Horizontal or Vertical Engines, in all sizes up to a discharge of 4808
300 TONS PER MINUTE.



EDWARDS & SYMES,

SHIPBUILDERS & ENGINEERS, WHARF ROAD, CUBITT TOWN, LONDON, E.

CONTRACTORS TO THE ADMIRALTY AND H.M. INDIAN GOVERNMENT.

BUILDERS Of all classes of STEAM and SAILING VESSELS, TORPEDO LAUNCHES, YACHTS, TUGS, LAUNCHES.



SILVER MEDAL PARIS EXHIBITION, 1878.

DREDGERS, HOPPER BARGES, FLOATING DOCKS, GIRDERS, ROOFS, &c.

YACHTS and LAUNCHES for Sea or River service, up to 100 feet in length, built of Steel, Wood or Iron. Speeds up to 22 miles an hour. Draught of water down to 6 inches for shallow Rivers. 886

BRABY'S PATENT GLAZING.

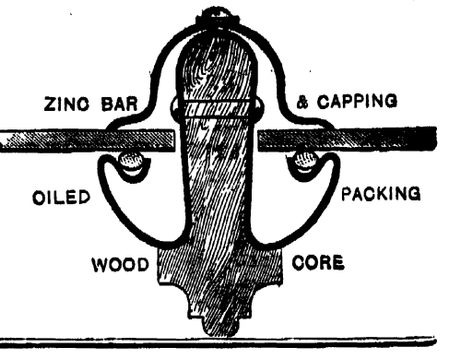
Glass set free, allowing Expansion and Contraction, and precluding Breakage.

ABSOLUTELY WATERTIGHT. PAINTING AND PUTTY SUPERSEDED.

OVER ONE MILLION FEET FIXED.

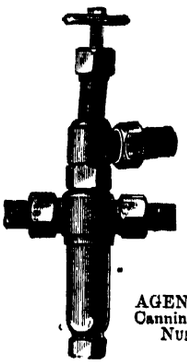
DRAWINGS AND PRICES ON APPLICATION.

MODELS AND SECTIONS ON VIEW. 5112



LONDON: 356 to 362, EUSTON ROAD. | LIVERPOOL: 6 and 8, HATTON GARDEN. | GLASGOW: 335, ARGYLE STREET.

BORLAND'S PATENT INJECTORS



START PROMPTLY WHEN THEY ARE HOT.

No Moving Parts. No Joints to make. Continuous Action. Cheap and Economical. Small and Neat. Cleaned in a few seconds. Of best Gun-Metal only.

SPECIALITY IN INJECTORS FOR TRAMWAY, TRACTION, & LIGHT LOCOMOTIVE ENGINES.

: SOLE LICENSEE :

CHAS. S. MADAN,

21, MANSFIELD CHAMBERS, ST. ANN'S SQUARE, MANCHESTER,

WHO TESTS ALL INJECTORS PERSONALLY.



SPECIALITY IN INJECTOR AND GENERAL BOILER FITTINGS, GUARANTEED TO BE OF HIGHEST UTILITY AND EXCELLENCE.

ALL OF BEST GUN-METAL ONLY. A LARGE STOCK KEPT.

AGENTS—London and District, HOPKINSON & PRINCE, 15, Walbrook, E.C.; Liverpool and District, THOS. HOSKING, 18, Strand Street, Canning Dock; Swansea and South Wales, PHILIP ROGERS, Coleridge House; Ashton-under-Lyne, JOHN FLETCHER, Borough Brass Works; Nuneaton and District, TITUS ROBOTTOM; Manchester, F. B. WELCH & CO., Market Street; Cork, D. MACILWRAITH & SONS; Midlands, HUNT & MITTON, Cozells Street North, Birmingham. 5120

PRICES, TESTIMONIALS, INSTRUCTIONS, &c., ON APPLICATION. LIBERAL TERMS TO THE TRADE.

JOHN SPENCER & SONS,

NEWBURN STEEL WORKS, NEWCASTLE-ON-TYNE,

AND

PARLIAMENT MANSIONS, VICTORIA STREET, LONDON, S.W.,

MANUFACTURERS OF

LOCOMOTIVE AND MARINE

CRANK SHAFTS.

STEEL CASTINGS.

PROPELLER BLADES.

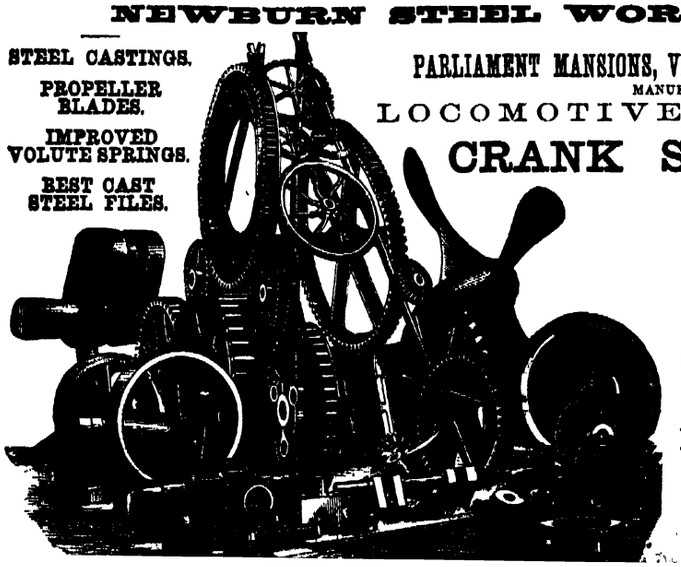
IMPROVED VOLUTE SPRINGS.

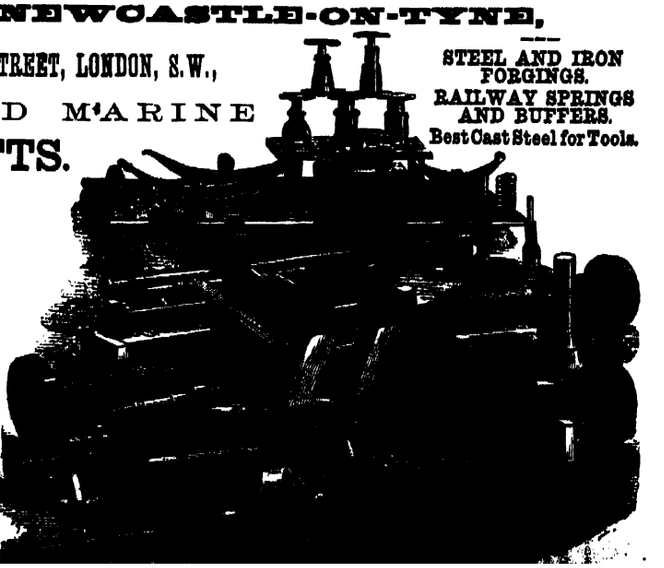
BEST CAST STEEL FILES.

STEEL AND IRON FORGINGS.

RAILWAY SPRINGS AND BUFFERS.

Best Cast Steel for Tools.





INGOTS.

—:o:—

BLOOMS.

—:o:—

BILLETS.

—:o:—

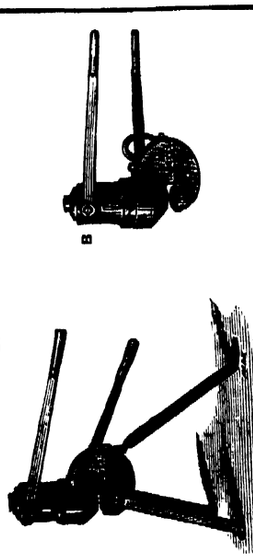
BARS.

4704

TANGYES LIMITED

CORNWALL WORKS, BIRMINGHAM.

TANGYES' HYDRAULIC PUNCHING BEAR
OPEN MOUTH.



This Bear is made in two forms, viz., with legs as A, or with handle instead of legs, as B. The latter is largely used by Ship-builders, for punching ship frames, &c.

Distance from centre of punch to back of gap is 1¼ ins. For extra depth of gap special quotation is necessary.

No.	To punch	Through Iron Plate	Weight	Price
1	⅝ in.	½ in.	84 lbs.	£7 10
1A	1 ,,	¾ ,,	90 ,,	9 0
2	1¼ ,,	1 ,,	120 ,,	10 10
3	1¼ ,,	1 ,,	120 ,,	21 0
4	1 ,,	steel rails	320 ,,	34 0

Price includes one Round Punch and Die.

PUNCHES AND DIES FOR HYDRAULIC AND SCREW BEARS

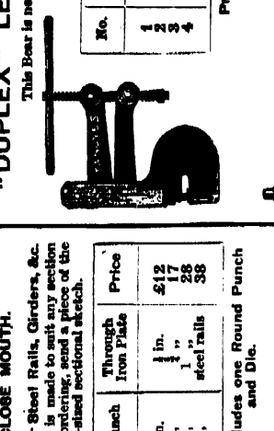
To Punch Hole .. in.	½	⅝	¾	⅞	1	1¼	1½
Through Iron Plate .. ,,	½	⅝	¾	⅞	1	1	1
Round .. per pair	5/-	5/6	6/6	7/-	7/6	10/-	20/-
Oval or Square .. ,,	10/-	11/-	12/-	14/-	15/-		

A Pair means one Punch and one Die.
Intermediate sizes charged at price of next larger size. 144

TANGYES' HYDRAULIC PUNCHING BEAR
CLOSE MOUTH.

For Iron or Steel Rails, Girders, &c.

This Bear is made to suit any section of rail. In ordering, send a piece of the rail or a full-sized sectional sketch.

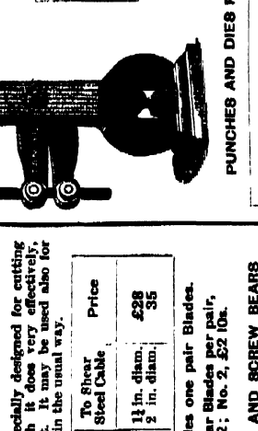


No.	To punch	Through Iron Plate	Price
1	¾ in.	½ in.	£12
2	1 ,,	¾ ,,	17
3	1¼ ,,	1 ,,	28
4	1 ,,	steel rails	38

Price includes one Round Punch and Die.

TANGYES' HYDRAULIC STEEL CABLE SHEARS

This Tool was specially designed for cutting Steel Cables, which it does very effectively, making a clean cut. It may be used also for Shearing Iron Bars in the usual way.



No.	To Cut Iron Bar	To Shear Steel Cable	Price
1	2 ins. × ½ in.	1½ in. diam.	£28
2	3 ins. × ¾ in.	2 in. diam.	35

Price includes one pair Blades.
Extra Shear Blades per pair,
No. 1, £2; No. 2, £2 10s.

PUNCHES AND DIES FOR HYDRAULIC AND SCREW BEARS

To Punch Hole .. in.	½	⅝	¾	⅞	1	1¼	1½
Through Iron Plate .. ,,	½	⅝	¾	⅞	1	1	1
Round .. per pair	4/-	5/-	5/6	6/-	7/6	10/-	20/-
Oval or Square .. ,,	8/-	10/-	11/-	12/-	13/-	14/-	15/-

A Pair means one Punch and one Die.
Intermediate sizes charged at prices of next larger size. 145

"DUPLEX" LEVER PUNCHING BEAR
TANGYES'

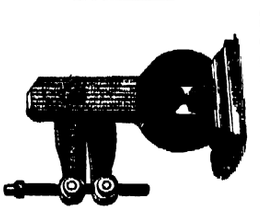
This Bear is now made almost entirely of Steel

OPEN MOUTH DUPLEX BEAR

No.	To punch	Through Iron Plate	Gap	Weight	Price
1	½ in.	½ in.	1½ ins.	18 lbs.	£3 10
2	¾ ,,	¾ ,,	2 ,,	31 ,,	4 10
3	1 ,,	1 ,,	2½ ,,	130 ,,	6 10
4	1¼ ,,	1¼ ,,			10 10

Price includes one Round Punch and Die.

CLOSE MOUTH DUPLEX BEAR



No.	To punch	Through	Price
1	1½ in.	¾ in. Iron Rail	£15 10
2	1¾ ,,	1 ,, Steel ,,	

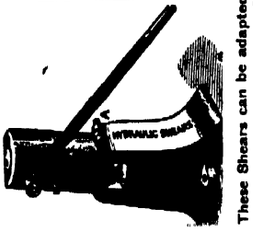
Price includes one Round Punch and Die.

PUNCHES AND DIES FOR HYDRAULIC AND SCREW BEARS

To Punch Hole .. .. in.	½	⅝	¾	⅞	1	1¼	1½
Through Iron Plate .. .. ,,	½	⅝	¾	⅞	1	1	1
Round .. .. per pair	4/-	5/-	5/6	6/-	7/6	10/-	20/-
Oval or Square .. .. ,,	8/-	10/-	11/-	12/-	13/-	14/-	15/-

A pair means one Punch and one Die.
Intermediate sizes charged at prices of next larger size. 147

TANGYES' HYDRAULIC SHEARS



No.	To cut Iron square or round	To cut Iron Bar	Price
1	1½ ins.	3 × ½ ins.	£16 0
2	2 ,,	4 × ¾ ,,	21 10

Weight: No. 1, 230 lbs.; No. 2, 390 lbs.
Extra Shear Blades, per pair:
No. 1, £2; No. 2, £2 10s.

These Shears can be adapted for power by attaching a joint pin to end of lever.

HYDRAULIC SHEARING MACHINE
(Eastwood's Patent)



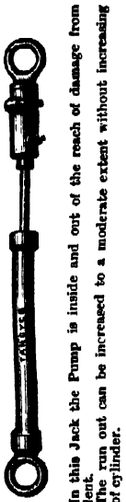
No.	To cut Iron square or round	Price
1	2½ ins.	£42
2	3 ,,	50
3	3½ ,,	65
4	4 ,,	90

All with 10 ins. gap, and two Pumps.

If made with separate Pump to be worked by power, extra.

If mounted on wheels, extra. 143

TANGYES' HYDRAULIC PULLING JACK



In this Jack the Pump is inside and out of the reach of damage from accident.

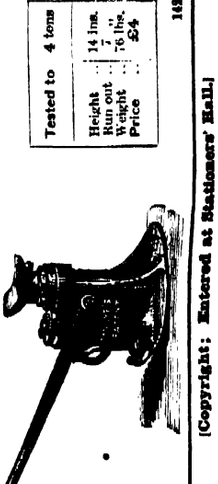
The run out can be increased to a moderate extent without increasing size of cylinder.

Tested to tons	2	4	6	8	10
Run out .. .. ins.	24	24	24	24	24
Weight .. .. lbs.	60	70	90	120	180
Price .. .. £	9	11 10	14	18	80/-
Extra run out, ... per ft.	60/-	60/-	70/-	90/-	

INSTRUCTIONS FOR USING THE PULLING JACK.

After filling it with water, which can be poured in through the air screw, suspend it with the cistern end downwards, screw up the stop valve and work the hand lever; the water will thus be pumped from the cistern through the inner tube to the underside of the piston, thus impelling it forward, and at the same time the water from the back of the piston is constantly flowing through the passages indicated to supply the cistern. TO LOWER, open the stop valve, when the water will return to the cistern.

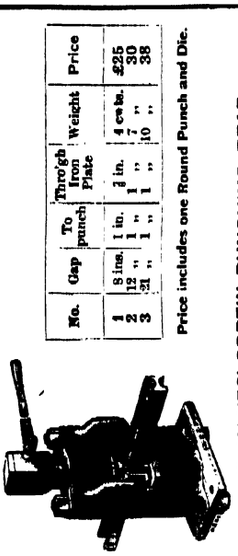
TANGYES' HYDRAULIC TIMBER JACK



Tested to 4 tons	
Height	14 ins.
Run out	14 ,,
Weight	76 lbs.
Price	£4

142

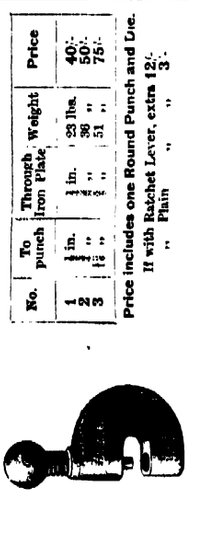
TANGYES' HYDRAULIC PUNCHING MACHINE
STANDARD



No.	Gap	To punch	Through Iron Plate	Weight	Price
1	8 ins.	1 in.	⅞ in.	4 cwts.	£25
2	12 ,,	1 ,,	1 ,,	7 ,,	30
3	21 ,,	1 ,,	1 ,,	10 ,,	38

Price includes one Round Punch and Die.

TANGYES' SCREW PUNCHING BEAR



No.	To punch	Through Iron Plate	Weight	Price
1	½ in.	½ in.	28 lbs.	40/-
2	¾ ,,	¾ ,,	36 ,,	50/-
3	1 ,,	1 ,,	51 ,,	75/-

Price includes one Round Punch and Die.

If with Ratchet Lever, extra 12/-
,, Plain ,, ,, 3/-

PUNCHES AND DIES FOR HYDRAULIC AND SCREW BEARS.

To Punch Hole .. in.	½	⅝	¾	⅞	1	1¼	1½
Through Iron Plate .. ,,	½	⅝	¾	⅞	1	1	1
Round .. per pair	4/-	5/-	5/6	6/-	7/-	7/6	10/-
Oval or Square .. ,,	8/-	10/-	11/-	12/-	13/-	14/-	15/-

A Pair means one Punch and one Die.
Intermediate sizes charged at price of next larger size. 146

[Copyright: Entered at Stationers' Hall.]

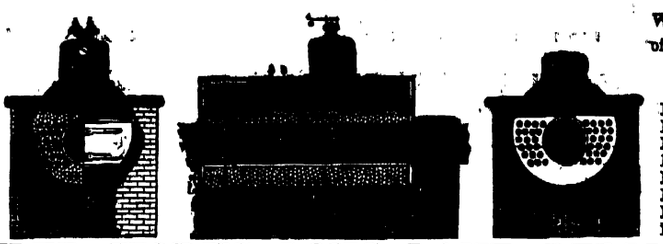
TANGYE BROTHERS, { London - 35, Queen Victoria St. / Newcastle St. Nicholas Buildings. | Manchester - St. Mary's Gate & Deansgate. / Glasgow - - Argyle & Hope Streets.

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breeze, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft.	long,	5ft. 0in.	diameter,	20-horse power.
10ft.	,,	5ft. 6in.	,,	30 ,,
12ft.	,,	6ft. 0in.	,,	40 ,,
13ft.	,,	6ft. 6in.	,,	50 ,,
14ft.	,,	7ft. 0in.	,,	60 ,,
15ft.	,,	7ft. 6in.	,,	70 ,,
16ft.	,,	8ft. 0in.	,,	80 ,,
17ft.	,,	8ft. 0in.	,,	90 ,,
18ft.	,,	8ft. 0in.	,,	100 ,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

DICK, KERR & CO., Engineers and Contractors, (Five Medals awarded, Calcutta International Exhibition, 1883-4.)



SOLE MANUFACTURERS OF

KERR'S PATENT

PORTABLE RAILWAY

SUITABLE FOR MINES AND PLANTATIONS.

WAGONS & LOCOMOTIVES

FOR ALL CLASSES OF WORK.

Catalogues and Prices on application. 5024



101, LEADENHALL ST., LONDON, E.C. Works: Britannia Engineering Works, KILMARNOCK.

R. HORNSBY & SONS, Limited,

[Established 1815.] General and Agricultural Engineers, Ironfounders, Boilermakers, &c. [Established 1815.]

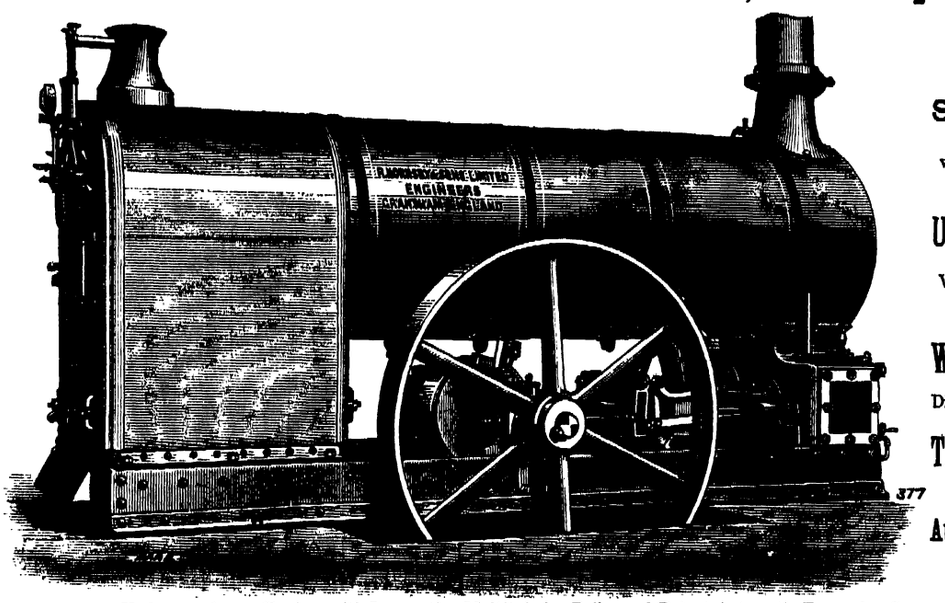
MAKERS OF IMPROVED STEAM ENGINES OF EVERY KIND, FROM 2½ TO 100 HP.

PORTABLE
With Inside or Outside Cylinders.

SEMI-PORTABLE
With Inside or Outside Cylinders.

VERTICAL
WITH
CROSS-TUBE BOILERS.

VERTICAL
WITH
Vertical Tubular Boilers.



HORIZONTAL STATIONARY
Both Simple & Compound, with or without Condensers.

COMPOUND Undertype Stationary,
AND
With or without Condensers.

HORIZONTAL WINDING ENGINES,
BOTH
Direct-acting and with Gearing.

TRACTION ENGINES.

HORNSBY'S PATENT
Automatic Expansion Gear
CAN BE FITTED TO MOST OF THEIR ENGINES.

New Compound Undertype Steam Engine, with Locomotive Multitubular Boiler and Patent Automatic Expansion Gear.

BOILERS: Lancashire, Cornish, Vertical, Cross-Tube, Multitubular, Egg-Ended, etc., etc.

The Hornsby Patent String Sheaf-Binding Harvester, winner of the £100 First Prize of the Highland and Agricultural Society of Scotland, and numerous other High-class Awards.

For Particulars of the most modern improved and successful Agricultural Machinery, including the R.A.S.E. First Prize Mowers, Reapers, Ploughs, Dressing Machines, Corn Screens, Turnip Cutters, Root Pulpers, &c., SEE ILLUSTRATED CATALOGUES in English, French, German, Spanish, Russian, &c., sent GRATIS and POST FREE on application.

PLOUGH SHARES OF CHILLED CAST IRON, WROUGHT IRON, MALLEABLE IRON AND STEEL, OF PATTERNS TO SUIT EVERY VARIETY OF WORK, AND MADE TO LOCAL PATTERNS IF DESIRED.

At the most important Exhibitions and trials since 1874, R. HORNSBY & SONS' Specialities have gained 527 PRIZES, including 65 Gold Medals, 117 Silver Medals, and 309 FIRST PRIZES.

SPITTLEGATE IRON WORKS, GRANTHAM. 4905

London Office: 84, LOMBARD STREET. Telephone No. 1294. South African Depot: EDINBURGH BUILDINGS, DOCK ROAD, CAPE TOWN.

JAMES FARMER & SONS,

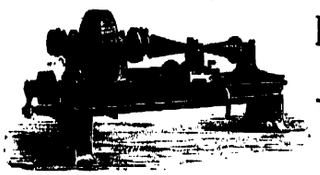
ADELPHI STREET IRONWORKS, SALFORD, MANCHESTER,

MAKERS OF

STEAM ENGINES, BLEACHING, FINISHING, DYEING & CALICO PRINTING MACHINERY,

WIRE MACHINERY

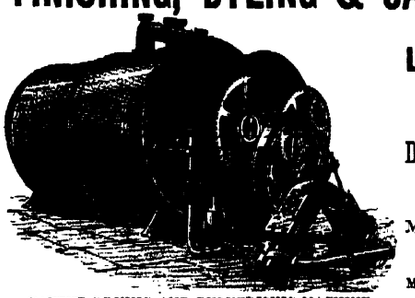
Consisting of Continuous and other Rolling Mills, Wire Pointing Machines, Wire Looms, Wire Testing Machines, Wire Blocks, &c.



COPPER TUBE ROUCHING LATHE.

BRASS & COPPER TUBE MILLS.

Wrought Iron TUBE MACHINERY.



PATENT DRYING AND PULVERISING MACHINE.

COMPLETE PLANT FOR

LINOLEUM MACHINERY

Two and Four Yards wide.

"PATENT"

Drying & Pulverising MACHINE

For Excrementitious Matter & other Materials and Compounds.

MACHINERY IN GENERAL.



POWER WIRE LOOM. 4859

FOR BRICK, TILE, & PIPE MACHINES,

JOHN WHITEHEAD & CO.,

ALBERT WORKS, PRESTON, LANCASHIRE,

HAVE BEEN AWARDED

FOURTEEN PRIZES by the Royal Agricultural Society of England,

INCLUDING THE SOCIETY'S SPECIAL SILVER MEDAL FOR SUPERIOR EXCELLENCE.

Also Awarded the PRIZE MEDALS of the INTERNATIONAL EXHIBITIONS of LONDON, 1851, 1862, and 1874; PARIS, 1855, 1856, 1867, and 1878.

ILLUSTRATED CATALOGUES FREE ON APPLICATION. 4907

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

BELL'S Asbestos Works, Southwark. S.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure.....110 lbs. | **Vacuum**.....29 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,

D. HENDERSON, Chief Engineer, S.S. "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,

Mr. J. BELL. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts, Admiralty, Whitehall, 30th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core.....square. | Elastic core.....round.

To Mr. JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 60 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

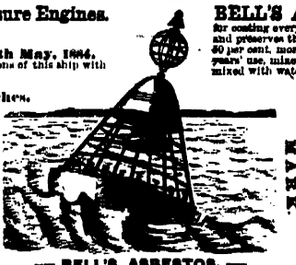
BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



TRADE MARK.

BELL'S ASBESTOS.

The goods of this House are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depôts and not through agents or factors.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates.....**166 deg.**

" **Covering**.....**94 deg.**

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 28th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly, "W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

Mr. JOHN BELL, Southwark, S.E. Gunnislake, Tavistock, 8th April, 1884.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ½ in. to 3 in. wide, and any thickness from 1-16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

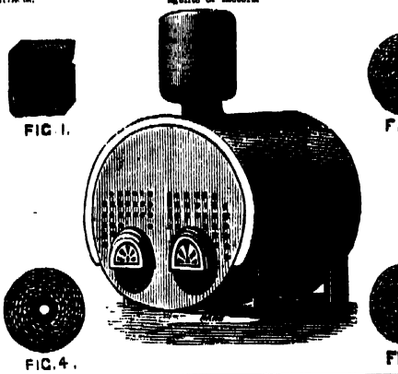


FIG. 1.

FIG. 2

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and 1 millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts, Admiralty, Whitehall, S.W., 17th May, 1884.

SIR,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,

Director of Navy Contracts.

Mr. JOHN BELL.

FIG. 4.

FIG. 3.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REGD.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

4908

OR THE DEPOTS—

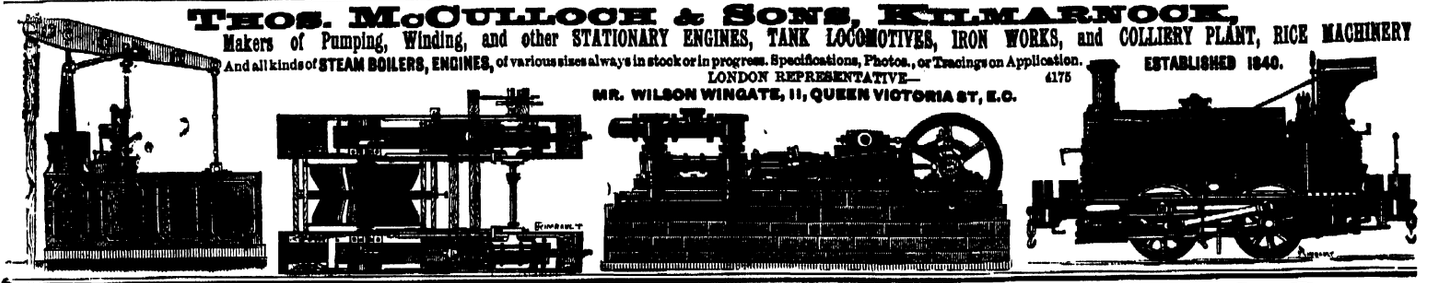
18a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

THOS. McCULLOCH & SONS, KILMARNOCK,

Makers of Pumping, Winding, and other STATIONARY ENGINES, TANK LOCOMOTIVES, IRON WORKS, and COLLIERY PLANT, RICE MACHINERY

And all kinds of STEAM BOILERS, ENGINES, of various sizes always in stock or in progress. Specifications, Photos., or Tracings on Application. ESTABLISHED 1840.

LONDON REPRESENTATIVE—
MR. WILSON WINGATE, 11, QUEEN VICTORIA ST, E.C. 4175



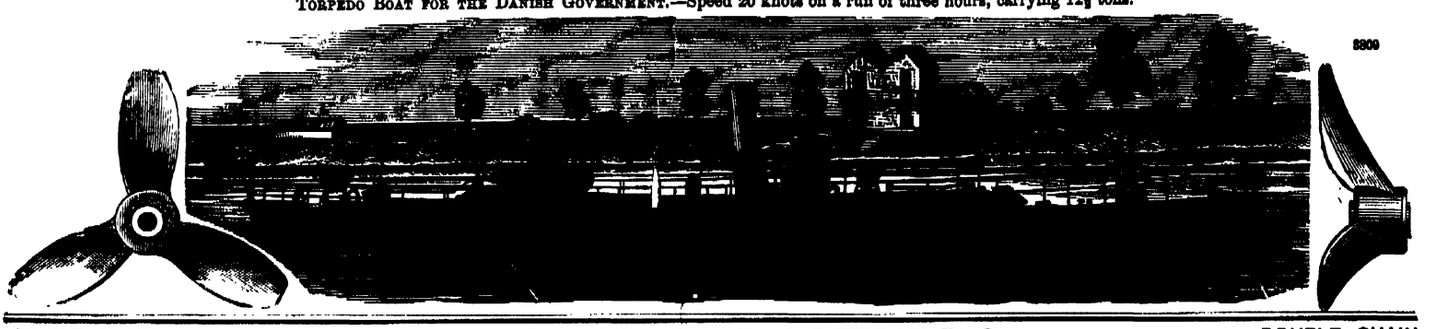
JOHN I. THORNYCROFT & CO.,

STEAM YACHT AND LAUNCH BUILDERS,
CHURCH WHARF, CHISWICK, LONDON, W.

YACHTS AND LAUNCHES FOR SEA OR RIVER SERVICE, from 25 to 100 feet in length, and Speeds from 10 to 25 Miles per Hour

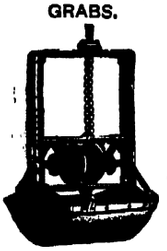
Thornycroft's Patent Screw Propellers made for all sizes of Vessels. Efficiency superior to any hitherto brought out.

TORPEDO BOAT FOR THE DANISH GOVERNMENT.—Speed 20 knots on a run of three hours, carrying 12½ tons.



3309

SINGLE CHAIN GRABS.



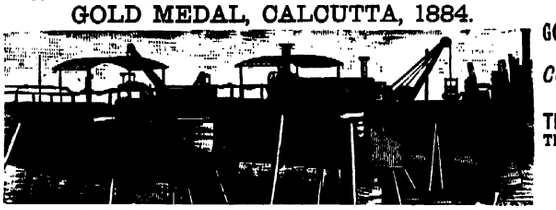
SUPPLIED TO ORDER WHEN PREFERRED.

WORKS:
Holderness Foundry, HULL.

PRIESTMAN BROTHERS.

CONTRACTORS FOR BARGES TO H.M. GOVERNMENT & THE INDIAN BOARD.
GOLD MEDAL, CALCUTTA, 1884.

AWARDS
DIPLOMA of HONOUR AMSTERDAM,
Paris, Melbourne, Adelaide.
Contractors for Dredgers to
THE ENGLISH GOVERNMENT
THE CROWN AGENTS FOR THE COLONIES
The German Government
,, French Government
,, Italian Government
,, Cape Government
,, Danish Government
,, Chinese Government
,, Chilian Government

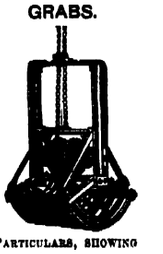


THE PATENT DREDGER EXCAVATOR & ELEVATOR.

LONDON OFFICE:
52, QUEEN VICTORIA STREET.

AWARDS
GOLD MEDAL FISHERIES LONDON,
Sydney, New Zealand, Tynemouth.
Contractors for Dredgers to
THE INDIAN BOARD
THE MERSEY DOCK & HARBOUR BOARD
The South Australian Government
,, New Zealand Government
,, Spanish Government
,, Victorian Government
,, New South Wales Government
,, Dutch Government
,, Queensland Government

DOUBLE CHAIN GRABS.

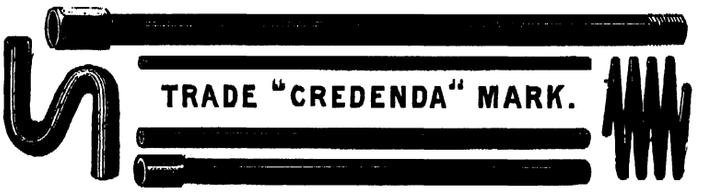


PARTICULARS, SHOWING GREAT ADVANTAGES, ON APPLICATION. 5057

—:- PATENT -:—

COLD-DRAWN SEAMLESS

THE CREDENDA
COLD-DRAWN SEAMLESS
STEEL TUBE COMPANY,
BIRMINGHAM.



TRADE "CREDENDA" MARK.

BIRMINGHAM WORKS & OFFICES:
LEDSAM STREET,
MONUMENT LANE STATION.

LONDON OFFICE:
4, WATER LANE,
GT. TOWER STREET, E.C.
4990

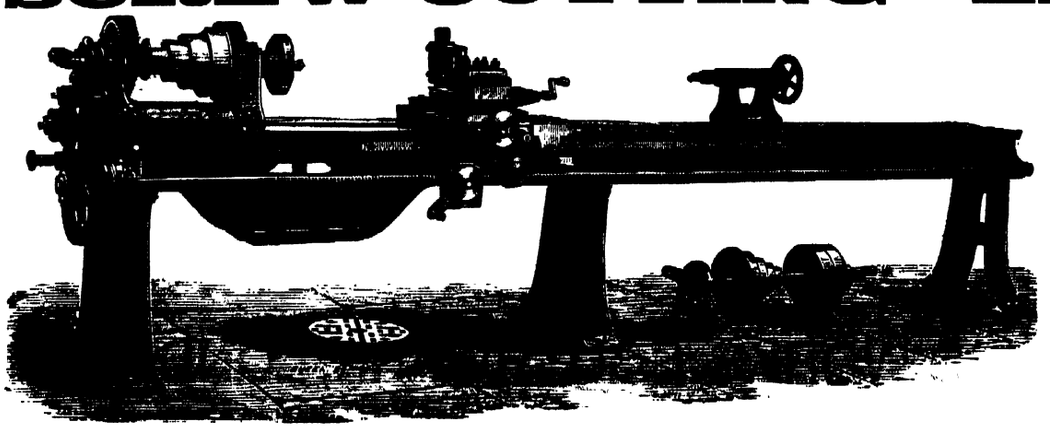
FOR BOILERS AND STAYS,
HYDRAULIC PRESSES,
AIR RESERVOIRS,

STEEL TUBES.

BORING RODS, COUPLINGS,
BUSHES, SPINDLES, COLLARS,
BICYCLES & OTHER USES.

SCREW-CUTTING LATHES,

6 in. to 24 in. Centres.



PRICED CATALOGUES
ON APPLICATION.

LOUDON BROTHERS,

Bothwell St., GLASGOW. } AND { U. Thames St., LONDON.
4780

CLASS A.



LOCO. PATTERN, SINGLE LEVER.

ONLY GOLD MEDAL Paris, 1878.

THE HANCOCK

INSPIRATOR

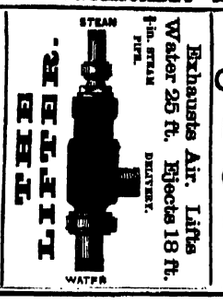
FIRST AWARD, Sydney, 1879.

60,000 IN USE.

THE DONKEY PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND RELIABLY.

No Adjustment.
Draws Water at 140°.
All Sizes lift water 25 ft.
Delivers to Boiler up to 212°.

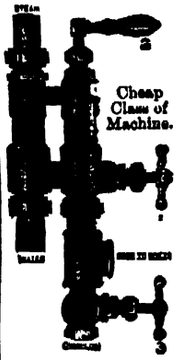
ESTIMATES FOR FIXING COMPLETE with Guarantee to start in good working order, and all information on application to—



Feeds through Heaters.
Can be used as a Pump only.
No Valves or Wearing Parts.
Can be examined instantly.

THE HANCOCK INSPIRATOR CO., 108, Upper Thames St., London, E.C.

CLASS O.



STATIONARY PATTERN. 5115

Henry Bessemer and Co., Limited,

Manufacturers of Cast Steel,

SHEFFIELD.

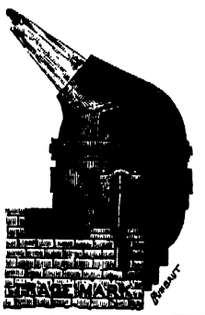
FORGINGS

In Steel of any size.—Quotations given either for uses or finished complete.

STEEL CASTINGS

Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0.30 per cent. carbon, and to bear a tensile strain of 34 tons to the square inch.

TYRES AND AXLES.



SOFT CAST STEEL

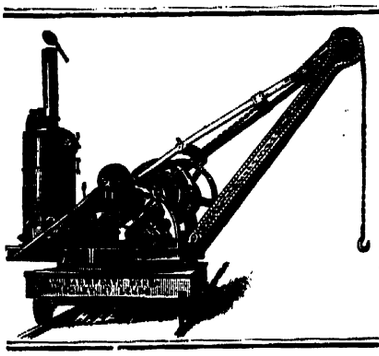
In bars and rods, for general use in Engineering Works.

BLOOMS, BILLETS, & SLABS

Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,

Of superior quality. 5197



EXORS. OF WM. BALMFORTH,

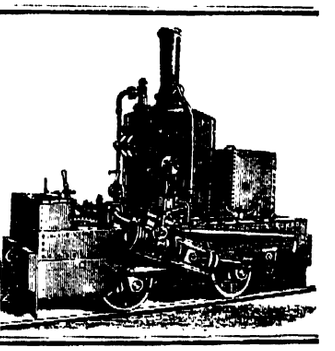
RODLEY, NEAR LEEDS,

MANUFACTURERS OF

LOCO. STEAM CRANES, CONTRACTORS' LOCOS.,
TRAVELLERS, HOISTS,
AND ALL KINDS OF LIFTING MACHINERY.

4637

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes.





THE COALBROOKDALE COMPANY, LIMITED

MAKERS OF

STEAM ENGINES,

HORIZONTAL AND VERTICAL,

AND

OTHER MACHINERY.

MAKERS OF

STEAM PUMPS.

PARKER & WESTON'S PATENT

PUMPING ENGINES for Mines, Sewage and Water Works.

BOILER FEEDERS and SLIP PUMPS.

AGENCIES { LIVERPOOL - 19, SWEETING STREET.
MANCHESTER, 29, PRINCESS STREET. 5190

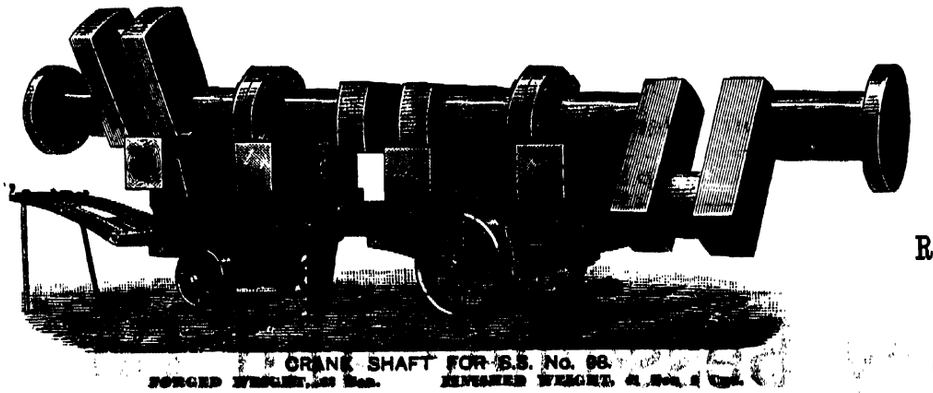
WORKS & OFFICES, COALBROOKDALE, SHROPSHIRE.

THE MERSEY FORGE, Ltd., LIVERPOOL,

MANUFACTURERS OF

MARINE AND OTHER CRANK SHAFTS

FORGINGS OF ALL KINDS IN IRON & STEEL.



CRANK SHAFT FOR S.S. No. 98.

STERN AND RUDDER FRAMES.

4063

WORKS: GRAFTON STREET. Town Office: 5, Harrington Street.

BRICKMAKING MACHINERY.

THOMAS C. FAWCETT, OLD VICTORIA FOUNDRY, MANOR ROAD, & BURMANTOFTS FOUNDRY, CROMWELL ST., LEEDS,



Maker of Patent Semi-dry & Plastic Brickmaking Machines,

Steam Presses, Pugmills, Solid and Perforated Bottomed Clay Pans, Clay Rollers, Clay Mixers, and Sieves,

BOILERS, ENGINES, MARINE AND STATIONARY

SHAFTING AND MILLWRIGHT WORK,

DRUMS AND PULLEYS OF ALL SIZES,

SPUR, BEVIL, MITRE,

And other Wheels by Patent Moulding Machine.

ILLUSTRATED CATALOGUES FREE. 4068



POINTS & CROSSINGS

FROM EVERY SECTION OF RAIL.

Portable Railways, and General Railway Plant.

HARTLEY & ARNOUX BROS.

CALEDONIA WORKS STOKE-ON-TRENT.

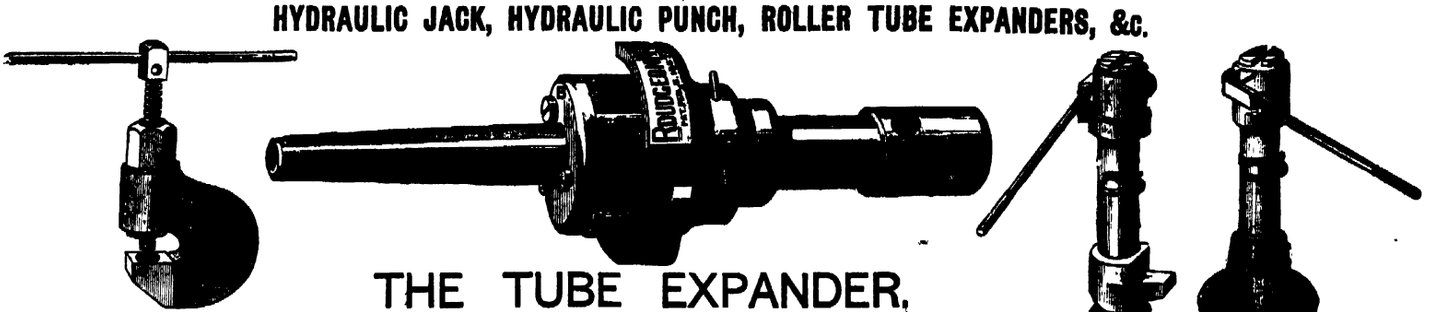
4468

RICHARD DUDGEON,

114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF HIS

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, &c.



THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "DUDGEON'S ROLLER TUBE EXPANDERS," R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only are stamped as under:—

R. DUDGEON, N.Y., Patd. Feb. 5th, 1867, on the Guide-ring of each Tool, WITHOUT WHICH NONE ARE GENUINE.

These can always be obtained at R. Dudgeon's English Depôt, 114, Fenchurch Street. If more convenient to get them through Merchants care should be taken to specify "*Dudgeon's own make*" *on the Order*, but as R. Dudgeon observes with regret that *imitations* bearing his *stamp counterfeited* are being sold as his, he would respectfully recommend both Merchants and Users requiring Expanders of his make to apply direct. In urging this he merely seeks to secure the identity of what is made by himself, by which he is content to stand or fall.

R. Dudgeon takes this opportunity of returning thanks for past favors, either by orders or recommendation, and it being his intention strictly to maintain the Quality and Workmanship so essential for such a Tool as the Expander, begs to solicit a continuance of the same.

CATALOGUES AND PRICE LISTS ON APPLICATION TO R. DUDGEON, 114, FENCHURCH STREET, LONDON, E.C. 3840

13 PRIZE MEDALS.] **THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED,** [13 PRIZE MEDALS.

4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 3. GLASGOW, 1880, 2. LONDON, 1882, 1.



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 4794

100 TO 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

New Patent TWIN-ENGINES. Impulse every Revolution.

THE "OTTO." GOLD MEDAL at Crystal Palace, & HIGHEST AWARD at Paris Electrical Exhibitions.



New Patent SELF-STARTER. Best, Safest, and Simplest made, may now be applied.

CROSSLEY'S NEW VERTICAL ENGINE, Requiring little floor space.

½ TO 100 HP. IND. MANY IMPROVEMENTS. OVER 14,000 IN USE.

GAS ENGINE

LONDON: 24, POULTRY, E.C. GLASGOW: 58, UNION STREET 4775

CHEAP GAS TO MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·3 lb. per ind. H.P. per hour.

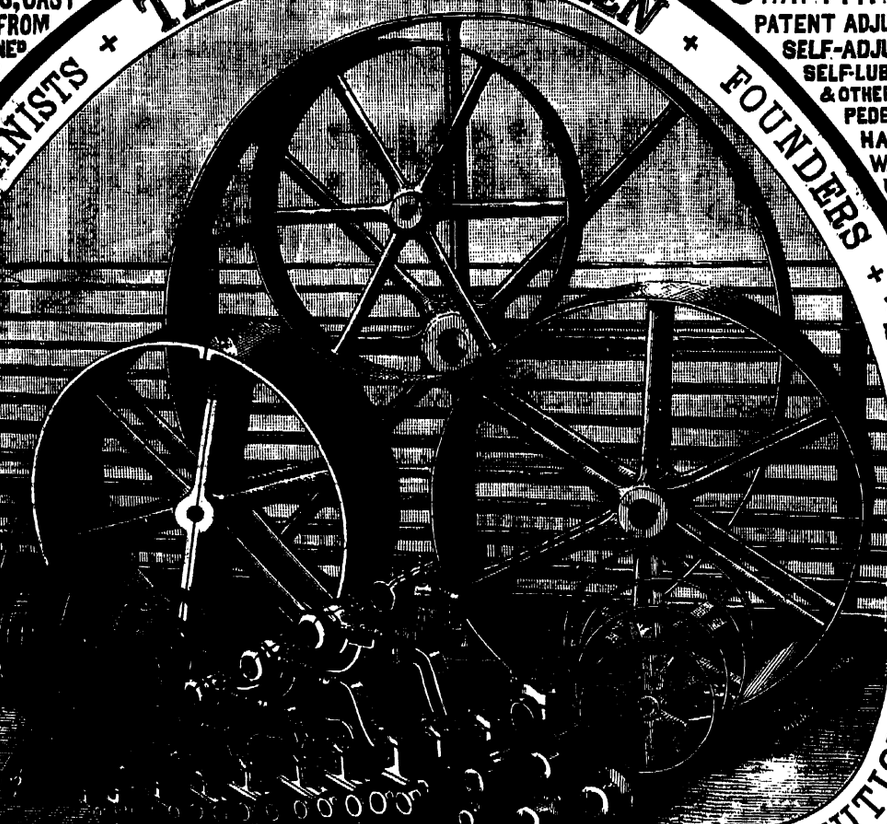
THE DOWSON ECONOMIC GAS COMPANY, Ltd., 3, Gt. Queen St., Westminster, S.W. 4883

PULLEYS, FOR TRANSMISSION OF POWER BY BELTS, CAST OF SELECTED IRON, FROM CAREFULLY DESIGNED PATTERNS, EITHER WHOLE OR IN HALVES, PLAIN OR GROOVED, TURNED, BORED, BALANCED & FINISHED

TAYLOR & CHALLEN

ENGINEERS + MACHINISTS + FOUNDERS + SMITHS

DERWENT FOUNDRY + BIRMINGHAM + CONSTITUTION HILL



TURNED SHAFTING, SHAFT-FITTINGS, PATENT ADJUSTABLE, SELF-ADJUSTING, SELF-LUBRICATING, & OTHER BEARINGS PEDESTALS, HANGERS, WALL-BOXES, BRACKETS

COUPLINGS COLLARS

SOLE MAKERS OF WITHINSHAW'S NEW PATENT

FEED-WATER HEATER AND Purifier.



Great Saving in

BOILERS AND COAL.

MAKERS OF

Winding, Forge Mill & Pumping Engines.

Price Lists on application.

This Advertisement appears once a Month. 4181

PATERSON & COOPER,

ELECTRIC LIGHT ENGINEERS AND CONTRACTORS,

76, LITTLE BRITAIN, LONDON. Steam Factory: POWNALL ROAD, DALSTON.

Complete Sets of Electric Lighting Machinery and Fittings for Lighting Hotels, Public Buildings, Factories, Mills, Ships, &c., &c.

ESTIMATES FOR INSTALLATIONS FREE OF CHARGE. EXPERIENCED MEN SENT TO ALL PARTS OF THE COUNTRY.

Licensees of the "Clarke and Bowman" Arc Lamp, and of Joel's Storage Batteries.

PATERSON & COOPER'S DIRECT CURRENT "PHŒNIX" DYNAMOS.

No. 1.—For	16	20 candle-power Lamps, or	2 Small Arcs, or	1 Large Arc £36
No. 2.— „	30	„ „ „	3 „ „	2 „ „ 54
No. 3.— „	75	„ „ „	7 „ „	4 „ „ 80
No. 4.— „	120	„ „ „	12 „ „	7 „ „ 120
No. 5.— „	200	„ „ „	24 „ „	14 „ „ 180
No. 6.— „	300	„ „ „	... ...	 250
No. 7.— „	500	„ „ „	... ...	 400

4096

Awarded a First-Class CERTIFICATE OF MERIT at Manchester, and a First-Class DIPLOMA OF MERIT at Tynemouth.

PATENT DIAGONAL ROCKING FIRE-BARS

—(Can be Fixed in a Few Hours.)— ARE ECONOMICAL, DURABLE, SMOKE-CONSUMING. —(No Attachment to Boiler necessary.)—

Numerous Official Tests show an average economy of over 10 per cent. These Patent Bars last Years where ordinary Bars last only Months.

Recently supplied to the order of the eminent builders of the engines and boilers of the most powerful Ironclad afloat for use in the whole of the furnaces, to work with "Forced Draught," MAKING THE THIRD Ironclad fitted. Used by the most eminent Engine and Boilermakers (Marine and Land), Railways, Home and Foreign Governments, &c. 5119

Agents having connections among Steam Users Required in Principal Towns. — Particulars of the Manager at the Offices, 259, Gresham House, E.C.

REGISTERED TRADE MARK

'PHOSPHOR BRONZE'

...and Other Durable Metal for Bearings and Bushes of every Description; Hydraulic Pumps, Pinions, Valves, &c. &c. Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c.

SOLE MANUFACTURERS UNDER SEVERAL PATENTS— 1475

The PHOSPHOR BRONZE COMPANY, Limited, Sumner & Emerson Streets, Southwark, London, S.E.

Calcutta, 1884.—HIGHEST AWARD.



THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

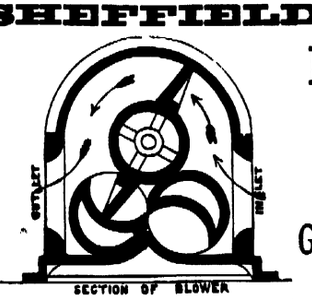
Baker's Patent Rotary Pressure Blower and Gas Exhauster

—:o:—

BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

—:o:—

HALL'S PATENT STONE BREAKER.

—:o:—

General Machinery of Every Description.

London Offices and Exhibition Rooms, 58, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4000

CHARLES CHURCHILL & CO.,

AMERICAN MACHINERY AND TOOL IMPORTERS,

21, CROSS STREET, FINSBURY, LONDON, E.C.

ESTABLISHED IN 1862.



C. C. & Co. have just removed to much larger premises with ample show rooms and warehouse, and will carry a greatly increased stock of all the best American tools.

SOLE AGENTS FOR

THE ONLY GENUINE AMERICAN MORSE TWIST DRILL,

WITH CENTRE GRINDING LINE, STOCKS AND DIES, REAMERS AND MILLING CUTTERS,

Stephens' Patent Vices, Horton Chucks, Cushman Chucks, Westcott Chucks, Sweetland Chucks, Stanley Rule & Level Co.'s Planes, &c., &c., Gould's Manufacturing Co.'s Pumps, and a great variety of New American Tools.

New Catalogue for 1883 just issued, 215 pages Quarto, sent on receipt of One Shilling in Stamps.

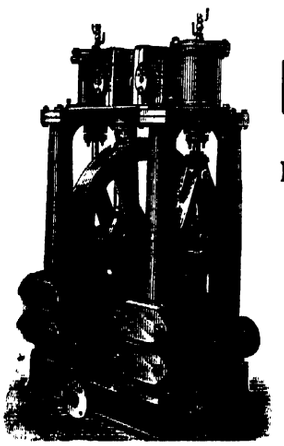
(THE LARGEST CATALOGUE OF AMERICAN TOOLS EVER PUBLISHED IN GREAT BRITAIN.) 4124

W. NEILL & SON,

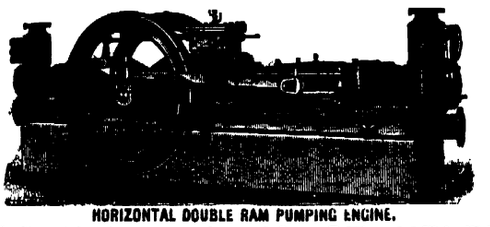
ENGINEERS, IRON & BRASS FOUNDERS, BOILER MAKERS, &c.

MANUFACTURERS OF

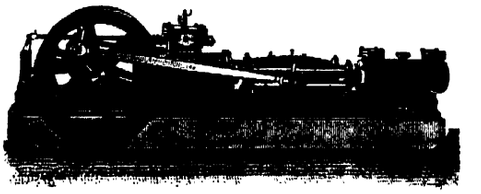
PUMPING ENGINES, BLOWING ENGINES, STEAM ENGINES, AIR COMPRESSORS, and VACUUM PUMPS.



DOUBLE RAM PILLAR PUMPING ENGINE.



HORIZONTAL DOUBLE RAM PUMPING ENGINE.



BLOWING ENGINE AND AIR COMPRESSOR. 4258

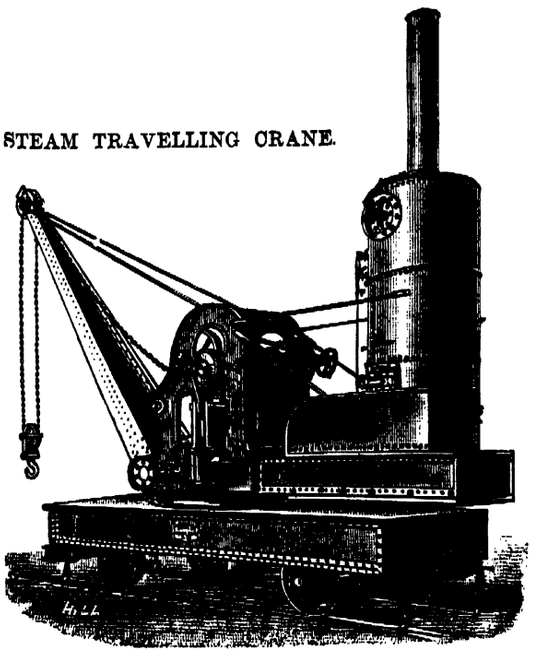
BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.

COWANS, SHELDON & CO., LTD.,

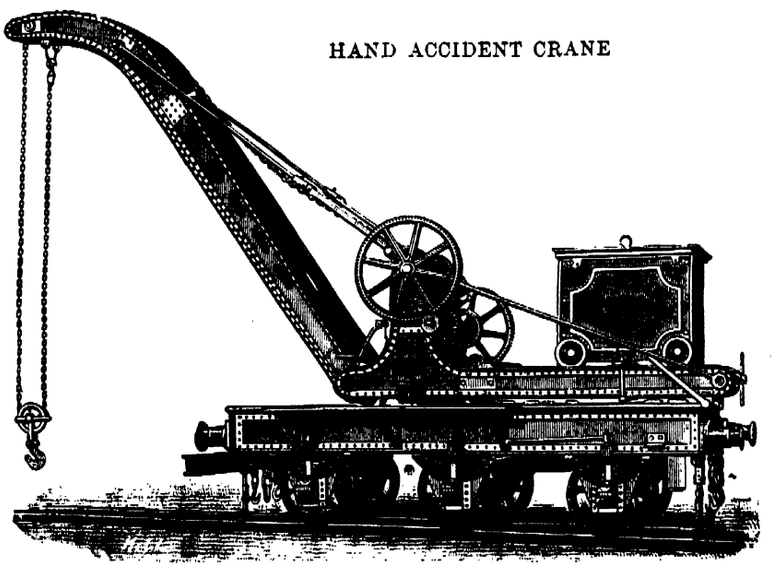
ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.

STEAM TRAVELLING CRANE.



HAND ACCIDENT CRANE



TURNTABLES, CRANES, MASTING SHEERS, AND TRAVERSERS OF EVERY DESCRIPTION BY STEAM, HAND, OR HYDRAULIC POWER. 5007



Anglo-American Oil Press for 16 12 lb. Cakes.

ROSE, DOWNS & THOMPSON,

Established 1777.

OLD FOUNDRY, HULL.

Makers of the ANGLO-AMERICAN

OIL-MILL MACHINERY,

For crushing Linseed, Cotton Seed, Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent. in labour and power, and 2 to 4 per cent. in Oil. (See *Engineer*, May 6, 1881, and Nov. 23, 1883.)

PRESSES FOR ALL KINDS of OIL SEEDS.

Elevators and Creepers for Grain Warehouses, Accumulators and Hydraulic Dock Machinery, Stationary Engines, Boilers, Trawling Engines, and Capstans for Fishing Boats.

SOLE MAKERS OF

KINGSTON DREDGER,

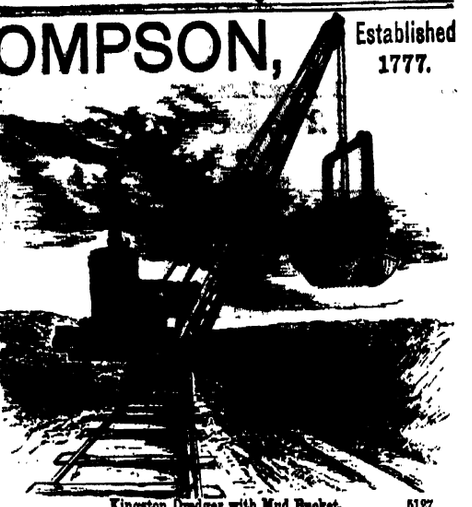
Grabs and Buckets for Mud, Sand, Shingle, Silt, Clay, Rock, Débris, Boulders, Coke, Ore, &c., supplied on Pontoons for Harbour and Dock Dredging.

NO HEAVY BALANCE WEIGHTS.

NO SPECIAL CHAINS.

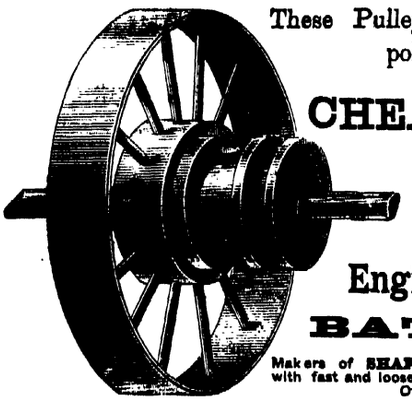
PERFECT AND RAPID WORK.

London Office (Dredging Machinery): 36, KING WILLIAM STREET, E.C.



Kingston Dredger with Mud Bucket. 5127

TURNED WROUGHT IRON PULLEYS.



These Pulleys are **TURNED IN A LATHE,** and not polished on a Grindstone like those generally sold.

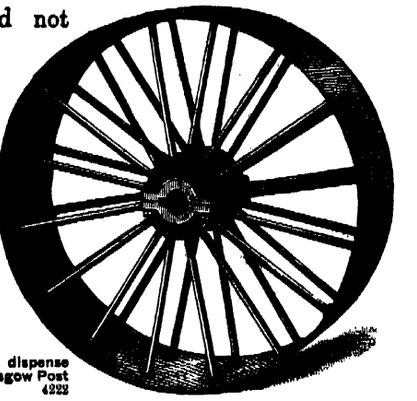
CHEAP, STRONG, AND TRUE.

Illustrated Circular Post Free.

J. BACSHAW & SONS,

Engineers, Ironfounders & Millwrights,

BATLEY, YORKSHIRE,



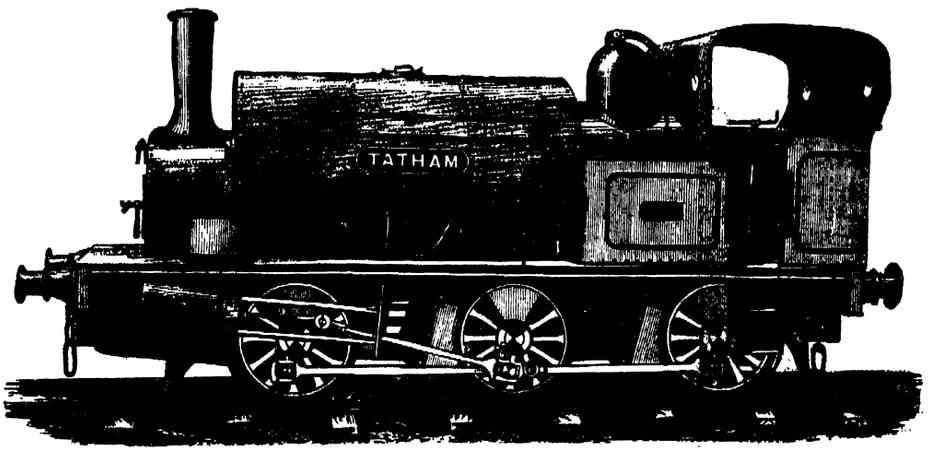
Makers of SHAFTING and FRICTION PULLEYS for Electric Lighting Machinery, which dispense with fast and loose Pulleys: one Pulley answers for both. In use at L.-S.W. Railway, Nine Elms; Glasgow Post Office; King's Cross Station; and all principal Factories home and abroad. 4222

ESTABLISHED 1860.

HUDSWELL, CLARKE & Co.,

RAILWAY FOUNDRY, LEEDS.

PRICES and SPECIFICATIONS on Application.



FOR CASH or DEFERRED PAYMENTS.

LOCOMOTIVE TANK ENGINES

OF ALL SIZES AND TO SUIT ANY GAUGE OF RAILWAY,

For Main Line or Branch Railways, Contractors, Ironworks, Collieries, &c.

CRANES! CRANES!

RAILWAY PLANT!!

SEE HALF-PAGE ADVERTISEMENT JULY 25th, Page 33.

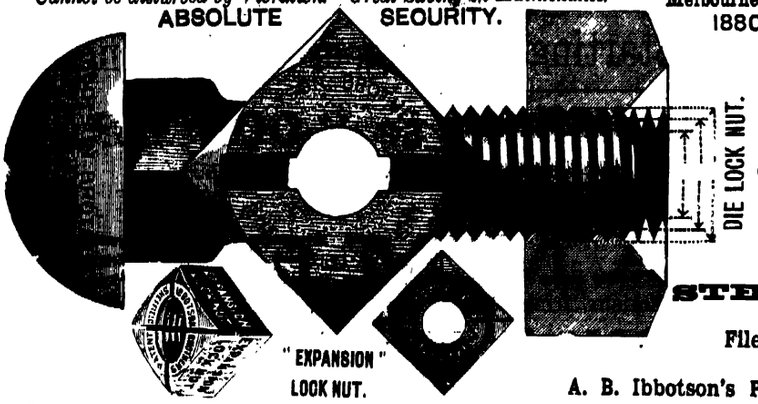
SEE HALF-PAGE ADVERTISEMENT AUGUST 8th, Page 33.

RANSOMES & RAPIER, 5, Westminster Chambers, LONDON, S.W., and Waterside Ironworks, IPSWICH. 5052

Patent Steel Lock Nuts and Steel Fish Bolts.

Cannot be disturbed by Vibration. *Great Saving in Maintenance.*

ABSOLUTE SECURITY.



FIRST-CLASS MEDALS, LONDON, PARIS, SYDNEY, ADELAIDE, &c.

18 GOLD MEDALS Melbourne Exhibition, 1880–81. } ONLY FIRM awarded GOLD MEDALS for Nuts and Bolts, Buffers, Couplings, Cradles, Springs, Steel Sleepers, Rail Joints, &c. GOLD MEDALS for Steel, Files, Saws, Steel Forgings, Railway Appliances, &c.

IBBOTSON BROTHERS

AND COMPANY, LIMITED,

GLOBE IRON AND STEEL WORKS

SHEFFIELD.

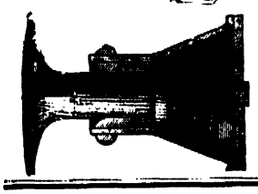
Manufacturers of

STEEL OF EVERY DESCRIPTION

STEEL FORGINGS, AXLES, &c., RAILWAY SPRINGS OF ALL KINDS.

Files (Hand Cut only), Saws, Edge Tools, and Patent Automatic Central Coupling Buffers.

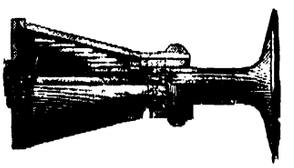
A. B. Ibbotson's Patent Steel Die and Expansion Lock Nuts, and Steel Bolts, Railway Fastenings, &c., &c.



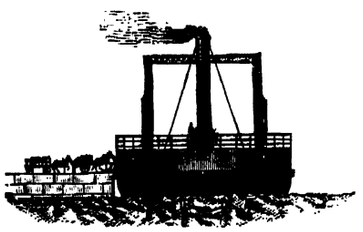
GEORGE TURTON'S PATENT WROUGHT IRON BUFFERS,

AND PATENT COMPOUND CAST STEEL SPRINGS. { 4120 3813

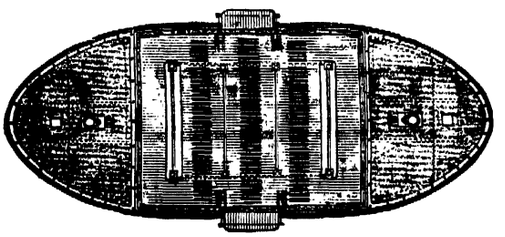
LONDON OFFICE: 4, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W.



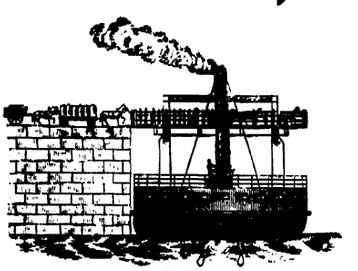
PATENT ELEVATING STEAMER,



HIGH TIDE.

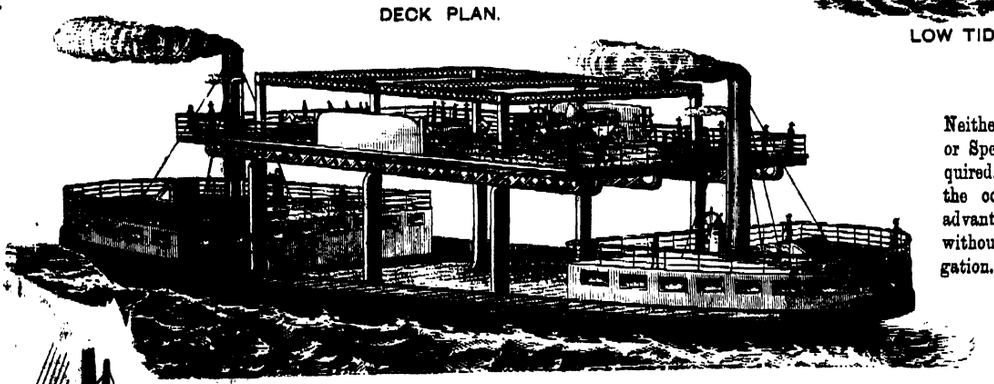


DECK PLAN.



LOW TIDE.

For Ferry Traffic, to Land and Embark Passengers, Carriages, Wagons, and Cattle on same level as Pier or Quay, irrespective of the rise and fall of tide. Also for Landing and Embarking Troops, Horses, and Artillery.



Neither Slips or Pontoons, or Special Berths are required. At a fraction of the cost it has all the advantages of a Bridge, without obstructing Navigation.



LANDING TROOPS.

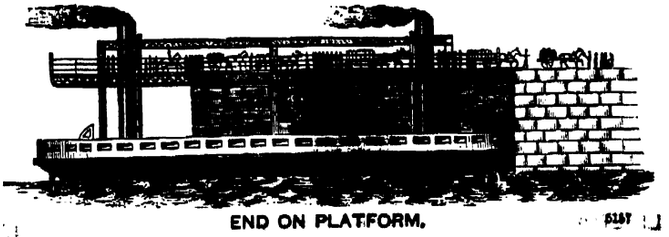
W. SIMONS & CO.,

SHIPBUILDERS & ENGINEERS,

RENFREW,

SCOTLAND,

CONSTRUCTORS.



END ON PLATFORM.

5157

ESTABLISHED 1839. ESTABLISHED 1839.

TRADE MARK. SANS CHANGER.

JOHN MUSGRAVE & SONS, Ltd.,

GLOBE IRON WORKS, BOLTON,

Manufacturers of the only Patent Safety Starting, Turning, or Barring Engine.

Makers of STEAM ENGINES up to 3,000 HP.

With Patent Automatic Cut-off Motion. Adaptable to Stamper Valves, Slide Valves, and Corliss Valves, which can also be applied to existing Engines.

STEAM HAMMERS,

On Condie's principle, with Patent Valve Motions, from 3½ cwt. to 25 tons.

Wrought-Iron and Steel STEAM BOILERS with drilled rivet holes only.

MILL-GEARING IN ALL ITS BRANCHES.

LARGE ROPE OR BELT DRUMS UP TO 35 FEET DIAMETER.

BLEACHING MACHINERY.

ALSO THE ONLY MODERN PLATE-GLASS MACHINE MAKERS. 4730

GOODFELLOW & MATTHEWS,

(Late B. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS.

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 5066

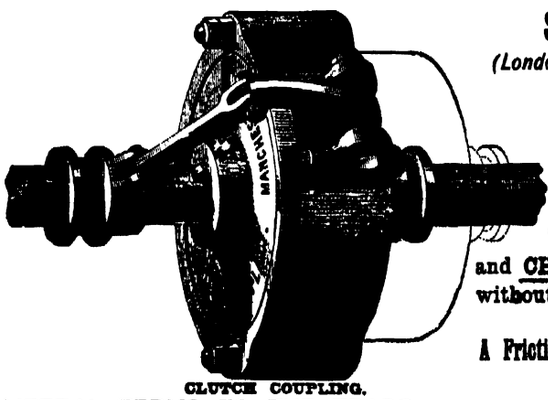
MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.

— PATENT —

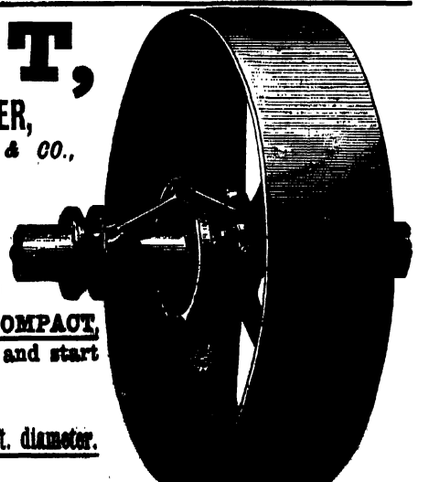
FRICTION CLUTCH.



CLUTCH COUPLING.

These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.



CLUTCH AND PULLEY 5200

LIBERAL TERMS TO THE TRADE.

PRICES ON APPLICATION.



—: THE :—

Patent Steam Boiler Co.

HENEAGE STREET, BIRMINGHAM.

Telegraphic Address:—"ROOT."

(SOLE PROPRIETORS OF THE EUROPEAN PATENTS.)

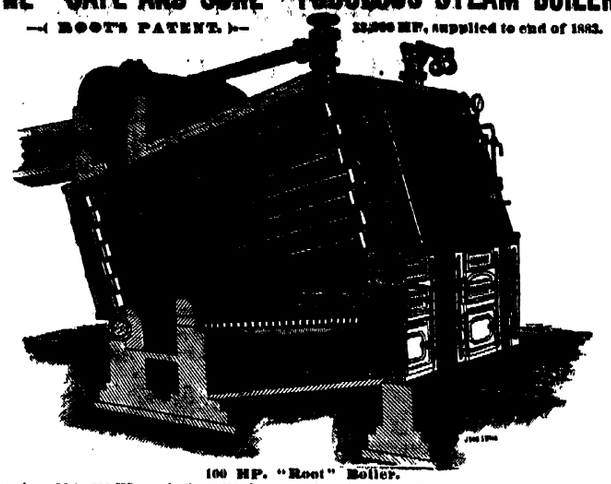
Agents:—Mr. CONRAD KNAP, 11, Queen Victoria Street, E.C., for London; ROSS & WALPOLE, for Dublin; A. TAPPER & Co., Invercargill, N.Z., for New Zealand; A. SHAW & Co., London, for Queensland; RABONE BROS., Birmingham, for New South Wales and Victoria.



THE "SAFE AND SURE" TUBULOUS STEAM BOILER

—(ROOT'S PATENT.)—

35,000 HP. supplied to end of 1883.

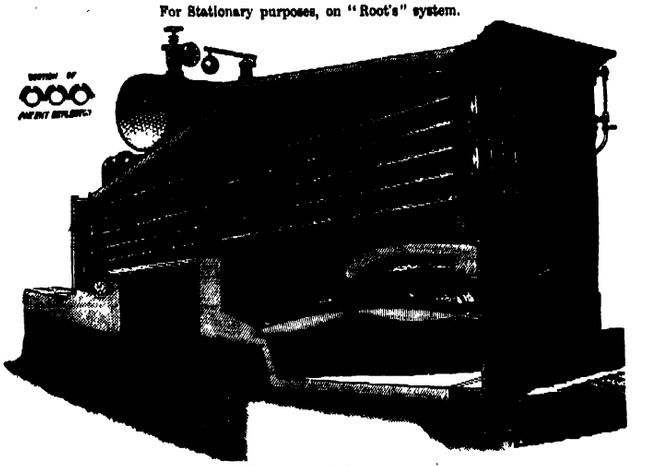


100 HP. "Root" Boiler.

Sizes from 10 to 300 HP., and of modified construction (but of equal strength) 1 to 8 HP. Nom. For Mountain Transport, made in pieces of 250 lbs., at special prices. An ordinary Mechanic can put together. Now working in a variety of situations all over the world, and in confined positions underground, &c. All parts made to gauge and kept in stock. Boilers of any power at a few days' notice. The Prices of our ROOT Boilers have been reduced; Lists on application. No accident to life or limb has ever been recorded against this Boiler. Tested to 500 lbs. per square inch with cold water. Large Steam Drums to 300 lbs. Suitable working pressure 150 lb.

THE "UNIVERSAL" SECTIONAL STEAM BOILER

For Stationary purposes, on "Root's" system.



"Universal" Boiler.

This powerful Steam Generator has been recently introduced to meet the views and requirements of many steam users. It is suitable for general application. Made in sizes from 5 to 300 HP. Nom. Attention is solicited to the advantages of this Boiler, viz.: Cheapness, Economy, Ample Steam and Water Space; Rapid Circulation, Prevention of Incrustation, Safety, High Power, Impossibility of Priming, Easily Cleaned, Durability, &c. This Boiler may be placed in space vacated by cylindrical boilers of far less power.

5152

References to the Birmingham Corporation (1,365 horse-power); Messrs. Cochrane and Co., Middlesboro' (1,590 horse-power).

T. W. LAPWORTH, Manager and Secretary. | For Estimates, Drawings, and full particulars, address— THE PATENT STEAM BOILER CO., Head Office, 28, Heneage Street, Birmingham.

THE

Oldham Boiler Works Company,

LIMITED,

AND REDUCED,

(Late JOSEPH PRITCHARD & SONS).

ESTABLISHED 1816.

Attendance
MANCHESTER EXCHANGE,
Tuesdays and Fridays,
1 to 2.30 o'clock,
P *Pillar.*

MAKERS OF ALL TYPES OF

IRON AND STEEL

STEAM BOILERS,

ON THE MOST MODERN PRINCIPLE.

By Patent Machinery, specially adapted for Drilling, Rivetting, and Flanging.

ALSO SOLE MAKERS FOR LANCASHIRE, YORKSHIRE, AND CHESHIRE, OF

MIRFIN & NIELD'S PATENT

COMBUSTION CHAMBERED BOILERS,

WITH INCREASED FLUE-HEATING SURFACE.

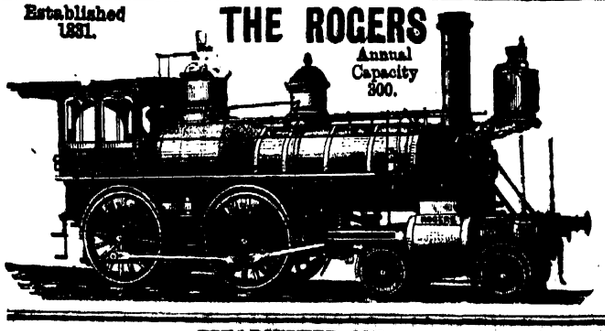
Works: OLDHAM, ENGLAND.

LONDON AGENT: Mr. G. W. BLOW, 11, QUEEN VICTORIA STREET, E.C. 4885

Established 1831.

THE ROGERS

Annual Capacity 300.



LOCOMOTIVE AND MACHINE WORKS.

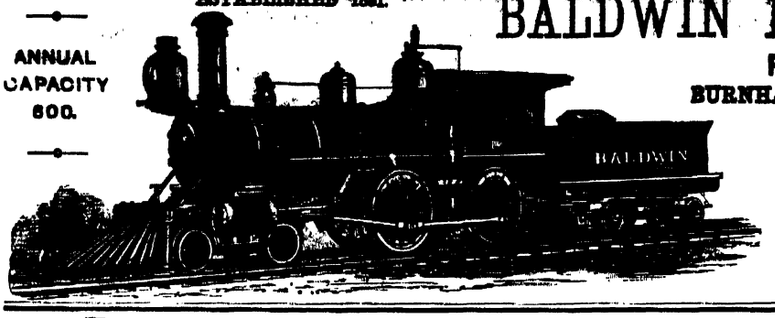
BUILDERS OF LOCOMOTIVE ENGINES OF ALL GAUGES
And for every variety of service,
PATERSON, NEW JERSEY,
UNITED STATES OF AMERICA.



6117

ESTABLISHED 1831.

ANNUAL CAPACITY 600.



BALDWIN LOCOMOTIVE WORKS,

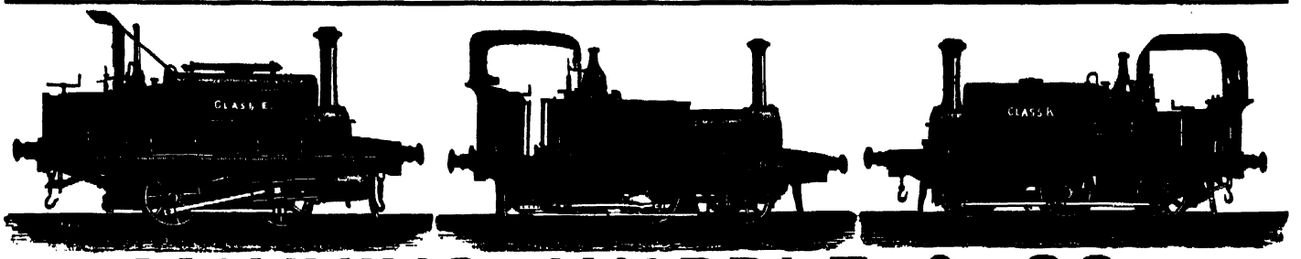
PHILADELPHIA, U.S.A.,
BURNHAM, PARRY, WILLIAMS & Co., Proprietors.
MANUFACTURERS OF

LOCOMOTIVE ENGINES,

Adapted to every variety of service, and built accurately to standard gauges and templates. Like parts of different engines of same class perfectly interchangeable.

PASSENGER AND GOODS LOCOMOTIVES.
MINE LOCOMOTIVES, NARROW GAUGE LOCOMOTIVES
STEAM STREET CARS, &c.

ILLUSTRATED CATALOGUES FURNISHED ON APPLICATION OF CUSTOMERS.
ALL WORK THOROUGHLY GUARANTEED. 1894



MANNING, WARDLE & CO.,

BOYNE ENGINE WORKS, LEEDS,

Have designed and constructed one hundred various types of Tank and other Locomotive Engines for upwards of thirty different widths of gauge, adapted where necessary for passing round sharp curves and ascending steep gradients, suitable for any climate, and for burning coal or wood, &c.: also for special duties required by Railway Companies, Contractors, Collieries, Iron Works, and Mines, Brick Works, Quarries, Gas Works, Ship Yards, Docks, Sugar Plantations, &c., &c. They are built accurately to standard gauges and templates in order that like parts of various classes of Engines will fit different Engines of the same type, and so that duplicates can be supplied on the shortest notice. The materials are the best of their respective kinds, and the workmanship cannot be excelled.
MANNING, WARDLE & Co., having designs and models of such a great variety of Engines, are enabled to execute orders for Locomotive Engines adapted to most requirements in a very short time.

Locomotive Tank Engines from 8 inches to 15 inches Cylinders on Four or Six Wheels all coupled, always in Stock or in Progress. 2486

SPECIFICATIONS, PHOTOS, AND PRICES, ON APPLICATION.

R. & W. HAWTHORN,

NEWCASTLE-ON-TYNE,
MANUFACTURERS OF

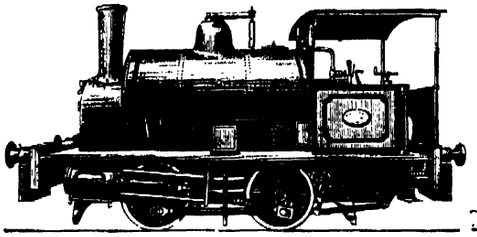
LOCOMOTIVE ENGINES

OF EVERY DESCRIPTION.

TRAMWAY LOCOMOTIVES.

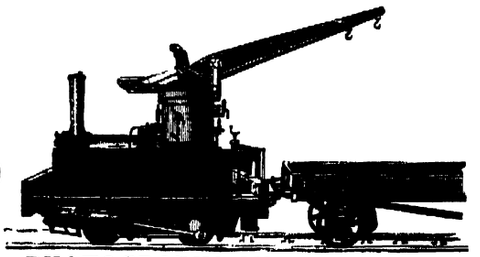
MAKERS OF 5050
WROUGHT IRON WHEELS & FORGINGS.

TANK LOCOMOTIVE.



VARIOUS CLASSES IN PROGRESS.

PATENT CRANE AND LOCOMOTIVE.



PHOTOGRAPHS ON APPLICATION.

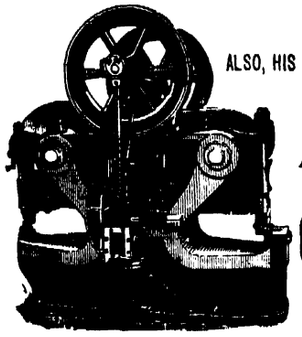
JOHN CAMERON'S SPECIALITIES

ESTABLISHED 1852.

CONTINUE TO BE HIS

STEAM PUMPS

For all purposes, and of which he continues to manufacture by far a larger number than any of his imitators. 8,000 Sold.

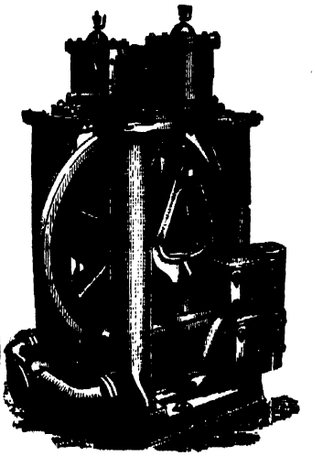


ALSO, HIS

PATENT CAM AND LEVER,

Punching and Shearing Machines

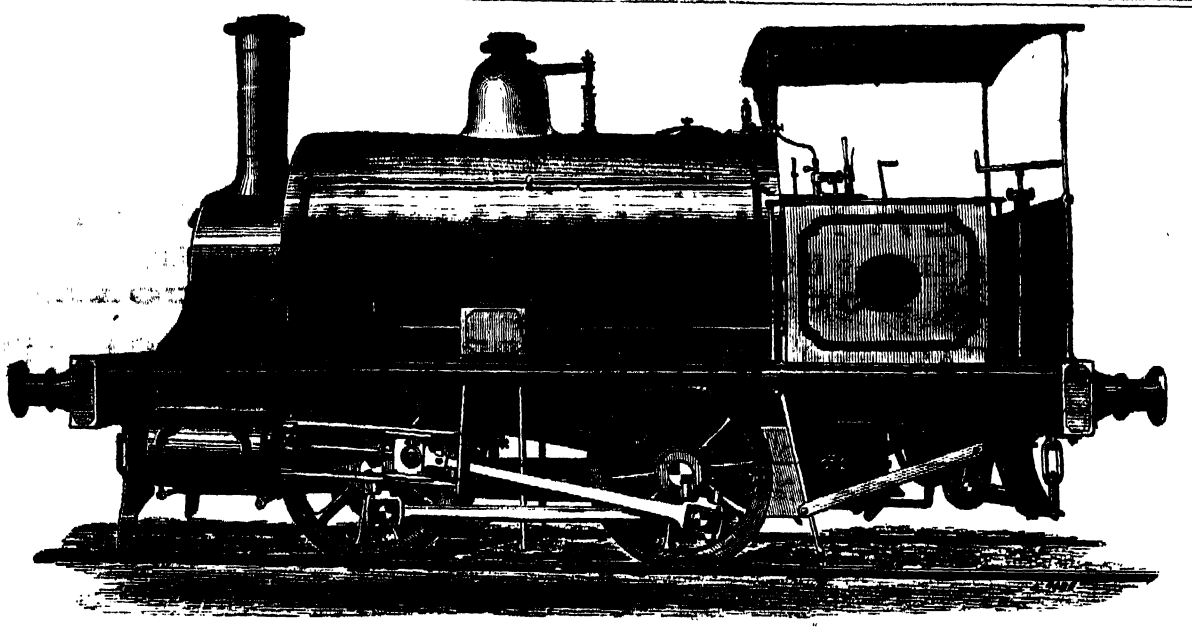
As used in all the principal Shipbuilding Yards (public and private) throughout the World.
ALWAYS READY OR IN PROGRESS TO ALL SIZES.



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MANCHESTER. 5209

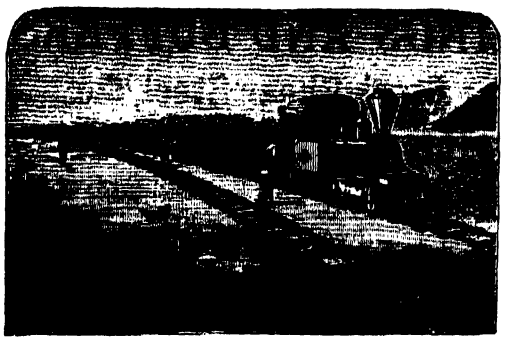
FOR LONDON AND DISTRICT: PRICE & BELSHAM, 52, QUEEN VICTORIA STREET, E.C.;
FOR NEWCASTLE AND EAST COAST: E. BECKWITH & CO., BONNERSFIELD, SUNDERLAND.



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Sydney Exhibition, 1880—Three First Prizes.
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HAND CUT **THOS. JOWITT & SONS, Scotia Steel Works, SHEFFIELD.** TRADE MARK TESTED 4903

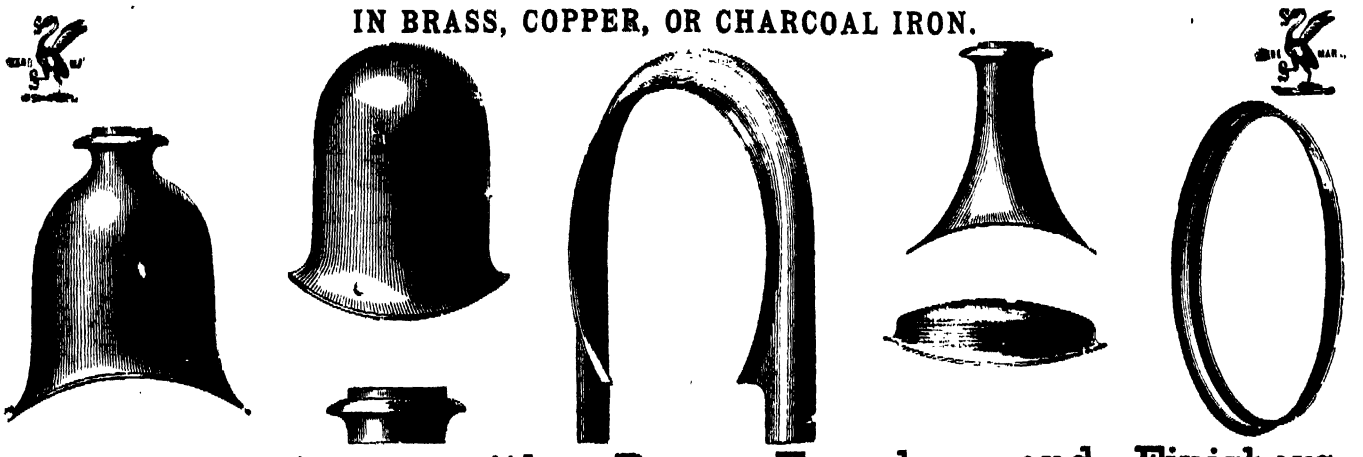
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COAL, LIME, & IRON WORKS, CLAY CROSS, near CHESTERFIELD,

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6 × 6	3 × 3	
6 × 3½	2½ × 2½	
5 × 3½	2 × 2	
4 × 3½	1¼ × 1¼	
4 × 4	1 × 1	

SECTION OF JOISTS.

3 × 3 = 10lbs.	4½ × 3 = 18lbs.	7 × 2½ = 14lbs.	9½ × 3½ = 24lbs.	12 × 5 = 42lbs.			
3 × 1½ = 5 ,,	5 × 4½ = 23 ,,	7 × 3½ = 20 ,,	9½ × 4½ = 29 ,,	12 × 6 = 56 ,,			
4 × 1½ = 7 ,,	6½ × 3 = 11 ,,	8 × 4 = 22 ,,	10 × 4½ = 32 ,,	14 × 6 = 60 ,,			
4 × 3 = 12 ,,	6½ × 3½ = 16 ,,	8 × 5 = 29 ,,	10 × 5 = 36 ,,	16 × 6 = 62 ,,			
4½ × 1½ = 8 ,,	9 × 5 = 29 ,,	8 × 6 = 34 ,,	10 × 6 = 56 ,,	17½ × 6½ = 82 ,,			
				19½ × 7½ = 100 ,,			

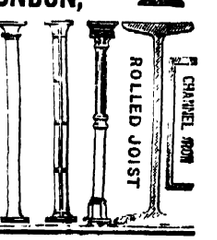
Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to 1". 5126

TEES.

5½ × 5½	
4 × 4½	
5 × 3	
3 × 3	
2½ × 2½	
2 × 2	
1½ × 1½	
1 × 1	

CHANNELS.

12 × 3	
9½ × 3½	
9 × 3½	
8 × 3½	
5½ × 2½	
4½ × 2½	
2½ × 1½	
1½ × ¾	



THOMAS TURTON & SONS,

MANUFACTURERS OF RAILWAY SPRINGS AND BUFFERS,

Files and Cast Steel of Superior Quality, Spring Steel, Shear Steel, &c. 4927

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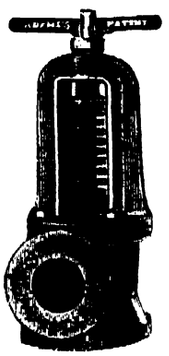
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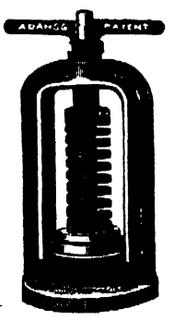
Two Special Prizes & Two Gold Medals



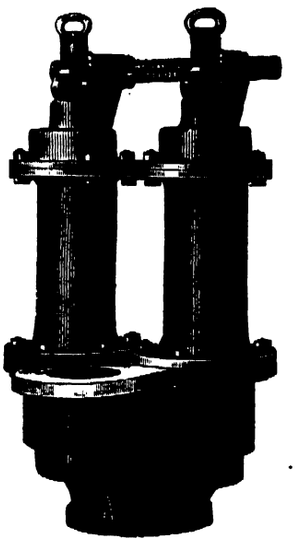




Pattern B—For Stationary Boilers.



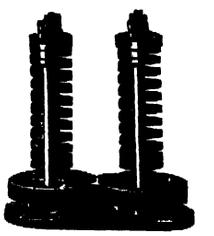
Pattern C—For Stationary Boilers



PATTERN A.—For Marine Boilers.



Pattern D—For Portable Engines.



Pattern E—For Locomotives.

Patterns D and E are made entirely of Gun Metal.

SPECIAL NOTICE.

Patterns B, C, and D are fitted with Hand Gear for LIFTING VALVE and TURNING SAME UPON ITS SEAT to meet the requirements of the Boiler Insurance and Steam Power Company.

NOTE.—WHEN ORDERING, ALWAYS GIVE THE PRESSURE THE VALVE IS REQUIRED TO BLOW OFF AT.

The FASTEST SHIPS AFLOAT are Fitted with ADAMS' VALVE.

H.M. ROYAL YACHT; the ADMIRALTY YACHT; H.M.S. "Iris," "Mercury," "Briton," "Colossus," "Himalaya;" the "Orient," of the Orient Line; the "Arizona," "Alaska," and "Oregon," of the Guion Line; the "Cephenolia," "Pavonia," and "Aurania," of the Cunard Line; the "Pretoria" and "Trojan," of the Union Line; the "Kinfauns Castle," of the Donald Currie Line; and above one-half of the entire Steam Mercantile Marine of Great Britain is now fitted with it. 4871

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CRUCIBLE STEEL CASTINGS
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For Lathe and Planing Tools and Drills: the Steel which requires no Hardening, and which cuts harder Metals with heavier feeds, quicker speeds, and fewer grindings than any other Tool Steel.

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CLYDE STEEL AND IRONWORKS, **SHEFFIELD.** 4218

DANIEL ADAMSON & CO.,

Engineers and Boiler Makers,

ORIGINAL PATENTEES

OF

THE ADAMSON FLANGE SEAM,

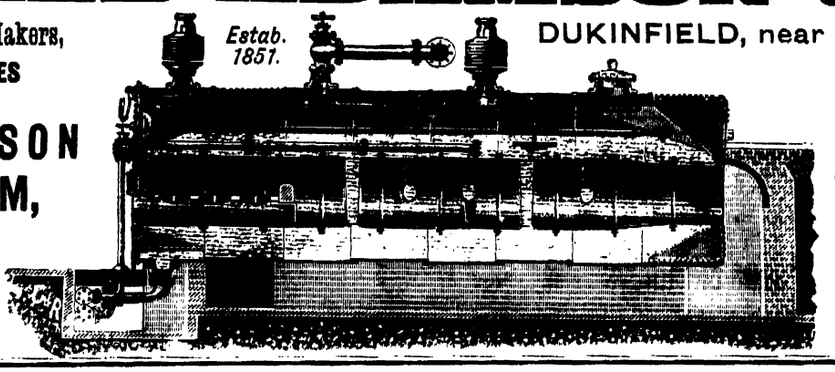
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DRILLED RIVET HOLES ONLY.

Estab. 1851.



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OF OUR

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PATENT BOILER FLUID,

For PREVENTING and REMOVING Incrustation and Corrosion in Steam Boilers.

ANALYTICAL REPORT UPON THE "DISINCRUSTANT MARSEILLAIS."

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An analysis of a sample of this shows it to contain neither Free Alkali nor Acid. It is purely Vegetable matter, and has *no injurious action upon Iron.*

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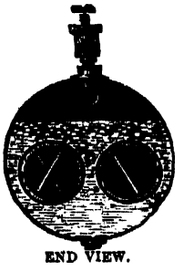
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PATENT FLANGED FLUED BOILER.

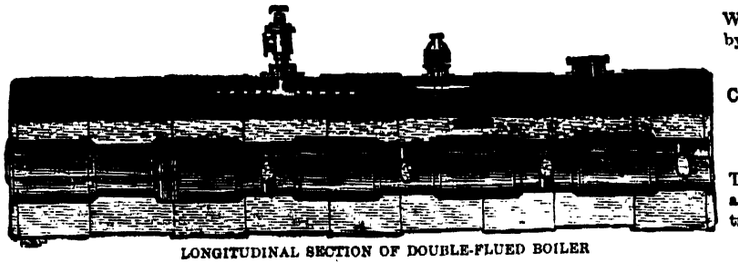
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Are now at work, large numbers having been working at very high pressures night and day for upwards of ten years, and with a success both in

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Which has not been equalled by any other Flued Boiler in the Market.

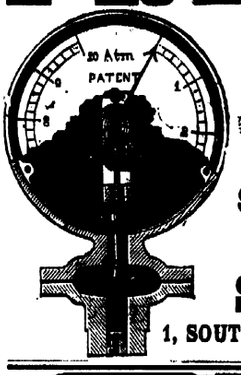
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The strength of this Flue and its provision for contraction and expansion are unrivalled.

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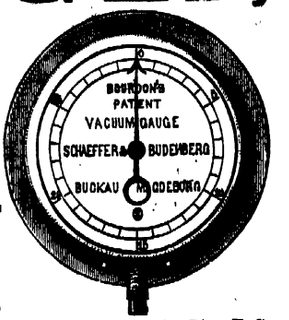




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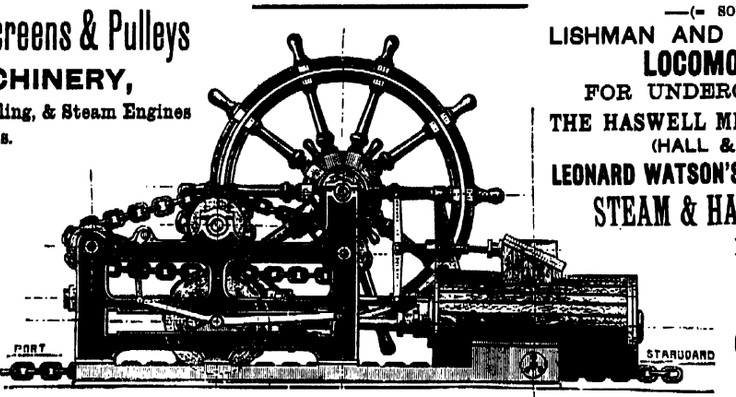
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EDWARDS 4998

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DIAM. OF WATER CYLINDER ..in.	2	2½	3	3½	4	4½	5	6	7	8	9	10	12	14
DIAM. OF STEAM CYLINDER.....	4 in.	5 in.	6 in.	6 in.	7 in.	7 in.	8 in.	10 in.	12 in.	12 in.	14 in.	14 in.	16 in.	18 in.
Length of Stroke	9 in.	9 in.	9 in.	9 in.	12 in.	12 in.	12 in.	12 in.	12 in.	18 in.	24 in.	24 in.	24 in.	24 in.
Content, Galls. per hour	950	1500	2160	2940	3840	4860	6000	8640	11590	15360	19440	24000	34650	46360
Price .....£	18	21	24	28	35	38	45	60	70	85	130	140	190	230

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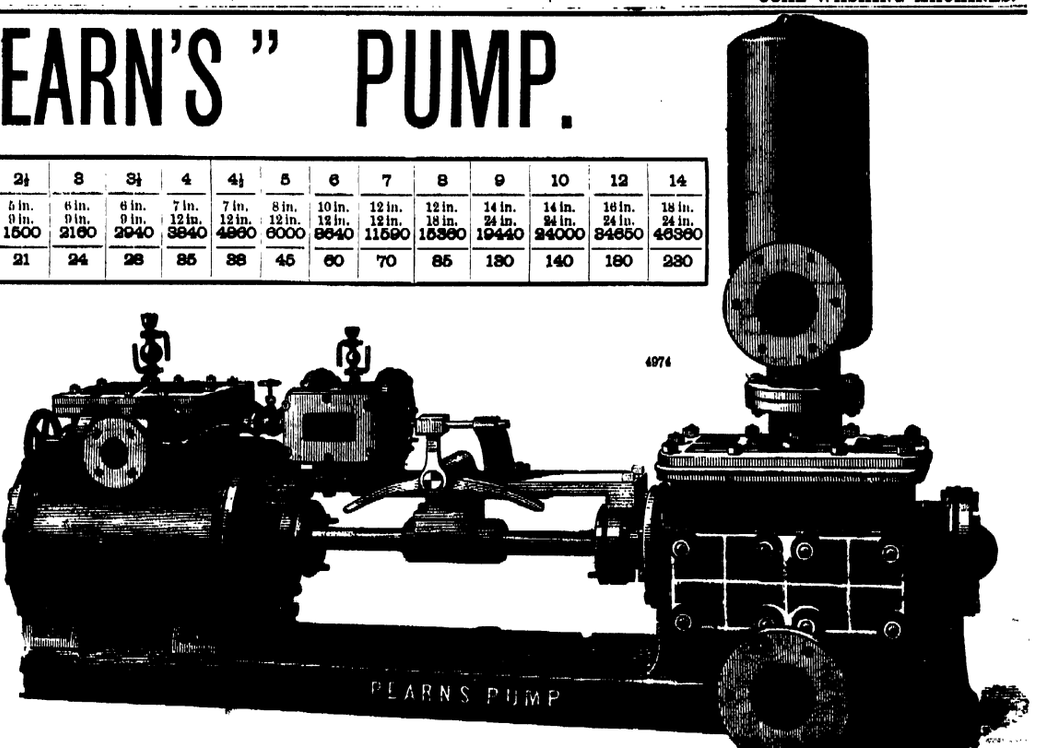
PEARN'S combination of the SLIDE VALVE and PORTS in the AUXILIARY CYLINDER is the Simplest and most PERFECT CUSHION.

SIMPLICITY AND DURABILITY.

It has NO INTRICATE PARTS.

The WORKING PARTS are the same as used in the ordinary STEAM ENGINE.

It is as simple and as DURABLE as any Fly-Wheel Pump, and cannot possibly become deranged.



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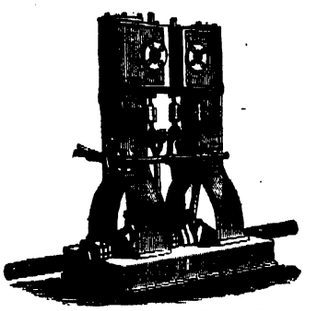
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THOMAS PIGGOTT & CO.,

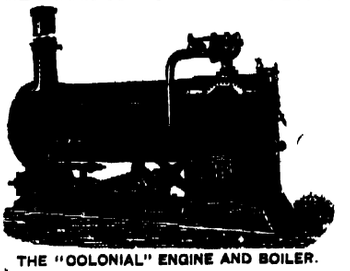
GAS ENGINEERS & BOILER MAKERS,

BIRMINGHAM.

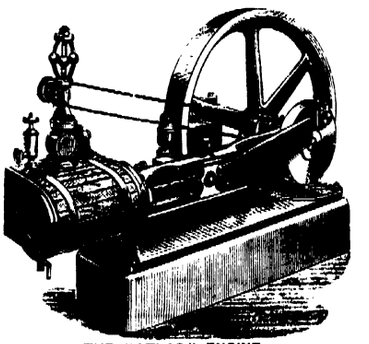
— ESTABLISHED 1822. —



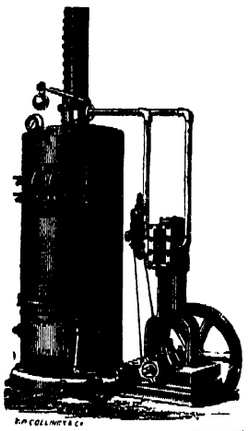
COUPLED VERTICAL ENGINES,
With Link Motion for Launches or Hauling.



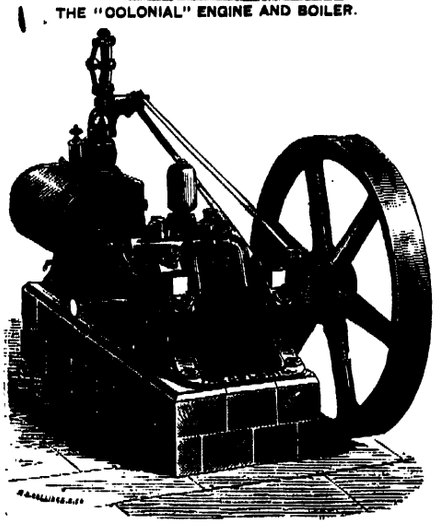
THE "COLONIAL" ENGINE AND BOILER.



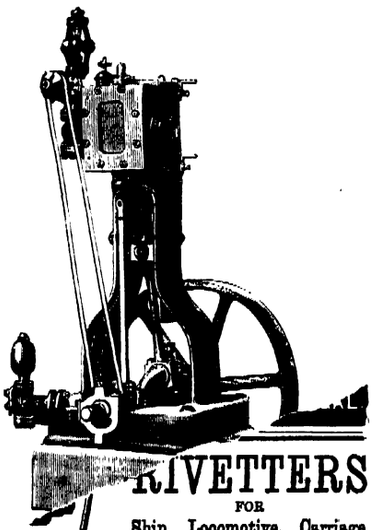
THE "ATLAS" ENGINE.

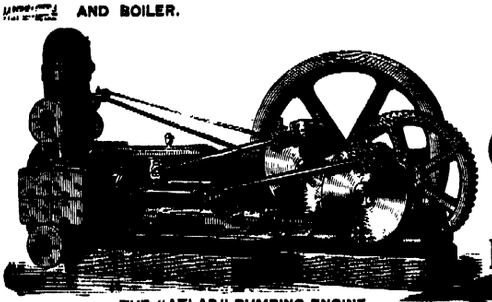


THE "ATLAS" VERTICAL ENGINE AND BOILER.



THE "COLONIAL" ENGINE





THE "ATLAS" PUMPING ENGINE.

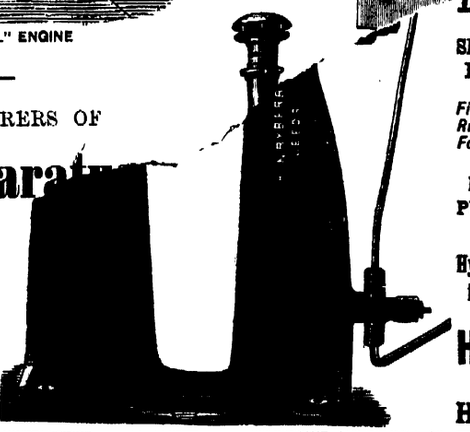
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Hydraulic Pressure Valves, Packing Leathers and Moulds, &c.

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ECTOR CONDENSER.

...ilable to all Steam Engines. | ...per cent. of Fuel Saved.
...Air Pump. | ...to get out of order for years.
...own cost in a few months.

REDUCED PRICES.

...Arrest...Improves feed water...temperature into Steam Boilers.
...Litters are fast superseding...in use for raising & forcing water.
...to be had on application, containing information and prices to be obtained from

MORTON & THOMSON,

...AND BOILER MANUFACTURERS,

...STREET, GLASGOW.

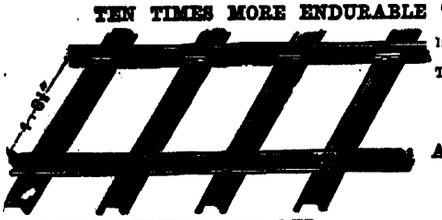
5226

THE "ATLAS"

WOOD'S PATENT

Steel and Iron Sleepers.

TEN TIMES MORE ENDURABLE THAN TIMBER.



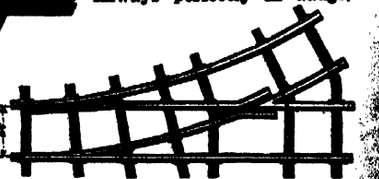
In use upon many Railways in England and the Colonies.

The first and only Cross Sleeper in use upon English Railways with Flat bottomed Rails.

Ample Bearing on Ballast.

Can be shifted without damage.

Always perfectly in Gauge.



THE MOST SIMPLE AND PERFECT FASTENING.

Narrow Gauge Railway, from 16 in. to 36 in., in use in the Cleveland and many other Mines.

Agricultural, Portable and Light Passenger Railways put down complete with Rolling Stock.

CHARLES WOOD, Tees Ironworks, MIDDLESBRO'

WATER PURIFICATION

JOHN HENDERSON PORTER, PATENTEE,
1 & 2, TUDOR STREET, LONDON, E.C., furnishes the necessary Plant.

The PORTER-CLARK PROCESS

Removes the Carbonates of Lime, Magnesia, and Iron from **Hard Waters**, and thus, the **causes of Incrustation in Boilers and Pipes.** This Process is in use in Paper Mills, Breweries, Sugar Works, India-rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c. One Railway Company employs it for feed-water to the extent of **1,000,000 gallons** daily, and one of the London Water Companies at two of its Pumping Stations. It is also in use in County Asylums, Public and other Schools, and Private Mansions. The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich, are rendered soft and clear. 522d

DESCRIPTIVE CIRCULAR ON APPLICATION.

JOHN MARSHALL & SONS,

GLASGOW TUBE WORKS, GLASGOW.
MANUFACTURERS OF

LAPWELDED IRON BOILER TUBES

FOR MARINE, STATIONARY, AND LOCOMOTIVE BOILERS, &c. 4751

WROUGHT IRON AND STEEL TUBES OF EVERY DESCRIPTION.

MANLOVE ALLIOTT FRYER & CO

MAKERS OF ALL KINDS OF

SUGAR MACHINERY

NOTTINGHAM, ROUEN, & LONDON.

SEE FUTURE ADVERTISEMENTS. 5076

Steam Cran.
VENTILATING F..
ENDLESS CHAIN PLANT.
BORING TOOLS. Chemical Works Plant.
TANK LOCOMOTIVES
For COLLERIES and IRONWORKS
Hydraulic Pumps and Slipways.

LOWAY & SONS.

PARIS, VIENNA & PHILADELPHIA.

"PEARN'S PU[illegible]

AND A LARGE NUMBER OF

BOILERS

DIAM. OF WATER CYLINDER ..in.	2	2½	3	3½	4	4½	5	6	7	8	9	10	[illegible]	[illegible]
DIAM. OF STEAM CYLINDER.....	4 in.	5 in.	6 in.	6 in.	7 in.	7 in.	8 in	10 in.	12 in.	12 in.	14 in.	14 in.	16 in.	18 in.
Length of Stroke	9 in.	9 in.	9 in.	9 in.	12 in.	12 in.	12 in.	12 in.	12 in.	18 in.	24 in.	24 in.	24 in.	24 in.
Content, Galls. per hour	950	1500	2160	2940	3840	4860	6000	8640	11590	16360	19440	24000	34650	46360
Price ....£	18	21	24	28	35	38	45	60	70	85	130	140	190	230

CUSHIONING.

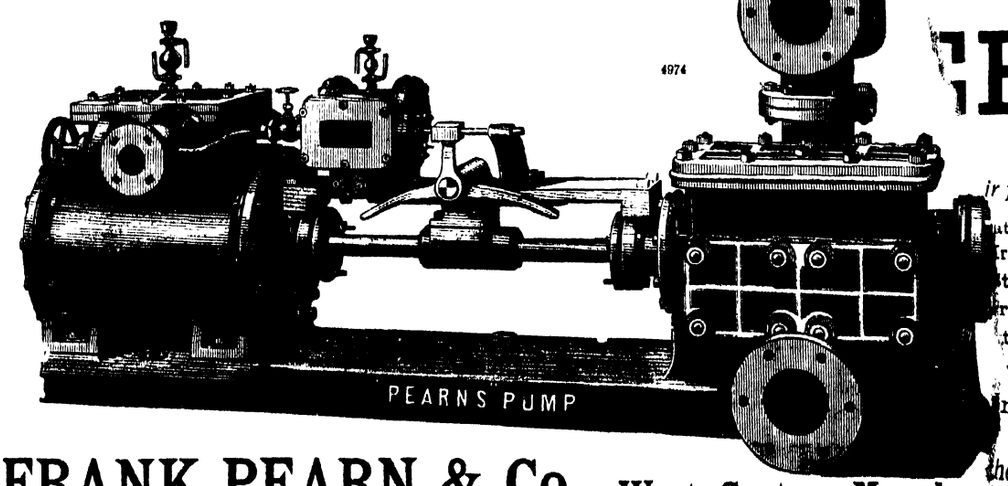
PEARN'S combination of the SLIDE VALVE and PORTS in the AUXILIARY CYLINDER is the Simplest and most PERFECT CUSHION.

SIMPLICITY AND DURABILITY.

It has NO INTRICATE PARTS.

The WORKING PARTS are the same as used in the ordinary STEAM ENGINE.

It is as simple and as DURABLE as any Fly-Wheel Pump, and cannot possibly become deranged.



4974

[illegible]RY.

ir fittings:—

[illegible]aterial.	Working Press
[illegible]ron ...	70 lbs
[illegible]teel ...	80 lbs
[illegible]ron ...	90 lbs.
[illegible]teel :	70 lbs.
[illegible]an. ...	80 lbs.

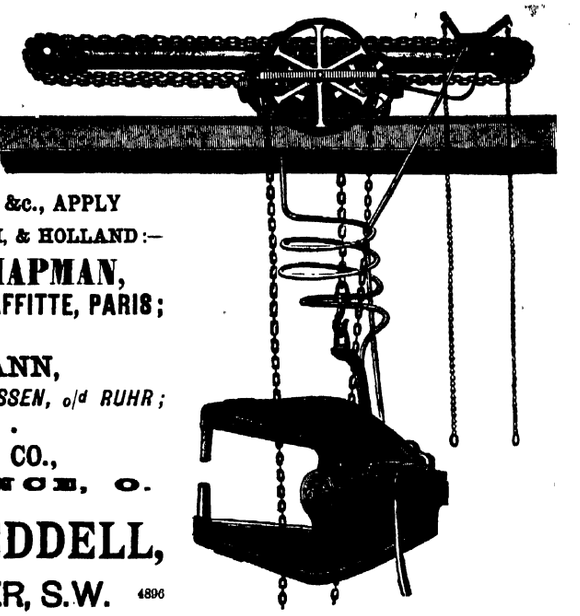
[illegible]n. 4336

FRANK PEARN & Co., West Gorton, Manches[illegible]

[illegible]he above Boiler[illegible]

TWEDDELL'S SYSTEM.

HYDRAULIC CRANES



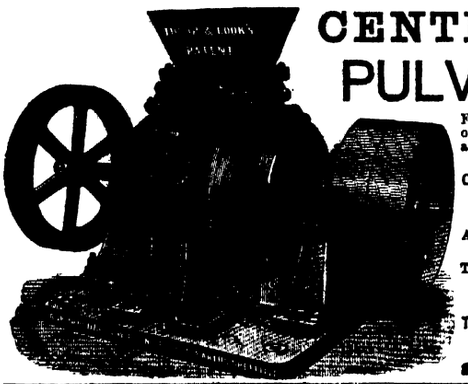
Sole Makers & Co-Patentees

FIELDING & PLATT,
GLOUCESTER.

FOR PRICES, &c., APPLY
FRANCE, BELGIUM, & HOLLAND:—
MR. HENRY CHAPMAN,
10, RUE LAFFITTE, PARIS;
GERMANY & AUSTRIA:—
Mr. G. DIECHMANN,
41, BAHUHOFST, ESSEN, o/d RUHR;
UNITED STATES:—
MORGAN ENGINEERING CO.,
ALLIANCE, O.
—— OR TO ——
Mr. RALPH HART TWEDDELL,
14, DELAHAY ST., WESTMINSTER, S.W. 4896

ASKHAM BROS. & WILSON, Ltd.,

SOLE MANUFACTURERS OF LUCOP & COOK'S PATENT



CENTRIFUGAL PULVERISER,

For reducing to an impalpable powder or to any requisite degree of fineness, all materials capable of being thus treated,

Cement, Chemicals, Grain, Coal, Colours, Phosphates, Lime, Copper, Tin, Zinc,

And other Ores, with Rapidity, Completeness, and Perfect Uniformity.

The only Guaranteed Machine for **GOLD QUARTZ.**

THE ONLY EFFICIENT PULVERISING MACHINE IN THE MARKET. 5000

SHEFFIELD.

RACOSINE OIL

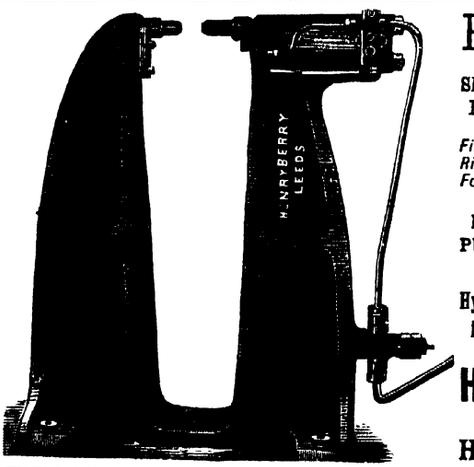
THE RUSSIAN NATURAL LUBRICATING OIL. Gold Medal, Paris, 1878.

Pure Hydro-carbon, free from acid. Body superior to Olive or Lard Oil | Never gums or clogs. Never freezes or thickens.

No. V 2s. 6d. PER CAL.

RAGOSINE & CO.,
7, IDOL LANE, LONDON, E.C.,
And Love Lane, Quayside, Newcastle-on-Tyne.
Works—BALACHNA and CONSTANTINOW, RUSSIA.
Price Lists and full particulars on application 4779

No. VIII 2s. 0d. PER CAL.



RIVETTERS

FOR

Ship, Locomotive, Carriage Builders, and Boilermakers,
VIZ.:
Fixed and Portable Hydraulic Riveting, Flanging, Bending, Forging, and Punching and Shearing Machines,
HYDRAULIC PRESSURE PUMPS & ACCUMULATORS
HYDRAULIC CRANES.
Hydraulic Pressure Valves, Packing Leathers and Moulds, &c.

HENRY BERRY,
CROYDON WORKS, 5111
HUNSLET, LEEDS.

WOOD ENGRAVING

Draughtsmen & Engravers on Wood

HARE & Co

31 ESSEX STREET STRAND LONDON

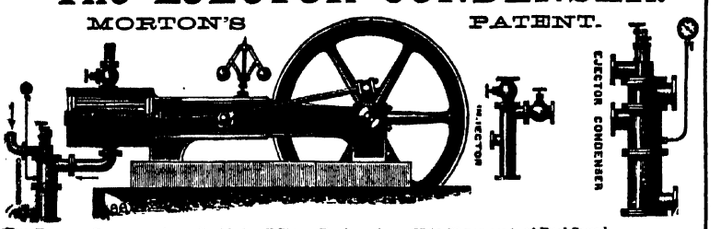
ESTIMATES ON APPLICATION

5236

EXTENSION OF PATENT FOR ITS GREAT MERITS.

"The EJECTOR CONDENSER."

MORTON'S PATENT.



THE EJECTOR CONDENSER is applicable to all Steam Engines. Produces a vacuum without Air Pump. Has no moving parts.

25 to 50 per cent. of Fuel Saved. Not liable to get out of order for years. Repays its own cost in a few months.

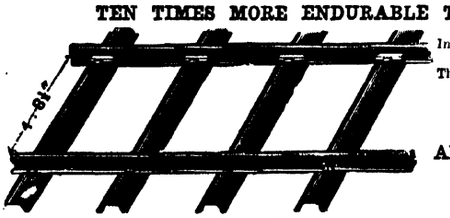
REDUCED PRICES.

THE FIXED DOUBLE NOZZLE AUTOMATIC INJECTORS feed water of a high temperature into Steam Boilers. These Injectors & the Water Lifters are the most simple & efficient apparatus in use for raising & forcing water. All communications to be addressed to and full information and prices to be obtained from

ALEXR. MORTON & THOMSON,
PATENTEES AND SOLE MANUFACTURERS,
96, BUCHANAN STREET, GLASGOW. 5290

WOOD'S PATENT Steel and Iron Sleepers.

TEN TIMES MORE ENDURABLE THAN TIMBER.



In use upon many Railways in England and the Colonies.

The first and only Cross Sleeper in use upon English Railways with Flat bottomed Rails.

Ample Bearing on Ballast.

Can be shifted without damage.

Always perfectly in Gauge.

THE MOST SIMPLE AND PERFECT FASTENING.



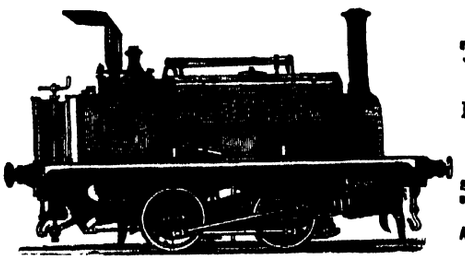
Narrow Gauge Railway, from 16 in. to 36 in., in use in the Cleveland and many other Mines.

Agricultural, Portable and Light Passenger Railways put down complete with Rolling Stock.

3655

CHARLES WOOD, Tees Ironworks, MIDDLESBRO'

THE HUNSLET ENGINE COMPANY, LEEDS.



LOCOMOTIVE TANK ENGINES

Of all descriptions and any size, for Ironworks, Collieries, Contractors, Docks, Manufactories, Branch Railways, &c., &c.

Specially designed for any circumstances, or to suit any Gauge of Railway. 4291

ARRANGEMENTS MADE FOR HIRE

On Purchasing Lease or otherwise.

FOR LOCOMOTIVE MARINE OR OTHER ENGINE

ELECTRIC LIGHT MACHINE

STROUDLEY'S PATENT SPEED INDICATOR

300 IN USE

TAITE & CARLTON

4887

Portable Railways.

3410 CUSTOMERS USE

DECAUVILLE'S PORTABLE RAILWAY

Awarded 25 GOLD MEDALS, and ALL FIRST PRIZES, 14 for the last eight years.

Railway and Wagons for Sugar Plantations, Farms, Mines, Quarries, Contractors, Ironworks, Brick and Cement Works, Docks, Harbours, Railway Extensions, Fortresses, Military Expeditions, Narrow Gauge Passenger Lines, and the like.

FOR PRICES AND PARTICULARS ADDRESS: 4777

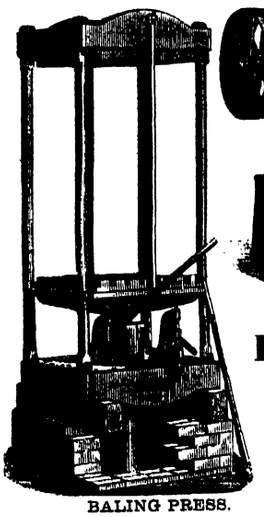
ROBT. von GLEHN & SONS, 7, Idol Lane, LONDON, E.C.

HAYWARD TYLER & CO.,

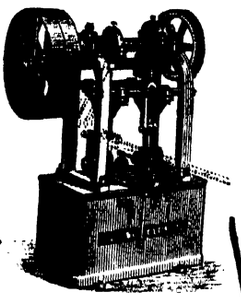
ENGINEERS

AND

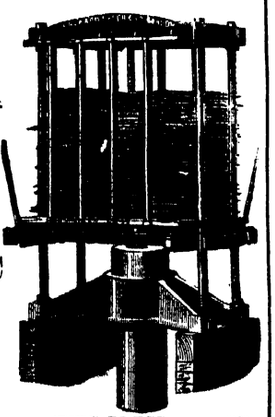
CONTRACTORS TO H.M. GOVERNMENT.



BALING PRESS.



HYDRAULIC PUMPS AND PRESSES.

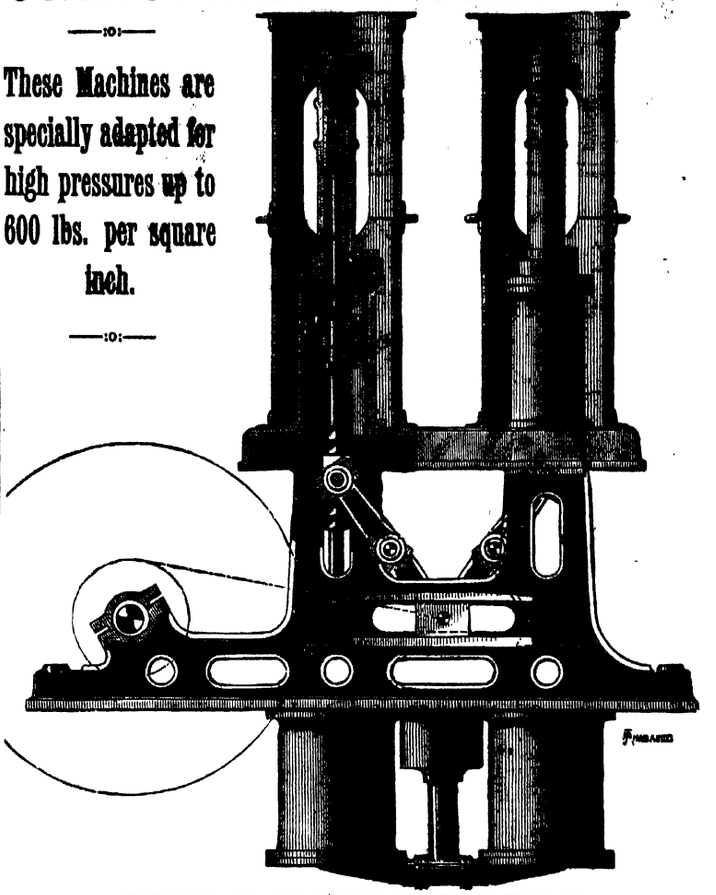


HIDE PRESS. 4930

84 & 85, WHITECROSS STREET, LONDON.

OWEN'S PATENT AIR COMPRESSOR.

These Machines are specially adapted for high pressures up to 800 lbs. per square inch.



PARTICULARS AND PRICES ON APPLICATION TO

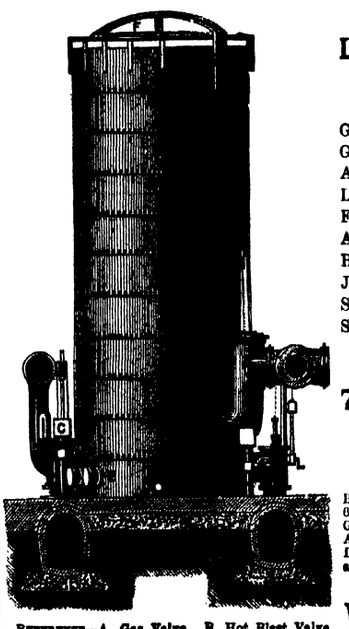
OLIVER & CO., Limited,

Broad Oaks Ironworks, Chesterfield. 4878

London Office: 9, NORTHUMBERLAND ST., CHARING CROSS, W.C.

FIRE BRICK HOT BLAST STOVES

(WHITWELL'S PATENT).



REFERENCE.—A, Gas Valve. B, Hot Blast Valve. C, Chimney Valve. D, Cold Blast Valve. E, Lower Cleaning Doors. F, Upper Cleaning Doors. G, Air Inlets for Combustion of Gas. NOTE.—Dimensions vary according to size required.

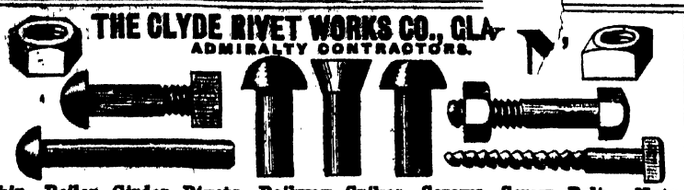
LIST OF STOVES IN WORK OR CONSTRUCTION.

	Stoves.	Blast Furnaces.
Great Britain	241	... 74
Germany	99	... 26
Austria	40	... 14
Luxembourg	16	... 3
France	110	... 36
America	228	... 73
Belgium	43	... 11
Japan	3	... 1
Spain	12	... 4
Saxony	3	... 1
Total...	795	... 243

795 STOVES IN WORK OR CONSTRUCTION.

AGENTS.—Germany, Herr MACCO, Siegen; France, Belgium, and Luxemburg, M. MAURICE, SAUTTER, 6, Rue de L'Oratoire, St. Honore, Paris, and M. C. GUYENET, Engineer, 83, Boulevard Magenta, Paris; Austria, M. P. KUPELWIESER, Witkowitser Eisenwerks Direction, Witkowitz; America, Messrs. WITHEROW and GORDON, Pittsburgh.

WILLIAM WHITWELL, STOCKTON-ON-TEES. 4870



THE CLYDE RIVET WORKS CO., GLA
ADMIRALTY CONTRACTORS.

Ship, Boiler, Girder Rivets, Railway Spikes, Screws, Screw Bolts, Nuts.
BEST MATERIALS AND WORKMANSHIP. MODERATE PRICES.
PROMPT DELIVERIES OF ALL HOME AND EXPORT ORDER 5071

WHITEHOUSE & CO.,
TIPTON HALL CHAIN WORKS,
TIPTON, STAFFORDSHIRE.

MAKERS OF THE CELEBRATED

CRANE AND INCLINE CHAINS.



ORDERS DESPATCHED ON RECEIPT OF TELEGRAM.

ALL HIGH-CLASS CHAINS made by EXPERIENCED WORKMEN, from SPECIALLY-PREPARED IRON, under the most careful PERSONAL SUPERVISION, thus ensuring the GREATEST POSSIBLE STRENGTH, UNIFORMITY, and DURABILITY.

SEND FOR PRICES. 5211

AGENTS:—
LONDON: J. C. S. OGG, 13, Crutched Friars, E.C.
MANCHESTER: C. J. BROWN, 7, Exchange Arcade.
LIVERPOOL: HOLT & ADDLINGTON, 24, Fenwick Street.

MACHINE-MOULDED WHEELS,
— ALSO —
SHAFTING PULLEYS, PLUMMER BLOCKS,
WROUGHT IRON COLLARS, &c.

ELIZA TINSLEY, *Engineer and Ironfounder,*
GREAT BRIDGE, STAFFORDSHIRE. 4717

CLAYTON & SHUTTLEWORTH,
Stamp End Works, Lincoln; and 78, Lombard Street, London.



The Royal Agricultural Society of England have awarded every FIRST PRIZE to CLAYTON AND SHUTTLEWORTH for PORTABLE and other STEAM ENGINES since 1863, and PRIZES at every MEETING at which they have competed since 1849.

Steam Engines, Portable and Fixed. (Over 21,500 Sold).
For Coals, Wood, Straw, and every kind of Fuel.
Thrashing Machines. (Over 19,500 Sold).
Straw, Corn & Hay Elevators. Chaff Cutters for Steam Power.
Grinding Mills. Saw Benches. Traction Engines, &c.

GOLD MEDAL and First Class Certificate at the Calcutta International Exhibition, 1883-4.

THE ONLY GOLD MEDAL awarded for PORTABLE STEAM ENGINES.

Gold Medals and other Prizes have been awarded to CLAYTON AND SHUTTLEWORTH at all the important International and Colonial Exhibitions, including: London, 1851 & 1862; Paris, 1855, 1867, & 1878; Vienna, 1857, 1866, and 1873.

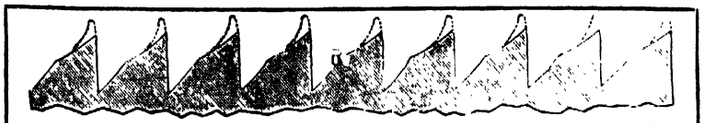
Catalogues in English and in all European Languages free on application. 5130



BEESLEY'S
PATENT VERTICAL
Multitubular Boiler,
— WITH QUADRANT FLUE TUBES. —
ADVANTAGES:
Compactness, Durability, Economical, Accessible, Cheap in First Cost, Suitable for all uses, and adapted for Export.

VARIOUS SIZED BOILERS
IN STOCK AND PROGRESS.

Illustrated Price Lists Post-free upon application to Patentees
BEESLEY & SONS,
MANUFACTURERS OF
Marine, Lancashire, Cornish, Rastrick, and the ordinary Cross Tube Vertical Boilers,
IN IRON OR MILD STEEL.
Riveting done by Machinery.—First-class Workmanship and Best Materials used.—Low Quotations given.—Address:
FURNESS BOILER WORKS, 4479
BARROW-IN-FURNESS, ENGLAND.



This Illustration represents the teeth of a Sand Blast File, highly magnified. The dotted outline shews the shape of the teeth before being sharpened.

Used exclusively by many of the Principal Railways and Marine, Locomotive, and General Engineers.
Specified in all the Indian Government Contracts for Files.

SAND BLAST SHARPENED FILES
NEW FILES FINISHED BY THE SAND-BLAST PROCESS.

Files so treated cut much faster, work more freely, and wear longer than the ordinary kind

The labour saved in one hour's actual filing will more than repay extra charge for Sharpening.

☞ These Files may be obtained from any Sheffield File Manufacturer, and La Societe pour l'affutage des limes, 124, Rue d'Allemange, Paris, by specifying on orders for Files, "To be Sharpened by the Sand Blast."

THUGHMAN'S PATENT SAND BLAST COMPANY, SHEFFIELD. 5051



THE EMPIRE LUBRICATOR COMPANY,
EMPIRE WORKS,
GREAT BRIDGEWATER STREET,
MANCHESTER.

MANUFACTURERS OF
GRANDISON'S
EMPIRE LUBRICATOR

Which shows each drop of oil passing into the steam through the medium of a Glass Tube, and is the BEST APPARATUS now known for Lubrication of

STEAM ENGINES,
LAND OR MARINE.

Lubricators sent on approval to any part of the kingdom and references given to users in all parts of the inhabited world.

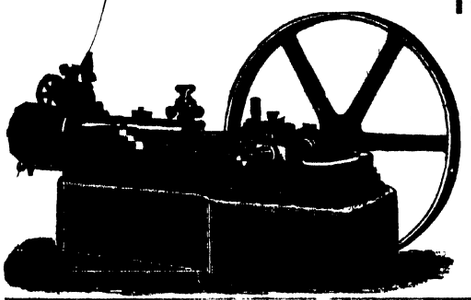
FURTHER PARTICULARS ON APPLICATION. 4706

MARSHALL, SONS, & CO., LIMITED,

[TELEPHONE No. 6848.

BRITANNIA IRONWORKS, GAINSBOROUGH, AND MARSHALLS' BUILDINGS, 79, FARRINGDON ROAD, LONDON, E.C.

MANUFACTURERS OF PORTABLE, SEMI-PORTABLE, HORIZONTAL, FIXED, VERTICAL, AND TRACTION ENGINES, THRASHING, CORN GRINDING, SAWING AND TEA PREPARING MACHINERY.



HORIZONTAL ENGINES WITH INSIDE CRANKS

3 TO 10 HORSE POWER INCLUSIVE.

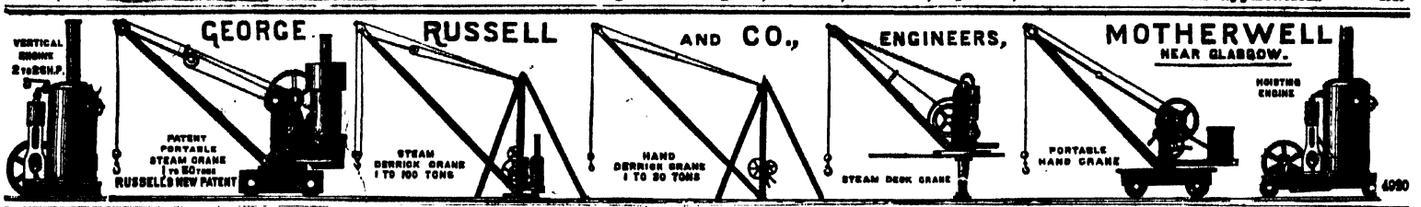
These Engines are self-contained and very readily fixed, they are of great strength and extra capacity, and are fitted either with Equilibrium Throttle Valves and Quick Speed Governors, or our Patent Automatic Expansion Valve Gear, at option of Purchasers.

CALCUTTA EXHIBITION, 1884—FIVE GOLD AND THREE SILVER MEDALS.
AMSTERDAM EXHIBITION, 1883—THE DIPLOMA OF HONOUR.
ELECTRICAL EXHIBITION, CRYSTAL PALACE, 1882—GOLD MEDAL.
MELBOURNE, 1881—HIGHEST AWARD FOR ALL EXHIBITS. FIVE GOLD MEDALS.
SYDNEY EXHIBITION, 1880—TWO SPECIAL AND FOUR FIRST PRIZES.
PARIS EXHIBITION, 1878—TWO GOLD MEDALS AND OTHER PRIZES.

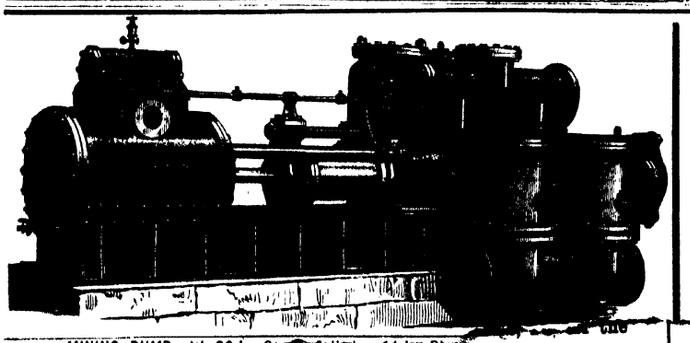
Catalogues in English, French, German, Spanish, or Russian free on application. 2529

GEORGE RUSSELL AND CO., ENGINEERS, MOTHERWELL

NEAR GLASGOW.



4920



MINING PUMP with 30 in. Steam Cylinder, 14 in. Plungers by 36 in. Stroke.

eight years.

PULSOMETER for Sugar Plantations

Ironworks,

Extensive

PUMPING MACHINERY (DEANE SYSTEM)

The Only Gold Medal FOR ALL DUTIES.

for direct-acting Steam Pumps given at Calcutta was awarded to the P. E. Co., Ld., for "THE DEANE."

UNEQUALLED SIMPLICITY OF MECHANISM.

10,000 in Use. CERTAINTY OF ACTION.

Compound Pumping Engines, Boiler-Feeding and Fire Pumps, Marine Pumps, PARTICULARS AND PRICES [illegible]ic Pumps, Artesian Well Pumps, Mining Pumps, Sinking Pumps, Hydraulic [illegible] Condensers. Independent Air Pumps and [illegible]

Chester, LONDON, S.W.

PULSOMETER ENGINEERING CO., Limited, Nine Elms Iron Works,

A LARGE STOCK KEPT OF
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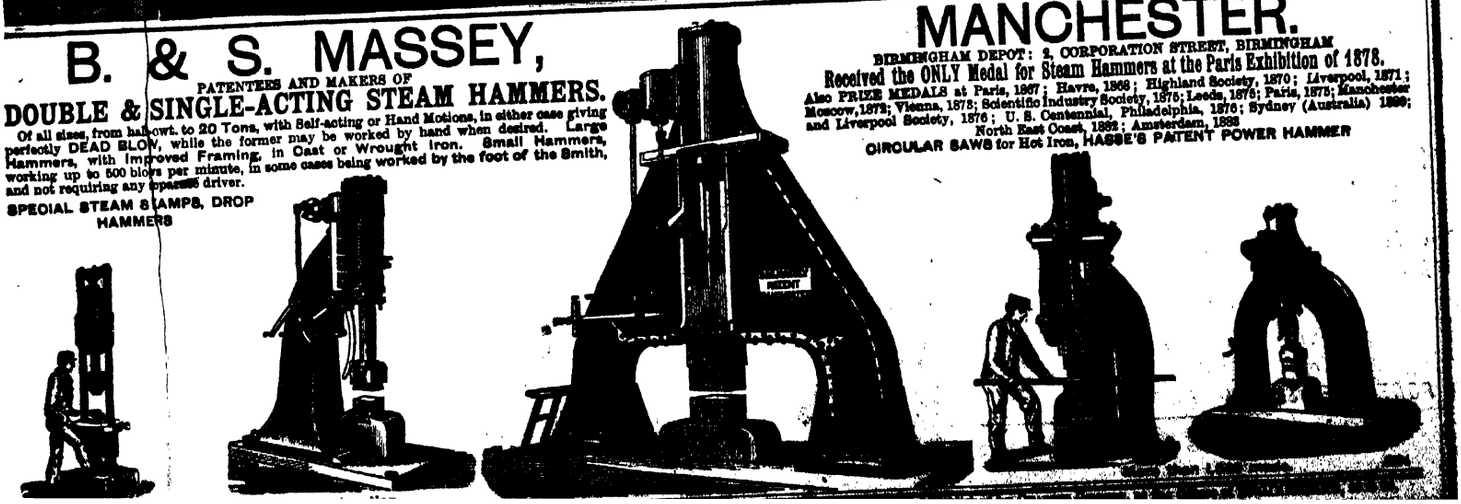
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See Advertisement last week, page 33 3627

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See Illustrated Advertisement last week, page 49

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H.R.H. THE PRINCE OF WALES, K.G.

Applications to Exhibit must be made on Printed Forms, which will be supplied on application to the SECRETARY, International Inventions Exhibition, South Kensington, S.W. These must be filled up and returned on or before the 1st October, 1884. G 689

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SESSION 1884—1885.

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TO ENGINEERS, IRONFOUNDERS, &c.

SOMERSET EAST, SOUTH AFRICA, WATER SUPPLY.

The Municipal Council of Somerset East, Cape Colony, require

Tenders for the Supply and

DELIVERY in England of about 400 tons of straight PIPES (9 in. to 3 in. diameter), and special CASTINGS, and of a number of Sluice and Air Valves, Hydrants, and Fittings.

The Specification and Drawing may be seen at the Standard Bank of South Africa, Clement's Lane, E.C., between Eleven and Two, on and after Monday, August 18th, and copies of the Specification and Form of Tender can be obtained there on payment of Half-a-Guinea.

Tenders, which must be endorsed on the outside "Tender for Pipes, &c., Somerset East," and addressed to ROBERT STEWART, Esq., Standard Bank of South Africa, Clement's Lane, E.C., must be delivered not later than noon on September 6th, 1884.

Mr. Stewart has power to accept Tenders, and enter into Contracts on behalf of the Municipal Council.

Tenders for the Pipes and Specials, or for the Valves and Fittings, will be considered, as well as Tenders for the whole of the work.

Intimation of the acceptance of any Tender will be given not later than October 1st, 1884.

The lowest or any Tender will not necessarily be accepted. G 705

TO BUILDERS, CONTRACTORS, AND OTHERS.

The Metropolitan Board of Works will meet at the Office of the Board, Spring Gardens, S.W, on Friday, the 3rd day of October, 1884, at Twelve o'clock at noon precisely, and will then be prepared to open

Tenders by Parties who may

be willing to CONTRACT for the RE-BUILDING of the SUPERSTRUCTURE and the STRENGTHENING of HAMMERSMITH BRIDGE, and also for constructing a Temporary Timber Bridge for the accommodation of the traffic during the closing of the permanent structure. Parties desirous to submit Tenders may, upon the payment of £5, obtain a Copy of the Drawings, Specification, Form of Tender, and other particulars on application to the Engineer of the Board, at the Office, Spring Gardens, between the hours of Nine a.m. and Four p.m. (or on Saturdays between the hours of Nine a.m. and Two p.m.) until Thursday, the 2nd day of October, 1884. The Tenders, which must be on the form supplied from this Office, and addressed to the Clerk of the Board, are to be delivered at the Office before Four o'clock on the last-mentioned day, and no Tender will be received after that hour. The parties tendering must be in attendance at the Board at Twelve o'clock on the day appointed for opening Tenders, and any Tender which is not fully filled up in every particular will be rejected.

The Board do not bind themselves to accept the lowest or any Tender.

J. R. WAKEFIELD, Clerk of the Board.
Spring Gardens, S.W., 20th August, 1884. G 726

TENDERS FOR GASHOLDER.

The Directors of the PRESTON GAS COMPANY are prepared to receive

Tenders for the Erection of a

TELESCOPIC GASHOLDER, about 150 ft. diam. Sealed Tenders, endorsed "Tender for Gasholder," and addressed to the Chairman of the Company, must be delivered on or before Wednesday, the 10th September next. Plans and Specifications may be seen at the Office of the undersigned on and after the 14th inst. G 671

Gas Office, Preston, HENRY GREEN,
8th August, 1884. Engineer.

THE SOUTHERN MAHRATTA RAILWAY COMPANY, LIMITED.

The Board of Directors of the Southern Mahratta Railway Company, Limited, are prepared to receive

Tenders for the Supply of

IRON UNDERFRAMES, UNDERFRAME and BODY IRONWORK and FITTINGS for First, Second, and Third Class Carriages, Composite Carriages, Horse Boxes, and Brake Vans, as per Specification and Drawings to be seen at this Office. Tenders are to be delivered in sealed envelopes, addressed to the Secretary, marked "Tender for Underframes, &c.," not later than Twelve o'clock, at noon, on Wednesday, the 17th September, 1884.

The Company is not bound to accept the lowest or any Tender.

By order of the Board,
Secretary's Office, EDW. Z. THORNTON,
31, Lombard Street, E.C., Secretary.
8th August, 1884. G 666

SOUTH INDIAN RAILWAY COMPANY.

The South Indian Railway Company is prepared to receive

Tenders for the Supply of

LOCOMOTIVE and ENGINEERING STORES, comprising: Lowmoor Plates, Steel Cranks, India-rubber Suction Pipes, Crucible Cast Steel Tyres, Buffer Springs, Leather Delivery Pipes, Copper Pipes, Galvanised Wrought Iron Pipes, Screwing Apparatus, and Carpenters' and Fitters' Tools.

Specifications and Forms of Tender may be obtained at the Company's Offices.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, and marked "Tender for Locomotive Stores," must be left with the undersigned not later than Twelve o'clock noon of Tuesday, the 2nd day of September, 1884.

The Company is not bound to accept the lowest or any Tender.

A charge of Ten Shillings (which will not be returned) will be made for Copies of the Specification.

By order,
Company's Offices, HENRY W. NOTMAN,
55, Gracechurch St., Managing Director.
London, 20th August, 1884. G 738

CALEDONIAN RAILWAY.

CONTRACT FOR NEW ENGINE SHED, &c., AT DUNDEE.

The Directors of the Caledonian Railway are prepared to receive

Tenders for Executing under

our Contract the whole work required in the erection of a new Engine Shed, &c., at Dundee (West) Station, including excavation, mason and brickwork, joiner, plumber, slater, plaster, and cast and wrought-iron work. The shed will be about 286 feet long, and 131 feet wide, and there will be about 60 tons of cast and 70 tons of wrought-iron work.

Drawings may be seen at the Office of Mr. BURR, Resident Engineer, Northern Division, Caledonian Railway, Perth, on and after Friday, the 22nd curt., where copies of the Specification and duplicate schedule of Measurements may be obtained on payment of One Guinea. A copy of the Drawings and Specification may also be seen at the Engineer's Office, Buchanan Street Station, Glasgow, and at the Company's West Station, Dundee.

Sealed Tenders, addressed to the undersigned, and marked "Tender for Engine Shed, &c., Dundee," must be lodged with him on or before Monday, the 1st proximo.

The Directors do not bind themselves to accept the lowest or any Tender.

ARCH. GIBSON, Secretary.
Caledonian Railway Company's Offices. G 719

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The date specified is the latest at which applications can be received. They must be made on Forms to be obtained, with particulars, from the SECRETARY, Civil Service Commission, London, S.W. G 686

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ENSOR DRURY, Registrar.
Firth College, Sheffield. G 704

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Foreman.—An UNDER FOREMAN or ASSISTANT is WANTED in the Marine Boiler Department of Messrs. MAUDSLAY, SONS, and FIELD, of London and East Greenwich. Applications must be addressed to the undersigned, or to Messrs. MAUDSLAY, SONS, and FIELD, Lambeth, and must state age, past experience, and where last employed, together with copies of any recent testimonials as to ability and character. Only men of good practical knowledge of marine boiler work need apply; also some experience of repair work will be expected. If satisfactory on trial, Messrs. M. S. & F. will defray all expenses of removal of family to London.—E. HUTCHINGS, Secretary Iron Trades Employers' Association, 17, Cooper Street, Manchester. G 707

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Lists of Berths Vacant or

WANTED. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5262

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Certificated, with three years in marine works, WISHES to ENTER a good C.E.'s office; mines, railways, or docks preferred.—Address, G 698, Offices of ENGINEERING. G 698

A Young Engineer desires

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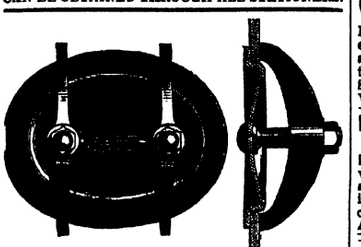
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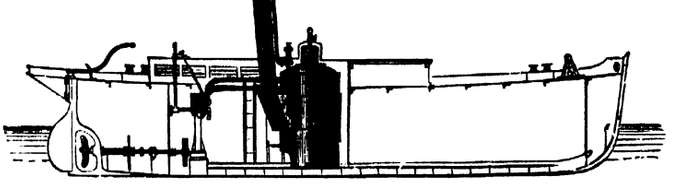


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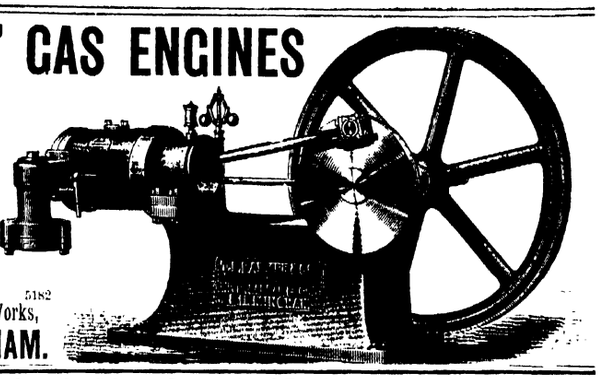


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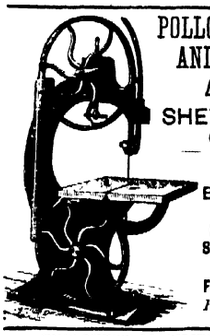
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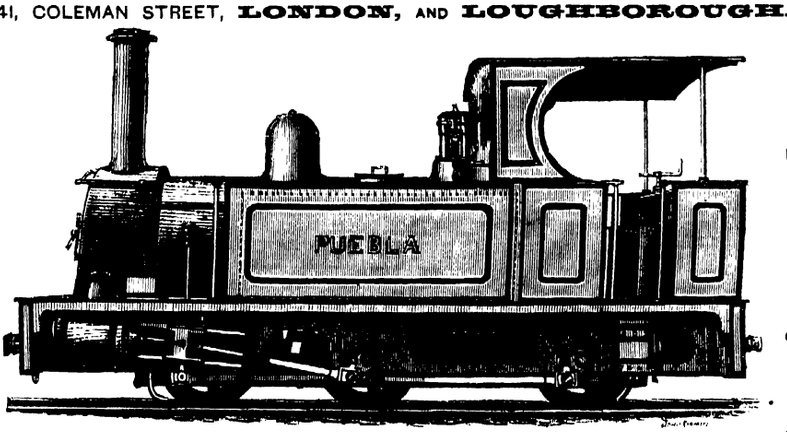
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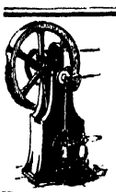
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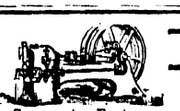
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VERTICAL Combined Engines and Boilers. 5109
HORIZONTAL ENGINES.

BRIDGE FOUNDATION CYLINDERS.
THE STOCKTON FORGE CO.,
STOCKTON-ON-TEES.
Make a Specialty of this work, turning out over 100 tons per week; also large quantities of Railway Chairs. 4809


Non-Compression Engine.

GAS ENGINES
FROM 1 MAN TO 100 HP.


Compression Engine.

ALL SIZES ABOVE 2 HP. SELF STARTING. 5136
ATKINSON'S PATENTS.


Feed-Water Heater.

FEED-WATER HEATERS.
—(JOHN HASTIE & CO., GREENOCK, SOLE MAKERS OF THESE HEATERS FOR SCOTLAND.)—
Sole Makers: BRITISH GAS ENGINE & ENGINEERING COMPANY, Limited, 11, Queen Victoria St., London, E.C.

Portable Railways.

3410 CUSTOMERS USE

DECAUVILLE'S PORTABLE RAILWAY

Awarded 25 GOLD MEDALS, and ALL FIRST PRIZES, 14, for the last eight years.

Railway and Wagons for Sugar Plantations, Farms, Mines, Quarries, Contractors, Ironworks, Brick and Cement Works, Docks, Harbours, Railway Extensions, Fortresses, Military Expeditions, Narrow Gauge Passenger Lines, and the like.

FOR PRICES AND PARTICULARS ADDRESS: 4777

ROBT. von GLEHN & SONS, 7, Idol Lane, LONDON, E.C.





THE PERTH GAUGE GLASS,

Warranted to stand upwards of **1500 lbs.** pressure to the square inch, and bear great variation of temperature.

These Medals have been awarded for the above-mentioned qualities.

JOHN MONCRIEFF, 5265

North British Glass Works, PERTH.

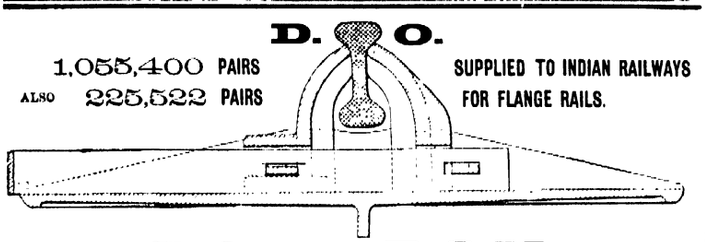


D. O.

1,055,400 PAIRS

ALSO 225,522 PAIRS

SUPPLIED TO INDIAN RAILWAYS FOR FLANGE RAILS.



D-O. AND D-O-M.

PATENT TRANSVERSE CAST IRON PLATE SLEEPERS,

For any Gauge and for any form of Rail; without Wooden Keys or any perishable part.
As in use on Guaranteed and State Railways in India.

COST IS LESS THAN INDIGENOUS TIMBER.

Vide "Minutes of Proceedings of the Institution of Civil Engineers," Nov., 1881, Vol. LXVII., p. 37).

FOR PARTICULARS APPLY TO

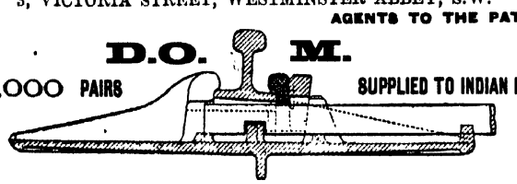
MESSRS. THOMSON & BROWNING,

3, VICTORIA STREET, WESTMINSTER ABBEY, S.W.

AGENTS TO THE PATENTEES.

D.O. M.

230,000 PAIRS



SUPPLIED TO INDIAN RAILWAYS.

5175

Ships' Engine and Steering Telegraphs.

Over 3000 Vessels have been fitted with **CHADBURN & SON'S** Patent Telegraphs, including all the noted Steamers in the World, also 200 Vessels for English and Foreign Navies.

EXHIBITION AWARDS: LONDON, PARIS, N.E. COAST, AMSTERDAM, FISHERIES.



CHADBURN & SON'S

NEW

PATENT 'DUPLEX GONG 1883.

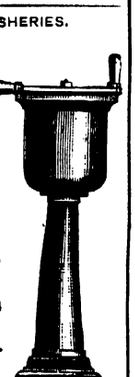
ENGINE AND STEERING REPLY TELEGRAPHS.



ORDERS INDICATED BY SOUND & SIGHT.

A DEEP GONG from Astern to Ahead.

A SHRILL GONG from Ahead to Astern.



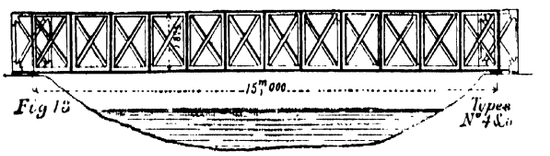
TELEGRAPH WORKS—WATERLOO ROAD,

GLASGOW-69, ANDERSTON QUAY. **LIVERPOOL.** LONDON-96, FENCHURCH ST.

5040

COTTRAU'S

Patent Portable Bridge



See "Engineering," 15th August, 1884.

CHARLES CLAUSON, 39, Lombard St., London,

Representative for Great Britain and the Colonies.

SLAG WOOL *Loose* *and* SILICATE CLOTH *Felted.*

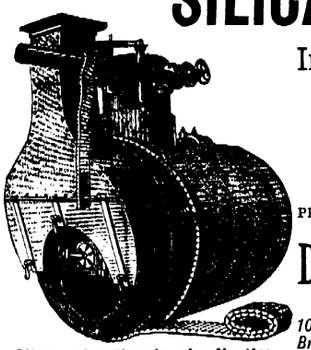


Illustration Showing Application of Silicate Cloth.

Incombustible.
Best Non-conductor Extant.
Easily Applied.
Removable.
Re-applicable.

PRICES, ESTIMATES, AND FULL INSTRUCTIONS FREE ON APPLICATION TO

D. ANDERSON & SON, Ltd.,

PATENT FELT MANUFACTURERS, 5223

10, London Street, Fenchurch Street, LONDON; 118, Broomielaw, GLASGOW; and Lagan Felt Works, BELFAST

CHAS. BURRELL & SONS,

ENGINEERS,

THETFORD, ENGLAND,

LONDON OFFICE: 123, CANNON STREET, E.C.,

MANUFACTURERS OF

MARINE ENGINES,

COMPOUND
SURFACE
CONDENSING
to 600 I. HP.

—

ALSO

BOILERS

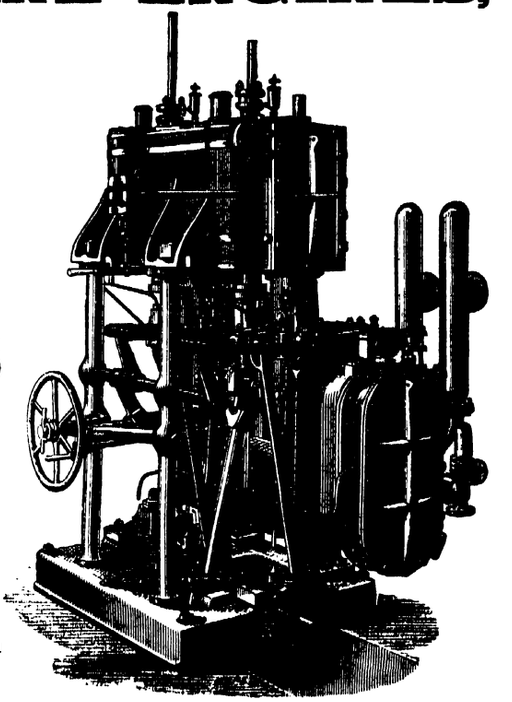
For ditto in

Steel or Iron.

—:—

PRICES ON APPLICATION.

4951



Harpers Limited,

Founders, Engineers, Millwrights, Blacksmiths, Storemen,

Albion Iron Works,

Aberdeen, Scotland.

From the **Foundry** Department.

The main Building of this Department is 240 feet long × 74 feet wide, and is replete with modern appliances. A powerful and novel overhead travelling Crane driven by a rope from the Engine commands almost the entire length of the Foundry, while several swing Cranes for the lighter work are affixed to the walls. These, combined with power fettling tools, patent moulding machinery, perpetual core drying stoves, and a large staff of workmen, enable Castings to be produced quickly and well. Patterns, as a rule, are in the sand the morning after receipt of order if they be not in use at the time or require lengthy alterations or additions. Engineers, Millwrights, and others who get their Castings here are well pleased with the Finish and Quality, the excellence of which may always be depended on, as we do so much machining ourselves that we are compelled, though it were only for the profitable working of our own Turning Shops, to use only the best of metals constantly.

Our present **Trade** Prices per Cwt. for Castings are as follows,

Inclusive of the payment by us of Freight to

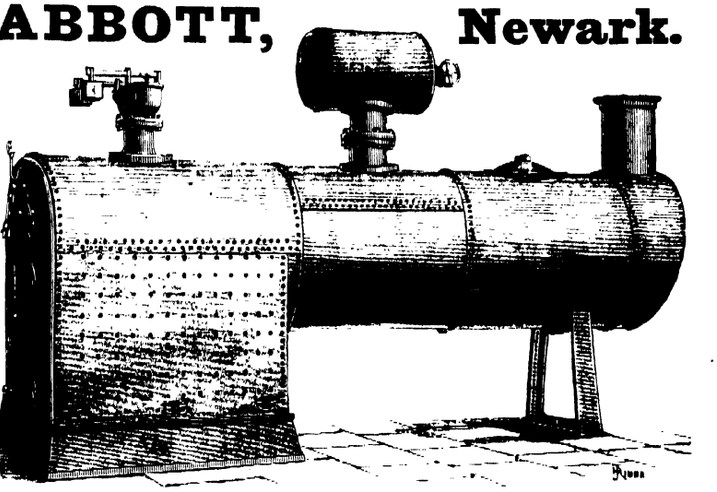
London, Liverpool, Hull, Newcastle, or Leith,

And subject to 5 % Discount if paid promptly on 10th of month following despatch

Spur, Bevel, Mitre, Worm, and Mortice Wheels, all from Superior Machine-cut Patterns,	1 in. pitch or larger,	13/-
	Extra for ¾ in. and ⅞ in. pitch,	3/-
	Extra for ½ in. and ⅝ in. pitch,	5/-
Flange Couplings (for Shafting) of almost any size desired,		11/-
Pedestals (for Shafting)	do. do. do.	13/-
Stools, Hangers, and Wall Boxes, all of modern design,		13/-
Scroll Arm Fly Wheels of almost any size not under 30 in. Dia. 4 in. face, and convex if desired,	Whole,	11/-
	Extra if Split,	3/-
Scroll Arm Rope Pulleys of almost any Diameter, width, and number of grooves,	Whole,	16/
	Extra if Split,	4/-
Our Well-Known Scroll Arm Belt Pulleys of almost any Diameter and width,	Whole,	13/-
	Extra if Flanged,	3/-
	Extra if Split,	5/-

The bushings of our Split Pulleys are now very neat, and all their bolt holes are cored, which Engineers will find is a great saving as compared with drilling.

ABBOTT, Newark.



SEMI-PORTABLE BOILERS,

2 to 60 HP. Nominal, suitable for pressures from 50 lbs. to 250 lbs. per square inch.

PRICES ON APPLICATION 4013

HANSON'S SPECIALITIES

Steam Pumps, Steam Engines, Steam Winches, Steam Dryers, Steam Traps, Steam Reducing Valves, Steam Purifying Apparatus for Boilers, Water Engines and Hoists for Warehouses.

WILLIAM HANSON,

QUEBEC WORKS, BRADFORD.

LONDON OFFICE: 37, WALBROOK. 5070

(See Illustrated Advertisement August 15th, page 11.)

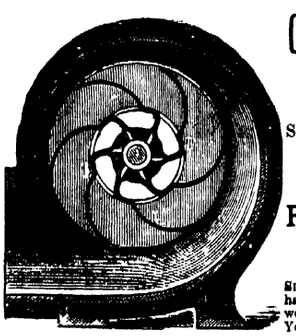
MACHINE-MOULDED WHEELS,

— ALSO —

SHAFTING PULLEYS, PLUMMER BLOCKS, WROUGHT IRON COLLARS, &c.

ELIZA TINSLEY, *Engineer and Ironfounder,*

GREAT BRIDGE, STAFFORDSHIRE. 4717



CAPELL Double-Power FAN

(PATENT),

THE MOST POWERFUL YET MADE.

See *Engineer*, February 16th, 1883, and Tests of Mr. D. K. CLARKE, C.E., *Engineer*, March 28th, 1884.

LICENSEES FOR THE NORTH:

R. LLOYD & CO., 136, Steelhouse Lane, BIRMINGHAM.

ACORN AND MIDLAND WORKS, Darlaston, 3rd June.—"DEAR SIRS,—In reply to yours of the 29th, the CAPELL 20 in. FAN we had of you is working satisfactorily, and is doing quite as much work as the 30 in. it replaced, and *taking less power* to drive it.—Yours truly, J. SIMPSON & SONS."

From S. NORTHWOOD & SON, Viaduct Foundry, Birmingham.—"We have much pleasure in testifying to the excellent manner in which the CAPELL FAN works which you supplied to us some time ago. Although a larger Fan than we had previously in use, it takes *considerably less power* to drive, while at the same time we get a better and more uniform blast, and Fan we do not drive up to speed." 5251

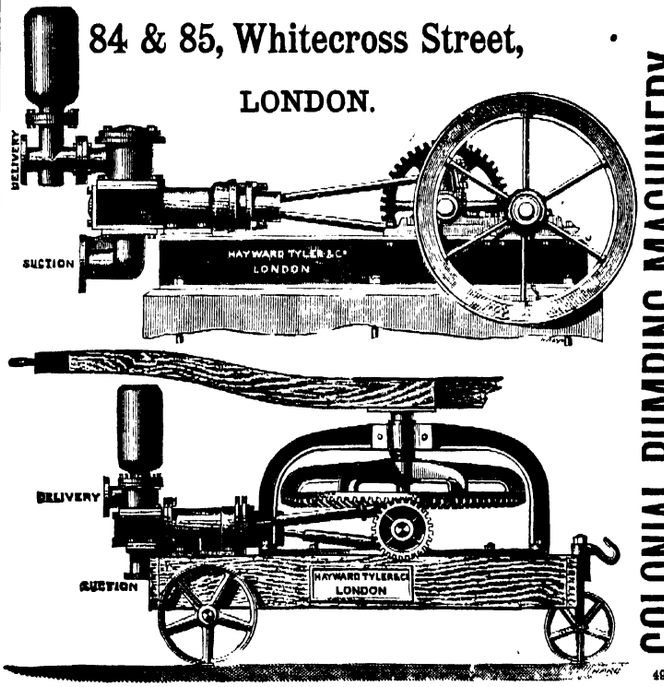
Agents for London and District:

Messrs. HOPKINSON & PRINCE, 15, Walbrook, London, E.C.

HAYWARD TYLER & CO.,

84 & 85, Whitecross Street,

LONDON.



COLONIAL PUMPING MACHINERY.

4980

Gold Medal Paris, 1881.

ELECTRIC LIGHT.

Gold Medal Crystal Palace, 1882.

WORKSHOPS, MILLS, DWELLING HOUSES, OUT-DOOR CONTRACTS.

R. E. CROMPTON & CO., Electric Light Engineers,

MANSION HOUSE BUILDINGS, LONDON, and ARC WORKS, CHELMSFORD,

Contractors to H.M. Board of Works, General Post Office, Principal Railway Companies, &c.,

ARE PREPARED TO SUPPLY SETS OF MACHINERY FOR

ELECTRIC LIGHTING EITHER BY ARC OR INCANDESCENT SYSTEM,

AS UNDER:

ARC LIGHTING.

	£	s.	d.
10-light set (including Burgin Dynamo machine, Ten 16-hour, 2,000 candle-power lamps, cable, switch, &c.) packed and delivered free to any railway station in England	330	0	0
6-light set do. do. do. ...	195	0	0
3-light set do. do. do. ...	120	0	0

INCANDESCENT LIGHTING.

	£	s.	d.
30-light set (including self-regulating Burgin Dynamo machine, Thirty Swan 20 candle-power lamps, 30 holders, cable, branch wire, cut-outs, plain wall brackets or pendants) packed and delivered free to any railway station in England	100	0	0
75-light set do. do. do. ...	195	0	0
150-light set do. do. do. ...	300	0	0

OTHER PRICES AND LIST ON APPLICATION.

Extract from a Letter from the Manager of the South Wales Tin Plate Works (who have since increased their installation by the addition of both Arc and Incandescent Lamps), with reference to an Installation by R. E. CROMPTON & CO.

"Six months' experience is too short a time to enable me to give anything but an estimate of the cost of Electric Lighting, as some parts of the machines only require renewing once in every two or three years. In fact, as yet the cost of renewals has been almost nothing, except in lamps. I, however, estimate that over a series of years this item of expense will not exceed £60 per annum for 100 lights, exclusive of lamps, and this is confirmed by the reports of others, who say that 10 per cent. upon the cost of the plant will quite cover repairs, and £60 is a great deal in excess of 10 per cent. upon the cost of our plant. Taking this sum as the expenditure on repairs, the cost of the Electric Light will be as follows in cases similar to our own, where there is spare steam at night:

	£	s.	d.
Wages	£62	0	0
Lamps	90	0	0
Repairs, &c.	60	0	0
Oil and Stores	13	0	0
	225	0	0
Less work done by Engineer ...	41	6	8
	£183	13	4

I deduct the above amount for the work done by the engineer. He has nothing to do except to oil the bearings once or twice during the night, and can turn rolls, screws for the mills, &c., in a lathe driven by the same engine as the Dynamos; in fact, it is an advantage in more ways than one to give him this work to do, as it prevents him from going to sleep and so neglecting oiling the machinery, as well as the saving in wages.

"This cost is for 100 lamps of 17 candle power for a year, using them on an average five nights a week for 14 hours in the winter six months, and nine hours in the summer six months; this gives a total of 2,990 hours, during the whole of which we have 1,700 candle power of light for the sum of £183 13s. 4d.

"What would an equal light cost in Gas at 3s. 9d. a 1,000 cubic feet? We cannot calculate on burning less than one cubic foot of Gas per hour for every three candles' power; so to get 1,700 candles power for 2,990 hours, we should burn 1,694,300 cubic feet of Gas costing £317 14s. 7d. against £183 13s. 4d. for the same light if supplied by the Incandescence Electric system.' 4813

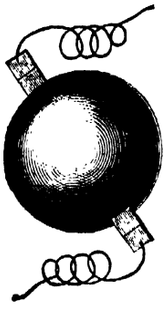
New Patent Barring Engine.

AUTOMATIC MOTION FOR MOVING INTO GEAR, AND FALLS OUT OF GEAR AUTOMATICALLY WHEN MAIN ENGINE STARTS.

The SIMPLEST, SAFEST and BEST, and also the CHEAPEST Automatic Safety Apparatus for Turning Main Engines.

Sole Makers: HICK, HARGREAVES & CO., ENGINEERS, MILLWRIGHTS, AND BOILER MAKERS.

SOHO IRONWORKS, BOLTON. 5199



HANNAY'S PATENT

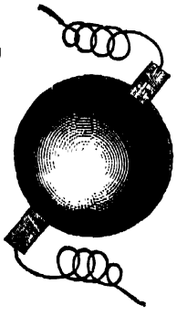
ELECTROGEN

FOR PREVENTING

CORROSION AND SCALE

IN ALL KINDS OF

STEAM BOILERS.



HANNAY'S MARINE APPLIANCES COMPANY, Ltd.,

67, GREAT CLYDE STREET, GLASGOW. 5296



WATER METERS.

H. FROST'S PATENT.

POSITIVE! RELIABLE! DURABLE!

Many Thousands in use both at Home and Abroad.

THE MANCHESTER WATER METER CO., Ltd.

TIPPING STREET, ARDWICK, MANCHESTER.

ESTABLISHED 1860 4433

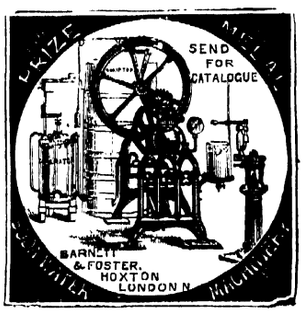


4965

Soda Water Machinery,

For the Manufacture of all kinds of Aerated Drinks in the highest state of perfection,

— BY —



BARNETT & FOSTER,

"NIAGARA WORKS,"

25½, EAGLE WHARF ROAD,

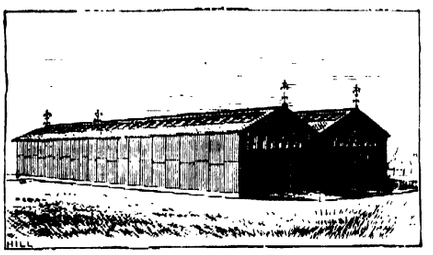
LONDON, N.

A COMPLETE SODA WATER MACHINE, including Bottling Apparatus, is supplied for £40 per set for producing 100 doz. Lemonade, Ginger Ale, &c., per day.

No technical knowledge is required, as all information is given to purchasers of Machines. 4910

ILLUSTRATED CATALOGUE FORWARDED FREE.

IRON ROOFS & FIRE-PROOF BUILDINGS.



TANKS & CISTERNS.

Galvanizing Baths.

DAVIES BROS & Co. CONTRACTORS FOR IRON ROOFS BUILDINGS BRIDGES &c. CROWN IRON WORKS WOLVERHAMPTON

Galvanized and Painted Corrugated Sheets.

IRON ROOFS, IRON BUILDINGS,

ENGINE SHEDS, STORES.

Constructional Iron Work and Smiths' Work of every description. 5027

DAVIES BROS. & CO., Crown Ironworks, Wolverhampton.

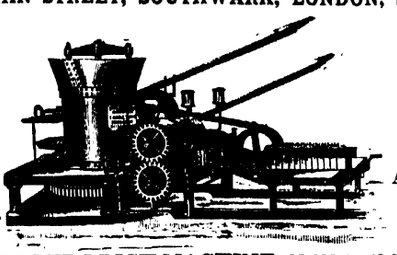
MURRAY'S PATENT BRICKMAKING MACHINERY.

Sole Manufacturers, THOMAS MIDDLETON & Co., Engineers,

LOMAN STREET, SOUTHWARK, LONDON, S.E.

Patent Steam Driven Cutting Tables.

Patent Lubricating Solid Die, for all sorts of Clay.



Patent Plunger Brick Press, for Bricks or Tiles.

Patent Brick Shaping Apparatus, for all kinds of Fancy Bricks.

IMPROVED ROLLER BRICK MACHINE, 12,000 to 40,000 Bricks per day, for Clamp and Kiln Burnt Bricks. 3164

Also Manufacturers of all kinds of Clay Crushing Rolls, Mixing Mills, Steam Engines & Hydraulic Machinery.

S. OWENS & Co.,

WHITEFRIARS ST., LONDON, E.C.

HYDRAULIC ENGINEERS,

SOLE MANUFACTURERS OF

Blake's Patent Steam Pumps.

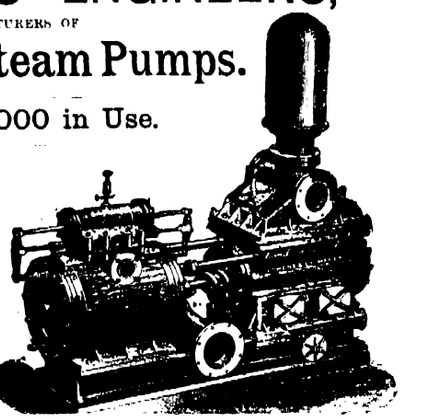
More than 16,000 in Use.

FOR PUMPING

TAR WATER,

OR

Ammoniacal Liquor.



5094

Price Lists and full Particulars furnished on application.

CROWN PHOSPHOR-TIN.

BY USING OUR PHOSPHOR-TIN,

Phosphor-Bronze can be made Superior to any now in the Market,

AT 30 PER CENT. LESS COST.

Three cwt. of our tin will produce one ton of Phosphor-Bronze, thereby effecting a considerable saving in carriage, and enabling Manufacturers to use the same stock of Copper for all purposes.

(See our Circular.)

BILLINGTON & NEWTON,

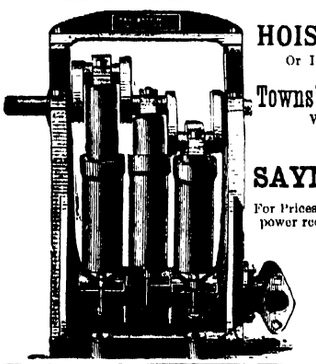
LONGPORT, STAFFORDSHIRE. 5159

Agents.—London: HAUGHTON & CO., 110, Cannon Street, E.C.

North of Europe: A. SINGTON & CO., St. Peter's Square, Manchester.

JOHN RAMSBOTTOM'S

PATENT WATER ENGINES & STEAM PUMPS



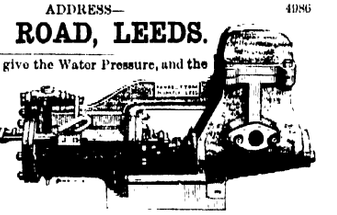
Are for HOISTING USES, Or Driving all kinds of Machines by Towns' Water Pressure Where sufficient.

This Pump is UNSURPASSED Either for SIMPLICITY, PRICE, Or for General Efficiency.

ADDRESS— 4086

SAYNOR ROAD, LEEDS.

For Prices, should give the Water Pressure, and the power required.

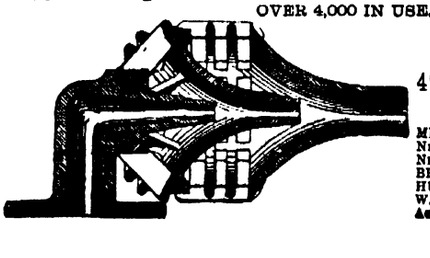


HIGH PRESSURE MARINE BOILERS.

Best and Cheapest Means of Preventing Unequal Expansion.

"WEIR'S" PATENT HYDROKINETER.

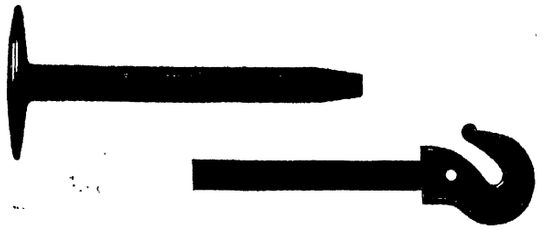
OVER 4,000 IN USE.



G. & J. WEIR,

49, JAMAICA STREET, GLASGOW.

MENZIES & BLAGBURN, KING STREET, NEWCASTLE-ON-TYNE WM. REID & CO., 5, NEW LONDON STREET, LONDON, E.C. A. & R. BROWN, WATERLOO ROAD, LIVERPOOL. R. HUGHES & CO., FULTON STREET, DITTO. W. S. VON ESSEN, ENGINEER, HAMBURG AGENT FOR SCANDINAVIA & GERMANY. 5231



Apply—THE KIRKSTALL FORGE CO., near Leeds. 4686

"STANDARD" STEAM BOILING NOZZLE

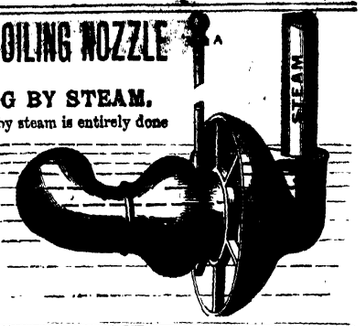
FOR

HEATING OR BOILING BY STEAM.

The objectionable noise when boiling by steam is entirely done away with, and the liquor Heated or Boiled QUICKLY, ECONOMICALLY, and SILENTLY.

½	¾	1	1½	2	3	4 in. pipe
50/-	60/-	65/-	100/-	130/-	175/-	260/-

NUMEROUS TESTIMONIALS. 4991



PICKING, HOPKINS & CO.

BOW, LONDON, E.

THE BOWLING HOOP

STEEL CASTINGS

OF EVERY DESCRIPTION

THE BOWLING IRON Co LTD

BRADFORD YORKS

ORIGINAL PATENTEES AND SOLE MAKERS

IN IRON OR STEEL

4567

—: MAKER OF :—

SUGAR, RICE AND FLOUR MILLS,

STEAM ENGINES,

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Engineer, KIRKCALDY, N.B. 4946

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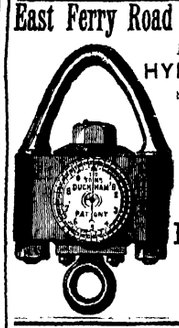
MILLWALL, LONDON, E.

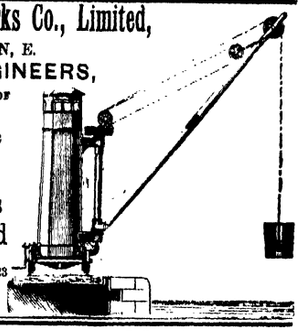
HYDRAULIC ENGINEERS,

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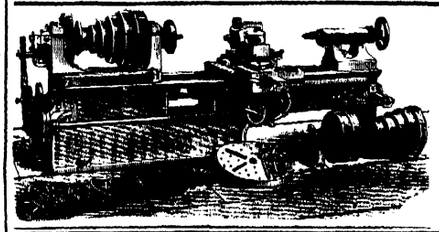
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For Foot or Power. 5220

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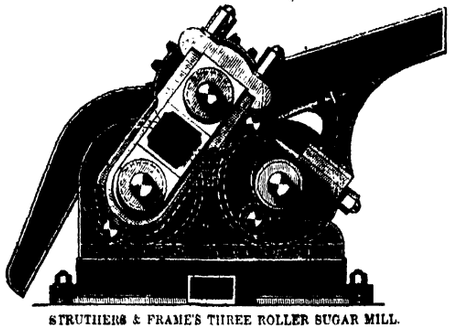
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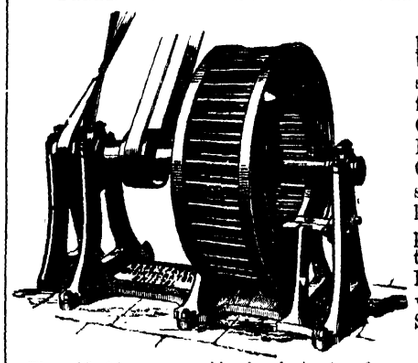
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This Machine effectually pulverizes by the combined influences of percussion and of centrifugal force, Iron, Zinc, and other Ores; Asphalte, Artificial Manures, Phosphates, Fire Clay, and many other substances. It is also largely in use for the pulverization of Coal for the manufacture of Coke, Patent Fuel, &c.; and is very effective for mixing Sugar.

These Machines are capable of reducing to a fine granular powder from 50 to 200 tons per day (according to size) of any unfibrous material. Machines made to order from 18 inches diameter, to suit special requirements of purchasers; these small machines being specially adapted to the requirements of Chemical Manufacturers for Mixing and other purposes.

No Agents. All Machines will in future bear the Registered Trade Mark ("Carr's Disintegrator") in three places—viz. on Bedplate, and on outside Face of each Cage.

A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee, 2523

PHILIP TRIGGS, Albion Chambers, BRISTOL.

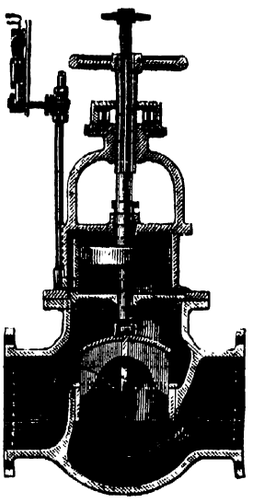
TATE'S PATENT

Electric Valve-Closing Apparatus

FOR STEAM ENGINES.

Medals Awarded AT THE INDUSTRIAL EXHIBITION, BRADFORD, 1882.

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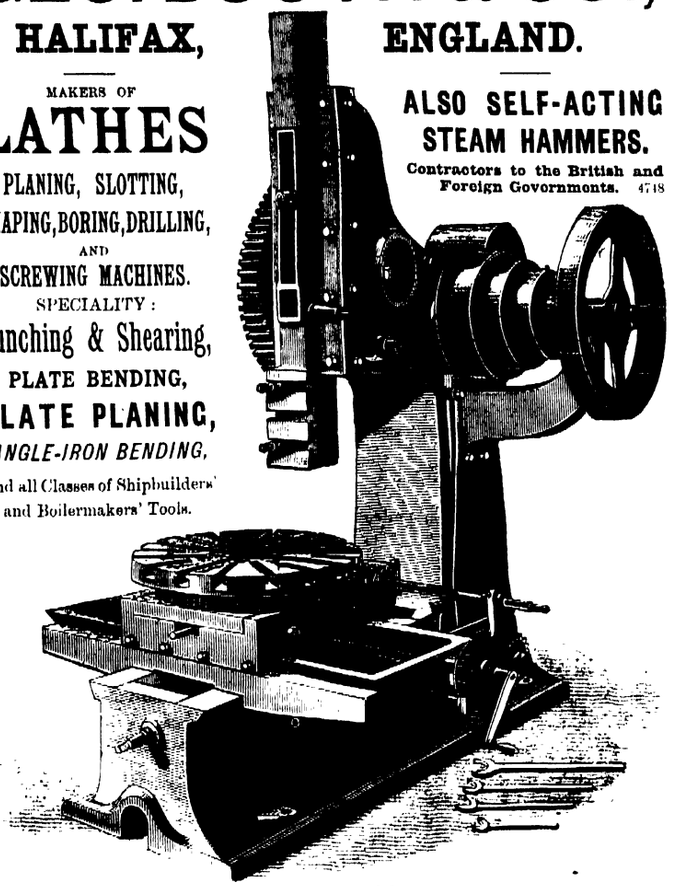
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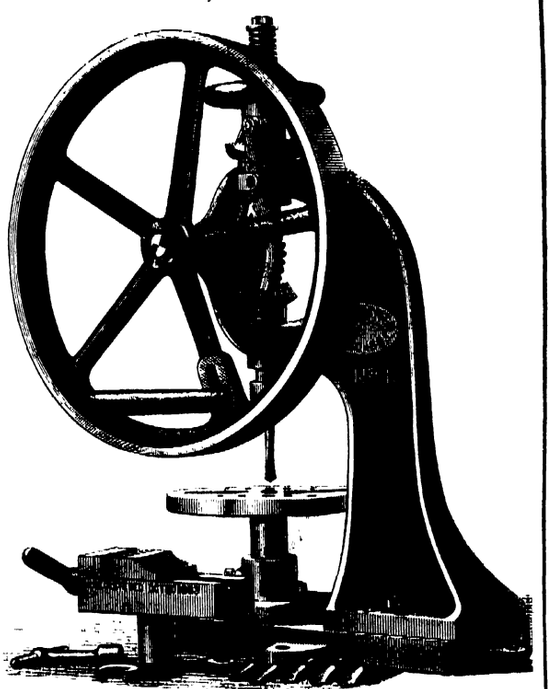
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Registered Self-Feeding Bench Drilling Machine
WITH REGISTERED VICE.
This Machine is suitable for Hand or Power. Prices on application.
SIX DRILLS AND A SET OF SPANNERS SENT WITH EACH MACHINE.

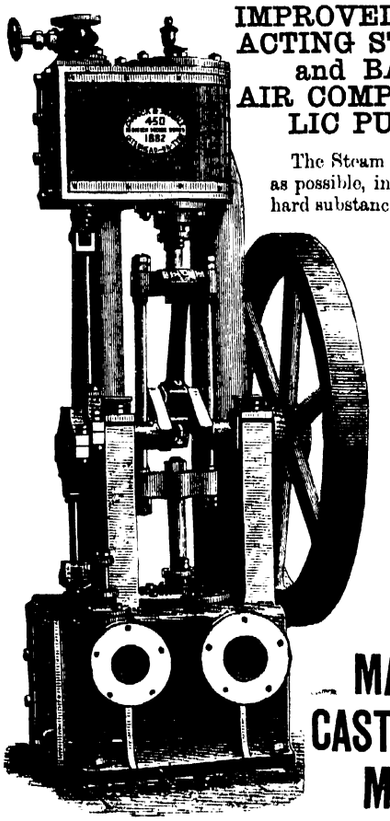


4128

No.	Height.	Weight.	Depth of Feed.	Diameter of Table.	Drills up to
210	2 ft. 3 in.	100 lbs.	2½ in.	9½ in.	⅝ in.

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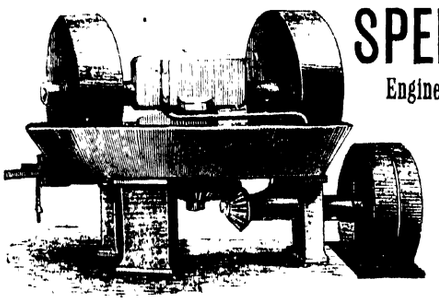
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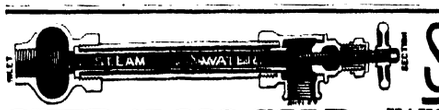
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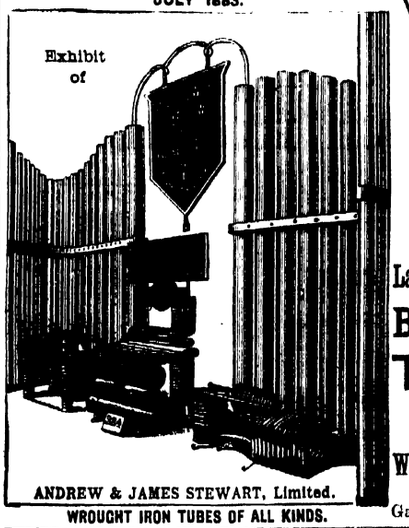


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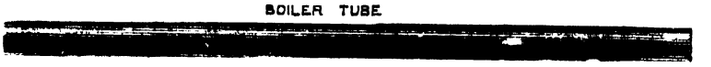
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FOR 5105
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GAS, STEAM & GALVANIZED TUBES.
STEEL TUBES. 5106

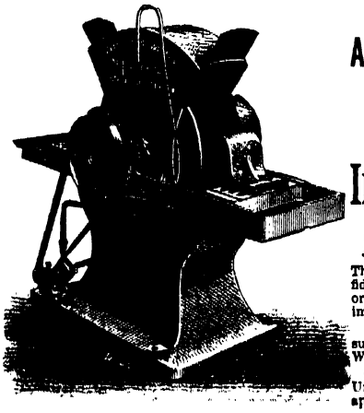
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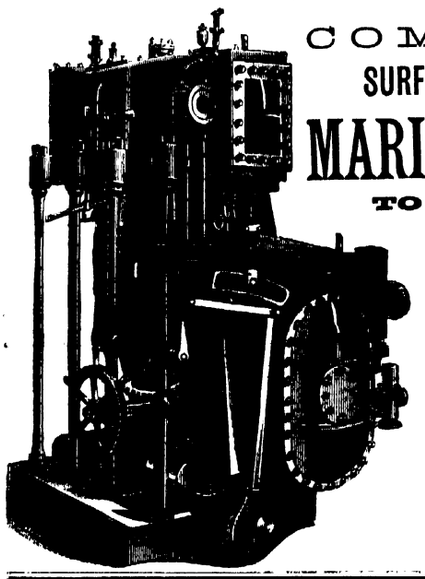
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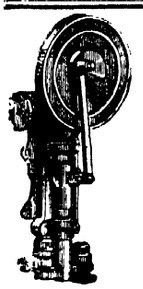
Best Economical Results.

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5236

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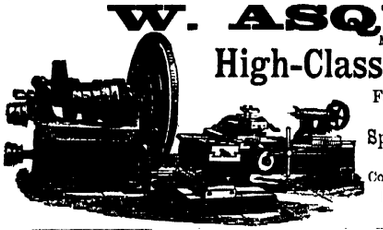
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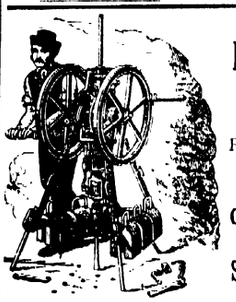


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FOR HAND-LABOUR ONLY.

IN HARD ROCK.

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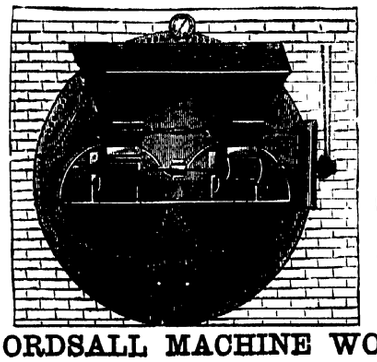
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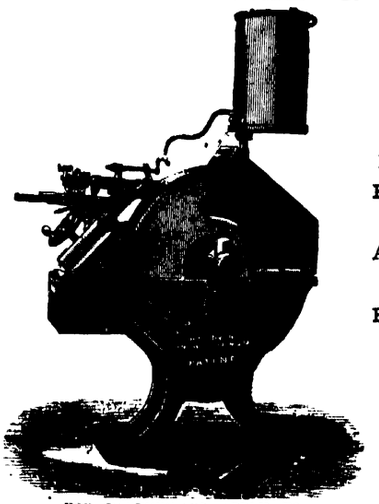
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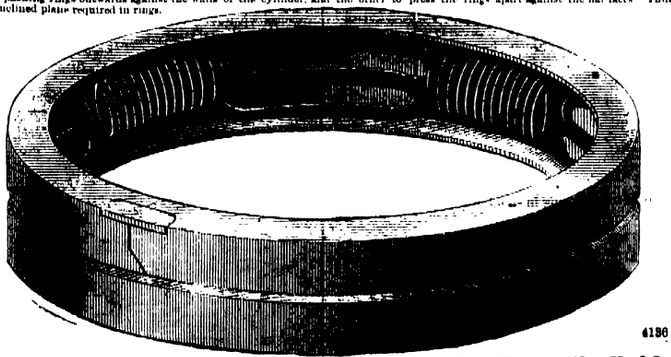


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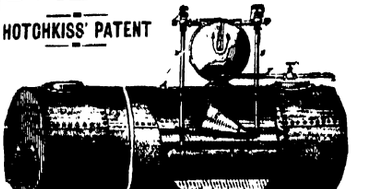
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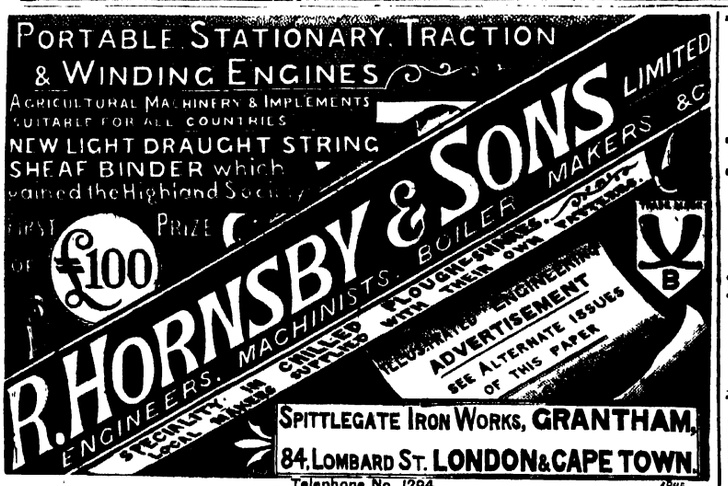
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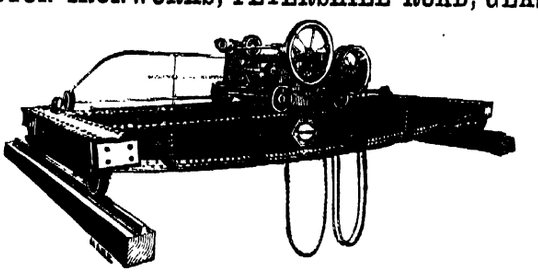
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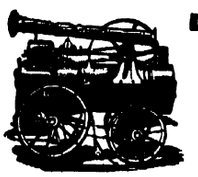
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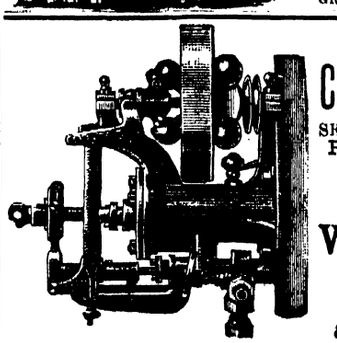
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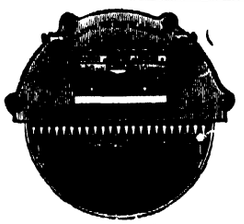
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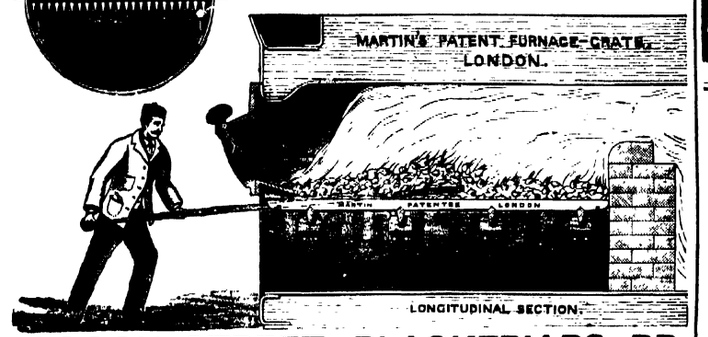
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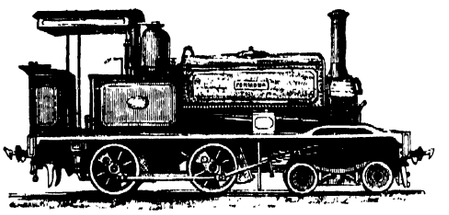
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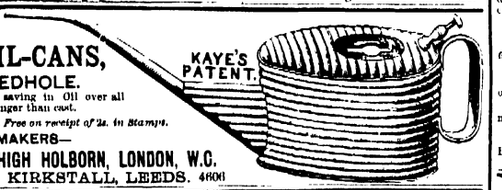
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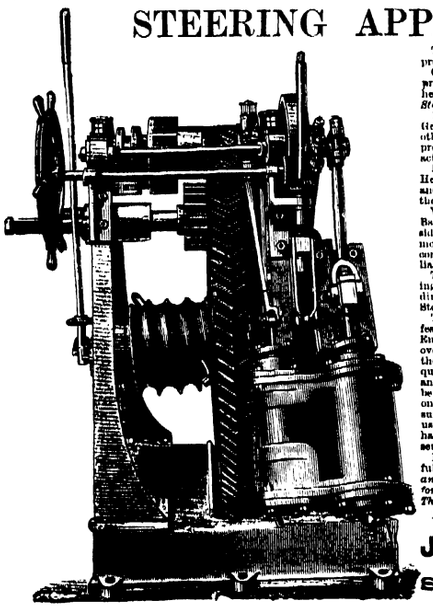
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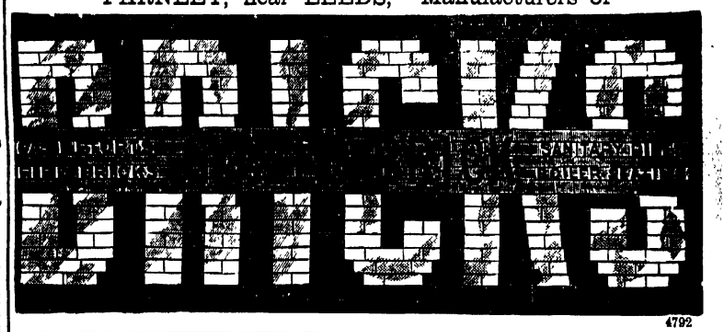
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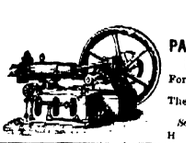


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Die Maschine bereitet das Gas welches sie in Bewegung setzt

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Produce gas sin fuego ni calor. Sirve para alumbrar lugares en que no puede proporcionarse gas de carbon.

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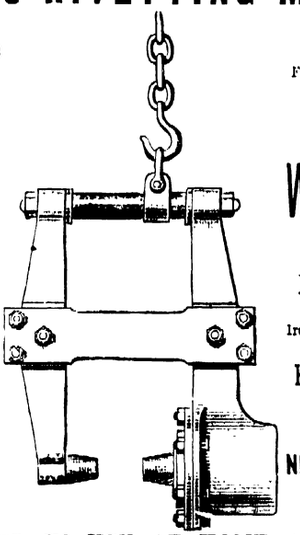
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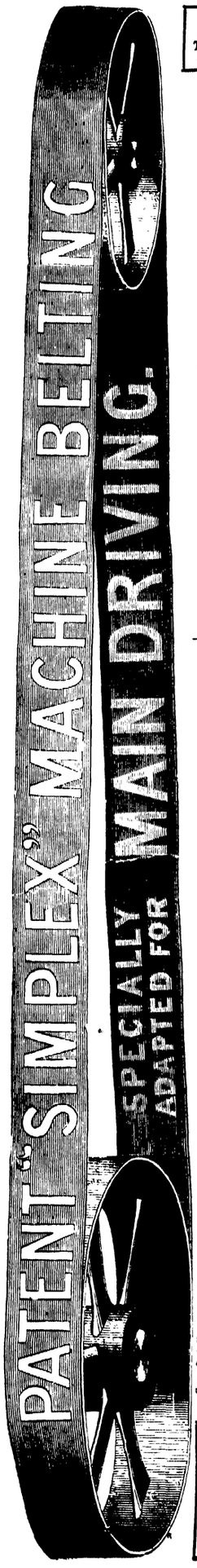
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From SAML. SPEDDY, CRAVEN & Co., Bagley Mills, Hunt Street, Manchester, September 7th, 1880.
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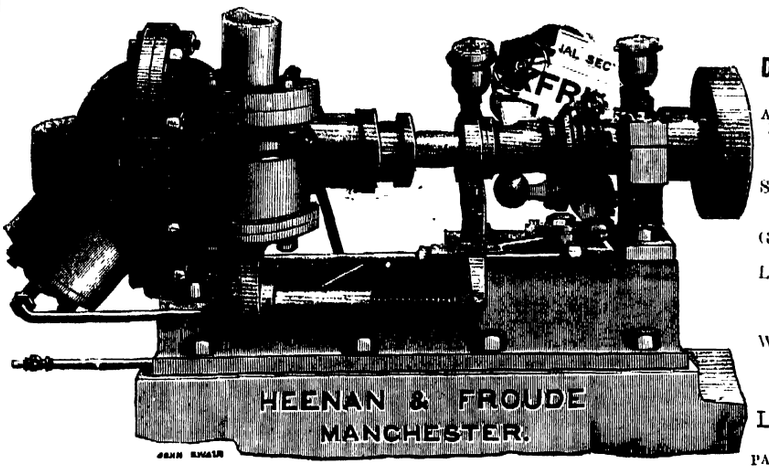
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THE BEST ENGINE FOR DYNAMOS, STEAM LAUNCHES, BLOWERS, PUMPS,

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Less Space occupied, and Less Weight than any other Engine (an Engine realising 30-HP. on the brake weighing only 90 lbs.

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IRON BOILERS AND STEEL BOILERS OF ANY TYPE.

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All Rivet Holes Drilled in position after Plates are bent to form.

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ADVANTAGES.

1st. This Form of Spring is the **Only One** with a **Vertical Action** which can be put into the **same depth** of Groove as a **Common Ring.**

2nd. It is **Less Liable to Damage** through **Priming.**

3rd. Is **Twice as Strong as any other** of the **Same Weight.**

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5th. It is the **Only One** which can be **made** in **Bronze** suitable for **Air-Pumps.**

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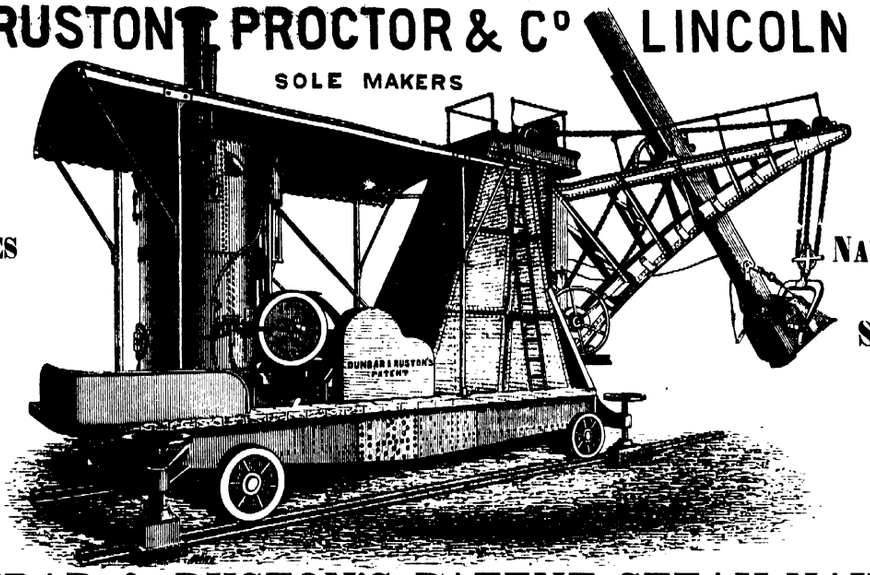
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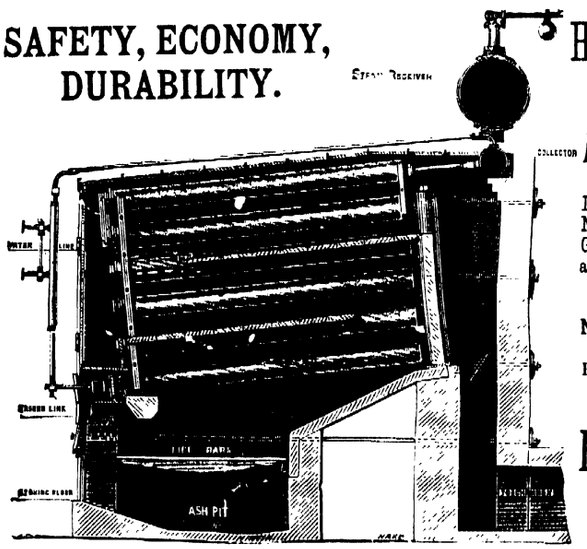
Unapproachable by any other machine for handiness and efficiency in work.

Requires two men and a boy to drive the Engine and guide the Machine; excavates and delivers in trucks the hardest clay and material known (not being rock), at the rate of from 400 to 600 cubic yards per day.—Full details, with prices on application to. 4066

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SAFETY, ECONOMY, DURABILITY.



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120,000 HP. ALREADY SUPPLIED,

All TESTED to 300 lbs. PER SQUARE INCH.

Important Improvements. Considerable Reduction in Number of Joints. Made entirely of Wrought Iron Tubes. Greatly Enlarged Steam Space. Simplicity of Construction and Setting. Economy of Fuel and Space. Portability. Economy of Freight and Transport.

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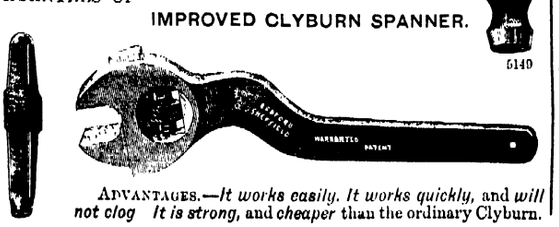
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ADVANTAGES.—*It works easily. It works quickly,* and *will not clog It is strong,* and *cheaper* than the ordinary Clyburn.

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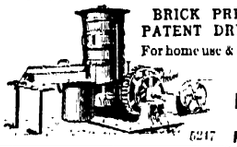
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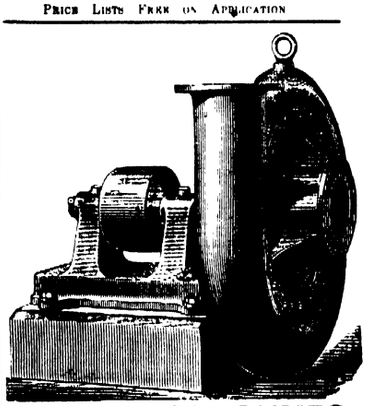
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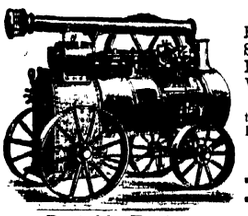
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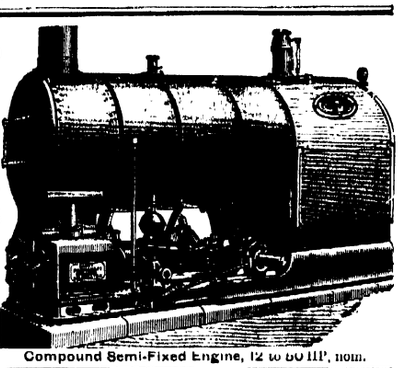
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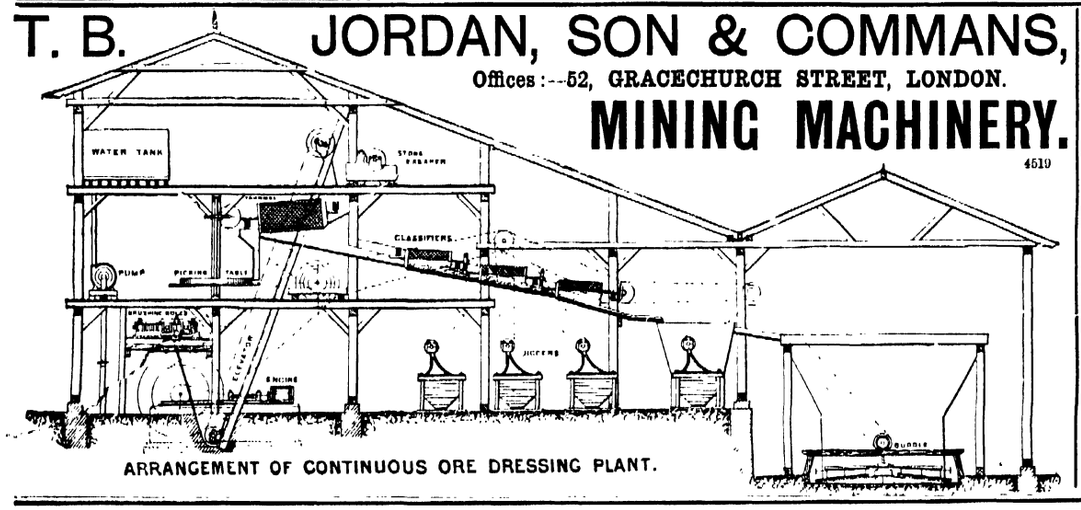


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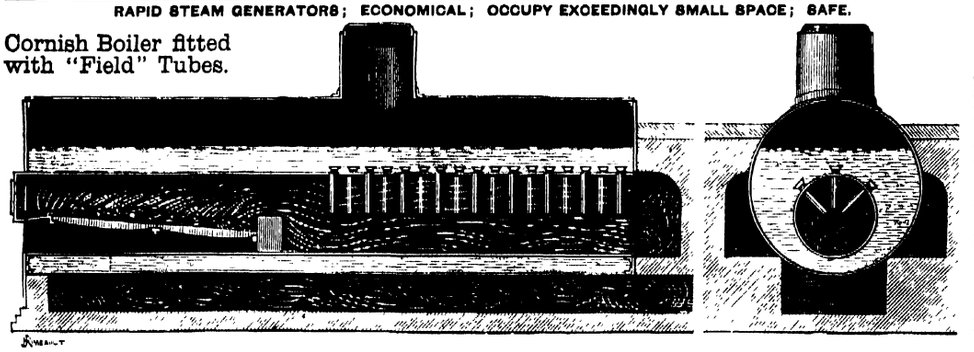
AN Advertisement having been inserted in sundry papers by Messrs. F. REDDAWAY & Co., setting forth that Mr. GANDY has been ordered to pay their costs, about £5,000, in reference to the action brought by him against them, Mr. GANDY Gives Notice that as yet no costs have been paid to Messrs. F. REDDAWAY & Co. by him, that the decision referred to is now under Appeal, and that the amount of costs named is grossly exaggerated, and it is premature to say by whom the costs will ultimately have to be paid. 3149

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RAPID STEAM GENERATORS; ECONOMICAL; OCCUPY EXCEEDINGLY SMALL SPACE; SAFE.

Cornish Boiler fitted with "Field" Tubes.



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GENTLEMEN,—I have fixed the 38 2½ in. Field Tubes I received from you in my boiler, and they are acting splendidly. I reckon they save me at least 33 per cent. of fuel.—Yours faithfully,
(Signed) J. McLEOD,
Caledonian Iron Foundry.

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The DIRECTORY will be published as often as occasion may require, but its appearance is not guaranteed at any stated period, and as it is desired to make it serviceable and reliable, the Publisher will feel obliged by advertisers pointing out any errors or omissions that may be noticed.

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Cochran & Co .. .. .. Birkenhead
Copeland, J., & Co .. .. Dobbie's Loan, Glasgow
Dalziel, R., & Co .. .. St. Helen's, Lancashire
Davey, Paxman & Co .. .. Colchester
Davy Brothers, Limited Sheffield
Fawcett, Thomas C .. .. Manor Road, Leeds
Fernihough, John, & Sons .. Shirley bridge, Lancashire
Foster, W., & Co., Limited .. Lincoln
Galloway, W. & J., & Sons Manchester
Garrett, R., & Sons, Limited .. Leiston Works, Suffolk
Goodwin, J., & Co Motherwell, N.B.
Grange Iron Co., Limited .. Durham
Hall, J. & F. .. .. Dartford, Kent
Hamer, Donald & Wilson .. Paisley, N.B.
Haddingham, G. G. M. .. 191, Fleet Street, London, E.C.
Hartley & Sugden, Limited .. Halifax
Hawkesley, Wild & Co. .. Sheffield
Hawthorn, R. & W. .. .. Newcastle-on-Tyne
Hayes, Ed. .. .. .. Stone Shattord
Hick, Hargreaves & Co Soho Ironworks, Bolton
Hornsby, R., & Sons, Limited Grantham
Horton, J. & W. .. .. Smethwick, near Birmingham
Iona Foundry & Engineering Co Newport, Mon
Lane & Reynolds .. .. Cranbrook St., Old Ford Rd., E.
Lane, Howard, & Co .. .. Palmerston Buildings, Old Broad Street, E.C.
Leeds Forge Co .. .. .. Leeds
Lowca Engineering Co., Ltd., The Whitehaven
Lumley, E. Son & Wood Wet Grove Works, Halifax
Machinery & Hardware Co., Ltd 147, Queen Victoria Street, E.C.
Maldive, Elliott, Price & Co. Nottingham
Marshall, Sons & Co., Limited Gainsborough
McCulloch, T., & Son .. .. Kilmarnock
Musgrave, J., & Sons .. .. Bolton
New, D., & Co. .. .. .. 15, Devonshire Chambers, E.C.
Norman, J., & Co .. .. .. Keppochill Engine Works, Glasgow
Oldham Boiler Works Co .. .. Oldham
Olrick, L., & Co .. .. .. 27, Leadenhall Street, E.C.
Patent Steam Boiler Co. .. Heneage Street, Birmingham
Penman & Co .. .. .. 277, Dalmarnock Rd., Glasgow
Piggott, Thos., & Co. .. .. Spring hill, Birmingham
Plenty & Son .. .. .. Eagle Ironworks, Newbury, Berks.
Reading Ironworks Co., Limited Reading
Ruben & Co. .. .. .. Lincoln
Ross, Downie & Thompson .. Hull
Ross & Duncan .. .. .. Glasgow
Russell, Geo. & Co Motherwell, near Glasgow
Ruston, Proctor & Co Lincoln
Scriven & Co. .. .. .. Marsh Lane, Leeds
Shanks, Alexander, & Son .. Denny Ironworks, Arbroath
Smedley Brothers .. .. .. Belper
Tangye Limited .. .. .. Cornwall Works, Birmingham
Vosper & Co. .. .. .. Portsmouth
Walker Brothers .. .. .. Pagefield Ironworks, Wigan
Watt, Jas., & Co. .. .. .. 90, Leadenhall Street, E.C.
Wellford Brothers .. .. .. Sunderland
Wilson, J. H., & Co. .. .. Sandhills, Liverpool
Wilson, Wm .. .. .. Lilybank Boiler Works, Glasgow
Wood Brothers .. .. .. Valley Ironworks, Sowerby Bridge

Boiler Cleaners.

Nelson, Horatio .. .. .. 90, Worship St., London, E.C.

Boiler Manholes.

Galloway, W. & J., & Sons Manchester
Leeds Forge Co. .. .. .. Leeds
M'Neil, C., Jr. .. .. .. Kinning Park Ironworks, Glasgow

Boiler Furnaces.

Leeds Forge Co., Limited .. Leeds

Bolts, Rivets, Nuts, Screws, &c.

Clyde Rivet Works Co. .. .. Glasgow
Galloway, W. & J., & Sons .. Manchester
Ibbotson Bros. & Co., Limited .. Sheffield
Mercer, R. .. .. Hollinwood, Manchester

Brakes (Railway).

Westinghouse Brake Co .. .. Canal Road, King's Cross, N.

Brass Founders and Brass Finishers.

Billington & Newton .. .. Longport, Staffordshire
Bodley Brothers & Co Exeter
Cockshott & Jowett .. .. Bradford
Deverrue & Co .. .. .. 158, Great Dover Street, S.E.
Hughes, J. & J. .. .. Birmingham
Hunter & English .. .. Bow, E.
Neill & Son .. .. .. St. Helen's Junction, Lancashire
Sayile Street Foundry and Engineering Co., Limited .. Sheffield
Storey T. & Sons .. .. Knott Mill, Manchester
Winn, Charles, & Co. .. .. Granville Street, Birmingham

Bread-Making Machinery.

Drysdale & Co .. .. .. Bon Accord Flour Works, Glasgow
Pfleiderer Paul .. .. .. 86, Upper Ground Street, S.E.

Brewers and Distillery Plant.

Copeland, J., & Co Dobbie's Loan, Glasgow
Hunter & English .. .. Bow, London, E.
Woods, H., & Co. .. .. Salford, Manchester

Brick and Tile Making Machinery.

Bentlon, W .. .. .. Burslem, Staffordshire
Clayton, Howlett & Venables .. Harrow Road, London
Fawcett, Thos. C .. .. Manor Road, Leeds
Middleton, Thos., & Co .. .. Lemon Street, Southwark, S.E.
Page, E., & Co .. .. .. Victoria Ironworks, Bedford
Patent Brick Machine Co. .. Middlesbro-on-Tees
Whitehead, John, & Co .. .. Pendleton, Lancashire

Bricks.

Burham Brick, Lime, & Cement Co .. .. .. Nicholas Lane, E.C.
Farnley Iron Co., Limited .. Farnley, near Leeds
Kershaw & Pole .. .. .. 1, Cullum Street, E.C.

Bridge Foundation Cylinders.

Henry, Donald & Wilson .. Paisley
Stockton Forge Co .. .. Stocktonon Tees

Bridges.

Appleby Brothers .. .. East Greenwich, S.E.
Ashbury Railway Carriage & Iron Co., Limited .. .. Open shaw, Manchester
Clanson, Charles .. .. 2a, Langham Street, E.C.
De Bergue & Co., Limited .. Manchester
Goodwin, J. & Co. .. .. Motherwell, N.B.
Hanna, Donald & Wilson .. Paisley
Lanson, C., Son, & Co. .. .. Darlington
Lea Foundry & Engineering Co Newport, Monmouthshire
Lowca Engineering Co., Ltd., The Whitehaven
Walker Brothers .. .. Wigan

Buffers.

Ibbotson Bros. & Co., Limited Sheffield
Jones, — .. .. .. 70a, Gresham House, Old Broad Street, E.C.
Midland Railway Carriage and Wagon Co. Limited .. Abbey Works, Shrewsbury
Spencer, J., & Sons .. .. Newburn Steel Works, Newcastle-on-Tyne
Tinton, Geo .. .. .. 1, Westminster Chambers, S.W.
Turton, T., & Son .. .. Steel Works, Sheffield

Buoys (Iron and Steel).

Bellamy, John .. .. .. Dyke Street, Millwall, E.

Cables (Electric Light, Telegraph and Telephone).

Glover, W. T., & Co. .. .. 2 Booth Street, Manchester

Carriage (Railway) Builders.

Ashbury Railway Carriage and Iron Co., Limited .. Openshaw, Manchester
Falcon Engine and Car Works, Limited .. .. Loughborough
Metropolitan Railway Carriage and Wagon Co., Limited Saltley Works, Birmingham
Midland Railway Carriage and Wagon Co. Limited .. Abbey Works, Shrewsbury

Castings (Iron).

Bailey Brothers & Co .. .. Exeter
Bowling Iron Co., Limited .. Bradford
Carrick & Wardale .. .. Gateshead
Clay Cross Co. .. .. Clay Cross, near Chesterfield
Clayton, Howlett & Venables Harrow Road, London, W.
Cockshott & Jowett .. .. Thornton Road, Bradford
Forsyth, Miller & Co. .. .. Mile End, Glasgow
Goodwin, J., & Co. .. .. Motherwell, N.B.
Hall, J. & F. .. .. .. Aberdeen
Hind, H., & Son .. .. Nottingham
Hunter & English .. .. Bow, E.
Jackson, F. R., & Co. .. .. Salford Rolling Mills, Manchester
Macfarlane Walter, & Co Possilpark, Glasgow
Mc Ulloch, P. & Son Kilmarnock
Midland Railway Carriage and Wagon Co. Limited Abbey Works, Shrewsbury
Neill, W. & Son .. .. St. Helen's Junction, Lancashire
Sayile Street Foundry and Engineering Co., Limited .. Sheffield
Tinsley, Fitz .. .. Gratwbridge, Staffordshire

Castings (Malleable Iron).

Palmer, W. R. Limited .. Bagot St. Foundry, Birmingham
Tangye, Limited .. .. Cornwall Works, Birmingham

Castings (Steel).

Askham Bros. & Wilson, Ltd Sheffield
Bessemer, Henry, & Co. Limited Sheffield
Bowling Iron Co., Limited .. Bradford
Brown, Bayley, Dixon & Co. Sheffield
Darlington Steel & Iron Co., Ltd Darlington
Forsyth, Miller & Co. .. Mile End, Glasgow
Hecla Steel Foundry Co Sheffield
Jackson, F. R. & Co. .. Salford Rolling Mills, Manchester
Jessop, Wm. & Sons .. Sheffield
Landore Siemens Steel Co Landore, South Wales
Osborn, S. & Co. .. .. Sheffield
Rowlandson, A. .. .. Newcastle-on-Tyne
Sayile Street Foundry and Engineering Co., Limited .. Sheffield
Spencer, John, & Sons .. Newburn Steelworks, Newcastle-on-Tyne
Stanners Close Steel Co Wolsingham, via Darlington
Steel Co. of Scotland, Ltd., The Glasgow
Tangye, Limited .. .. Cornwall Work, Birmingham

Cement.

Buttam Brick, Lime, & Cement Co. .. .. Nicholas Lane, E.C.
Frances & Co. .. .. .. Ashhall, S.W.
Francis, C., Son & Co .. .. 11, Great Church Street, E.C.
Grover, Bull & Eakin .. .. Watford.
Rugby Portland Cement Co Rugby, Warwickshire
Wouldham Cement Co .. .. 39, Lime Street, E.C.

Chains and Cables.

Hodgkinson & Co., Limited .. Manchester
Pickering, John .. .. Stockton-on-Tees
Whitehouse & Co. .. .. Tipton, Staffordshire
Wright, Jos. & Co. .. .. Tipton, Staffordshire

Chemical Works (Plant for).

Carrick & Wardale .. .. Gateshead
Dalziel, R., & Co. .. .. St. Helen's, Lancashire
Gerrans Iron Co., Limited .. Durham
Pigott, Thos., & Co. .. .. Birmingham

Clutches (Friction).

Buckley, T., & Son .. .. Batley
Mallet & Platt .. .. .. Salford Ironwork, Manchester

Coal Cutting Machines.

Grange Iron Co., Limited .. Durham

Coal Merchants.

Clay Cross Co. .. .. .. Clay Cross, near Chesterfield

Coke Ovens.

Jameson Patent Coke Co. .. St. Nicholas Chambers, Newcastle

Colliery Plant.

Clay Cross Co. .. .. Clay Cross, near Chesterfield
Dalziel, R., & Co. .. .. St. Helen's, Lancashire
Davy Brothers, Limited .. Sheffield
Goodwin, James, & Co. .. Attercliffe, S.E.
Grange Iron Co., Limited .. Durham
Hathorn, Davey & Co. .. Leeds
Lowca Engineering Co., Ltd. The Whitehaven
Walker Brothers .. .. Pagefield Ironwork, Wigan
Woods, H., & Co. .. .. Salford, Manchester

Compasses.
Negretti & Zambra .. .. Holborn Viaduct, E.C.

Condensers (Fresh Water).
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Normandy, A. .. .. .. Custom House Station, Victoria Docks, E.
Suffield & Brown .. .. .. James St., Commercial Rd. E.

Condensers (for Steam Engines).
Morton, Alexr., & Thomson .. 96, Buchanan Street, Glasgow

Coppersmiths.
Birmingham Battery & Metal Co Birmingham
Storey, I., & Sons .. .. .. Knott Mill, Manchester

Cotton Presses.
Piggott, Thos., & Co. .. .. Birmingham
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Couplings (Railway).
Roger, Robert, & Co. .. .. Stockton-on Tees
Turton, Geo. .. .. .. 4, Westminster Chambers, S.W.

Cranes, Travellers, Winches, &c.
Appleby Brothers .. .. .. East Greenwich, S.E.
Ashbury Railway Carriage & Iron Co., Limited .. .. Openshaw, Manchester
Bainforth, Wm., Executors of (Late Steam) .. .. .. Rodley, near Leeds
Bowsar, W., & Son .. .. .. Great Wellington St., Glasgow
Butters Brothers .. .. .. 93, Hope Street, Glasgow
Carrick & Ritchie .. .. .. Edinburgh
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Cochrane, Jno .. .. .. Berthead
Coles, H. J. .. .. .. 89, Stanmer Street, S.E.
Cowans, Sheldon & Co., Limited .. St. Nicholas Works, Carlisle
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
East Ferry Road Engineering Works Co., Limited .. .. Millwall, E.
Fielding & Platt .. .. .. Gloucester
Gibbins, R. C., & Co. .. .. Berkley Street, Birmingham
Grange Iron Co., Limited .. Durham
Hanna, Donald & Wilson .. .. Paisley, N.B.
Hanson, Wm. .. .. .. Quebec Works, Bradford
Janson, C., Son & Co. .. .. Darlington
Jas Foundry & Engineering Co Newport, Monmouthshire
Jessop, J., & Son .. .. .. Leicester
Melville, W. M. .. .. .. Kirkcaldy
Ormerod, Grierson & Co .. .. Hulme, Manchester
Paul, M., & Co .. .. .. Levenford Works, Dumbarton
Pickering, Jthn. .. .. .. Stockton-on Tees
Priestman Brothers .. .. .. Hull
Ransomes & Rapier .. .. .. 9, Westminster Chambers, S.W.
Roger, R., & Co. .. .. .. Iron Foundry, Stockton-on-Tees
Rose, Downs & Thompson .. .. Hull
Russell, Geo., & Co. .. .. .. Motherwell, near Glasgow
Saville Street Foundry and Engineering Co., Limited .. .. Sheffield
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Shanks, Alexander, & Son .. .. Dens Ironworks, Arbroath
Shiviaw, A., & Co. .. .. .. Berkley Street, Birmingham
Smith, Thos. .. .. Rodley, near Leeds
Stothert & Pitt, Limited .. .. Bath
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Thomas, T., & Sons .. .. .. Acme Works, Cardiff
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W.
Walker, T., & Co. .. .. .. Leeds
Wilson, John H., & Co .. .. .. Sandhills, Liverpool

Crankshafts.
Beardmore, I. & W. .. .. .. Glasgow
Bessemer, Henry, & Co., Limited Sheffield
Clarke's Crank Co., Limited .. Lincoln
Mersey Forge, Limited, The .. Liverpool

Crucibles.
Doulton & Co. .. .. .. Lambeth, S.E.

Disinrustants.
Bell, J. .. .. Asbestos Works, Southwark, S.E.
Hannay's Marine Appliances Co., Limited .. .. .. 67, Great Clyde Street, Glasgow
The Disinrustants Marseillaise Co. Cheetham, Manchester

Disinfectors.
Manlove, Alliott, Fryer & Co. .. Nottingham

Disintegrators.
Askam Bros. & Wilson, Ltd. .. Sheffield
Evans, J., & Co. .. .. .. Trumpet St., Gathorne, Manchester
Farmer, Jas., & Sons .. .. Salford, Manchester
Hartley & Arnoux Brothers .. Stoke-on-Trent
Jordan, T. B., Son & Commans. 92, Grewcock Street, E.C.
Marsden, Francis .. .. .. Sheffield
Triggs, P. (Carr's) .. .. .. 39, Broad Street, Bristol

Distillery Plant.—*(See Brewery and Distillery Plant).*

Distilling (Water) Apparatus.
Chaplin, Alex., & Co. .. .. Glasgow
Normandy, A. .. .. .. Custom House Station, Victoria Docks, E.
Ross & Duncan .. .. .. Glasgow

Diving Apparatus.
Barnett & Foster .. .. .. 252, Eagle Wharf Road, N.

Drawings, Tracings, &c.
Kell, J., & Son .. .. .. 40, King Street, Covent Garden
Messer & Thorpe .. .. .. 8, Quality Court, E.C.

Dredging Machines.
Bruce & Batho .. .. .. 9, Victoria Chambers, S.W.
Clark, Bunnett & Co., Limited .. Bathbone Place, W.
Edwards & Symes .. .. .. Wharf Road, Cubitt Town, E.
Fleming & Ferguson .. .. Paisley, N.B.
Hanna, Donald & Wilson .. .. Paisley, N.B.
Hunter & English .. .. .. Bow, London, E.
Priestman Brothers .. .. Hull
Rose, Downs & Thompson .. .. Old Foundry, Hull
Stothert & Pitt, Limited .. .. Bath

Drying Machines for Textile Materials.
Smith & Johnston .. .. .. Paisley Road, Glasgow

Ebonite.
Winter, F. .. .. 138, London Wall, E.C.

Economisers (Fuel).
Gosling, Robert, & Co. .. .. Hatton Court Ipswich
Green, E., & Son .. .. .. St. Ann's Square, Manchester
Lewcock, A. .. .. .. Coleham Foundry, Shrewsbury
Pollock, Macnab, & Highgate .. Shettleston, Glasgow

Electric Lighting Plant.
Crompton, R. E., & Co. .. .. Arc Works, Chelmsford
Glover, W. T., & Co. .. .. 28, Booth Street, Manchester
Lane Howard, & Co. .. .. 115 & 116, Palmerston Buildings, London, E.C.
Woodhouse & Rawson .. .. 11, Queen Victoria Street, E.C.

Electrical Engineers.
Chamberlain & Hookham, Ltd. .. Birmingham
Crompton, R. E., & Co. .. .. Mission House Buildings, E.C.
Gerard & Co., Limited .. .. 82, Hatton Garden, E.C.
Hartnell, W. .. .. .. Park Row, Leeds
Johnson & Phillips .. .. 14, Union Ct., Old Broad St., E.C.
Woodhouse & Rawson .. .. 11, Queen Victoria Street, E.C.

Elevators, Grain, Coal, &c.
Priestman Brothers .. .. Hull
Rose, Downs & Thompson .. Old Foundry, Hull

Emery and Emery Cloth.
Acton & Borman .. .. .. 72, Shoe Lane, E.C.
Goldsworthy, T., & Sons .. .. Hulme, Manchester
Oakey, John, & Sons .. .. Wellington Mills, London, S.E.

Emery Wheels.
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria St., E.C.
Slack's Emery Wheel & Machine Co., Limited .. .. .. Artwick, Manchester
Sterne, L., & Co., Limited .. Glasgow & London

Engine and Boiler Fittings.
Cran, Jno, & Co. .. .. .. Albert Engine Works, Leith
Dewrance, John, & Co .. .. 156, Great Dover Street, S.E.
Galloway, W. & J., & Sons .. Manchester
M'Neil, C., Jr. .. .. .. Clutha Park Ironworks, Glasgow
Picking, Hopkins & Co. .. .. Bow, London, E.
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Weir, G. & J. .. .. .. 40, Jamaica Street, Glasgow
Winn, Charles, & Co. .. .. Granville Street, Birmingham

Engines (Air).
Tylor, H., & Co. .. .. .. 84, Whitecross Street, E.C.

Engines (Blowing).
Adamson, D., & Co. .. .. Dukinfield, Manchester
Carrick & Wardale .. .. .. Gateshead
Daglish, R., & Co. .. .. .. 86, Helen's, Lancashire
Davy Brothers, Limited .. .. Sheffield
Galloway, W. & J., & Sons .. Manchester
Goodfellow & Matthews .. .. Hyde, near Manchester
Neill, W., & Son .. .. .. St. Helen's Junction, Lanc.
Ormerod, Grierson & Co. .. .. Hulme, Manchester
Saville Street Foundry and Engineering Co., Limited .. Sheffield
Walker Brothers .. .. .. Wigan

Engines (Fire).
Rose, W., & Co. .. .. .. Deansgate, Manchester

Engines (Gas).
Andrew, J. E. H., & Co .. .. Stockport
Barker, T. B., & Co. .. .. Scholefield St., Birmingham
British Gas Engine & Engineering Co .. .. .. 11, Queen Victoria Street, E.C.
Crossley Bros., Limited .. .. Manchester
Müller, H. L. .. .. .. Birmingham
Otto, J. C. H. .. .. .. 39, Queen Victoria Street, E.C.
Sterne, L., & Co., Limited .. Crown Ironworks, Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Victor Gas Engine Co. .. .. 72, Whitechapel, Liverpool

Engines (Locomotive).
Appleby Brothers .. .. .. East Greenwich, S.E.
Bagnall, W. G. .. .. .. Stafford
Baldwin Locomotive Works .. Philadelphia, U.S.A.
Bainforth, Wm. (Executors of) Rodley, near Leeds
Black, Hawthorn & Co. .. .. Gateshead-on Tyne
Chaplin, A., & Co. .. .. .. Glasgow
Decauville, Aîné .. .. .. Petit-Bourg, (Seine et Oise), France
Falcon Engine & Car Works, Ltd. Loughborough
Grange Iron Co., Limited .. Durham
Hawthorn, R. & W. .. .. Newcastle-on-Tyne
Hudswell, Clarke & Co. .. .. Leeds
Hunslet Engine Co .. .. .. Leeds
Jessop, J., & Son .. .. .. Leicester
Kerr, Stuart & Co. .. .. .. 29, Buckleresbury, E.C.
Lowca Engineering Co., Ltd., The Whitehaven
Manning, Wardle & Co. .. .. Boyne Engine Works, Leeds
M'Culloch, T., & Sons .. .. Kilmarnock
Pecket, Thomas .. .. .. Atlas Engine Works, Bristol
Rogers Loco & Machine Works .. Paterson, N.J., U.S.A.
Walker Brothers .. .. .. Pagefield Ironworks, Wigan

Engines (Marine).
Appleby Brothers .. .. .. East Greenwich, S.E.
Burrell, C., & Sons .. .. .. Thetford
Cran, John, & Co. .. .. .. Albert Engine Works, Leith
Hanna, Donald & Wilson .. .. Paisley, N.B.
Hawthorn, R. & W. .. .. .. Newcastle-on-Tyne
Hayes, Ed. .. .. Stony Stratford
Hunter & English .. .. .. Bow, E.
Paul, M., & Co. .. .. .. Levenford Works, Dumbarton
Plenty & Son .. .. .. Eagle Ironworks, Newbury, Berks
Rankin & Blackmore .. .. Glenbuck
Roger, R., & Co. .. .. .. Stockton-on-Tees
Rose, Downs & Thompson .. .. Hull
Ross & Duncan .. .. .. Whitefield Works, Glasgow
Thornycroft, J. I., & Co. .. Chiswick, W.
Vosper & Co. .. .. .. Broad Street, Portsmouth
Wilson, Alex. & Co. .. .. Vauxhall Ironworks, Wands worth Road, S.W.
Wilson, H. M. .. .. .. Blyth, Northumberland
Wood Brothers .. .. .. Valley Ironworks, Sowerby Bridge, Yorkshire
Yarrow & Co. .. .. .. Isle of Dogs, London, E.

Engines (Portable).
Appleby Brothers .. .. .. East Greenwich, S.E.
Barrows & Stewart .. .. .. Banbury
Belleville, J. & Cie. .. .. .. 8 St. Denis, Seine
Clayton & Shuttleworth .. .. Lincoln
Davey, Paxman & Co. .. .. Colchester
Farmer, Robey, Brown & Co. .. Gainsborough
Foster, W., & Co., Limited .. Lincoln
Garrett, R., & Sons .. .. Leiston Works, Suffolk
Hindley, E. S. .. .. .. Bourton, Dorset
Hornsby, R., & Sons, Limited .. Grantham
Marshall, Sons & Co., Limited .. Gainsborough
Mather, G. R. .. .. .. Wellingborough
Ransomes, Head & Jefferies .. Ipswich
Reading Ironworks Co. Ltd .. Reading
Robey & Co. .. .. Lincoln
Ruston, Proctor & Co. .. .. Sheaf Ironworks, Lincoln
Smedley Brothers .. .. .. Helper
Turner, E. R. & F. .. .. .. St. Peter's, Ipswich

Engines (Rotary).
Heenan & Froude .. .. .. Manchester

Engines (Stationary).
Adamson, D., & Co. .. .. .. Dukinfield, Manchester
Appleby Brothers .. .. .. East Greenwich, S.E.
Aitken, McNeil & Co. .. .. .. Helen Street, Govan, Glasgow
Allen & Macalellan .. .. .. Sentinel Works, Glasgow
Barrows & Stewart .. .. .. Banbury
Brotherhood, P. .. .. .. Belvedere Road, Westminster Bridge, S.E.
Buckley and Taylor .. .. .. Castle Ironworks, Oldham
Bunnett, E. D. .. .. .. Bradford, Staffs.
Carrick & Wardale .. .. .. Gateshead
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Clayton & Shuttleworth .. .. Lincoln
Coalbrookdale Co., Limited .. Coalbrookdale, Shropshire
Cochrane, J. .. .. Berthead
Coles, H. J. .. .. Sumner Street, S.E.
Copeland, J., & Co. .. .. .. Dobbie's Loan, Glasgow
Daglish, R., & Co. .. .. .. 86, Helen's, Lancashire
Davey, Paxman & Co. .. .. Colchester
Davy Brothers, Limited .. .. Sheffield
Dunkin, B., & Co. .. .. .. Bermondsey, S.E.
Douglas & Grant .. .. .. Dunnikier Foundry, Kirkcaldy, N.B
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Farmer, Jas., & Sons .. .. Salford, Manchester
Farmer, Robey, Brown & Co. .. Trent Foundry, Gainsborough
Fawcett, Thomas, C. .. .. Manor Road, Leeds
Foster, W., & Co., Limited .. Lincoln
Galloway, W. & J., & Sons .. Manchester
Garrett, R., & Sons .. .. Leiston Works, Suffolk
Goodfellow & Matthews .. .. Hyde, near Manchester
Grange Iron Co., Limited .. Durham

Engines (Stationary).—*Continued.*
Hanson, Wm. .. .. .. Quebec Works, Bradford
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Hathorn, Davey & Co. .. .. Leeds
Heenan & Froude .. .. .. Manchester
Hick, Hargreaves & Co. .. .. Soho Ironworks, Bolton
Hindley, E. S. .. .. .. Bourton, Dorset
Holborow & Co. .. .. .. Dudbridge Ironworks, Stroud
Hornsby, R., & Sons, Limited .. Grantham
Hunter & English .. .. .. Bow, E.
Iron Foundry & Engineering Co. Newport, Monmouthshire
Jessop, J., & Son .. .. .. Leicester
Lane & Reynolds .. .. .. Greenwich St., Old Ford Rd., E.
Lowca Engineering Co., Ltd., The Whitehaven
Machinery & Hardware Co., Ltd. 147, Queen Victoria Street, E.C.
Manlove, Alliott, Fryer & Co. .. Nottingham
Marshall, Sons & Co., Limited .. Gainsborough
McCulloch, T., & Sons .. .. Kilmarnock
Musgrave, J., & Sons .. .. Bolton
Neill, Wm., & Son .. .. .. St. Helen's Junction, Lancashire
New, D., & Co. .. .. .. 15, Devonshire Chambers, E.C.
Norman, J. & Co. .. .. .. Keppochhill Engine Works, Glasgow
Ormerod, Grierson & Co. .. .. Hulme, Manchester
Paul, M., & Co. .. .. .. Dumbarton
Peckett, Thomas .. .. .. Atlas Engine Works, Bristol
Piggott, T., & Co. .. .. .. Springhill, Birmingham
Ransomes, Head & Jefferies .. Ipswich
Robey & Co. .. .. Lincoln
Roger, R., & Co. .. .. .. Stockton-on Tees
Rose, Downs & Thompson .. .. Old Foundry, Hull
Russell, Geo., & Co. .. .. .. Motherwell, near Glasgow
Ruston, Proctor & Co. .. .. Sheaf Ironworks, Lincoln
Saville Street Foundry and Engineering Co., Limited .. .. Sheffield
Shanks, Alexander, & Son .. .. Dens Ironworks, Arbroath
Smedley Brothers .. .. .. Eagle Ironworks, Helper
Smith & Johnston .. .. .. Paisley Road, Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Taylor & Challen .. .. .. Birmingham
Tylor, H., & Co. .. .. .. 84 & 85, Upper Whitecross Street, E.C.
Walker Brothers .. .. .. Pagefield Ironworks, Wigan
Watson, T., & Co. .. .. .. Leeds
Watford Bros. .. .. .. Sunderland
Williams & Robinson .. .. .. Thames Ditton, Surrey
Wilson, Alex., & Co. .. .. Vauxhall Ironworks, Wandsworth Road, S.W.
Woods, H. & Co. .. .. .. Manchester

Engines (Traction).
Aveling & Porter .. .. .. Rochester
Burrell, C., & Son .. .. .. Thetford
Clayton & Shuttleworth .. .. Lincoln
Foster, Wm., & Co., Limited .. Lincoln
Fowler, John, & Co. .. .. Leeds
Marshall, Sons & Co. .. .. Gainsborough
Reading Ironworks Co., Ltd. .. Reading

Engravers, Mechanical, &c.
Cattell, A. S., & Co. .. .. 17, Bear Alley, Farringdon Street, E.C.
Hare & Co. .. .. 31, Essex Street, Strand
Rimbault, J. H. .. .. .. 30, Maiden Lane, W.C.

Excavators.
Bruce & Batho .. .. .. 9, Victoria Chambers, Westminster, S.W.
Chaplin, Alex., & Co. .. .. Glasgow
Fleming & Ferguson .. .. Paisley, N.B.
Priestman Brothers .. .. .. 51, Queen Victoria Street, E.C.
Ross, Downs & Thompson .. .. Hull
Ruston, Proctor & Co. .. .. Sheaf Ironworks, Lincoln

Fans and Blowers.
Allday, Wm., Sons, & Co. .. Birmingham
Capell, R. A. .. .. 42, Cadogan Street, Glasgow
Dunkin, B., & Co. .. .. .. Bermondsey, S.E.
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Grange Iron Co., Limited .. Durham
M'Culloch, T., & Sons .. .. Kilmarnock
Saville Street Foundry and Engineering Co., Limited .. .. Sheffield
Schiele, C., & Co. .. .. .. 2, Clarence Buildings, Manchester
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Thwaites Brothers .. .. .. Yulcan Ironworks, Bradford
Union Engineering Co. .. .. Booth Street, Manchester
Walker Brothers .. .. .. Wigan

Feed-Water Heaters.
British Gas Engine & Engineering Co. .. .. .. 11, Queen Victoria Street, E.C.
Saville Street Foundry and Engineering Co., Limited .. .. Sheffield
Sterne, L., & Co., Limited .. Crown Ironworks, Glasgow
Suffield & Brown .. .. .. James Street, Commercial Road, East, E.
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Taylor & Challen .. .. .. Derwent Foundry, Birmingham
Wood, Hamilton & Co. .. .. Salford, Manchester
Wright, Jos., & Co. .. .. .. Tipton, Staffordshire

Files and File Sharpening Apparatus.
Bedford, J., & Sons .. .. .. Lion Works, Sheffield
Jowitt, T., & Sons .. .. .. Sheffield
Tilghman Patent Sand Blast Co., Sheffield

Filtering Apparatus.
Halliday, J., & Co. .. .. .. Water Street, Newtown, Manchester
Pulsometer Engineering Co. .. Nine Elms, S.W.

Fireburs.
Patent Diagonal Rocking Fireliar Co. .. .. .. 230, Gresham House, E.C.

Fire Clay Goods.
Farnley Iron Co. .. .. .. Farnley, near Leeds
Glenboig Union Fire Clay Co., The Glasgow
Kershaw & Pole .. .. .. 1, Cullum Street, E.C.

Flexible Shafts.
Bolling & Lowe .. .. .. 7, Laurence Pountney Hill, E.C.

Floor Cloth Machinery.
Farmer, Jas., & Sons .. .. Salford, Manchester
Landale, James .. .. .. Kirkcaldy, N.B.
Summers, T. & W. .. .. .. Gloucester

Forgings (Iron and Steel).
Askham Bros. & Wilson, Ltd. .. Sheffield
Beardmore, I. & W. .. .. .. Glasgow
Bessemer, Henry, & Co., Limited Sheffield
Brown, Bailey, Dixon & Co. .. Sheffield
Clarke's Crank Co. .. .. .. Lincoln
Glasgow Hydraulic Forge Co. .. Sentinel Works, Polmadie, Glasgow
Goodfellow & Matthews .. .. Hyde, near Manchester
Hill & Smith .. .. Brierley Hill Ironworks, near Dudley
Ibbotson Brothers & Co., Ltd. .. Sheffield
Jessop, Wm., & Sons .. .. Sheffield
Kirkstall Forge Co. .. .. .. Near Leeds
Landore Siemens Steel Co. .. .. Landore, South Wales
Leeds Forge Co. .. .. .. Leeds
Mersey Forge, Limited, The .. Liverpool
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury
Osborne, S. & Co. .. .. .. Sheffield
Reichwald, A. .. .. Newcastle-on-Tyne
Saville Street Foundry and Engineering Co., Limited .. .. Sheffield
Spencer, J., & Son. .. .. .. Newcastle-on-Tyne
Staffordshire Wheel & Axle Co., Limited .. .. Springhill, Birmingham
Steamers Close s Steel Co. .. Wolsingham, via Darlington
Steel Co. of Scotland, The .. Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Furnace Fittings.
Galloway, W. & J., & Sons .. Manchester
Martin, W. A. & Co. .. .. .. Pocock Street, S.E.

Galvanised Iron.
Hill & Smith .. .. .. Tipton, Staffordshire
Lysaght, John, Limited .. .. Bristol
Morewood & Co. .. .. .. Soho, Birmingham

Gas Exhausters.
Donkin, B., & Co. .. .. .. Bermondsey, S.E.
Körting Brothers .. .. .. 17, Lancaster Avenue, Manchester
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Saville Street Foundry and Engineering Co., Limited .. .. Sheffield

Gas Works (Plant for).
Dowson Economic Gas Co., Ltd., 3, Great Queen Street, Westminster, S.W.
Grange Iron Co., Limited .. Durham
Hanna, Donald & Wilson .. Paisley, N.B.
Horton, J. & W. .. .. .. Etna Works, Smethwick, Birmingham
Janson, C., Son, & Co. .. .. Darlington
Müller, H. L. .. .. .. Birmingham
Piggott, Thos., & Co. .. .. Springhill, Birmingham

Gauge Glasses.
Martin, Guilbert .. .. .. 1 & 2, Falcon Street, E.C.
Mourcieff, John .. .. .. Nth. Brit. Glass Works, Perth
Tomey & Sons .. .. .. Tay Glass Works, Perth, N.B.
Tomey, Jos., & Sons .. .. Manor Glass Works, Aston, Birmingham

Gauges (Pressure).
Dewrance & Co. .. .. .. 156, Great Dover Street, S.E.
Salter, Geo., & Co. .. .. West Bromwich
Schaffer & Budenberg .. .. 1, Southgate, Manchester

Gearing.—*(See Wheels, Geared.)*

Girders.
Ashbury Railway Carriage & Iron Co., Limited .. .. .. Openshaw, Manchester
Davies Bros. & Co. .. .. .. Crown Ironworks, Wolverhampton
De Bergue & Co., Limited .. Manchester
Goodwin, James, & Co. .. .. Motherwell, N.B.
Janson, C., Son & Co. .. .. Darlington
Jas Foundry & Engineering Co. Newport, Monmouthshire
Lowca Engineering Co., Ltd., The Whitehaven
Lysaght, John, Limited .. .. Bristol
McCulloch, T., & Sons .. .. Kilmarnock
Southwark St., S.E.

Glass Machinery (Plate)
Daglish, R., & Co. .. .. .. St. Helen's, Lancashire
Musgrave, J., & Sons .. .. Bolton

Glazing.
Braby & Son .. .. .. 336, Euston Road, London
Grover & Co., Limited .. .. Britannia Works, Wharf Rd., N.

Governors (Engine).
Blair, George .. .. 32, Queen Street, Glasgow
Duncan Bros. (Taite's Electric) .. 32, Queen Victoria Street, E.C.
McCulloch, T., & Sons .. .. Kilmarnock
Murdoch, Wm., & Co. .. .. 30, Hope Street, Glasgow
Schaffer & Budenberg .. .. Manchester
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Whitley Partners .. .. .. Hunslet Road, Leeds

Grindstones.
Robson, Robert .. .. .. 21, Grainger Street, West, Newcastle-on-Tyne

Gunpowder Machinery.
Hall, J. & E. .. .. .. Dartford, Kent
Hastie, J., & Co. .. .. .. Hillhead Engine Works, Greenock.
Saville Street Foundry and Engineering Co., Limited .. .. Sheffield
Taylor & Challen .. .. .. Birmingham

Hammers (Hydraulic).
Fielding & Platt .. .. .. Gloucester
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W

Hammers (Power).
Player, W. & J. .. .. .. Lionel Street, Birmingham

Hammers (Steam).—*(See Steam Hammers.)*

Heating Apparatus.
Gibbs, R. R. .. .. .. St James' Heating Works, Mill Street, Liverpool
Körting Brothers .. .. .. 17, Lancaster Avenue, Manchester
Thames Bank Iron Co., The .. Upper Ground Street, S.E.

Hematite Pig Iron.
West Cumberland Iron & Steel Co. .. .. Workington, Cumberland

Hoisting Machinery.
Appleby Brothers .. .. .. East Greenwich, S.E.
Bainforth Wm. (Executors of). Rodley, near Leeds
Bowser & Son .. .. .. Great Wellington St., Glasgow
Carrick & Ritchie .. .. .. Edinburgh
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works Glasgow
Coles, H. J. .. .. Sumner Street, S.E.
Cowans, Sheldon & Co., Limited St. Nicholas Works, Carlisle
Crowley, John, & Co. .. .. Sheffield
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Gibbins, R. C., & Co. .. .. Berkley Street, Birmingham
Glover, Walter T., & Co. .. 28, Booth Street, Manchester
Hunter & English .. .. .. Bow, E.
Jessop, J., & Son .. .. .. Leicester
Melville, W. M. .. .. .. Kirkcaldy
Pickering, Jthn. .. .. .. Stockton-on-Tees
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Shanks, Alexander, & Son .. Dens Ironworks, Arbroath
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Thomas, T., & Sons .. .. .. Cardiff
Waygood, R., & Co. .. .. .. Newington Works, Falmouth Street, S.E.

Hoops for Boiler Flues.
Bolton Iron & Steel Co. .. .. Bolton
Bowling Iron Co., Limited .. .. Bradford

Hose Pipe (Flax).
Richards & Co. .. .. Aberdeen

Hydraulic Machinery.
Adamson, D., & Co. .. .. .. Dukinfield, Manchester
Anderson & Galloway .. .. .. 8, Buckingham Street, W.C.
Beck & Co., Limited .. .. .. 130, Great Suffolk Street, Southwark, S.E.
Berry, Henry .. .. Croydon Works, Hunslet, Leeds
Coles, H. J. .. .. 89, Sumner Street, S.E.
Cowans, Sheldon & Co., Limited St. Nicholas Works, Carlisle
Drysdale & Co. .. .. .. Bon Accord Engine Work Glasgow
Dudgeon, Richard .. .. .. 24, Upper Ashburn Street, E.C.
Fielding & Platt .. .. .. Gloucester
Hathorn, Davey & Co. .. .. Leeds
Middleton, Robert .. .. .. Bluepeper Foundry, Leeds
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Ramsbottom, J. .. .. .. Hunslet, Leeds
Rose, Downs & Thompson .. Old Foundry, Hull
Tangyes Limited .. .. .. Cornwall Works, Birmingha
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W.
Williams, W. L. .. .. .. 2, Westminster Chambers, S.

Hydraulic Presses.

Bessemer, Henry, & Co., Limited — Sheffield
Carrick & Wardale .. .. — Gateshead-on-Tyne
Coles, H. J. .. .. .. — 89, Sumner St., Southwark, S.E.
Copeland, J. & Co. .. — Dobbie's Loan, Glasgow
Drysdale & Co. .. .. .. — Bon Accord Engine Works, Glasgow
Fielding & Platt .. .. — Gloucester
Middleton, Robert .. .. — Shiesmear Foundry, Leeds.
Norman, John, & Co. .. — Keppochhill Engine Works, Glasgow
Rose, Downs & Thompson — Old Foundry, Hull
Stothert & Pitt, Limited .. — Bath
Tangyes Limited .. .. — Cornwall Works, Birmingham
Tweddell, R. H. .. .. — 14, Delahay Street, S.W.
Tyler, H., & Co. .. .. — 84, Upper Whitecross St., E.C.
Woods, H., & Co. .. .. — Salford, Manchester

Hydrokineter.

Weir, G. & J. .. .. .. — 40, Jamaica Street, Glasgow

Ice Making Machines.

Piggott, T., & Co. .. .. — Springhill, Birmingham

India Rubber Goods.

Angus, Geo., & Co. .. .. — Newcastle-on-Tyne
Harbitz India Rubber Comb Co. — 138, London Wall, E.C.
India Rubber, Gutta Percha & Telegraph Works Co., Limited — Silvertown, Essex
Macfarlane, George, & Co. .. — Glasgow Rubber Works, Glasgow
North British Rubber Co., Ltd. — Edinburgh
Star Rubber Co., The .. .. — 131, West Regent St., Glasgow

Indicators (Steam Engine).

Hannan & Buchanan .. .. — 75, Robertson Street, Glasgow
Tylte & Carlton (Stroudley's Speed) — 65, Queen Victoria Street, E.C.

Injectors.

Donald, J., & Son .. .. .. — 42, Cadogan Street, Glasgow
Fairburn & Hall .. .. — 63, Royal Exchange, Manchester
Gresham & Craven .. .. — Manchester
Hancock Inspirator Co. .. .. — 106, Upper Thames St., E.C.
Holden & Brooke .. .. — 86, Simon Works, Salford
Korting Brothers .. .. .. — 17, Lancaster Avenue, Manchester
Madan, C. S. .. .. .. — 21, Mansfield Chambers, St. Ann's Square, Manchester
Manlove, Alliott, Fryer & Co. .. — Nottingham
Patent Exhaust Steam Injector Co., Limited .. .. — 4, St. Ann's Square, Manchester
Schaffer & Budenberg .. .. — St. Mary Street, Manchester

Insurance Companies.

Employers' Liability Assurance Corporation, Limited .. .. — 84 & 85, King William Street, E.C.
London Mutual Boiler Insurance Co., Limited .. .. — 17, Queen Victoria Street, E.C.

Iron Buildings.

Clark, Bunnett & Co., Limited .. — Bathbone Place, W.
Davies Brothers & Co. .. .. — Crown Iron Works, Wolverhampton
Davies, M. H. .. .. .. — Grange Rd., Bermondsey, S.E.
Dixon, T. .. .. — Windsor Ironworks, Liverpool
Lysaght, John, Limited .. .. — Bristol
Macfarlane, Walter, & Co. .. — Possil Park, Glasgow
Morewood & Co. .. .. — Soho, Birmingham
Morton, P., & Co., Limited — Naylor St. Ironworks, Liverpool

Iron and Steel Works (Plant for).

Adamson, D., & Co. .. .. — Dukinfield, Manchester
Davey, Bros., Limited .. .. — Sheffield
Galloway, W. & J., & Sons .. — Manchester
Goodwin, James, & Co. .. .. — Ardrossan, N.B.
McCulloch, T., & Sons .. .. — Kilmarnock
Thwaites Bros. .. .. .. — Bradford
Walker Bros. .. .. .. — Wigan
Walker, T., & Co. .. .. .. — Leeds
Whitwell, W. (Stoves) .. .. — Stockton-on-Tees
Woods, H., & Co. .. .. .. — Salford, Manchester

Jacks (Lifting).

Dudgeon, Richard .. .. .. — 114, Fenchurch Street, E.C.
Gibbins, R. C., & Co. .. .. — Berkley St., Birmingham
Pickering, John .. .. .. — Stockton-on-Tees
Selig, Sonnenthal & Co. .. .. — 85, Queen Victoria Street, E.C.
Shirlaw, A., & Co. .. .. — Berkley Street, Birmingham
Tangyes Limited .. .. .. — Cornwall Works, Birmingham

Keys and Pins.

Mills, Jas. (Executors of) .. — Bredbury, near Stockport
Smith, H. Ford .. .. .. — Seddon St., Salford, Manchester

Lamps.

Barnett & Foster .. .. .. — 29a, Eagle Wharf Road, N.

Launches and Yachts.

Burnet, L., & Co. .. .. .. — Govan, Glasgow
Chaplin, Alex., & Co. .. .. — Cranston Hill Engine Works, Glasgow
Cochran & Co. .. .. .. — Birkenhead
Cran, J., & Co. .. .. .. — Albert Engine Works, Leith
Des Vignes, G. F. G. .. .. — Chertsey
Edwards & Symes .. .. .. — Wharf Rd., Cubitt Town, E.
Forrestt & Son .. .. .. — Limehouse, E.
Hannn, Donald & Wilson .. — Paisley, N.B.
Hayes, Ed. .. .. — Stony Stratford
Kerr, Stuart & Co. .. .. .. — 20, Bucklersbury, E.C.
Miller & Tapp .. .. .. — Middle Mall, Hammersmith
Paul, M., & Co. .. .. .. — Levenford Works, Dumbarton
Ross & Duncan .. .. .. — Whitefield Works, Glasgow
Thornycroft, J. I., & Co. .. — Chiswick, W.
Vosper & Co. .. .. .. — Bread Street, Portsmouth
Yarrow & Co. .. .. .. — Poplar, E.

Laundry Machines.

Manlove, Alliott, Fryer & Co. .. — Nottingham

Leather Machinery.

Drysdale & Co. .. .. .. — Bon Accord Engine Works, Glasgow
Stothert & Pitt, Limited .. — Bath

Letter Files.

Cameron, T., Amberg & Co. .. — 27, Little Britain, London, E.C.

Lifts.

Coles, H. J. .. .. — 89, Sumner Street, S.E.
Drysdale & Co. .. .. .. — Bon Accord Engine Works, Glasgow
Gibbins, R. C., & Co. .. .. — Berkley St., Birmingham
Hanson, W. .. .. — Bradford
Hunter & English .. .. .. — Bow, E.
Pickering, John .. .. .. — Stockton-on-Tees
Thomas, T., & Sons .. .. — Cardiff
Waygood, R., & Co. .. .. — Falmouth Road, S.E.

Linoleum Machinery.—*(See Floor Cloth Machinery.)*

Lithographers.

Kell, Thos., & Son .. .. .. — 40, King Street, Covent Garden, W.C.

Locomotive Details.

Storey, I., & Sons .. .. .. — Knott Mill, Manchester

Locomotive Engines.—*(See Engines, Locomotive.)*

Lubricants and Oils.

Bell, J. .. .. — Asbestos Works, Southwark, S.E.
Bliven's American Lubricating Cream .. .. .. — 23, Brunswick St., Liverpool
Bradford, J., & Sons .. .. — Liverpool
Crane, P. Moir, & Co. .. .. — Bank Street, Manchester
Engelbart & Co. .. .. .. — 70 & 71, Bishopsgate St., E.C.
Fleming, A. B., & Co., Limited — 15, Whitefriars Street, E.C.
Price's Patent Candle Co., Ltd. — Battersea, S.W.
Ragosine & Co. .. .. .. — 7, Idol Lane, E.C.

Lubricators.

Dewrance & Co. .. .. .. — 138, Great Dover Street, S.E.
Empire Lubricator Co. .. .. — Great Bridgewater Street, Manchester
Korting Brothers .. .. .. — 17, Lancaster Avenue, Manchester
Nettlefolds, Limited .. .. — Birmingham
Trier Brothers .. .. .. — 19, St. George St., Westminster
Whitehouse & Co. .. .. .. — Tipton Hall Chain Works, Staffordshire

Machine Tools.

Anderson & Gallway .. .. — 8, Buckingham Street, W.C.
Archdale, Jas., & Co. .. .. — Ledsam Street, Birmingham
Ashham Bros. & Wilson, Ltd. .. — Sheffield
Asquith, W. .. .. .. — Highroad Well Works, Halifax
Barlow, H. B., & Co. .. .. — Combrook Works, Manchester
Berry, F., & Sons .. .. .. — Calder Ironworks, Sowerby Bridge
Berry, H. .. .. — Croydon Works, Hunslet, Leeds
Booth, Geo., & Co. .. .. — Halifax
Butterfield, F. & J., & Co. .. — Keighley, Yorkshire
Cameron, John .. .. .. — Oldfield Road Ironworks, Salford
Churchill, C., & Co. .. .. — Cross Street, Finsbury, E.C.
Davis & Primrose .. .. .. — Elm Ironworks, Bangor Road, Leith, N.B.
De Bergue & Co., Limited — Manchester
Dun & Lawson .. .. .. — Cranston Hill Tool Works, Glasgow
Earnshaw, A., & Co. .. .. — Crown Works, Booth Town, Halifax
Easterbrook, Alcard & Wild .. — Sheffield
Fielding & Platt .. .. .. — Gloucester
Galloway, W. & J., & Sons .. — Manchester
Harvey, Robert, & Co. .. .. — Park Grove Ironworks, Glasgow
Heap, Joshua, & Co. .. .. — Arden-under-Lyne
Kendall & Gent .. .. .. — Victoria Works, Manchester
Lang, J., & Sons .. .. .. — Johnstone, N.B.
Lee, Rod'k, Ward & Howl .. — Tipton, Staffordshire
Lee & Hunt .. .. — Ark-wright Works, Manchester
London Bros. .. .. .. — Bothwell Street, Glasgow
Machinery & Hardware Co., Ltd. — 147, Queen Victoria Street, E.C.
McArthur, A., & Son .. .. — Johnston, N.B.
Muir, Wm., & Co. .. .. .. — Sherbourne Street, Manchester
New, D., & Co. .. .. .. — 15, Devonshire Chambers, E.C.
Pitt Bros. .. .. — Yorkshire Machine Tool Works, Liversedge
Pollock, Macnab, & Highgate .. — Shettleston, Glasgow
Rushworth & Co. .. .. .. — Sowerby Bridge, Yorkshire
Scott Bros. .. .. — West Mount Ironworks, Halifax
Scriven & Co. .. .. .. — Leeds Old Foundry, Marsh Lane Leeds
Selig, Sonnenthal & Co. .. .. — 85, Queen Victoria Street, E.C.
Shepherd, Hill & Co. .. .. — Leeds
Shirlaw, A., & Co. .. .. .. — Suffolk Works, Birmingham
Smith & Coventry .. .. .. — Orchell Lane, Salford, Manchester
Smith & Willshaw .. .. .. — Halifax
Tangyes Machine Tool Co., Ltd. — Soho, Birmingham
Tweddell, R. H. .. .. .. — 14, Delahay Street, S.W.
Widdowson, J. H. .. .. .. — Orchell Lane, Salford
Winn, Charles, & Co. .. .. — Granville Street, Birmingham

Maize Dressing Machinery.

Copeland, J., & Co. .. .. — Dobbie's Loan, Glasgow
Norman, John, & Co. .. .. — Keppochhill Engine Works, Glasgow

Mathematical Instruments, Makers.

Archbutt, J. & W. E. .. .. — Westminster Bridge Road, Lambeth, S.W.
Götz, J. R. .. .. — 19, Buckingham Street, W.C.
Negretti & Zambra .. .. — Holborn Viaduct, E.C.
Stanley, W. F. .. .. .. — Great Turnstile, Holborn, W.C.

Metals (Phosphor, Alloys, &c.).

Billington & Newton .. .. — Longport, Staffordshire
Cockshott & Jowett .. .. — 145, Thornton Road, Bradford
Dick, Alex. .. .. — 110, Cannon Street, E.C.
Evans, James, & Co. .. .. — Gaythorn, Manchester
Hartmann, G. .. .. .. — 16, Great St. Helen's, E.C.
Hughes, J. & J. .. .. .. — Woodcock Street, Birmingham
Phosphor Bronze Co., Limited .. — Sumner Street, S.E.

Meters.

Manchester Water Meter Co., Limited .. .. — Ardwick, Manchester

Mill Gearing, Shafting, &c.

Ashham Bros. & Wilson, Ltd .. — Sheffield
Bessemer, Henry, & Co., Limited — Sheffield
Bodley, Bros., & Co. .. .. — Exeter
Brown, Bayley, Dixon & Co. .. — Sheffield
Buckley & Taylor .. .. .. — Castle Ironworks, Oldham
Forsyth, Miller & Co. .. .. — Mile End, Glasgow
Goodfellow & Matthews .. .. — Hyde, near Manchester
Hawthorn, R. & W. .. .. — Newcastle-on-Tyne
Hick, Hargreaves & Co. .. .. — Soho Ironworks, Bolton
Hind, H., & Co. .. .. .. — Nottingham
Jackson, P. R., & Co. .. .. — Salford Rolling Mills, Salford
Kirkstall Forge Co. .. .. — Leeds
McCulloch, T., & Sons .. .. — Kilmarnock
Musgrave, John, & Sons .. .. — Bolton
Rowlandson, A. .. .. .. — Newcastle-on-Tyne
Saville Street Foundry and Engineering Co., Limited .. .. — Sheffield
Smith, Parfrey & Hitchinge .. — Buckingham Palace Rd., S.W.
Staffordshire Wheel & Axle Co. — Spring Hill, Birmingham
Taylor & Challen .. .. .. — Derwent Foundry, Birmingham
Tinsley, Eliza .. .. .. — Great Bridge, Staff
Yates & Co. .. .. — Shaw Works, Hunslet Road, Leeds

Mill Machinery (Flour, Corn, and Rice).

Carter, J. H. .. .. .. — 82, Mark Lane, E.C.
Clayton & Shuttleworth .. .. — Lincoln
Copeland, J., & Co. .. .. — Dobbies' Loan, Glasgow
Hunter & English .. .. .. — Bow, E.
Lendale, James .. .. .. — Kirkcaldy, N.B.
Marshall, Sons & Co., Limited .. — Gainsborough
McCulloch, T., & Son .. .. — Kilmarnock
Norman, J., & Co. .. .. — Keppochhill Engine Works, Glasgow
Ransomes, Head, & Jeffries .. — Ipswich
Ruston, Proctor, & Co. .. .. — Lincoln
Turner, E. R., & F. .. .. — Ipswich

Mills (Paint, Oil, Mortar, &c.).

Butters Brothers .. .. .. — Lambhill Street, Glasgow
Follows & Bate, Limited (Paint) — Manchester
Rose, Downs, & Thompson .. — Hull
Selig, Sonnenthal & Co. .. .. — 85, Queen Victoria Street, E.C.
Spencer & Co. .. .. .. — Melksham, Wilts
Wilson, John H., & Co. .. .. — Sandhills, Liverpool

Mining Machinery.

Ashham Bros & Wilson, Ltd. .. — Sheffield
Chaplin, Alex., & Co. .. .. — Cranston Hill Engine Works, Glasgow
Clay Cross Co. .. .. .. — Clay Cross, near Chesterfield
Daglish, R. & Co. .. .. .. — St. Helens, Lanc.
Hathorn, Davey & Co. .. .. — Leeds
Jordan, T. B., Son & Commans. .. — 52, Gracechurch Street, E.C.
Robey & Co. .. .. — Lincoln
Ruston, Proctor & Co. .. .. — Lincoln
Tangyes Limited .. .. .. — Cornwall Works, Birmingham
Walker, Bros. .. .. .. — Wigan

Non-Conducting Compositions.

Anderson, D., & Son, Limited .. — Lagan Felt Works, Belfast
Bell, J. .. .. — Asbestos Works, Southwark, S.E.
Haacke, A., & Co. .. .. .. — 21, Lime Street, E.C.
Keenan, M. .. .. — Armagh Works, Tredegar Wks., N. Bow, E.
Leroy, F., & Co. .. .. .. — Gray Street, Commercial Rd., E.

Nuts (Finished).

Mercer, Ed. .. .. — Hollinwood, Manchester

Oils.—*(See Lubricants.)*

Oil Cans.

Kaye, Jos., & Co. .. .. .. — Bank Works, Kirkstall, Leeds.

Oil Distilling Plant.

Copeland, J., & Co. .. .. — Dobbie's Loan, Glasgow
Norman, John, & Co. .. .. — Keppochhill Engine Works, Glasgow

Oil Mill Machinery.

Piggott, Thos., & Co. .. .. — Birmingham
Rose, Downs & Thompson .. — Old Foundry, Hull
Rowlandson, W. .. .. .. — 122, Boundary St., Liverpool
Tangyes Limited .. .. .. — Cornwall Works, Birmingham

Packing (Engine).

Beldam Packing & Rubber Co. .. — 77, Gracechurch Street, E.C.
Bell, John .. .. — Asbestos Works, Southwark
Binney & Son .. .. .. — Cathcrine St., City Road, E.C.
Lindsay, R. B., & Co. .. .. — Plantation Quay West Glasgow
Mead, F. M., & Co. .. .. — 322b, Kennington Road, S.E.
Tuck & Co., Limited .. .. — 116, Cannon Street, E.C.
United Asbestos Co., Ltd., The .. — 161, Queen Victoria Street, E.C.

Paints.

Ragosine & Co. .. .. .. — 7, Idol Lane, Great Tower St.
United Asbestos Co., Limited .. — 161, Queen Victoria Street, E.C.

Paper.

Hodgkinson & Co. .. .. .. —

Paper Making Machinery.

Donkin, B., & Co. .. .. .. — Bermondsey, S.E.
Douglas & Grant .. .. .. — Kirkcaldy, N.B.

Patent Agents.

Alexander, E. P. .. .. .. — 36, Southampton Buildings, W.C.
Allison, Brothers .. .. .. — 52, Chancery Lane, W.C.
Brewer & Jensen .. .. .. — 23, Chancery Lane, W.C.
Brookes, Wm. .. .. .. — 53 & 56, Chancery Lane, W.C.
Craven, T. E., & Son .. .. — 24, Victoria Chambers, South Parade, Leeds
Hardingham, G. G. M. .. .. — 191, Fleet Street, E.C.
Harris & Mills .. .. .. — 23, Southampton Buildings, W.C.
Horn & Son .. .. — 172, Strand, W.C.
Inventors' Patent Right Association, Limited .. .. .. — 21, Cockspur Street, S.W.
Phillips & Leigh .. .. .. — 22, Southampton Buildings, Chancery Lane, W.C.
Redfern, G. F. .. .. .. — 4, South Street, Finsbury, E.C.
Rogers, F. M. .. .. .. — 21, Finsbury Pavement, E.C.
Thompson & Bovill .. .. — 6, Lord Street, Liverpool
Thomson, W. R. M., & Co. .. — 86, Buchanan Street, Glasgow
Vaughan & Son .. .. .. — 57, Chancery Lane, W.C.
Wise, W. Lloyd .. .. .. — 46, Lincoln's Inn Fields, W.C.

Patterns.

Ormerod, Otterson & Co. .. .. — Manchester
Walker, E. .. .. — Avonside Engine Works, Bristol

Permanent Way.

Ashham Bros. & Wilson, Ltd. .. — Sheffield
Dick, Kerr & Co. .. .. .. — 101, Leadenhall Street, E.C.
Hartley & Armour Brothers .. — Stoke on Trent
Iron Foundry & Engineering Co. — Newport, Monmouthshire
Kerr, Stuart & Co. .. .. .. — 20, Bucklersbury, E.C.
Railway Sleeper Supply Co., The — 17, Gracechurch St., London
Thomson & Browning .. .. .. — 3, Victoria Street, E.C.

Photographic Appliances.

Götz, J. R. .. .. — 19, Buckingham Street, W.C.

Pig Iron Breakers.

Evans, J., & Co. .. .. .. — Trumpet Street, Manchester

Pile Drivers.

Gibbins, R. C., & Co. .. .. — Berkley Street, Birmingham

Piles.

Goodwin, James, & Co. .. .. — Ardrossan, N.B.
Le Grand & Sutcliff .. .. — 100, Bunhill Row, E.C.

Pipe Founders.

Clay Cross Co. .. .. .. — Clay Cross, near Chesterfield
Iron Foundry & Engineering Co. — Newport, Monmouthshire

Pipe (Drain) Making Machinery.

Clayton, Howlett & Venables .. — Harrow Road, W.

Pipes (Sanitary).

Doulton & Co. .. .. .. — Lambeth, S.E.
Farnley Iron Co., Limited .. — Farnley, near Leeds
Glenboig Union Fire Clay Co., The — Glasgow

Pistons and Piston Rings.

Atkins & Co. .. .. .. — Special Tool Works, Stanley Street, Sheffield
Bates, Timothy, & Co. .. .. — Sowerby Bridge
Jackson, P. R., & Co. .. .. — Salford Rolling Mills, Manchester
Lockwood & Carlisle .. .. — Eagle Foundry, Park, Sheffield

Plates (Iron and Steel).

Beardmore, I. & W. .. .. — Glasgow
Brown, Bayley, Dixon & Co. .. — Sheffield
Jessop, Wm., & Sons, Limited — Sheffield
Landore Siemens-Steel Co., The .. — Landore, South Wales
Leeds Forge Co., The .. .. — Leeds
Shelton Bar Iron Co., Limited — Stoke-on-Trent
Steel Co. of Scotland, Limited .. — Glasgow
West Cumberland Iron & Steel Co., Limited .. .. .. — Workington

Portable Engines.—*(See Engines, Portable.)*

Portable Railways.—*(See Railways, Portable.)*

Pottery and Encaustic Tile Machinery.

Bodley Brothers & Co. .. .. — Exeter
Boulton, W. .. .. .. — Burslem, Staffordshire

Presses (Hydraulic).—*(See Hydraulic Presses.)*

Printing Machinery for Textile Fabrics.

Farmer, Jas., & Sons .. .. — Salford

Propellers.

Ross & Duncan .. .. .. — Glasgow
Savile Street Foundry and Engineering Co., Limited .. .. — Sheffield

Pulley Blocks.

Crowley, John, & Co. .. .. — Sheffield
Glover, Walter T., & Co. .. — 23, South Street, Manchester
Grimshaw & Co. .. .. .. — 58, Paxton Street, Accrington
Pickering, John .. .. .. — Stockton-on-Tees
Selig, Sonnenthal & Co. .. .. — 85, Queen Victoria Street, E.C.
Tangyes Limited .. .. .. — Birmingham
Thomson, Wm. .. .. .. — Kinning Park, Glasgow

Pulleys (Cast Iron).

Bagshaw, J. & Sons .. .. — Batley, Yorkshire
Bodley Brothers & Co. .. .. — Exeter
Buckley & Taylor .. .. .. — Castle Iron Works, Oldham
Crossley, Geo. .. .. .. — Cleckheaton, Yorkshire
Fawcett, Thos. C. .. .. .. — Manor Road, Leeds
Goodfellow & Matthews .. .. — Hyde, near Manchester
Harper & Co. .. .. .. — Albion Ironworks, Aberdeen
Jackson, P. R., & Co. .. .. — Salford Rolling Mill, Manchester
Grimerod, Grierson & Co. .. .. — Hulme, Manchester
Reading Ironworks Co. .. .. — Reading
Rowlandson, W. .. .. .. — 122, Boundary St., Liverpool
Taylor & Challen .. .. .. — Derwent Foundry, Birmingham
Yates, J. & Co. .. .. .. — Hunslet, near Leeds

Pulleys (Wrought Iron).

Bagshaw, J., & Sons .. .. — Batley
Crossley, G. .. .. .. — Albion Machine Works, Cleckheaton
Hall, J. & F. .. .. .. — Dartford Ironworks, Kent
Hudswell, Clark & Co. .. — Railway Foundry, Leeds
Mackie, J. & J., & Co. .. — Berks Ironworks, Reading
Okes, J. C. R. .. .. .. — 39, Queen Victoria Street, E.C.
Pickering, John .. .. .. — Stockton on Tees
Reading Ironworks Co., Ltd. .. — Reading

Pumps and Pumping Machinery.

Allen, W. H., & Co. .. .. — York Street, Lambeth, S.E.
Cameron, John .. .. .. — Old Field Rd. Ironworks, Salford
Carrick & Wardle .. .. .. — Gateshead
Chaplin, A., & Co. .. .. — Glasgow
Clay Cross Co. .. .. .. — Clay Cross, near Chesterfield
Coalbrookdale Co., Limited .. — Coalbrookdale, Shropshire
Cochrane, John .. .. .. — Borehead, N.B.
Coles, H. J. .. .. .. — 89, Sumner St., Southwark, S.E.
Hanson, W. .. .. .. — Quitsee Works, Bradford
Hathorn, Davey & Co. .. .. — Leeds
Hatton, J. .. .. — Coventry
London Brothers .. .. — Bothwell Street, Glasgow
Lowca Engineering Co., Ltd., The — Whitehaven
New, D., & Co. .. .. .. — 15, Devonshire Chambers, E.C.
Okes, J. C. R. .. .. .. — 39, Queen Victoria Street, E.C.
Owens, S., & Co. .. .. .. — Whitefriars Street, E.C.
Roger, R., & Co. .. .. .. — Stockton-on-Tees
Stannah, J. .. .. — 29, Southwark Bridge Rd., S.E.
Tangyes Limited .. .. .. — Cornwall Works, Birmingham
Wilson, Alex., & Co. .. .. — Vauxhall Ironworks, Wandsworth Road, S.W.
Wilson, John H., & Co. .. .. — Sandhills, Liverpool

Pumps (Centrifugal).

Allen, W. H., & Co. .. .. — York St. Works, Lambeth, S.E.
Drysdale & Co. .. .. .. — Bon Accord Engine Works, Glasgow
Evans, J., & Sons .. .. .. — Wolverhampton
Hathorn, Davey & Co. .. .. — Leeds
Hett, C. L. .. .. — Bilke
Lowca Engineering Co., Ltd., The — Whitehaven
New, D., & Co. .. .. .. — 15, Devonshire Chambers, E.C.
Owens, S., & Co. .. .. .. — Whitefriars Street, E.C.
Ruston, Proctor & Co. .. .. — Lincoln
Simpson & Co. .. .. .. — Pimlico, London
Tangyes Limited .. .. .. — Cornwall Works, Birmingham

Pumps (Donkey).

Cameron, John .. .. .. — Oldfield Rd. Ironworks, Salford
Chaplin, Alex., & Co. .. .. — Cranston Hill Engine Works, Glasgow
Coalbrookdale Co., Limited .. — Coalbrookdale, Shropshire
Cochrane, John .. .. .. — Borehead, N.B.
Coles, H. J. .. .. .. — 89, Sumner St., Southwark, S.E.
Hanson, W. .. .. .. — Quitsee Works, Bradford
Hathorn, Davey & Co. .. .. — Leeds
Hatton, J. .. .. — Coventry
London Brothers .. .. — Bothwell Street, Glasgow
Lowca Engineering Co. Ltd., The — Whitehaven
New, D., & Co. .. .. .. — 15, Devonshire Chambers, E.C.
Okes, J. C. R. .. .. .. — 39, Queen Victoria Street, E.C.
Owens, S., & Co. .. .. .. — Whitefriars Street, E.C.
Roger, R., & Co. .. .. .. — Stockton-on-Tees
Stannah, J. .. .. — 29, Southwark Bridge Rd., S.E.
Tangyes Limited .. .. .. — Cornwall Works, Birmingham
Wilson, Alex., & Co. .. .. — Vauxhall Ironworks, Wandsworth Road, S.W.
Wilson, John H., & Co. .. .. — Sandhills, Liverpool

Railway Agents.

Oldham Brothers .. .. .. — 110 Cannon Street, E.C.

Railway and Contractors' Plant.

Ashham Bros & Wilson, Ltd .. — Sheffield
Brown, Bayley, Dixon & Co. .. — Sheffield
Chaplin, Alex., & Co. .. .. — Cranston Hill Engine Works, Glasgow
Darlington Steel & Iron Co., Ltd — 3, Victoria St., Westminster, S.W.
Decauville, Aîné .. .. .. — Petit-Bourg (Seine et Oise), France
Dick, Kerr & Co. .. .. .. — 101, Leadenhall Street, E.C.
Goodwin, Jas., & Co. .. .. — Ardrossan, N.B.
Hadfield's Steel Foundry Co. .. — Attercliffe, Sheffield
Hartley & Armour Brothers .. — Stoke on Trent
Hudson, R. .. .. — Gildersome Foundry, near Leeds
Jansen, C., & Co. .. .. .. — Darlington
Iron Foundry & Engineering Co. — Newport, Monmouthshire
Ransomes & Rapier .. .. .. — 3, Westminster Chambers, S.W.
Thomson & Browning .. .. .. — 3, Victoria St., Westminster, S.W.
Wood, C. .. .. — Tees Ironworks, Middlesbrough-on-Tees

Railways (Portable).

Bagnall, W. G. .. .. .. — Stafford
Decauville, Aîné .. .. .. — Petit-Bourg (Seine et Oise), France
Dick, Kerr & Co. .. .. .. — 101, Leadenhall Street, E.C.
Hartley & Armour Brothe .. .. — Stoke on Trent
Kerr, Stuart & Co. .. .. .. — 20, Bucklersbury, E.C.
Wood, C. .. .. — Tees Ironworks, Middlesbrough-on-Tees

Rail Benders.

Bellmer & Jones .. .. .. — Dane-end House, London, E.C

Rail Lifters.

De Bergue & Co., Limited .. — Manchester

Rails (Steel or Iron).

Ashham Bros & Wilson, Ltd .. — Sheffield
Beckton, J. & Son .. .. .. — 402, St. Mary's Gate, Derby
Brown, Bailey, Dixon, & Co., Ltd — Sheffield
Darlington Steel & Iron Co., Ltd. — 3, Victoria St., Westminster, S.W.
Hartley & Armour Brothers .. — Stoke on Trent
Steel Co. of Scotland, Limited .. — Glasgow
West Cumberland Iron & Steel Co. — Workington, Cumberland

Reducing Valves.

Hanson, Wm. .. .. .. — Quitsee Works, Bradford

Refrigerating Machinery.

Copeland, J., & Co. .. .. — Dobbie's Loan, Glasgow
Douglas & Grant .. .. .. — Dunnikier Foundry, Kirkcaldy, N.B.
Hall, J. & E. .. .. .. — Dartford Ironworks, Kent

Rice Dressing Machinery.

Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Douglas & Grant .. .. .. Kirkcaldy, N.B.
Hunter & English .. .. .. Bow, E.
Landale, James .. .. .. Kirkcaldy, N.B.
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow

Rivets.—*(See Bolts, Rivets, &c.)*

Rivetting Machines.

Anderson & Gallwey .. .. 8, Buckingham Street, Adelphi, W.C.
Berry, Henry .. .. .. Croydon Works, Munslet, Leeds
De Bergue & Co., Limited .. Manchester
Drysdale & Co. .. .. Bon Accord Engine Works, Glasgow
Fielding & Platt .. .. .. Gloucester
Gilmer, W. F., & Co. .. .. Quayside, Newcastle-on-Tyne
Harvey, Robert, & Co .. .. Park Grove Ironworks, Glasgow
Higginson & Co. .. .. .. Mersey Street, Liverpool
New, D., & Co. .. .. .. 15, Devonshire Chambers, E.C.
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W.

Rock Drills.

Glover & Hobson .. .. .. St. James's Road, S.E.
Hartley & Arnoux Brothers .. Stoke-on-Trent
Jordan, T. B., Son, & Commans 52, Gracechurch St., E.C.

Rolling Mills.—*(See Iron & Steel Works, Plant for.)*

Rolls (Chilled and Grain).

Perry, Thomas, & Son .. .. Highfield Works, Bilston
Tinsley, Eliza .. .. .. Great Bridge, Staffordshire

Roofs (Iron, Steel and Zinc).

Ashbury Railway Carriage & Iron Co., Limited .. .. .. Openshaw, Manchester
Clarke, Bunnett & Co., Limited Rathbone Place, W.
Davies, Bros., & Co. .. .. Crown Ironworks, Wolverhampton
Davies, M. H. .. .. .. Grange Road, Bermondsey, S.E.
De Bergue, & Co., Limited .. Manchester
Dixon, Isaac .. .. .. Windsor Ironworks, Liverpool
Goodwin, Jas., & Co. .. .. Motherwell, N.B.
Hanna, Donald & Wilson .. Paisley, N.B.
Hill & Smith .. .. .. Tipton, Staffordshire
Jaques, C., Son & Co. .. .. Darlington
Ince Foundry & Engineering Co. Newport, Monmouthshire
Lowca Engineering Co., Ltd., The Whitehaven
Lysaght, J., Limited .. .. St. Vincent Works, Bristol
Morewood & Co. .. .. .. Woodford Ironworks, Soho, Birmingham
Morton, Francis & Co. .. .. Naylor St. Ironworks, Liverpool
Walker Brothers .. .. .. Wigan

Rope Driving Gear.

Goodfellow & Matthews .. .. Hyde, near Manchester

Ropes (Wire).—*(See Wire Ropes.)*

Rustless Iron.

The Bower Barff Rustless Iron Co., Limited .. .. .. 23, Queen Victoria Street, E.C.

Sanitary Appliances.

Doulton & Co. .. .. . Lambeth, S.E.
Winn, Charles, & Co. .. .. Granville Street, Birmingham

Shafting.

Bagshaw, J., & Sons .. .. Batley, near Leeds
Bessemer, Henry, & Co., Limited Sheffield
Brown, Bayley, Dixon & Co. . Sheffield
Goodfellow & Matthews .. .. Hyde, near Manchester
Harper & Co. .. .. .. Albion Ironworks, Aberdeen
Hick, Hargreaves & Co .. .. Soho Ironworks, Bolton
Hind, H., & Son .. .. .. Nottingham
Kirkstall Forge Co. .. .. .. Leeds
New, D., & Co .. .. .. 15, Devonshire Chambers, E.C.
Taylor & Challen .. .. .. Derwent Foundry, Birmingham
Tinsley, Eliza .. .. .. Great Bridge, Yorkshire
Yates, J., & Co .. .. .. Sheaf Works, Hunslet Rd., Leeds

Ship Builders.

Abercorn Shipbuilding Co. . Abbey Works, Paisley, N.B.
Alley & Macllellan .. .. .. Glasgow
Rose & Duncan .. .. .. Glasgow
Simons, W., & Co. .. .. Renfrew
Yarrow & Co. .. .. .. Isle of Dogs, E

Slide Valves.

Thom, J. .. .. 8 Storey Sq., Barrow in Furness

Soda Water Machinery.

Barnett & Foster .. .. .. 28q, Eagle Wharf Road, N.

Speed Indicators.

Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Tuite & Carlton .. .. .. 63, Queen Victoria Street, E.C.

Springs.

Ibbotson Brothers & Co., Limited Sheffield
Osborn, Samuel, & Co. .. .. Sheffield
Salter, George, & Co. .. .. West Bromwich
Spencer, J., & Sons .. .. Newburn Steel Works, Newcastle-on-Tyne
Starne, L., & Co., Limited .. Crown Ironworks, Glasgow
Turton, Thos., & Sons .. .. Sheaf Works, Sheffield

Steam Hammers.

Booth, Geo., & Co. .. . Halifax
Cochrane, John .. . Barrhead
Davis & Primrose .. . Etna Ironworks, Bangor Road, Leith, N.B.
Davy Brothers, Limited .. .. Sheffield
Dudgeon, Richard .. .. .. 114, Fenchurch Street, E.C.
Harvey, Robert, & Co .. .. Park Grove Ironworks, Glasgow
Massey, B. & S. .. .. .. Manchester
Musgrave, J., & Sons .. .. Bolton
Pollock, Macnab, & Hodgate .. Shettleston, Glasgow
Rushworth & Co. .. .. .. Sowerby Bridge, Yorkshire
Saville Street Foundry and Engineering Co., Limited .. .. Sheffield
Thwaites Brothers .. .. .. Vulcan Ironworks, Bradford
Walker Brothers .. .. .. Pagefield Ironworks, Wigan
Walker, T., & Co .. .. .. Leeds

Steam Traps.

Hanson, W. .. .. .. Quebec Works, Bradford
Lancaster & Tonge .. .. .. Pendleton, Manchester
Vaughan & Son .. .. .. West Gorton, Manchester

Steaming Machines.

Smith & Johnston .. .. .. Paisley Road, Glasgow

Steel Makers.

Askham Bros. & Wilson, Ltd. .. Sheffield
Beardmore, I. & W. .. .. Parkhead Ironworks, Glasgow
Bessemer, H., & Co., Limited .. Sheffield
Bolton Iron & Steel Co. .. .. Bolton
Brown, Bayley, Dixon & Co. .. Sheffield
Hadfield's Steel Foundry Co. .. Attercliffe, Sheffield
Howell & Co. .. .. .. Sheffield
Ibbotson Bros., & Co., Limited .. Sheffield
Jessop, W., & Sons, Limited .. Sheffield
Landore Siemens-Steel Co., Ltd. Landore, South Wales
Leeds Forge Co. .. .. .. Leeds
Marsden, Francis .. .. .. Shoreside Works, Sheffield
Osborn, S., & Co. .. .. .. Sheffield
Stanners Close's Steel Co. .. Wolsingham, near Darlington
Steel Co. of Scotland, The .. 120, Hope Street, Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Turton, T., & Sons .. .. Sheaf Works, Sheffield
West Cumberland Iron and Steel Co. .. .. .. Workington, Cumberland

Steel and Iron Works (Plant for).—*(See Iron and Steel Works.)*

Steering Gear.

Donkin & Nicholson .. .. .. Newcastle-on Tyne
Grange Iron Co., Limited .. Durham
Lynn, John, & Co. .. .. Sunderland
Paul, M., & Co. .. .. .. Leven Ford Works, Dumbarton
Piggott, T., & Co. .. .. .. Springhill, Birmingham
Wilson, J. H., & Co. .. .. Sandhills, Liverpool

Stokers (Mechanical).

Knap, Conrad .. .. .. 11, Queen Victoria Street, E.C.
Hodgkinson & Co., Limited .. Manchester
Proctor, J. .. .. Burnley, Lancashire

Stone Breakers.

Baxter, W. H., & Co. .. .. Albion Street, Leeds
Goodwin, Jas., & Co. .. .. Motherwell, near Glasgow
Saville Street Foundry & Engineering Co., Limited .. Sheffield

Stone Dressing Machinery.

Harper & Co. .. .. .. Albion Ironworks, Aberdeen
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow
Western & Co. .. .. .. Cloghbaden Works, Derby

Sugar Machinery.

Aitken, McNeil & Co. .. .. Helen Street, Govan, Glasgow
Clayton, Howlett & Venables .. Harrow Road, W.
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Landale, James .. .. .. Kirkcaldy, N.B.
Manlove, Alliott, Fryer & Co. .. Nottingham
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow
Piggott, T., & Co. .. .. .. Springhill, Birmingham
Struthers & Co. .. .. .. 90, Buchanan St., Glasgow

Surface Plates.

Okes, J. C. B. .. .. .. 39, Queen Victoria Street, E.C.
Richards, G., & Co. .. .. Atlantic Works, Broadheath, near Manchester

Tanks.

Bellamy, John .. .. .. Byng Street, Millwall, E.
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Davies Bros. & Co. .. .. Crown Ironworks, Wolverhampton
Hanna, Donald & Wilson .. Paisley, N.B.
McCulloch, T., & Sons .. .. Kilmarnock
Morewood & Co. .. .. .. Soho, Birmingham
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow

Tanners and Curriers.

Hepburn & Gale, Limited .. Long Lane, Southwark, S.E.
McIntosh, Peter, & Sons .. 1296, Stockwell St., Glasgow
Norris, S. E., & Co. .. .. High Street, Shadwell, E.
Webb & Son .. .. .. Stowmarket
White, John, & Sons .. .. Bingley, Yorkshire
Wilcock, Mark .. .. .. Sowerby Bridge

Tea Dressing Machinery.

Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Marshall, Sons & Co., Limited .. Gainsborough

Telegraphs (Engine and Steering).

Chadburn & Son .. .. .. Lord Street, Liverpool

Telegraph Wire and Cables.

Glover, W. T., & Co. .. .. 25, Booth Street, Manchester

Timber Merchants.

Keen, J. .. .. 264, Waterloo Bridge Road, S.E.

Tools (Hand and Small).

Bedford, J., & Sons . .. Lion Works, Sheffield
Chatwin, Thos. .. .. .. 64, Tibdal St., Birmingham
Churchill, C., & Co. .. .. 21, Cross Street, Finsbury, E.C.
Ibbotson Brothers & Co., Limited Sheffield
Jowitt, Thos., & Sons .. .. Sheffield
Lee, Howl, Ward & Howl .. Tipton
Nettlefolds, Limited .. .. Birmingham
Richards, George, & Co .. .. 12, City Road, Manchester
Selig, Sonnenthal & Co .. .. 85, Queen Victoria Street, E.C.
Shirlaw, A., & Co. .. .. Suffolk Works, Birmingham
Smith & Coventry .. .. .. Orisell Lane, Salford, Manchester
Waddowson, J. H. .. .. .. Orisell Lane, Manchester

Torpedo Boats.

Hanna, Donald & Wilson .. Paisley
Thornycroft, J. I., & Co. .. Chiswick, W.
Yarrow & Co. .. .. .. Isle of Dogs, E.

Tramways and Tramway Plant.

Askham Bros. & Wilson, Ltd. . Sheffield
Carrington, W. T. H. (Wire) 9 & 11, Fenchurch Street, E.C.
Dick, Kerr & Co. .. .. .. 101, Leadenhall Street, E.C.
Hadfield's Steel Foundry Co. .. Attercliffe, Sheffield
Hartley & Arnoux Brothers .. Stoke-on-Trent
Kerr, Stuart & Co. .. .. 20, Bucklersbury, E.C.
Saville Street Foundry and Engineering Co., Limited .. .. Sheffield

Tube Cleaners.

Bonz, W. .. .. 29, West India Dock Road

Tubes (Brass).

Birmingham Battery & Metal Co. Birmingham
Munts's Metal Co., Limited .. Tranch Walls, nr. Birmingham

Tubes (Iron and Steel).

Aird, Jas. .. .. Tipton, Staffordshire
Birmingham Battery & Metal Co. Birmingham
Caledonian Tube Co. .. .. Coatbridge, near Glasgow
Creinonia Cold-Drawn Seamless Steel Tube Co., The .. .. Lozells Street, Birmingham
Donald, J., & Son .. .. .. 42, Cadogan Street, Glasgow
Eadie, J., & Sons .. .. .. Clydesdale Tube Works, Ruthergien, near Glasgow
Farmer, Jas., & Sons .. .. Salford
Galloway, W. & J., & Sons .. Manchester
Hildick & Hildick .. .. Tube Works, Walsall
Howell & Co. .. .. .. Brook Steel Works, Sheffield
Lewis, E., & Sons .. .. .. Wolverhampton
Lloyd & Lloyd .. .. .. Birmingham
Marshall, J., & Sons .. .. Glasgow
Russell, Jas., & Sons .. .. Crown Tube Works, Wednesbury
Skidmore, H. P. .. .. .. Wednesbury
Spencer, John .. .. .. Wednesbury
Spencer, J. E. & S. .. .. 3, Queen Street Place, Cannon Street, E.C.
Stewart, A. & J. .. .. .. Clyde Tube Works, Coatbridge
Sun Tube Co. .. .. .. Coatbridge, N.B.
Weldless Steel Tube Co. .. .. Ickniield Port Rd., Birmingham

Tube Expanders.

Dron & Lawson .. .. .. Cranstonhill Tool Works, Glasgow
Dudgeon, Richd. .. .. .. 114, Fenchurch Street, E.C.
Gibb, James, & Co. .. .. 23, St. Mary Axe, E.C.
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria St., E.C.
Thomson, Wm. .. .. .. Kinning Park, Glasgow

Tube Making Machinery.

Farmer, Jas., & Sons .. .. Salford, Manchester

Tube Wells.

Isler, C., & Co. .. .. .. 88, Southwark Street, S.E.
Le Grand & Sutcliff .. .. 100, Bunhill Row, E.C.

Turbines.

Donkin, B., & Co. .. .. .. Bermondsey, S.E.
Hanna, Donald & Wilson .. Paisley, N.B.
Hett, C. L. .. .. .. Ancholme Foundry, Brigg
King, H. J. H. .. .. .. Stroud, Gloucestershire
McKenzie, Thos., & Sons, Ltd. 16, Holborn Viaduct, E.C.
Stothert & Pitt, Limited .. .. Bath

Turnstiles.

Isler, C., & Co. .. .. .. 88, Southwark Street, S.E.
Le Grand & Sutcliff .. .. 100, Bunhill Row, E.C.

Tuyeres.

Newlove, R. R., & Co. (Water) .. Nottingham

Tyres (Railway).

Bessemer, H., & Co., Limited .. Sheffield
Brown, Bailey, Dixon, & Co. .. Sheffield
Landore Siemens-Steel Co., Ltd. Landore, South Wales
Leeds Forge Co. .. .. .. Leeds

Valuers, Engineering.

Kirk, W., Price & Goulty .. 52, Queen Victoria Street, E.C.

Valves (Gas, Water, &c.).

Alley & Macllellen .. .. .. Glasgow
Dennis, T. H. P., & Co. .. .. Chelmsford
Dewrance, J., & Co. .. .. 159, Great Dover Street, S.E.
Donkin, B., & Co. .. .. .. Bermondsey, S.E.
Duncan Brothers .. .. .. 32, Queen Victoria Street, E.C.
Hanna, Donald & Wilson .. Paisley, N.B.
Hanson, Wm. .. .. .. Quebec Works, Bradford
Hartley & Sugden, Limited .. Halifax
Hunter & English .. .. .. Bow, London, E.
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Rhodes, B. .. .. 240, Bow Road, E.
Walker, Bros. .. .. .. Pagefield Ironworks, Wigan
Wood, H., & Co. .. .. .. Salford Manchester

Valves, Safety.

Adams, Thos. (Executors of) .. West Gorton, Manchester
Turnbull, Alex., & Co. .. .. Glasgow

Ventilators.

Boyle, R., & Son .. .. .. 64, Holborn Viaduct, E.C.

Vices.

Macbrair, W. M. .. .. Sheaf Island Works, Sheffield

Vulcanite.

Winter, F. .. .. 138, London Wall, E.C.

Wagon (Railway) Builders.

Ashbury Railway Carriage & Iron Co., Limited .. .. .. Openshaw, Manchester
Bagnall, W. C. .. .. .. Stafford
Falcon Engine & Car Works, Ltd. Loughborough
Metropolitan Railway Carriage & Wagon Co., Limited .. .. Saltley Works, Birmingham
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury

Wagons (Tip).

Decauville, Aîné .. .. .. 8 Petit-Bourg (Seine et Oise), France
Dick, Kerr & Co, ... 101, Leadenhall Street, E.C.
Hartley & Arnoux Brothers .. Stoke-on-Trent
Hudson, R. .. .. Gildersome Foundry, near Leeds

Water Closets.

Winn, Charles, & Co. .. .. Granville Street, Birmingham

Water Meters.

Manchester Water Meter Co., Ltd. Tipping Street, Ardwick, Manchester

Water Purifying Apparatus.

Porter, John Henderson .. .. 1 & 2, Tudor Street, E.C.

Water Wheels.

Aitken, McNeil & Co. .. .. Helen Street, Govan, Glasgow
Bodley Brothers & Co. .. .. Exeter
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Hett, C. L. .. .. Brigg
King, H. J. H. .. .. .. Stroud, Gloucestershire
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow
Stothert & Pitt, Limited .. .. Bath

Weighing Machines.

East Ferry Road Engineering Works Co., Limited .. .. Millwall, E.
Hodgson & Stead .. .. .. Regent Road, Manchester
Inmon, Chas., Son & Co. .. Darlington
Pooley, Henry, & Son .. .. Albion Foundry, Liverpool
Salter, G., & Co. .. .. .. West Bromwich
Scott, Jas., & Son .. .. .. 10, Tibb Lane, Cross Street, Manchester

Well Engineers.

Isler, C., & Co. .. .. .. 88, Southwark St., London, S.E.
Le Grand & Sutcliff .. .. 100, Bunhill Row, E.C.

Wheels (Geared).

Bodley Brothers & Co. .. .. Exeter
Buckley & Taylor .. .. .. Castle Ironworks, Oldham
Fawcett, Thomas C. .. .. Manor Road, Leeds
Forsyth, Miller & Co. .. .. Mile End, Glasgow
Goodfellow & Matthews .. .. Hyde, near Manchester
Haddield's Steel Foundry Co. .. Attercliffe, Sheffield
Harper & Co. .. .. .. Albion Ironworks, Aberdeen
Hawthorn, R. & W. .. .. Newcastle-on-Tyne
Hind, H., & Son .. .. .. Nottingham
Jackson, P. R., & Co. .. .. Salford Rolling Mills, Manchester
Manlove, Alliott, Fryer, & Co. .. Nottingham
McCulloch, T., & Sons .. .. Kilmarnock
Musgrave, J., & Sons, Limited .. Bolton
Ormerod, Grierson & Co. .. Rulme, Manchester
Reichwald, A. .. .. .. Newcastle-on-Tyne
Rowlandson, W. .. .. .. 132, Boundary St., Liverpool
Smith, Parfrey & Hitchings .. Buckingham Palace Rd., S.W.
Staffordshire Wheel & Axle Co. Springhill, Birmingham
Tinsley, Eliza .. .. .. Great bridge, Staffordshire

Wheels (Railway).

Ashbury Railway Carriage and Iron Co., Limited .. .. Openshaw, Manchester
Metropolitan Railway Carriage and Wagon Co. .. .. .. Saltley, Birmingham
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury
Staffordshire Wheel & Axle Co., Limited .. .. Springhill, Birmingham

Wheels (Road) and Axles.

Smith, Parfrey & Hitchings .. Buckingham Palace Rd., S.W

Whistles (Signal).

Cran, J., & Co. .. .. .. Leith

Winches, Steam.—*(See Cranes).*

Wire and Wire Rope Makers.

Birmingham Battery & Metal Co. Birmingham
Bullivant & Co. .. .. .. 72, Mark Lane, London, E.C
Cradock, Geo., & Co. .. .. Wakefield
Glover, W. T., & Co. .. .. 25, Booth Street, Manchester
Warrington Wire Rope Co. .. 13, Goree Piazzas, Liverpool

Wire Making Machinery.

Crossley, Geo. .. .. .. Cleckheaton, Yorkshire
Farmer, Jas., & Sons .. .. Salford, Manchester

Wire Working Machinery.

Farmer, Jas., & Sons .. .. Salford, Manchester

Wire Tramways.

Carrington, W. T. H. .. .. 9 & 11, Fenchurch Avenue, E.C

Wood Working Machine Makers.

Carrick & Ritchie .. .. .. Waverley Engineering Works, Edinburgh
Hindley, E. S. .. .. .. Burton, Dorset
Marshall, Sons, & Co., Limited .. Gainsborough
M'Dowall, John, & Sons .. .. Johnstone, near Glasgow
Ransome, A., & Co. .. .. Stanley Works, Chelsea
Richards, G., & Co. .. .. Atlantic Works, Broadheath near Manchester
Robinson, Thos., & Son, Limited Rochdale
Sands, H. .. .. Pelham Street, Nottingham
Watson, J., & Son. .. .. Kilmarnock, N.B.
Western & Co. .. .. .. Cloughbaden Works, Derby
Worssam, Samuel, & Co. .. King's Road, Chelsea, S.W.

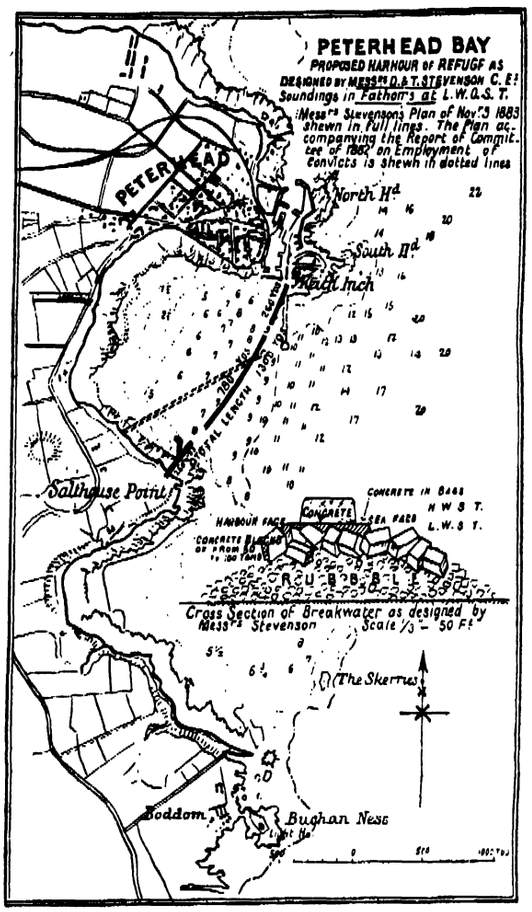
THE PROPOSED HARBOUR OF REFUGE AT PETERHEAD.

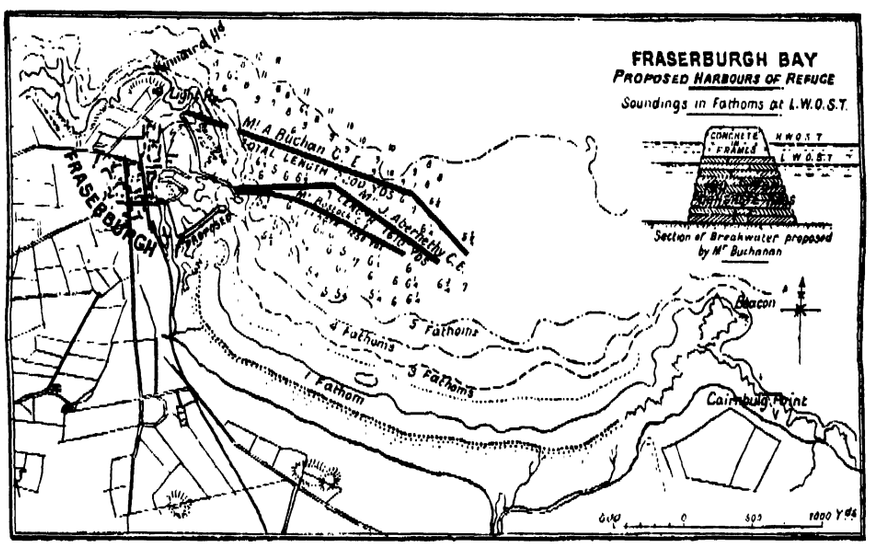
The sub-committee appointed to investigate the question of "the most suitable place for a harbour of refuge on the east coast of Scotland to be constructed by convicts" have recently issued their report, and it has been printed, along with the evidence, in the form of a Blue-book. As we mentioned on a former occasion, this sub-committee consisted of Captain Sir Federic Evans, R.N., Lieut.-Col. P. Smith, R.E., and Captain Sir George Nares, R.N.

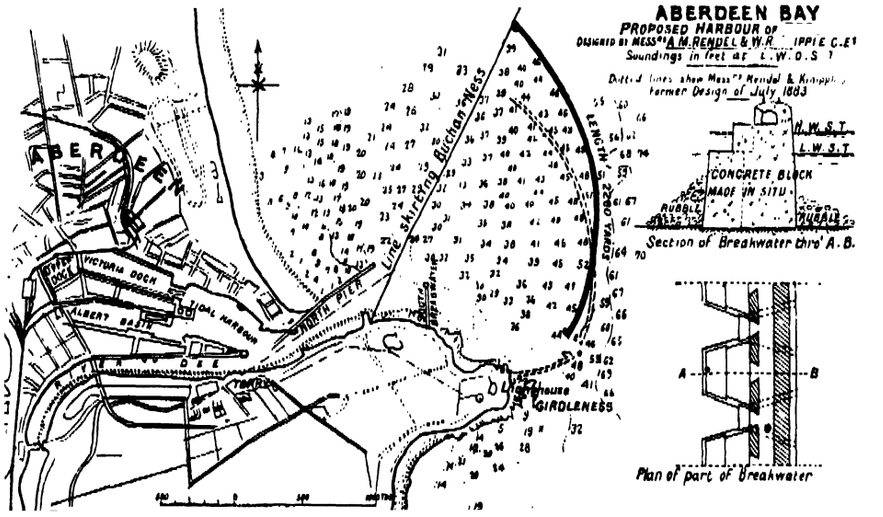
The Committee on the Employment of Convict Labour, which sat in 1882, reported in favour of the employment of convicts in the construction of harbours of refuge, and Peterhead was the only place in Scotland referred to as a suitable site. Other places on the east coast north of the Firth of Forth claimed to be heard, and, as we pointed out at the time (ENGINEERING, March 9, 1883), Peterhead might be the most suitable site, but it had not then been proved to be so, because no examination had been made into the merits of other places. These representations were followed by the appointment of this sub-committee, and it also has reported in favour of Peterhead,

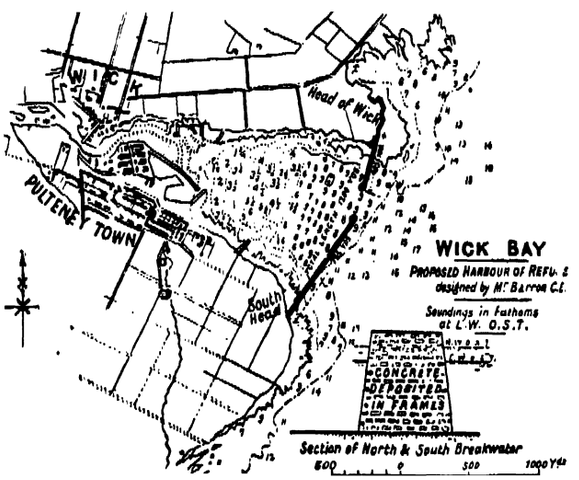
When writing on this subject in the article already referred to (March 9, 1883) we stated that in our opinion appearances were against Peterhead, that it could not be called a good site *per se*, but that of course it was quite possible there might not be a better. Now that we have read the evidence taken by the sub-committee and considered the grounds on which the report is based, we must go a step further and say that the only point which is satisfactorily established, as yet, is that Peterhead is certainly not the place at which a large expenditure, such as is now proposed, should be made. That the sub-committee have arrived at an opposite conclusion is perhaps not surprising, considering the erroneous opinions they seem to hold and the sort of argument which they use in supporting their recommendations. Judging from the general tone of the questions asked, from the remarks made by the chairman at Stonehaven, and from the way in which the Cairnbulg case was snuffed out (the Rev. Mr. Macgregor has our sympathy as the treatment he received was hardly as courteous as it might have been), the sub-committee seems to have entirely misapprehended its instruction. It was distinctly appointed to report on the "most suitable site, &c.," and not merely, as the chairman at any rate seems to have thought, to report which of certain submitted schemes might be the best. Sir F. Evans does not even seem to have thought it necessary to consider whether any of the suggested sites were suitable apart from the plans proposed; and indeed the whole tenor of the proceedings almost leads one to think that the sub-committee had already made up its mind before commencing the inquiry. The evidence tendered seems to have been accepted without question, and the Court does not seem to have exercised much of the judicial faculty of discrimination. As an example of the sort of evidence accepted, we may mention that the chairman asked one witness if it were not true that as many as 500 or 600 vessels have been seen in St. Margaret's Hope, and the witness answered "Yes." We wonder what the witness would have replied if the words "for refuge" and "when" had been added to the question. We venture to state that 500 vessels, or even 400, have not been seen in St. Margaret's Hope for refuge at one time during the last ten years, and further that no one living is likely to see even 300 again. We had occasion (ENGINEERING, August 17, 1883) to draw attention to a similar loose statement with regard to Bridlington Bay accepted by the Convict Labour Committee.

Even, however, if the sub-committee had examined every possible place on the coast it must have come to an erroneous conclusion, simply it seems to have laid down a false axiom to start with. The report states that a distinction must be drawn between "national" and "local" harbours of refuge, and then proceeds to argue that while it is quite right that "local" refuge harbours should be in the light of a bay, the exact reverse is the case with "national" harbours, which should be on salient points so as to be useful to "passing trade," and as ports of observation in time of war. This absurd distinction reminds us very forcibly of the equally nonsensical terms used by the Royal Commission of 1858-59, which divided harbours into "refuge" and "life" harbours (see ENGINEERING, February 9, 1883). So far as we could judge from the evidence, the Royal Commission wished to plump for Filey, but finding the evidence against this course, it introduced this curious distinction to enable it to make out a plausible case for its pet locality. Similarly now, as it appears









the wreck statistics are against Peterhead, this "national" and "local" absurdity is introduced to cover the deficiencies of the Peterhead case. Even for military purposes it would be an error to build a large harbour in such a situation, but at present it is only the civil and commercial aspect of the question which is under review, so it suffices to say that if the proposed harbour is to be purely for military purposes, let it be distinctly understood that it is on this ground, and this ground only, that Peterhead is selected.

The sub-committee maintain that a harbour on a salient point would be more useful to "passing trade"—what is this passing trade? Sir F. Evans and his colleagues seem to consider that a vessel bound on a long voyage is more precious than one which has only a few miles further to go; the safety of a vessel bound to the west coast is of more importance than that of one bound to Dundee, although the average tonnage of the latter class of ship may be greater, and although the latter voyage is more destructive to life. And be it remarked that a harbour so situated that it would save nearly all vessels wrecked between Peterhead and Dundee, would also save a large number of those wrecked north of Girdleness, but it is certain that few, if any, of the wrecks south of that point would be saved by a harbour at Peterhead. If "passing trade" means anything it must have some reference to the number of vessels which pass any particular point within a reasonable distance, and we have no hesitation in saying that more ships pass, say, the Bell Rock than pass Peterhead. It is, of course, difficult to quote figures in support of either place, and the sub-committee contents itself with general abstracts of tonnage passing to various districts. Taking these figures as they stand, however, it appears only a small proportion of the tonnage which would be more benefitted by a harbour of refuge on the point than by one more to leeward. No doubt it would take some vessels considerably out of their course to run down to a harbour somewhere between Girdleness and the Tay, but this ought to be a minor consideration; conversely, how many vessels off the stretch of coast named could weather Girdleness in any storm from N.E. to S.E.? If this proposed harbour of refuge is to be merely a convenience to vessels, not a refuge in dire necessity—if it is to be merely a port of call for the Orkney and Shetland steamers and Her Majesty's gunboats, certainly Peterhead is the place to have it, as the Orkney steamer could not afford the time to run far to leeward and the gunboats would like a convenient port half way between Granton and Kirkwall, so that they may not have to remain a night at sea in rough weather. But if we are to have a harbour for saving lives and vessels from destruction, surely it ought to be where it will save the greatest number, and the only way to determine that question is by a reference to the wreck charts and returns.

In deciding on the general locality of any harbour of refuge, the wreck statistics ought to be the ruling consideration, making due allowance of course for the direction of the prevailing winds. Whether or not vessels are "passing" or merely "local" traders, does not, so far as we can see, affect the question; vessels presumably do not get into the neighbourhood of a lee shore in a gale if they can help it, and a harbour near where most wrecks occur is the harbour that would save most lives and property. If there are other reasons against the most central point it is better to have a harbour to leeward than one to windward. In the case now before us, these considerations clearly indicate that the first harbour of refuge on the east coast of Scotland ought to be south of the Girdleness. And it is hardly correct to speak of this stretch of coast as the bight of a bay, because, as a glance at the map will show, the bay is so large and this side of it is so straight that in many winds vessels which might miss the harbour would still have a chance of making the Forth or Tay.

It must not be supposed that in opposing, as we do, the scheme now proposed for Peterhead we are actuated by any desire to prevent Scotland having her share of the benefits arising out of the recommendations of the Convict Labour Committee, nor have we a predilection in favour of any other site, but a careful study of the whole subject has forced us to form a strong and definite opinion on this matter. We believe that the formation of the large harbour now proposed at Peterhead would prove to be one of the worst things possible for the east coast of Scotland, more particularly if it be made after the design submitted to the sub-committee. In the first place it is not, as already pointed out, the right place to save lives and vessels from destruction; in the second place it is a bad site (*i.e.*, an expensive one) from an engineering point of view; and in the third place so much money will be swallowed up that other places will for years stand a poor chance of getting assistance from the public funds, either in the form of grant or loan. Even if the works at Peterhead promise to be successful, all other and minor attempts at improvement will be met with the reply that the Government are building a large harbour at Peterhead at a cost of more than half a million, and Scotland has got enough money for the present; and if the works fail, as they will fail, if carried out as proposed, it will be so much the worse. The attempt to carry out a somewhat similar scheme in Wick Bay has done more to check harbour extension than any other circumstance of the last twenty years, and we do not for a moment believe that this was such an exceptional case that it is impossible for the disaster to be reproduced.

After all there can be little doubt that the view held by Mr. Abernethy is the only sound one; these large "national" harbours are a gross mistake as a rule, and the country has fooled away enough money over them to have made half a dozen harbours of refuge of the class that is really wanted. The cost of the works now proposed at Peterhead is estimated at about half a million; estimates are always exceeded, and as this seems to be a very sanguine one, let us say the works will cost 700,000*l.* before they are finished. Instead of spending that 700,000*l.* at one harbour, let it be distributed over three or four on the east coast of Scotland, and far more refuge accommodation would be provided than is proposed at Peterhead; and, of course, not being concentrated at one point, the refuge would be of immensely greater value for saving lives and vessels. The class of ship which requires refuge now-a-days on the east coast is very small and does not need deep water. Even supposing that the harbour now proposed at Peterhead could have saved every vessel which has been wrecked during the last twelve years between Fifeness and Dunnet Head (as a matter of fact, it could have saved a very small proportion of them), what does it all amount to? According to the return published with the report, 49 vessels of more than 300 tons, and 18 of these vessels over 500 tons. To provide against an average of four wrecks per annum of over 300 tons we are asked to construct a harbour having a depth of 48 ft. at low water along nearly the whole length of its piers. Why the thing is preposterous; a harbour having a limited area of 5 or 5½ fathoms of water at its deepest part would shelter every one of the forty-nine, and cost less than half the money, and it is not necessary to provide shelter for a larger class of vessel because the experience of the last twelve years has shown that either such a class of vessel does not exist off the Scotch coast, or that if it is there the ships are well able to stand the weather. That the average of the last twelve years is not likely to be exceeded in the future is quite certain, because sailing vessels—other than fishing craft—are rapidly disappearing. This is a fact which Sir Frederic Evans seems very loth to believe, but it is a fact nevertheless, and Sir Frederic may as well make up his mind to it. The old stage-coach drivers would not believe that new-fangled railways and the steam horse would ever succeed in driving them off the road, but coaches have gone as sailing vessels will go; and in a comparatively few years the yacht clubs will keep green the memory of old nautical days, even as the four-in-hand and coaching clubs prevent us forgetting that it once took a whole day to travel from London to Bath.

The decrease in sailing tonnage entering and clearing at all ports on the east coast between the Humber and Peterhead during the last eight years has been 27 per cent.; during the same period the increase in steam tonnage has been 70 per cent. At some ports, such as Grimsby and Scarborough, there has been no decrease or even a slight increase in the sailing vessels, because at these ports the bulk of the trade is in fishing, and fishing vessels are on the increase. If this class of vessel were deducted from the returns—they do not require 8 fathoms at low water—the decrease in sailing tonnage would be much more marked.

Steam vessels do not appear to require harbours of refuge. Taking the section of coast before mentioned—from Fifeness to Dunnet Head—there seem, according to the return quoted, to have been only six steamers of over 100 tons wrecked in the last twelve years; and of these six, one was wrecked through carelessness and one was a simple case of stranding inside a harbour. Are we to spend at least half (probably three-quarters) of a million and provide eight fathoms at low water to save four steamships in twelve years, the largest of which would not draw more than about 20 ft. or 22 ft. of water? We have not referred to the smaller class of vessel, because there is no doubt that for vessels up to 300 tons a harbour of refuge is much required at Peterhead, as indeed at several other points of the Scotch coast; what we protest against is the useless expenditure involved in inclosing eight fathoms at low water.

Referring to some of our former remarks on this branch of the question, the engineer to the Peterhead scheme, Mr. Stevenson, attempts to justify the extension of the piers into deep water on the ground that if silting takes place they can afford to lose some depth. The argument is hardly worthy of any engineer and requires no comment. Besides, Mr. Stevenson does not expect there would be any deposit at Peterhead, and in this we agree with him.

Turning now to the more strictly engineering aspect of the Peterhead scheme, we notice that Mr. Stevenson, who appears to have been the designer of the plan published in Engineering of August 17, 1883, has amended his views, taking the piers further seaward and increasing the estimate. We now give a copy of the new plan, together with the section of the pier proposed, and it will be seen that it consists of a rubble base covered with large concrete blocks, *pierre perdu*, up to a little above low water, where a level base is made of concrete in bags and the superstructure carried up in monolith. That this section will stand the sea at Peterhead we do not believe, and if Mr. Stevenson is entrusted with the work and carries it out according to the plan and section submitted, he will certainly add to his already large stock of experience. Engineers are supposed to learn more from their failures than from their successes, and as Sir F. Evans remarked, Mr. Stevenson has a large experience. The sub-committee pressed Mr. Stevenson rather closely on the subject of his proposed rubble foundation, and particular reference was made to Wick. Mr. Stevenson does not believe that the rubble base was disturbed at Wick to a greater depth than 18 ft., and at another place he says Wick is so exceptional a case that he does not know what to say about the sea there. We understand the superstructure at Wick was pretty well all washed away, and consequently the sea passed clean over the rubble base; had the superstructure not been washed away so soon there is little doubt that the rubble base would have been disturbed to a much greater depth that 18 ft. The experience of Sir James Douglass certainly corroborates this view, and we should prefer him as a guide. Even the sub-committee seem to have had some doubts on the point and suggest what reads like a modification of the section. The rational course would have been of course to have done away with the rubble base altogether, but "it" (*i.e.* a monolithic system) "is not one that can be so well carried out by contract labour as a breakwater consisting of rubble and concrete blocks thrown pell-mell into the sea." A sentence of this kind seems to suggest the question, Are we making harbours for the sake of employing the convicts, or are we using convict labour to reduce the cost of properly designed works? If an attempt be made to carry out the section proposed it is in the highest degree probable that at some future date the Stevenson of the day, when asked to explain why the south bay is strewn with large stones and blocks of concrete, may tell us that "Peterhead is so entirely exceptional a place that I do not know what to say about it at all."

On the subject of concrete blocks, *pierre perdue*, reference is made to Anstruther, a harbour in the Firth of Forth practically dry at low water. Mention is also made of a rubble base at Portrush, which we are told has stood for fifty-seven years, but where of course the sea is very different to that at Peterhead; is Mr. Stevenson not aware that a considerable breach was made in Portrush pier only last year? As was pointedly remarked by Sir Frederic Evans, all the engineers who have submitted designs for Wick, Fraserburgh, and Arbroath (also Aberdeen) have discarded the rubble base, and it is a little singular that at Peterhead the old style of construction should be adhered to. The situation is as

TABLE SHOWING COST AND CAPACITY OF DIFFERENT SCHEMES FOR HARBOURS OF REGUGE PROPOSED SINCE 1880, COMPARED WITH THOSE OF THE EXISTING NATIONAL HARBOURS AT PORTLAND AND HOLYHEAD.

	Completed Harbours.		Proposed Harbours.											
	Portland.	Holyhead.	Dover.		Filey.	Tees Bay.	Warkworth.	Arbroath.	Aberdeen.	Peterhead	Fraserburgh.			Wick.
Names of designers	—	—	No. 1, The Committees of 1834 and 1883.	No. 2. Mr. Druce.	Sir J. Coode.	Mr. Rendel	Messrs. Meik.	Mr. Cay.	Messrs. Rendel and Kinipple.	Messrs. Stevenson	No. 1. Mr. Buchan.	No. 2. Mr. Abernethy.	No. 3. Mr. Bostock	Mr. Barrow.
Sheltered area { Below low-water mark, acres	1800	667	520	420	1,750	..	1200	1220	410	250	340	320	220	170
" three fathoms line "	1590	575	330	200	1,085	..	700	650	390	148	310	208	156	120
" five " "	1290	330	285	150	565	1,104	360	520	330	108	200	138	74	75
Total length of piers below L.W.M., feet	8000	7400	9000	6500	13,000	20,000	16,000	18,000	6600	3300	6400	4830	3750	3000
Depth in which piers are situated below low water { Maximum, feet	54	54	43	40	62	55	48	54	56	54	54	42	42	60
" Average "	45	37	34	30	40	29	22	34	49	42	38	37	34	44
Total cost* { Convict labour	1,033,000*l.*	..	1,040,000*l.*	790,000*l.*	1,250,000*l.*	1,400,000*l.*	1,250,000*l.*	..	..	..	..	..	..	..
" { Free labour	..	1,285,000*l.*	1,210,000*l.*	920,000*l.*	1,500,000*l.*	1,680,000*l.*	1,500,000*l.*	..	1,212,463*l.*	1,100,000*l.*	526,579*l.*	1,000,000*l.*	700,000*l.*	500,000*l.*	400,000*l.*
Cost per foot run of piers below low water { Convict labour	129*l.*	..	115*l.*	121*l.*	96*l.*	70*l.*	{ 84*l.* closed work / 80*l.* open "	..	..	..	..	..	..	..	..
" { Free labour	..	173*l.*	134*l.*	141*l.*	115*l.*	84*l.*	{ 100*l.* closed " / 80*l.* open "	67*l.*	107*l.*	159*l.*	156*l.*	145*l.*	133*l.*	133*l.*

* In the case o completed piers the actual cost is given, in other cases the figures given are the estimates of the designers.

exposed as that of Aberdeen, and certainly more so than any of the others except perhaps Wick. That the other engineers are right there can be no question, and if an attempt is ever made to build piers at right angles to the sea at Peterhead, as the design shows them, it would, we think, be the height of folly to adopt any but a monolithic system.

Since this article has been in type the Select Committee on Harbour Accommodation has issued its report, in which it abundantly confirms our expression of opinion regarding the danger of rubble foundation in such a position as Peterhead. It says, "Your Committee have examined many eminent engineers and have been much impressed by the practical unanimity of opinion expressed by them that the best system of construction for piers and breakwaters is to be found in building them up in solid monolithic walls of concrete. Different engineers have different methods of effecting this object, but whether, as at Newhaven, the system is adopted of sinking the concrete in bags, or whether, as recommended by Mr. Rendel, by means of caissons, or whether building it up without such assistance round a staging, as adopted by Mr. Strype at Wicklow, or whether by the system adopted by Mr. Dyce Kay at Aberdeen, they are unanimous in declaring that the new system is far preferable to the older system of rubble or *pierre perdu* foundation."

No one would welcome more than ourselves the construction of a first-class refuge harbour for fishing craft at Peterhead, and the sooner such a harbour is commenced the better, but the present scheme cannot be too strongly deprecated. It is not necessary—if successful as an engineering work the absorption of so much money would impede the promotion of more useful works at other places, and it would not be so useful to Peterhead as a more moderate undertaking, which could be more rapidly carried out, and if, as we fear, it results in disaster it would be disastrous not only to Peterhead but the whole country.

Along with the plan and section of the Peterhead scheme we publish on page 169 the designs of the two other principal proposals, Wick, Fraserburgh, Aberdeen. The plan of the fourth harbour, Arbroath, will be found on page 513 of our thirty-fifth volume. We also reprint above the comparative Table given in ENGINEERING of May 30, 1884, amended so as to include the five Scotch harbours.

QUEEN CHARLOTTE'S ISLANDS.

(*Concluded from page* 151.)

NOTHING could be better or more substantial than the works of the Mining Company, who spent a great deal of money in their attempts to bring this coal into the market. Their houses, sheds, tramways, wharf, and mechanical appliances were all of excellent construction, and well laid out, and it is much to be regretted that their operations have not been attended with more success. The position of the coal is placed by Mr. Richardson, of the Geological Survey, who visited and reported upon the deposit, in the Jurassic or lower cretaceous rocks, and the same measures are traceable on the mainland of British Columbia, but as far as at present known, without the associated anthracite of the Queen Charlotte Islands. Coal is not the only mineral that has been found on these islands. The existence of gold was known as early as 1852, before the later discoveries on the mainland had proved British Columbia to rival California in the richness, and perhaps in the extent, of her auriferous deposits. From the report of the Indians, the Hudson's Bay Company were induced to despatch their steamer the Una, with a party of miners drafted from the coal workings of Vancouver's Island, and provided with every requisite for a thorough examination. A valuable quartz vein, rich in visible gold and 7 in. in width, was pointed out in Mitchell's Harbour, which they traced for over 80 ft., and broke off some very fine specimens. But the natives struggled with the miners for the lumps as soon as they were quarried, and though the scrimmage was without arms, and partly in good humour, yet the Scotch miners were no match for the naked oily Haidars. The Una put to sea with her party, and such of the samples as they could secure, but was wrecked and burnt on her way back to Victoria, and, excepting some good specimens from 14 oz. to 16 oz. in weight, but little remained of the expedition, nor have the Hudson's Bay Company cared to repeat it. Copper has been also found in Moresby Island, and at one time some money was expended in prospecting for it, but the works were abandoned; as was also another exploration of the gold in Mitchell's Harbour. Specimens of antimony and arsenic have been exhibited by the Indians as found on the Western Islands, and Captain Steward, of the Hudson's Bay Company, reports copper ore as existing in large quantity on a small island off Fort Frederick. It is not, however, likely that any minerals will be worked satisfactorily until some more permanent settlement of the islands; and it would seem that a wholesale clearance of the singularly heavy forest must precede any systematic attempt to work the deposits, which undoubtedly exist in large quantities on this important group of islands. The timber growth here attains a magnificence probably unequalled in any part of the world. From the meagre accounts of the few white men who have penetrated the country inland, all concur in expressing their astonishment at the size and value of this glorious forest. Special trees have been measured which, at 7 ft. above the ground, were 36½ ft. in circumference, and which ran up straight without a branch for over 100 ft. Cedar trees were observed of the same majestic proportions; and, as an illustration of the richness of the soil, the seed of some Timothy grass, accidentally dropped, sprung up to the height of nearly 6½ ft. The general surface of the ground, though in some places mountainous, is not rocky; a heavy rich soil covers the hills, and the greater part of Graham's Island is known to be good level land. The rainfall appears to be greater than in Vancouver's Island, and in this respect to compare more with the United Kingdom. West of the Seymour mountains there is perhaps, as in Devonshire, a little too much rain for comfort, but not for agriculture, and the winter and summer are both wonderfully tempered against the extremes of either.

The Haidars, or Hyders, the native Indians of Queen Charlotte's Islands, appear to be a far superior class to the North American Indian tribes further east, and to hold an intermediate place between the Japanese, whom they closely resemble, and the warlike Sioux, or Camanches, of the western plains They are of the same family as the Aleuts of the Aleutian Islands and Southern Alaska, and the Chinooks and Skeena Indians of British Columbia, to whom they assimilate in language, religion, physiognomy, and general intelligence. There is a strong Mongolian cast of countenance, and when the head is not interfered with in infancy, the flat central ridge, peculiar to the Mongolians, is found on the skull. Their houses are large, well built, and, except for the filth and smell, would be comfortable, and in front of those of the principal men they sometimes erect a very ornamental pole or mast, beautifully carved nearly to the top, evidently the product of considerable skill, time, and patience. Some of these carved masts are really works of art, and must have occupied years in their ornamentation; but there is a sad want of artistic effect in the grouping of their subjects, and the most beautiful embellishments are associated with the meanest surroundings. On the mainland, where such an article is procurable, an old beaver hat will sometimes surmount a handsome mast, 3 ft. in diameter at its base, 50 ft. in height, and covered with carvings that would be no discredit to a European artist. These Haidars understand something of road-making and bridge-building, and in more than one locality, suspension bridges wholly of wood, fastened together by withes and branches, are thrown over the most frightful canyons. In the whole range of the Queen Charlotte's and Aleutian Islands, and on the mainland of Alaska and British Columbia, there are not far from 30,000 of these allied but not always friendly tribes; but their numbers are fast decreasing—bad whisky, European vices and diseases, their filthy habits, and their intestine quarrels are slowly and surely doing the work of extermination, and they will shortly die out as other tribes of the red men have before them. Besides wood carving, they understand the working of gold and silver, which they make into rings and bracelets as beautifully as any trained jeweller, and the best canoes in British America, and the most tastefully finished, are made in Queen Charlotte's Islands. It is, in fact, on and about the water that they principally excel; they make long trips of fifty or sixty miles across rough water in their fragile canoes, and in their simple baidars, framed of wood or bone with sealskin stretched over, a number of them will attack a whale, with implements apparently altogether disproportionate to the strength and magnitude of the creature they so fearlessly pursue.

The seas and bays round these islands abound in fish; there are on these coasts and the opposite mainland at least four varieties of salmon, and what is perhaps peculiar, the fish after ascending the rivers to spawn never return; their mission accomplished, their instinct leads them to a suicidal death, and their bodies by thousands are sometimes seen on the Frazer and other rivers where their decomposition taints the air. Cod, skate, bass, flat fish, anchovy, herrings, sardines, hoolakan, and halibut all grow to perfection, and swarm on the shores by myriads. The hoolakan is about the size of a small herring, from which is extracted an oil, very similar to cod-liver oil and equally nutritious. On this the Indians largely feed, and as they are not fastidious about its being fresh or untainted, their food is as odorous as it is nourishing, and their

arrival is to be detected quite as soon by the smel that precedes them, as by the sight. These fish are so rich that the natives burn them like a torch, and they swarm in such miraculous numbers that they literally comb them out of the sea; a long pole, with nails driven through it to form the teeth, being the instrument with which they scoop them up into their canoes. The halibut, which the Indians use as we do bread as the base of their feeding, can be caught in such immense numbers that a vessel of 400 tons can be filled, it is said, between these islands and Vancouver in forty-eight hours. The fisheries of British Columbia, Oregon, and the adjacent islands, although only yet in their infancy, are fast becoming an enormous factor in the business and resources of these countries. If the estimate of the Canadian Inspector of Fish is correct as to the quantities taken out and consumed by the Indians, who are almost exclusively fish eaters, British Columbia has already the largest fish product of any of the provinces. The largest value of the fish export is from the salmon. In 1874 there were barrelled and exported from the Pacific shore 14,500,000 lb. of salmon, worth 400,000*l*. The trade was fairly inaugurated in 1872, when the Columbia River fisheries exported 2,700,000 lb. of canned salmon, and this business increased so rapidly that in 1876 there were eighteen large establishments on the Lower Columbia River, which put up 428,730 cases, each containing four dozen 1 lb. tins. Some of these fisheries captured an average of 15,000 fish each night for twenty-six nights during the season, the fish averaging 16 lb. weight each. In the same year, 1876, there were only three canneries on the Frazer River, there are now eighteen; whilst the exports of the British Columbia fisheries have increased from 37,706 dols. in 1872 to 1,014,210 dols. in 1882, an increase of twenty-seven fold, and this mainly in canned salmon. Yet the great bulk of this Pacific salmon, sent to all the markets of the world, is still taken from a river the important part of which is not on British soil, a river the whole of which was ours by every argument and circumstance that establishes the ownership of a new country. Our people and not the Americans first explored its majestic proportions, and pierced the rugged defiles of the Rocky Mountains to establish trading posts on its waters, to hunt its wild animals, and traffic with its wilder inhabitants. But at the conclusion of the war of 1813, with the usual supineness of official ignorance when pitted against American 'cuteness, the States claimed, and the British Government conceded, the possession of the most valuable State in the union, the immense region of the magnificent Oregon. "A British ship of war sent to protect British interests on the Pacific of the ill-starred name for diplomacy, the Columbia, with a nobleman for commander, fond of salmon fishing, tried his twisted wing of mallard, or summer duck, to tempt the mighty ekowan, monarch of salmon, in the waters of the Columbia,* but the fish would not bite, and in disgust he wrote to his brother, a prominent statesman, that the whole country was worthless."† Yet this is the river that furnishes two-thirds of the above salmon. It was the old story, a pine forest, a useless wilderness, a hopeless blank on the face of nature, a worthless sop to barter for some more valuable consideration, and a country the size and value and climate of France, hastily signed away.

The wild moist climate of Queen Charlotte's Islands and their wonderful fertility are caused by precisely the same circumstances that have preserved the islands of Great Britain from the cold and bleakness of the Labrador coast, that lays in the same parallel of latitude. The Gulf Stream that imparts to England and Ireland the warmth of a southern climate and the moisture of a northern sea, has its counterpart in the Pacific; and as the old forests of Great Britain and Ireland were the products of that warm ocean river that runs through the Atlantic, so are the mighty forests of our western possessions in America, a product of the great "Kuro Siwo," the gulf stream of the Pacific. There is a wonderful similarity between the dear old England, upon which the great warm wave of the Atlantic impinges, and this newer Britain that is just emerging from the chrysalis state, but which the Japan current of the Pacific, with its greater influence, has been for ages preparing for the most marvellous developments. The great centres of population have ever been found where climatic conditions were the most favourable. Rome and London, Pekin and New York, have all risen under the same isothermal line, and the locations of these great capitals was not the result of chance, or altogether a topographical necessity, but largely of man's intuitive perception, in determining the belt of the earth's surface best adapted for his intellectual and physical activities. All substances expand by heat, and consequently bulk for bulk become lighter, and hence arises the two great oceanic movements in the northern hemisphere, the Gulf Stream and the Japan current. In the great cauldron of the torrid zone, the water is heated even as high as 85 deg.; it expands and flows off to the cooler regions of the north, its place being supplied by the colder and heavier water running at a greater depth from the polar sea. This, together with the amount of equatorial precipitation, produces in their respective oceans the two great parallel currents of the northern hemisphere, which, forced by the movement of the earth against the north-eastern flanks of both continents, until they reach the latitude of about 46 deg., are thence deflected by the more elevated plateau of the ocean's bed, and the shape of the land, and running eastward, break upon the shores of Great Britain and north-western Europe in one case, and upon the western coasts of Greater Britain in North America in the other. The movement of the Gulf Stream is well understood. Leaving the Caribbean Sea and the Gulf of Mexico, it moves north-easterly along the coast of the United States, till it impinges on the great fishing banks of the North Atlantic and Newfoundland. This gives it a more eastern course, which, leading it over the great plateau on which the Atlantic cables are laid, crosses the Atlantic to break upon the shores of northern Europe, a magnificent river of warm water to carry heat and life and fertility to what must otherwise have been an Arctic region of snow, storm, and barrenness.

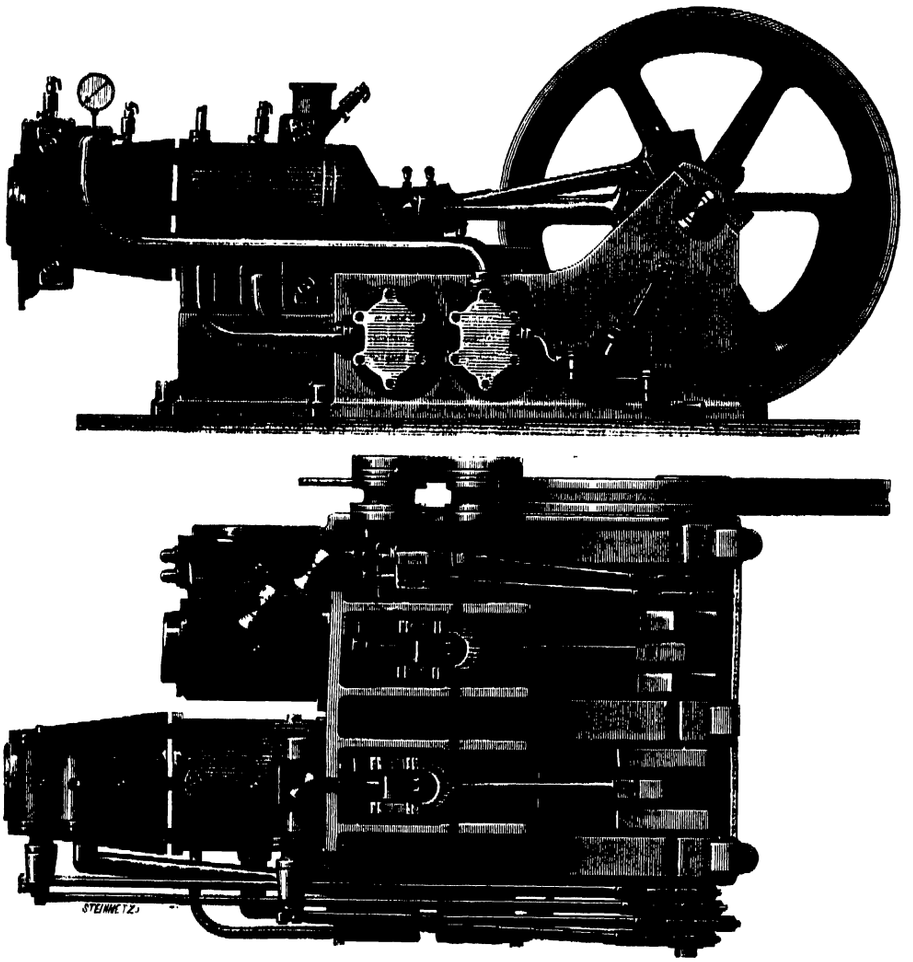
The Pacific has a similar great river, as much grander as the ocean through which it flows. In the seething Indian Ocean, south of Formosa and China, the Japan current has its origin. Moving along the outlying islands on the eastern shore of Asia, as the Gulf Stream hugs the coast of North America, it runs northward skirting the Kurile Isles till the projecting point of Kamtschatka and the Aleutians deflect it more to the east. As this wonderful range of rocks curbs its direction and leads it towards the Columbian coast, a portion escapes between them, and warming the Behrens Sea, passes through the straits into the Arctic Ocean, whence, running still east and fast past , with its surcharged heat, it emerges into the North Atlantic through Baffin's Bay and Davis Straits, as the Polar current which brings the icebergs and chilling influences of the north to the Atlantic waters, ultimately perhaps to rise to the surface and be started on another ocean course to Europe as the Gulf Stream. This motion of the Japan current accounts for the fact that icebergs, so constant in the Atlantic, are never found in the North Pacific. The other and larger portion of the Japan current, deflected again southward by the Alaska peninsula, flows as an offshore current along the western coasts of America, ultimately to sink below the surface, as its heat and energy are exhausted, and be lost in the equatorial waters. The mass of this Japan current is so wide and deep, that it retains a greater part of its caloric during a course of many thousand miles, and it scarcely varies two degrees in temperature between Queen Charlotte's Islands and San Francisco, a distance of over a thousand miles. Nor does the summer elevate, or the winter lower its temperature to any great extent; 50 deg. in winter, 52 deg. in summer, are the average of its thermometric range as steadily, silently, and uniformly it moves in its magnificent orbit, to fulfil, like the faithful servant of the Almighty that it is, its beneficent career. The ameliorating effect of

* Named after his ship.
† Butler's "Wild North Land," p. 319.

LIGHTFOOT'S DRY-AIR REFRIGERATOR.

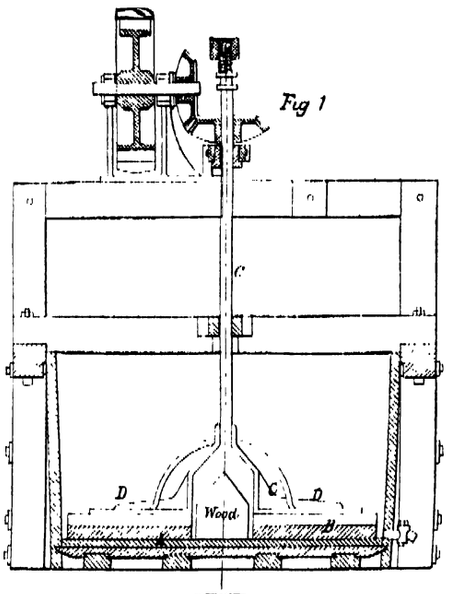
CONSTRUCTED BY MESSRS. SIEBE, GORMAN, AND CO., LONDON.

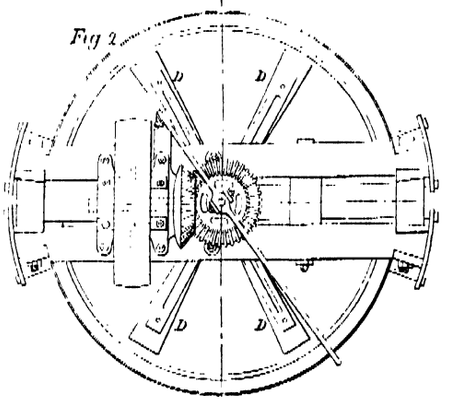
(*For Description, see opposite Page*).

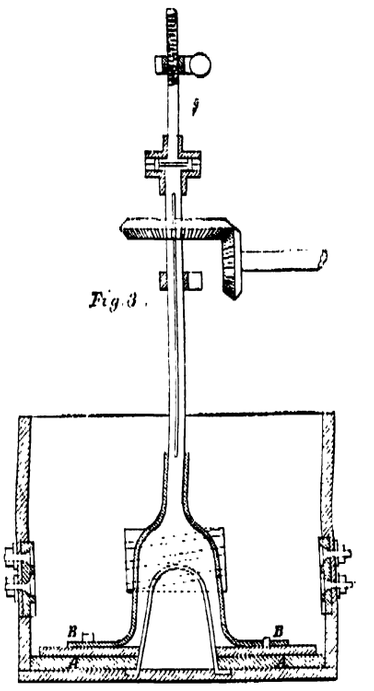


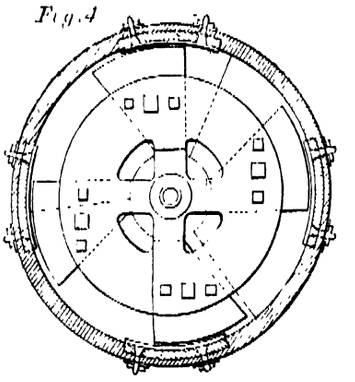
THE FRANCKE "TINA" PROCESS FOR THE AMALGAMATION OF SILVER ORES.

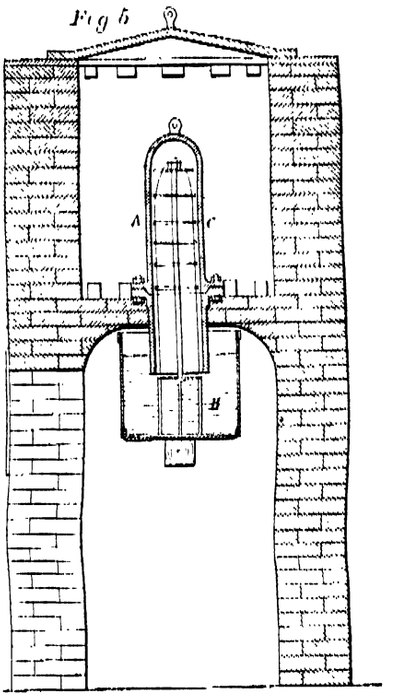
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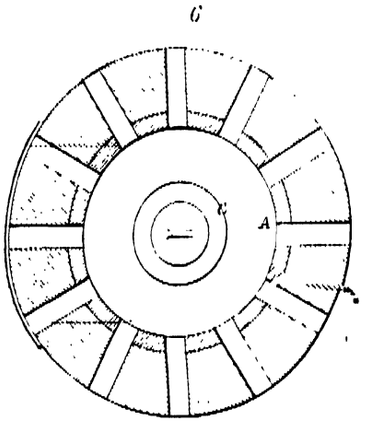












this wonderful current is so marked that the average annual temperature of Sitka, in latitude 57 deg., is higher than Ottawa in latitude 45 deg. The mean temperature of the former is 44.8 deg., whilst the latter is 37.4 deg., and the southern part of Vancouver's Island averages only 3 deg. higher than Sitka, which is 9 deg. further north. Queen Charlotte's Islands, more insular and entirely bathed by this tepid volume, have even a milder and moister climate than Vancouver, and in consequence a greater fertility.

The present climatic condition of our north-western possessions in the Pacific may probably not long, in a geological sense, have been so favourable as at present. The Aleutian Islands, deflecting the mass of the Japan current, with its millions and millions of tons of uniformly warm water sweeping every hour along these coasts, and giving rise to the invigorating dews and rains upon which their fertility depends, were not always in their present position. They are solely of volcanic origin, and twenty-four active volcanoes, rising from 3000 ft. to 8000 ft. above the sea, cast their lurid flames over the Behrens Sea. In 1796, after one of the terrible storms to which the district is liable, a small speck of rock was seen where, during the tempest, smoke had been observed rising from the waves. It developed into an island in the same long line, and intermediate between two others; flames issued from its summit, lava poured down its sides into the hissing abysses of the ocean, and amidst a succession of earthquakes and the violent commotion of the waters, it reared itself into a huge volcano, two to three miles in circumference, and some thousands of feet in height. Eight years after it was still too hot to be walked upon, and it is said to be still increasing. On most of the other islands huge lava piles and immense masses of scoriæ present their precipitous sides to the ocean, and those still in activity are constantly increasing their altitude and circumference. Time probably was when these obstructions in the channel, so useful in their present deflection of the great current, were not in existence, and the Kuro Siwo swept along in full force through Behrens Straits, giving its warmth and vigour to a northern clime. The coal deposits of Melville Island far to the north of the straits, the tusks and bones of huge animals of a warmer country now lying on the northern shores of Alaska, prove that there was a time, probably not so long since, when all this boreal district enjoyed a more congenial climate, and the flora and fauna of a temperate zone flourished, where all is now locked up in the frozen embrace of perpetual winter. May not the volcanic eruption of this long line of the Aleutians, their present activity, and the increasing mass which annually enlarges most of these great breakwaters of nature's own engineering, be planted there for a wise and beneficent purpose, and be gradually increasing the life-giving influence of this great "moving of the waters," invigorating all it touches, ameliorating the climatic condition of the lands around it, defying the Arctic agencies under which all must otherwise languish, and bidding the wilderness blossom as a rose. How long the present favourable conditions have continued we know not, but this much we do know, that away off in the Pacific Ocean, one-third of the earth's circumference from England, and at the eastern extremity of her continuous sovereignty, there is at present in one possession, though scarcely as yet inhabited by her sons, a country that has within itself every desirable element of comfort and of wealth, that is blessed with a climate in every respect superior to England, whose rocks and sands contain gold, silver, iron, copper, coal, and a score of other valuable minerals, whose bays and rivers are teeming with fish of the most valuable descriptions, which is covered with a forest superior to anything else known at present in the world, that it is placed as the outlying sentinel over a coast 400 miles in length, containing the gold mines of the empire, and backed by the greatest and most productive wheat-producing area in existence. Canada on the Pacific has a bright, an enormous future before her. There rests on the present generation, and the Government that moulds its energies, a mighty responsibility, if the important trust placed by Providence in its hands, to utilise, cultivate, and develop her, is suffered to remain any longer under the neglect of the past, and this wonderful country is permitted to continue as at present, an encumberance on the empire, a blank in the civilisation of the world.

THE "UNIVERSAL" DRY AIR REFRIGERATOR.

This machine, of which we give illustrations on the opposite page, is made to the designs of Mr. T. B. Lightfoot, M. Inst. C.E., by Messrs. Siebe, Gorman, and Co., of Westminster Bridge-road, and is now being shown at work at the International Health Exhibition.

The example shown is known as an "E" machine, and is designed to discharge 10,000 cubic feet of air per hour at a temperature of 70 deg. below zero, Fahrenheit. The air is compressed to 50 lb. to the square inch. There is one double-acting engine of the ordinary pattern with a 10 in. cylinder, the stroke being 15 in. The air compressor cylinder single-acting; it is 15 in. in diameter and 15 in. stroke. The expansion cylinder is 11½ in. in diameter, the stroke also being 15 in. The main stea

valve is of the ordinary kind, but the expansion is adjustable by a Meyer valve with hand regulating gear. The suction and delivery valves to the air compressor cylinder and the inlet and exhaust valves to the expansion cylinder, are circular slide valves and are made of phosphor-bronze. They work very quietly, and are no doubt in this respect an immense improvement on the old clack valves at first used. Judging from the running of the machine at the Exhibition this refrigerator makes no more noise in work than any ordinary steam engine must necessarily do.

The cooling apparatus is in the bed of the machine, and consists of a surface cooler composed of solid drawn ½ in. Muntz metal tubes. The refrigerating water is supplied by an ordinary plunger pump placed on the side of the foundation casting. It is driven from an eccentric on the main shaft, and has a 2¼ in. phosphor-bronze ram. The water is taken into the cooler first, and then passes out through the jacket of the compression cylinder. We understand that there is a special arrangement for extracting moisture from the compressed air before it enters the expansion cylinder. The "E" machine is designed, as we have said, to supply about 10,000 cubic feet of air per hour, at a temperature of 70 deg. Fahr. below zero. This will require about 18 indicated horse-power. The machine at the Exhibition usually runs at 160 revolutions per minute, the steam pressure being about 60 lb., and the cut-off at a little before quarter stroke. This machine is designed to keep in the tropics a chamber of 4000 cubic feet at about or just below freezing point; whilst in a temperate climate about double the space could be served. The total weight of the machine would be 5½ tons. The air cylinders are, as will be seen by the illustration, placed tandem-wise, but being single-acting no stuffing-boxes are required between them, a saving in space at an important part being thus obtained.

The machine as a whole appears to be excellently designed. The bearing surfaces are ample, and all the working parts are open and accessible for adjustment. The air valves can be got at by taking out four bolts, an operation that should not occupy much more than a minute.

A recent application of these machines has been made in the s.s. Yon Yangs, which is now engaged in carrying refrigerated meats and cattle from the northern ports of Queensland, to supply the Sydney and Melbourne markets. The installation in this case has been made by Messrs. Hughes, Pye, and Rigby, of South Melbourne, the machine being made by Messrs. Siebe, Gorman, and Co., who are the sole manufacturers under Mr. Lightfoot's patent.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, August 8, 1884.

WITHIN sixty days 21 anthracite and bituminous blast furnaces have gone out of blast, reducing the producing capacity 6000 tons per week, or at the rate of over 300,000 tons per annum. The greatest reduction is in bituminous iron. The blowing out of furnaces is offset considerably by the renovations and improvements constantly being made in other furnaces in order that the cost of production may be decreased. The present weekly capacity of the anthracite furnaces is 26,144 tons; of bituminous furnaces, 43,877 tons; total, 70,021 tons, equal to an annual nominal producing capacity of 3,500,000 tons in round numbers. This throws out of account the charcoal production, which has very little effect at present on market prices. The weekly capacity of anthracite furnaces out of blast is 29,525 tons; of bituminous furnaces, 49,244 tons; total, 78,769 tons per week. That is to say, over half of the producing capacity is idle, and the decline in production is still in progress. At present prices only the very best located furnaces, and those most thoroughly equipped and best managed, are making money. In some localities in Eastern Pennsylvania ore and furnace hands are working at 92 cents per day, and are unable to better themselves. Pig iron quotations average 20 dols. for No. 1, 18.50 dols. for No. 2, 17.50 dols. to 18 dols. for grey forge, 16 dols. for low grade forge, 19 dols. for foreign Bessemer, 18 dols. for American Bessemer at furnace, 23 dols. for 10 to 12 per cent. spiegeleisen, 28 dols. for 20 per cent., 76 dols. to 77 dols. for 80 per cent. ferro-manganese; foreign steel blooms are delivered here at 40 dols., domestic steel slabs are selling at 36 dols., and a good deal of business is in sight at something less. Several thousand tons of old rails, footing up at present writing between 7000 and 8000 for the week, have sold at prices ranging from 18 dols. to 19.50 dols.; good American old rails are selling at 19.50 dols. to 20 dols.; one sale of bull heads was made, ex-ship, at 18.50 dols.; double heads are in request at 20.50 dols.; offers are made at 19.50 dols. and 20 dols., for shipment. The finished iron market shows very little vitality. Millowners are struggling along, in the face of discouragements, seeking orders at 1.80 for refined bars. Small lots sell for one-tenth more. Nails are weak at 2.20 dols., excepting in small lots. Plate iron has been quiet all the week, but for plate and structural iron there is a good outlook, on a basis of 2.10 for plates and angles, shell and T iron, 2.75 nominally; beams and channels, 3.50; and firebox, 4.25 cent. A great deal of uncertainty is felt as to steel rails. Rumours prevail of some sort of a syndicate as likely to be formed, to buy up steel rails, on a basis of 27 dols. to 27.50 dols., for speculation. Small lots are selling at 28 dols. to 29 dols.

THE AMALGAMATION OF SILVER ORES.

*Description of the Francke "Tina" or Vat Process for the Amalgamation of Silver Ores.**

By Mr. EDGAR P. RATHBONE, of London.

IN the year 1882, whilst on a visit to some of the great silver mines in Bolivia, an opportunity was afforded the writer of inspecting a new and successful process for the treatment of silver ores, the invention of Herr Francke, a German gentleman long resident in Bolivia, whose acquaintance the writer had also the pleasure of making. After many years of tedious working devoted to experiments bearing on the metallurgical treatment of rich but refractory silver ores, the inventor has successfully introduced the process of which it is proposed in this paper to give a description, and which has, by its satisfactory working, entirely eclipsed all other plans hitherto tried in Bolivia, Peru, and Chili. The Franke "tina" process is based on the same metallurgical principles as the system described by Alonzo Barba in 1640, and also on those introduced into the States in more recent times under the the name of the Washoe process.†

It was only after a long and careful study of these two processes, and by making close observations and experiments on other plans, which had up to that time been tried with more or less success in Bolivia, Peru, and Chili—such as the Mexican amalgamation process, technically known as the "patio" process, the improved Freiberg barrel amalgamation process, as used at Copiapo, and the "Kronke" process—that Herr Francke eventually succeeded in devising his new process, and by its means treating economically the rich but refractory silver ores, such as those found at the celebrated Huanchaca and Guadalupe mines in Potosi, Bolivia. In this description of the process the writer will endeavour to enter into every possible detail having a practical bearing on the final results; and with this view he commences with the actual separation of the ores at the mines.

Ore Dressing, &c.—This consists simply in the separation of the ore by hand at the mines into different qualities, by women and boys with small hammers, the process being that known as "cobbing" in Cornwall. The object of this separation is twofold: firstly, to separate the rich parts from the poor as they come together in the same lump of ore, otherwise rich pieces might go undetected; and, secondly, to reduce the whole body of ore coming from the mine to such convenient size as permits of its being fed directly into the stamps battery. The reason for this separation not being effected by those mechanical appliances so common in most ore-dressing establishments, such as stone breakers or crushing rolls, is simply because the ores are so rich in silver, and frequently of such a brittle nature, that any undue pulverisation would certainly result in a great loss of silver, as a large amount would be carried away in the form of fine dust. So much attention is indeed required in this department that it is found requisite to institute strict superintendence in the sorting or cobbing sheds, in order to prevent as far as practicable any improper diminution of the ores. According to the above method the ores coming from the mine are classified into the four following divisions:

1. Very rich ore, averaging about six per cent. of silver, or containing say 2000 ounces of silver to the ton (of 2000 lb.)
2. Rich ore, averaging about one per cent. of silver, or say from 300 to 400 ounces of silver to the ton.
3. Ordinary ore, averaging about ½ per cent. of silver, or say from 150 oz. to 200 oz. of silver to the ton.
4. Gangue or waste rock, thrown on the dump heaps.

The first of these qualities—the very rich ore—is so valuable as to render advantageous its direct export in the raw state to the coast for shipment to Europe. The cost of fuel in Bolivia forms so considerable a charge in smelting operations, that the cost of freight to Europe on very rich silver ores works out at a relatively insignificant figure, when compared with the cost of smelting operations in that country. This rich ore is consequently selected very carefully and packed up in tough raw hide bags, so as to make small compact parcels some 18 in. to 2 ft. long, and 8 in. to 12 in. thick, each containing about 1 cwt. Two of such bags form a mule load, slung across the animal's back.

The second and third qualities of ore are taken direct to the smelting works; and where these are situated at some distance from the mines, as at Huanchaca and Guadalupe, the transport is effected by means of strong but lightly built iron carts, specially constructed to meet the heavy wear and tear consequent upon the rough mountain roads. These two classes of ores are either treated separately, or mixed together in such proportion as is found by experience to be most suitable for the smelting process.

On its arrival at the reduction works the ore is taken direct to the stamp mill. At the Huanchaca works there are sixty-five heads of stamps, each head weighing about 500 lb., with five heads in each battery, and crushing about 50 cwt. per head per twenty-four hours. The ore is stamped dry, without water, requiring no coffers; this is a decided advantage as regards first cost, owing to the great weight of the coffers, from 2 to 3 tons—a very heavy item when the cost of transport from Europe at about 50*l.* per ton is considered. As fast as the ore is stamped, it is shovelled out by hand, and thrown upon inclined sieves of forty holes per lineal inch; the stuff which will not pass through the mesh is returned to the stamps.

Dry stamping may be said to be almost a necessity in dealing with these rich silver ores, as with the employment of water there is a great loss of silver, owing to the finer particles being carried away in suspension, and thus getting mixed with the slimes, from which it is exceedingly difficult to recover them, especially in those remote regions where the cost of maintaining large ore-dressing establishments is very heavy. Dry stamping, however, presents many serious drawbacks, some of which could probably be eliminated if they received proper attention. For instance, the very fine dust, which rises in a dense cloud during the operation of stamping, not only settles down on all parts of the machinery, interfering with its proper working, so that some part of the battery is nearly always stopped for repairs, but is also the cause of serious inconvenience to the workmen. At the Huanchaca mines, owing to the presence of galena or sulphide of lead in the ores, this fine dust is of such an injurious character as not unfrequently to cause the death of the workmen; as a precautionary measure they are accustomed to stuff cotton wool into their nostrils. This, however, is only a partial preventive; and the men find the best method of overcoming the evil effect is to return to their homes at intervals of a few weeks, their places being taken by others for the same periods. In dry stamping there is also a considerable loss of silver in the fine particles of rich ore which are carried away as dust and irrevocably lost. To prevent this loss, the writer proposed whilst at Huanchaca that a chamber should be constructed, into which all the fine dust might be exhausted or blown by a powerful fan or ventilator.

Roasting.—From the stamps the stamped ore is taken in small ore cars to the roasting furnaces, which are double-bedded in design, one hearth being built immediately above the other. This type of furnace has proved, after various trials, to be that best suited for the treatment of the Bolivian silver ores, and is stated to have been found the most economical as regards consumption of fuel, and to give the least trouble in labour.

At the Huanchaca mines these furnaces cost about 100*l.* each, and are capable of roasting from 2 to 2½ tons of ore in twenty-four hours, the quantity and cost of the fuel consumed being as follows:

	Bolivian Dollars at 3s. 1d.
Tola (a kind of shrub), 3 cwt. at 60 cents	1.80
Yareta (a resinous moss), 4 cwt. at 80 cents	3.20
Torba (turf), 10 cwt. at 40 cents ..	4.00
Bolivian dollars	9.00, say 28s.

One man can attend to two furnaces, and earns 3s. per shift of twelve hours.

Probably no revolving mechanical furnace is suited to the roasting of these ores, as the operation requires to be carefully and intelligently watched, for it is essential to the success of the Francke process that the ores should not be completely or "dead" roasted, inasmuch as certain salts, prejudicial to the ultimate proper working of the process, are liable to be formed if the roasting be too protracted. These salts are mainly due to the presence of antimony, zinc, lead, and arsenic, all of which are unfavourable to amalgamation.

The ores are roasted with 8 per cent. of salt, or 400 lb. of salt for the charge of 2½ tons of ore; the salt costs 70 cents, or 2s. 2d. per 100 lb. So roasted the ores are only partially chlorinised, and their complete chlorinisation is effected subsequently, during the process of amalgamation; the chlorides are thus formed progressively as required, and, in fact, it would almost appear that the success of the process virtually consists in obviating the formation of injurious salts. All the sulphide ores in Bolivia contain sufficient copper to form the quantity of cuprous chloride requisite for the first stages of roasting, in order to render the silver contained in the ore thoroughly amenable to subsequent amalgamation.

Amalgamating.—From the furnaces the roasted ore is taken in ore cars to large hoppers or bins situated immediately behind the grinding and amalgamating vats, locally known as "tinas," into which the ore is run from the bin through a shoot fitted with a regulating slide. The tinas or amalgamating vats constitute the prominent feature of the Francke process; they are large wooden vats, shown in Figs. 1 and 2, page 173, from 6 ft. to 10 ft. in diameter and 5 ft. deep, capacious enough to treat about 2½ tons of ore at a time. Each vat is very strongly constructed, being bound with thick iron hoops. At the bottom it is fitted with copper plates about 3 in. thick, A in Fig. 1; and at intervals round the sides of the vat are fixed copper plates, as shown in Figs. 3 and 4, with ribs on their inner faces, slightly inclined to the horizontal, for promoting a more thorough mixing. It is considered essential to the success of the process that the bottom plates should present a clear rubbing surface of at least 10 square feet.

Within the vat, and working on the top of the copper plates, there is a heavy copper stirrer or muller B, Figs. 1 and 2, caused to revolve by the shafting C at the rate of 45 revolutions per minute. At Huanchaca this stirrer has been made with four projecting radial arms D D, Figs. 1 and 2; but at Guadalupe it is composed of one single bell-shaped piece, Figs. 3 and 4, without any arms, but with slabs like arms fixed on its underside; and this latter is claimed to be the most effective. The stirrer can

* Paper read before the Institution of Mechanical Engineers at the Cardiff meeting.

† Transactions of the American Institute of Mining Engineers, vol. ii., p. 139.

be lifted or depressed in the vat at will by means of a worm and screw at the top of the driving shaft, Fig. 3.

The bevel gearing is revolved by shafting connected with pulley wheels and belting, the wheels being 3 ft. and 1½ ft. in diameter, and 6 in. broad. The driving engine is placed at one end of the building. Each vat requires from 2½ to 3 horse-power, or in other words, an expenditure of 1 horse-power per ton of ore treated.

At the bottom of the vat, and in front of it, a large wooden stop-cock is fitted, through which the liquid amalgam is drawn off at the end of the process into another shallow-bottomed and smaller vat, Figs. 1 and 2. Directly above this last vat there is a water hose, supplied with a flexible spout, through which a strong stream of water is directed upon the amalgam as it issues from the grinding vat, in order to wash off all impurities.

The following is the mode of working usually employed. The grinding vat or tina is first charged to about one-fifth of its depth with water and from 6 cwt. to 7 cwt. of common salt. The amount of salt required in the process depends naturally on the character of the ore to be treated, as ascertained by actual experiment, and averages from 150 lb. to 300 lb. per ton of ore. Into this brine a jet of steam is then directed, and the stirrer is set to work for about half an hour, until the liquid is in a thoroughly boiling condition, it which state it must be kept until the end of the process.

As soon as the liquid reaches boiling point, the stamped and roasted ore is run into the vat, and at the end of another half-hour about 1 cwt. of mercury is added, further quantities being added as required at different stages of the process. The stirring is kept up continuously for eight to twelve hours, according to the character and richness of the ores. At the end of this time the amalgam is run out through the stop-cock at bottom of the vat, is washed, and is put into hydraulic presses, by means of which the mercury is squeezed out, leaving behind a thick pulpy mass, composed mainly of silver, and locally termed a "piña," from its resembling in shape the cone of a pine tree. These "piñas" are then carefully weighed and put into a subliming furnace, Figs. 5 and 6, in order to drive off the rest of the mercury, the silver being subsequently run into bars. About four ounces of mercury are lost for every pound of silver made.

The actual quantities of mercury to be added in the grinding vat, and the times of its addition, are based entirely on practical experience of the process. With ore assaying 150 oz. to 175 oz. of silver to the ton, 75 lb. of mercury are put in at the commencement, another 75 lb. at intervals during the middle of the process, and finally another lot of 75 lb. shortly before the termination. When treating "pacos" or earthy chlorides of silver, assaying only 20 oz. to 30 oz. of silver to the ton, 36 lb. of mercury is added to 2½ tons of ore at three different stages of the process as just described.

The rationale of the process therefore appears to be that the chlorinisation of the ores is only partially effected during the roasting, so as to prevent the formation of injurious salts, and is completed in the vats, in which the chloride of copper is formed progressively as required, by the gradual grinding away of the copper by friction between the bottom copper plates and the stirrer; and this chloride subsequently becoming incorporated with the boiling brine is considered to quicken the action of the mercury upon the silver.

Subliming.—The subliming furnace, shown in Figs. 5 and 6, is a plain cylindrical chamber A, about 4 ft. diameter inside and 4½ ft. high, lined with firebrick, in the centre of which is fixed the upright cast-iron cylinder or retort C, of 1 ft. diameter, closed at top and open at bottom. The furnace top is closed by a cast-iron lid, which is lifted off for charging the fuel. Round the top of the furnace is a tier of radial outlet holes for the fuel smoke to escape through; and round the bottom is a corresponding tier of inlet air-holes, through which the fuel is continually rabbled with poles by hand. The fuel used is llama dung, costing 80 cents, or 2s. 6d. per 250 lb.; it makes a very excellent fuel for smelting purposes, smouldering and maintaining steadily the low heat required for subliming the mercury from the amalgam. Beneath the furnace is a vault containing a wrought-iron water-tank B, into which the open mouth of the retort C projects downwards and is submerged below the water. For charging the retort, the water-tank is placed on a trolly; and standing upright on a stool inside the tank is placed the piña, or conical mass of silver amalgam, which is held together by being built up on a core-bar fitted with a series of horizontal discs. The trolly is then run into the vault, and the water tank containing the piña is lifted by screw-jacks, so as to raise the piña into the retort, in which position the tank is then supported by a cross-beam. The sublimed mercury is condensed and collected in the water; and on the completion of the process the tank is lowered, and the spongy or porous cone of silver is withdrawn from the retort. The subliming furnaces are ranged in a row, and communicate by lines of rails with the weigh-house.

SHEAF BINDER TRIALS.

To the Editor of Engineering.

SIR,—I write to call your attention to what I think was an error in the mode of conducting the sheaf binder trials at Shrewsbury, and trust the ventilation of the subject may lead to their being conducted on a different principle in the future.

I entered my machine for trial in March last; came to the Show in due course; but before I was allowed to remove my machine from the show-yard I had to deposit 25*l.* with the Society as a guarantee that I should come to the trials for which the machine was entered. I am informed by printed circular that the trials are to consist of a competition in oats, wheat, barley, and beans. I am tested on three-quarters of an acre of oats, and I must accept the points awarded me by the judges for this piece of work. But have I not a right to demand that my machine shall be tested in the other crops in the same way, and under the same conditions, as the other competitors, for, assuming I did badly on the oats, I might have distanced all competitors in the other three crops?

I was not informed why I was disqualified, but I see in the *Times* report that heavy draught is assigned as a reason. This opinion of the machine is not shared by some competent judges, and was, at any rate, premature till the dynamometer test had been applied. It seems to me unjust that any prizes should be awarded by the judges till every machine has been equally tested, unless a stoppage is caused by breakage. To rule out a machine like a sheaf binder because the first half-hour's work is a little faulty is, I maintain, unfair. Not to mention my own case, nothing could illustrate this better than that of the Johnstone Harvester Company's machine, which made splendid work the night before at a private trial, which I saw, but which failed the next morning, because it was not exactly adjusted to the crop.

Yours truly, H. J. A. KING.

Newmarket, August 13, 1884.

CONTINUOUS BRAKES.

To the Editor of Engineering.

SIR,—The directors of this company much regret that they are obliged again so soon to ask for space in your columns, but they feel that they would not be doing their duty to their shareholders or to the travelling public if they neglected to take public notice of the remarks made by Mr. Moon, the chairman of the London and North-Western Company, at the half-yearly meeting of that company, which took place on Saturday last.

Mr. Moon, on being asked by Mr. F. Hill, a shareholder, for information as to whether there was any cause to apprehend a disaster such as that which had occurred on another railway, stated in reply as follows: "They themselves—the London and North-Western Railway Company—had made every provision to prevent accidents. A year ago he—Mr. Moon—told them that finding the South-Western, the Great Western, Midland, Lancashire and Yorkshire, Great Northern, and North Staffordshire Companies were all using the vacuum brake they had decided that it was better for them to interchange with those companies and use the same brake. They were, therefore, now putting on the vacuum brake to a great extent. He had no doubt this brake would work well, and, as far as could be, would prevent accidents."

Mr. Moon went on to make a most unfair attack upon the Westinghouse brake, to which I shall presently refer; but before doing so, it is only right to point out the fallacies contained in the above quotation. As a matter of fact—and of indisputable fact—the vacuum brakes used by the various companies which Mr. Moon enumerates differ from one another in various essential particulars. The Great Northern Company, working with the Manchester, Sheffield, and Lincolnshire Company, which Mr. Moon now omits from his list, use the brake known as Smith's vacuum brake, which is not automatic, and which becomes useless when a coupling is fractured, for instance, between the engine tender and the leading vehicle. It was this brake which so palpably failed at Penistone—and the failure of which led to the death of twenty-five persons, and the injury to numerous others—and it was a joint Sheffield and Great Northern train to which this disaster occurred. This is, with the modifications to be hereafter explained, the brake which Mr. Moon proposes for adoption—to supersede the chain brake which he has hitherto so much belauded on the London and North-Western Railway. The Midland, another company referred to by Mr. Moon, employs mainly an automatic vacuum brake, which contains a leakhole only too well known to those who are in the habit of using that brake. The effect of this leakhole is that when the brake has been applied the force leaks away in about 1½ minutes, and when it is necessary to apply it two or three times in rapid succession, as in approaching junctions and terminal stations, the engine driver is unable to make use of it until one or two minutes have elapsed to allow him to recuperate his power. It is also useless on steep inclines, because it is no sooner applied than it begins to leak off and to lose power. Other modifications of the automatic vacuum brake are employed on the Great Northern, the Lancashire and Yorkshire, and other companies referred to by Mr. Moon.

The brake now applied to certain trains on the London and North-Western Railway is, however, used upon only one of the railways enumerated by Mr. Moon, viz., the North Staffordshire, and is different in important and essential particulars from the brakes employed by the other companies referred to, as well as from those in use on any other railway in the United Kingdom, the Continent of Europe, or America. The London and North-Western brake is, in fact, a non-automatic vacuum brake, with an automatic arrangement in the brake vans only. Such a brake would be useless to prevent loss of life and injury to passengers in the case of any accident in which the couplings between the carriages became detached, as at Penistone. The brake arrangement in the London and North-Western van would, it is true, so far as its brake power went, prevent a few carriages from running back down an incline on becoming detached from the remainder, and it might in such a case give warning to the guard; but the London and North-Western system would be just as useless as the ordinary Smith's vacuum brake in any sudden emergency when its action would be most required for automatically locking every wheel throughout the train.

The great object of automatic action in all brakes is to provide that on the sudden occurrence of accidents of the most fatal class, such as those of Penistone, Downton, Abbots Ripton, Shipton, Wigan, Morpeth, Marshan Meadows, Lockerbie, and numerous others, the brake shall, and without any action of the guard or engine-driver, be applied to every wheel of the train and prevent the hinder carriages from running forward unchecked upon the engine and tender or upon the leading carriages so as to cause destruction to the rolling stock and loss of life to the passengers.

This point is completely met by the Westinghouse brake, but having special reference to the above accidents, it cannot be obtained at all by the Smith vacuum brake, and it can only be obtained partially, and in inferior degree, by the other brakes referred to. In the case of the Westinghouse brake, there being a store of high-pressure air in a reservoir on each vehicle, like a loaded air-gun ready to go off, the following combination of advantages is provided in the best manner, viz.: (1) instantaneous action on every wheel of the train; (2) instant application by guards as well as engine-drivers; (3) unfailing tell-tale of its own efficiency.

The above considerations lead further to the accusations so often made by the advocates of the vacuum brake, and now reiterated by Mr. Moon, of the number of failures recorded in the Board of Trade returns by the various descriptions of automatic and non-automatic brakes respectively. A vast number of the so-called failures of the Westinghouse brake are in reality the most important proofs of its success. They are made up of short periods of delay in the running of trains, obliging the servants of the company to make it efficient before they are able to proceed with their trains, and it is observable that the failures of the vacuum brakes are, in a large proportion, dangerous failures, such as when the brake was required to act and did not act, in case of an accident to a train, or of an imminent collision. On the other hand, those recorded of the Westinghouse brake are mainly from neglect of servants, or defects of material, which have caused the brake to fly on, and have therefore been sources of delay without danger. I have the pleasure to inclose a copy of the latest circular which has been issued by the Westinghouse Company on this subject, which will fully illustrate these points, though it is too long to introduce into this letter.

Referring to the same subject, Mr. T. E. Harrison, in his report on the working of the Westinghouse brake on the North Eastern Railway, a copy of which accompanied our last letter, makes the following forcible remarks: "It may here be remarked that the above delays are not attended with danger—though called 'failures,' they are in most cases the best proof of the reliability of the automatic brake acting as a 'tell-tale' to call attention to any slight derangement, and they will certainly be gradually and greatly diminished in number, particularly in the bursting of hose pipes. The whole result is a delay to one train every other week-day of three to five minutes, out of all the trains working on the North-Eastern system—not as great a delay as occurs every hour under the working of the block system. The returns of failures made by different companies for the half-year ending December 31, 1883, vary a great deal, in one case being relatively more than six failures to one on the North-Eastern."

Referring again to the companies stated by Mr. Moon to be using the vacuum brake, though different varieties of it, it is only right to conclude by saying that the following companies have adopted and are successfully using the Westinghouse brake in this country: The North-Eastern, the London and Brighton, the Great Eastern, the Chatham and Dover, the North British, the Caledonian, the Glasgow and South-Western, the Rhymney, the West Lancashire, and Eastern and Midlands Railway, and that there is not one of these companies that has not found the greatest advantage from it in avoiding or mitigating serious accidents, as, for instance, at Healey, Whitehall Junction, Ormside, Kirkstall Forge, Blackwell sidings, Bickley, Waterloo Colliery, Leeds, Thirsk, Redhill, New Cross, Bricklayers' Arms, Helpingham, Streatham Fen, near Ely, and many others, not to refer to the numerous accidents which have been altogether avoided, and of which, having never been made public, there is no record. Mr. T. E. Harrison, in his report above alluded to, states as follows: "There does not appear to be any one point in the principle and arrangement of the Westinghouse brake, as now in use, requiring alteration, and it entirely complies with all the requirements of the Board of Trade.

ALBERT KAPTEYN,
Secretary and Manager for the Westinghouse Brake Company.

August 21, 1884.

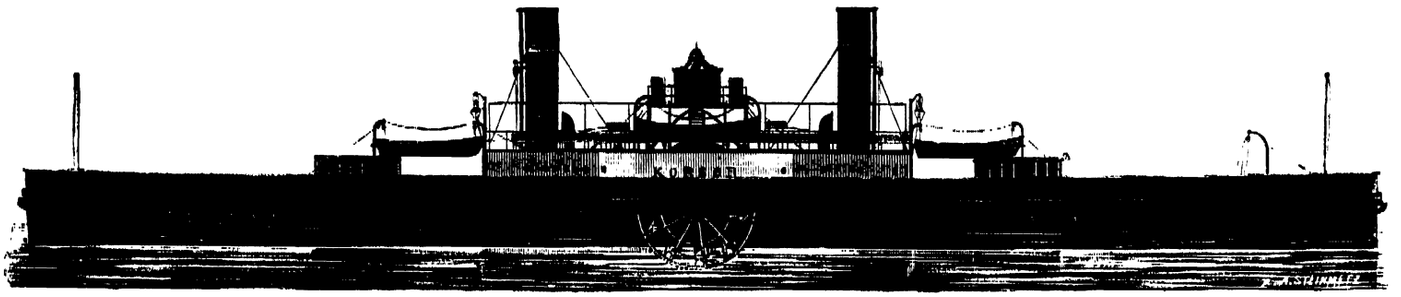
ATCHISON, TOPEKA, AND SANTA FE RAILROAD.—A new bridge across the Colorado at the Needles was opened for traffic July 31. It will give the Atchison, Topeka, and Santa Fé Railroad Company an unbroken line from the Missouri to all points in California.

FRENCH COAL MINING.—The production of coal in the French department of the Nord in 1883 was 3,789,067 tons, as compared with 3,777,638 tons in 1882. The working staff amounted to 19,880 men last year, as compared with 20,056 in 1882.

SEWAGE AT ADELAIDE.—The South Australian hydraulic engineer reports that the Adelaide sewage system is working well, and that the plan of erecting ventilating shafts which has been adopted in North Adelaide to prevent stenches arising from the drains has been successful in abating the nuisance.

THE DANISH RAILWAY FERRIES "KORSÖR" AND "NYBORG."

CONSTRUCTED BY THE KOCKUMS MEKANISKA WERKSTAD, MALMÖ, SWEDEN.



In the latter end of 1881, the Danish Government invited tenders for the construction of two large railway ferries. Small boats having a single line of rails on deck, had previously been in use on the Little Belt, between Middlefart and Fredericia; the connection of Copenhagen with the Continent, over the Great Belt, being made by ordinary paddle steamers, thus necessitating a complete transfer of goods and mails and causing much loss of time. It was now proposed to make two ferries large enough to carry seventeen loaded goods wagons or thirteen passenger carriages. They were necessarily to be of great strength and seaworthiness, not only to withstand the severe weather sometimes experienced in the Belt, but to force their way through the ice in winter, and keep the communication between Zealand and Jutland open in all possible weathers. A speed of 13 knots in both directions was required, and the arrangements for the comfort of passengers and the safe navigation of the ship in all weathers were unusually complete.

The whole contract for both vessels with machinery and outfit, was placed in the hands of Kockums Mekaniska Werkstad Aktie Bolag, Malmö, Sweden, and their construction was entered upon in the spring of 1882.

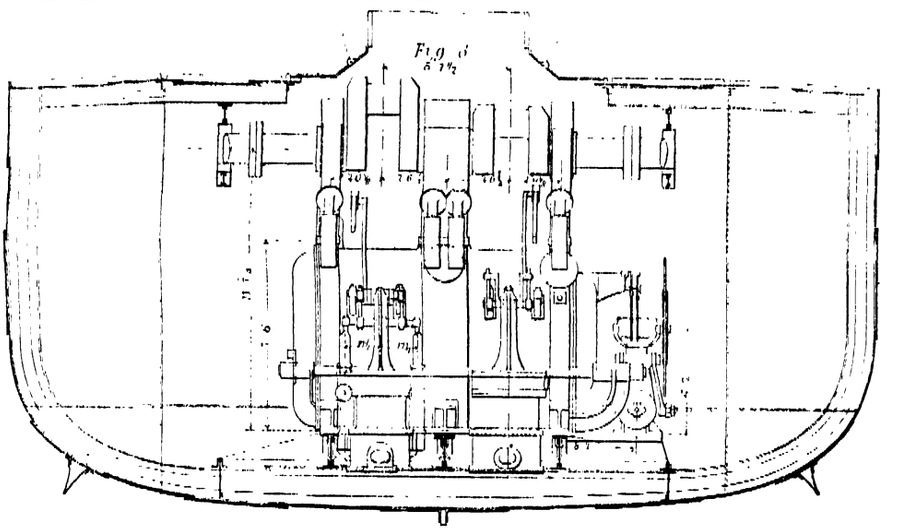
The hull of each boat is of steel from the Steel Company of Scotland, the steel deck is supported by strong plate and angle iron cross-beams, and has a heavy girder running fore and aft under each line of rails. Both ends of the ship are exactly similar in form, a rudder being fitted behind the stem fore and aft. On deck the rails finish on a platform which supports one end of the gangway when wagons are being taken on board.

The two-page plate that we published in our issue of the 8th inst., a [illegible] the general view given above, show the arrangement with sufficient fulness to obviate much recapitulation here, but attention may be directed to one or two points. The great height between decks, 10 ft., adds to the handsome appearance of the saloons, which are ornamented with panels of bird's-eye maple, with walnut-tree columns, walnut furniture, and sofas covered with red velvet. Great attention has been bestowed on the heating and ventilating of each vessel. Under the lower deck there is a large chamber containing several systems of pipes supplied with steam from the main boilers. Into this chamber fresh air is driven by a centrifugal fan in the forward stokehole, hence it is led to the various cabins by trunks having a regulating valve in each; similar trunks concealed in the roof of the saloon carry off the vitiated atmosphere to large exhaust casings near the funnels. In summer cool air is driven direct through various compartments. Electric lighting by arc lamps is arranged on deck and in the engine-room to facilitate night traffic. The outfit includes Harfield's steam windlass, Muir and Caldwell's steam steering gear for both rudders, steam capstans for warping the wagons on board, 500 life-belts conveniently hung around the ship's side, and life-boats specially constructed for ice-bound waters.

The machinery, of which we publish engravings in a two-page plate this week, consists of two complete compound engines coupled to the same shaft, having a common surface condenser supporting the entablature. The guides are formed of stout square steel columns connecting the cylinders to the framing, making the design both light and accessible. Four boilers arranged in pairs fore and aft, supply steam at 80 lb. per square inch. Fox's corrugated furnaces are used for the first time in these waters. The paddle wheels are of the ordinary feathering type, made of Swedish iron, and of extra strong dimensions for going through ice.

The following are the principal dimensions in English measure of the hull and machinery:

	ft.	in.
Length over all	248	10
Breadth of beam	34	10
,, over paddle-boxes	56	0
Light draught with 75 tons on deck ...	8	6
Displacement	1187 tons.	
Midship area	244 sq. ft.	



Diameter of high-pressure cylinders	33¾ in.
low-pressure ,,	63½ ,,
Length of stroke	4 ft. 6 in.
Condensing surface	2000 sq. ft.
Diameter of air pumps	27 in.
,, circulating pumps	21 ,,
Stroke of all pumps	22 ,,
Diameter of crankshaft ...	13 ,,
,, wheel over floats ...	19 ft.
Size of floats	8 ft. 6 in. by 3 ,,
Diameter of boilers	12 ,,
Length ,,	10 ,,
Total heating surface	5700 sq. ft.
fire-grate	188 ,,

Result of Trials made over a 12-Knot Course in the Sound on Light Load Draught.

	Consumption Trial.	Full Speed Trial.	
		Ahead.	Astern.
Steam, lb. ..	80	80	—
Vacuum, in. ..	25	25	24½
Revolutions ..	33	37½	39
Grade of expansion	.375		.05
I.HP.	1100	1700	1720
Speed	12.25	13.31	12.97
Coal per hour per I.HP., lb.	1.98		

A noticeable result was observed, in going astern, the engine made more revolutions in this direction with less steam, while the speed was somewhat less, slip being greater. As much more water was carried round by the wheel, this result is no doubt due to the fact that the float, when going astern, enters water already broken by the radius rod, levers, &c., which have preceded it, while in going ahead it presents a perfectly flat surface to a solid body of water. Both steamers were delivered in October of last year, and are giving every satisfaction, performing the journey from Korsor to Nyborg in about an hour. The arrangement for running the carriages on board works with great smoothness, the whole time from the arrival of the train in the station until the ferry is ready to leave the harbour with the passengers and wagons on board being about ten minutes. The vessels were constructed at Messrs. Kockum's yard in Malmö, under the management of Mr. A. B. Munter, assisted by Mr. Ortmann for the ship work, and Mr. Irving in the machinery department, while the work was inspected by Director Nielsen, Captain Jesperson, and Mr. Ursin on behalf of the Danish Government.

In connection with this subject, we may add that a mixed Swedish and Danish commission is at present considering the question of completing the chain of ferries by placing similar steamers on the Sound, thus giving the whole Scandinavian peninsula direct railway connection with the Continent. We should mention that the dimensions marked on our illustrations are in Swedish feet and inches, the ratio to English measure being .9741 English feet equal to one Swedish foot.

BESSEMER BLOWING ENGINE.

(*Concluded from page* 154).

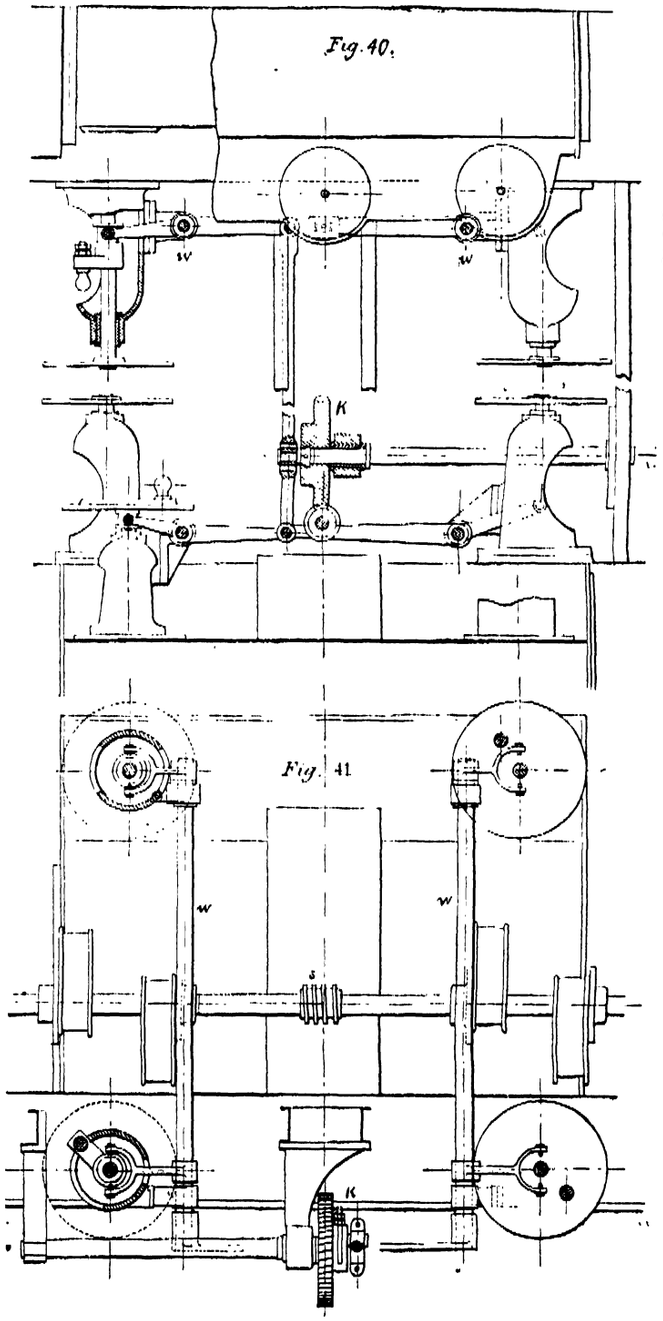
We have already in a previous article (see page 104 *ante*) said a few words about the general arrangement of the steam cylinders of the Bessemer blowing engines at the Helf Steel Works, and we propose now to describe these parts more fully in detail. The engine, it will be remembered, is of the compound type, with cylinders of 35.24 in. and 49.6 in. in diameter respectively, and 4 ft. 11.06 in. stroke, and is provided with an intermediate receiver placed horizontally between the two cylinders. The two groups of sixteen heating pipes are each divided by a longitudinal vertical partition, so as to more fully bring the high-pressure exhaust, which surrounds the pipes, in contact with the live steam which passes direct from the boilers through the pipes. The receiver is provided with ample arrangements for draining both the live and the exhaust steam chambers, and, in case of repairs or for cleaning the heater, a shut-off valve for the live steam is provided; the heater is also fitted with a safety valve. A valve is, moreover, provided on the live steam chamber of the receiver, through which steam can be supplied direct to the low-pressure cylinder; for the purpose of starting the engine this has proved unnecessary, but it may at times be desirable to work both cylinders, or the low-pressure cylinder alone, with high-pressure steam.

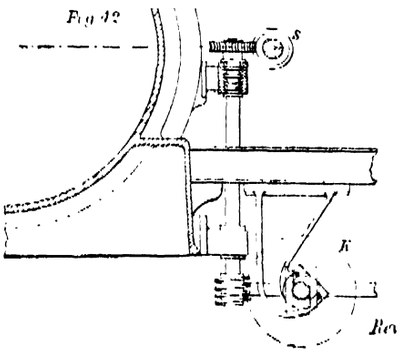
The provision in these engines for steam jacketting both cylinders and their cylinder covers by live steam is very complete, as Professor Riedler lays great stress upon the importance of warming up large engines some time previous to their starting by means of steam jackets, a subject of special importance with blowing engines for Bessemer plant, which are frequently stopped and started at short intervals. Fig. 42 shows in detail the connection for supplying steam to the cylinder covers from the jackets, arranged in such a manner that no pipes or joints have to be disconnected when lifting the cylinder covers. The condensed water from the jackets can either be run back to the boiler feed tanks, or it can be directly returned to the boilers by means of a special little force pump.

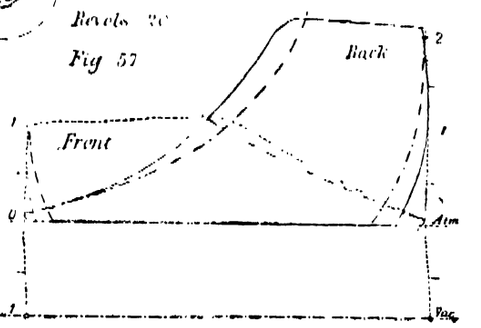
The valve and valve motions of these engines are

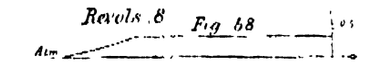
DETAILS OF BESSEMER BLOWING ENGINE FOR THE HELF STEEL WORKS.

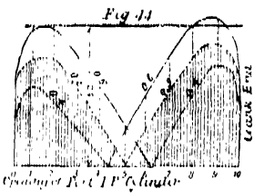
CONSTRUCTED BY MESSRS. BREITFELD AND DANEK, ENGINEERS, PRAGUE; FROM THE DESIGNS OF PROFESSOR RIEDLER, MÜNICH.

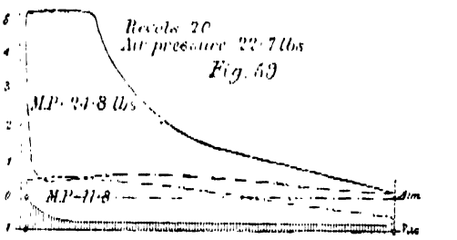


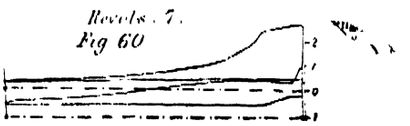


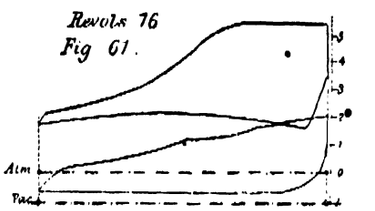












somewhat peculiar, and, be it at once said, not quite to the satisfaction of the designer, but they were the result of the peculiarly unfavourable conditions already referred to, and have proved quite successful in working, which after all is the main point. Both steam and exhaust valves for the low-pressure cylinder are cylindrical valves with slight longitudinal motion; the steam valves for the high-pressure cylinder are double beat, and the exhaust valves cylindrical. Only the high-pressure steam valves have adjustable variable cut-off, ranging from one-tenth to six-tenths, while a slight variation from four-tenths to six-tenths is obtainable in the low-pressure cylinder by means of a varied lap, full port opening being obtained only between .45 and .5 cut-off (see diagram, Fig. 44).

The valves, in the case of each cylinder, are driven from a second motion shaft running parallel to the centre line of the cylinder. In the low-pressure valves, see Fig. 7 on our two-page engraving for August 1st, eccentrics coupled to a disc on the valve spindle are used, while for the high-pressure cylinder the exhaust valve is driven in a similar manner; the admission valve, however, is worked by a lever and cam motion from the shaft, the cams being made to slide on the shaft and having a varying lift so as to adjust the point of cut-off. This is effected by means of a travelling screw, provided with a handwheel, see Fig. 3, two-page plate for July 18th. Some complication in the valve gear was necessarily introduced, seeing that the cylindrical valves had to be rotated by eccentrics on a shaft lying at right angles to their axes, and had also to be capable of a slight longitudinal motion. To render this possible the eccentrics and the pins on the valve discs were constructed as ball-and-socket joints (see Figs. 45, 46, and 47). This construction appeared perfectly admissible in this case, as only slight movements were required and there was no very great resistances to overcome. The arrangement for effecting the longitudinal motion of the cylindrical valves is clearly shown in Figs. 41 and 42; a worm on the valve gear shaft s works in a worm-wheel fixed to a vertical shaft, the lower end of which, passing below the bed-plate of the engine, carries another worm, gearing with a wormwheel k on a short shaft, fitted with an adjustable crank disc; from this crank disc levers convey the vibrating motion to two vertical shafts w, see Fig. 41, to which by means of short cranks the valve spindles are coupled. The usual longitudinal motion of the valves is 1⅛ in., but it can be slightly adjusted. The attachment to the valve spindles is clearly shown in Figs. 48 and 49. The air pump, shown in Figs. 3 and 6, is of the single-acting vertical plunger type, 21.27 in. in diameter and 25.53 in. stroke; stuffing-boxes and valves are completely placed under a water seal so as to avoid air leakages.

The plunger is guided in the long sleeve of the stuffing-box; the pump has four suction valves 11.8 in. in diameter fixed in the bottom of the pump cylinder, and twelve delivery valves 7.7 in. in diameter arranged around the stuffing-box. A small valve at the foot of a pipe connecting the top of the condenser with the air pump (see Fig. 6), serves to take away the air out of the condenser, while a hood over the steam inlet prevents the latter from directly entering the air pump through this pipe. The condenser, which in its upper part is 27½ in. diameter, is reduced in its lower part to 11¾ in., so as to give as much space as possible between the injection inlet and the condenser water level during the upstroke of the air pump; while, on the other hand, the top of the air pump is increased to such a diameter that the water level never falls below the bottom of the stuffing-box.

The injector is provided with a double starting valve, an ordinary shut-down valve, under control the engine driver, by means of the handwheel S (se Fig. 6), and a balanced valve V, shown in detail in Fig. 52, the starting lever of which is fixed at a convenient spot close to the high-pressure cylinder, so as to enable the engine driver to suddenly stop the in-

jection water when desirable. For short stoppages the ordinary shut-down valve, worked by means of the handwheel S, is not touched, but the balanced valve V only is used. This arrangement was considered necessary so as to avoid the possibility of filling the condenser and low-pressure cylinder with water in case of a sudden stop of the engine. The injection water was supplied from an overhead tank under the pressure of the water head, and to avoid drowning the engine-room, a safety valve (see Fig. 53) is provided on the condenser, which opens to an overflow as soon as any water pressure occurs in the condensers. To avoid leakage by this valve, it is always under a water seal. The water supply under pressure to the condenser was, however, ultimately abandoned for fear of an accident from drowning and an injection water tank provided, from which the injection pipe could draw its supply. The injection water is at times very dirty, and carries sand and other impurities, and this was one of the chief reasons why a solid bucket plunger had to be used for the air pump. The water is, moreover, allowed to settle and the injector pipe is fitted with a float, so as to always take the water off the surface.

A direct exhaust is only partially provided for these engines in case of breakdown of the condensing arrangement, the bends joining the cylinders to the exhaust main not having been fixed. As a reason for this Professor Riedler says that if a convenient mode of working condensing engines without the condenser is provided, the engineer flies to it immediately the least repair is required to the condensing part, and the engines are often worked at considerable expense as non-condensing, instead of the slight necessary repairs being carried out. In the case of the blowing engines at Heft, it would be more trouble to connect up the exhaust bends than to attend to ordinary pump repairs, although in cases of emergency the bends could soon be put up without much delay.

With a view of the utmost safety in working and the possible avoidance of repairs, large bearing surfaces and very strong construction of details have been everywhere studied; the crankshaft bearings are 21½ in. long, the plummer blocks are made adjustable sideways by means of wedges, and strong guides and adjustable and large guide blocks, have all added to make these engines a successful job. In calculating the weight of the flywheel, which for the purpose of easy transport had to be made in four segments, and the boss and arms cast separately, the compression curve in the air cylinder at the end of the stroke was taken carefully into consideration; Fig. 54 shows a diagram constructed to show the pressures in a single cylinder blowing engine due to air and steam pressure combined, *a b* representing the air compressing curve and *c c* the rurve of steam pressure; the great variety of work done and strain upon the driving parts is clearly represented in the hatched surfaces.

The starting gear is of an ordinary type with two rows of ratchet teeth cast in the rim of the flywheel overlapping each other one-half pitch. The upper two pawls *b* serve to turn the flywheel, the two lower pawls *a* to prevent the engine from running back. If the starting bar is completely depressed it throws, by means of small lever connections, all four pawls out of gear with the wheel.

The results of working have so far been in every respect most satisfactory, and with the exception of a few slight mechanical derangements, nothing of any moment has happened. It was found that some of the suction valves of the blowing cylinder did not keep tight, owing to uneven thickness of the leather rings, but this was easily remedied by turning them accurately. Most of the working parts of the engine are made of mild steel, as are also the crosshead and crosshead bolts; one after the other the latter gave way, owing, it was thought, to a one-sided strain; ball washers were provided, and iron bolts used in place of steel, and this little difficulty successfully overcome.

The steam consumption of the new engines compared with the old is of course very considerably reduced, although a great increase in power is one of the most important features in the new engine, enabling a reduction in the time of the blast, and consequently causing an economy in furnace linings, amounting to about 600*l.* per annum, which amount will, it is expected, be still bettered by improved tuyeres. While with the old engine, two coal-fired boilers using daily 10 tons of coal, were necessary in addition to some boilers fired by furnace gases, one coal-fired boiler was laid off immediately, and the coal consumption for the other brought down to about one-third of the original, but since the erection of a new blast furnace, and the arrangement of one more gas-fired boiler, this quantity has come down to two tons per day. The boilers have some other engines in the place to supply with steam, but it is expected that before long, coal for boiler purposes will be dispensed with altogether.

In conclusion, we have reproduced a few indicator diagrams; Fig. 57 is a set of diagrams taken off the blowing cylinder running at twenty revolutions, the dotted lines show the true Mariotte curves; Fig. 51 is also a diagram from the blowing cylinder during the time of warming up the engine, the latter only making eight revolutions.

Figs. 59 to 61 are diagrams taken off the steam cylinders, and show a fair distribution of steam, the figures on the scales representing atmospheres about 14.7 lb. Altogether these engines, built by Messrs. Brietfeld and Danek, of Prague, to Professor Riedler's designs, have proved a very successful job, and they possess numerous features well worth careful consideration when designing engines of similar type.

We are indebted for the drawings and descriptions of these engines to a reprint from the *Zeitschrift des Vereins Deutsche Ingenieure*, sent us by Professor Riedler.

MR. RICHARD GARRETT.

We record with regret the death of Mr. Richard Garrett, the head of the firm of Messrs. R. Garrett and Sons, of Leiston Works, Suffolk. His decease took place on the 30th ult., from heart disease, and although he was known to be in delicate health it was a surprise to most of his friends. He had just completed his fifty-fifth year, having been born on July 22, 1829, at the Works House, Leiston. He was the eldest son of the proprietor of the works, which were founded in 1778 and was the fourth who had borne the same name, and who had been, or has since become, the senior partner of the firm. He was educated at a private school at Woodbridge, and when he attained the age of fourteen was apprenticed to his father. The business originally consisted of a foundry, a smithy, and a wheelwright's shop, and was gradually transformed into an engineering concern as the demand arose for agricultural machinery here and abroad. Mr. Garrett became a partner with his father and brother in 1853, and on the death of the former in 1860, he succeeded him as the head of the firm, which then consisted of himself and his two brothers, Mr. Harry Newson Garrett and Mr. Frank Garrett.

Notwithstanding the high reputation Mr. Garrett had in the world as an agricultural engineer, he was better known among his neighbours as a tenant farmer, and it was this department of his work in which he took the greatest pleasure. At the time of his death he held 2000 acres of land, and was an enthusiastic breeder of Suffolk horses. He was an earnest supporter of all associations for the purpose of encouraging or extending agriculture, and for some years held the position of vice-president of the Suffolk Agricultural Association. His zeal for the welfare of Suffolk farmers naturally caused him to take a great interest in the Albert Memorial College at Framlington, and at the death of his father he was elected to the position of governor, which he retained until the last, although for some time he had been unable to take an active part in the management of the Institution. All his life he took a keen interest in sport, and for many years hunted twice a week. He rented a moor near Inverness, and when his health no longer allowed him to follow grouse shooting, he found a less fatiguing substitute for it in his native county.

Mr. Garrett was a member of the Institution of Civil Engineers, and also of that of Mechanical Engineers. His reputation as an engineer rests to a great extent upon the many improvements he effected in the thrashing machine, first as an implement worked by horses, and afterwards as the completer machine which is now to be found on every important corn-growing farm in the country. His patent for the combined thrashing, dressing, and straw-shaking machine was taken out in conjunction with James Kerridge, the foreman of the thrashing machine department of his works, on January 18, 1859. Side by side with the thrashing machine comes the portable engine, and this naturally occupied much of Mr. Garrett's attention, receiving from his hands many of the improvements which have aised it to its present degree of excellence and economy. In mechanical, as indeed in all other matters, he had the courage to form and uphold his own opinions, and he would never follow a fashion in engineering which did not meet with his approval, preferring to remain singular, even at the expense of losing orders, than to adopt arrangements which he considered unnecessary or indefensible.

In reviewing Mr. Garrett's career it is impossible not to be struck with the wide area over which he gained fame and esteem. As an engineer his name is known by the whole English-speaking agricultural population of the world, while in his native county he enjoyed the greatest popularity among all classes. He was a bold rider, a steady shot, a successful farmer, a capital judge of cattle and horses, a popular major of volunteers, an active politician, and a genial neighbour, and into all his pursuits he threw, for the time being, all his ardour. Such a character never fails of recognition in any part of the world, and least of all in England. It is easy to understand the feeling of sorrow with which the news of his death was received, not only by his friends and neighbours, but also by those who had met him in business, either as an engineer or as a farmer.

TRIAL TRIPS AND LAUNCHES.

On Friday, August 1st, the s.s. Ashton, built to the order of the Manchester, Sheffield, and Lincolnshire Railway Company, by Messrs. Edward Withy and Co., of Middleton Shipyard, West Hartlepool, left Hartlepool for Grimsby on her trial trip. The Ashton is a sister ship to the s.s. Chester, lately completed for the same owners. In the s.s. Ashton the Manchester, Sheffield, and Lincolnshire Railway Company have added a most valuable and speedy vessel to their fleet; during the trial trip to Grimsby she averaged 13.9 knots per hour, and she is expected to make the passage from Grimsby to the Continent in remarkably quick time. The comfort and safety of the passengers have been a paramount consideration, but after conceding to them every convenience, the vessel is still capable of carrying about 1000 tons of cargo inclusive of bunkers. On account of her large beam and the length of the water-tight deck erections her range of stability is very great, and at Lloyd's certified load line she has the large amount of 36 per cent. surplus buoyancy. Before the vessel left Hartlepool she was put under a series of inclining tests, and from the subjoined calculations it will be seen that under all conditions she will be a very stable boat at sea, and even supposing she was carrying eight locomotives on deck she would have a maximum stability of 42 deg.

—	Metacentre Height.	Maximum Stability.	Maximum Righting Moment.	Stability Variables.
	ft. in.	deg.	foot-tons.	deg.
Light draught	3 6½	42½	2359	77
Coal cargo at 45 cubic feet	3 3½	45	3091	94
,, and eight locomotives on deck	3 1	42	2971	88
Homogeneous cargo at 66.4 cubic feet	2 7½	36½	2185	80

There are also keels fitted along each bilge to further assist in steadying the ship. The holds are divided into six water-tight compartments, each connected to a very powerful centrifugal pump in the engine room, and a large Downton pump fitted on deck. The whole of the deck erections are of iron, and for further protection against ice the bows of the vessel are covered with double plating. During the trial trip the vessel was put under a series of interesting experiments, such as reversing the engines when going full steam ahead, turning completely round to port and starboard, &c., and proved fully up to the highest expectations of the builders, answering her helm with remarkable precision and steadiness. The triple expansion engines, with which the vessel is fitted by Messrs. J. Richardson and Son, Hartlepool, worked with smoothness and regularity. These engines, under the able management of Mr. R. Wyllie, have lately secured very marked success both as regards power developed and economy of fuel. Churchill's patent governor is fitted to the engines, which are supplied with steam at 140 lb. pressure by two cylindrical boilers. The s.s. Ashton, during construction, has been superintended by the company's marine superintendent, Captain Kennet Hore, and the engines by Mr. G. H. Clarke, of Grimsby.

The s.s. Rosalind sailed on her trial trip on Saturday, August 9, when she steamed at the rate of 9½ knots over the measured mile. The dimensions are 177 ft. by 27¼ ft. by 12¼ ft. The cylinders are 22 in. and 41 in. in diameter by 30 in. stroke, and there is an extra large steel boiler according to Board of Trade requirements for 95 lb. working pressure. The vessel has been built for Messrs. Coppack, Carter, and Co., of Connah's Quay, from designs and specifications by Mr. Joseph R. Oldham, of Liverpool. The builders are the Royal Shipbuilding and Engineering Company "de Schelde," Flushing.

On August 14, the s.s. Ituni, built to the order of the Demerara and Berbice Steamship Company by Messrs. Wigham, Richardson, and Co., was taken on her trial trip. The dimensions of this vessel are 237 ft. length between perpendiculars by 32 ft. breadth and 16 ft. 3 in. moulded depth. This vessel and her sister ship, the s.s. Eeta, already running, are constructed for the Demerara and Berbice trade, which, owing to the difficulties of the port of Demerara, requires a large displacement on a light draught. The engines have cylinders 27 in. and 54 in. in diameter and 36 in. stroke, and two boilers of ample power working 90 lb. pressure. The trial was satisfactory, the vessel attaining a mean speed of 10 knots. The vessel has been built to the specifications and plans of Messrs. Flannery and Baggallay, London, superintending engineers for the owners.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Pontefract Gas Company.—At the half-yearly meeting, Mr. T. W. Tew, chairman, presided, and the report showed that 10,966,459 cubic feet of gas had been consumed during the half-year, being an increase of 171,202 cubic feet. A dividend of 10 per cent. on the original shares and 7½ per cent. on the new shares was declared, payable on the 1st of September next. It was recommended that the Corporation and private consumers should pay one uniform price of 3s. 3d. per 1000 ft., instead of the Corporation paying 2s. 9d. per 1000 ft., and the public 3s. 4d. A great number of pipes had been laid during the half-year, but it was to be regretted that the overseers of Pontefract and Tanshelf had greatly increased the assessment on the gas works and on the gas mains. The report was adopted.

Leeds Tramways Company.—The twenty-fourth half-

yearly report of the directors to be submitted to the shareholders has been issued. It states that the accounts show that the receipts have been 20,970*l.* 0s. 4d., in addition to the amount brought forward from last account, 445*l.* 5s. 8d.; total, 21,415*l.* 6s. The expenditure has been 17,803*l.* 1s. 11d., leaving a balance of 3612*l.* 4s. 1d., which the directors propose to appropriate as follows: Dividend at the rate of 4 per cent. per annum, 3200*l.*; contingent fund, 200*l.*; balance to carry forward, 212*l.* 4s. 1d.; total, 3612*l.* 4s. 1d. The total car receipts show an increase of 365*l.* 12s. as compared with the corresponding half of last year. There has been an increase in the cost of engine haulage, which is owing to a larger number of engines being in use, and also in maintenance of roads. With these exceptions, there is a reduction in most of the charges to the debit of revenue. The charge for maintenance of roads not only covers the general repairs (in the execution of which a great deal of new stone has been used), but it also includes the cost of relaying a large portion of the tramways with new steel rails. The directors some months ago ordered six more engines from Messrs. Kitson and Co., of Leeds, and expect to have them all delivered by the middle of August, and then the company will have ten engines altogether. They also ordered two large bogie-wheeled cars from Messrs. Starbuck and Co., of Birkenhead.

Furness Railway Company.—The report of the directors to be submitted to the 80th half-yearly general meeting of the company, to be held at the offices, Barrow-in-Furness, on Friday, the 22nd inst., says that in their two last half-yearly reports the directors referred to the unsatisfactory state of the iron and steel trades. The depression in these industries has, during the past half-year, become more severe, and the general traffic of the district has consequently materially decreased. The result is a large falling-off in the receipts of the company, not only from the carriage of minerals, but also from passenger and general traffic. The directors have endeavoured as far as possible, to reduce the working expenses. They have also curtailed the expenditure upon capital, proposed and sanctioned at the last general meeting to the extent of about 11,000*l.* The gross earnings of the half-year are 250,268*l.*, being 22,644*l.* less than those of the half-year ending June 30, 1883. The working expenses are 119,751*l.*, showing a reduction of 7185*l.*, as compared with the corresponding period of 1883. The net receipts amount to 130,517*l.*, being 15,458*l.* less than those for the corresponding period of the year 1883. After providing for all preference charges, there remains the sum of 40,604*l.* available for dividend upon the ordinary stock at the rate of 3 per cent. per annum. This will absorb 39,630*l.*, leaving 974*l.* to be carried forward to the next half-year's account. During the half-year the sum of 55,765*l.* has been received on account of the 200,000*l.* of 4 per cent. preference stock issued in pursuance of the resolutions passed at the general meeting of the company held on the 23rd of August, 1883. The total sum received in respect of this stock to the 30th of June last is 75,000*l.* The directors express regret at the death of the Duke of Buccleuch and Queensberry, who had been associated with the company since its formation, and had been a director for eighteen years. Mr. Edward Wadham, of Barrow-in-Furness, has been elected by the directors to fill the vacancy.

Messrs. H. Briggs and Co. (Limited).—The report of the directors for the year ending June 30, 1884, states that the result of the year's business has been most disappointing, and the directors regret that the depression of trade referred to in the last half-yearly report has increased during the last six months. The effect of the unusually mild winter has been a general restriction in the demand for house coal and a large accumulation of stock, which, under ordinary circumstances, would have been consumed during the winter. The profit from the Yorkshire Coal and Steamship Company (Limited) also shows a diminution owing to increased competition on the Hamburgh line through the running of steamers by the Co-operative Wholesale Society (Limited) between that port and Goole. The balance standing to the credit of profit and loss account, after payment of interest on debentures and prepaid calls, is 3332*l.* 19s. 5d., which the directors propose to carry forward. The debenture bonds of the company have been reduced by a sum of 3350*l.* paid off during the year, and bonds to the amount of 18,700*l.* have been renewed on terms more favourable to the company.

UNIVERSITY COLLEGE, BRISTOL.—The engineering department of this college includes courses of instruction for those intending to become civil, mechanical, or electric engineers, or surveyors or architects. The courses arranged for civil engineers, architects, and surveyors are intended to meet the generally acknowledged want of a preparatory training for one or two years before the usual entrance as articled pupil into an office. The course for civil engineers has received the approval of local engineers; and the course on architecture has also received the approval of local architects. Students who attend the mechanical engineering course enter engineering works during the six summer months, and in accordance with this scheme various manufacturing engineers in the neighbourhood have consented to receive students of the college into their offices and workshops as articled pupils. Special courses have been arranged for students studying for the profession of engineering, who wish to include in their professional training some knowledge of electricity and its technical applications, especially with regard to electric lighting and telegraphy, electro-plating, &c. The engineering laboratory has recently been provided with a powerful testing machine; and a practical acquaintance with the use of tools is afforded in the workshop. Theoretical and practical courses in surveying are given, and excursions for field practice are frequently made.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig Iron Market.—Last Thursday's market was steady, and on forenoon 'Change there were transactions at 41s. 7d. down to 41s. 6d. and back to 41s. 7d. cash, also at 41s. 8½d., 41s. 8d., and up to 41s. 9d. one month, the close being buyers at 41s. 7d. cash and 41s. 9d. one month, with sellers asking ½d. per ton more. The top quotations were again reached in the afternoon, but sellers at the close were accepting 41s. 6½d. cash and 41s. 8½d. one month, with buyers at ½d. per ton lower. The market was somewhat easier on the following day, with business done during the forenoon at 41s. 6d. and 41s. 6½d. cash, the market closing with sellers at 41s. 6½d. cash and 41s. 8½d. one month, and buyers at ½d. less per ton. Down to 41s. 5½d. cash and 41s. 7½d. one month were accepted in the afternoon, which were also the closing prices for sellers, buyers offering ½d. per ton under. Monday's market was quiet and easy, but the close was the same as that of Friday, though both forenoon and afternoon 41s. 5d. cash and 41s. 7d. one month were reached. The warrant market was firmer yesterday, and a fair amount of business was done at prices higher than those of the previous day, and the closing price was ½d. per ton higher than that of Monday. During the forenoon market there were transactions at 41s. 5d. up to 41s. 6½d. cash, and up to 41s. 8d. one month, the close being buyers at 41s. 6d. cash, and 41s. 8d. one month, and sellers wanting ½d. more per ton. Business was reported in the afternoon at 41s. 6¾d. and 41s. 6d. cash, also at 41s. 8d. one month, with sellers at the close asking the top prices, and buyers offering ½d. lower per ton. Prices again advanced to-day to 41s. 7d. cash, and 41s. 9d. one month, which were the closing quotations for sellers in the afternoon, with buyers offering ½d. lower per ton. A year ago the cash price was about 47s. per ton. With the exception that some of the shipping brands have been dearer, and in some cases very scarce, there has been no feature of any special interest in the Glasgow pig iron market during the past week. The market has certainly been steady, with comparatively little fluctuation in prices, and a considerable quantity of iron has changed hands, buyers having come forward somewhat more freely. Still, there does not seem to be much ground for concluding that an improvement is taking place, for as the wants of purchasers get supplied, the market again inclines to become heavy. No change in the state of trade at home falls to be noted, nor is any improvement reported from the Continent or from America. There are now 94 blast furnaces in actual operation, one having been damped down during the week at the Gartsherrie works of Messrs. William Baird and Co. At this time twelvemonth there were 114 furnaces blowing, or 20 more than at the present time, hence it may be said that compared with that of last year at this time, there is a reduction in the make of pig iron to the extent of about 4000 tons per week. Last week's shipments of pig iron from all Scottish ports amounted to 11,484 tons as against 9727 tons in the preceding week, and 14,884 tons in the corresponding week of last year. They included 2000 tons to Italy, 1850 tons to Germany, 1400 tons to the United States, 1363 tons to Canada, 990 tons to Holland, 515 tons to Belgium, 265 tons to France, 255 tons to Australia, &c., and lesser quantities to other countries. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood at 586,447 tons yesterday afternoon, as compared with 586,836 tons yesterday week, showing a decrease over the week amounting to 389 tons.

Death of Mr. Walter Neilson, of Summerlee Iron Works.—The Glasgow newspapers of this afternoon announce the death of Mr. Walter Neilson, of Summerlee Iron Works, which took place at Ayr, where he was seized with illness about two months ago. Mr. Neilson was the son of the well-known John Neilson, of the Oakbank Foundry, Glasgow, and for the major portion of his life he was prominently identified with the manufacture of pig iron at the above-named works. The career of the deceased is well entitled to a fuller notice, which we hope to be able to give in our next issue.

Boats for the Nile Expedition.—Several firms on the Clyde have taken in hand the building of a number of boats to form the flotilla for the Gordon Relief Expedition up the Nile. Messrs. D. and W. Henderson and Co., Meadowside Shipbuilding Yard, Glasgow, have undertaken to supply thirty-three of the boats; and Messrs. John Shearer and Son, Glasgow, will supply a smaller number. Overtures were made on Monday to Greenock and Port-Glasgow builders, but as the time within which the boats were to be completed and delivered, namely, twenty-seven working days, was so short, the offer was not seriously entertained by the Greenock, although two contracts were taken up by Port Glasgow firms. The boats are to be 30 ft. long by 7 ft. wide, and 2½ ft. in depth. Their weight is not to exceed 1000 lb., and they are each to carry 6500 lb., which is about the weight of fifteen soldiers, with ammunition, provisions, &c. The boats will be provided with rollers, so that when the cataracts are reached the boats will be run ashore and rolled over the land until navigation can be again resumed. Each boat is also to be supplied with six poles to push them over sandbanks or any other obstructions that may be encountered.

Railway Locomotive Works—Resumption of Full Time.—The Glasgow and South-Western Railway Company's employés at their workshops at Kilmarnock have this week been again put on full time. For the past three months or so they were working only five days a week. A similar happy change in the fortunes of the workmen has also taken place at the North British Railway Company's workshops at Burntisland.

Trade at Bonnybridge.—For many years the ironfounding business connected with the manufacture of Singer sewing machines has been carried on at Bonnybridge, near Falkirk, but as the Singer Company are now concentrating all their operations at Kilbowie, near Clydebank, in Dumbartonshire, where they will do all their own ironfounding, trade at the first-named place is now suffering in some measure. No fewer than 200 foundry workmen have left Bonnybridge to be employed in the immense works of the Singer Company, at Kilbowie, but there is every confidence that Messrs. Ure and Co. will, in the course of time, do something to make up for the loss of the trade in sewing machine castings. In the same place there is a very large business in making the castings for the so-called American stoves, of which there are almost endless varieties. This business was started a long time ago by Messrs. Smith and Wellstood, and the production of the sewing machine castings was engrafted upon it; indeed the work started by that firm may be said to have been the origin of the sewing machine trade on this side of the Atlantic.

Dundee Shipbuilding Trade.—It is reported that several Dundee shipbuilding firms have refused contracts owing to the high rate of wages demanded by the workmen, the rate being nearly 25 per cent. higher than what is paid on the Clyde. One firm had the keel of a vessel laid down and another has a contract in hand ready to proceed with, but the exorbitant demand of the men has stopped all work, and it is fully expected that the contracts will be transferred to the Clyde.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday, owing to the local holidays for Stockton races there was a thin attendance on 'Change, and the amount of business transacted was very small. Little lots of No. 3 Cleveland pig changed hand at 36s. 3d. per ton f.o.b. for prompt delivery over a month or two. Shipments are disappointing, being 43,300 tons up to date against 44,600 tons to same time last month. As nearly all the rolling mills and foundries are closed, and as the Eston Steel Works are still idle for want of contracts, a considerable increase in the stocks is expected during the current month. Reports from the iron centres in England, the Continent, and America are not encouraging for a satisfactory winter's trading, and with this in view consumers and merchants incline to hold off from purchasing. The manufactured iron trade continues dull at 5*l.* per ton for ship plates and 4*l.* 15s. for angles less 2½ per cent. at makers' works. Hematite pig iron is flat at 44s. and 44s. 6d. per ton for Nos. 1, 2, and 3 f.o.b. west coast ports. There is no indication of any improvement in trade.

The Steel Trade.—For the past few weeks the great Eston Steel Works of Messrs. Bolckow, Vaughan, and Co., of Middlesbrough, have been standing idle owing to the difficulty there is of obtaining orders at rates which will leave a profit. These gigantic works are capable of producing about 5000 tons of steel per week. While they have been inoperative, the enterprising firm have been adapting themselves to the change which is going on in the iron industries, and have been putting down extensive plant for rolling steel plates. Bolckow, Vaughan, and Co., have made such additions and alterations as will place them in a position to supply either Siemens or basic steel. The works will be shortly recommenced, and it is hoped that they will be kept going uninterruptedly for some time.

Engineering and Shipbuilding.—There is no change to report in the general dull state of these industries.

The Coal and Coke Trades.—There is no alteration in the coal and coke trades.

The Salt Trade at Middlesbrough.—This new trade is developing satisfactorily. Messrs. Bell Brothers, the pioneers, are raising brine which makes about 500 tons of salt per week, and next month they will put in operation their new alkali works close to the salt pans at Port-Clarence. A new company have commenced boring, and Messrs. Bolckow, Vaughan, and Co. are continuing their boring operations.

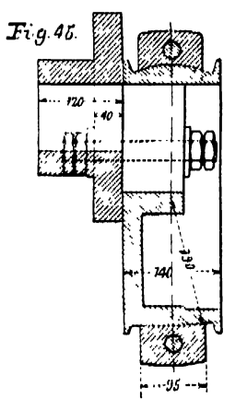
MESSRS. HORNSBY AND CO.'S SHEAF-BINDERS.—The correspondent of the *Times*, from whose account we extracted the brief notice we published last week of the trials of the sheaf-binding reapers, has written to that journal to correct some errors in his statement as regards Messrs. Hornsby's machines. In Monday's trial, machine No. 4568 made "very few misses," and not sixteen as previously stated; while No. 4569 tied every sheaf. The next day this latter machine cut its allotted portion without a stoppage. In the final contest Hornsby's No. 4568 and Howard's No. 47 alone entered the field, and both cut twice round successfully.

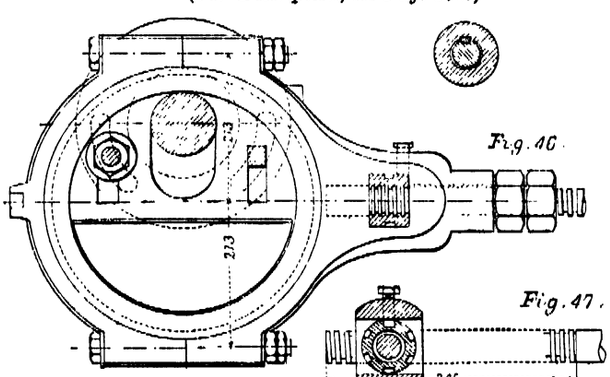
AXLE BREAKAGES IN GERMANY.—The report of axle breakages in 1883 on the railways in the German Union shows a total of 157, against 181 in the previous year. Of those breaking last year 122 were iron and 35 steel. One of these axles had been running 35 years, three more than 30 years, 10 more than 25 years, and 35 more than 20 years. The average life of those whose age was known was a little less than 15 years. Three of the broken axles were under passenger cars, 100 under freight cars, 35 under tenders, and 19 under locomotives. On the average they had run more than 200,000 miles each. The causes of the breakages are given as follows: Defects in material, 17; defective manufacture, 2; an old crack which could not be detected, 39; an old crack which could have been detected, 49; collisions, 3; derailment, 1; hot journals, 10; unknown, 36.

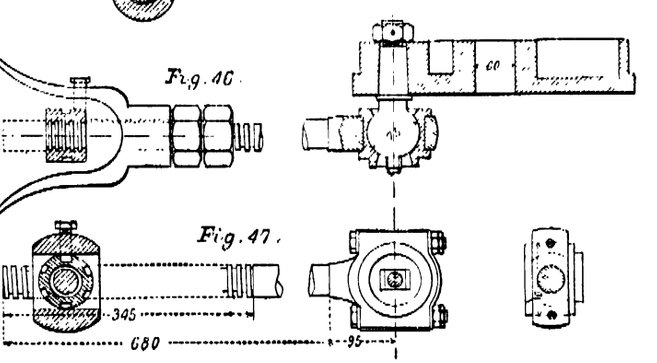
DETAILS OF BESSEMER BLOWING ENGINE FOR THE HEFT STEEL WORKS.

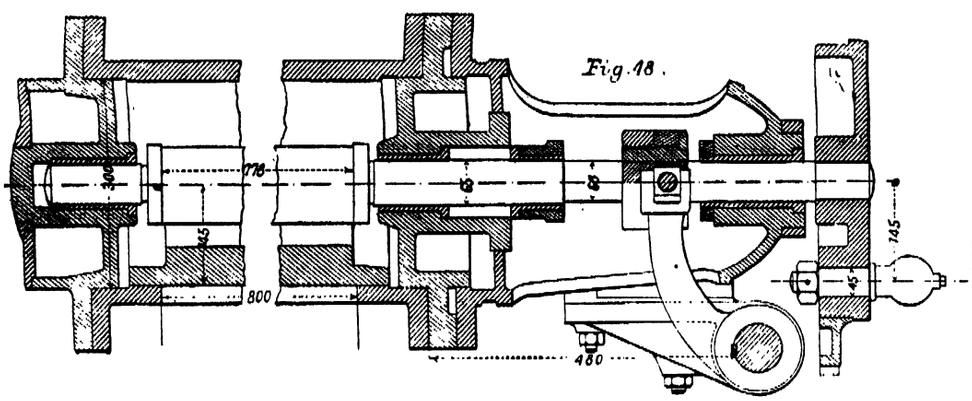
CONSTRUCTED BY MESSRS. BREITFELD AND DANEK, ENGINEERS, PRAGUE; FROM THE DESIGNS OF PROFESSOR RIEDLER, MÜNICH.

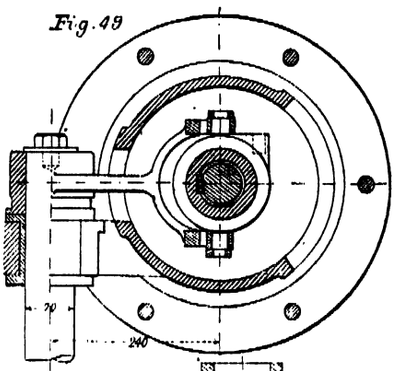
(*For Description, see Page* 176.)

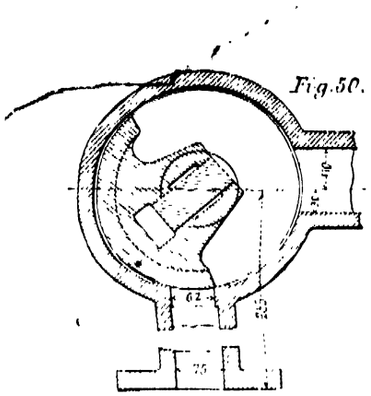


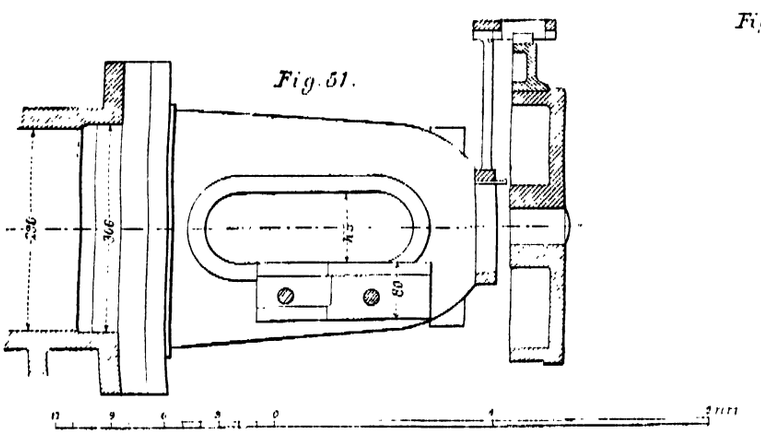


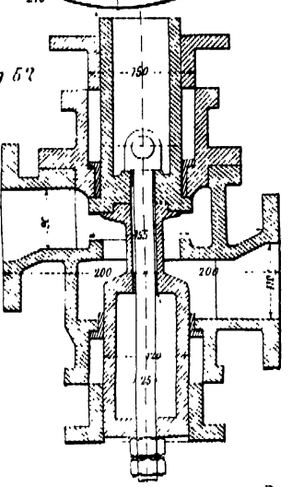


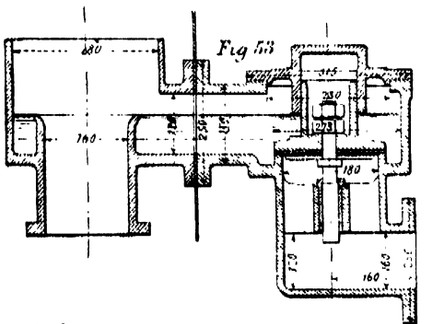


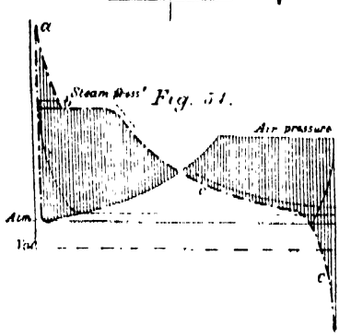


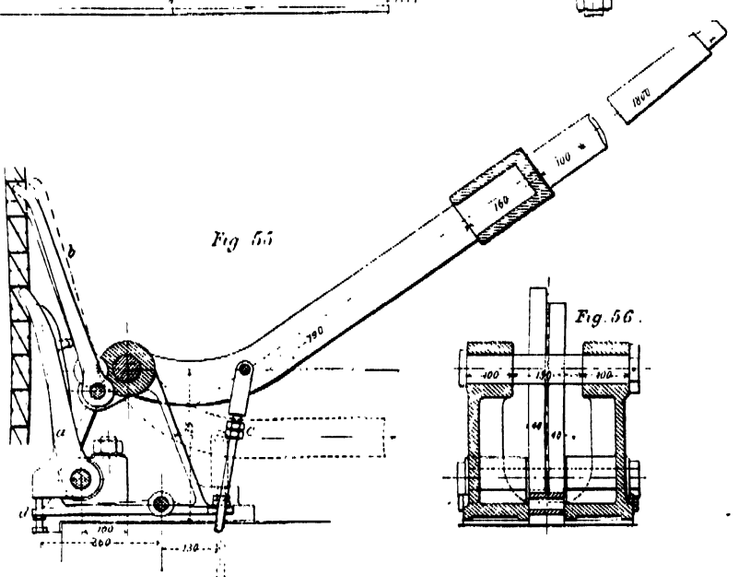












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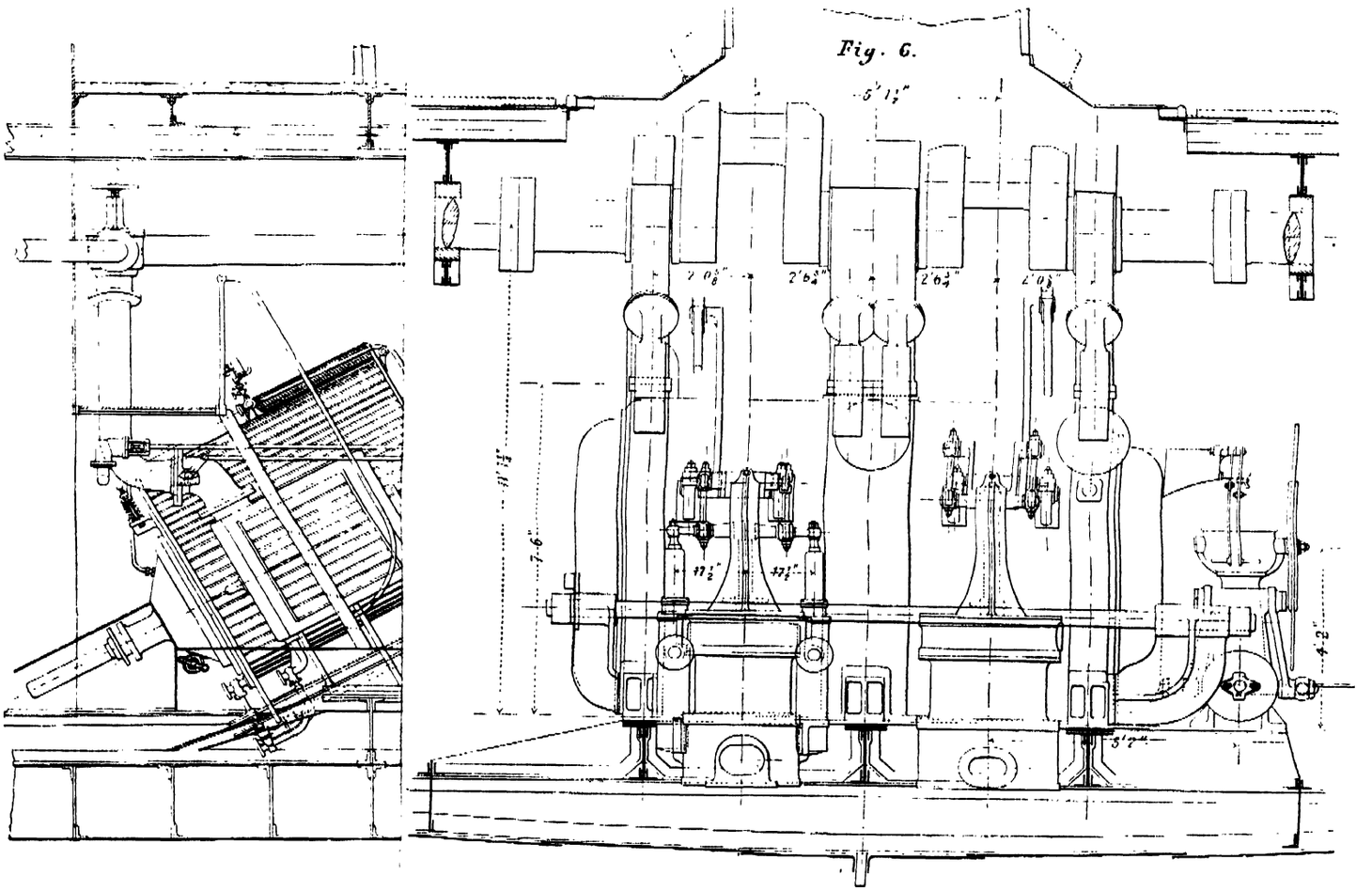


Fig. 6.

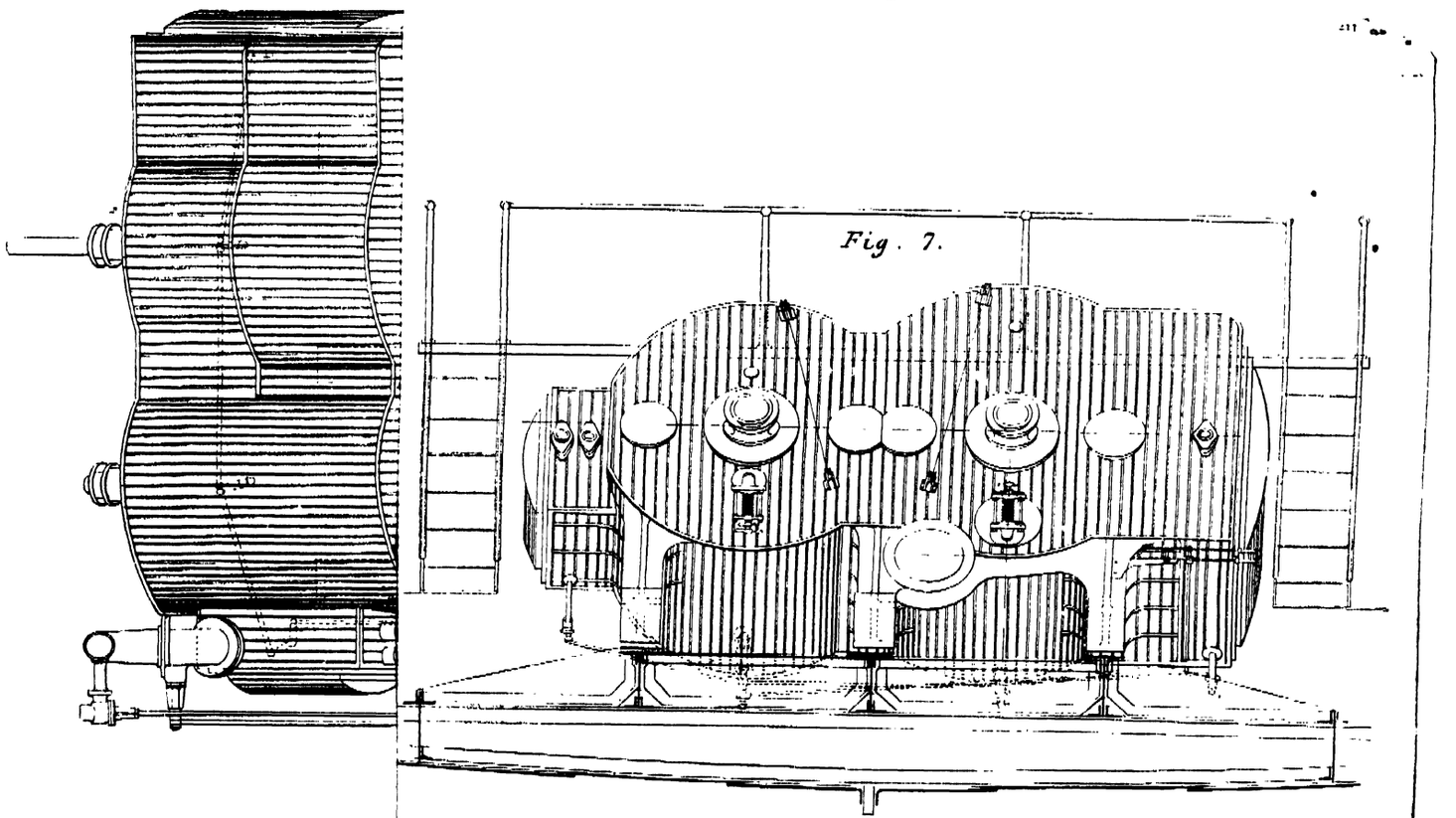


Fig. 7.

AGENTS FOR "ENGINEERING."

BELGIUM: F. Baffly, 12, Rue du Parchemin, Brussels.
BERLIN: Messrs. A. Asher and Co., 5, Unter den Linden.
CALCUTTA: G. C. Hay and Co.
EDINBURGH: John Menzies and Co., 12, Hanover-street.
FRANCE: Veuve J. Boyveau, Librairie Etrangère, 22, Rue de la Banque, Paris; M. Em. Terquem, 15, Boulevard St. Martin, Paris.
GLASGOW: William Love.
LEIPSIC: Alphons Dürr.
F. A Brockaus.
LIVERPOOL: Mrs. Taylor, Landing Stage.
MANCHESTER: John Heywood, 143, Deansgate.
OSTEND: Kirkland and Cope.
ROTTERDAM: H. A. Kramers and Son.
UNITED STATES: John Wiley's Sons, 15, Astor Place, New York.
VIENNA: Lehmann and Wenzel, Kärntnerstrasse.

Advertisements intended for insertion in the current week's issue must be delivered not later than 6 P.M. on Thursday. The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. Serial advertisements will be inserted with all practical regularity, but absolute regularity cannot be guaranteed.

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Foreign subscribers, especially when renewing their subscriptions, are particularly requested to advise the Publisher of the transmission of the Post Office Order, and the exact amount for which it is made payable. If this precaution is omitted, some difficulty is very likely to occur in obtaining the name of the sender.

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TELEPHONE NUMBER—3663.

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READING CASES.—Reading cases for containing twenty-six numbers of ENGINEERING may be had of the publisher or of any newsagent. Price 6*s.* each.

NOTICE TO AMERICAN SUBSCRIBERS.

We beg to announce that we have appointed the firm of John Wiley's Sons, 15, Astor Place, New York, the sole agents for ENGINEERING in the United States, and all subscriptions for the United States will in future be payable to them. They will also be prepared to receive advertisements for ENGINEERING, and will afford full information as to terms, &c., on application.

The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

ENGINEERING.

FRIDAY, AUGUST 22, 1884.

MR. MOON AND THE BRAKE QUESTION.

THE railway accidents at Downton and Penistone would seem to have disturbed the equanimity of the chairmen of those railways which are least prepared to cope with catastrophes of a similar character. In a recent number we drew attention to the somewhat absurd remarks of Sir Edward Watkin at the South-Eastern meeting when, to show the superiority of the vacuum brake, that gentleman depicted some quite imaginary dangers which he said were to be expected from the explosion of the Westinghouse brake. Mr. Moon, of the London and North-Western Railway, has now followed Sir Edward Watkin's lead, and at the recent half-yearly meeting of that company he made a further gratuitous attack upon the same appliance. It is a significant and encouraging fact that these gentlemen should have been moved at all, if only to defend their actions. Their continued contempt of the Board of Trade recommendations will surely result in compulsory legislation at the first opportunity, and it is no doubt the realisation of this fact which has led them to go out of their way to attack the opponent who has with such determined perseverance, introduced an apparatus which, of the several continuous brakes more or less in service, alone thoroughly complies with the conditions laid down by the Board of Trade.

At the recent half-yearly meeting of the North-Western Company, a shareholder referred to the severe censure from the Board of Trade which the South-Western Company had brought upon themselves on account of the Downton accident, and trusted there was no reason to apprehend a similar disaster on the North-Western Railway. The shareholders were assured by Mr. Moon in reply, that whatever might be the state of things on the South-Western line, "they themselves had made every provision to prevent accidents. A year ago he told them that finding that the South-Western, the Great Western, the Midland, the Lancashire and Yorkshire, the Great Northern, and the North Staffordshire Companies were all using the vacuum brake, they had decided that it was better to interchange with those companies and use the same brake. They were therefore now putting on the vacuum brake to a great extent." Mr. Moon, who appeared well primed for the occasion, then produced a number of statistics relating to the so-called failures of brakes as returned to the Board of Trade, with the view of showing the inferior character of the Westinghouse brake, and that from the fact of there being fewer incidents in connection with the vacuum brake per mile run, the latter was therefore a much superior appliance. Mr. Moon has many times assured his shareholders that in the Clark-Webb chain brake they possessed the "best brake in the world," and on his own method of reasoning, it must be so still, for there are many more miles run per failure with this brake than with any other, according to the returns. If this is really a test of efficiency, however, it is somewhat extraordinary that no other railway company would adopt it, and that the North-Western Company have themselves abandoned it. It must be evident to logical understandings that Mr. Moon has attempted to prove too much, indeed, he would be just as consistent if, having discarded the brake which is least mentioned in the returns, and which has been proved to be inefficient, he had resolved to adopt that which is mentioned most frequently as being the best. So far as these returns go, it would in our opinion be just as reasonable to select a brake on account of its frequent reports, as to condemn it without taking the principle of the apparatus, and its capacity for being of service, into consideration, as well as all the circumstances attending each case. These brake returns are really of no value whatever for the purpose of judging as to the relative merits of brakes. Each company has its own idea as to what constitutes a failure, and as to what cases should be reported. There is a very palpable tendency on the part of some companies to favour the appliance they have made their own, and it is notorious that they have not returned even well-known cases of absolute failure, from which Board of Trade inspectors have found collisions resulted. Mr. Moon had likewise provided himself with an extract from the report of Colonel Yolland on the Blackburn collision which took place in August, 1881, and he read some of that gentleman's inferences which were in themselves of a most contradictory character. Reference to our columns in which the subject of the collision was fully dealt with at the time, as well as to the evidence at the inquest, will make it fully clear to all unprejudiced minds that the Westinghouse brake was in no way responsible for the accident at Blackburn, and that the verdict of the jury, who found that it resulted solely from the loose system of working the signals and the recklessness of the driver, was the correct solution. It is not our intention to go further into the matter of the brake returns or to discuss once more Colonel Yolland's misconceptions. The Westinghouse automatic brake can defend itself. It is the only brake which thoroughly and efficiently complies with the Board of Trade conditions, which can be worked on trains of any length, as well as on slip portions both before and after slipping. It has been in use for ten years, it is now in daily operation around London in facilitating the most crowded suburban traffic in the world, and as we pointed out in a recent article, it has increased during the last four years at an average rate of about 1200 sets per month in all parts of the world. In face of such facts as these, and of such practical testimony as is contained in the report of Mr. T. E. Harrison as to the working of the brake on the North-Eastern Railway, which we published on page 71, the attacks of Sir Edward Watkin and Mr. Moon have absolutely no value.

But perhaps of more interest to the public in general, and to the North-Western shareholders in particular, are Mr. Moon's statements of the step they have taken with a view to uniformity. It is well known that mankind is much more ready to accept broad and bold statements, without question, collectively than individually, and both Sir Edward Watkin and Mr. Moon seem certainly to bear this fact in mind when addressing their respective shareholders. At least we must assume this to be the case, for it would not be doing justice to either of those illustrious chairmen to suppose that they have not taken pains to master the brake question in all its phases. Now the Clark-Webb chain brake having proved quite inadequate to meet every-day emergencies, having, moreover, been repeatedly the subject of the severest censure of the Board of Trade and its inspecting officers, it is, after an enormous outlay, to be abandoned, and Mr. Moon gravely assures his shareholders that it is done in the interests of uniformity. Finding, he says, that their neighbours were using the vacuum brake, "they had decided that it was better for them to interchange with those companies and use the same brake." But what are the facts? The Great Northern and Manchester and Sheffield Companies use a non-automatic vacuum brake, with a double coupling having male and female sockets; the Great Western and Midland Companies have a so-called automatic vacuum brake of their own with a single coupling, and a leak-off arrangement which destroys the brake power in about one and a half minutes; the Lancashire and Yorkshire also employ an automatic vacuum brake, but of different construction to that just named, the power of which is not intended to leak off, but the coupling is the same as that used on the Midland and Great Western Railways; the North-Western Company have adopted the non-automatic vacuum, but with the addition of an arrangement for automatically applying the brake in the guards' van, which it is suggested will answer all necessary purposes (a somewhat singular delusion), and the same single coupling as that on the Midland is used.

We have here then no less than four kinds of vacuum brakes employed on six railways, and not one of them will work harmoniously with any of the others. The couplings of the Lancashire and Yorkshire brake will, of course, unite with those of the Midland, but a brake which proceeds to come off so soon as it is applied cannot be expected to work harmoniously with one which remains on. The Lancashire and Yorkshire brake will also couple to the London and North-Western, but being upon opposite principles, the brakes of course cannot be worked on all the vehicles in a mixed train. The North-Western brake, on the other hand, is the same in principle as that on the Sheffield and Great Northern Railways, but since the couplings are different their carriages cannot be interchanged so far as the brake is concerned. This being the existing state of confusion we confess ourselves unable to see in what way the chairman of the North-Western Company has acted, as he claims, in the interests of uniformity, the fact being that, as regards the power of mutually working the brakes upon their own and other carriages, which is really what is required, this railway company is just as isolated as when they employed the discarded chain brake. Mr. Moon must surely have acquainted himself with the facts before making his statement; but whether he desired only to soothe uneasy shareholders, or is really unacquainted with the merits of the case, the facts remain, and are worthy the serious attention of North-Western shareholders, and of the public generally.

This question of uniformity in brakes is one of the utmost importance. Already there exists a state of things which is in the highest degree discreditable to our railway management, and it is time some check should be put to a system

which involves such a large waste of money. So far as the three main routes to the North are concerned, the joint-stock of each, that is, the carriages on the East Coast, West Coast, and Midland joint-stock are each now equipped with two forms of brake, viz., the Westinghouse and some description of vacuum brake. The latter, moreover, as we have shown, are all of a different class. In other words, there are four kinds of brakes fitted to the stock of three companies, and the Westinghouse is the only one which is common to them all, as well as to the whole of Scotland and four of the principal English lines in addition. There are twice as many Westinghouse brakes in this country as of any other single system, and there can be no question as to which will ultimately have to give way. The Board of Trade have repeatedly urged the companies to united and harmonious action, and so long ago as the 30th August, 1877, a strongly worded circular, putting the matter very clearly, was issued to the railway companies. Mr. Moon at the recent meeting said, "they would object to legislation, believing that legislation stereotyped what it did, and they looked for improvements which were constantly being made." Had Mr. Moon been really actuated by a desire for improvements, he would scarcely have retained the chain brake so many years, and then have adopted a vacuum brake which has repeatedly been censured by the Board of Trade, and has too often proved to be inadequate in emergencies.

Two reports have just been issued which concern both these brakes. Colonel Rich, reporting on an accident which occurred at Lime-street Station, Liverpool, on the North-Western line, says of the one, "The brake is not a continuous brake, but a very indifferent sectional brake; and I would strongly urge the company to adopt one of the automatic continuous brakes that have now been in use on many of the railways in the kingdom for some time, and have proved to be fairly effective." Major Marindin, speaking of the other apparatus in connection with an accident at Manchester, on the Manchester and Sheffield line, says, "The train would not have run as it did for 75 yards after the collision if this non-automatic brake had not been rendered useless by the breaking of the vacuum pipe." We are ourselves, on general principles, averse to State interference, but on a question which involves the safety of the travelling public, and which has been so much neglected by the existing authorities, we confess to see no other way of evolving order out of such chaos, than that of compulsory legislation.

THE MESSAGERIES MARITIMES.

The Council of Administration of this great French steam shipping enterprise has recently presented a detailed report upon the position of the undertaking at the close of 1883. It appears that the original cost of the fleet, tools, &c., of the company was 4,591,191*l.*, which had been written down to 2,089,799*l.*, by successive allowances for depreciation. The practice adopted by the company is to charge off, as an allowance for depreciation, 5 per cent. of the original value of the fleet every year. The allowance at this rate represented a deduction for 1883 of 194,137*l.* A special allowance of 42,419*l.* was also made last year in respect of the steamer Méandre, the hull of which was sold in 1883 for the purpose of being broken up. The company having undertaken a few years since a new line to the Bristish Australian colonies, the Council of Administration deemed it advisable to proceed with the construction of six new steamers at the company's La Ciotat yard. Three of the vessels, the Caledonie, the Sydney, and the Salazie, were completed in the course of 1883; and they have been placed upon the Australian line, in conjunction with the Melbourne, which was brought into use in 1882. The fifth vessel, the Yarra, also left on her first voyage in February this year. The sixth and last vessel, the Océanien, is still in hand at the La Ciotat yard. All the six vessels are of a large size, and of a nearly uniform type. The Yarra has a total displacement of 5908 tons, and is fitted with high-pressure engines of 3480 horse-power; upon her trial trip she attained a speed of something over 15 knots per hour, or more than four knots per hour in excess of the speed stipulated for in the specification. The Yarra is also fitted with the electric light; this light is extended to all parts of the ship, and renders circulation as easy during the night as during the day. If the anticipations which are now entertained as to the result of this installation on board the Yarra are fully realised, as there is little doubt they will be, a similar system of lighting will be successively introduced into the other large steamers of the company's fleet. Besides building some first-class steamers with a view of efficiently discharging the obligations of the undertaking in connection with the company's trans-oceanic lines, the Council of Administration has deemed it advisable to construct a certain number of commercial vessels or cargo-boats, principally intended for the conveyance of goods. Four ships of this description were commenced last year in the company's yards; and their construction is now sufficiently advanced to justify the administration in anticipating that the new vessels will shortly be ready for service. The first of the four ships, the Cordovan, is, indeed, completed, and the three others, the Médoc, the Matapan, and the Ortegal will follow in succession at intervals of a few months. They are all four of large carrying capacity, being each of about 2000 tons burthen. They are fitted with engines of great power, and are capable of developing a rather high rate of speed. At the close of 1883 the company's fleet comprised fifty-four ships afloat and six in course of construction, making a total of sixty steamers, of an aggregate collective force of 24,715 horse-power, or 98,860 horse-power effective, and having an aggregate displacement of 229,173 tons. As a proof of the financial skill which characterises the management of the company, it may be stated that during the last four years, twelve vessels of large size, including four cargo-boats, have been constructed, at a cost of 995,493*l.*, which has been provided by deductions from revenue without any new capital having been raised by the company.

In the course of last year the company's steamers ran a longer aggregate distance than in any previous twelve months. The distance traversed in 1883 was 686,115 marine leagues, exclusive of 10,229 leagues run by new steamers, experimentally, or by vessels forwarded for repairs to La Ciotat from Marseilles. The corresponding distance run by the company's steamers in 1882 was 601,500 marine leagues. The increase of 84,615 leagues, which occurred in the distance run in 1883 was the result of voyages made last year on the Australian and New Caledonian services, inaugurated in November, 1882. The company is now working four lines of steamers, the first in the Mediterranean; the second, in the Atlantic; the third, to India and China; and the fourth, to Australia. The steamers engaged upon these lines executed last year 521 voyages, which may be classified as follows: 284, comprising 561,499 leagues, in the accomplishment of the postal service and the obligatory colonial service; 226 regular voyages, comprising 114,604 leagues, upon the company's lines in the Black Sea, the Indian Ocean, and the Sydney and Nouméa branch; and, finally, eleven supplementary voyages, comprising 9912 leagues run by steamers sent to certain stations in replacement of other vessels. The whole of these voyages were effected by fifty-four steamers belonging to the company, and one sailing vessel, chartered at Singapore, in order to temporarily replace the Emirne, which has been laid by for repairs. It follows that the average distance run by each vessel in the company's fleet last year was 12,706 marine leagues. With the exception of a few rare accidents, the company's services were carried on last year with much regularity, and the speed attained showed a notable excess upon that prescribed in the contracts entered into with the French Government. Upon the Brazilian and La Plata line, the average speed attained was 12 knots per hour; upon the Indo-Chinese line, 12.03 knots per hour; and upon the Australian line, 12.21 knots per hour. No important changes were introduced last year into the postal service carried on by the company. It may be observed, however, that the Réunion and the Mauritius service has been detached from the Indo-Chinese service, and has been tacked on to the Marseilles and Nouméa line, a more direct transit of letters and papers to and from France, the Mauritius, and Réunion being thus secured. Upon the application of the Government of Cochin-China, the annual number of voyages between Saïgon and Haïphong was also carried last year from twelve to thirteen; and it is ultimately proposed to increase the number of annual voyages to twenty-six, a corresponding increase being made in the remuneration allowed to the company. As a consequence of the modifications made last year in the postal arrangements carried out by the company, the annual obligatory distances which the company will in future have to run are as follows: State service—Mediterranean line, 146,553 marine leagues; Atlantic lines, 99,552 leagues; Indo-Chinese lines, 199,507 leagues; Australia and New Caledonia line, 102,622 leagues; total, 548,234 leagues. Colonial service—Saïgon and Haïphong line, 14,837 leagues; Saïgon and Singapore line, 11,197 leagues; total, 25,584 leagues. The company's aggregate compulsory voyages for 1884 accordingly came out at 573,818 marine leagues. The company carried last year 108,988 passengers, 393,420 tons of goods, and specie and securities to the value of 5,065,358*l.* The revenue of the company from all sources in 1883 was 2,014,022*l.*; the working expenses of the year were 1,834,477*l.*, leaving the profit for the twelve months at 179,545*l.* Of this sum 26,837*l.* was absorbed by interest on debentures, leaving a balance of 152,708*l.* available for dividend upon the share capital. Out of this balance a dividend at the rate of 6 per cent. per annum has been declared for 1883, absorbing 144,000*l.* A sum of 7635*l.*, being 5 per cent. of the balance available for dividend, was carried to the statutory reserve fund, and a final balance of 1073*l.* was carried forward to the credit of 1884. The dividend of 6 per cent. paid for 1883 may appear a fairly good result; but it may, perhaps, be well to remark that the corresponding dividend for 1882 was at the rate of 7 per cent. per annum. No doubt the Messageries Maritimes has suffered, to some extent, from the depression which of late has affected industry all over the world.

SANITARY AND INSANITARY HOUSES.

The latest attraction at the Health Exhibition is the pair of houses that have been erected in the grounds to illustrate the difference between a dwelling as it ought to be, and is fit to live in, and one of the too ordinary type, *i.e.*, in which hygienic appliances are all but entirely neglected. We use the word "attraction" advisedly, as since the opening day the buildings have been thronged by crowds of sightseers. How many make the tour of the two houses for the sake of getting practical information, and how many simply because it is part of the show, it would be invidious to inquire; but the work has been so admirably designed by the special committee, and so well carried out, that it cannot fail to afford valuable instruction to those who will take a small amount of trouble to master the details. We would strongly advise those who wish to make an intelligent examination of these houses to carry with them that excellent work "Dangers to Health; a Pictorial Guide to Domestic Sanitary Defects," by Mr. T. Pridgin Teale, M.D., M.R.C.S. This book contains a series of graphic illustrations of the commoner dangers of house construction.*

The insanitary house is the first met with on the tour of inspection. The entrance to this is by what would ordinarily be the tradesman's door in the front area. The first object claiming attention is the dust bin, which is placed close to the entrance. It is of ordinary construction, being simply the end of the area partitioned off. It is only when one sees the small portable iron dust bin of the exemplary residence next door that one appreciates the defects of this roomy refuse receptacle. There can be no greater fault in a dust bin than being too big, because in that case it is likely to be seldom emptied.

Entering the house we find three rooms on the basement. We first notice a label placed on the lower part of the walls which draws attention to the damp arising from the absence of an efficient damp-proof course. In the centre room of the three there is a cistern placed snugly away in a dark corner, which, we are informed, is intended to supply drinking water. It is also used for the servants' W.C., and has a branch leading to the scullery sink. The overflow pipe discharges directly into the drain, and is presumably untrapped, all of which points, it is needless to say, are the reverse of what should exist. On the floor above, and immediately over this cistern, there is a water-closet, any leakage from which will run directly into the cistern, as there is no safe to it.

* We understand that a very complete guide to this feature in the Exhibition is now being prepared under the superintendence of Mr. Ernest Turner, F.R.I.B.A., and will be shortly issued by the Literary Department.

In the front of the scullery sink, as well as in the front area, is a cast-iron bell-trap, a contrivance which may be said to be practically useless for preventing the ascent of foul gases. The annular groove intended to hold the water seal invariably gets filled with dirt or grit, and even if this were not so, it is far too small to contain sufficient water. The manufacture of these traps should be made a criminal offence. Another label over an opening in the floor points out that there is a "dip trap." This form of trap consists generally of a rectangular chamber formed below the level of the drain, and in the centre of which a hanging partition dips into the water contained. Putting aside the probability of foul air ascending through imperfect formation of the dip, the trap is very badly designed. From its form it is practically impossible to flush it and the water forming the seal will become so foul as to generate noxious gases, which may prove almost as troublesome as if the drain were entirely untrapped. Another opening in the floor discloses the drain which runs under the house. It is composed of stoneware pipes with puddled joints of clay. The unsuitability of such material is obvious. If the clay is allowed to dry, it cracks and falls out, and in any case it never makes a very safe and efficient joint. Cement joints are also liable to crack in the event of walls settling through which the drain passes, or from other causes affecting the position of the pipes after they have been laid. Too often, however, the leakage that occurs from bad jointing is trifling to that which actually exists. In our own columns there was recently described a case in which all the soil from a house was deposited under the basement floor, the drain not being sufficiently whole to carry it into the sewer; indeed, cases are not unknown in which no connection has been made to the sewer at all, the drain simply discharging into some convenient space, say for intance that between the kitchen floor and the ground. It is desirable that drains should not be carried beneath the dwelling, but where this cannot be avoided the ordinary pipe drain should be bedded in cement.

In the middle room on the basement floor is to be seen the D trap which is connected with the closet above. This is open to the same objections as the dip-trap, and invariably becomes a nucleus of foul emanations. In the present case, however, a most diabolical combination has been planned, several waste pipes from sinks and lavatories leading directly into the trap and so setting up direct communication with the interior of the house and the accumulation of excreta which always lodges in a D trap no matter how often the closet may be flushed. The soil pipe from the closet is of course placed inside the house and is presumably unventilated. The danger that arises from this, supposing the pipe becomes corroded, is too obvious to need comment. It may be remarked, however, that cheap soil pipes, even if whole, when first put up, seldom remain so for long. The best material for this purpose is the drawn lead pipe in which there is no longitudinal joint, for sewer gas has a most damaging effect on solder. Soil pipes are often made of iron, which would be a good material if the danger of rusting and the difficulty of keeping joints tight owing to expansion and contraction could be overcome. The servants' water-closet is placed in a dark corner under the stairs. It is fitted with the common "deep hopper," a form of basin that is seldom clean, owing to the fact that the flush of water only flows on one side. The water strikes the side of the basin at a tangent in order that it may run round. It is seldom, however, that the volume and force are sufficient to give the desired effect. This closet, however, is probably better, supposing a syphon be placed beneath it, than the one on the floor overhead. This is known as the "pan closet," which is both the commonest and worst form met with. The lower part of the basin fits into a metal receiver or container. The pan which closes the bottom of the basin forms a trap as the opening at the bottom of the basin dips into it. The D trap under the container has already been referred to. The objection to this closet is that the large container becomes filled with foul matter which generates evil stenches, in fact the container as well as the D trap below are simply small but active cesspools placed in the middle of a dwelling.

Another opening in the floor shows a second part of the drain. Here the joints have been made with cement and to all appearance are perfectly good, but the label attached informs us that the cement is only placed in the upper part of the joint, which is easily accessible and also in view. The natural consequence of such an arrangement is that the filth leaks through and saturates the earth below. There is no trap to this drain, so that the foul gases would ascend from the sewer directly into the dwelling. A junction, by which a branch is carried into the principal drain, is shown. This is of bad design, as the branch is at right angles to the main line of pipes, and an eddy is thus caused which is likely to cause obstruction. All junctions should be made so as to deliver the flow at an easy angle. It may be here remarked that too often no junction at all is used, a hole of more or less regular shape being simply knocked in the main drain pipe into which the end of the branch is loosely inserted. Another form of scampish work in connection with drains is using straight pipes for forming bends by placing them at angles to each other. The consequence is that the foul matter runs easily through the angular space left by the imperfect junction of each pipe. Both these forms of homicidal workmanship are common in parts where inspection is not what it ought to be. Another bad form of closet is shown on the first floor. It is placed in the same dark and totally unventilated position under the stairs and is fitted with a D trap below. It is flushed from a "service box" in the cistern. This is a form of apparatus that is very liable to get out of order, although when properly used and kept in order it is perhaps better than the last closet described. The partition under the seat of this closet not being ordinarily in sight is not plastered so that evil stenches escape into the adjoining room. In this closet is a tap supplied from the cistern, which is in direct communication with the closet. This tap would naturally be used by the housemaid for filling jugs and water bottles. The waste pipe from the housemaid's sink is also in direct communication with the soil pipe of the closet. The same remark applies to the waste pipe of the bath, and to the overflow pipe which is connected with it. The rain-water pipe in this house delivers into the soil pipe of the closet, which of course is carried into the drain. In this way a regular service of poisonous gas is laid on outside the house and finds an exit in the neighbourhood of the top floor windows, or in any part of the pipe where there may be a leaking joint. The joists of the basement flooring are placed directly on the earth instead of being above a concrete bottom. Such a house as this would in effect simply form a ventilating shaft for the street sewer, to say nothing of the foul gases that might be engendered from the sulliage that would be retained by faulty appliances. The cistern supplying drinking water would also be in direct communication with the closet and drain, and the water drawn from it could not fail to be of the most unwholesome description. No one could live in such a house and be in even fairly good health. Yet dwellings practically as unwholesome as this are common throughout the country. Perhaps it would not be easy to find one combining all the defects we have enumerated, but probably those containing a large part of them are in the majority. Within a few days of writing this we have been called on to examine a handsomely built residence in one of the best suburbs in London. There was the pan closet for servants' use placed next to the larder, the only partition between the two under the seat being composed of badly fitted boarding, warped and cracked in all parts. The waste from the bath and the rain-water pipe were connected directly with the drain leading to the cesspool, for no sewerage system has yet been laid down here. The overflow pipe from a cistern at the top of the house was carried into the rain-water pipe referred to, and so there was an immediate connection between the cesspool and the cistern, as well as between the cesspool and the interior of the house. This house is situated on the edge of a breezy common, and has a large and well-planted garden. It has had several inhabitants within the last few years, the last tenants leaving before the term expired "because the neighbourhood did not agree with them."

The "sanitary house," which is entered from the insanitary house by the attic, is of course the opposite to all we have hitherto described. The first thing to attract attention are the windows. These have a bead 3/8 in. deep on the sill, so that the lower sash can be raised, and an opening for ventilation is thus made at the meeting rails without letting cold air in at the bottom. Both sashes also pivot as well as raise and lower, which enables them to be cleaned with ease. The gas brackets are ventilated, one having an inverted iron pan over it, and another being covered with a bell-glass terminating in a tube leading outside the house. When it is remembered that a single ordinary gas jet will require as much fresh air to support its combustion as will suffice for between four and five people, and gives off 3.21 cubic feet of carbonic acid per hour, the necessity for ventilating gas burners will be apparent. It must be remembered too that gas is by no means the worst offender in this respect, both paraffin oil and candles vitiating large volumes of air. Of course the best plan is to use the electric light, and several incandescence lamps are shown in the lower part of the house.*

The cistern in this house is easy of access and well lighted. This is a point too often overlooked even in houses in other respects well designed. A case lately came under our notice in which a new house had been supplied with all the most modern and approved drainage and ventilating appliances, the owner, who had built the house for his own residence, having a large family, spared neither pains nor trouble in his endeavour to make it hygienically perfect. It was found after a time that the children were suffering from continual diarrhœa and other evil symptons, the cause of which could not be explained. The cistern for supplying the upstairs rooms had been placed in the roof, and on examination it was found that two sparrows' nests had been built over it so that all the droppings fell in the water. The bodies of three dead birds were removed when the cistern was cleaned. It is no uncommon thing for small birds and mice to fall into cisterns placed in out-of-the-way places, whilst rats or cats, and even a ferret have been known to meet untimely ends in domestic cisterns. Perhaps the most disgusting case that we ever met with, was one in which the black beetles of a household had selected the cistern as their last resting place. In the case of the house in the Exhibition, a cistern is provided especially for the bath and closets, but separate flushing cisterns are fitted for the latter so that there is no communication between the closet and water that can be used for any other purpose.

The bath has a large waste pipe, which not only allows it to be speedily emptied but permits of the waste water becoming efficient for flushing the drains. This pipe is properly trapped, although it discharges into the rain water head instead of into the drain as before described. The bath-room has a cork flooring. The housemaid's sink is made of enamelled earthenware, and is placed in a well-lighted position. The waste pipe is trapped and discharges into the open air.

The water-closets are placed in a light and well-ventilated position. The hopper form is also used here, but it differs from the one already described. The flush of water comes from all round the upper rim, so that the whole of the basin is washed out on each occasion. A flushing cistern with siphon action insures a good rush of water no matter how long the handle is held up. The pipe leading from the cistern is of ample size (1½ in.), so that the flush is not throttled in its descent. There is no more miserable economy than that of putting in small pipes when large ones should be fitted A lead safe to catch drippings or overflow is placed to all the closets in this house, a feature which is of course absent in the disreputable establishment next door. The drain from the safes passes through the house wall from which it projects a few inches. In this way any leakage is likely to be noticed by the droppings from the pipe.

The water-closet on the ground floor is of the "valve" type, which is one of the best forms of water-closet in use. The valve at the bottom of the basin retains the water. The overflow pipe is trapped, and is brought into use every time the handle is pulled up. This closet is trapped by a lead siphon trap in place of the filthy D trap used in the other house. The servants' water-closet is placed in the yard. It is of the same form as the one on the upper floor, and has a separate flushing cistern.

There are one or two other interior features it will be well to notice before passing to the outdoor arrangements. The insanitary house is hung with paper printed with arsenical preparations. These are not necessarily bright greens, such as the notorious "emerald green" that we heard so much of

* On page 13 of the present volume this subject is fully dealt with.

some years ago, but many of the quiet delicate tinted greys and blues contain a certain percentage of arsenic. It is impossible to decide without chemical analysis that no arsenic has been used in the preparations of many colours, although there are many in which this mineral can be authoritatively pronounced to be present. The only thing the householder can do is to trust to the honesty of the manufacturer, and to see that the colours are properly fixed, as it is the dust, mostly from the commoner papers, which is so injurious. The ventilation is provided for in the sanitary house by means of inlet and outlet ventilators, and the paint here, which is of reddish brown, is said to have a non-poisonous base in place of the ordinary white lead. The driers too are non-poisonous. The under part of the mantlepiece was decidedly "tacky" on the occasion of our visit. It does not seem very probable that any one would be poisoned by good oil-paint, at any rate after it had once been laid on and become dry, and we cannot help thinking the "non-poisonous driers" is somewhat of a "fad." The walls and ceilings of the basement being covered with washable distemper is a most desirable feature, and the stop-cocks placed throughout the water service to shut off any one part are desirable, if not absolutely necessary adjuncts. The pet-cock to drain the pipes is also useful in case of frost. The hall stove in the ground floor is not ventilated in the insanitary house, whilst in the sister dwelling this most important feature has of course received due attention. The flooring in the latter house is composed of parquet, a truly hygienic if somewhat costly arrangement.

Passing into the yard of the sanitary house we first notice the rain-water pipe which terminates a few inches from the ground in the open air, the water running from it into a proper gully. The overflow pipes of cisterns, and the waste pipes of safes under the baths and closets, all project a few inches beyond the external wall and so serve as a warning in case of leakage in the way already explained. The ventilating pipe to the valve-box of the ground floor water-closet, is also seen projecting into the open air. The waste pipes from housemaid's sink on the first floor, and from the bath, discharge into an open head in the rain-water pipe. The waste pipe of the scullery sink discharges into an open trapped gully. No grease trap is fitted, and no doubt is not necessary in small establishments or where the cook is allowed to sell the "kitchen stuff." Examples of damp-proof courses of slate set in Portland cement, of perforated stoneware, and of ½ in. asphalte are shown; a stoneware air brick to ventilate under the basement floor is also shown. The leaden soil pipe from the closets is placed outside the house, and is used for no other purpose. It is carried up its full size to the top of the house in order to keep it well ventilated.

The inspection chamber into which the gullies for waste and rain water discharge themselves, as well as the soil pipe and water-closet at the basement, is in the present case covered with a thick sheet of glass, to enable the arrangement to be seen in place of the usual air-tight door. In the bottom of this chamber there are three or four half-round pipes or gutters into which the above discharges flow. These gutters in turn lead into the iron drain that runs under the house in order to connect with the street sewer. It is, as we have already remarked, desirable that the drain should not be carried under the building, but where this is unavoidable it should be in one straight length from an inspection chamber to the manhole, which we are about to refer to. In fact, drains which are used for carrying foul matter should always be laid in straight lines with inspection chambers at any angle required for altering the direction. The drain under the house is made in this instance of iron socketted pipe, although many prefer stoneware pipes laid in concrete.*

Whether of iron or stoneware it is needless to say that the pipes should be socketed, great care being taken that the spigot fits fairly in the socket, and that the joint is well luted all round, unless Stanford's patent joints are adopted, an arrangement which was recently described and illustrated in these columns†. Iron pipes laid under a house, where the temperature is fairly regular, are not so liable to leak at the joints as when they are used for soil pipes outside a house wall, exposed to the heat of the sun and the sudden cooling of a shower or heavy dew. It is supposed, of course, that the drain will not be brought within the influence of kitchen fires or other disturbing causes. In any case great care must be taken in making the joints of iron drain pipes. Lead is not advisable, as iron is electro-positive to it, and the pipes will therefore corrode when galvanic action is set up. Perhaps the old-fashioned rust joint would be as good as anything. Spence's metal has also been suggested. Iron pipes should be treated on the interior in some way to prevent rusting. This is a point too often neglected. All drains should have a falling gradient towards the sewer, steep enough to insure the drain being sufficiently flushed in ordinary use. About 1 ft. in every 50 ft. or 60 ft. run will be generally sufficient supposing the drain be straight and used for ordinary domestic purposes of a dwelling-house.

The drain passes from under the house—a room being shown in section with the flooring up to exhibit its structure—and terminates in a manhole in the front area, which is also covered with a sheet of thick glass. This manhole is very similar to the inspection chamber already described, and in fact forms an inspection chamber. It is here that the disconnection between the house drainage and the branch leading to the street sewer is placed. This cannot be actually seen as it is below the level of the paving, but it doubtless consists of a stoneware syphon. There is a stoppered entry or by-pass above the bend by means of which the branch to the sewer can be cleared if it becomes blocked in any way. It is needless to point out that whenever the plug is removed it should be replaced as soon as possible, and rendered gas-tight as before. The manhole is fitted with an air-tight cover, and a ventilating passage having its inlet a few inches from the bottom of the area wall, delivers air into it. The air passes right through the iron drain and up the various pipes delivering into the inspecting chamber in the back yard. The soil pipe being carried the highest, naturally takes the larger volume. By this means any noxious gas that might otherwise accumulate through local influences will be carried above the roof and be dispersed. It has been suggested that an air inlet may under certain conditions become a foul air outlet, and a species of non-return valve has been devised to counteract evil influences that might so arise. We are not aware, however, that the phenomenon has ever been proved to exist to any serious extent.

Such are the leading features of the sanitary and insanitary houses. This most useful work has been well carried out by Mr. J. R. Roberts, of South Kensington, under the supervision of the special committee consisting of Messrs. H. H. Collins, F.R.I.B.A., W. H. Corfield, M.A., M.D., Rogers Field, B.A., M. Inst. C.E., Douglas Galton, C.B., F.R.S., and Ernest Turner, F.R.I.B.A.

If, in conclusion, we might venture to make one suggestion it would be that large sectional drawings should be made of those details the interior of which cannot be seen, and that they should be hung close to the objects themselves.

* The old-fashioned brick drain is a barbarous contrivance, especially if of large size such as are frequently met with in old country houses.

† See Engineering, page 20 *ante*.

THE TEXTILE TRADES EXHIBITION.

The Textile Trades Exhibition may now be supposed to have attained maturity, as it has been open three weeks, and the stands are complete. The vacant spaces have been filled up with bazaar exhibits of various kinds, and everything is ready for the inspection of the public, which up to the present has shown no curiosity whatever in the matter. Nor indeed is it likely to do, for with the exception of some dozen exhibits, there is nothing which can interest it. There is an utter want of continuity in the processess. One preparing machine, two ring spinning frames, and a dozen looms, no matter how excellent they may be individually, do not suffice to give an outsider a comprehensive grasp of the cotton trade, while, as for experts in textile industries, they do not exist in London, and are scarcely likely to come from Lancashire or Yorkshire. There are still a few of the miscellaneous exhibits which we have not yet described, and with them we shall conclude our notice of a show, which, while containing many articles of interest and merit, yet, taken as a whole, is a decided failure.

Messrs. Hick, Hargreaves, and Co., of Bolton, show an improved automatic barring engine for turning large engines by steam, either for the purpose of bringing the cranks into a favourable position for starting, or for effecting repairs to the engine or to the gearing. In cotton mills, particularly of the older type, the toothed gearing wheels are not bored out, but are fixed or "staked" on to the shafts by four keys, and hence when a new wheel is introduced it often happens that the engine has to be barred round many times in order to get the wheel accurately adjusted. This barring engine is shown in perspective and in detail on the opposite page. It consists of a pair of vertical engines, having cylinders 7½ in. in diameter, driving a crankshaft upon which is mounted a worm. This worm gears into a wheel which acts both as a wormwheel and a spur pinion, one side of each tooth being cut at an angle to suit the worm, and the other side being designed to gear with a ring of internal spur teeth cast on the inside of the flywheel of the main engine. The wheel is fixed upon a shaft carried in long slots, in which it can move from end to end. It is, however, normally kept at the inner end of these slots by a pair of springs. Underneath the wheel is a brakeblock which can be applied by a lever to stop its rotation for a moment, when it is out of gear with the main engine. If the barring engine be running and the brake be applied, the result is that the wheel rolls forward on its bottom side until its teeth come into gear with those of the flywheel, when the brake may be released. The main engine then begins to turn, and should the regulator be open, so that the engine will get away under its own steam as soon as the crank passes the centre, the pinion will remain in gear until this happens. The instant, however, that there is no longer any load on the pinion, the spring commences to draw it back, and should the flywheel overrun it, the influence of the spring is increased by a direct push which forces the two sets of teeth out of gear, and removes all danger of injury to either of them. The apparatus illustrated is suitable for application to engines up to about 400 or 500 indicated horse-power. A larger size with 9 in. cylinders will turn engines of 1500 indicated horse-power. The makers have already built several of these engines, both for this country and abroad. Messrs. Hick, Hargreaves, and Co. also show several of Knowle's supplementary governors, which have been lately described in these columns.

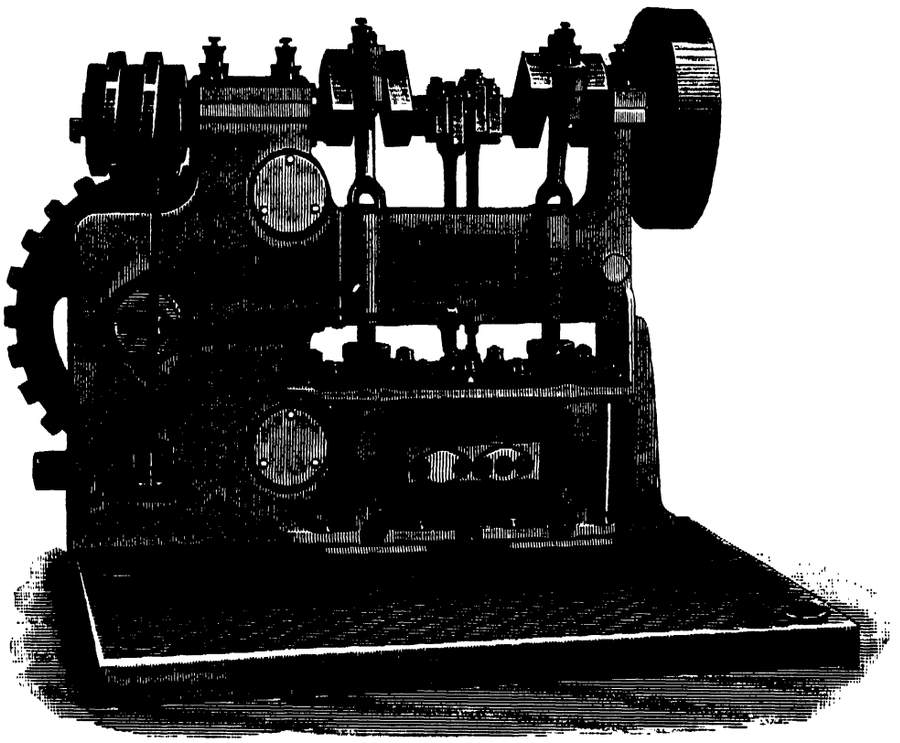
Hoists are shown by Messrs. Barker and Sons, of Park-street, Oldham, and by Messrs. Higginbottom and Mannock, of Gorton, Manchester. The former kind was fully described in our issue of May 12, 1876, and equally with the latter, is of the type in which a monkey travelling along a beam or cathead, goes out from the mill or warehouse to pick up a load from a truck or trolly, and then returns to deposit it upon the floor inside the building. This is a much safer and more convenient method of receiving goods than by means of a jib crane, which requires considerable skill on the part of the attendant, and can be applied with special ease in cotton mills, where the incoming goods are all bales of cotton weighing 4 cwt., and the outgoing goods are skips of cops, weighing 250 lb. In Messrs. Higginbottom and Mannock's hoist the monkey travels on two light wrought-iron beams, which ordinarily project about 7 ft. outside the building. The chain is made fast at one end to the extremity of the beam, hangs in a bight through the monkey, and is fixed at its other end to the chain barrel. This is carried on a shaft one end of which is supported in a movable bearing, capable of being held by a hand lever in three positions. Upon this shaft is a large friction pulley, which in the three respective positions of the shaft is either in gear with the frictional lifting pinion or the lowering pinion, or with a fixed brake. The lever is connected to a hand rope by the door, so that the attendant has perfect control of the machinery while he keeps his eye upon the load. The monkey is worked in and out by a pitch chain passing over a chain wheel on the opposite end of the chain barrel shaft to that upon which the large friction wheel is keyed. This chain wheel is loose on the shaft and is attached to a friction wheel, which like the preceding one, can be moved into gear with either of two friction pinions to draw the monkey backwards or forwards. The frictional pinions are driven by a cotton rope from the line shaft, and run continuously. The whole forms a very simple and handy hoist, and is one that is to be commended for its security to the man who works it, and to passers-by in the street below.

Messrs. Buckley and Co., of Sheffield, make a large display of their well-known pistons, of which they announce there are 11,000 in use, nearly

AUTOMATIC BARRING ENGINE.

CONSTRUCTED BY MESSRS. HICK, HARGREAVES, AND CO., ENGINEERS, BOLTON.

(*For Description, see opposite Page.*)



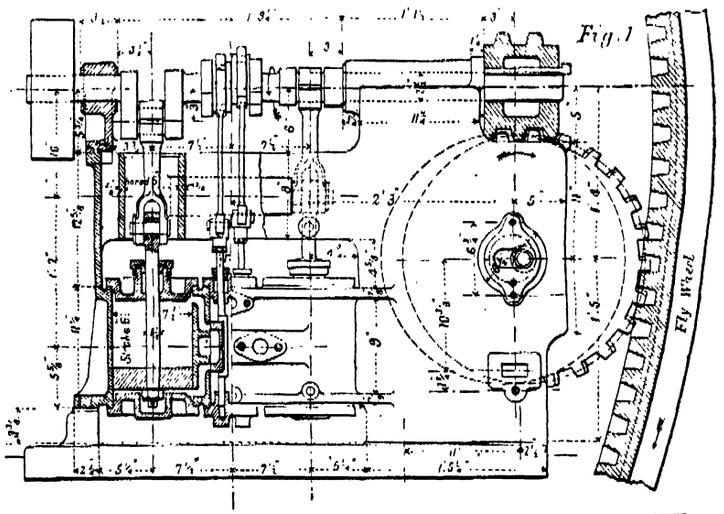


Fig. 1.

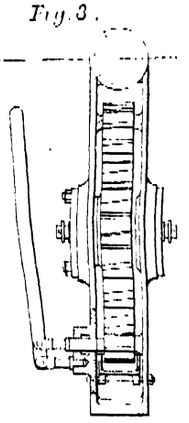


Fig. 3.

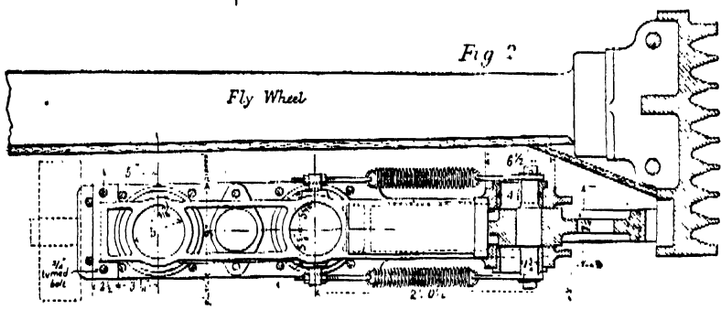
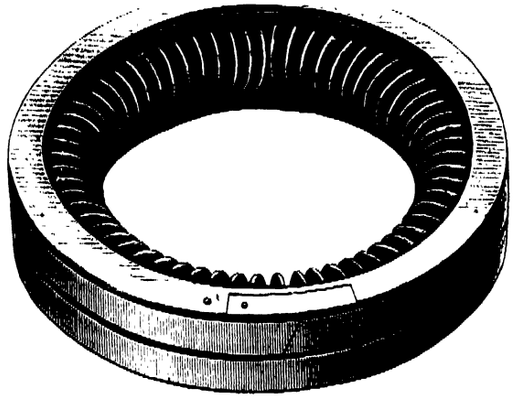


Fig. 2.

every well-known vessel, including the Umbria and Etruria, being fitted with them.

Mr. James Procter, of Hammerton-street, Burnley, shows one of the latest patterns of his mechanical stokers. Below the hopper is a trough or channel, with an opening in the centre of its upper side into the hopper, and one in its lower part over the entrance to each furnace. In the middle of this trough is a ram which moves backwards and forwards, and delivers the coal which falls in at the upper opening, to the two furnaces alternately. When the coal falls out of the trough it drops on to an extension of the dead-plate, and lies there until it is flung forward by an appliance which is called a shovel, but is scarcely described by that term. It resembles a flap valve, and is carried by a rock shaft which is intermittently rotated by a lever resting on a cam. As soon as the lever reaches the highest point of the cam and passes the edge, it falls instantly to the lowest part under the action of a spring which was compressed during the previous motion, and the shovel is forced forward, driving the coal before it. There are several projections and depressions around the circumference of the cam, and these are of gradually increasing height, so that the stroke of the shovel, and the distance to which it throws the coal, and varied for the purpose of covering the bars evenly. These latter have an intermittent rocking motion imparted to them to loosen the clinker when the fire becomes dirty, the mechanism being set in motion by throwing a pawl into gear. This pawl works a ratchet wheel on a countershaft. On one end of this shaft is a crank with its pin connected to a strong spring. As the shaft is gradually rotated the spring is compressed until the crank-pin comes over the top centre, when the spring suddenly carries the shaft through the next half revolution, and gives a rapid motion to the bars.

Messrs. Lancaster and Tonge, of Pendleton, Manchester, show a new form of piston, which we illustrate in the annexed engraving. A straight spiral spring, bent into a circle, forces the rings out against the walls of the cylinder, and at the same time holds them firmly between the junk ring and the piston body. The pressure between the piston rings and the cylinder results from the natural elasticity of the spring and its effort to regain its natural shape, and does not depend upon the screwing down of the junk ring. There is therefore no danger of excessive friction being set up between the piston and the cylinder by careless adjustment. The same firm has a large show of their steam traps and brass fittings which we have noticed from time to time.



Knitting machinery is shown by Messrs. Moses Mellor and Sons, of Lee Works, Nottingham, and by Mr. J. A. Claringburn, of Roden-street, Nottingham. The former firm exhibit circular machines only. One of them, of very large size, is designed for the manufacture of stockinette cloth, which has been largely used for ladies' outer garments during the last few years. In addition to the ordinary hosiery web it lays in a backing thread, which serves to render the cloth firm and much less elastic than it would otherwise be. When the appliance which inserts this thread is removed the machine produces the ordinary work used for the manufacture of underclothing.

THE HEALTH EXHIBITION.

EDUCATIONAL EXHIBITS.—No. IV.

ENGLISH primary education is represented at the International Exhibition by the School Boards of London, Birmingham, Edinburgh, and Glasgow. One would, *à priori*, have supposed that these expensive and fussy Boards would have bestirred themselves, and all the forces they control, to make a good figure at the Exhibition. Knowing that their work would be examined critically, and compared with that from other countries, it behoved them to give ocular and tangible proof that their boasted system is as prolific in results as any other, be it French, Belgian, or Lasallian. Now have they so bestirred themselves? We think that no intelligent visitor to the Technical Institute will answer in the affirmative. We confess that we were greatly disappointed at the paltry show made by scholastic Bumbledom, to whose exchequer the public is compelled to contribute so largely. So much has been loudly asserted (and denied) about the excellence of their system, the efficiency of their staff, the zeal with which masters and mistresses, regardless of the effects of over-pressure, strive to cram the youthful mind with rags and scraps of more or less unsuitable knowledge, that it was natural to expect a many-sided representation which should at least contribute to the glorification of these costly instructors of the children of the poor.

Three rooms, numbered respectively One, Two, and Three, are occupied by the School Board collections. It is our present purpose to endeavour to give an analysis of their contents; and this will be all the easier as these rooms are not models of "furnished apartments."

In the grand corridor near Room 1 (Glasgow and Edinburgh), there is a series of maps of Scotland. They are large but poorly designed, and uncommonly lively in colour. To say the very least such vivid colouring denotes bad taste. The most conspicuous objects in the room are models of public schools. They are arranged to the best advantage, and occupy no small fraction of the whole available space. On an adjoining table there is a very small number of albums, which visitors are invited to examine. Some relate to map-drawing, others to penmanship, and others again to freehand drawing. They have one character in common, they are all equally bad. In our critical examination of the educational section, we certainly have found no scholastic products less deserving of a place in an exhibition, than these. They are in no way creditable to the institutions from which they emanate. As to school appliances there are very few, the most conspicuous being an abacus, which by its stylishness and excess of ornament is entirely unfitted for a class-room.

Room 2 contains the work of the Birmingham School Board, a collective display which has some points of suggestiveness and interest. The class-work which is exhibited is not general, being chiefly representative of elementary science. Within glass cases, and therefore out of reach, are copy-books and sheets of foolscap containing questions and their solutions in mechanics, hydrostatics, physiology, and chemistry. The papers appear to be worked out with care, only one should have liked to have seen, and to have been able to finger scores of them instead of the few that were really accessible to public inspection. However, there was enough to show that an intelligent and zealous teacher presides over this department. Though we find no scientific heresies, we should have approved, nevertheless, in some cases, of a few emendations by the master. Such corrections do not, as some people imagine, disfigure a page, they really enhance its value. Some teachers seem to think that everything sent to an exhibition should be like paintings sent to the Academy, each with a claim to excellence. This is a mistake. Intelligent visitors and members of juries are rightly chary of praise and rewards for such would-be paragons of performance; they always prefer specimens done in the ordinary routine of school with appropriate corrections, the unmistakable evidences of methodical and painstaking instructors.

It is well known that the Birmingham School Board has been the pioneer of science teaching in elementary schools. Its members have devised and carried out a scheme which, however odd it may appear in some respects, has not been so devoid of results as many more ambitious School Board efforts. The science demonstrator is itinerant; he goes from school to school, bringing with him in a humble hand-cart the apparatus necessary to illustrate the particular lesson which he has to give. To insure that the lesson has been listened to with profit, a general account is required from the class, or a paper of questions is set. We admit that this, the itinerant system, has the advantage of cheapness, and that it insures competency on the part of the demonstrator; but, withal, the apparatus that is wheeled about from place to place must be none the better for so much locomotion, especially if it be similar to the few specimens exhibited in Room 2. Many of these are small and flimsy, whilst others are of a very primitive kind. With such apparatus, we should anticipate manipulatory difficulties of no small degree.

In the schools of the Birmingham Board efforts appear to be made to excite the interest of the young students in natural science not only by exacting abstracts of the lessons, but also by encouraging the pupils to construct models and appliances for themselves, such as levers, pile-drivers, compasses, electrical machines, &c. This is, if practical, an excellent way to render instruction thorough and useful; it trains the hands, quickens attention, and tends to develop the inventive faculty.

In the room allotted to the London School Board, one looks in vain for evidences of any really useful work. Even the humbler branches are not represented. School-work is tabooed from Room 4. In its stead we find desks, blackboards, maps, bookcases containing specimens of the literature doled out to the boys and girls, and a large assortment of dolls and Kindergarten pastimes.

As to the maps, they are, for the most part, crowded with names to such an extent as to render them of but little service for class purposes. The single model for teaching the physiology of the human subject is excellent. We do not know whether the Board possesses the whole of this very valuable collection. The collections of minerals seem fairly good, only the importance of the veriest elements of mineralogy in the education of children is open to question. The specimens of chemical and physical apparatus supplied for the instruction of pupil teachers is fairly good. One, however, would like something of a more substantial nature. Instead of new instruments, it would have been more to the point to have sent to the Exhibition apparatus from the physical and chemical laboratories. It would be surely much more interesting to see the appliances which are in daily use rather than instruments which have not yet lost the fine polish given them by the maker.

It must be conceded that our School Boards have lost a golden opportunity of removing an unfavourable impression upon the public mind.

CANADIAN PACIFIC RAILWAY.
No. XVII.

British Columbia.

In the year 1577, Sir Francis Drake sailed from Plymouth with five vessels, the largest only 100 tons burthen, for the Pacific Ocean. The victim of a succession of relentless storms, his vessels nearly all destroyed and their crews mostly drowned, with only one schooner left and sixty men, but anxious to save the treasure he had taken from some Spanish galleons that he had encountered and captured, Drake conceived the bold idea of reaching Europe on his way back by the Straits of Anian, a passage which was supposed to exist between the Atlantic and Pacific Oceans somewhere in the neighbourhood of the 48th parallel of latitude. How far north Drake went in search of this imaginary channel is not known, but that he penetrated at least as far as the 48th deg., passing and discovering what is now California and Oregon, which he named Nova Albion, appears from his diary, and by virtue of this voyage, England had a right to the possession of this country, which he had discovered. The Straits of Anian, however, he never saw, and returned home by Magellan, as he came. A few years later, Cavendish, in 1587, took and plundered a Spanish ship trading between Manilla and Acapulco, amongst the crew of which was a Greek pilot rejoicing in the classical name of Apostolos Valerianos, but who had been nicknamed by his shipmates Juan de Fuca. After his release, this clever impostor, on his return to Mexico, gave such an account of his experiences in the Straits of Anian that he was sent back by the Spanish viceroy with three ships to take possession of these straits, and to fortify them to prevent these being used by English vessels. This apocryphal voyage of De Fuca's took place in 1592, and there is little doubt that he did find the large strait which bears his name, and through which he said that he sailed for twenty days, till he came to what he supposed was the Atlantic Ocean, and just as Cortoreal, when he had sailed up the St. Lawrence 800 miles, made sure that he had found the Atlantic portion of the Straits of Anian, so De Fuca when he had sailed through his straits without finding the end, fancied that he had been half way to the Atlantic, and returned to claim the reward. But though he failed to carry out that part of his instructions which required him to fortify the straits, a subsequent grievous failure in British diplomacy has supplied the intended injury to British commerce, and they can now be closed against English vessels by the hostile guns on the Island of San Juan quite as effectually as he could possibly have accomplished had he been a more trustworthy agent than he was.

Nearly 200 years elapsed, and still the Straits of Anian were an unsolved mystery, and even the existence of the part that did exist, the Straits of De Fuca, began to be doubted. The British Government offered a reward of 20,000*l.* for the discovery of the sea passage between the two oceans, and in 1776 Captain Cook, who had acquired the highest reputation as a circumnavigator, was commissioned to examine the east coast of the Pacific, especially between the forty-seventh and forty-eighth parallel of north latitude between which De Fuca asserted that his inlet was situated. On the 7th of March, 1778, Cook sighted the coast near 44 deg., and running along it to beyond 48 deg., came opposite the promontory now so well known as the entrance to the Straits of De Fuca, which he named Cape Flattery, an allusion to the improved weather which he expected to enjoy from that point, but he saw no inlet, and unhesitatingly declared that no straits existed. Over a dozen years elapsed, when in 1790 Captain Vancouver, who had served as a lieutenant with Cook, was despatched to the same coast, and no one will grudge this gallant officer the honour of conferring his name on the new England in the Pacific, which he was the first to explore and circumnavigate.

The discovery remained unheeded and unimproved for fifty years, and, as far as known, no white man revisited it, but Vancouver had given his name to a cape which he discovered in Oregon, near which Fort Vancouver has been built by the Hudson's Bay Company, and from this fort an officer of the Hudson's Bay Company established in 1843 a branch trading post at the north end of the island, and another where Victoria is now situated. In 1848 the island was granted to the company by the British Government, who formed a sort of allied company to work its minerals and develop its resources, but although the grant was coupled with provisions for its settlement and colonisation, the company, true to their uniform policy, maintained such exclusive control over it that five years afterwards the population was only 450, and nearly all of these were the company's employés. Two years before this the conclusion of the Mexican war had given California to the United States, and in the same year, 1848, Colonel Fremont had explored the magnificent bay on which San Francisco now stands, and had named the strait by which it is approached from the ocean the Golden Horn, little dreaming probably how prophetic the name would prove. There was then probably a population of 1000 in the whole district, and water lots worth 400,000*l.* ten years afterwards might then all have been bought for 20*l.* Amongst the other settlers, mostly military men retired after the war, General Sutter had erected an adobe house near where the city of Sacramento now stands, and in the winter preceding this same eventful year of 1848 made a contract with a builder, James Marshall, to erect a sawmill on the American River. This was now completed, when in scouring out the tail race he let on the full head of water, and next morning glittering specks were seen mixed with the sand and gravel washed down by the stream. One lump, brighter and larger than the rest, attracted his attention, and in six months the world was excited with the gold discoveries in California. The first arrivals were not the best, and San Francisco was soon the resort of the worst set of rowdies that ever disgraced a community. In the course of five or six years the town had been burnt down half a dozen times, and the corporate seal appropriately exhibits a phœnix rising from its ashes. The immense wealth poured in from the necessities, the luxuries, and the vices of the mining districts round, overcame all these accidents, and the means dissipated at the San Francisco gambling tables only put capital into circulation the more quickly from the unrighteous process. "Easy come, easy go," and with a light heart and lighter pocket, the ruined spendthrift again turned to the mountains. This rowdy element soon passed away, or perhaps was diluted past recognition by a better and more desirable class of arrivals.

California had other resources besides gold; in a short time there were money and industry and enterprise for all these, and in less than thirty years California took her place as one of the most prosperous and agreeable States in the Union. Its agricultural wealth is enormous, and already its shipments of wheat influence the markets of Europe. Its vineyards and orange groves, its fish and its fruit, its cattle and its other produce, find a market in the East, and in almost every department its exports are of a quality unequalled elsewhere. Mines and minerals are still the most important sources of wealth in California and its allied districts; besides gold, twenty-six different varieties of silver ore are worked, copper, iron, mercury, zinc, lead, tin, arsenic, bismuth, and platinum are known to exist, and are worked in more or less abundance, whilst of minerals of less value, coal, salt, gypsum, sulphur, alum, asphalte, and marble are all successfully

wrought, and form in greater or lesser quantities, articles of export. The silver mines of Washoe before they were in existence six years, were averaging an annual yield of twenty millions of dollars, and argentiferous leads are so numerous and so rich in the Pacific mountains that the mind is bewildered in contemplating their magnificent promises. Under these enormous influences no wonder that population and wealth congregated with marvellous rapidity, that in five years the population of Washoe should increase from 2000 to 70,000, and that San Francisco should, in so short a period, have grown to be a city of the extent that it now is.

The existence of the precious metals was known to the Hudson's Bay Company in British Columbia almost as soon as it was ascertained in California, and in 1857 a party of Canadians commenced the regular exploration of the Thompson River. Their success was no secret, and another rush took place to this district in 1858 similar to that which ten years before had marked the feverish settlement of California. Stock in that State fell, and in six weeks 225 shops and stores sprang up in Victoria. Steamers from California crowded with miners and speculators arrived every day, the quiet village was thronged with an eager and excited crowd, and in four months 20,000 people had landed in the harbour. The country drained by the Frazer River and its tributaries resembles mountainous European countries in the same latitude, where streams begin to swell in June, and do not reach their lowest stage till the winter, precisely as might be expected in rivers fed principally by the melting snows of an extensive mountain range. The miners who came in March and April, when the water was low, extracted large quantities of gold from the bare beaches and bars of the rivers then exposed above the low water. Those who came afterwards found these covered, and as a consequence underwent most distressing privations before they were able to operate with any advantage. Disheartened and in misery most of them worked their way back to San Francisco, cursing the country and all that belonged to it. Immigration was at an end, and of the hundreds who had crowded Victoria with their chattels and their merchandise, most were only too glad to save out of the wreck as much as would take them back safely to California. Yet on a calm review the first beginning of gold mining in British Columbia was not such a failure as to justify the wholesale condemnation which it received, and which for some time seriously damaged the character of the country. The first six months' operations in California in 1849 was estimated to have produced only 240,000 dols. All the gold brought to Melbourne in 1851 amounted to 104,154 ounces, worth, 1,666,464 dols., whilst New South Wales gave in the first six months only 723,000 dols. Victoria, from the end of June to the end of October, 1858, shipped 543,000 dols., besides the enormous quantity bought by the Hudson's Bay Company and taken away in private hands, and this was all taken from the surface washings of a few easily explored rivers.

In September, 1859, the population of Victoria had decreased to 1500, and those not of the best quality of the thousands that had flocked there twelve months before. But a reaction again set in, bags of dust and nuggets coming in from new discoveries rewarded the heroism of the explorers that remained, and marvellous stories were in circulation of individual enrichment. Of the 1500, for instance, that went to Antler Creek, one-third had made independent fortunes, and most of the remainder had amassed more or less "piles" that represented a fair surplus over expenses. On Williams' Creek one miner took out 1300*l.* sterling value in a single day, and the entire sum realised in a short time in a space of 80 ft. was 24,000*l.* In four months a party of three men netted 8000*l.* each. In one claim worked by three men, 1000 oz. of gold were taken out in a single day. In 1863 there were 4000 miners at work on Williams' Creek, and most of them were making profits that in any other gold-producing districts would be considered unusual. The steamer Enterprise brought down in one trip, August 10, 1864, over 1200 lb. weight of gold. From the very carefully prepared tables published in the annual report, of the Minister of Mines of British Columbia, the exportation of gold for the first complete ten years ending 1869, was nearly 25,000,000 dols., and the total to the end of 1882 was 47,141,713 dols. for a little over twenty-four years from the first discoveries, which is a very remarkable result in a province, the whole white population of which would probably not average during the same period 12,000, and the greatest number of miners ever employed not much over 4000, whilst for the last ten years they have not averaged 2000. The greatest areas of the gold-producing rocks appear in connection with the disturbed region lying west of the Rocky Mountains, known in various parts of the length as the Purcell, Selkirk, Columbia, Cariboo, Omineca ranges, all of which seem to be the geological equivalents of some of the richest auriferous rocks of California. The Cariboo district, discovered in 1860, has so far been the most permanent and productive. The fifty-third parallel of latitude passes through the centre of this wild mass of mountains tumbled together in the most picturesque confusion, the summits 6000 ft. to 7000 ft. in altitude, whilst the Frazer River runs round the whole, and with one of its tributaries forms almost a circle. As in all new goldfields, the shallower placer deposits and gravels in the stream courses first attracted attention, but with the experience of California before them it was not long before the "deep diggings" were found to be the most profitable. Williams' and Lightning Creeks have so far yielded the greater part of the gold of Cariboo. By regular mining operations the rocky bottom of the valley is followed beneath 50 ft. to 150 ft. of overlying clays and gravels. In the hollows of the rocky channel, traceable by the polished rock of the ancient bed of the stream, the richest "lead" of gold is usually found, and the rock surface laterally for a greater or less width from the centre of the channel is generally discovered to be rich enough to work. One of the most successful of these Lightning Creek workings is the Van Winkle Mine. The claim covers 2050 ft. in length of the deepest part of the old valley, and of this when officially reported upon between 1600 ft. and 1700 ft. had been cleared out, the workings having attained a breadth in places of from 200 ft. to 300 ft. Over 10,000 dols. was expended before the gold at the bottom of the old channel was reached. It has paid handsomely ever since, having produced gold in one week worth 15,700 dols. Up to the end of 1876 the gold produced had amounted to 500,965 dols. The average depth of the workings was only 70 ft. the lowest shaft being placed 300 ft. from the creek. The greater part of the gold is found lying directly on the bed-rock, and only occasionally are paying streaks seen in the gravel a few feet above this. The area uncovered by each "set" of lumbers being about 35 ft. square of the bed-rock, with a height of 6 ft., the average yield is from 2½ oz. to 3 oz. of gold to each set. In some of these workings there has been great difficulty with the water, but in most the machinery for pumping is very creditable, and the result has been satisfactory. The enterprise is generally conducted entirely by the miners themselves without the aid of foreign capital, and with labour and materials of all kinds at fabulous rates. In most gold-producing countries the crushing of the quartz rock has generally been the result of mere superficial workings, but so far but little of this kind of work has been attempted and not a single stamp mill is yet in operation in British Columbia. With altered circumstances as to transportation this will probably be changed, and many districts now unnoticed will spring into activity. The gold-mining industry is at present on the decline. Since 1864, when 3,735,850 dols. worth of gold was sent out of the country, it has gradually grown less, and in 1882, the last year for which the returns are complete, it was only 954,085 dols., the smallest yield of any, whilst the number of miners had decreased in a similar ratio, and only 1738 had been on an average at work for the season.

British Columbia lies between 49 deg. and 60 deg. of north latitude and between 115 and 136 west longitude, and contains with Vancouver and Queen Charlotte's Islands 341,305 square miles, being a little larger than Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward's Island, the five older provinces that constituted all Canada a few years since, put together, their united area being 340,635 square miles. Measured in a straight line along the Pacific, the coast line is nearly 600 miles in length, but following the indentations of the coast the total length would be at least 3000 miles. The breadth from the Rocky Mountains to the Pacific is about 400 miles, and from the south-east corner to the north-west taken diagonally it is 805 miles. Vancouver's Island lies between 48 deg. and 51 deg. of north latitude and between 123 deg. and 128 deg. west longitude, being 240 miles long and from 40 to 70 miles wide, embracing an area of 14,000 square miles, or rather less than one-fourth the size of Great Britain. Vancouver's Island was constituted a colony in 1849, with its capital at Victoria. The mainland became a colony in 1858 with New Westminster as its seat of Government. In 1866 these two were united under the name of British Columbia, Victoria being the capital, and on July 20, 1871, the colony became one of the provinces of the Dominion of Canada. Working their way from the east the rival fur companies of London and Montreal had dotted the great plains to the east of the Rocky Mountains with their forts and trading posts, where the old North-West Company nearly a century since, determined to push their business beyond its then limits, and sent the heroic Mackenzie through the gorge of the Peace River to the unexplored region beyond, the first white men in all probability who had ever visited what was afterwards called British Columbia. When his hardy companions saw the labyrinth of mountains to the west of the main rocky chain, it reminded them of the rugged features of their old Highland homes, and they called it New Caledonia. Later on another Highlander, Simon Frazer, discovered the Leather Head Pass through the mountains, and following down the great river to which he has given his name, built in 1806, the first fur-trading establishment on its banks, and before long the whole country was dotted over with the different forts of the enterprising company that at first explored it. After a time the whole of this immense region was made over to the great fur company, which lucrative monopoly was continued till the colony was established in 1858.

This is the only colony that Great Britain has upon the western or Pacific coast of America, and from its commanding geographical position, its fine climate, its magnificent harbours, the variety of its resources, its vast deposits of coal, iron, and other minerals of economic value, the province may be regarded as in many respects a duplicate, in North-West America, of Great Britain and Ireland, bearing the same relation to the western continent and the Pacific that the parent country does to Europe and the Atlantic. Both of them owe the peculiarity of their climate and the amelioration of its normal temperature to the same mysterious ocean and air currents, which, charged with the warmth of the tropical regions, discharge their invigorating influences on the soil and the atmosphere. Vancouver Island especially is often called the England of the Pacific, and nothing is wanting but enterprise, capital, and development to make this distant appendency as important and advantageous a depôt on the Pacific as the other is on the Eastern Ocean. Approaching from the broad western waters, and running through the Straits of Fuca, which are eleven miles wide, the spectacle on a bright day is very inviting. On the south, in the territory of Washington, belonging to the United States, the Olympian range of mountains lift their rugged summits above the line of perpetual snow. On the left is the rocky shore of the island beyond which are the hills of the interior covered with a dense and lofty vegetation, frowning conspicuously amongst which is Mount Arrowsmith, which rises 5000 ft. above the sea level. The coast line is rugged and broken by numerous bays and harbours, some of which are destined before long to be the industrial centres of a busy population. Following the south shore, one of these indentations, 8½ miles from the Race Rocks, is the entrance to the magnificent harbour of Esquimalt. It is two miles by three in extent, with an average depth of from 36 ft. to 48 ft., and affording for ships of large tonnage the most perfect shelter that can be found between this point and San Francisco 750 miles south. This is England's chief naval station on the Pacific, and here the Pacific squadron finds safe anchorage, workshops and stores for the maintenance and repair of ships exist, and a first-class dry dock is being now constructed for the examination and reparation of any of the portions below the water line that require attention. Three miles east of Esquimalt, and on another but inferior harbour, is the city of Victoria, the capital of the province. The inlet which forms an extension of Victoria Harbour, though several miles long, is separated at one point from Esquimalt Harbour by a neck of land only 600 yards across, and some day no doubt the two harbours will in this way be conveniently connected. There is little doubt that before long, these two places will be all included in one large city, that the admirable facilities of Esquimalt will afford to

the ocean steamers and the Pacific shipping, the depth and room they require, whilst local steamers and smaller vessels will find in Victoria Harbour sufficient accommodation for their draught and necessities. This ultimately will be the Liverpool of the Pacific, the only drawback being that beyond this there are so many other fine harbours and admirable ports, that the difficulty will be in gathering to any one place the trade and business which is invited and diverted to so many other and eligible points. As a station for war purposes, Esquimalt perfectly protects the entrance to the Fuca Straits, and at a comparatively small expense may be rendered impregnable.

Victoria, fixed upon in 1843 by Sir James Douglas as a trading post for the Hudson's Bay Company, in latitude 48 deg. 25 min., and longitude 123 deg. 22 min., in the south-east corner of Vancouver's Island, has one of the most delightful and invigorating climates in the world, and all the elements within itself of a great city. In 1790 Captain Vancouver wrote: "The serenity of the climate, the innumerable pleasing landscapes, and the abundant fertility of the soil, require only to be enriched by the industry of man to render it the most lovely country that can be imagined." There is seldom any frost or snow, the mean temperature of the whole year is 50 deg., the average of the lowest month, December, being as high as 38.4 deg., whilst the highest, August, is 53.8 degrees. The climate is unequalled anywhere for invalids, the atmosphere is charged with ozone, peculiar to Victoria only. It originates in the snow-cooled breezes in the Olympian range, about 60 miles south-west of the city, mixed with the salt sea air of the Pacific, giving it peculiar health-restoring and life-prolonging qualities, which are fast making Victoria the sanatorium of the Pacific. The Gulf of Georgia separates Vancouver Island from the mainland, and a most delightful sail of 75 miles through some of the most lovely scenery in the world brings you to New Westminster, the former capital of the mainland province. The course is through the once disputed channel which the San Juan award has rendered unsafe for hostile vessels, commanded as it is by the heavy guns on the island of San Juan, belonging now to the United States. Leaving Victoria in the same direction, but turning northernly along the island coast, in 78 miles is the town of Nanaimo, the centre of the coal mining industry of British Columbia, and the increasing value of the exports of which make up for the declining exports of gold, for although the yield of gold has fallen off in the ten years from 1872 to 1882 from 1,610,972 dols. to 954,085 dols., the total exportation of the produce of the mine has increased in the same time from 1,389,585 dols. (of which 1,208,229 dols. was gold dust) to 1,437,072 dols. (of which 795,071 dols. was gold in dust and nuggets), whilst the total exports have increased in the same time (ten years) from 1,858,050 dols. to 3,118,119 dols., the proportion of gold being nearly 60 per cent. of the total in 1872, whilst it is little over 25 per cent. in 1882. Immediately opposite to Nanaimo across the Gulf of Georgia, and up Burrard Inlet, is Port Moody, the terminus of the Pacific Railway, and 57 miles north of Nanaimo, and still on the island, is Comox, another great coal district, which at present is scarcely developed.

In a general review of British Columbia, there are are seen to be more extensively spread out for development all the elements for the creation of a great and wealthy community than anywhere else, either in Canada or the United States. The one thing wanting is railway communication with the rest of the world and the removal of that painful isolation which so far has been a damper upon all enterprise and a bar to any marked progress. By the census of 1881 the total population was only 49,459, of which number 25,661 were the native Indian races, and 4350 were Chinese, principally imported to work upon the railway, leaving under 20,000 white people for a country seven times the size of England, and more than 60 per cent. larger than either France or Germany. This sparse population is due solely to the isolation of the country, the difficulty of access, and the expense of conducting business before the needful appliances of cheap transportation, and accessibility to the markets of the world are at hand. Professor Macoun, of the Dominion Geological Survey, closes his report on British Columbia in the following true words: "It remains only for me to add that, as years roll on, and our possessions become developed, the value of this second Britain will come so vividly before our people that men will ask with astonishment why such ignorance of its resources prevailed in the past. To-day there are 600 miles of coast line in these our western possessions, clothed with a forest growth superior to anything else in the world at present known. Its shores indented with multitudes of harbours, bays, and inlets teeming with myriads of the choicest and most valuable fish. Its rocks and sands contain gold, silver, iron, and coal in immense quantities, and equal to the best in Great Britain, besides a great variety of other descriptions of minerals. And in addition to this a climate superior to England in every respect, both as regards heat and moisture, and a soil the productions of which so far exceed the usual average, that ordinary agriculturists refuse to credit the most truthful statements. Yet men are disposed to ask, What is this country worth? I answer, worth more than Ontario and all the maritime provinces together, and sceptics may rest assured that the day is not far distant when these words will be accepted as truth."

NOTES.

Cork Bricks.

A composition of cork, sand, and lime moulded into bricks is now being tried in Germany for building light partition walls. It is said to have the advantage of excluding sounds better than ordinary brickwork, while being light and a good non-conductor.

Queensland Railway Progress.

Queensland appears to be applying itself vigorously to the work of railway construction. Speaking recently upon the subject, Mr. Miles, the Colonial Minister for Works, said that at the end of 1883 the total length of railway open for traffic in Queensland was 1038 miles, and the total amount of the railway loan authorised to date, was 9,708,000*l*. The gross earnings on all the lines during the year was 590,000*l*., the balance of earnings over expenditure being 299,000*l*. The Government could with confidence go into the market to borrow money for railway construction, and they meant to go ahead in that way. He had asked the Colonial Treasurer to make provision for 6,000,000*l*. for railway construction, and he must have it. The Colonial Government meant to commence a railway from the Gulf, and put the transcontinental scheme aside for ever. He also promised a direct line from Brisbane to Warwick, and thence to St. George.

Overhead Electric Cables.

Mr. C. Masden, director of the telephone company at Copenhagen, has devised a new overhead cable which is being manufactured by Messrs. Felten and Guilleaume, of Mülheim. The cable contains 25 conductors, is only 15 millimetres in diameter, that is little more than half an inch, weighs .6 kilogramme per metre (equal to .4 lb. per foot), and possesses a tensile strength of 1500 kilogrammes. Spans of 70 metres (230 ft.) are considered quite admissible, and the cable is handy and flexible and yet strong. The insulation is expected to withstand all atmospheric influences. When these conductors are used there emerge from the central telephone office only a few cables instead of the ordinary numerous telephone wires on poles. The cost of this cable averages one-half that of ordinary cables, but is higher of course than the usual bare wires; its long life, together with other advantages, is, however, expected to fully justify the greater expense.

Danchell's Electric Railway.

There is on exhibition at the Westminster Aquarium a working model of a new electric railway for which very considerable advantages are claimed by the inventor, Mr. Danchell. The feature which distinguishes it from previous attempts of the same kind is that the locomotive and vehicles run between a pair of rails placed vertically one over the other, the lower carrying the weight and the upper serving as a guide to prevent the vehicles from falling over sideways, and also, in some instances, increasing the adhesion of the locomotive. Each vehicle has two wheels, one before the other. These wheels are not flanged, but are kept on the track by eight guide rollers, two running against each side of the upper rail and two against each side of the lower rail. The electric motor carries on its spindle a small friction pulley, situated between the two driving wheels of the locomotive. These wheels are carried in sliding bearings and can be set up to obtain a sufficient pressure against the friction pulley, so that the rotation of the motor is imparted to them. For lines with steep gradients, a small wheel is fixed over each driving wheel in such a way that it has a constant tendency to jam itself between the wheel and the upper rail and thus increase the adhesion of the locomotive. The rails act as the conductors for the current, which enters the motor from one of them and leaves it by the other. It is claimed for this railway that it will run with very small friction, and that exceedingly high speeds are possible without danger, but it is difficult to find any argument for putting an electric locomotive on a single rail which is not equally applicable to a steam locomotive, while the safeguard afforded by an overhead rail is as available with one kind of carriage as another. An engineer who put forward such a plan with any existing form of traction would expose himself to derision, and we fail to see that the use of electricity as a propelling power alters the conditions of stability under which a railway works. As to the electrical part of the scheme it appears devoid of novelty, and whatever advantages exist in the Danchell railway are to be found in the use of a single track and a steadying overhead rail.

Meteorological Information from Ben Nevis.

The secretary of the Scottish Meteorological Society, Mr. Alex. Buchan, has communicated to *Nature* some interesting and unexpected deductions from the observations made during the last year, and portions of two previous years, on the summit of Ben Nevis, 4406 ft. above the sea. At the top of Ben Nevis the coldest month is February, the approximate mean being 22 deg.; and the warmest, July, 41.3 deg.; August being nearly as warm, 41.1 deg.; and the annual mean temperature of the air in the shade being 30.9 deg. The greatest monthly mean difference, due to elevation, is 18 deg. in May, from which it steadily diminishes to 14.9 deg. in December, and then rises more rapidly towards May; the annual difference being 16.3 deg. The greatest difference, or the most rapid fall of temperature with height, is in the spring and early summer, when the climate of the west of Scotland is driest, the temperature of the Atlantic, lowest relatively to that of the air, and the top of the mountain still covered with snow. The least difference is in late autumn and early winter. There is decidedly marked variation in the decrease of temperature with elevation with the hour of the day. In January the decrease of temperature, in the vertical, deduced from the mean maxima and minima respectively, was 16.2 deg. and 15.2 deg.; but in April these gave 23.1 deg. and 12.9 deg.; being thus in January nearly equal, whereas in April the difference of the maxima was nearly double that of the minima. The annual means give a decrease of temperature with height at the rate of 1 deg. for every 270 ft. of ascent, the most rapid decrease being 1 deg. for every 245 ft. in April, and the least rapid 1 deg. for every 296 ft. in December. Instances of abnormally large decrease of temperature between the summit of the Ben and the sea level are related to storms. Instances of abnormally small differences between the temperature at the top and at the base of the mountain, are accompanied with high temperature and excessive dryness of the atmosphere. On December 31, 1883, at 11 A.M., the temperature at the summit was 4.5 deg. higher than at the sea level with excessive dryness, relative high temperature, and high pressure 30.6 in. at sea level. These results, considered in connection with the small decrease of temperature often experienced during balloon ascents, quite unsettle the so-long accepted law of decrease of temperature with increase of elevation, and show the fallacy of reducing all the mean temperatures of elevated stations to sea level values by adding to them 1 deg. for every 300 ft. above the sea, a method adopted in the monthly temperature chart published in the *Times*. Tornadoes and other destructive winds, asserts Mr. Buchan, originate when the air is abnormally warm and moist near the surface, while aloft the temperature and humidity diminish with abnormal rapidity. On plains and extensive plateaux, the wind attains a diurnal maximum velocity shortly after noon, which is generally nearly double the minimum, which occurs shortly before sunrise. But on Ben Nevis, in common with other observatories which are situated on peaks rising to considerable heights above the whole of the surrounding region, the reverse of this takes place, the maximum velocity occurring during the night, and the minimum during the day.

NOTES FROM THE SOUTH-WEST.

Gloucester Wagon Company (Limited).—The directors observe in their report: "The directors beg to submit the statements of accounts of the company for the year ending 30th June, 1884, from which it will be seen that the business of the past year has been slightly more favourable than that of the preceding one. On referring to the accounts, it will be observed that the balance of the year's revenue from all sources, including the balance brought forward, is 30,671*l.* 6s. 10d., which, after deducting 10,661*l.* 12s. for the usual depreciation of wagons and 8375*l.* paid as an interim dividend at four per cent. per annum, leaves a balance of 11,643*l.* 14s. 10d. now available for distribution, which the directors propose to appropriate by paying a dividend for the past half-year at the rate of four per cent. per annum, making four per cent. for the year, adding 2000*l.* to the reserve fund, and carrying forward a balance of 1259*l.* 14s. 10d. to the next account. The wagon stock belonging to the company now consists of 5765 wagons let on simple hire, and 3566 sold on deferred payments. In addition to work done for cash payments, 329 wagons have been built for the company's stock, all of which have been sold on deferred payments. The company have now to repair and maintain 13,705 wagons, including 5024 which are not the property of the company."

Hill's Dry Docks and Engineering Company (Limited).—This company acquired in 1882 the system of graving docks formerly belonging to Messrs. C. Hill and Sons, at the East and West Bute Docks, Cardiff. They have since that date improved and added to the property. A new graving dock alongside the old one in the East Bute Dock has been constructed, as well as a large block of workshops contiguous to the new dock, &c. The yearly balance sheet, to the 30th of June, was issued on Saturday, and enables the directors to recommend a dividend of 10 per cent. for the year, in addition to which all the preliminary expenses, amounting to 2633*l.*, have been paid off, while 1500*l.* is placed to reserve.

Severn and Wye Railway.—The directors observe in their report, "The Woods and Forests Department introduced a Bill into Parliament this session for the purpose of facilitating the opening of the deep coals in the Forest of Dean, and your directors, believing that it would materially conduce to the prosperity of the district, and of your railway, petitioned in its favour. The Bill has been referred to a commission of inquiry, which the directors hope will lead to a reconciliation of conflicting interests. The shipments of Welsh coal at Sharpness Docks are still limited, owing to the need of a new tip for loading in deep water."

Cardiff.—The steam coal trade has maintained much the same tone. Merchants are able to keep their collieries going regularly, but there is not much new business. The patent fuel trade also is in a more healthy state. The iron ore trade remains without much alteration. Last week's clearances comprised 124,575 tons of coal, 2904 tons of iron, and 2649 tons of patent fuel. From Bilbao there arrived 4439 tons of iron ore, and 2432 tons came to hand from other sources.

The Bristol Coal Field.—Mr. Handel Cossham has lately read a paper at Kingswood on a recent discovery of coal in that neighbourhood. Mr. Cossham expressed his opinion that the Kingswood section of the Bristol coalfield contains probably the most ancient coal workings, probably older than those of South Wales, Somerset, or Dean Forest. He proceeded to describe his explorations in search of various seams in the locality, and said that at the proper distance below the second vein, known as the Gilliers end vein, he found a particular and remarkable bed of strata, known in the district as the "worm bed," in its proper position in connection with this vein. He also knew that if he were correct in his opinion, he should find at a distance of some 30 yards vertically above this vein, the splendid seam or bed of coal known as the Kingswood great vein, which he had no doubt was the equivalent of the celebrated 4 ft. Aberdare steam coal vein. Driving a drift across measures he discovered on the 21st of last February the vein known as the Kingswood great vein, lying in splendid position, and on an average of 5 ft. thick, or from that to 5 ft. 6 in. Since that time he had been driving on these veins north, east, south, and west, and found that he was on the floor of the original coalfield with a gentle dip to the west and rise to the east of about 3 in. to the yard, and apparently extending to the north and east far beyond the bounds of his mineral estate. He did not want to trouble his hearers with anything that was merely personal and commercial, but he was sure they would pardon him for saying that not the least interesting feature of this discovery to him was that it had revealed the existence of from 6,000,000 to 8,000,000 tons of steam coal in his mineral estate which he had no expectation of having, and he could see clearly that for the next fifty to a hundred years at least the collieries he worked could go on landing a large quantity of coal, at a cost which would enable those who worked them to hold their ground against all competition.

FOREIGN AND COLONIAL NOTES.

Canadian Pacific Railway.—The Canadian Pacific Railway Company is constructing large stockyards at Hochelaga, hoping to obtain live stock traffic through the Michigan Central and Credit Valley lines.

American Telegraphy.—The Baltimore and Ohio Telegraph Company has placed a cable across the Mississippi from Bird's Point to Cairo. It is 635 ft. long, weighs 10½ tons, and contains eight wires. The Baltimore and Ohio wires are now ready for work from Cairo north. They are to extend down the Texas and St. Louis Railroad to New Orleans and Galveston.

German Rail Exports.—It appears that rails were exported from Germany in the first five months of this year to the extent of 53,671 tons.

Western of France Railway.—The Council of Administration of the Western of France Railway Company is about to make various improvements in the St. Lazare terminus, Paris. The municipality of Paris is about also to improve the approaches to the station.

The Isthmus of Panama.—The Isthmus of Panama Canal Company has now accumulated a force of 19,000 employés and workpeople upon the Isthmus of Panama. A good medical service has been organised, and the company states that the rate of mortality upon the company's works has not exceeded the corresponding rate upon corresponding works in Europe.

Gas in Paris.—The revenue of the Parisian Company for Lighting and Heating by Gas amounted in the first half of this year to 1,459,638*l.*, showing an increase of 41,017*l.*, or 2.90 per cent., as compared with the corresponding period of 1883.

Railway Rolling Stock in Germany.—According to a recent official German return there are 11,000 locomotives in the German Empire. The aggregate amount of capital invested in German railways is now estimated at 450,000,000*l.*

Railroads in Texas.—Texas is largely dependent upon railroads for means of internal transportation, the rivers in the State not being navigable except for lighters and vessels of the smaller size. In 1860, the length of line in operation in the State was 307 miles; in 1870, 711 miles, and in 1880, 3257 miles. This year the length of line in operation has expanded to 6166 miles.

Another Electric Street Railway.—Cleveland, Ohio, expects soon to be able to boast of the first street railway operated by electricity in the United States. Successful experiments have been conducted for six months past at the works of the Brush Electric Light Company by Mr. W. H. Knight, one of the inventors of the system, and the results have warranted Mr. Knight in putting his invention to practical use by running an electric line from Garden-street to New-street, and up New-street to Quincy-street as far as Lincoln Avenue.

New South Wales Railways.—The Mudgee Railway extension has been opened for traffic as far as Rylstone. It is reported that the men employed by Messrs. Amos and Co., the contractors for the construction of a line between Homebush and Waratah, have struck work in consequence of a reduction in their wages from 7s. 6d. to 7s. per day. About 500 have left work, bringing progress on the line to a standstill.

Victorian Railways.—A line from Castlemaine to Maldon has just been opened for traffic. The Victorian Railway Commissioners intend to adopt a number of improvements in the management of the colonial railways, such as the more frequent inspection and repair of locomotive boilers, and the abolition of the barrier system, by which it will be all but impossible for station masters to give tickets to engine-drivers in place of the staff, without showing the staff to them.

New Zealand Coal.—The coal trade of the north island of New Zealand promises to be extensive. Coal is found at the Bay of Islands, where a mine is in full operation. At Whangharei two mines are at present working; at Raglan coal of good quality has recently been found, and at the Mokau a seam of excellent coal is seen cropping out to a great thickness for a distance of between 20 and 30 miles. Besides these places, coal is now being worked to a considerable extent at several points on the Waikato, and a large seam of coal—between 50 ft. and 60 ft. in thickness—on the estate of the late Mr. Foote, on the Maramarua Creek, is expected to become a source of supply shortly.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF SPECIFICATIONS PUBLISHED DURING THE WEEK ENDING AUGUST 16, 1884.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

Copies of Specifications may be obtained at 88, Cursitor-street, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, and addressed to MR. H. READER LACK.

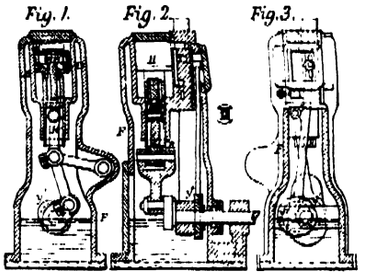
NUMBER OF APPLICATIONS FOR PATENTS.

	1884	1883	1883
Aug. 12th	47	..	17
,, 13th	42	21	12
,, 14th	44	20	—
,, 15th	34	19	5
,, 16th	43	19	9
,, 17th	—	20	8
,, 18th	39	12	11
Total for week	249	111	62
Total from January 1st to Aug. 18th (inclusive)	11,408	4018	1939

5058. Apparatus for Sifting Ballast: R. and G. Neal and C. E. Whitmee, London. [6*d.* 2 *Figs.*]—The apparatus consists of an arrangement of hopper and screens or sieves of different gauges hung from a fixed frame or support so as to be capable of receiving an oscillatory movement. (October 24, 1883).

5430. Using Steam and Hot Air Combined, and Construction of Engines in Connection therewith: W. Turnbull, London. [6*d.* 3 *Figs.*]—The engine comprises high and low-pressure steam cylinders, hot-air cylinders, and pumps. In order to minimise the space between the various cylinders and the driving shaft so as to dispense with connecting rods, there is mounted on convex surfaces of each of the cylinders a sliding steam-tight plate covering an elongated slot in the cylinder cover and having projecting from it a stuffing-box through which the piston rod slides, the rod being maintained in position by radial arms and coiled springs. The arms are jointed to the cylinder cover at one end and to the crosshead at the other, the rod sliding through the crosshead. The coiled springs are placed between the cover and crosshead. The piston rods are connected by pin joints to their piston and directly to their cranks; friction and wear between the cylinders and their piston on that side opposed to the angular thrust is diminished by the use of steam or hot air which is admitted by suitable ducts. (November 17, 1883).

5543. Construction of Gas Engines, &c.: L. H. Nash, Brooklyn, U.S.A. [8*d.* 15 *Figs.*]—The working fluid after compression is employed to cool the heated portions of the engines on its way to the working cylinder. Cold water is injected into the gas compression chamber with the gases before or during compression. The parts subjected to wear are arranged so as not to be immediately effected by the heat developed in the power cylinder. The storing chamber for the compressed working fluid surrounds the power cylinder and working parts of the engine, and serves also as a reservoir for water and for the lubricant, the working fluid being thus kept moist and lubricated. The back stroke of the piston is aided by the pressure of the compressed gas in the storage chamber, which acts upon an enlarged hollow piston rod. Referring to the illustrations, the working cylinder A and operating connections are arranged within a shell F forming the storage chamber for the compressed working fluid and for water and oil. The valves are also inclosed in the casing. The lower end of the cylinder A terminates in an open cylinder



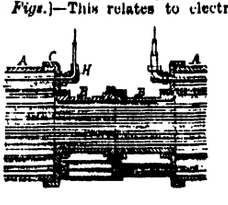
forming a bearing for the trunk or hollow rod R which opens into the storage chamber, and is thereby operated on its back stroke by the pressure of the stored gases. The piston does not touch the working cylinder, being provided with a packing ring D suited to stand a high temperature. A cap or cover H over its rear end protects it from direct contact with the ignited gases. In the arrangement shown in Fig. 1, the compressed gases pass from the lower part of the cylinder into the piston space and through the hollow piston rod into the storage chamber. The connection of the piston to the crank is clearly shown in the illustrations, with the parts in the positions they occupy at the end of the explosion, the connecting-rod being in such position as to exert its greatest power in producing rotation of the crank. The eccentrics p^1 p^2 on the crankshaft are connected to the cylindrical valves, as shown in Figs. 2 and 3. The one valve is set quartering to the crank and controls the exhaust, the admission of gaseous products to the compression chamber, and the admission of the compressed gases to the other valves. The cut-off valve operates to cut off the admission of the charge at any desired instant, to light the charge, and as a pump to compress charges of gas for the lighter. (November 27, 1883).

5565. Tube and Carriage for the Launching of Fish Torpedoes by Means of Gunpowder: A. Sauvee, London. (*J. B. G. A. Canet, Paris*). [8*d.* 10 *Figs.*] The arrangement for launching the torpedo allows of the use of an ordinary explosive instead of compressed air or steam, the explosive being fired by means of mechanism and a fuze. In order to reduce the effort for firing, there is employed a spring which is tightened beforehand so that the gunner having laid the tube can readily fire it whilst taking better aim. A special arrangement of carriage allows greater facility for training the tube without the aid of racers, as it adjusts itself to the slope of the deck. The breech of the tube is closed by mechanism which prevents the charge being fired unless the breech is properly closed. The charge of explosive to launch the torpedo is placed in a cup provided in the breech-piece. (November 29, 1883).

5747. Anchors: G. Tyzack, South Shields. [6*d.* 7 *Figs.*]—A curved toggle bolt is substituted for the crown pin, and is attached to the arm of the anchor, so as to work with it in such manner that the holding and gripping power is increased. The patentee refers to his former Patent 3940 of 1876. (December 15, 1883).

5788. Treating Ores to Purify and Prepare them for Smelting: W. R. Lake, London. (*C. Cherry, Chicago, Ill., U.S.A.*) [8*d.* 2 *Figs.*]—This relates to a process of and apparatus for treating ores, and has for object to purify ores and prepare them for smelting, by freeing or expelling their impurities, such as phosphorus, sulphur, antimony, arsenic, and other substances capable of being removed in a gaseous form. Another object is to obtain a uniform temperature about the retort, so that a more uniform product is obtained. (December 18, 1883).

5790. Electrical Conductors, &c.: H. H. Lake, London. (*C. H. Goebel and G. W. Bratton, Philadelphia, U.S.A.*) [8*d.* 30 *Figs.*]—This relates to electrical conductors



and underground conduits for the same. In order to insulate the conductors which are ordinarily covered with gutta percha, and to protect the covering from injurious action of the earth and

[illegible] of
A second coating of tar [illegible]
whole receiving a coating [illegible]
The tar employed is preferably Stockholm tar combined with linseed oil. The illustration shows one form of conduit. The two tubes A A are coupled together by smaller tubes B and caps C. The outer faces of the caps are formed with nipples, and to coincident nipples on opposite caps are attached section wire receiving pipes. The pipes are telescopic, being formed in two lengths, one sliding freely within the other. Branch pipes H may be attached to the nipples. Several other forms of tubes and conduits are described and illustrated. (December 18, 1883).

5791. Middlings-Purifiers: W. R. Lake. [illegible] (*J. T. Walter, Easton, Penn., U.S.A.*) [8*d.* 9 *Figs.*]—This comprises a housing or casing, one or more inclined vibrating screens contained therein, and means for inducting an air current through the screens. The objects are (1) to provide means for separating the coarser particles from the dust that is taken up by the air blast; (2) in a machine having two or more oppositely inclined screens arranged so that the tailings of one screen are delivered to the head of the screen below, to provide means for removing the larger and lighter specks; (3) to provide means for separating the material passing through different portions of a screen; and (4) to provide an improved device for operating the rotary beaters which clear the bolting cloth. (December 18, 1883).

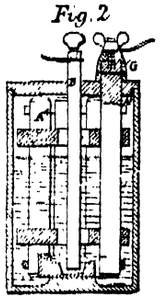
5832. Lighting by Hydro-Carbon Vapour; Storing Inflammable Liquids: N. L. Pouschkareff, Moscow. [6*d.* 15 *Figs.*]—The illuminating apparatus consists of a tube closed at one end and there provided with small holes or perforations. The tube is provided with a wick, a free space being left at the closed end, in which the vapours are generated, the wick not taking part in the combustion. The reservoirs are let into the walls, and are filled through the burner by means of a system of articulated pipes, the liquid again passing back to the burner. (December 21, 1883).

5856. Electric Batteries: W. P. Thompson, Liverpool. (*J. C. Himmer, New York, U.S.A.*) [6*d.* 2 *Figs.*]—An annular series of carbon rods are supported within a suitable cell or jar and are connected by means of carbon plates, one of the rods being provided with a metallic terminal. The zinc electrode extends between the rods and through the annular connecting plates, and carries at its lower extremity a cup for containing mercury provided with a cover by which it is attached to the zinc and with several apertures so that the mercury can escape and amalgamate with the surface of the zinc. Referring to the illustrations, the carbon rods A together constitute a single positive element of a battery, and the zinc rod B constitutes the negative element. Electrical connection is made to the positive element by means of the metallic thimble G. The lower extremity of the zinc rod extends into a glass cup containing mercury. (December 24, 1883).

Fig. 1

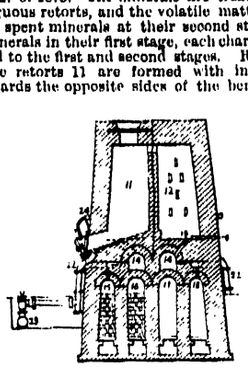


Fig. 2



5862. Manufacture of White Lead: G. Hand-Smith, London. [6*d.* 5 *Figs.*]—The white lead is manufactured from metallic lead by submitting the metallic lead within a suitable chamber to the corroding action of acid vapours and air prepared in a saturating chamber, introduced under pressure and allowed to expand. (December 25, 1883).

5873. Obtaining Oil and Gas from Minerals, &c.: N. McF. Henderson, Broxburn, Linlithgow. [6*d.* 8 *figs.*]—This refers to improvements on the apparatus described in Specification 1327 of 1878. The minerals are treated at different stages in contiguous retorts, and the volatile matters proceeding from the partly spent minerals at their second stage are [illegible] through the minerals in their first stage, each charge being successively subjected to the first and second stages. Referring to the illustration, the retorts 11 are formed with inclined bottoms descending towards the opposite sides of the bench, and immediately beneath them are arched spaces 14 forming the combustion chambers, connected by flues 15 with the flue spaces 12. Regenerative chambers 15, 16, 17, and 18 are arranged below the combustion chambers, and are provided with the necessary flues and valves. Two retorts are arranged opposite to or in line with each other across the bench, and communicate with each other at the top, and when the contents of one retort are going through their second stage, the gases pass over from that retort to the other retort, and from its bottom by the pipe 22 to the mains 23. Steam is supplied by pipes 24. (December 27, 1883).



5885. Indicating or Signalling Time by Electricity: A. G. Brookes, London. (*L. N. Downe, Boston,*) [8*d.* 6 *Figs.*]—The object is to provide a system by which the subscribers of a telephone system may be provided with the current time from a single standard clock by signals repeated in continuous succession throughout all the minutes of the day, and without the necessity of electric clocks or dials. A "repeating" clock transmits signals over the telephone lines to the receiving instruments. (December 28, 1883).

5887. Expansion Wrand Mandrels, Reamers, and Arbors [illegible] London (*A. E. Lytle, Chicago, U.S.A.*) [6*d.*]—This comprises a hollow shell provided with loose dogs in combination with a movable expanding plug, and means for drawing the plug in or out to expand or contract the dogs. The shell is formed with longitudinal slots having recessed ends. The dogs are serrated upon their rear faces, and are provided with end flanges. The tapering plug has a screw shank and inclined and dovetailed grooves in its faces, and is moved backwards and forwards by two screw-rods engaging with it from opposite ends of the shell. (December 28, 1883).

5897. Creating Currents of Air or Gas for Ventilating Purposes, &c.: R. Lofthouse, Manchester. [6*d.* 9 *Figs.*]—This comprises a stationary tube and a rotating cylinder provided with an Archimedean screw blade in its interior. The apparatus is provided with suitable deflecting plates. (December 28, 1883).

5901. Apparatus for Imparting Step-by-Step Motion to Parts of Mechanism: C. W. F. Hill, London. [illegible] 4 *Figs.*]—This consists of a wheel or disc with pins or teeth, a driving lever with a propelling surface and a stop surface, and a spring lever also with a propelling surface and a stop surface. (December 28, 1883).

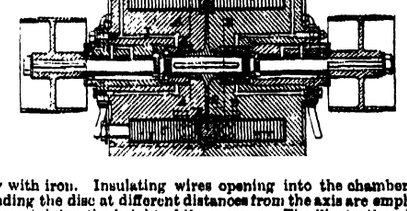
5907. Steam Boilers and their Furnaces: G. Stevenson, Airdrie, Lanark. [8*d.* 7 *Figs.*]—The boiler comprises an upper horizontal cylindrical shell with the water level at about its middle, and a series of tubes attached to the side of the shell so as to extend in various directions, and crossing each other beneath the shell, in an inclosed heating chamber. The upper ends of the tubes extend out beyond the top of the heating chamber, and are provided with removable covers, whilst their lower ends extend through the side walls, or through the bottom partition of the furnace. Each tube is provided with an inner circulating tube communicating with the shell. The attachment of the tube to the cylinder is effected by means of an internal distance piece formed with two passages, one at its lower part for the circulating pipe, and one at its upper part for the upward current. The furnace is constructed on the regenerative principle and is provided with suitable valves at each end. The fuel feeding apparatus comprises a truck arranged to pass under the grate bars, and provided with spaces for coal, the tops of the spaces being left directly beneath openings left between the grate bars at each side of the middle. Two pistons formed with curved guided racks are employed to push the coal through the openings. The rack teeth are acted on by a single pinion, and are made of zig-zag form, each tooth having a middle part inclined in one direction, and lateral parts inclined in the reverse direction. (December 29, 1883).

5919. Rotary Blowers, Exhausters, and [illegible] W. and E. Allday, Birmingham. [6*d.* 25 *f*[illegible] blower consists essentially of a case nearly oval in cross section, and containing two rotating diaphragms having in cross section a figure resembling generally the numeral 8. These diaphragms rotate in opposite directions, a current of air being drawn in on one side of the case and forced out at the opposite side. (December 29, [illegible]

5921. Machinery for Cutting Sheets of Steel and other Metals: W. T. Beesley, Sheffield. [6*d.* 2 *Figs.*]—Pairs of cutting discs mounted upon spindles rotating in opposite directions are employed, the edges being sufficiently close to cut or divide the steel. Each pair of cutters is so adjusted that as the steel to be cut is passed forward a separate and distinct cut is made therein. (December 29, 1883).

5926. Dynamo-Electric Machines and Electric Meters: S. Z. de Ferranti, London. [1*s.* 6*d.*

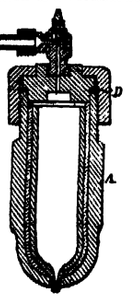
In order to construct a machine in which a continuous current may be produced without the aid of a commutator a good conducting, non-magnetic, metallic disc is revolved between two fixed annular poles of an electro-magnet, the pole on one side of the disc being an N pole and on the opposite an S pole, the outer ends of the poles being connected to form a horseshoe magnet. Each annular pole-piece is surrounded by insulating exciting coils. The disc revolves in a fixed metallic casing and contact is made between the outer edge of the disc and the casing by means of a film of mercury; or rubbers lubricated with mercury may be employed. The current is collected from the axis by bosses surrounded by fixed casings filled with mercury or by rubbers. The parts with which the mercury comes in contact are coated electrolytically with iron. Insulating wires opening into the chamber surrounding the disc at different distances from the axis are employed for ascertaining the height of the mercury. The illustration shows a longitudinal section of the machine; A B are the cylindrical magnet poles connected to form a horseshoe magnet by outer cylinders A' B'. The exciting coil is preferably in the form of a conducting strip C set edgewise as shown. The case E in which the disc D rotates is insulated at its exterior. The bosses G of the disc revolve in chambers H filled with mercury. I I and K are passages for the mercury. In a modification the iron pole-pieces are dispensed with, the disc revolving between two insulated conducting coils. The electric meter is composed of a circular bath of mercury or other conducting liquid through which the current to be measured is made to pass radially, and is also made to pass through insulated conducting coils surrounding the circumference of the bath or of a magnet pole placed above or below it. The rotation of the mercury caused by the passage of the current is measured by suitable recording mechanism. (December 29, 1883).



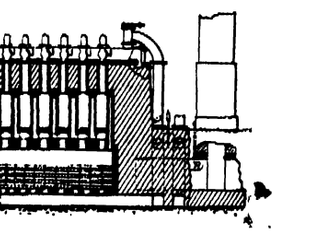
5967. Barrel Forming Machines: P. M. Justice, London. (*F. Myers, Hamburg, Germany*). [8*d.* 7 *Figs.*]—The discs whereon the staves are arranged are stationary and have grooves into which the staves are pushed through notches in the outer rims of the grooves and around in the grooves to make the form. The staves, prior to entering the grooves, pass over a bulging device and thence over a ring located midway between the holding discs that presses the staves outwards and maintains them in bulge shape, the axis of the staves being confined in the grooves. The ring is connected to a support, which, when about [illegible] of the barrel form is placed around the ring, is made [illegible] release it and it is retained by the staves already in place. The truss hoops are then forced on and the ends of the staves spring inwards against the inner walls of the grooves of the discs and the barrel is trussed. One of the discs is then drawn back to discharge the barrel; and the ring is collapsed and withdrawn. (December 31, 1883).

5971. Dressing, Ornamenting, or Polishing Stone, &c.: W. and T. Brindle, Upholland, Lanc. [6*d.* 5 *Figs.*]—A revolving or reciprocating surface is caused to alternately bear against the surface of the stone to be dressed, and then to be parted from it sufficiently to receive a layer of fresh sand or water between the rubbing surface and the rubbed. (December 31, 1883).

Manufacture of Carbons for Incandescent [illegible] Lamps: J. W. Swan, Bromley, Kent. [6*d.* 2 *Figs.*]—The filaments are manufactured from a solution of nitro-cellulose in acetic acid or other solvent combined or not with other carbonisable material, or from nitro-glucose rendered plastic by heat. This material is pressed through holes in dies so as to form filaments of the required length, thickness, and section. The filaments as they issue from the dies are projected into alcohol or other liquid which has the effect of giving coherence to the issuing thread. The illustration is a vertical section of the apparatus employed. The strong metallic cylinder A is closed by a cover held down by a cap piece which is screwed down so as to compress the packing D to give a tight joint. The pipe E from the reservoir of a compressing pump leads to the interior of the part A, which is lined with a glass cylinder terminating in a nipple piece or jet, through which the material is slowly forced by the pressure of the air into a vessel containing alcohol or its equivalent. The filament is then treated with a solution of hydrosulphate of ammonia or other deoxidising agent, is washed, carbonised, and afterwards bent to shape. (December 31, 1883).



5979. Regenerative Coke Furnaces: A. J. Boult, London. (*Schlesische Kohlen und Koks Werke, Gottesberg, Germany*). [6*d.* 13 *Figs.*]—The Siemens regenerators are combined with ordinary horizontal coke furnaces. The removal of the gases from the furnaces is effected by the pressure of the products of distillation, the regulation of this pressure being employed to prevent an access of air being drawn into the furnaces, and the consequent burning of the product. Referring to the illustration, coal being introduced, the gases evolved rise through tubes into the hydraulic main, and then pass through the channel E into the regenerator and to the combustion chamber, where they are ignited and pass by the other pair of regenerators to the chimney. When the regenerators are sufficiently heated the draught is reversed. (December 31, 1883).



UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

THE ÆOLUS WATERSPRAY VENTILATOR.—Amongst the most recent applications of the Æolus waterspray system of cooling, ventilating, and warming, are those which are being made for St. Mary's Church, Tenby, the University of North Wales at Bangor, Mr. Findlay's House, Edinburgh, and the Clerks' Café, Liverpool.

AMERICAN RAILROADS.—There were transported last year over the railroads of the United States 400,453,439 tons of freight, the value of which, at only 25 dols. per ton, would have exceeded 10,000,000,000 dols. The total length of the track worked was 149,188 miles, of which 78,491 miles were laid with steel rails. The number of locomotives employed was 23,823; of freight cars, 748,661; of passenger cars, 17,879; of baggage, mail, and express cars, 5948.

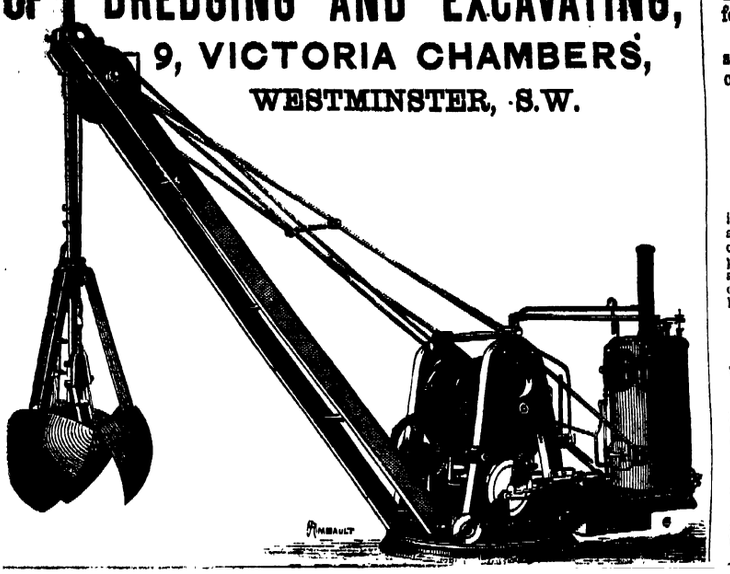
CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—The members of this Society on the 14th inst. visited the East and West India Company's new docks at Tilbury. The party was conducted over the works by the resident engineer, Mr. Donald Baynes. After these works had been inspected the party proceeded to the Clarendon Hotel for luncheon, and afterwards by special boat to Thames Haven to inspect the petroleum stores over which they were conducted by the engineer, Mr. William C. Street.

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Contractors' Engineer.

PARKESTON, HARWICH, 28th Jan., 1882.

W. DUFF BRUCE, Esq., 9, Victoria Chambers, Westminster, S.W.

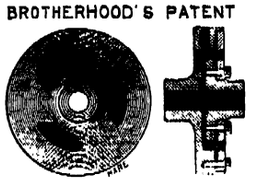
DEAR SIR,—We have much pleasure in informing you that the Excavators supplied to us by you for sinking the concrete cylinders required for the New Quay we are constructing here for the Great Eastern Railway Company, are giving us every satisfaction. With them we are able to sink the cylinders NINE FEET in diameter through the stiff silty clay forming the bed of the river, a depth of about 30 ft., in two days.

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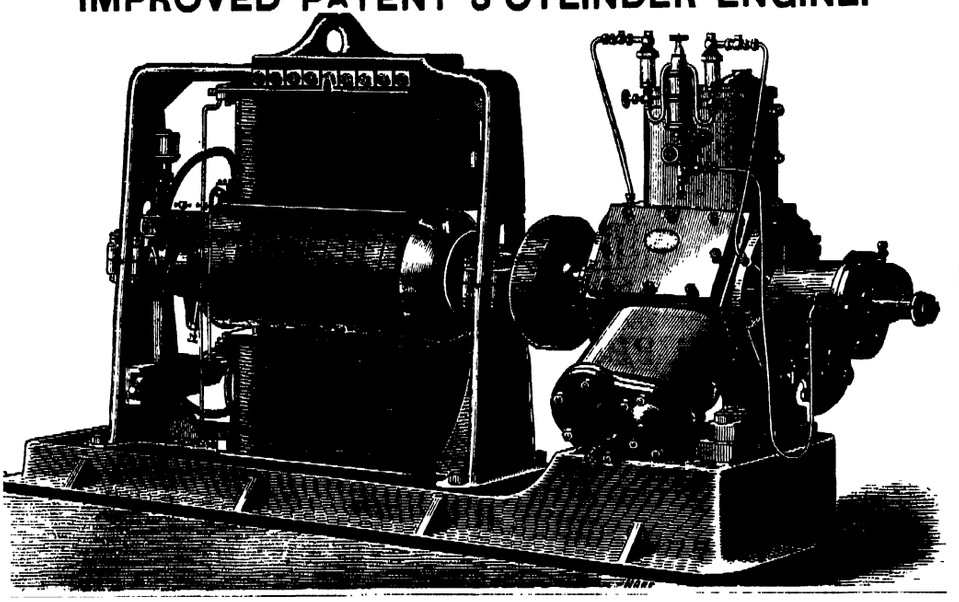
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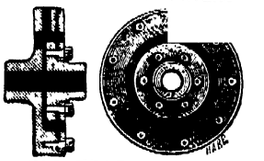


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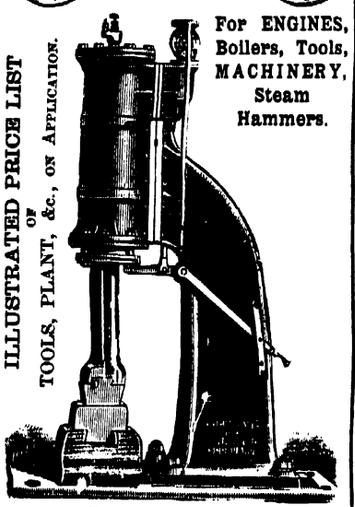
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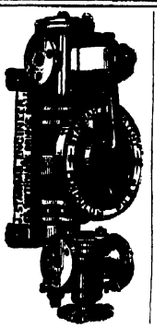
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WELL BORING TOOLS 5022

THE CALEDONIAN TUBE COMPANY,

Established 1844. COATBRIDGE, NEAR GLASGOW, Manufacturers of



4788

IRON & STEEL BOILER TUBES

THWAITES BROTHERS,

Engineers, Steam Hammer Makers.

SOLE MAKERS OF

PATENT IMPROVED DOUBLE-ACTION

Steam Hammers.

1,000 SUPPLIED.

ROOT'S PATENT IMPROVED

BLOWERS AND EXHAUSTERS.

5,000 SUPPLIED.



STEAM STAMPS

Price Lists ON APPLICATION

100 STEAM HAMMERS IN PROGRESS.

CALCUTTA INTERNATIONAL EXHIBITION, 1883-84.

British Exhibits—Section G.

THWAITES BROTHERS

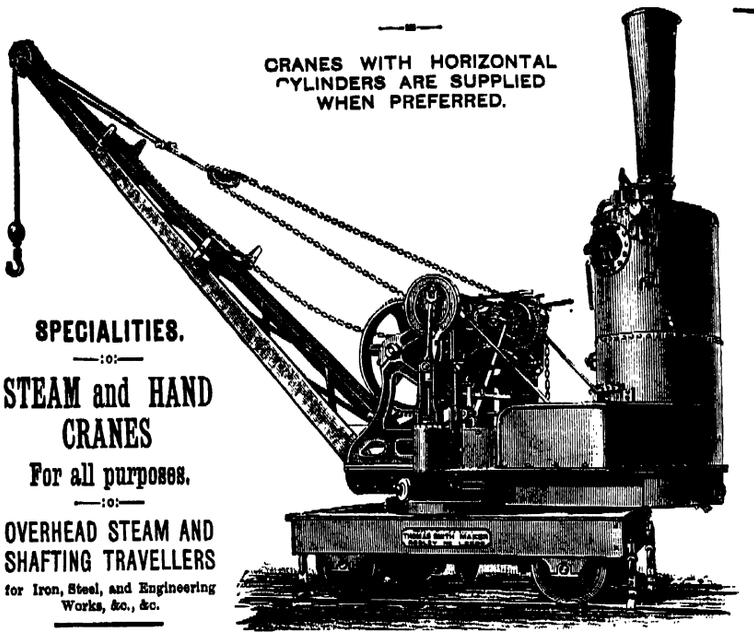
Obtained the Highest Awards, viz.: for Steam Hammer, First-Class Certificate and Silver Medal; and for Root's Patent Improved Blower and Engine, another First-Class Certificate and Silver Medal.

"VULCAN" PORTABLE FORGE.

4456

VULCAN IRON WORKS, BRADFORD, YORKSHIRE.

SMITH'S STEAM CRANES.



CRANES WITH HORIZONTAL CYLINDERS ARE SUPPLIED WHEN PREFERRED.

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STEAM and HAND CRANES

For all purposes.

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OVERHEAD STEAM AND SHAFTING TRAVELLERS

for Iron, Steel, and Engineering Works, &c., &c.

LOCOMOTIVE & PORTABLE STEAM CRANES

IN STOCK AND PROGRESS,

Having all the most recent improvements, including

RAPID MOTIONS

For working Expeditiously.

Adapted for Docks, Public Works, Railways, and Iron, Steel, and Engineering Works, &c.

40 *Supplied to the*

NEW DOCK WORKS, HULL;

And 10 *to*

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And many other Important Works, both at Home and Abroad.

SEND FOR PRICES AND PARTICULARS. 4722

THOMAS SMITH, Steam Crane Works, RODLEY, near LEEDS.



PATENT WIRE TRAMWAYS

Of all descriptions on the Single and Double-Rope Systems; Self-Acting, and Driven by Steam, Water, or Horse Power.

Carrying from 50 to 1,000 tons per day. Over 150 miles erected in all parts of the world. For Particulars and Estimates apply to

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ENGINEER AND MANAGER TO THE OWNER OF THE PATENTS FOR WIRE ROPE TRANSPORT. 5006

COCKSHOTT & JOWETT,

145, THORNTON ROAD, BRADFORD, YORKSHIRE,

Brass & Malleable Iron Founders.

Mall. Iron Screw Keys all sizes, always in stock.

MANUFACTURERS of BRASS SHELLS for CALLENDER BOWLS, PUMP BARRELS, &c.

MANUFACTURERS OF

PHOSPHOR TIN & PHOSPHOR LEAD,

From which Phosphor Bronze of very best quality can be made at a saving of over 30 per cent. 4723





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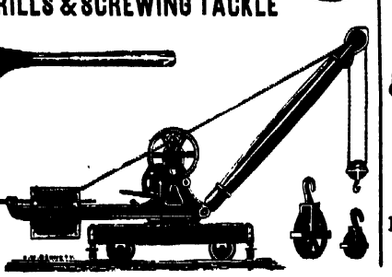


—::—

Steam & Hand Cranes, Crab Winches, and all kinds of Lifting Tackle

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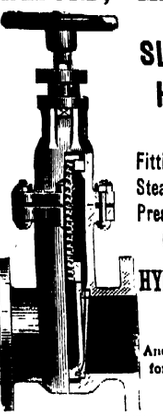


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SLUICE VALVE, HYDRANTS,

And all Classes of

Fittings for Water Works, Steam, Gas & Sewage, High Pressure Condensing and Compound Engines,

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And all kinds of MACHINERY for Ironworks, Collieries, and General Purposes.

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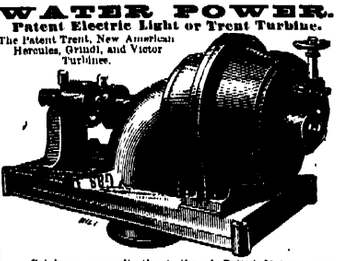
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WATER POWER.

Patent Electric Light or Trent Turbine.

The Patent Trent, New American Hercules, Grindl, and Victor Turbines.



Catalogues on application to the sole British Maker. 4081

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ESTABLISHED 1831.



PRIZE MEDALS LONDON, PARIS, AMERICA, &c.

Engineers and Machine Tool Makers

To Governments and Leading Works.

Tools always in stock and progress (immediate delivery).

LATHES, 6 in. and 7 in. Slide, Surfacing, and Screw-cutting, 6, 7, 8, and 10 ft. beds.

LATHES, 8 in. do. do. 8 ft., 10 ft., and 12 ft. beds.

LATHES, 9 in. do. do. up to 20 ft. beds.

LATHES, 10 in. and 12 in. do. do. up to 28 ft. beds

PLANES, 2 ft. by 2 ft. by 4 ft., 5 ft. and 6 ft. long.

PLANES, 2 ft. 6 in. by 2 ft. 6 in., by 6 ft. and 8 ft. long.

Our Patent Square Centreing, Facing, and Chamfering Machines will square centre any length of shafts. Over 500 in use.

SLOTTERS, 7 in., 8 in., 10 in., and 12 in. stroke.

Bench Drills, Pillar Drills, Radial Drills, Milling Screwing, Screw and Stud Making Machines, &c.

Price Lists Free, which will favourably compare with any. Tools for shipment securely packed.

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YORKSHIRE MACHINE TOOL WORKS, 4838

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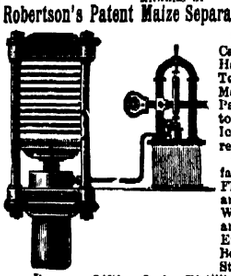
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MAKERS OF

Robertson's Patent Maize Separating Machinery.



McTear's Patent Calcining Furnaces; Haworth's Patent Tea Leaf Rolling Machines; Kirk's Patent Refrigerators, for producing Ice—no chemicals required.

They also Manufacture all kinds of Flour, Rice, Corn, and Sugar Mills Water Wheels, High and Low-Pressure Engines; Steam Boilers; Tanks; Oil Stills; Hydraulic Presses; Lifting Jacks, Distilling Plant, &c.

Lithographs and all Particulars on application.

PULTENEY STREET ENGINE WORKS,

DOBBIE'S LOAN, GLASGOW.

LONDON OFFICE: JAMES REID & CO., 4868

27, MARTIN'S LANE, CANNON STREET, E.C.

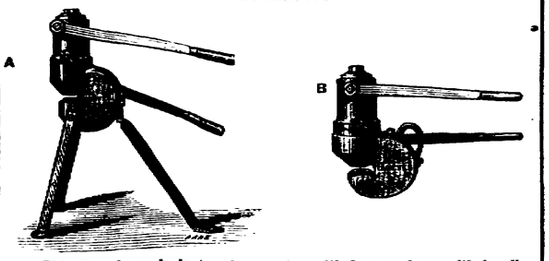
TANGYES LIMITED,

CORNWALL WORKS, BIRMINGHAM.

TANGYE BROTHERS, { London - 35, Queen Victoria St. / Newcastle St. Nicholas Buildings. | Manchester - St. Mary's Gate & Deansgate. / Glasgow - - Argyle & Hope Streets. 4509

TANGYES' HYDRAULIC PUNCHING BEAR

OPEN MOUTH.



This Bear is made in two forms, viz., with legs as A, or with handle instead of legs, as B. The latter is largely used by Ship-builders, for punching ship frames, &c.

Distance from centre of punch to back of gap is 1¼ ins. For extra depth of gap special quotation is necessary.

No.	To punch	Through Iron Plate	Weight	Price
1	¾ in.	½ in.	64 lbs.	£7 10
1A	⅞ ,,	⅝ ,,	90 ,,	9 0
2	1 ,,	¾ ,,	120 ,,	10 10
3	1¼ ,,	1 ,,	220 ,,	21 0
4	1 ,,	steel rails	320 ,,	34 0

Price includes one Round Punch and Die.

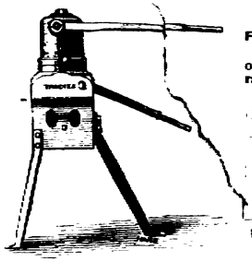
PUNCHES AND DIES FOR HYDRAULIC AND SCREW BEARS

To Punch Hole .. in.	½	⅝	¾	⅞	1	1¼	1½
Through Iron Plate ,,	½	⅝	¾	⅞	1	1	1
Round .. per pair	4/-	5/-	5/6	6/-	6/6	7/-	7/6	10/-
Oval or Square ,,	8/-	10/-	11/-	12/-	13/-	14/-	15/-	20/-

A Pair means one Punch and one Die.
Intermediate sizes charged at price of next larger size. 144

TANGYES' HYDRAULIC PUNCHING BEAR

CLOSE MOUTH.



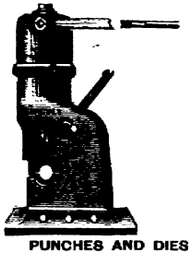
For Iron or Steel Rails, Girders, &c.

This Bear is made to suit any section of rail. In ordering, send a piece of the rail or a full-sized sectional sketch.

No.	To punch	Through Iron Plate	Price
1	¾ in.	½ in.	£12
2	1 ,,	¾ ,,	17
3	1¼ ,,	1 ,,	28
4	1 ,,	steel rails	38

Price includes one Round Punch and Die.

TANGYES' HYDRAULIC STEEL CABLE SHEARS



This Tool was specially designed for cutting Steel Cables, which it does very effectively, making a clean cut. It may be used also for Shearing Iron Bars in the usual way.

No.	To Cut Iron Bar	To Shear Steel Cable	Price
1	2 ins. × ½ in.	1½ in. diam.	£28
2	3 ins. × ¾ in.	2 in. diam.	35

Price includes one pair Blades.

Extra Shear Blades per pair,
No. 1, £2; No. 2, £2 10s.

PUNCHES AND DIES FOR HYDRAULIC AND SCREW BEARS

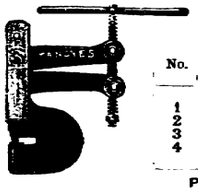
To Punch Hole ..... in.	½	⅝	¾	⅞	1	1¼	1½
Through Iron Plate..... ,,	½	⅝	¾	⅞	1	1	1
Round.....per pair	4/-	5/-	5/6	6/-	6/6	7/-	7/6	10/-
Oval or Square..... ,,	8/-	10/-	11/-	12/-	13/-	14/-	15/-	20/-

A Pair means one Punch and one Die.
Intermediate sizes charged at price of next larger size. 145

TANGYES'

"DUPLEX" LEVER PUNCHING BEAR

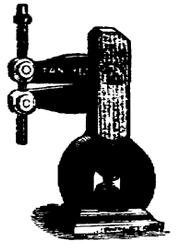
This Bear is now made almost entirely of Steel



OPEN MOUTH DUPLEX BEAR

No.	To punch	Through Iron Plate	Gap	Weight	Price
1	½ in.	½ in.	1½ ins.	18 lbs.	£3 10
2	⅝ ,,	⅝ ,,	1½ ,,	38 ,,	4 10
3	¾ ,,	¾ ,,	2 ,,	81 ,,	6 10
4	⅞ ,,	⅞ ,,	2½ ,,	120 ,,	10 10

Price includes one Round Punch and Die.



CLOSE MOUTH DUPLEX BEAR

No.	To punch	Through	Price
1	1½ in.	½ in. Iron Rail	£17 10
2	1¼ ,,	½ ,, Steel ,,	

Price includes one Round Punch and Die.

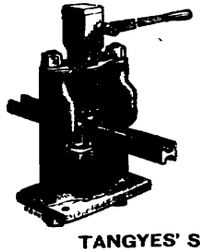
PUNCHES AND DIES FOR HYDRAULIC AND SCREW BEARS

To Punch Hole .. .. in.	½	⅝	¾	⅞	1	1¼	1½
Through Iron Plate .. ,,	½	⅝	¾	⅞	1	1	1
Round .. .. per pair	4/-	5/-	5/6	6/-	6/6	7/-	7/6	10/-
Oval or Square .. .. ,,	8/-	10/-	11/-	12/-	13/-	14/-	15/-	20/-

A Pair means one Punch and one Die.
Intermediate sizes charged at prices of next larger size. 147

TANGYES'

STANDARD HYDRAULIC PUNCHING MACHINE



No.	Gap	To punch	Through Iron Plate	Weight	Price
1	8 ins.	1 in.	¾ in.	4 cwts.	£25
2	12 ,,	1 ,,	1 ,,	7 ,,	30
3	21 ,,	1 ,,	1 ,,	10 ,,	38

Price includes one Round Punch and Die.

TANGYES' SCREW PUNCHING BEAR



No.	To punch	Through Iron Plate	Weight	Price
1	½ in.	½ in.	23 lbs.	40/-
2	¾ ,,	¾ ,,	36 ,,	50/-
3	1⅛ ,,	⅞ ,,	51 ,,	75/-

Price includes one Round Punch and Die.
If with Ratchet Lever, extra 12/-
,, Plain ,, ,, 3/-

PUNCHES AND DIES FOR HYDRAULIC AND SCREW BEARS.

To Punch Hole .. in.	½	⅝	¾	⅞	1	1¼	1½
Through Iron Plate ,,	½	⅝	¾	⅞	1	1	1
Round .....per pair	4/-	5/-	5/6	6/-	6/6	7/-	7/6	10/-
Oval or Square ,,	8/-	10/-	11/-	12/-	13/-	14/-	15/-	20/-

A Pair means one Punch and one Die.
Intermediate sizes charged at price of next larger size. 146

TANGYES' HYDRAULIC PULLING JACK



In this Jack the Pump is inside and out of the reach of damage from accident.

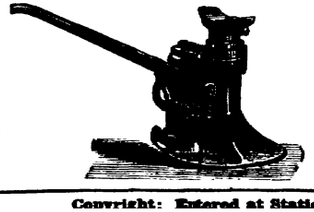
The run out can be increased to a moderate extent without increasing size of cylinder.

Tested to tons	2	4	6	8	10
Run out .. .. ins.	24	24	24	24	24
Weight .. .. lbs.	60	70	90	120	180
Price .. .. £	9	11 10	14	16	18
Extra run out, ... per ft.	60/-	60/-	70/-	80/-	80/-

INSTRUCTIONS FOR USING THE PULLING JACK.

After filling it with water, which can be poured in through the air screw, suspend it with the cistern end downwards, screw up the stop valve and work the hand lever; the water will then be pumped from the cistern through the inner tube to the underside of the piston, thus impelling it forward, and at the same time the water from the back of the piston is constantly flowing through the passages indicated to supply the cistern. TO LOWER, open the stop valve, when the water will return to the cistern.

TANGYES' HYDRAULIC TIMBER JACK



Tested to	4 tons
Height ..	14 ins.
Run out ..	7 ,,
Weight ..	76 lbs.
Price ..	£4

142

TANGYES' HYDRAULIC SHEARS



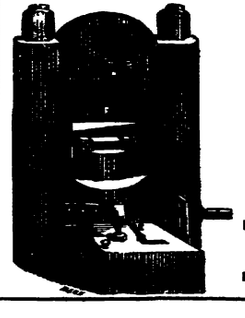
No.	To cut Iron square or round	To cut Iron Bar	Price
1	1½ ins.	3 × ½ ins.	£16 0
2	2 ,,	4 × ¾ ,,	21 10

Weight: No. 1, 230 lbs.; No. 2, 380 lbs.
Extra Shear Blades, per pair:
No. 1, £2; No. 2, £2 10s.

These Shears can be adapted for power by attaching a joint pin to end of lever.

HYDRAULIC SHEARING MACHINE

(Eastwood's Patent)



No.	To cut Iron square or round	Price
1	2½ ins.	£42
2	3 ,,	50
3	3½ ,,	65
4	4 ,,	90

All with 10 ins. gap, and two Pumps.

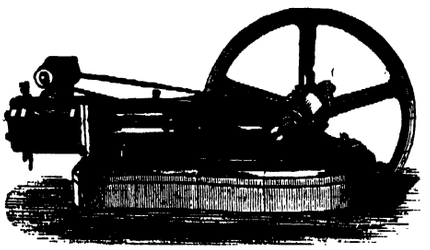
If made with separate Pump to be worked by power, extra.

If mounted on wheels, extra. 143

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SHANKS'S HORIZONTAL AND VERTICAL HIGH-PRESSURE STEAM ENGINES.

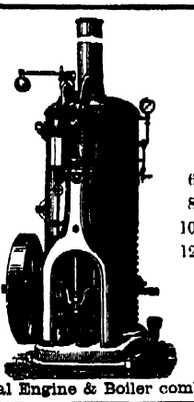
THESE ENGINES ARE THE CHEAPEST AND MOST POWERFUL IN THE MARKET.



"Caledonian" Horizontal Engine.

PRICES.

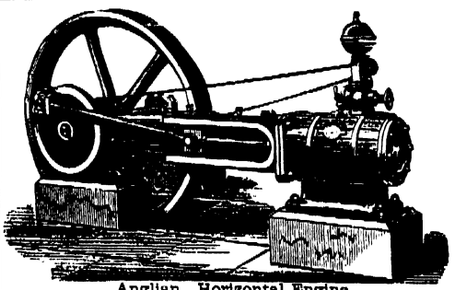
4 HP.	...	... £35	16 HP.	...	... £120
6 HP.	...	... 45	20 HP.	...	... 150
8 HP.	...	... 60	25 HP.	...	... 200
10 HP.	...	... 70	30 HP.	...	... 250
12 HP.	...	... 88			



Vertical Engine & Boiler combined.

PRICES.

2 HP.	...	... £70
3 HP.	...	... 80
4 HP.	...	... 90
5 HP.	...	... 100
6 HP.	...	... £110
8 HP.	...	... 150
10 HP.	...	... 175
12 HP.	...	... 200



Anglian Horizontal Engine.

PRICES.

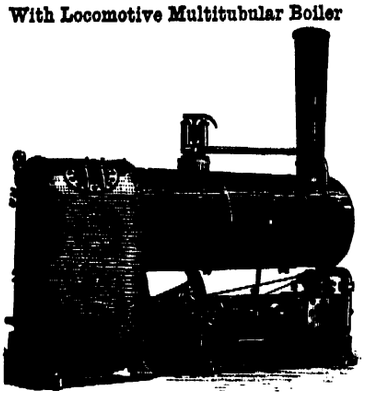
6 HP.	...	... £57 10s.	16 HP.	...	... £145
8 HP.	...	... 77 10s.	20 HP.	...	... 175
10 HP.	...	... 95	25 HP.	...	... 210
12 HP.	...	... 110	30 HP.	...	... 240

MARINE ENGINES

of MASSIVE CONSTRUCTION and LARGE WEARING SURFACES. The Smaller Surfaces are CASE-HARDENED, and all others provided with GUN METAL BEARINGS, with suitable provision for adjustment.

"THE CALEDONIAN,"

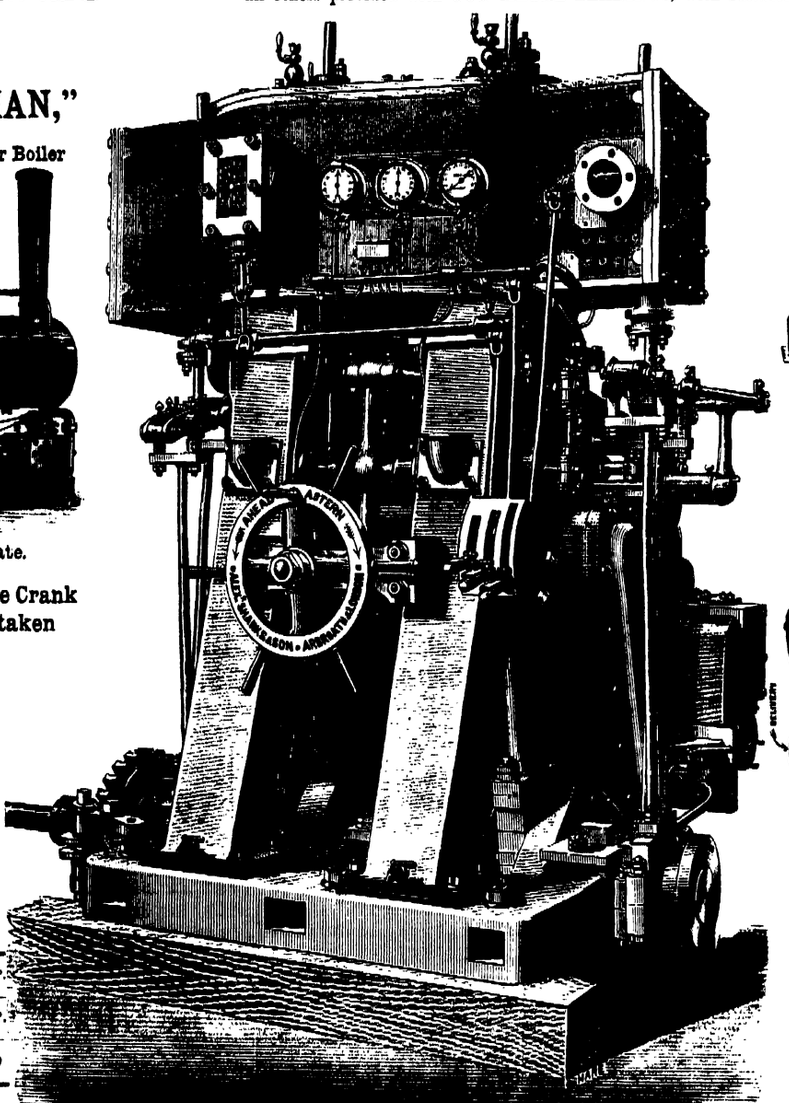
With Locomotive Multitubular Boiler



Combined on one Sole Plate.

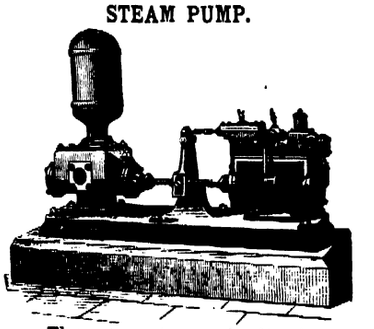
The Engine having a Double Crank enables the power to be taken from either side.

The above is the cheapest and most convenient form of Engine with Locomotive Boiler in the market.



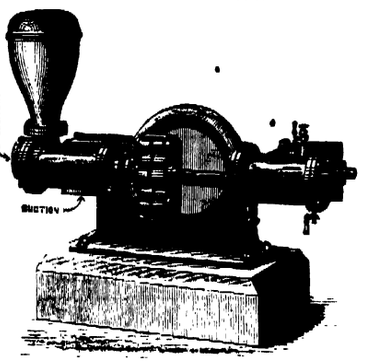
Size of Engine	4 HP.	6 HP.	8 HP.	10 HP.	12 HP.
Size of Boiler	6 HP.	8 HP.	10 HP.	12 HP.	14 HP.
Engine & Boiler as above	£130	£155	£210	£250	£300

SHANKS'S IMPROVED DIRECT-ACTING STEAM PUMP.



The utmost regularity in reversing and steadiness in working secured.

SHANKS'S IMPROVED EXPANSIVE STEAM PUMPING ENGINE.



THE SIMPLEST MADE. ACTION CERTAIN.

Prices, Illustrations & Particulars on application.

ALEX. SHANKS & SON will be glad to furnish, on application, detailed Specifications for Engines up to 1000 I. HP., with suitable Boilers, fixed on board complete, or securely packed for shipment.

STEAM CRANES AND HOISTING ENGINES OF ALL SIZES.

SHANKS'S PATENT COMPOUND STEAM ENGINES in the Horizontal or Vertical form, with or without Boilers.

SHANKS'S PATENT COMPOUND LAUNCH ENGINES.

ILLUSTRATIONS, WITH FULL PARTICULARS AND PRICES, ON APPLICATION.

ALEXANDER SHANKS & SON, DENS IRON WORKS, ARBROATH.

And 27, LEADENHALL STREET, LONDON, E.C.

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GALVANIZED CORRUGATED AND PLAIN SHEETS.
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WROUGHT AND CAST IRON GIRDERS, COLUMNS, &c.

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WOLVERHAMPTON: SWAN GARDEN MILLS.
LONDON: 28, GRACECHURCH STREET, E. C. 4666

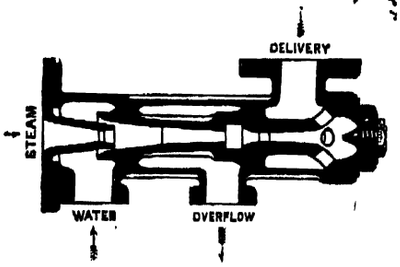
Gresham's Patent Improved Giffard's Injectors

FOR SUPPLYING STATIONARY, LOCOMOTIVE, AGRICULTURAL OR MARINE BOILERS WITH WATER

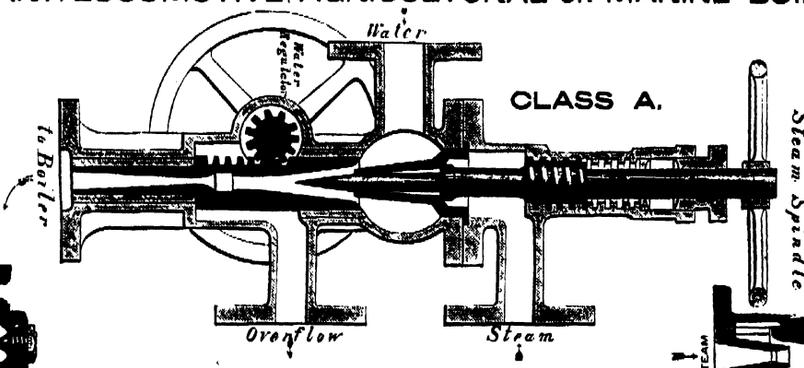
CLASS C 2.

Combining and Receiving Cones removable without breaking pipe joints.

(GRESHAM'S PATENT.)



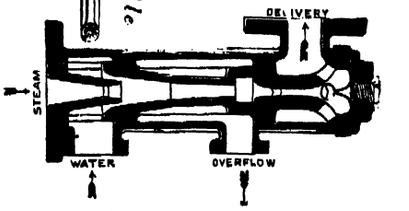
CLASS A.



CLASS G

All Cones removable without breaking any pipe joints.

(Sheward & Gresham's Patent.)



The above and every other class of Injector, Ejector, and Elevator in stock and in progress; also Brass Fittings for Locomotive and other Boilers.

:o:

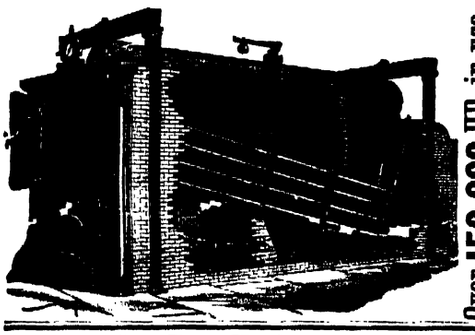
Sole Manufacturers: **GRESHAM & CRAVEN**, ENGINEERS, MANCHESTER,

Who are also the only Manufacturers of Ejectors and Brass Fittings for the Vacuum Brake Co., Ltd.

AGENTS.—LONDON: A. L. SACRÉ, 60, Queen Victoria Street, E.C. GLASGOW: WILLIAM LESTER, 58, Renfield Street.
NEWCASTLE-ON-TYNE: TANGYE BROS., St. Nicholas Buildings. BIRMINGHAM: TANGYES LTD. NOTTINGHAM: SMITH BROS. & Co., Hyson Green. 5039

THE BABCOCK AND WILCOX CO.

(NEW YORK & GLASGOW)



Over 150,000 HP. in use.

PATENT

WATER-TUBE STEAM BOILER.

Safe, Economical (as to space and fuel), and Durable; Having Perfect Water Circulation, and Spacious Steam-room; Easy of Transportation, and perfectly Accessible for Cleaning external and internally.

For Illustrated Circular and full particulars apply to our European Offices,

107, HOPE STREET, GLASGOW, SCOTLAND;
40, CANNON STREET, LONDON, E.C.; and
3, VICTORIA BUILDINGS, DEANSGATE, MANCHESTER.

For the Colonies and New Zealand, apply at No. 3, Spring Street, Sydney, N.S.W. 4770

LIGHT FORGINGS.

BRAKE WORK.
WAGON IRONWORK.

GLASGOW HYDRAULIC FORGE CO., LIMITED, Sentinel Works, Polmadie, Glasgow, and Canal Road, King's Cross, London. 5135

The only GOLD Medal at Paris Exhibition, 1878, for Best Cast Steel Castings. Also the only GOLD Medal for Best Cast Steel Castings, Melbourne, 1881. Three SPECIAL Diplomas, Sydney and Melbourne, 1880-81. Awarded SPECIAL DIPLOMA at Sydney Exhibition, N.S.W., for Best Cast Steel Castings. GOLD MEDAL, Madrid, 1883.

HADFIELD'S STEEL FOUNDRY CO., SHEFFIELD.

Contractors to H.M. Home, India, and Colonial Governments. Home, Foreign, & Colonial Railways, Admiralty, War Department, &c.

MISCELLANEOUS STEEL CASTINGS

OF UNSURPASSED QUALITY.

Railways.—Horn Blocks, Axle-boxes, Crossheads, Piston Blocks, Buffer Boxes, Bogie Engine Wheels, Trolley Wheels, Axles, &c., &c.

Tramways.—Patent Hecla Wheels (one-half the weight of cast-iron), Points, Crossings, &c.

Hydraulics.—Hydraulic Press Cylinders up to 20 ft. in length, Pumps, Glands, Seed-Crushing Rolls, &c., &c.

Gearing.—Every class of Spur, Bevel, &c., Gearing up to 7 tons each, Machine Moulded or from full patterns; also the new Helical Gearing.

Engineers' and General Castings of every description, Dredger Castings, &c., &c.

Colliery and Mining Tub, Corve, or Wagon Wheels, Rollers, Pulleys, Peds, &c.

OVER 1,100 PATTERNS IN STOCK.

Our Unhammered Steel Castings, as recently tested by H.M. Government, stood a tensile strain of 40 to 55 tons per square inch, and up to 20 per cent. elongation.

OUR SOLE SPECIALITY IS

STEEL CASTINGS.

FROM 4 LBS. TO 16,000 LBS. EACH.

SOLE MAKERS OF

HADFIELD'S CAST STEEL WHEELS & AXLES.

Over a Million and a Half in daily use, giving every satisfaction.

One of our departments is specially adapted for the production of our Patent Steel Wheels and Axles for Collieries, Tramways, Ironstone Mines, Slate Quarries, Iron Works, Lead Mines, &c., and we are now manufacturing about 2,000 per week. Owing to our patent system of fitting up Wheels and Axles, which is simple and effective, we are enabled to execute orders with promptitude, and undertake to supply all work entrusted to us in a first-class manner.

We manufacture only the **Best Quality.**

Over 1,200 different Wheel and Pulley Patterns in stock, any of which can be ready for use on the shortest notice.

Our Wheels possess extra **toughness, durability solidity,** and **lightness.** 4692

TANNETT WALKER & Co.

ENGINEERS, LEEDS,

Makers of the heaviest class of Machinery used in the manufacture of **IRON** and of **STEEL** by the Bessemer and Siemens processes.

COGGING, RAIL & PLATE MILL ENGINES.

Armour Plate and Forging Presses.

STEAM HAMMERS.

Hydraulic Cranes and Capstans. 5268

WORKS: EAST GREENWICH, LONDON, S.E.

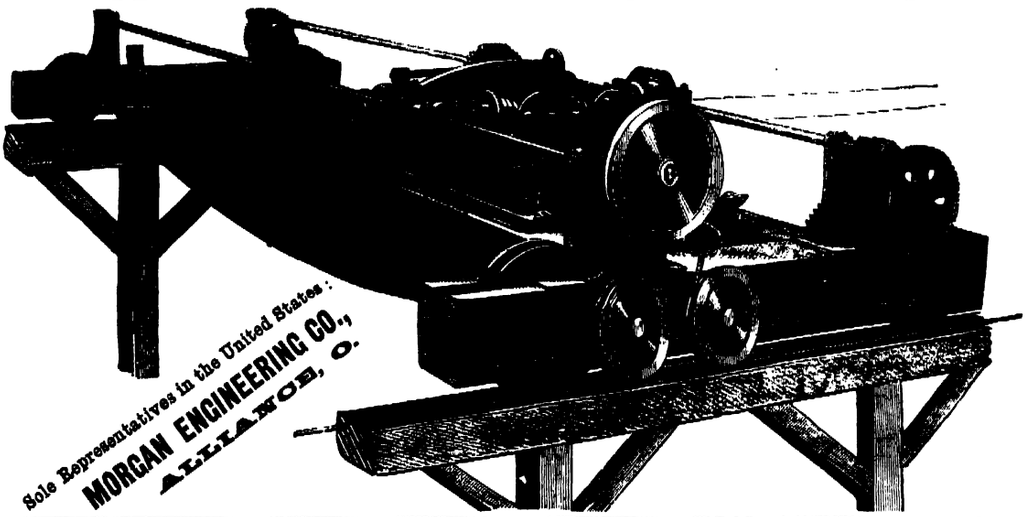
APPLEBY BROTHERS.

CITY OFFICE: 89, CANNON ST., LONDON, E.C.

Cranes, STEAM, HAND, AND HYDRAULIC, FIXED, PORTABLE OR LOCO.

OVERHEAD TRAVELLERS And Lifting Machinery of all descriptions.

Boilers. All types of Land and Marine, and in all sizes.



Sole Representatives in the United States: MORGAN ENGINEERING CO., ALLIANCE, O.

STEAM ENGINES Of all types and powers for Mills, Mines, Water Works, &c.

Winding Gear, PUMPING MACHINERY, Combined or separate.

IRON BRIDGES, Iron Roofs and Girder Work of all kinds. 4946

CRANES. TURNTABLES. TRAVERSERS

COWANS, SHELDON & CO., LTD., ST. NICHOLAS WORKS, CARLISLE. 5009



THE COALBROOKDALE COMPANY, LIMITED

MAKERS OF

STEAM ENGINES, HORIZONTAL AND VERTICAL, AND OTHER MACHINERY.

MAKERS OF

STEAM PUMPS. PARKER & WESTON'S PATENT PUMPING ENGINES for Mines, Sewage and Water Works. BOILER FEEDERS and SLIP PUMPS.

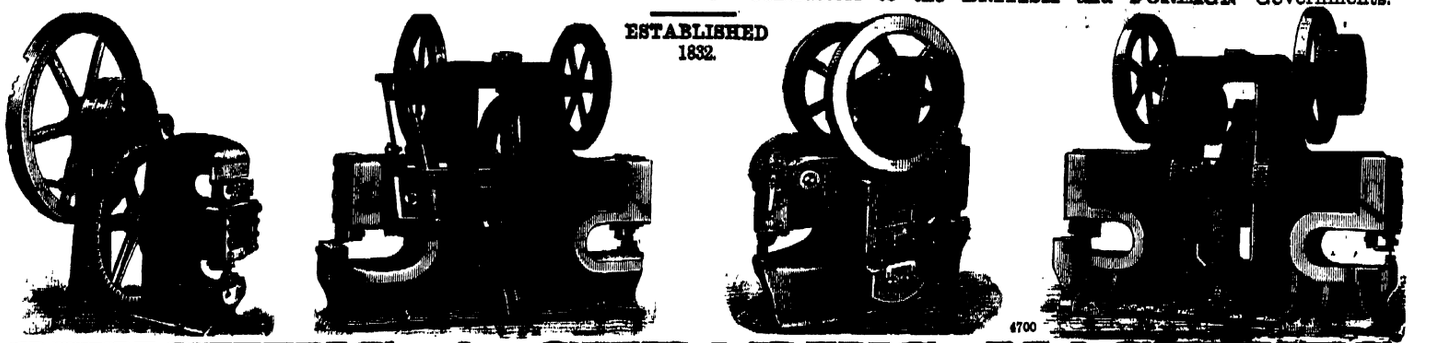
AGENCIES { LIVERPOOL - 19, SWEETING STREET. MANCHESTER, 29, PRINCESS STREET. 5126

WORKS & OFFICES: COALBROOKDALE, SHROPSHIRE.

FRANCIS BERRY & SONS, Ironfounders, Engineers, and Tool Makers, SOWERBY BRIDGE, ENGLAND.

Contractors to the BRITISH and FOREIGN Governments.

ESTABLISHED 1832.



PUNCHING & SHEARING MACHINES.

RUSHWORTH & CO.,

(Late Foremen with Messrs. Francis Berry and Sons.)

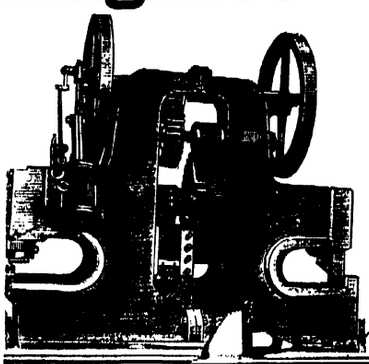
Engineers and Machine Tool Makers,

SOWERBY BRIDGE, YORKSHIRE,

MAKERS OF

Improved Lathes, Planing, Slotting, Shaping, Drilling, Screwing, Punching and Shearing Machines,

PLATE BENDING ROLLS, SPECIAL ANGLE AND T IRON BENDING MACHINES,



Special Multiple Punching & Shearing Machines for Gas Holder & Tank Makers,

STEAM HAMMERS, GEARED AND STEAM RIVETTING MACHINES, &c.

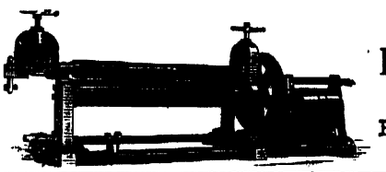
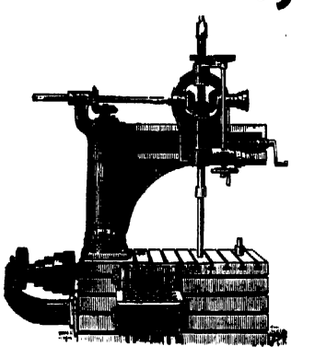


PLATE EDGE PLANING MACHINES

For Boiler Makers and Ship Builders. 5163



WALKER BROS., ENGINEERS AND BOILER MAKERS, Pagefield Iron Works, WIGAN,

MANUFACTURERS OF LOCOMOTIVES.

WALKERS' PATENT

AIR-COMPRESSING ENGINES

For COLLIERIES, STEEL WORKS, &c., and as supplied to HER MAJESTY'S GOVERNMENT for INDIA

WALKERS' PATENT GUIBAL VENTILATING FANS,

For Mines, Collieries, Tunnels, Sewers, &c. Diameters from the smallest size up to 50ft. With Simple or Compound Condensing Engines.
MAKERS OF THE GUIBAL, SCHIELE (his latest Patent), AND WADDLE FANS.

STEAM HAMMERS, Patterns up to 20 tons. FORGE and ROLLING MILL PLANT. WINDING, HAULING, and PUMPING ENGINES. IMPROVED FEED PUMPS for BOILERS.

STEAM CAPSTANS, Patterns for lifting up to 60 tons. OVERHEAD TRAVELLERS AND OTHER CRANES.

HORIZONTAL AND VERTICAL, STATIONARY, AND LOCOMOTIVE BOILERS.

Iron and Steel Forgings. Horizontal and Vertical Engines, Condensing and Non-Condensing. Roofs, Girders, Bridges, Pit Cages, &c., and all kinds of Iron and Steel Work.

WALKER'S Patent, as adapted to Bessemer Blowing Engines, is now in successful operation at the following Steel Works, and is about to be applied to other Engines for similar purposes :—

Messrs. BOLCKOW, VAUGHAN and CO., Eston, Middlesbro'.
" The DOWLAIS IRON CO., Dowlais.
" CHARLES CAMMELL and CO., Cyclops Works, Sheffield.
" The DARLINGTON IRON and STEEL CO., Darlington.
" The WEARDALE IRON and STEEL CO., near Durham.

And to 150 other Engines for a variety of purposes throughout the country.

The advantages afforded by the application of the Patented Valves to Bessemer Engines, are a greater endurance than has yet been attained by valves worked automatically (eccentrics, &c., for the valves not being required), and an almost perfect expulsion of the whole of the compressed air from the cylinders.

RANSOMES AND RAPIER,

5, WESTMINSTER CHAMBERS,

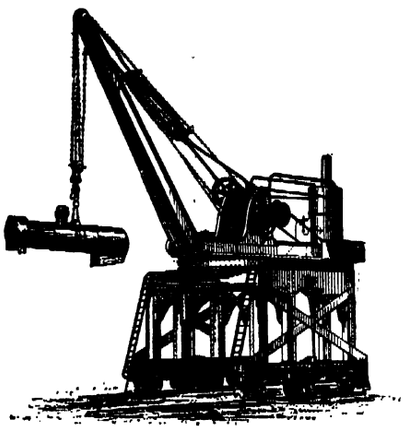
LONDON,

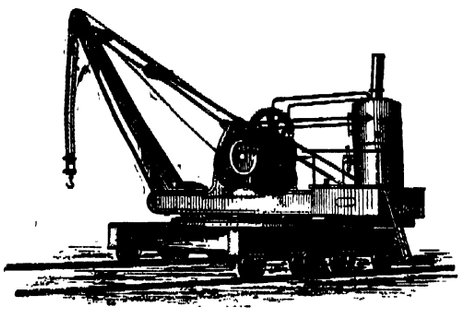
And WATERSIDE IRONWORKS, IPSWICH,

— MAKERS OF ALL KINDS OF —

STEAM & HAND CRANES

From 5 Cwt. to 50 Tons Load



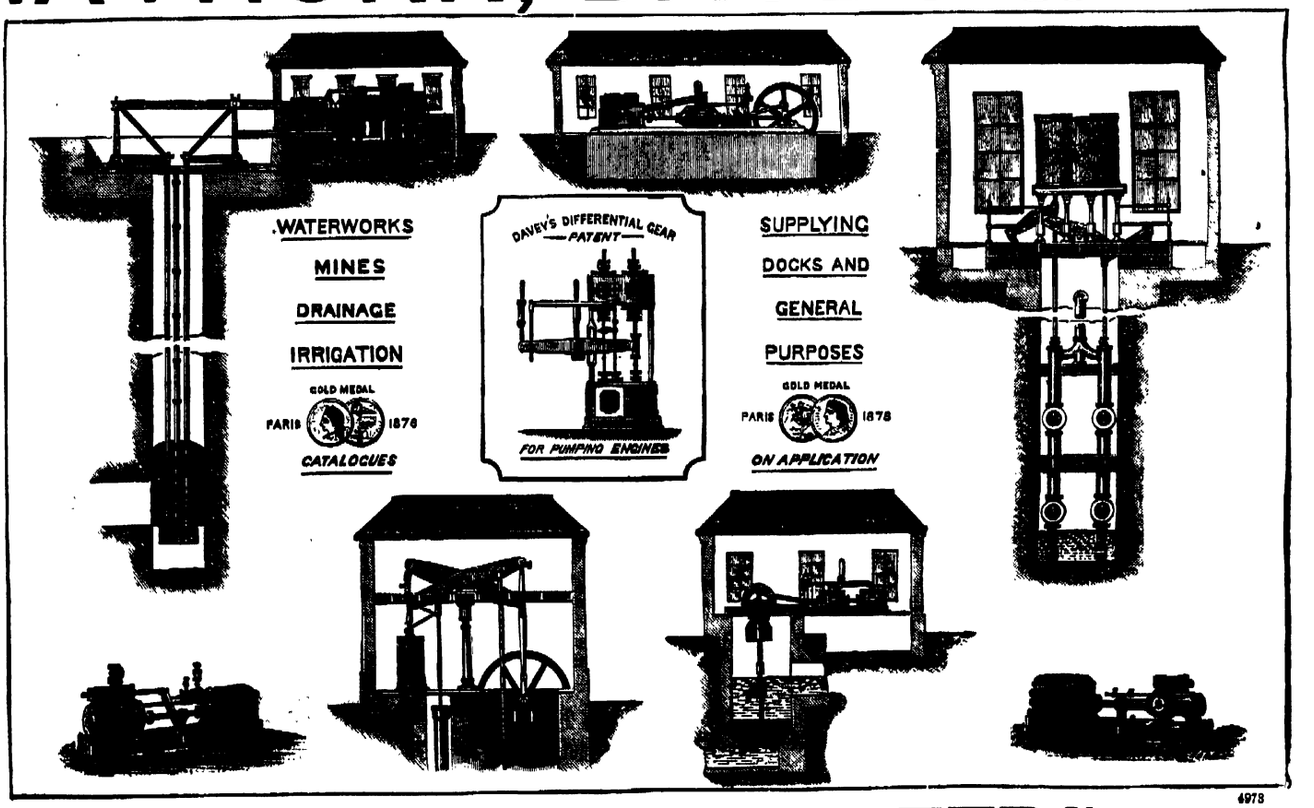




FOR PRICES AND ILLUSTRATIONS APPLY TO 5053

RANSOMES & RAPIER, 5, Westminster Chambers, LONDON, S.W.

HATHORN, DAVEY & CO.,



4973

SUN FOUNDRY, LEEDS.

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breeze, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft.	long,	5ft. 0in.	diameter,	20-horse	power.
10ft.	,,	5ft. 6in.	,,	30	,,
12ft.	,,	6ft. 0in.	,,	40	,,
13ft.	,,	6ft. 6in.	,,	50	,,
14ft.	,,	7ft. 0in.	,,	60	,,
15ft.	,,	7ft. 6in.	,,	70	,,
16ft.	,,	8ft. 0in.	,,	80	,,
17ft.	,,	8ft. 0in.	,,	90	,,
18ft.	,,	8ft. 0in.	,,	100	,,

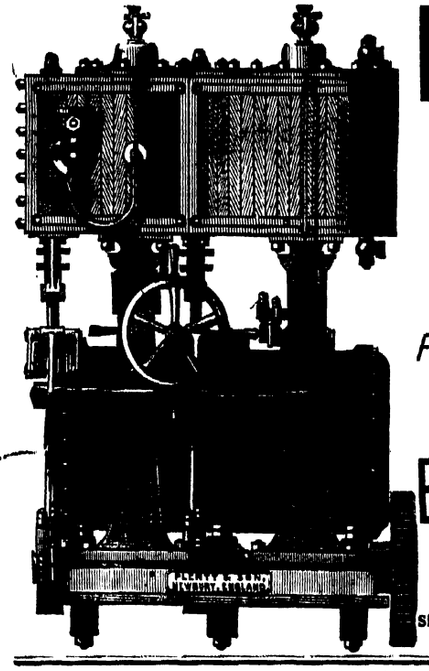
SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

BRASS & COPPER TUBES

SEAMLESS & BRAZED, FOR BOILERS, SURFACE CONDENSERS &c
BRASS & COPPER WIRE, SHEETS &c.. 4857

BIRMINGHAM BATTERY & METAL CO. BIRMINGHAM.



PLENTY & SON,

EAGLE IRONWORKS,

NEWBURY, BERKS.

MANUFACTURERS TO THE ADMIRALTY.

First Prize, Royal Yacht Club, Cowes.

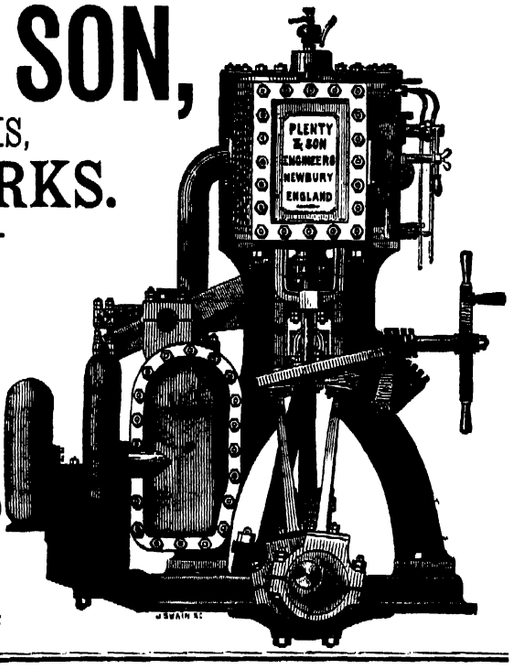
PATENT

ENGINES & BOILERS

FOR

SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &c.

Simple, High-Pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works. 4227

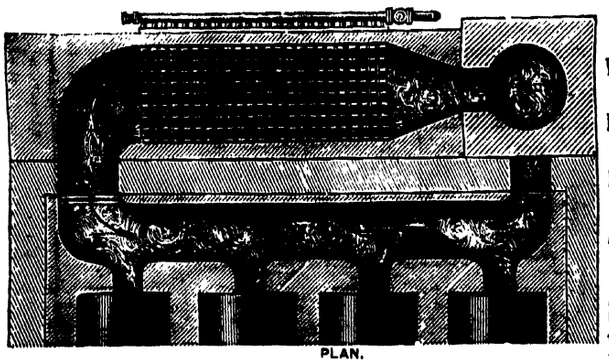


Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(FOR UTILISING THE WASTE HEAT FROM STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION



PLAN.

SPECIAL ADVANTAGES.

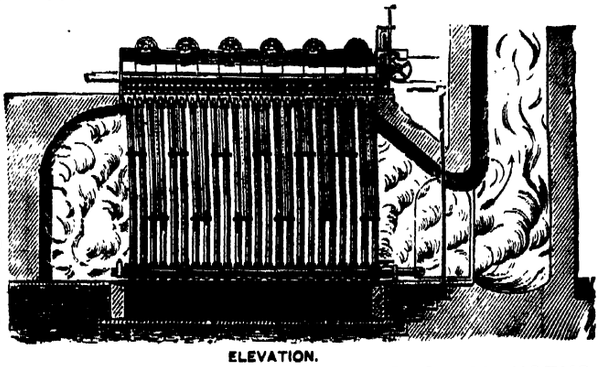
Vertical Pipe Castings. Guaranteed sound and perfectly true.

New Patent Spiral Scrapers The most effectual removers of *soot*.

Patent Reversing Gear. Never sticks or gets out of order.

ALREADY IN OPERATION TO HUNDREDS OF STEAM BOILERS.

Saves from 20 to 25 per cent. of the fuel.



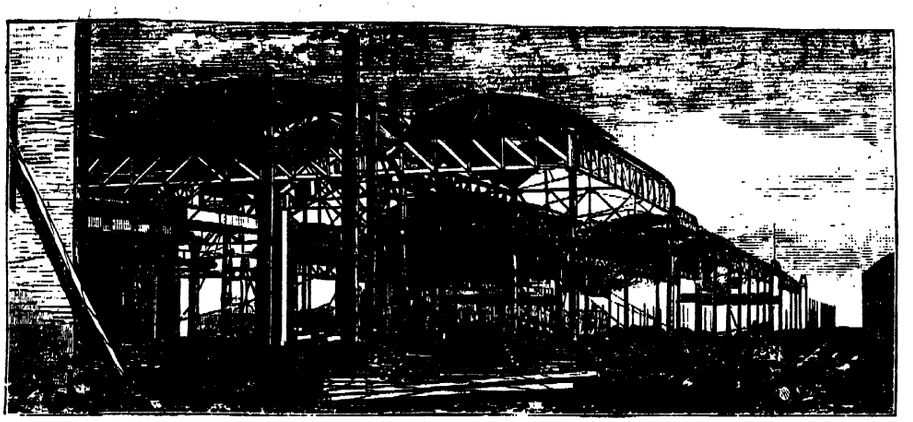
ELEVATION.

N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and abroad.

PRICES, TESTIMONIALS, AND FURTHER PARTICULARS ON APPLICATION TO 4430

ARTHUR LOWCOCK, (PATENTEE & SOLE MAKER) Coleham Foundry, Shrewsbury, England.



From Photo. of STEEL ROLLING MILLS, covering many acres, showing ROOFS in IRON and STEEL, in course of erection by MOREWOOD & CO.

Roofs and Buildings
IN IRON AND STEEL.
MOREWOOD & CO.
WOODFORD IRONWORKS,
SOHO, BIRMINGHAM.
LONDON OFFICES—158, LEADENHALL STREET, E.C.
CORRUGATED AND GALVANISED SHEETS,
LION WORKS, BIRMINGHAM
Manufacturers of every description of Roofs and Buildings in Iron and **STEEL** for Forges, Rolling Mills, Railway Stations, Goods Sheds, Yards, Docks, Stores, and General Purposes.
Special Curved Corrugated Iron Roofs without Framing for moderate Spans.
WROUGHT IRON WATER TANKS, any size.
ANNEALING AND GALVANIZING POTS.
Corrugated Iron & **STEEL** Sheets & Fastenings, &c.
Ridges, Gutters, and Tanks, Galvanized or Painted.
Wrought-Iron Lattice and Plate Girders. Railway, Road and Foot Bridges.
DESIGNS AND ESTIMATES ON APPLICATION. 4909

Paris, 1878.—GOLD MEDALS AWARDED.—Melbourne, 1881.

WM. JESSOP & SONS, LIMITED,

BRIGHTSIDE WORKS, SHEFFIELD,

MANUFACTURERS OF

EVERY DESCRIPTION OF TOOL STEEL & STEEL CASTINGS,

Cast, Shear, German, Spring, Blister & Sheet Steel for all purposes.

Files of First Quality.—Steel Lagging Plates for Cylinders.—Steel Boiler & Ship Plates & Forgings of all kinds.

DEPOTS:—Manchester, Paris, Dusseldorf, St. Petersburg, New York, Boston, Philadelphia, Cincinnati, St. Louis Chicago, San Francisco, Baltimore, Providence, Montreal.

LONDON OFFICE: MESSRS. CORNES, CALVERT & CO., 30, WALBROOK, E.C. 5137

DAVY BROTHERS, LIMITED,

SHEFFIELD,

MANUFACTURERS OF

STEAM HAMMERS

From 1 Cwt. to 50 Tons, for every kind of work,

Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.

BESSEMER STEEL WORKS PLANT,

FORGE AND ROLLING MILL MACHINERY,

Steam Engines for Mills, Ironworks, Collieries, &c.

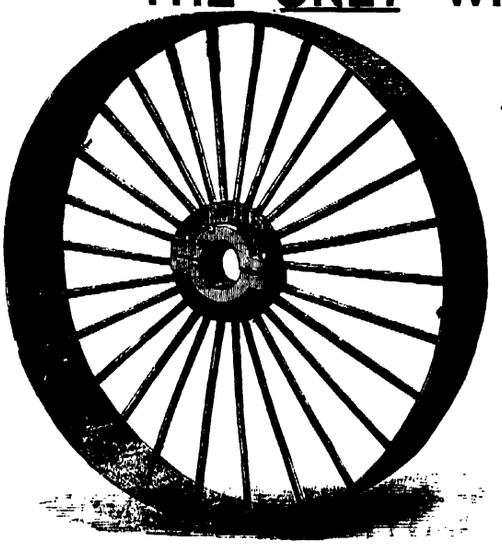
SINGLE AND DOUBLE FLUED BOILERS. 5178

STAND 15, TEXTILE EXHIBITION, AGRICULTURAL HALL, LONDON.

RODGERS' PATENT
WROUGHT IRON PULLEYS

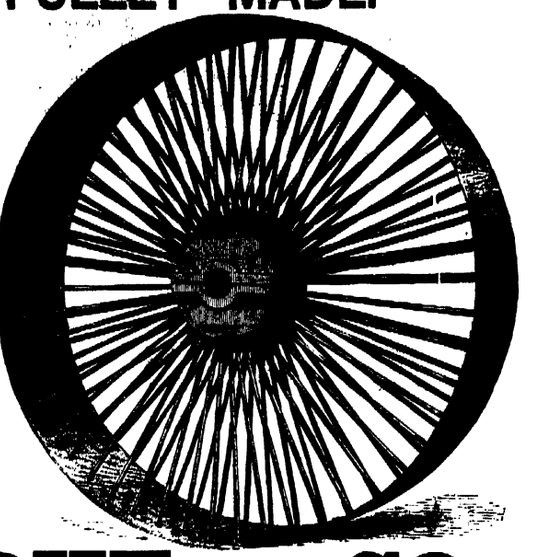
WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.

THE ONLY WROUGHT IRON PULLEY MADE.



SPLIT OR SOLID.

All Sizes up to 24 feet Diameter.



40,000

IN USE.

The Best Pulley in the World

USED SOLELY FOR

DRIVING THE ELECTRIC LIGHT

AT THE

HEALTH EXHIBITION,

SOUTH KENSINGTON.

SOLE MAKERS:

HUDSWELL, CLARKE & CO.,

RAILWAY FOUNDRY, LEEDS.

— SOLE AGENTS —

France—C. BORISSOW, Rue a Fiens, Par. Lille.
Russia—S. G. MARTIN, Galerny No. [illegible]ier 8, St. Petersburg.
Austria—J. EGLI, I, Berz Frei[illegible].
Saxony—W. W. DERHAM, Leip[illegible].
Belgium—D. GRANDY, Rue de l'Abattoir 80, Gand.
Italy—A. SINGTON & CO., Manchester and Milan.
Holland—VAN RIETSCHOTEN EN HOUWENS, Rotterdam.
Portugal—ALFD. HARRISON, Rua Nova St. Domingos 95, Oporto.
Dominion of Canada—T. J. CHURCH, 672, Craig St. Montreal.
Lancashire & District—F. B. WELCH & CO., Market St., Manchester.
North of England—Snowball & Co., Side, Newcastle-on-Tyne.
W. of England—Townsend & Young, Arch House, John St., Bristol.
Glasgow & District—Robertson & Co., 9, Old Sneddon St., Paisley.
South of Ireland—Jas. F. Roberts, 72, Francis Street, Dublin
New Zealand—Walter Brown, 1, College Green, Wellington. 4925

MATTHEW PAUL & CO.,

MAKERS OF

Steam and Hand Windlasses,

STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,

AND EVERY DESCRIPTION OF SHIP FITTINGS.

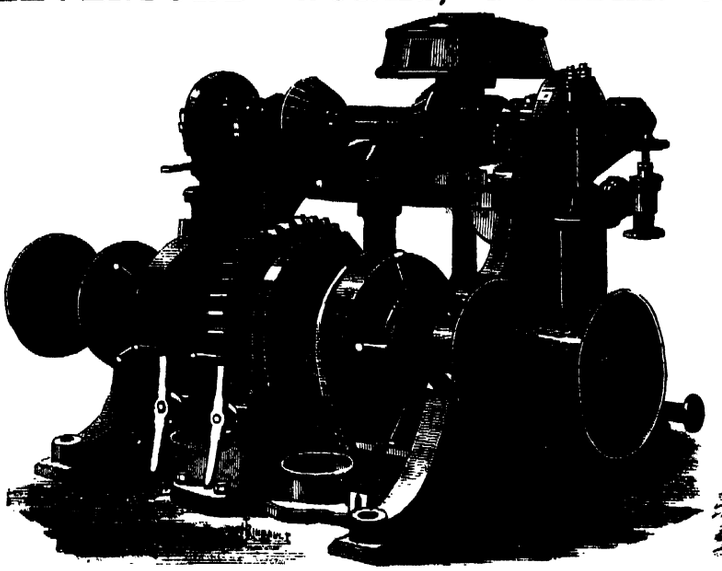
LAND & MARINE ENGINES,

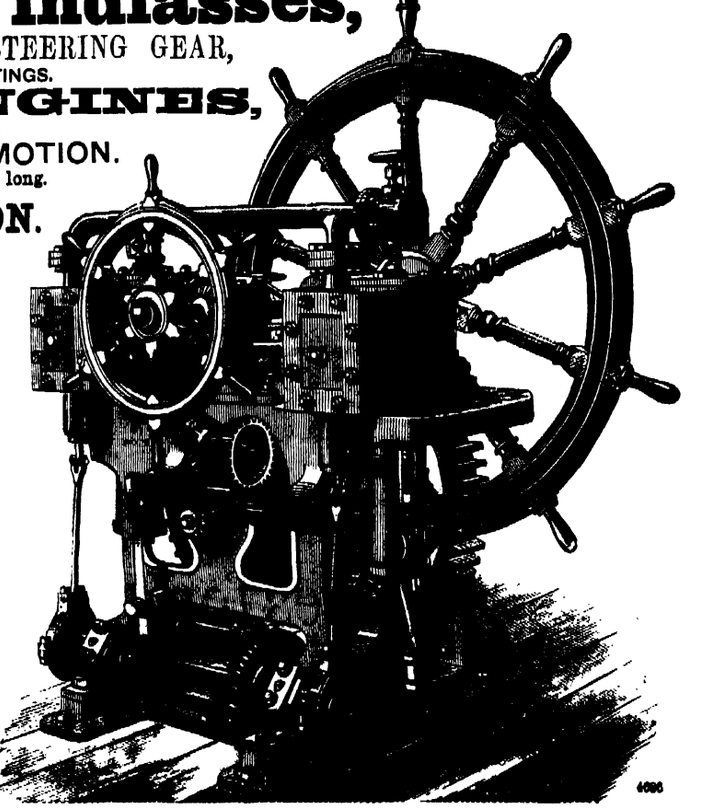
OF ALL SORTS AND SIZES UP TO 1,000 I.H.P.

LAUNCH ENGINES, WITH PATENT VALVE MOTION.

BUILDERS of LAUNCHES, BARGES, and YACHTS, up to 100 ft. long.

LEVENFORD WORKS, DUMBARTON.





4926

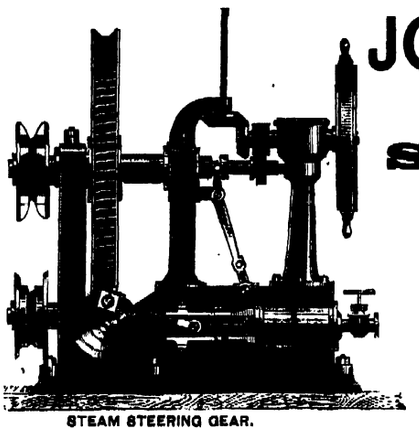
FOR MINING, LEATHER

ENGINEERING, INDIA-RUBBER

AND GENERAL MECHANICAL PURPOSES GUTTA-PERCHA

GEO. ANGUS & Co. NEWCASTLE-ON-TYNE 13, BILLITER STREET, LONDON. LIVERPOOL. And BUTE DOCKS, CARDIFF.

5101

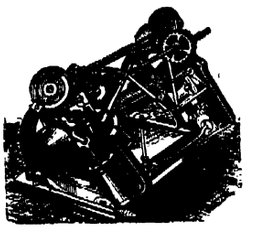


STEAM STEERING GEAR.

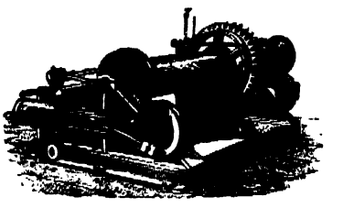
JOHN H. WILSON & CO.,

ENGINEERS AND BOILER MAKERS, &c.

SANDHILLS, LIVERPOOL.



VERTICAL STEAM WINCH.



HORIZONTAL STEAM WINCH.

4062

MANUFACTURERS OF STEAM CRANES, OVERHEAD TRAVELLERS, STEAM PUMPS, &c.

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

BELL'S Asbestos Works, Southwark. S.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure.....110 lbs. Vacuum.....29 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,

D. HENDERSON, Chief Engineer, S.S. "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,

Mr. J. BELL. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts, Admiralty, Whitehall, 20th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core.....square. | Elastic core.....round.

To Mr. JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ¼ in., 60 per cent.; ½ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

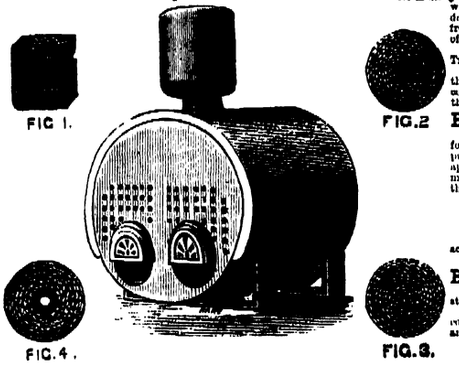
I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depôts and not through agents or factors.



BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates..... 194 deg.

" " Covering..... 84 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 26th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly,

" W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

Mr. JOHN BELL, Southwark, S.E. Gunnislake, Tavistock, 8th April, 1884.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ¾ in. to 3 in. wide, and any thickness from 1-16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and 1 millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts, Admiralty, Whitehall, S.W., 17th May, 1884.

SIR,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,

MR. JOHN BELL. Director of Navy Contracts.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REG'D.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

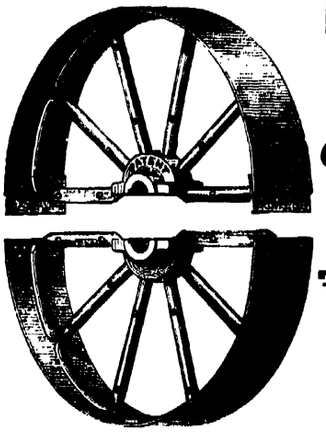
BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

OR THE DEPOTS—

4942

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

SOLE MAKERS, **READING IRONWORKS, LTD.** READING, ENGLAND.



THE PULLEY FOR THE WORLD.

THE PATENT WROUGHT IRON

"UNIVERSAL,"

Supplied to HER MAJESTY'S DOCKYARDS and Leading Engineers throughout the Kingdom, the Continent of Europe, the Colonies, &c., &c.

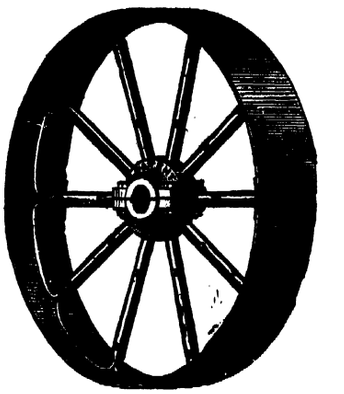
TENS OF THOUSANDS IN USE.

SILVER MEDALS

AWARDED AT THE INTERNATIONAL EXHIBITIONS:

AMSTERDAM, 1883; CALCUTTA, 1884.

PRICE LISTS FREE BY POST. 4781



THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

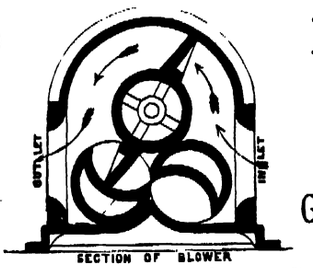
Baker's Patent Rotary Pressure Blower and Gas Exhauster

—:o:—

BAKER'S PATENT ROTARY PUMP. HALL'S PATENT STONE BREAKER.

—:o:— —:o:—

CRUCIBLE STEEL CASTINGS. General Machinery of Every Description.



SECTION OF BLOWER

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4653

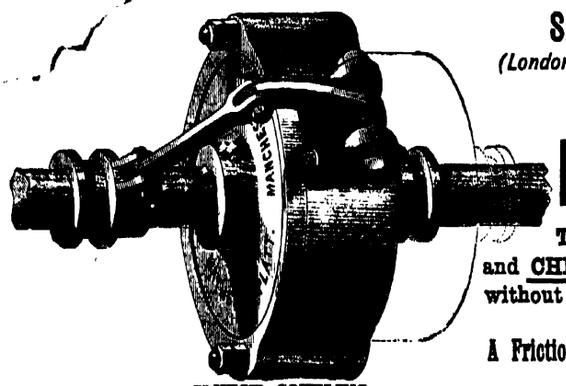
MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.

— PATENT —

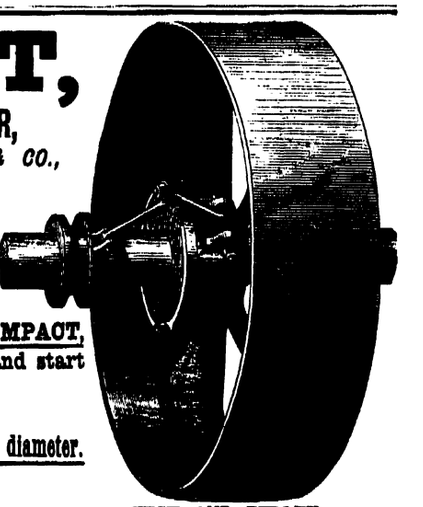
FRICTION CLUTCH.



CLUTCH COUPLING.

These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.



CLUTCH AND PULLEY

LIBERAL TERMS TO THE TRADE. PRICES ON APPLICATION. 5269

GOODFELLOW & MATTHEWS,

(LATE B. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS.

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 5006

MEASURES BROS. & CO., SOUTHWARK STREET, LONDON,

Manufacturers of Patent Girders, Rolled Joists in Iron or Steel, Rivetted Girders, Flitch Plates, Bulb and Channel Iron, Contractors' Rails, Tee, Angle, and Sash Iron, Bonding Hoops, Bolts, Rivets, Washers, Chequered Flooring Plates, Patent Fire-proof Floors, Cast or Wrought Iron Columns, Stanchions, Tanks, and every description of Builders' Iron Work,

Have now in their TOWN STOCK 5,000 TONS, and can guarantee prompt delivery at lowest Market Prices.

ESTIMATES, SECTION SHEETS, AND BOOKS FREE ON APPLICATION.



ANGLES.

8 × 4	3½ × 3½	
6 × 6	3 × 3	
6 × 3½	2½ × 2½	
5 × 3½	2 × 2	
4 × 3½	1½ × 1½	
4 × 4	1 × 1	

SECTION OF JOISTS.

8 × 3	= 10lbs.	4½ × 3	= 18lbs.	7 × 2½	= 14lbs.	9½ × 8½	= 24lbs.	12 × 5 = 42lbs.
8 × 1½	= 7 ,,	5 × 4½	= 23 ,,	7 × 3½	= 20 ,,	9½ × 4½	= 20 ,,	12 × 6 = 50 ,,
4 × 1½	= 7 ,,	6½ × 3	= 11 ,,	8 × 4	= 22 ,,	10 × 4½	= 32 ,,	14 × 6 = 50 ,,
4 × 3	= 12 ,,	6½ × 3½	= 10 ,,	8 × 5	= 29 ,,	10 × 5	= 36 ,,	16 × 6 = 62 ,,
4½ × 1½	= 8 ,,	6 × 5	= 29 ,,	8 × 6	= 34 ,,	10 × 6	= 56 ,,	17½ × 6½ = 82 ,,
								19½ × 7½ = 100 ,,

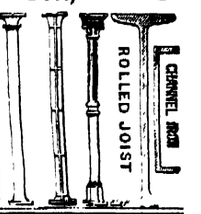
Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to ¾". 5126

TEES.

6½ × 6½	
4 × 4½	
5 × 3	
3 × 3	
2½ × 2½	
2 × 2	
1½ × 1½	
1 × 1	

CHANNELS.

12 × 3	
9½ × 3½	
9½ × 3½	
8 × 3½	
6½ × 2½	
6½ × 2½	
3 × 2	
2½ × 1½	
1½ × ¾	



DANIEL ADAMSON & CO.,

Established 1851.] ENGINEERS AND BOILER MAKERS, [Established 1851.

DUKINFIELD, NEAR MANCHESTER,

HIGH-PRESSURE, CONDENSING, & COMPOUND STEAM ENGINES.

SOLE MAKERS OF

THE WHEELOCK AUTOMATIC EXPANSION ENGINE,

(Grand Prize Paris, 1878, and First Prize Cincinnati, 1880, in competition with Corliss and other Automatic Expansion Engines).

THE BULKLEY PATENT INJECTOR CONDENSER, USED in the UNITED STATES at all the LARGE IRON and STEEL WORKS

ADAMSON'S PATENT TESTING MACHINES, to Test from 30 to 2,000 Tons.

BLOWING ENGINES, AIR COMPRESSORS, & BESSEMER PLANT.

PATENT HYDRAULIC JACKS.

GENERAL HYDRAULIC ENGINEERS. 4793

GEORGE SALTER & Co.

WEST BROMWICH,

MANUFACTURERS OF

Spring Balances, Roasting Jacks,

BOURDON'S, SCHAEFFER'S, & SILVESTER'S

PRESSURE GAUGES,

COLLIERY SIGNAL BELLS, RASTRICK'S TUBE SCRAPERS,

CONICAL, SPIRAL, and all kinds of COILED SPRINGS made to order.

DYNAMOMETERS

For Testing Strength of Wire, Rope, Cement, Cloth, &c.

GOODS SUPPLIED THROUGH ALL MERCHANTS AND FACTORS



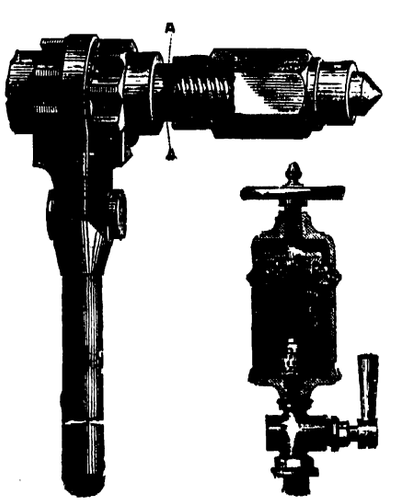
4769

NETTLEFOLDS LIMITED, BIRMINGHAM,

SOLE MANUFACTURERS OF

WESTON'S STORER'S

PATENT DIFFERENTIAL RATCHET BRACE.—PATENT OPEN TOP SUET LUBRICATOR.



These BRACES, which have been several years before the public, and are MUCH APPRECIATED by them, NETTLEFOLDS have lately CONSIDERABLY IMPROVED by enclosing the SCREW in a SLEEVE (A) which always PROTECTS it from INJURY either from DIRT or BLOWS. This SLEEVE also acts as a GUIDE for the NUT, thus keeping it steady throughout the whole of its traverse, and consequently enabling the drilling to be effected with PERFECT ACCURACY.

The SUET LUBRICATOR has effected a saving of 70 per cent. in the cost of lubricating material used for Nettlefolds' Engines, and has now been fully tested in their works on 15 Cylinders working to 750-horse power.

Messrs. HICKS, HARGREAVES & Co. write:—"We find the saving in *excess* of that stated in Messrs. Nettlefold & Chamberlain's Report—viz., 70 per cent., and the cylinders to which these Lubricators have been applied are in beautiful condition. We shall adopt them for all our engines."

By this Invention the steam is lubricated before passing to the valves, while the supply of grease is uniform and constant.

SOLD BY THE UNDERMENTIONED AGENTS:—

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EDINBURGH..	Redpath, Brown & Co., Thos. Scott.
BRISTOL	Weston, J. D., & Son.
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NOTTINGHAM ..	Manlove, Alliott, Fryer & Co.
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AUSTRIA	Simon Henry, Manchester.
GERMANY	Schaffer & Budenberg Manchester. 788

OF WHOM PRICED LISTS AND FULL PARTICULARS MAY BE OBTAINED.

THOMAS TURTON & SONS,

MANUFACTURERS OF RAILWAY SPRINGS AND BUFFERS,

Files and Cast Steel of Superior Quality, Spring Steel, Shear Steel, &c. 4027

SHEAF WORKS, AND SPRING WORKS, SHEFFIELD.

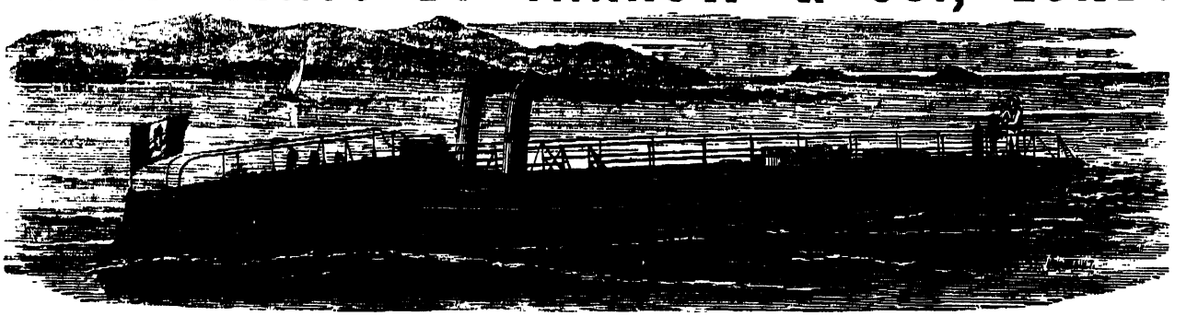
LONDON OFFICES, 90, CANNON STREET, CITY. PARIS DEPOT, 12, RUE DES ARCHIVES. BOSTON, U.S., 40, KILBY STREET.

SHAFTING

Turned true and bright to Whitworth's Gauges, any length, from 2 in. to 3 in. diameter, 14s. per cwt. at Nottingham. Also Couplings, Pulleys, Plummer Blocks, Hangers, Machine-made Spur, Bevel, and Mitre Wheels, Friction Gearing, &c.

H. HIND & SON, NOTTINGHAM, AND 62, BLACKFRIARS ROAD, LONDON, S.E. 4157

TORPEDO BOATS BY YARROW & CO., LONDON.



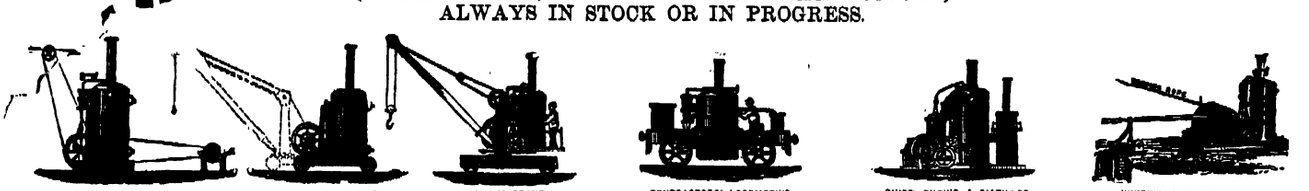
TORPEDO BOAT for the ITALIAN GOVERNMENT. Official Trial Dec. 13, 1881. SPEED on the Measured Mile 22.46 KNOTS. 5267

TORPEDO BOAT for the BRAZILIAN GOVERNMENT, tried June 27, 1882. Mean SPEED during a continuous run of 3 hours with 12½ TONS on board, 20.3 KNOTS.

CHAPLINS' PATENT PORTABLE STEAM ENGINES AND BOILERS

(PRIZE MEDAL, INTERNATIONAL EXHIBITION.)

ALWAYS IN STOCK OR IN PROGRESS.



STATIONARY ENGINE.	HOISTING ENGINE.	STEAM CRANE.	CONTRACTORS' LOCOMOTIVE.	SHIPS' ENGINE & DISTILLER	WINDING & PUMPING ENGINE
From 1 to 30-horse power. No Building required.	1 to 20-horse power. With or without Jib.	15 cwt. to 20 tons. For Wharf or Rail.	9 to 27-horse power. For Steep Inclines and Quick Curves.	For Winding, Cooking, and Distilling Sanctioned by H.M. Government.	6 to 30-horse power. 2468

PARTIES ARE CAUTIONED AGAINST USING OR PURCHASING IMITATIONS OR INFRINGEMENTS OF THESE PATENT MANUFACTURES.

Patentees and Sole Manufacturers—ALEXANDER CHAPLIN & Co., Cranstonhill Engine Works, Glasgow.

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BERKLEY STREET, BIRMINGHAM.



RICHARD C. GIBBINS & Co.

STEAM & HAND CRANES,

PORTABLE, WHARF, DERRICK, FOUNDRY, OVERHEAD, TRAVELLING,

Warehouse Cranes and Pile Drivers,

1691

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CRABS, JACKS, PULLEY BLOCKS, SCREW COUPLINGS, PLATELAYERS' TOOLS, &c.

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THE CLAY CROSS COMPANY,

COAL, LIME, & IRON WORKS, CLAY CROSS, near CHESTERFIELD,

SUPPLY HOUSE, GAS, AND STEAM COAL,

AND ARE MAKERS OF

PIG IRON, GAS and WATER PIPES, and ALL CASTINGS

In connection with Gas and Waterworks, Collieries, Engines, Pumps, &c. 5135

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LONDON OFFICES—21, PARLIAMENT STREET.
(E. B. SAUNDERS, Agent). 4987

Manufacturers of all kinds of Slide Lathes, Planing, Shaping, Slotting, Boring, Drilling, Punching, Shearing, Bending, and Screwing Machines, suitable for every class of Engineers and Shipbuilders



GIBBS' PATENT HEATING APPARATUS

As fitted in "Engineering," "Daily Telegraph," and "Daily Chronicle" Offices.

980 Working Successfully.

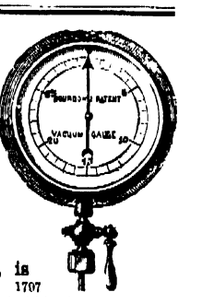
Highest Award for Heating Apparatus, INTERNATIONAL SANITARY EXHIBITION, LONDON, 1881. 4113

ST. JAMES'S HEATING APPARATUS WORKS, MILL STREET, LIVERPOOL.

Only Gold Medal for Gauges at the Paris Exhibition, 1878.



BOURDON'S TRADE E. BOURDON & Manufac MARK GAUGES (OWN MAKE)



NEGRETTI & ZAMBRA, OPTICIANS, HOLBORN VIADUCT,

TELEPHONE No. 6583.] SOLE AGENTS IN LONDON. [TELEPHONE No. 6583.

M. BOURDON cautions Persons using Steam Gauges that a large number of very inferior instruments are sold, bearing his name, which are not of his manufacture, a great proportion of them also having a forged Trade Mark.
AGENTS:—J. CASARTELLI, 43, Market St., Manchester; CHADBURN & SONS, 71 & 73, Lord St., Liverpool.

NEGRETTI & ZAMBRA'S NEW CATALOGUE of Scientific Instruments, 560 pages, 1,200 Engravings, is now published, price 5s. 6d. 1707

N. & Z. have been appointed Sole Agents by Messrs. Ritchie & Sons, of Boston, U.S.A., for the Sale in this Country and the Colonies for their patented Liquid Compasses.



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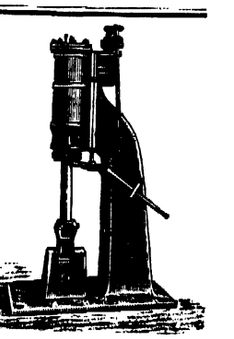
ETNA IRONWORKS, BANGOR ROAD, LEITH, N.B.

IMPROVED DOUBLE-ACTING STEAM HAMMERS

For Forges, Smithies, Stamping, &c.
AWARDED THE
FIRST PRIZE at SYDNEY EXHIBITION, 1880.

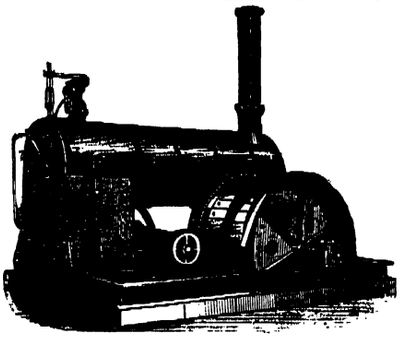
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Punching and Shearing Machines, Shipbuilders' and Boiler Makers' Tools, &c.



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MANUFACTURERS OF



Steam Cultivating Machinery — Traction Engines — Patent Compound Yorkshire Semi-Portable and Fixed Engines — Semi-Portable Engines — Horizontal High-Speed Stationary Engines — Hauling, Winding, and Pumping Engines — Patent Automatic Expansion Valve Gear and Governor, for ensuring Economy, Regularity, and Safety—Boilers of all types, adapted for every kind of fuel and country—Steel Portable Railway, for Sugar, Cotton, and Indigo Plantations, Contractors' Works, Military Depots, Workshops, Mines, Timber Yards, Agricultural Holdings, &c.—
Locomotives of various gauges. 3061

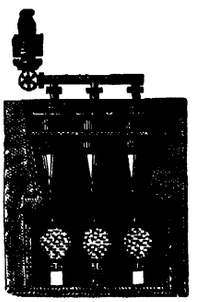
CALCUTTA EXHIBITION, 1884, FIVE FIRST PRIZES.

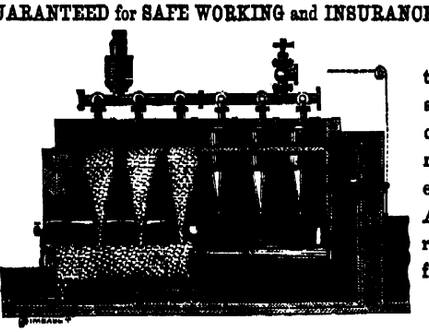
Budapest Agricultural Meeting, 1882—Two Gold Medals and other Awards.
Vienna Agricultural Meeting, 1882 — Special Diploma for excellency of work.
Sydney Exhibition, 1880.—Three First Prizes.
Hanover Agricultural Meeting, 1881—Gold Medal and Diploma of Merit.
Paris Exhibition, 1878—Grand Prix, Gold Medal. [and other Prizes.

SHEPHERD'S IMPROVED PATENT INTERNALLY FIRED CONE SECTION BOILER.

RISK of EXPLOSIONS REDUCED to a MINIMUM GUARANTEED for SAFE WORKING and INSURANCE up to 150 lbs. PRESSURE.

BOILERS on this principle have been in constant work for some years, with great success in the economical production of steam without priming. There are no parts liable to collapse, or stays subject to corrosion. They can be exported cheaply

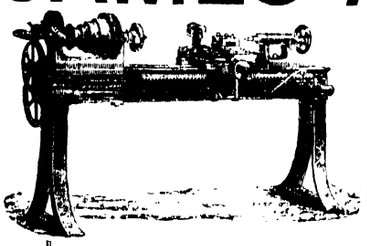




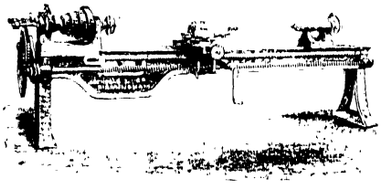
to all parts of the world. They are suitable for every description of work, and, consisting of a number of similar sections, are easy to erect, examine, and repair. Any portion can be removed and replaced quickly, and with great facility. 4880

For PLANS, ESTIMATES, and PARTICULARS of TRIALS, apply to the SOLE LICENCEES and MAKERS,
JAMES WATT & CO., (late Boulton & Watt), 90, Leadenhall St., London, E.C., and Soho Foundry, Birmingham.
Makers of Marine Engines, and of every kind of Land and Pumping Engines, Boilers, Hydraulic Machinery, Mining Plant, Air Compressors, Rock Borers, Rolling and Sugar Mills, Mint Machinery, and of Coins for the British Government and Foreign Countries.

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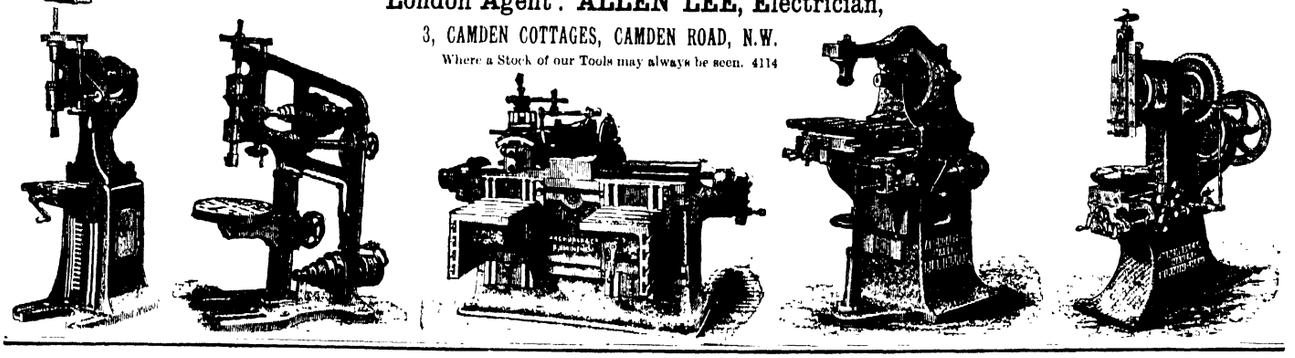


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Makers of all kinds of LATHES, PLANING, SHAPING, SLOTTING, DRILLING AND BORING MACHINES, &c., &c.
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London Agent: **ALLEN LEE**, Electrician,
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Where a Stock of our Tools may always be seen. 4114

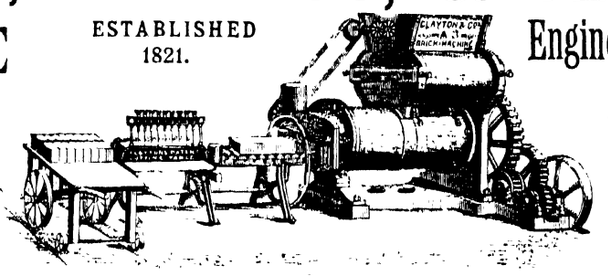


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BRICK & TILE MACHINERY,
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Illustrated Catalogues on Application.

ESTABLISHED 1821.



Engineers and Ironfounders,
Atlas Works, Harrow Road,
LONDON, W.

IRON CASTINGS
Of best London quality for ENGINEERS, &c.

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Sole Makers of the "HIGH-SPEED" AIR COMPRESSOR. Greatly Reduced Prices. 4983

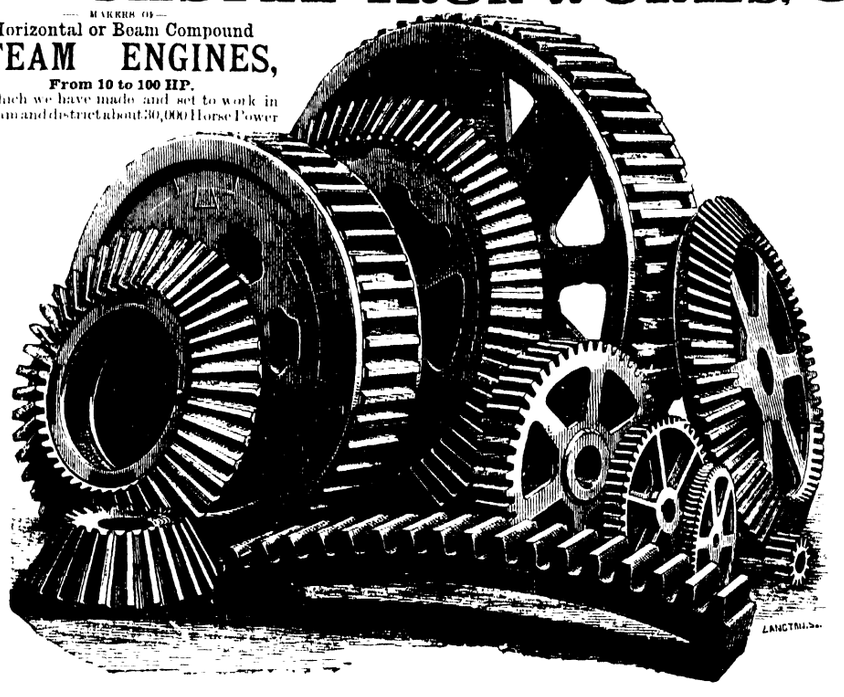
This Compressor having stood the test of ten years' practical working is now most confidentially recommended as superior to all others.—Send for New Price Lists

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ENGINEERS, MILLWRIGHTS, AND IRONFOUNDERS,

CASTLE IRONWORKS, OLDHAM.

—MAKERS OF—
Horizontal or Beam Compound
STEAM ENGINES,
From 10 to 100 HP.
Of which we have made and set to work in Oldham and district about 30,000 Horse Power



—MAKERS OF THE—
COMPOUND ENGINES
Driving the Textile Machinery at the Oldham Exhibition.

Lancashire Steam Boilers,
Made with the best Machinery, with Holes Drilled or Punched, and Plates Planed.

PATENT ELASTIC SPRING
PINION & BEVEL WHEELS,
Specially designed and adapted for heavy work, varying loads, and sudden shocks.

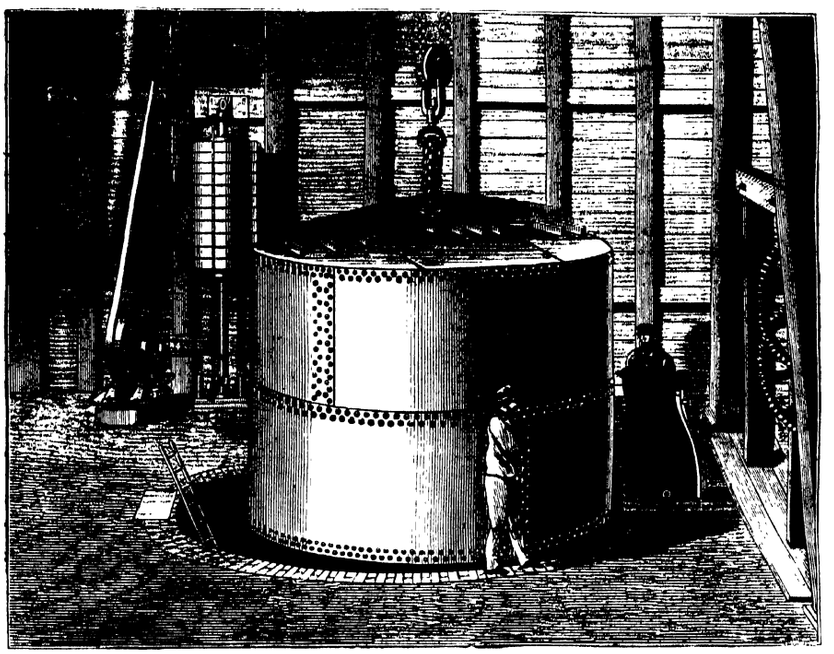
PATENT BEVEL WHEELS,
WITH SEPARATE STEEL RIMS,
Applied in cases where great strength is required.

MAIN DRIVING DRUMS,
For Ropes or Belts up to 30 feet diameter.

All other classes of Wheels moulded by our Patent Machinery. 4789

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OF THE MOST RECENT TYPES.

Punching, Shearing, Bending, Forging, Hoisting,

AND OTHER HIGH-PRESSURE

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Hydraulic Labour-Saving Machine Makers,

CREMORNE WORKS, 4085

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RAGOSINE OIL

THE RUSSIAN NATURAL LUBRICATING OIL. Gold Medal, Paris, 1878.

Pure Hydro-carbon, free from acid. Body superior to Olive or Lard Oil | Never gums or clogs. Never freezes or thickens.

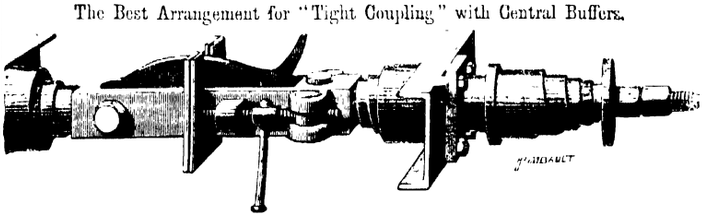
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7, IDOL LANE, LONDON, E.C.,
And Love Lane, Quayside, Newcastle-on-Tyne.
Works—BALACHNA and CONSTANTINOW, RUSSIA.
Price Lists and full particulars on application 4779

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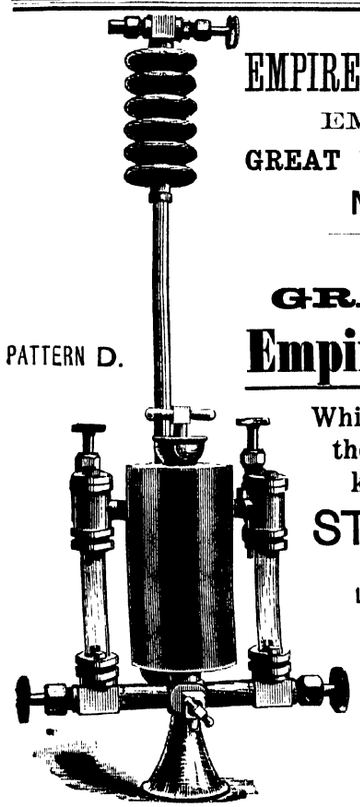
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The Best Arrangement for "Tight Coupling" with Central Buffers.



It is in use on the Indian State Railways, the Bengal and North Western, and other Indian Railways. 4078

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PATTERN D.

THE
EMPIRE LUBRICATOR COMPANY
EMPIRE WORKS,
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MAKERS OF

GRANDISON'S

Empire Lubricator,

Which is acknowledged to be the BEST APPARATUS now known for Lubrication of

STEAM ENGINES

OF ALL KINDS,
LAND OR MARINE.

Lubricators sent on approval to any part of the kingdom, and references given to users in all parts of the inhabited world.

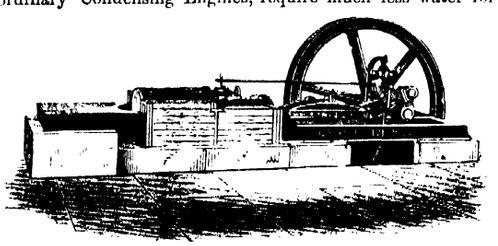
4703
FURTHER PARTICULARS ON APPLICATION.

PATENT HORIZONTAL

COMPOUND CONDENSING STEAM ENGINES.

The great and well-known economy in fuel of these Engines has been fully proved by very careful trials, particulars of which sent on application. (See also "Minutes of Proceedings of the Institution of Civil Engineers," Vol. 66, Session 1880-81, Part IV.)

They have repaid their cost in a short time, are not more complicated than ordinary Condensing Engines, require much less water for condensing, no greater skill to drive, and are as easily accessible for repairs as ordinary Engines.



In cases where Boilers are overworked, the adoption of these Engines leads to easy firing, saving of wear, tear, and labour, rendering old Boilers more durable and capable of giving off additional Engine power, thereby saving the cost of new Boilers, where an increase of power is wanted. All joints and working parts adjustable.

N.B.—One of these Engines was run from November 25, 1877, NIGHT and DAY, until October 28, 1879, without having the steam shut off (except on two occasions for a few hours to examine driving belts), being a continuous run of 712 days of 24 hours each, or about 17,080 hours in all.

B. DONKIN & CO., Bermondsey, LONDON,

MANUFACTURERS ALSO OF

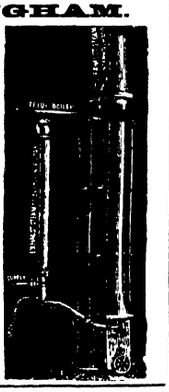
PAPER-MAKING MACHINERY,

TURBINES, VALVES FOR STEAM, GAS, WATER AND CHEMICALS,

GENERAL MILLWORK & MACHINERY. 2061

TAYLOR & CHALLEN,
ENGINEERS,
BIRMINGHAM.

SOLE MAKERS OF
WITHINSHAW'S PATENT
Feed Water
HEATER.



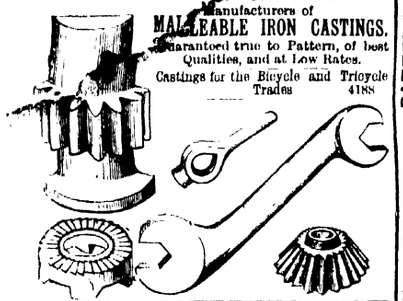
The most powerful invented.
Great Saving in Boilers, Coals, and Labour.
LARGE HEATING SURFACE
Solid Drawn Brass Tubes.
Free Expansion.
No Scurf adheres to the Tubes.
—o— 4837
List on application

BY ROYAL LETTERS PATENT.



MATHER'S
Fly-Wheel Portable Engines
ARE THE BEST FOR SMALL POWER.
They have large Fly Wheels on which they travel; they are light in draught and are handy.
—o— 5104
G. R. MATHER,
WELLINGBOROUGH, ENGLAND.

W. R. PALMER,
LIMITED,
BACOT STREET FOUNDRY,
BIRMINGHAM.



Manufacturers of
MALLEABLE IRON CASTINGS,
Guaranteed true to Pattern, of best Qualities, and at Low Rates.
Castings for the Bicycle and Tricycle Trades 4188

GOLD MEDAL, PARIS, 1878.

GAUGE GLASSES
AND
ENAMELS
For Iron, Cast-iron, Copper, &c.

PATENT GUILBERT MARTIN



Patentee and Manufacturer of the
PATENT
RED REFLECTING GAUGE GLASS,
Showing through the water a Broad Red Line.

N.B. All Glasses are of the finest quality, and manufactured expressly to resist extreme pressure.

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Aldersgate Street,
LONDON, E.C.

The above line shown in black is of a rich Red. 5002
REPRESENTED BY
E. M. HAMBURGER.

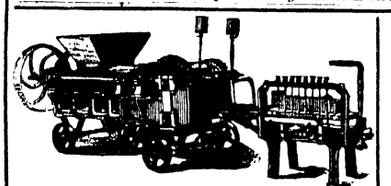
EDWARD HAYES, Engineer, STONY STRATFORD.
(LONDON OFFICE: 12, GREAT ST. HELENS, E.C.)

STEAM LAUNCHES
Speed from 10 to ... miles per hour.



MACHINERY constructed for Boats Built Abroad.
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Engines and Boilers kept in Stock.

BUILDER OF STEAM TUGS AND LAUNCHES.
Speciality in Small STEAM TUGS for towing Barges and Lighters. 5103



15,000 to 20,000 Bricks per day.

E. PAGE & CO.,
Victoria & Bedford Ironworks,
BEDFORD.
Illustrated and Priced Catalogues Free, in English, French, Spanish, or German, on application. 4718



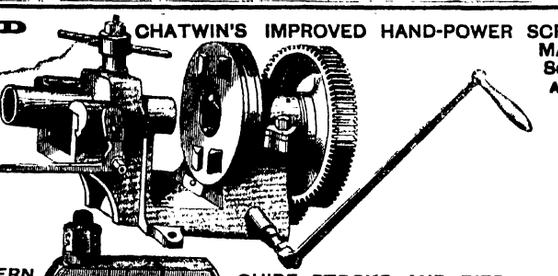
10,000 Bricks per day.

SPECIAL TOOL STEEL
FOR ALL PURPOSES.
BESSEMER AND SIEMENS STEEL FORGINGS AND SHAFTING.
SPECIAL TOUGH MINERS' DRILL STEEL
CRUCIBLE CAST STEEL TRAM CAR WHEELS AND AXLES. 5000
ASKHAM BROS. & WILSON, Ltd., SHEFFIELD

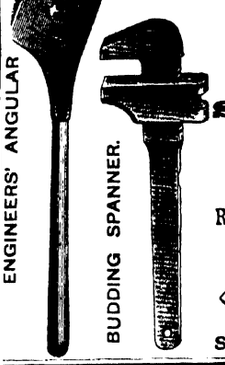
PATTERN STOCKS AND DIES.
ENGINEERS' ANGULAR

AWARDED
A Gold & Silver Medal
AND
Two 1st Class Certificates at Calcutta Exhibition, 1884.

CHATWIN'S IMPROVED HAND-POWER SCREWING MACHINE, SCREWING AT ONCE OVER.



WHITWORTH PATTERN GUIDE STOCKS AND DIES.



BUDDING SPANNER.

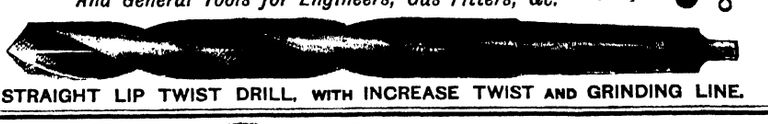


CLYBURN SPANNER



PATENT SOLID DIE STOCK FOR GAS TUBES SCREWING AT ONCE OVER

THOMAS CHATWIN,
GT. TINDAL STREET, BIRMINGHAM,
MANUFACTURER OF
STOCKS, DIES, AND TAPS,
PATENT HAND-POWER SCREWING MACHINES, TWIST DRILLS,
STANDARD CYLINDRICAL GAUGES, RIMERS,
CLYBURN, BUDDING, AND OTHER SPANNERS,
RATCHET BRACES, TUBE CUTTERS, TUBE WRENCHES, TUBE VICES,
And General Tools for Engineers, Gas Fitters, &c. 4824



STRAIGHT LIP TWIST DRILL, WITH INCREASE TWIST AND GRINDING LINE.

FUEL ECONOMISER
GREEN'S PATENT
Has been awarded the GOLD MEDAL at the CALCUTTA EXHIBITION, in addition to TWELVE MEDALS previously given at other Exhibitions. 5081
ST. ANN'S SQUARE, MANCHESTER. WORKS: WAKEFIELD.

BUTTERS BROS., Contractors' Engineers,

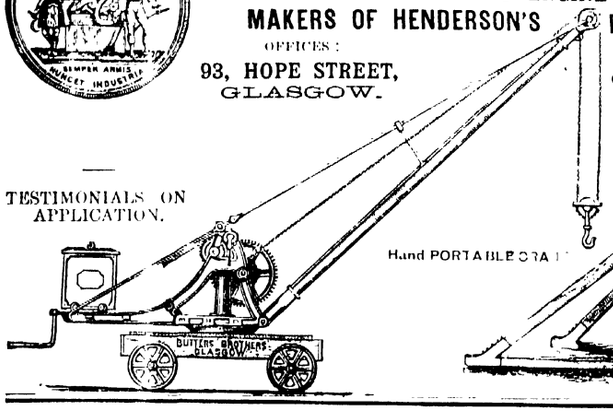
PERCY CRANE AND ENGINE WORKS, LAMBHILL STREET, PAISLEY ROAD,

MAKERS OF HENDERSON'S PATENT DERRICK CRANES, FROM 15 CWT. TO 30 TONS.

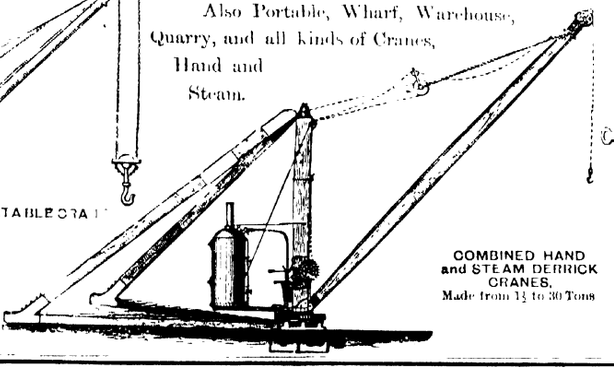
OFFICES: 93, HOPE STREET, GLASGOW.

Also Portable, Wharf, Warehouse, Quarry, and all kinds of Cranes, Hand and Steam.

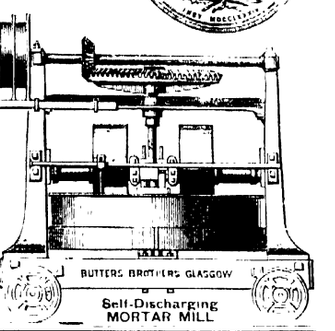
TESTIMONIALS ON APPLICATION.



Hand PORTABLE CRANE



COMBINED HAND and STEAM DERRICK CRANES, Made from 1½ to 30 Tons



Self-Discharging MORTAR MILL

CLARKE'S CRANK COMPANY, Ltd.,

BENT CRANKS, SOLID WEB CRANKS.

FORGINGS, SHAFTS, AXLES

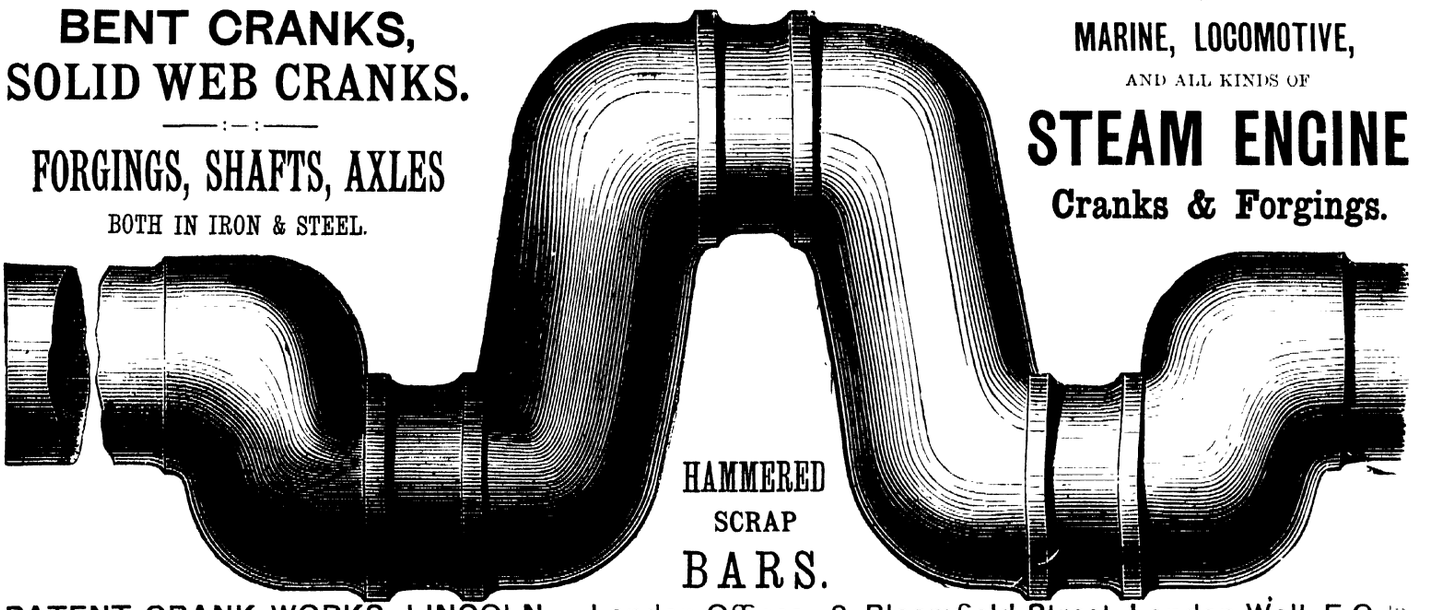
BOTH IN IRON & STEEL.

MARINE, LOCOMOTIVE,

AND ALL KINDS OF

STEAM ENGINE

Cranks & Forgings.



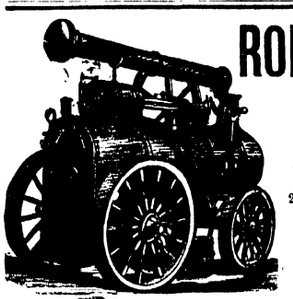
HAMMERED SCRAP BARS.

PATENT CRANK WORKS, LINCOLN. London Offices: 3, Bloomfield Street, London Wall, E.C.

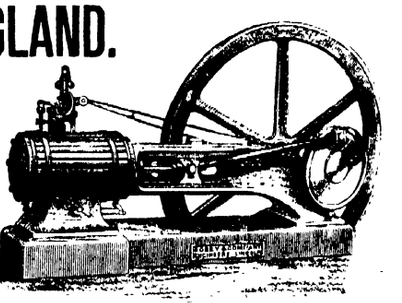
ROBEY & CO., ENGINEERS, LINCOLN, ENGLAND.

First PRIZE for PORTABLE ENGINES, Melbourne Exhibition, 1881.

PARIS, 1878, GOLD MEDAL.

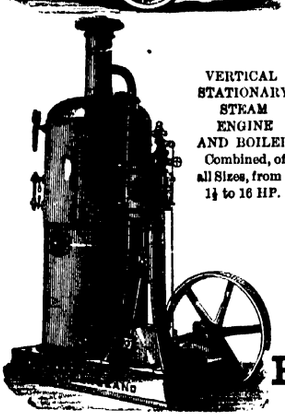


SUPERIOR PORTABLE ENGINES 2½ to 50 HP.

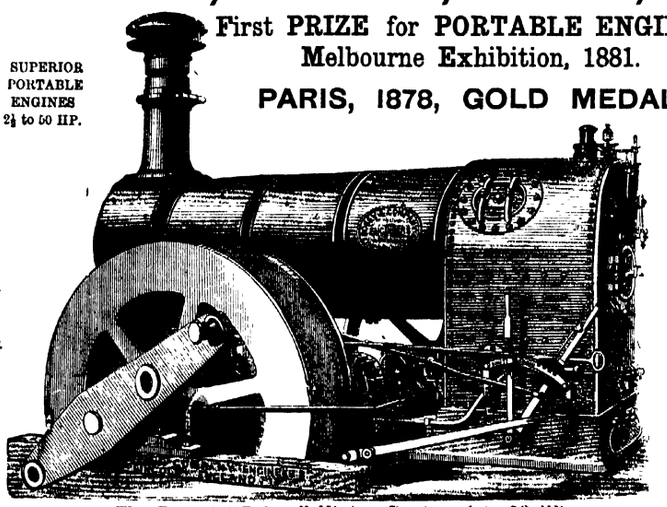


HORIZONTAL FIXED ENGINE, 4 to 60 HP.

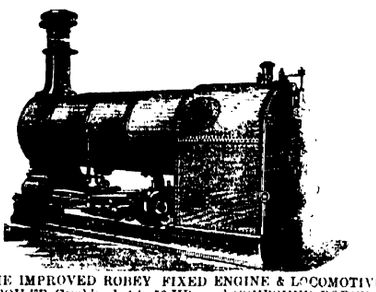
☞ References can be given to upwards of 8,000 Engines now at work.



VERTICAL STATIONARY STEAM ENGINE AND BOILER Combined, of all Sizes, from 1½ to 16 HP.



The Patent "Robey" Mining Engine, 4 to 50 HP.



THE IMPROVED ROBEY FIXED ENGINE & LOCOMOTIVE BOILER Combined, 4 to 50 HP., and COMPOUND ROBEY SEMI-FIXED ENGINE. 4051

Prices and full Particulars of the Machinery here illustrated on application to the Manufacturers

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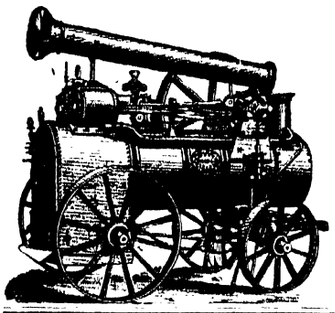
London Office: 117, CANNON STREET, LONDON, E.C.

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BRITANNIA IRONWORKS, GAINSBOROUGH, AND MARSHALLS' BUILDINGS, 79, FARRINGDON ROAD, LONDON, E.C.

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PORTABLE ENGINES, 1½ TO 35 HORSE POWER,

Adapted for all Countries, and constructed to burn Coal, Wood, Straw, Vegetable Matter and Refuse as Fuel.

Also fitted with Patent AUTOMATIC EXPANSION VALVE GEAR, for ensuring Great Economy in Fuel and Regularity of Speed under varying loads when required.

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A FIRST-CLASS ANTI-CORROSIVE LUBRICANT.

FOR CYLINDERS, VALVES, HEAVY BEARINGS, and SHAFTING.

Saves 40 per cent. over Tallow. Lasts twice as long as Olive Oil.

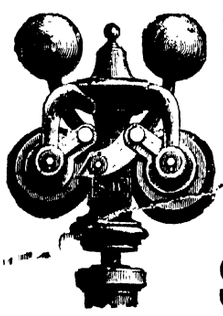
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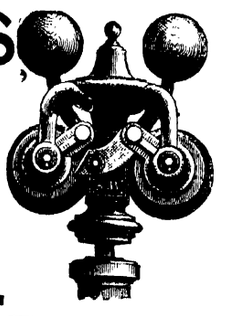


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The "BUSS" GOVERNOR is ESSENTIAL TO THE PERFECT STEADINESS AND SENSITIVENESS OF ANY ENGINE OF THIS TYPE.

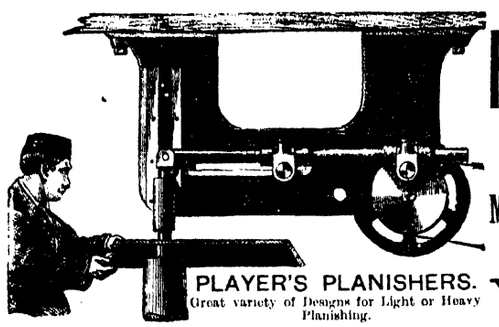




FULL PARTICULARS, PRICES, &c., ON APPLICATION TO

4915

SCHAFFER & BUDENBERG, MANCHESTER.



PLAYER'S PLANISHERS.
Great variety of Designs for Light or Heavy Planishing.

(CALCUTTA EXHIBITION, 1884, BRONZE MEDAL.)

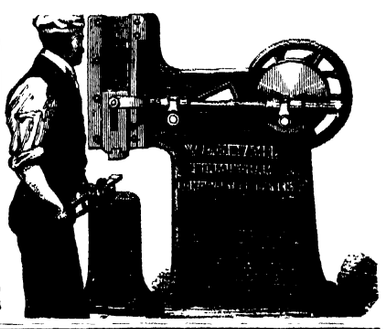
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More Economical & Effective than Steam Hammers.

Various Sizes and Designs. Player & Longworth's Patents.

CATALOGUES AND TESTIMONIALS FREE.

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IMPORTANT TO USERS OF BELTING.

GANDY v. REDDAWAY AND OTHERS.

Advertisements have been issued and largely circulated in this country and abroad by Mr. Maurice Gandy, in which he gives prominence to our name without mentioning the whole of the facts in connection with the above action. It is therefore necessary for us to inform the Users of Belting that the ACTION of

GANDY v. REDDAWAY & CO. and Others was dismissed as regards us, WITH COSTS TO BE PAID BY GANDY to

F. REDDAWAY & CO., the Patentees and Sole Makers of REDDAWAY'S BELTING.

We claim to manufacture the BEST and STRONGEST Cotton Belting in the Market, by Machinery of special construction and of our own invention.

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F. REDDAWAY & CO., FIRST PRIZE SILVER MEDAL.

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REDDAWAY'S PATENT CAMEL HAIR BELTING. | **REDDAWAY'S PATENT MACHINE-MADE CANVAS HOSE.**

—: F. REDDAWAY & CO., PENDLETON, MANCHESTER :—

[Registered at the General Post Office as a Newspaper.

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.

VOL. XXXVIII.—No. 974.] *LONDON: FRIDAY, AUGUST 29, 1884.* [PRICE...6d. BY POST..6½d.

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Portland Cement,

manufactured by

Francis and Co.,

The celebrated Nine Elms Brand, established 1810. Medals: London, 1851; Philadelphia, 1876; Paris, 1878. Offices: Vauxhall, London. Works, Cliffe, Rochester. 4714

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designed and constructed by MANNING, WARDLE, AND COMPANY, Boyne Engine Works, Leeds. 2487

See their Illustrated Advertisement, page 42.

Locomotive Tank Engines,

TRAMWAY ENGINES AND CARS.

Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough. 5206

See Illustrated Advertisement last week, page 9.

R. E. Crompton and Co.,

ELECTRIC LIGHT ENGINEERS,

MANSION HOUSE BUILDINGS, E.C. 4812

See Advertisement last week, page 12.

Over 15,000 "Otto" Engines

AT WORK,

Using 25 to 75 % less Gas

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Any other Engine.

Crossley's Patent Self-Starter,

Safest, Best, and Simplest made, may now be applied. 4776

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Impulse every Revolution. Very Steady in Running

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Steam Launches, fitted with really efficient and accessible tubular boilers. For small steamers, steam lighters, salt flats, &c., these boilers will be found unrivalled.—Apply, COCHRAN and CO., Birkenhead. See page 4. 4749

Steam Launches in Stock.— VOSPER & CO., Broad Street, Portsmouth, Build in Steel, Iron, or Wood, Sea-going Launches, fitted either with their Patent Silent Engines or ordinary ones. 3551

V. & CO.'S Steel Boilers work well in salt water.

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Steel Hydraulic Cylinders.— HENRY BESSEMER & CO., Limited, SHEFFIELD.

See Advertisement, page 51 3027

Willans' Patent Compound ENGINES, for marine and general purposes Stock sizes from 6 to 150 I. HP. Special patterns for Electric Lighting.—WILLANS & ROBINSON, Thames Ditton, Surrey. 5283

Iron Roofs, Sheds, Buildings, HOUSES. Best work, reduced prices Dixon's special CURVED IRON ROOFS are the most economical for spans up to 45 ft. Catalogues, Designs, Estimates, on application. ISAAC DIXON, Windsor Ironworks, LIVERPOOL 4833

George Russell & Co., ENGINEERS and BOILERMAKERS, ALPHA STEAM CRANE and ENGINE WORKS, MOTHERWELL, near GLASGOW SILVER MEDAL, PARIS, 1867. 4921

SIEMENS STEEL PLATES, ANGLES, RIVETS, BARS, FORGINGS, CASTINGS, &c.

The Landore Siemens-Steel CO., LIMITED, LANDORE, R.S.O., SOUTH WALES. 4961

WIRE TRAMWAYS.

W. T. H. Carrington, 9 and 11, FENCHURCH AVENUE, E.C. Removed from 76, Cheapside, E.C. 5095

See Illustrated Advertisement last week, page 27.

A First-Class Lubricant.

"Engelbert's Lubricator."

SEE ADVERTISEMENT LAST WEEK, On Back Outside Page of Cover 4919

Hunter and English, ENGINEERS AND MILLWRIGHTS, IRON AND BRASS FOUNDERS, BOW, LONDON, E.

DREDGING MACHINERY.
HYDRAULIC MACHINERY.
"WILLIAMS'" PATENT CAPSTANS.
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DISTILLERY AND BREWERY PLANT.
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HUNTER'S PATENT FLOATING CRANE FOR DOCKS, &c.
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Having Special Stock, Shipments and Repairs executed very rapidly. 4938

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See Illustrated Advertisement last week, page 24

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Thomas Kell and Son, Litho- graphers, &c., execute every description of Lithography, Chromo-lithography, Engraving, and Printing, Engineering, Architectural, and Pictorial Drawing in best manner. Paper Drawing, photo-lithography, &c.—40, King St., Covent Garden, W.C. 3462

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Thomas Smith,

STEAM CRANE WORKS, OLD FOUNDRY, 4345

RODLEY, NEAR LEEDS.

See Illustrated Advertisement last week, page 27.

International HEALTH EXHIBITION.

PAUL PFLEIDERER'S PATENT

Bread-Making Machinery

In Bakery Section. 4755

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London Mutual Boiler In- SURANCE COMPANY, LIMITED. Established in 1874 for the INSURANCE and PERIODICAL INSPECTION of all kinds of Land and Marine Boilers throughout the United Kingdom.—For particulars apply to the Secretary 17, Queen Victoria Street, London, E.C. 4759

The Assured are secured against loss from claims established under the Employers' Liability Act, 1880.

The "Differential" Pumping ENGINE.—DAVEY'S PATENT for Draining Mines; Water Supply of Towns; Irrigation; Supplying Docks; Pumping Sewage; and General Pumping Purposes.

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See Illustrated Advertisement last week, page 14

Dredgers and Excavators.—

HIGHEST PRIZE AT TYNEMOUTH

FOR

HYDRAULIC DREDGERS.

Bruce and Batho,

9, VICTORIA CHAMBERS, 4743

WESTMINSTER, S.W.

See Illustrated Advertisement last week, page 2.

L. Sterne & Co., Limited.

ENGINEERS,

Sole Makers of

Clerk's Patent

Self-Starting Gas Engine.

HIGHEST AWARD,

BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881.

GOLD MEDAL,

CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifiers,

WITH

STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels,

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10, Rue Lafitte, PARIS. 2588

International Inventions

EXHIBITION, London, 1885.
DIVISION I., INVENTIONS. DIVISION II., MUSIC.

Patron:
HER MAJESTY THE QUEEN.

President:
H.R.H. THE PRINCE OF WALES, K.G.

Applications to Exhibit must be made on Printed Forms, which will be supplied on application to the SECRETARY, International Inventions Exhibition, South Kensington, S.W. These must be filled up and returned on or before the 1st October, 1884. G 688

Owen's College, Manchester

(VICTORIA UNIVERSITY) ENGINEERING COURSE. A detailed Syllabus of the COMPLETE COURSE in ENGINEERING will be forwarded on application. The next Session COMMENCES on the 7th OCTOBER. G 727

J. HOLME NICHOLSON, Registrar.

The Mason College, Birmingham,

SESSION 1884—1885.

FACULTIES OF SCIENCE AND ARTS.

THE SESSION WILL COMMENCE ON FRIDAY, THE THIRD OF OCTOBER NEXT.

All departments of the College are open to both sexes on the same terms. Special arrangements are made for the convenience of ladies.

Syllabuses containing full information as to Admission of Students, Courses of Instruction, Fees, Entrance and other Scholarships, &c., will be forwarded on application to GEO. H. MORLEY, Secretary G 676

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ENGINEERING & MECHANICAL TECHNOLOGY Professor ALEX. B. W KENNEDY, M Inst. C.E., M Inst, M.E.

CIVIL ENGINEERING, Professor L. F. VERNON HARCOURT, M.A., M Inst C.E

ARCHITECTURE.—Professor T. ROGER SMITH, F.R.I.B.A

CHEMICAL TECHNOLOGY.—Professor CHAS GRAHAM, D. Sc F I C

Lectures and Practical Work in Engineering and Chemical Laboratories COMMENCE 3rd October

Prospectuses may be obtained from the College, Gower Street, W.C. G 709

TALFOURD ELY, M A., Secretary

University College, Bristol.

ENGINEERING DEPARTMENT.

PROFESSOR H. S. HELE SHAW.

The SESSION 1884 85, BEGINS on OCTOBER 7th The Department of Engineering includes separate courses for those intending to become Civil, Mechanical or Electric Engineers, or Surveyors or Architects

Students in Mechanical Engineering who study during the six winter months at the College, can spend the rest of the year in the workshops and offices of various firms in and near Bristol

Surveying and Fieldwork occupy a prominent place in the Civil Engineering Course during the Summer Term; and arrangements have been made with leading Civil Engineers and Architects for the entry into their offices of Students who have passed through the respective courses

Information with regard to the lodging of Students can be obtained on application

Calendar, containing full information, price 1s., by post 1s 3d. For Prospectus and further information apply to

ALFRED E STOCK, G 726
Registrar and Secretary.

TENDERS

THE SOUTHERN MAHRATTA RAILWAY COMPANY, LIMITED.

The Board of Directors of the Southern Mahratta Railway Company, Limited, are prepared to receive

Tenders for the Supply of

IRON UNDERFRAMES, UNDERFRAME and BODY IRONWORK and FITTINGS for First, Second, and Third Class Carriages, Composite Carriages, Horse Boxes, and Brake Vans, as per Specification and Drawings to be seen at this Office. Tenders are to be delivered in sealed envelopes, addressed to the Secretary, marked "Tender for Underframes, &c.," not later than Twelve o'clock, at noon, on Wednesday, the 17th September, 1884

The Company is not bound to accept the lowest or any Tender

By order of the Board,
EDW Z THORNTON,
Secretary.
31, Lombard Street, E.C.,
8th August, 1884. G 666

COMMISSIONERS FOR MAKING IMPROVEMENTS IN THE PORT OF CALCUTTA

NOTICE

Tenders are invited for the

SUPPLY of 6000 tons of PORTLAND CEMENT, to be delivered at the New Dock Works, Calcutta, before December, 1885

Contractors may tender for the whole or any quantity they can deliver within that time, and must state the quantity to be delivered monthly, and when delivery will commence.

Full particulars of the cement to be supplied, and the tests contractors will submit to after delivery in Calcutta, must be given with each Tender Payments will be made only after delivery at the Works in Kidderpare, Calcutta, and on a certificate from the Commissioners' Engineer that the cement is up to the standard guaranteed by contractors, and accepted by the Commissioners.

The Tenders will be received up to Wednesday, the 8th October, and should be submitted under sealed covers, marked "Tender for Portland Cement"

Tenders submitted from England should be dispatched by the mail leaving London on Friday, the 12th September

The Commissioners do not bind themselves to accept the lowest or any Tender

By order of the Commissioners, G 745
WM. DUFF BRUCE,
Vice-Chairman

TENDERS FOR GASHOLDER.

The Directors of the PRESTON GAS COMPANY are prepared to receive

Tenders for the Erection of a

TELESCOPIC GASHOLDER, about 150 ft. diam. Sealed Tenders, endorsed "Tender for Gasholder," and addressed to the Chairman of the Company, must be delivered on or before Wednesday, the 10th September next. Plans and Specifications may be seen at the Office of the undersigned on and after the 14th inst. G 671

Gas Office, Preston, HENRY GREEN,
8th August, 1884. Engineer.

EBBW VALE LOCAL BOARD.

IRON AND WARE PIPES, AND PIPE LAYING.

The Ebbw Vale Local Board are prepared to receive

Tenders (1) for the Supply of

CAST IRON SOCKET PIPES for the purpose of supplying water to Beaufort, and (2) for Hauling, Laying, and Jointing the same. The Tenders must be separate

The Board also invite Tenders (1) for the Supply of Cast Iron Socket Pipes for the purpose of supplying water to the Waln llwyd and Steel Works Districts, and (2) for Hauling, Laying, and Jointing the same. The Tenders must be separate.

The Local Board are also prepared to receive Tenders for the Laying of Glazed Hardware Socket Pipes for surface drainage at Cwm and Steel Works

Plans and Specifications, and other particulars, may be obtained from Mr. T. J. THOMAS, the surveyor for the Local Board, Ebbw Vale

Tenders to be sent into the undersigned on or before Monday, the 15th September, 1884.

JOHN E. WARD,
Newport, Mon., G 743
23rd August, 1884. Clerk to the Board.

PERTH GENERAL STATION.

CONTRACT FOR WORKS.

The Perth General Station Committee are prepared to receive

Tenders for the Enlargement

of the GENERAL STATION, PERTH.

The Drawings and Specification may be seen at the Office of Messrs. BLYTH & CUNNINGHAM, C.E., 135, George Street, Edinburgh, from Monday, the 8th of September, till Saturday, the 13th of September, and from Thursday, the 18th of September, till Friday, the 26th of September, and at the Office of the Secretary to the Perth General Station Committee, Perth, on Monday, Tuesday and Wednesday, the 15th, 16th and 17th of September, when an Engineer will attend to point out the Site of the Works to Contractors.

Forms of Tender, with copy of the Specification and duplicate copies of the Schedule, may be obtained from the Engineers, on payment of Four Guineas.

The successful contractor shall pay the cost of the measurements

Sealed Tenders, addressed to the undersigned, and marked "Tender for Works," must be lodged with him on or before Friday, the 26th day of September next.

The Committee do not bind themselves to accept the lowest or any of the Tenders

ROBERT MORISON,
Perth General Station, Secretary.
25th August, 1884 G 771

TO BUILDERS, CONTRACTORS, AND OTHERS.

The Metropolitan Board of Works will meet at the Office of the Board, Spring Gardens, S.W, on Friday, the 3rd day of October, 1884, at Twelve o'clock at noon precisely, and will then be prepared to open

Tenders by Parties who may

be willing to CONTRACT for the RE-BUILDING of the SUPERSTRUCTURE and the STRENGTHENING of HAMMERSMITH BRIDGE, and also for constructing a Temporary Timber Bridge for the accommodation of the traffic during the closing of the permanent structure Parties desirous to submit Tenders may, upon the payment of £5, obtain a Copy of the Drawings, Specification, Form of Tender, and other particulars on application to the Engineer of the Board, at the Office, Spring Gardens, between the hours of Nine a.m and Four p.m. (or on Saturdays between the hours of Nine a.m and Two p.m.) until Thursday, the 2nd day of October, 1884 The Tenders, which must be on the form supplied from this Office, and addressed to the Clerk of the Board, are to be delivered at the Office before Four o'clock on the last mentioned day, and no Tender will be received after that hour. The parties tendering must be in attendance at the Board at Twelve o'clock on the day appointed for opening Tenders, and any Tender which is not fully filled up in every particular will be rejected

The Board do not bind themselves to accept the lowest or any Tender.

J. E WAKEFIELD, Clerk of the Board.
Spring Gardens, S.W, 20th August, 1884 G 728

TO IRONMASTERS, BROKERS AND OTHERS.

The Oakerthorpe Iron Works

FOR SALE BY TENDER These works comprise two blast furnaces, with hot air stoves, blowing engine, steam boilers, with the necessary substantially erected buildings, loco. shed, weigh houses and machines, sidings on the Main Midland Line, eleven miles from Derby; never failing supply of water; raw material and labour plentiful and cheap; the necessary fixed and loose plant are included Owing to the death of proprietor, the entire works are FOR SALE, and having been lately thoroughly overhauled and put into good order, can be set to work quickly if desired. A very low figure will be accepted to close the estate —Full particulars and orders to view may be obtained upon application to Messrs WHEATLEY KIRK, PRICE and GOULTY, 52, Queen Victoria Street, London, E.C G 713

APPOINTMENTS OPEN.

Manager and Partner.—An

energetic business man with £500 required to manage and develop a business connected with railways and steam power users; all necessary plant erected, expenses under £50 per annum; capital under own control; good opportunity for a pushing man —MANAGER, 117, Chancery Lane, W.C. G 770

Civil Service Commission

—PRELIMINARY EXAMINATION.

ASSISTANT to Surveyor's Office of Works (21-30), 5th September. Technical training and qualifications necessary.

The date specified is the latest at which applications can be received. They must be made on Forms to be obtained, with particulars, from the SECRETARY, Civil Service Commission, London, S.W. G 686

It is intended to Appoint

PROFESSORS of METALLURGY and of MECHANICAL ENGINEERING in the Technical School in connection with FIRTH COLLEGE, Sheffield. The remuneration will depend on the qualifications of the applicants, but will in no case be less than £300 per annum, together with a portion of the respective class and laboratory fees.—For further particulars apply to the REGISTRAR, to whom applications, stating experience and qualifications must be sent, with the names of at least three referees, before 20th September, 1884.

ENSOR DRURY, Registrar.
Firth College, Sheffield. G 704

A Chemist is Required at

once in a large Works in South Staffordshire to analyse the Minerals, and the Iron and steel produced from them; also to carry out all the mechanical testing necessary. A knowlege of the practical manufacture and manipulation of steel will be a great recommendation. Only such applications will be considered as give full particulars of experience, with references and salary expected; also earliest date that appointment could be entered upon —Apply to THE NEW BRITISH IRON CO., Corngreaves, near Birmingham. G 742

Marine Boiler Makers' Under

Foreman —An UNDER FOREMAN or ASSISTANT is WANTED in the Marine Boiler Department of Messrs. MAUDSLAY, SONS, and FIELD, of London and East Greenwich Applications must be addressed to the undersigned, or to Messrs. MAUDSLAY, SONS, and FIELD, Lambeth, and must state age, past experience, and where last employed, together with copies of any recent testimonials as to ability and character. Only men of good practical knowledge of marine boiler work need apply; also some experience of repair work will be expected. If satisfactory on trial, Messrs. M. S. & F. will defray all expenses of removal of family to London. —E. HUTCHINGS, Secretary Iron Trades Employers' Association, 17, Cooper Street, Manchester. G 707

Wanted, a thoroughly efficient

DRAUGHTSMAN, accustomed to Machine Tools and Millwright work. State age, experience, and terms.—Apply to JAMES R. WALKER, Royal Exchange, Glasgow. G 750

Lists of Berths Vacant or

WANTED. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N SPON, 16, Charing Cross, London; or of all News Agents. 5202

SITUATIONS WANTED.

Wanted, Re-engagement by

a Mechanical Engineer; experienced in electrical work; fair draughtsman, well versed in French, German, Italian, acquired abroad; advertiser had for the last 4 years charge of workshops in an engineering college; good references —Address, W. S., 3, Humber Terrace, Westcombe Park, Blackheath, London. G 741

Wanted, Re-engagement by

Good FITTER and ERECTOR; age 30; speaking fluently German, French, and Italian, acquired abroad. Good references.—Address, W. S., 15, Ashburnham Grove, Greenwich, London. G 747

Wanted, an Appointment as

Manager or Assistant Manager to an Engineering Firm, with a view to future partnership, by a Gentleman of experience.—Address, FRED. J. BROWN, Gloucester Villa, Ealing, W G 755

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thorough theoretical knowledge of technical machinery, who for over two years was engaged in turbine and mill building works, DESIRES an ENGAGEMENT in England as Designer, in view of improving his knowledge of English. Advertiser is thoroughly conversant with French and German.—Address, A 889, care of RUDOLF MOSSE, Zurich, Switzerland. G 754

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Draughtsman, experienced in Bridgework, Locomotives, General Engineering and Surveying, DESIRES to CHANGE his present situation Address to 13 H C., 17, Dartmouth Street, Westminster, S.W. G 759

Engineer, age 23, five years'

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A Scotchman of nearly

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Civil Engineer, 20 years' pro-

fessional and commercial experience, desires to JOIN a well-established connection, or would take up *bona fide* business having remunerative prospects.—Address, M.I.C.E., 7, Little Queen Street, S.W. G 625

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—The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright.

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MACHINES, second-hand, to punch up to ¾ in. plates.—Address G 746, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. G 746

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CANAL BOATS, iron preferred, suitable for conveyance of tar and gas water.—Particulars of Mr. LEWIS T. WRIGHT, Gas Department, Nottingham. G 764

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Second-hand FILTER PRESS, with or without steam or hand filling pump attached.—Address, with price and full particulars of size, LISLE & CO., Newcastle-on-Tyne. G 753

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Three or Four Copies of Jan. 11th, 1884.—Address, with price, B. O. R., Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. G 691

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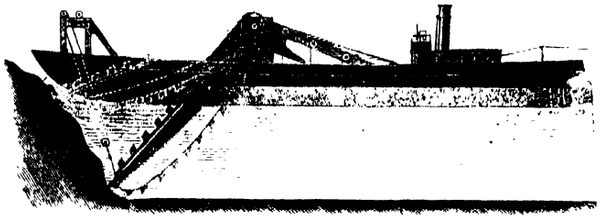
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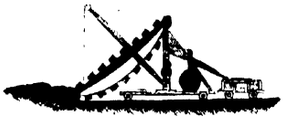
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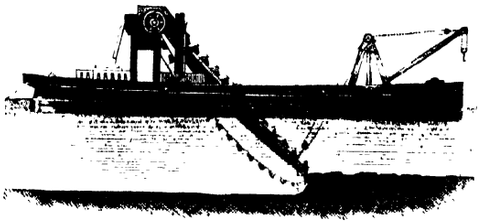
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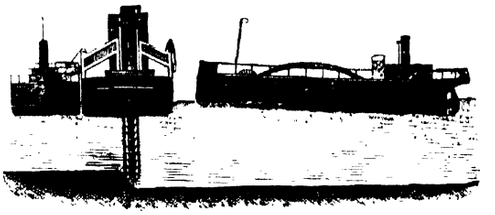
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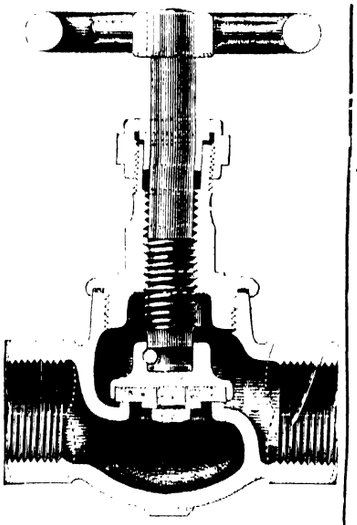
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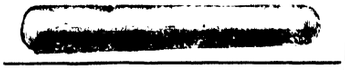


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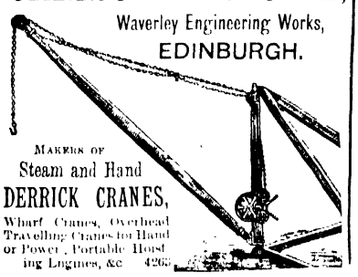
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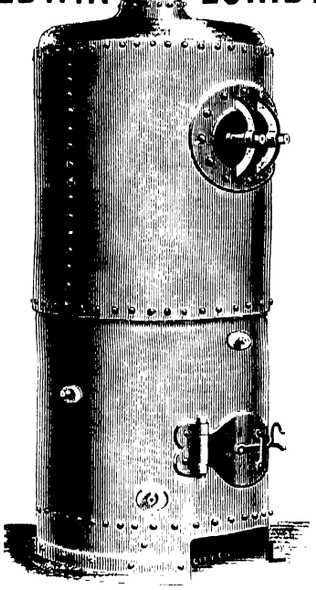
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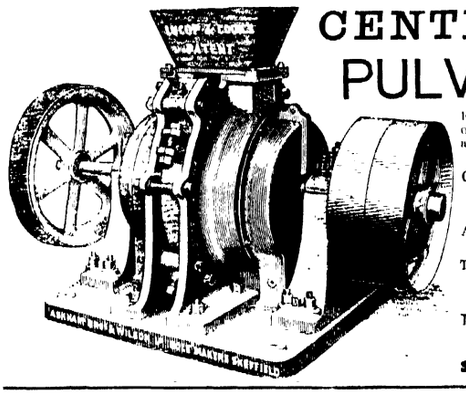
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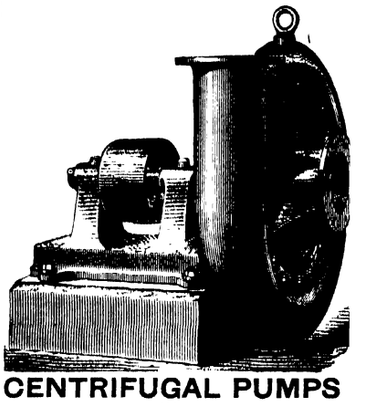
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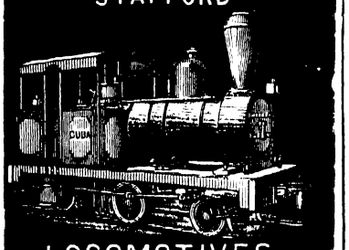
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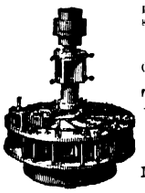
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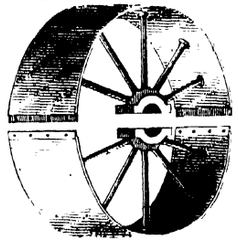
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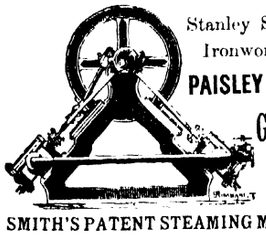
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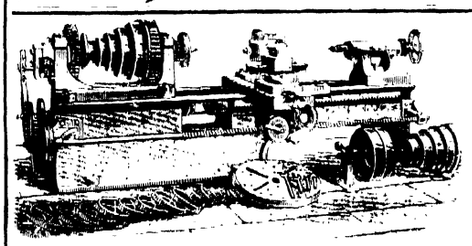


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STEEL TRAM RAILS, A SPECIALITY.
STEEL ANGLES, TEES, CHANNELS, BULBS, and BARS of other SECTIONS,
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Guaranteed, if required, to stand the Admiralty or Lloyds' Tests.
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TUBES
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TUBES and FITTINGS for Gas, Steam, and Water; Galvanised, Enamelled, and Hydraulic Tubes; Boiler Tubes and Fittings, Gasfitters' Tools, Brass Cocks. Anti-Corrodo Tubes and Fittings coated by Barff's Rustless Process.
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ALSO
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Shipbuilders' and Boilermakers' Tools
PATENT STEAM & HYDRAULIC RIVETTING MACHINERY.
4731



SPECIALITY IN
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SMITH & WILSHAW,
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Makers of all kinds of
Improved Self-Acting, Sliding, and Screw Cutting Lathes,
For Foot or Power 5260

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MANUFACTURER OF
CORNISH, LANCASHIRE & VERTICAL BOILERS
IN IRON OR STEEL
WROUGHT IRON AND STEEL BUOYS OF EVERY DESCRIPTION.
Tar Stills, Steam Pans, Jacket Pans, Shoots, Hoppers, TANKS, CISTERNS, &c.
PATENTEE AND SOLE MAKER OF
BELLAMY'S PATENT TUBULAR BOILER,
Unsurpassed for quick Steaming and Economy of Fuel. Also
BELLAMY'S PATENT HEATING BOILER,
SPECIALLY ADAPTED FOR HORTICULTURISTS 4922

CRANE'S PATENT OIL
FOR
CYLINDERS AND VALVES.
As Supplied to H. M. Navy and the Principal Steamship Companies.
Manufactured solely by
P. MOIR CRANE & Co.,
BANK STREET, MANCHESTER;
4, James Street, Liverpool, and 131, Fenchurch Street, London, E.C.



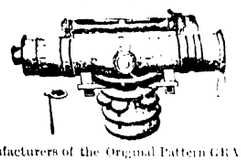
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PROVED to be the BEST OIL by the EVIDENCE before the COMMITTEE appointed by the LORDS COMMISSIONERS of the ADMIRALTY
FREE from ACID, leaves no DEPOSIT in the CONDENSERS, PRESERVES the BOILERS and SAVES FUEL.
All oils except those covered by Crane's Patent become acid in passing through the high-pressure cylinders, and consequently corrode boilers, leaving at the same time Deposits in the internal part of the machinery
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N.B.—As parties are imitating P. Moir Crane & Co.'s Advertisements and Circulars, and offer oil for Cylinders and Valves professing to give the same results as Crane's Patent Oil, the Patentees desire to state that their Patent Rights cover the use of ALL THE CLASS OF OILS which give these results, and that for their own security they must proceed against those infringing.
Crane's Patent Oil, the quality of which is fully established, can be obtained at about the same price as the imitations of it.

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THAMES AND MERSEY
LUBRICATING OILS.

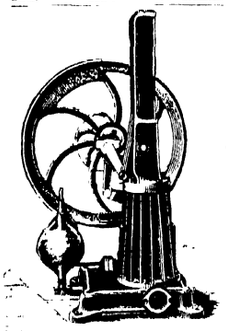


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As recommended by
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"For the preservation of SMALL ARMS and Articles made of Metal from oxidation."
Price Lists on application to
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BROMBOROUGH POOL, LIVERPOOL

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Westminster Bridge Road, Lambeth, near Astley's Theatre.

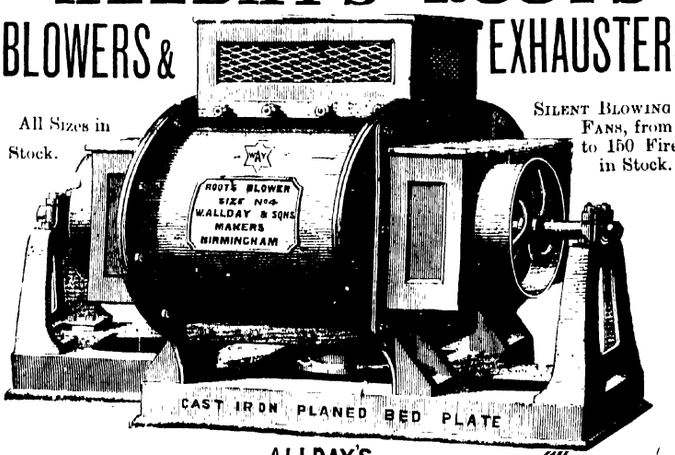


Manufacturers of the Original Pattern GRAVITY DUMPY
Revised list of prices—best 10-inch Dumpy Level complete £10 10s., ditto with Compass, £11 11s. 12-inch ditto £12 and £12 12s.—THEODOLITE equally low. 840



THE "BISSCHOP" PATENT
GAS ENGINE.
1,700 Engines Working in Great Britain.
J. E. H. ANDREW & CO.,
STOCKPORT. 4161
London Office—123a, QUEEN VICTORIA STREET, E.C.

ALLDAY'S ROOT'S
BLOWERS & EXHAUSTERS



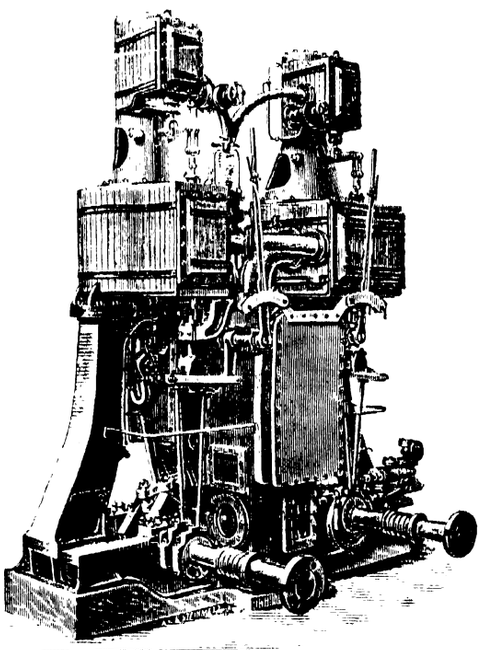
All Sizes in Stock.
Silent Blowing Fans, from 1 to 150 Fires, in Stock.

ALLDAY'S
6 ROOTS PRESSURE BLOWER SIZE N° 4
OF THESE BLOWERS WERE SUPPLIED WITH THE 150 Nos A76 HEARTHS FOR THE INDIAN STATE RAILWAYS OCTOBER 1880.
THE BEST BLOWER IN THE MARKET.—GREAT SAVING IN FUEL AND POWER.
PRICES AND PARTICULARS ON APPLICATION. 4334
Wm. ALLDAY, SONS & CO., Engineers, Birmingham.

RANKIN & BLACKMORE, Engineers,
GREENOCK,
MAKERS OF
Rankin's Patent 2-CYLINDER DISCONNECTING COMPOUND ENGINES
AND
4-CYLINDER DISCONNECTING TRIPLE-EXPANSION ENGINES,
FOR PADDLE AND TWIN-SCREW STEAMERS.

The principal advantages claimed for these Engines, as compared with the ordinary 4 Cylinder Compound and for 4 Cylinder Triple Expansion Engines, are

Simplicity of Construction, Economy of Fuel.



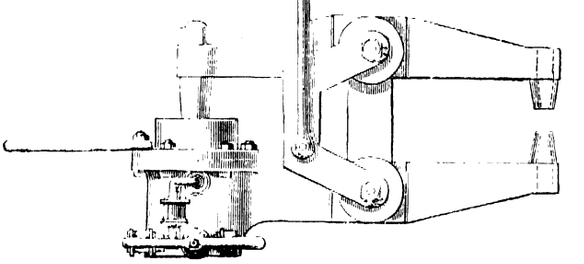
Accessibility of Working Parts. Superior Efficiency, and Less Tear and Wear.

FULL PARTICULARS AND PRICES ON APPLICATION. 5229
For Illustration of 2 Cylinder Paddle Engines, see ENGINEERING of this day Fortnight.

ARROL'S PATENT PORTABLE
HYDRAULIC RIVETTING MACHINES,
FOR
LAND AND MARINE
BOILERS,
Wagon Under-Carriages,
CIRDERS, GAS-HOLDERS,
SHIPWORK, &c., &c.

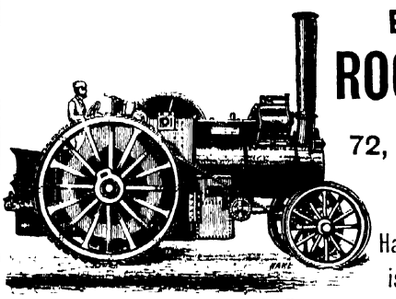


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4904
LARGE NUMBER IN USE AT HOME AND ABROAD.

TRACTION ENGINES
AVELING & PORTER,
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AND
72, CANNON STREET,
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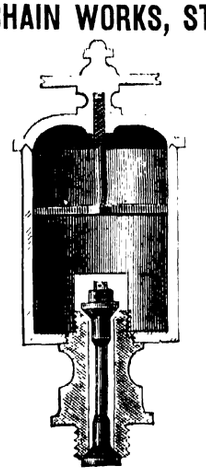


Haulage by Steam on Common Roads is 50 % cheaper than by horses.

WHITEHOUSE & CO.'S
PATENT
Self-Acting Adjustable Lubricator,
TIPTON HALL CHAIN WORKS, STAFFORDSHIRE.

A Clear Saving of 50 per cent. in Oil, Tallow, or Grease.

Cannot get out of order.



Perfectly Clean in working.

One Month's free trial allowed.

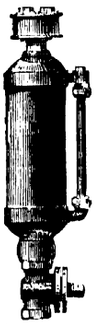
Sizes.
2 in., 2½ in., 3 in., 3½ in., 4 in.

Prices on Application.

Self-acting, with two valves which are set to requisite feed by means of lock-nut, to permit only necessary lubricant to flow. It ceases working with the engine, and remains closed until the engine commences working again, thus effecting every possible saving.

Agents { LONDON: J. C. S. OGG, 13, Crutched Friars, E.C.
MANCHESTER: C. J. BROWN, 7, Exchange Arcade.
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AIR INJECTORS
FOR ALL PUMPING ENGINES.
Beating Valves rendered noiseless.



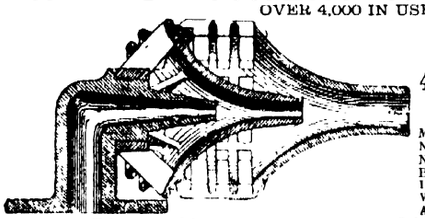
LIVERPOOL CORPORATION WATER WORKS,
DALE STREET, LIVERPOOL, August 24th, 1880

DEAR SIR,—Referring to your letter of the 23rd instant, I have much pleasure in stating that the two Air Injectors supplied for the Liverpool Pumping Stations have been in use about two years, and that during that time they have acted satisfactorily and have maintained a uniform volume of air in the air vessels.—Yours truly,

GEORGE H. DEACON.

WILLIAM TURNER,
Late OMMANNEY & TATHAM, 4873
SALFORD, MANCHESTER.

HIGH PRESSURE MARINE BOILERS.
Best and Cheapest Means of Preventing Unequal Expansion.
"WEIR'S" PATENT HYDROKINETER.
OVER 4,000 IN USE.



G. & J. WEIR,
49, JAMAICA STREET, GLASGOW.
MENZIES & BLAGBURN, KING STREET, NEWCASTLE-ON-TYNE WM. REID & CO., 5, NEW LONDON STREET, LONDON, E.C. A. & R. BROWN, WATERLOO ROAD, LIVERPOOL. R. HUGHES & CO., FULTON STREET, DITTO W. S. VON ESSEN, ENGINEER, HAMBURG, AGENT FOR SCANDINAVIA & GERMANY 5081

SAFETY

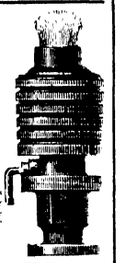


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TURNBULL'S VALVES PATENT
MANUFACTURERS to the ADMIRALTY.

Thousands in use, giving the very highest satisfaction.

Extract from "Engineering."

We have, as we have said, heard favourable reports of the action of Messrs. TURNBULL & Co.'s Valves, and we understand that they give good results both as regards their great discharging power and prompt closing power when the pressure falls again, whilst they are certainly very simple in construction."—See also articles by "Engineering," "Iron," "Colliery Guardian," "Marine Engineer," "Moniteur Industrielle," &c., &c.



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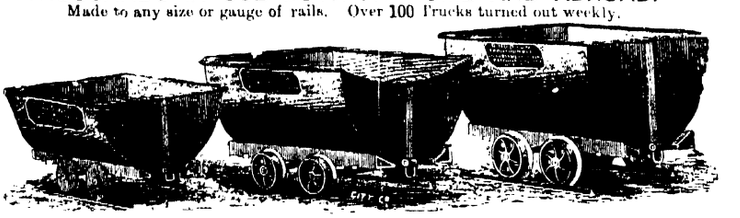
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PHOSPHOR-TIN.

BY USING OUR PHOSPHOR-TIN,
Phosphor-Bronze can be made Superior to any now in the Market,
AT 30 PER CENT. LESS COST.

Three cwt. of our tin will produce one ton of Phosphor-Bronze, thereby effecting a considerable saving in carriage, and enabling Manufacturers to use the same stock of Copper for all purposes.
(See our Circular.)

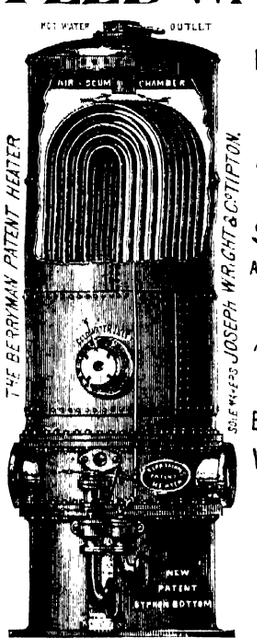
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With or Without "END" DOORS and "SWIVELLING" UNDERCARRIAGE, for Tipping at EITHER SIDE or END of Rails.
THOUSANDS IN USE BOTH AT HOME AND ABROAD.
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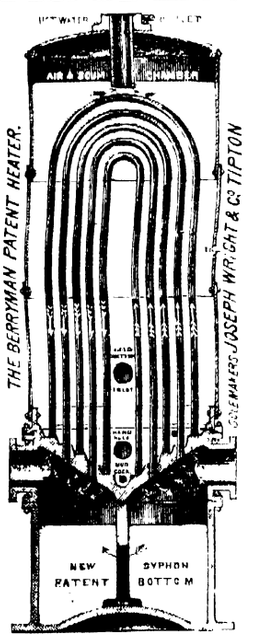


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Registered Telegraphic Address: GILDERSOME, LEEDS. 4550
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SOLE MAKERS OF
BERRYMAN'S IMPROVED PATENT UNIVERSAL EXPANDING TUBULAR
FEED-WATER HEATER



THE WELL KNOWN
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ARE NOW FITTED WITH OUR NEW
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SYPHON BOTTOM
AND OTHER IMPROVEMENTS,
SAVING
FROM 15% TO 50% OF
COALS,
BOILER POWER,
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OVER 1000 SOLD
SUITABLE
FOR HIGH OR LOW
PRESSURE
AND COMPOUND
ENGINES.



SOLE MAKERS OF THE A1. SPECIAL BEST BEST J.W. & Co. (REGISTERED BRAND)
CRANE CHAIN.



CHAIN CABLES
THEY HAVE NEVER BEEN SURPASSED FOR STRENGTH, UNIFORMITY OR DURABILITY, AND ARE MADE BY SPECIAL WORKMEN FROM IRON OF SPECIAL QUALITY, PREPARED EXPRESSLY FOR THIS COMPANY ONLY.

THE STEEL COMPY. OF SCOTLAND,

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(SIEMENS PROCESS).

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	Ship	Boiler	Special	Extra Fine
BRANDS	P S	P SS	P SB	P SB
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Boiler End & Furnace Plates, Flanged & Welded. Special Steel for Anti-Collapse Rings & Welded Tubes.

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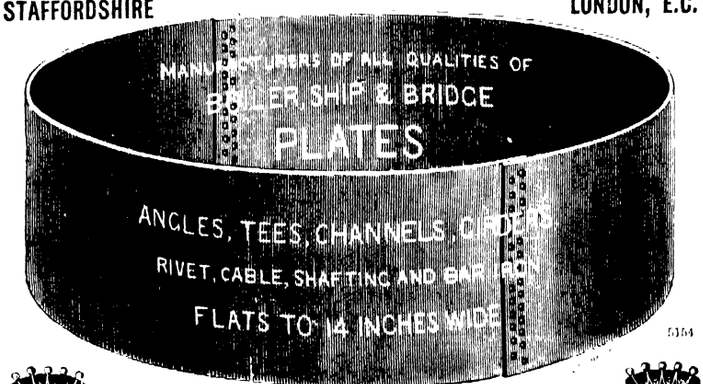
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5154

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Nozzles can be taken off at letter A, by simply unscrewing "bolts at back, and new ones fixed in five minutes, without removing tanks or their connections.

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THIS alloy is an improved brass, hard, durable, and strong as mild steel, possessing a beautiful golden colour, when melted it produces sound castings of fine grain; it can be forged hot and cold, and takes a very high polish.

DELTA METAL IS BEING LARGELY USED FOR ALL KINDS OF MACHINERY

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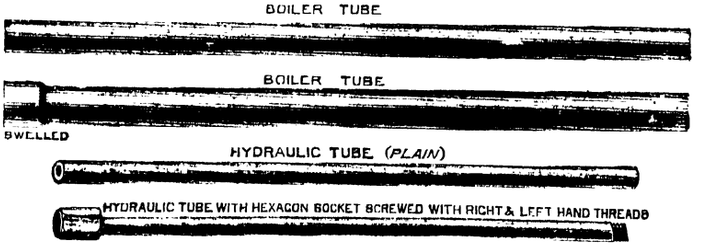
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PATENT WELDLESS STEEL TUBES

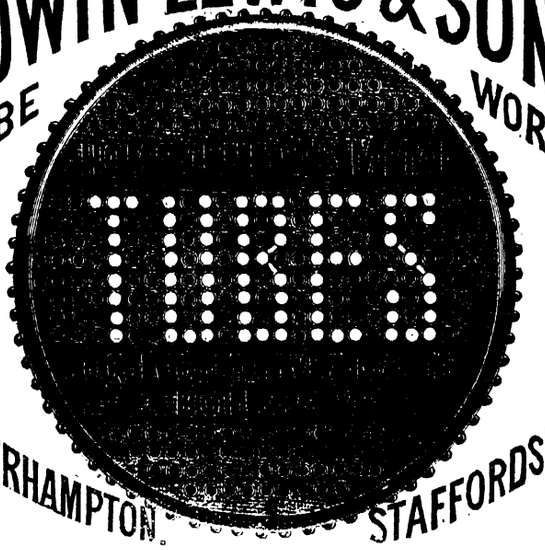
For Boilers, Hydraulic Presses, Ferrules, Boring Rods, Bushes, Shafting, Couplings, Spindles, Collars, and other uses.

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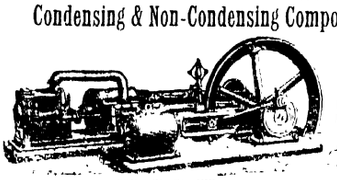
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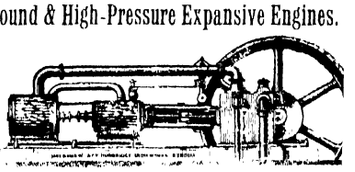
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Condensing & Non-Condensing Compound & High-Pressure Expansive Engines.



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THE **Coupled Engine** is fitted with HOLBOROW & Co.'s Invention of DISENGAGING VALVES, enal either half to work independently should it be necessary through accident or repair, thus virtually ma two Engines.

THE **Tandem Engine** is designed so that pistons can be withdrawn altogether for repairs by sli removing covers; it has no more working joints than ordinary engine, occupies no more space, nor requ more expensive foundations.

A vacuum of 14 lbs. below atmosphere is readily maintained by new SINGLE-ACTING AIR-PUMP CONDENSER; while consumption of fuel, as proved by exhaustive trial, does not exceed 2 lbs. per per hour, and piping is above floor.

THEIR SIMPLICITY ENABLES VERY LOW PRICES TO BE QUOTED.

"An excellent action of the valves and an unusually good and well maintained vacuum Exceptionally high vac very great economy—exceptionally good results in economy."—*See* ENGINEERING, Nov 12th, 1875, May 17th, 1878, and July 8th

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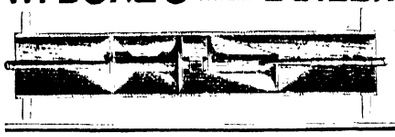
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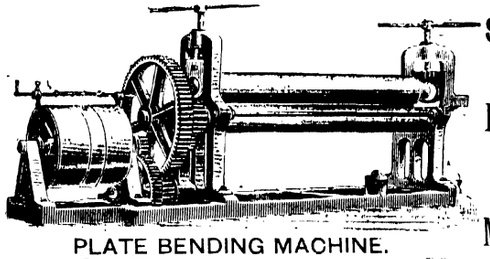
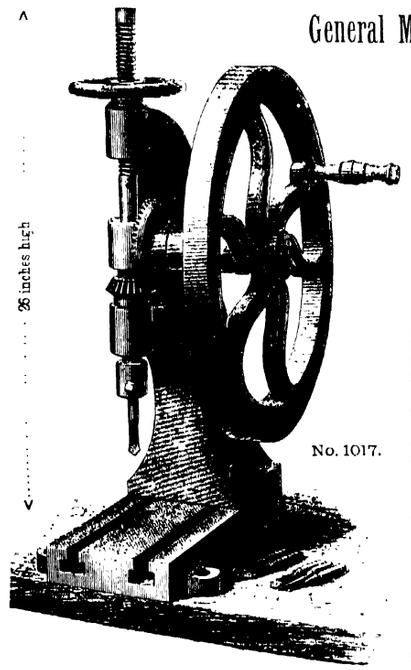


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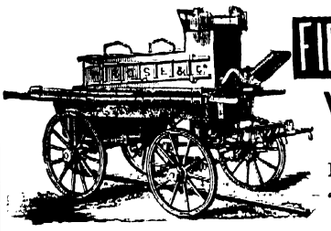
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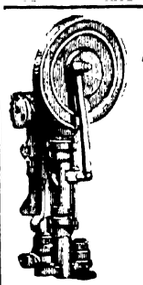
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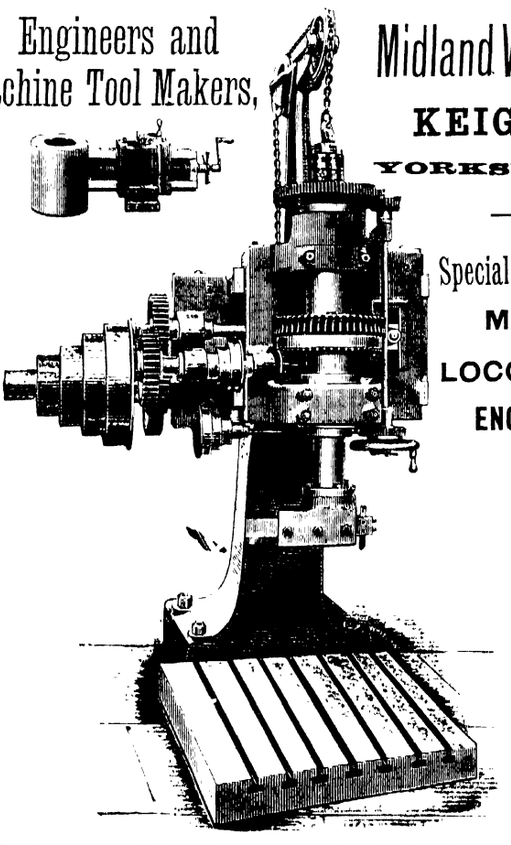
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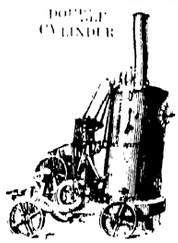
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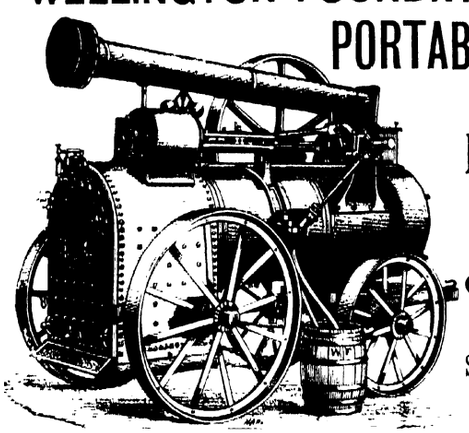
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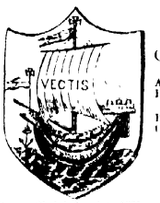
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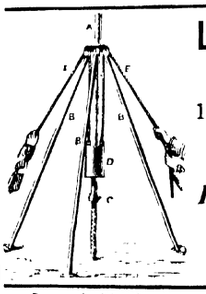
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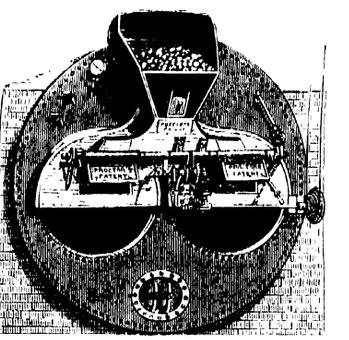
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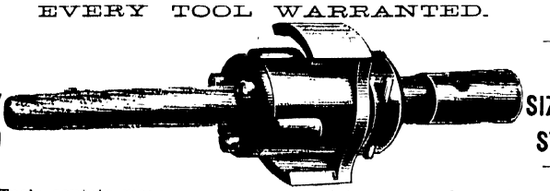
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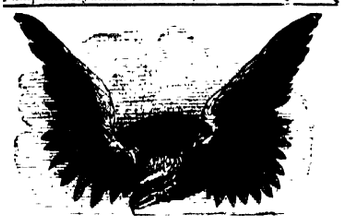
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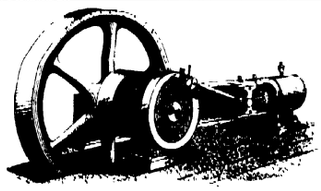
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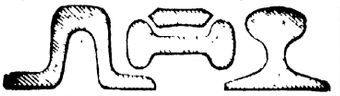
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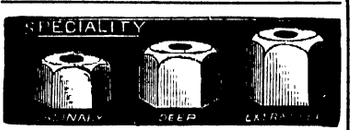
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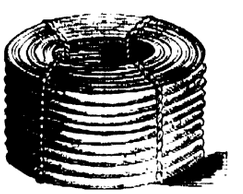
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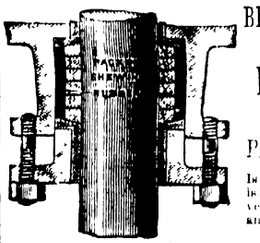


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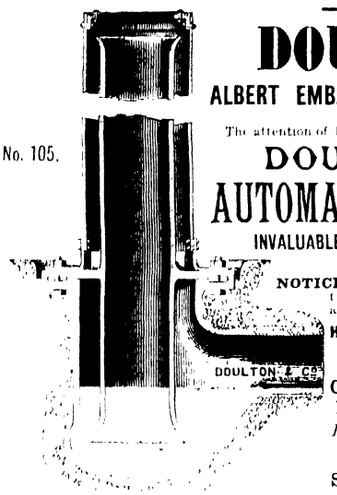
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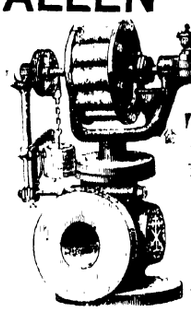
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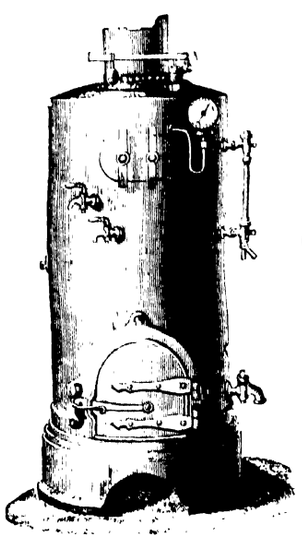
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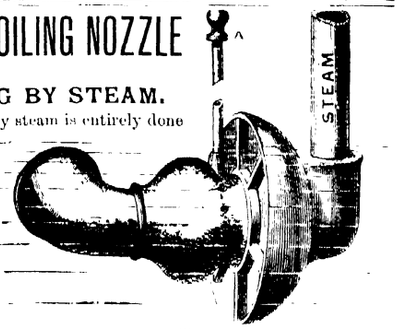
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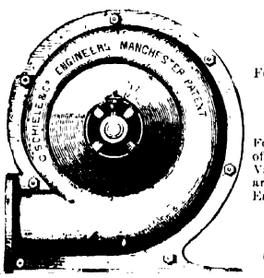
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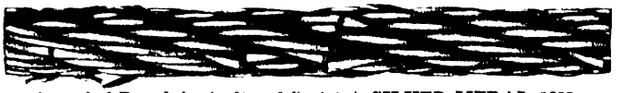


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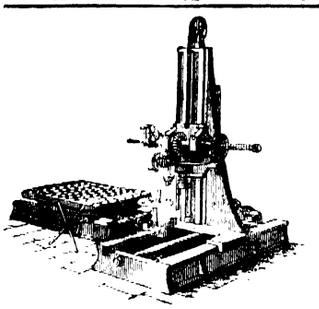
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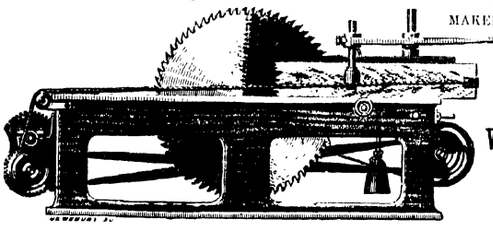
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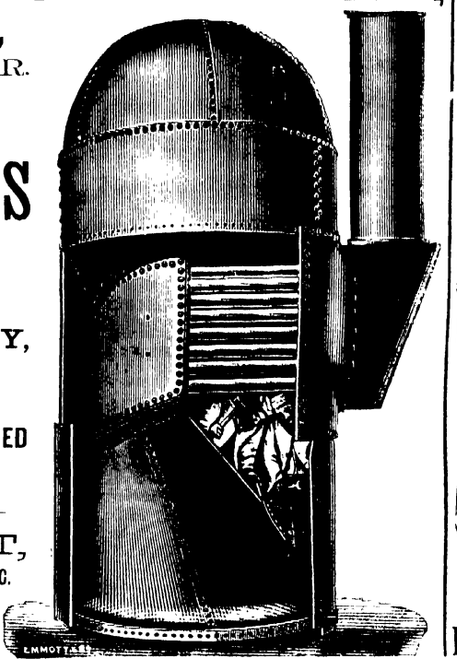
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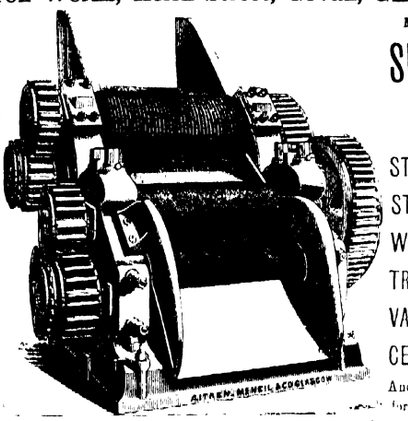
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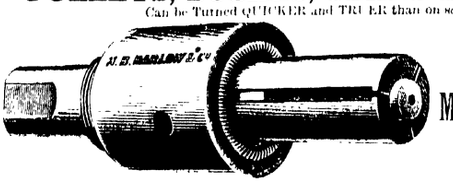
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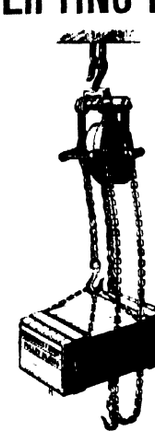
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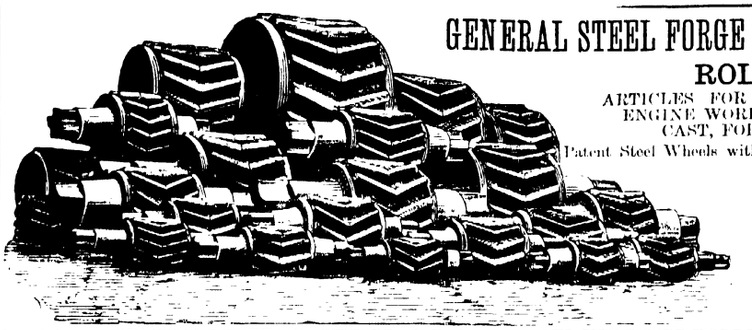
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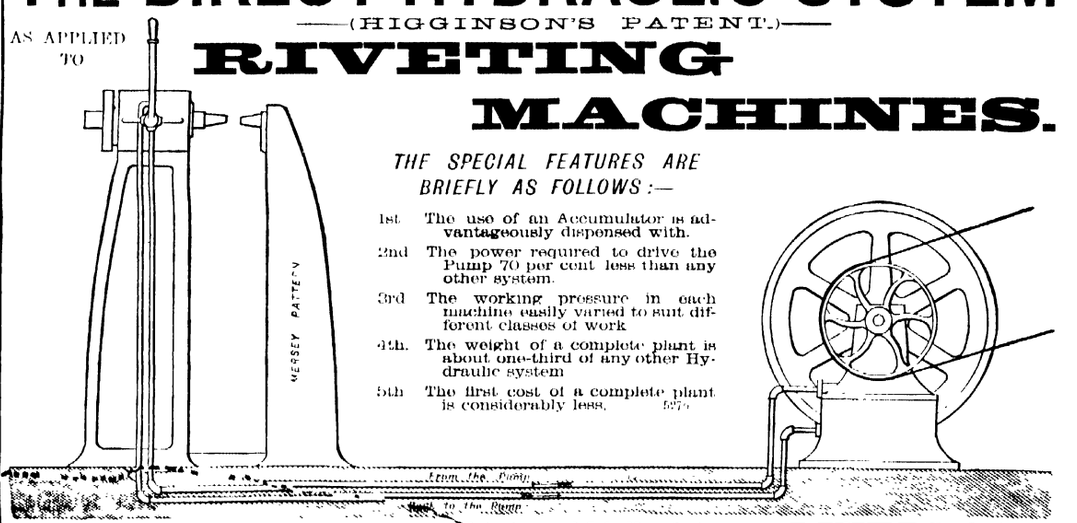
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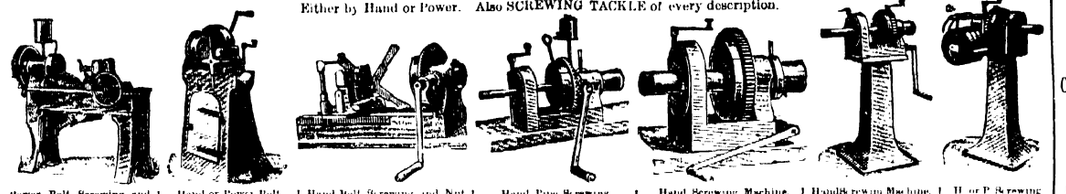
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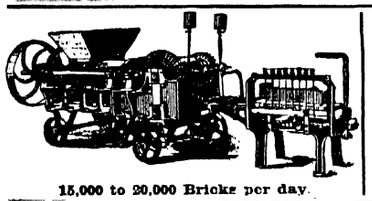
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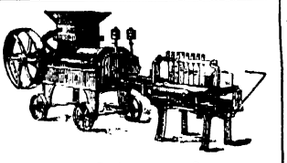
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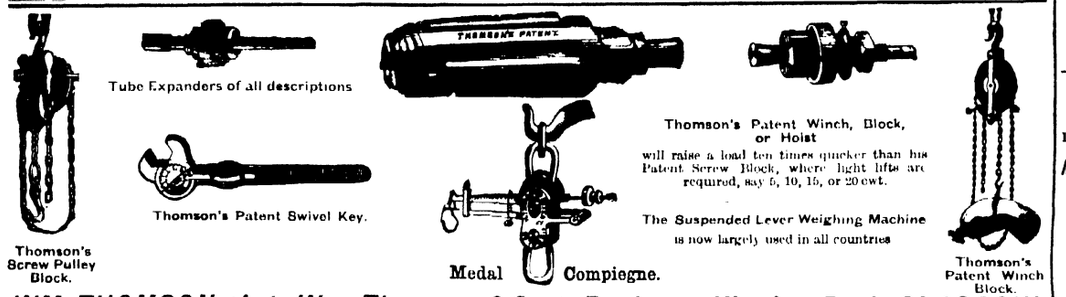
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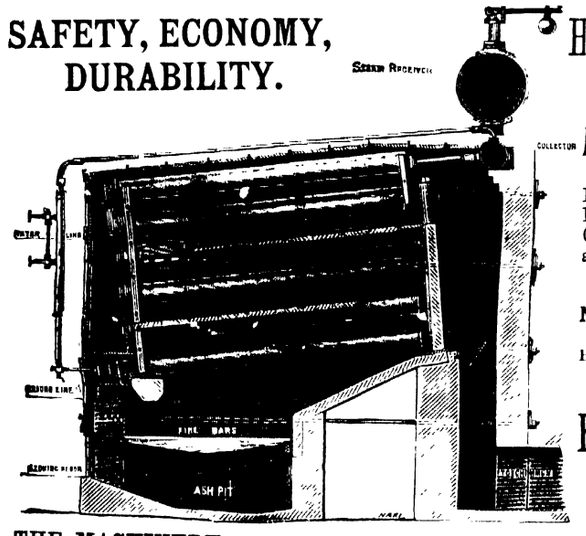
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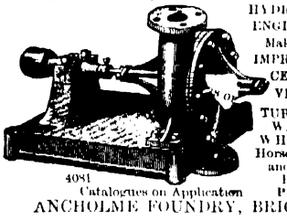
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CENTRIFUGAL PUMP

Is the only Pump from which the disc can be removed by breaking the joint on a single face only

Manufactured by CHARLES L. HETT



HYDRAULIC ENGINEER, Maker of IMPROVED CENTRE VENT TURBINES WATER WHEELS Horse, Steam and Wind Power PUMPS

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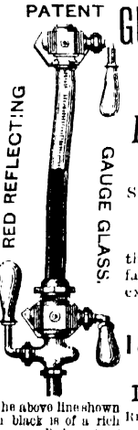
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For Iron, Cast-iron, Copper, &c.

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RED REFLECTING GAUGE GLASS,

Showing through the water a Broad Red Line.

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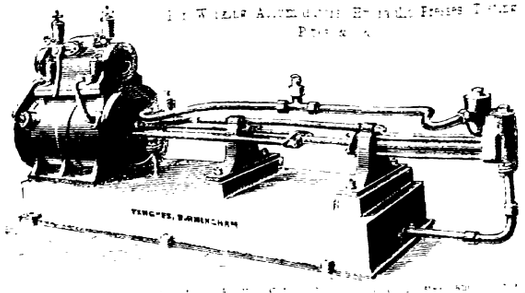
TANGYES LIMITED

LONDON 55, Queen Victoria Street. NEWCASTLE, St. Nicholas. CORNWALL WORKS, BIRMINGHAM. MANCHESTER Deansgate. GLASGOW, Argyle and Hope Streets.

Manufacturers of PROVED GAS Hydraulic Machinery, Steam Engines, Boilers, Cranes, Lifts, Wrought Iron Tubes, Cast Iron Pipes, Valves, Hydrants, Stop Cocks, Fittings, &c.

TANGYES "SPECIAL" CROSS-HEAD HYDRAULIC PRESSURE PUMP

For Working Accumulators, Hydraulic Presses, Testing Pipes, &c.



Diam. Steam Cylinder	ins.	9	10	12	14	16	18	18	21
" Plungers	"	1	1	1	1¼	1½	1¾	1¾	2
Length Stroke	"	9	12	12	18	18	18	18	24
Gallons per hour		110	200	240	320	450	550	650	1000
Pressure in lbs. per sq. in. with 40 lbs. steam	A	1700	1700	1700	1700	1700	1700	2000	2000
	B	1000	1000	1000	1000	1000	1000	1200	1200
Diam. Steam Inlet	ins.	1	1¼	1½	2	2	2½	3	3
" Exhaust Outlet	"	1½	2	2	2½	2½	3	3	4

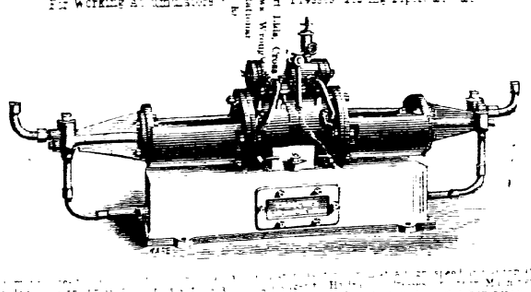
A. Working at 1700 lbs. per sq. in.

B. Working at 1000 lbs. per sq. in.

The above and other sizes quoted for on application. 153

"SPECIAL" HYDRAULIC PRESSURE PUMP

For Working Accumulators, Hydraulic Presses, Testing Pipes, &c.



Diam. Steam Cylinder	ins.	9	10	12	14	16	18	18	21
" Plungers	"	1	1	1	1¼	1½	1¾	1¾	2
Length Stroke	"	9	12	12	18	18	18	18	24
Gallons per hour		110	200	240	320	450	550	650	1000
Pressure in lbs. per sq. in. with 40 lbs. steam	A	1700	1700	1700	1700	1700	1700	2000	2000
	B	1000	1000	1000	1000	1000	1000	1200	1200
Diam. Steam Inlet	ins.	1½	1½	2	2½	2½	3	3	4
" Exhaust Outlet	"	1½	2	2	2½	2½	3	3	4

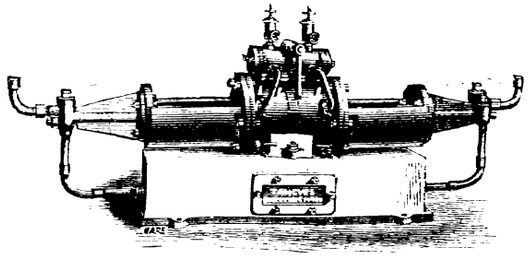
A. Working at 1700 lbs. per sq. in.

B. Working at 1000 lbs. per sq. in.

The above and other sizes quoted for on application. 154

TANGYES'

"SPECIAL" HYDRAULIC PRESSURE PUMP



This arrangement is for lighter pressures than that shown on page 154, but the description given there applies equally to this.

The Pumps are made strong enough for pressure up to 2000 lbs. per square inch.

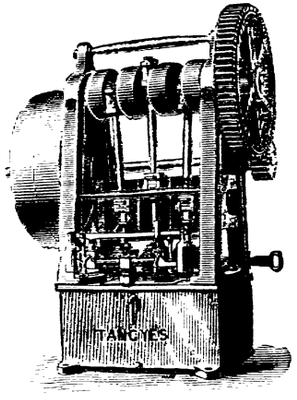
Diam. Steam Cylinder,	ins.	8	8	10	12	12	14	14	16	18	18	21	21
" Plungers	"	1½	2	2	2	2¼	2½	3	3	3	3½	3½	4
Length Stroke	"	12	12	12	12	18	18	18	18	18	18	24	24
Gallons per hour		455	510	650	810	1270	1650	1854	1840	1840	2500	2500	3260
Pressure in lbs. per sq. in. with 40 lbs. steam		750	415	600	830	600	850	650	700	930	670	930	710
Diam. Steam Inlet	ins.	1½	1½	1½	2½	2½	2½	2½	3	3	3	3½	3½
" Exhaust Outlet	"	1½	1½	2	2½	2½	3	3	3½	3½	3½	4	4
" Pump Pipes	"	1	1½	1½	1½	2½	2½	2	2	2	2½	2½	2½

The above and other sizes quoted for on application. 155

TANGYES'

GEARED HYDRAULIC PRESSURE PUMP

As designed for H.M. Government.



This arrangement of three-throw pumps and plungers, Double Safety Valves, Steel Piston Rods, Steel Connecting Rods, Steel Crank Shaft, Gun Metal Bushes, Phosphor Bronze Worm Wheel, Steel Worm, Steel Spur Pinion working in Spur Wheel keyed on Crank Shaft. Cylinders 9 in. bore, 9 in. stroke. Connecting Rods fitted with Brasses and Cranks Shaft running in Steel Pedestals, with Brass Bushes. Connecting Rods fitted with Brasses and Cranks Shaft running in Steel Pedestals, with Brass Bushes. Cylinders 9 in. bore, 9 in. stroke

LITERATURE.

The Collieries, Coalfields, and Minerals of New South Wales, Australia. By ALFRED J. G. SWINNEY, Author of "Handbook to the Examinations for Colliery Managers' Certificates of Competency." London: *Colliery Guardian* Office. 1884.

THIS little volume is the result of the author's observations during a five years' residence in New South Wales, where he had special opportunities of getting information respecting the coalfields. According to the author the coal measures extend from the 29th to the 35th parallel of south latitude, and crop out to the water's edge along many miles of seaboard. The area shown upon the map as the probable coalfield is about 15,430 square miles. This presumably once constituted a single coal basin, but since its formation the strata and seams near the outcrop have been thrown into a series of synclinal and anticlinal curves by upheavals and disturbances of the strata. In the year 1879 the total output of coal was 1,583,380 tons from 27 collieries, and it is probable that in 1883 it reached 2,000,000 tons. At the former date, 621,087 tons were exported to colonial ports, 376,962 tons to foreign ports, chiefly San Francisco, Hong-Kong, and India, and 583,331 tons were consumed in the colony. There are two carboniferous strata, the upper and the lower, separated by millstone grit, carboniferous limestone (represented by a fine conglomerate), and series of shales and mountain limestones, the whole belonging to the Upper Palæozoic epoch. Mr. Swinney goes through each district of the coalfield, giving the name and chief characteristics of the mines, including a section of the beds. Incidentally he mentions many localities where the presence of the coal is apparent, and where capital would find remunerative employment. In some places there have been found beds of very rich kerosine shale, or oil-bearing cannel coal. Two companies are in operation, manufacturing large quantities of first-class illuminating oil from the shale, and also shipping a considerable quantity to England and elsewhere for gasmaking.

The subjects of iron, copper, tin, silver, lead, and gold are briefly treated, but enough is said to show that the mineral wealth of the colony is very considerable, and that when labour is cheaper and capital more plentiful, far larger industries will arise. The author is not very minute in his information, nor is it always up to date, but he says enough to give a good general idea of the mineral resources of New South Wales.

Steel and Iron: Comprising the Practice and Theory of the Several Methods pursued in their Manufacture, and of their Treatment in the Rolling Mills, the Forge, and the Foundry. By WILLIAM HENRY GREENWOOD, F.C.S., Assoc. M.I.C.E., M.I.M.E., Associate of the Royal School of Mines. With Ninety-seven Diagrams from Original Working Drawings. London: Cassell and Co. (Limited).

MR. GREENWOOD has undertaken in the volume before us to treat of a very big subject in a small space, and the result is that he fails in many cases to do justice to his undoubted ability to deal with the question. He proposes to write for both "the general student of the branch of technical science of which it (the book) treats, and to offer to the intelligent workman a succinct statement of the scientific principles upon which depends the success of the several processes conducted and superintended by him." It is difficult to determine whether the workman is sacrificed to the student, or the student to the workman; whether the reader is too often supposed never to have been brought in practical contact with the production of iron and steel, or whether his knowledge on certain points is too often taken for granted. As a matter of fact, in writing a work of the class under consideration, the distinction between workman and student should be obliterated. No workman could consult Mr. Greenwood's work without becoming a student, whilst no student, unless he were in some sort a workman, and practically engaged in the production of the iron and steel, can hope to get definite and useful information from any work, however exhaustive. In fact, the "general student" is a nuisance, and we too often find space devoted to an endeavour to instruct him on points that he could not fail to know after ever so short an actual apprenticeship. Bearing these facts in mind, one is the more surprised at the vast amount of information the author has contrived to pack within the two covers of his book.

Starting with a chapter on the explanation of terms, the three subsequent chapters are devoted to refractory materials, the ores of iron, and the metallurgical chemistry of iron. Pig iron and the various methods of its production is followed by an account of different forms of blast furnaces, hot blast stoves, and blowing engines, after which there is a chapter on casting and the foundry. Wrought iron and its various methods of production, with descriptions of the plant used, occupies the middle part of the book; a chapter devoted to mechanical puddling being one that will be perhaps of most interest to the majority of Mr. Greenwood's readers. The last half-dozen chapters are devoted to a description of the various methods by which steel is produced. Some of the direct processes in which it is obtained direct from the ore are first briefly treated of, after which descriptions are given of the manufacture of blister steel by cementation and its subsequent conversion into shear and crucible steel. Other less known methods of producing steel are also described.

The Siemens open hearth process, the Siemens Martin process, and the Bessemer process, are then as fully treated of as space will allow. The basic process is also well described, recent modifications being mentioned bringing the whole fairly up to date.

A last chapter is devoted to the production of homogeneous steel ingots, and the fluid compression of steel both by the Whitworth hydraulic system and the steam pressure system of Mr. Jones, of the Edgar Thomson Works. The manufacture of compound armour plates is also briefly described.

The final paragraph in the book is reserved for a reference to the details of the manufacture of steel castings. It is a subject on which the readers of a book by Mr. Greenwood might reasonably hope to gain valuable information. Our author intimates, however, that all the particulars are secrets of too valuable a nature to be revealed.

On the whole the work is a valuable addition to literature of the class it represents. The numerous illustrations are well executed, and although several of them come to us in the familiar guise of old friends they all thoroughly illustrate the text. There is also a useful index attached.

Technologisches Wörterbuch, in Englischer und Deutscher Sprache. Von GUSTAV EGER. Revised by OTTO BRANDES. Friedrich Vieweg und Sohn, Braunschweig.

AT a time like the present, when industries and sciences are not only growing rapidly, but when new industries, based upon the rapid advance of science, are actually created, technological dictionaries soon get behind time, and a volume that ten years ago might have justly been called efficient, would be sadly wanting in a great many instances to-day. New industries create new words and necessitate new dictionaries, and however well any one may be up in two or more languages, he will at times find the necessity of referring to a dictionary, nothing is then more annoying than to discover, that on the particular subject in question, the dictionary does not contain any more than the searcher knows, or worse still, gives a term as an equivalent, which the searcher knows is wrong. No one will deny that to compile a technological dictionary is a task too great by far for one individual, and very difficult, however many brains may be employed in it, but it is only when this extremely difficult and tedious task has been satisfactorily solved, that a technological dictionary worthy of the name can be produced. When in 1853 the first technological dictionary in German, French, and English, compiled by Beil, was introduced into the learned world by Professor Karmarsch, the volume enjoyed a well deserved reception and kindly criticism, and as the first work of its kind it was undoubtedly excellent, but to-day one would in vain search its pages for many a word that is already so much common property that any good ordinary dictionary contains it. Later editions have, from time to time, brought this excellent work fairly up to date, and it still maintains its position as one of the best of technological dictionaries. A very recent and excellent offspring is the volume we have to-day before us for review. Thanks to a judicious subdivision of labour, the author of this dictionary has produced a really valuable book, which, though only embracing two languages, English-German and German-English, treats these two well and exhaustively, and, best of all, correctly. At present, we are only in possession of the first part, "English-German," which covers about 700 large octavo pages closely printed, still the selection of type is such that the utmost order and clearness prevail. The dictionary is very exhaustive, and, while specially treating all subjects connected with architecture, engineering, chemical and mechanical technology, mining, and physical science, it also devotes considerable space to such remote subjects as botany and zoology. We can confidently recommend the work to every one who has to work in English and German technical terms. Typography and paper are of the usual good quality of Messrs. Vieweg and Sons' publication.

BOOKS RECEIVED

A Treatise on Ore Deposits. By J. ARTHUR PHILLIPS, F.R.S. With Numerous Illustrations. London: Macmillan and Co.

A Treatise on Practical and Theoretical Mine Ventilation. By EUGENE B. WILSON. New York: J. Wiley and Sons. London: Trübner and Co.

The Modern High Explosives. By MANUEL EISSLER. New York: J. Wiley and Sons. London: Trübner and Co.

The Electrician's Pocket-Book. The English Edition of Hospitalier's "Formulaire Pratique de l'Electricien." Translated with Additions by GORDON WIGAN, M.A. London, Paris, and New York: Cassell and Co., Limited.

Text Book on Practical Solid or Descriptive Geometry. By DAVID ALLAN LOW. In Two Parts. Part II. London: Longmans, Green, and Co.

The Imaginary Meridional System of the Great Pyramid of Gizeh. By E. A. P. BARNARD, LL.D., S.T.D. New York: John Wiley and Sons. London: Trübner and Co.

Society of Engineers. Transactions for 1883. Edited by BARTHOLOMEW REECE, Assoc. Soc. Eng., Secretary. London and New York: Lyall & N. Spon.

The Materials of Engineering. In Three Parts. Part III. *Non-Ferrous Metals and Alloys.* By ROBERT H. THURSTON, A.M., C.E. New York: John Wiley and Sons. London: Trübner and Co.

The Principles of Ventilation and Heating and their Practical Application. By JOHN S. BILLINGS, M.D., LL.D. (Edinburgh), Surgeon U.S. Army. London: Trübner and Co.

THE MANCHESTER SHIP CANAL.

IN former issues of our journal we have published the plans and arguments of the promoters of the Manchester Canal Company, the recent action of the Select Committee on the Bill, in unanimously rejecting which has caused widespread surprise throughout the kingdom, the Bill having previously passed the Committee of the House of Lords. We propose to present to our readers a synopsis of the leading objections to the scheme which have been presented to this Committee.

PATENT CENTRIFUGAL PUMP
which the disc can be removed on a single face only.
CHARLES L. HETT
HYDRAULIC ENGINEER,
Maker of IMPROVED

The technical controversy over the Bill was one of the most remarkable which has ever occurred in Great Britain. Able Queen's counsel examined before the Committee some of the most widely known engineers of Great Britain and America both for and against the scheme, and it is currently believed that, at least, 300,000*l.* have been expended by the contestants.

Mr. E. Leader Williams, who designed the proposed canal, defended his project with great ability and was supported by Mr. Abernethy and Mr. Brunlees, both ex presidents of the Institution of Civil Engineers, and by Mr. Messent, engineer of the Tyne, Mr. Deas, engineer of the Clyde, Mr. Fowler, engineer of the Tees, and several others.

Among the engineers who appeared for the opposers were Sir Joseph W. Bazalgette, President of the Institution of Civil Engineers, and engineer to the Metropolitan Board of Works; Sir Frederick Bramwell, F.R.S., Vice-President of the Institution; Mr. Thomas Stevenson, engineer to the Northern Lighthouse Board, the Forth, &c.; Mr. George F. Lyster, engineer to the Mersey Docks and Harbour Board; Mr. Robert Manning, chief engineer of Public Works in Ireland; Mr. Harcourt, engineer to the Hull Albert Dock; Mr. Deacon, engineer to the Liverpool Water Works; Professor Sir William Thomson, F.R.S., and Captain Graham H. Hills, R.N., surveyor. The Mersey Docks and Harbour Board engaged the additional services of the American engineer, Mr. Eads, who was requested last winter to make an inquiry into, and report to the Board upon, the physical condition of the estuary, and especially upon the probable effects which the proposed works of the Canal Company would have upon the Mersey bar, and the access to their docks.

The question turned almost wholly upon the probable effects which would be produced in the Mersey if the works of the promoters were permitted to be constructed in it. These works were to consist

mainly of two parallel training walls from Astmoor Marsh to Garston, about ten miles long, to be located through the middle of the estuary, with an auxiliary line of similar works to Ellsmere Port. Neither line was intended to be built above the tops of the sandbanks through which they were to pass, that is, 12 ft. or 14 ft. below high water.

The result of Mr. Eads' studies of the subject brought to light some remarkable facts regarding the tidal flow and the deposits of the estuary, which were graphically placed before the Committee by diagrams which we reproduce. His argument, based on well-known and accepted laws relating to hydrodynamics, and especially to sediment bearing rivers, which he briefly explained to the Committee, was thoroughly logical, while his diagrams presented at a glance undisputed facts relating to the estuary which were not only novel but very suggestive.

Fig. 1 is a copy of the tidal diagram of the River Mersey furnished to Mr. Eads by Captain Hills, R.N., showing the various heights of a spring tide at the bar; at George's Pier in Liverpool; at Garston, Stanlow Point, Halehead, Runcorn, Fiddler's Ferry, and Warrington, the head of the tidal flow; Fig. 2 was constructed to show the movements of the tide, on the line of the proposed works. By this it is seen that the highest water occurs at Garston and at Halehead, distant six miles from each other, at the same moment of time, and that when high water occurs at these points, but little difference exists in the level of the water's surface between them. At high water the tide at Garston is about 32 ft. above extreme low water at that point, the range of the tide being greater there than at any other place in the estuary. After high water occurs at these two points, the surface of the estuary between them remains comparatively level for two hours and forty minutes, during which time the water falls at each one of these places about 13½ ft.

The aggregate superficial area of the shoals in Liverpool Bay exposed during low tide is estimated at thirty-five square miles. Over this enormous surface an equinoctial spring tide rolls in to the height of 30 ft., and, being highly charged with sand, rushes up through the narrow channel at Liverpool—about 2800 ft. wide and 70 ft. deep—over a sandstone bottom, with great velocity to the upper reaches of the estuary, with little or no loss of rapidity. The total superficial area of the estuary between Dingle and Runcorn is 27¾ square miles. During low water about twenty square miles of this area is covered with huge shoals of sand and earthy matter. The average width of the estuary between Garston and Halehead is about 2½ miles. These extensive sandbanks are from 20 ft. to 25 ft. above water when the tide is down, consequently when the high tide has covered them and the water is comparatively free from current, the sand with which the water has been charged falls all over the tops of these banks, as well as in the channels between them, and as little or no current is created for two hours and forty minutes after high tide, and not until the water has fallen 13½ ft., it follows that a large area of the tops of these banks are then high and dry above water, and out of reach of any current whatever. Diagram Fig. 2 was constructed by Mr. Eads to illustrate graphically the different slopes of surface which the water assumes after this two hours and forty minutes of quiet repose, and thus it gives an idea of its velocity. Supposing high water occurs at noon, then it will be seen from the diagram that while little or no slope has occurred during the first two hours and forty minutes, afterwards, the slope from Halehead to Garston in the next hour and twenty minutes, or at four o'clock, has increased by the fall of the water at Garston to 10½ in. per mile. At five o'clock this slope has increased to 17¼ in. At six o'clock it has increased to nearly 26 in. At seven o'clock it has the enormous slope of 29½ in. per mile, and at the end of the eighth hour, the tide then having begun to fall rapidly at Halehead, it is still 21½ in. per mile. From these facts it becomes apparent that for a period of five hours and twenty minutes, after the tide has fallen 13½ ft., a most vigorous current is maintained in the low-water channels of the estuary, but the sandbanks at this time are entirely dry and out of the reach of all current except where the bases of the banks form the sides of these channels. Here this rapid current is engaged during five hours and twenty minutes after every high water, in undermining and tumbling down these sandbanks which are being as constantly formed by the depositions of every high tide. The low-water channel is therefore continually shifting its location.

Mr. Eads called attention to the chart of Admiral Spratt, conservator of the Mersey, whose duty it is to keep this low-water channel buoyed for the benefit of the navigation of the estuary. This chart was published in 1880 (see plan, Fig. 3, page 193). It shows that from 1825 to 1880 every portion of the estuary above Garston has been occupied by the wanderings of this low-water channel, and that what are high sandbanks to-day, were deep low-water channels a few years ago. It is therefore plain that as the first currents of the ebb are too

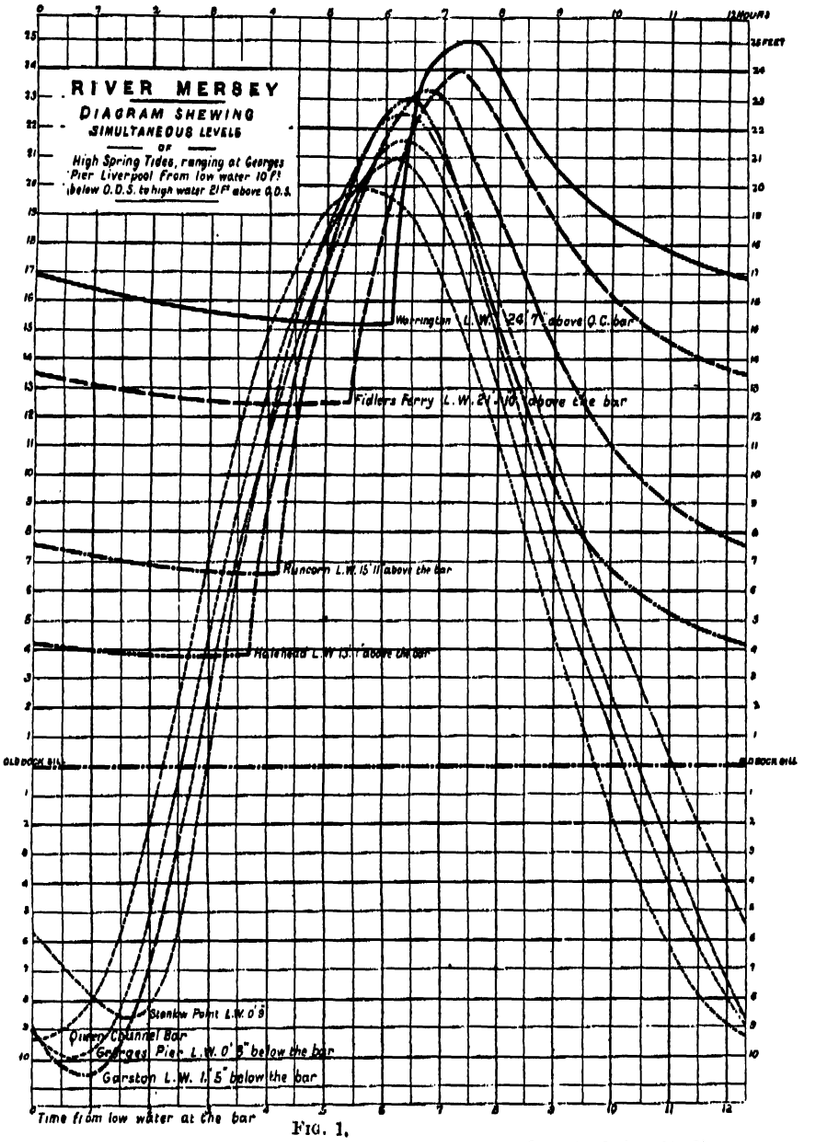


Fig. 1.

sluggish to reduce these banks, the only possible means of arresting their growth, and carrying back to the sea the semi-daily additions of sand deposited on them by every high tide, is through the energetic action of this low-water channel, which is continually undermining them, the process being perfectly analogous to what is known as "the caving banks" on the Mississippi River. Mr. Eads drew attention to the fact that the power of flowing water to transport sand in suspension, increases with the square of the velocity of the water. In the bend of a river where a current of four miles exists, it is not at all unusual for the current on the opposite side or point, to be only three miles per hour. The current in the bend would therefore carry sixteen units of sediment, while that on the point, flowing at three miles an hour, would carry but nine, or but little more than half as much; hence a rapid erosion would occur in the bends because there the water would take up more sand and thus steepen the shore and cause it to fall down, while on the point the feebler current would drop the surplus of its load and build up the shore. Where two bends approach each other by this caving-in process, they ultimately connect and form what is called a cut-off, and thus radical changes occur in the location of the channel. Fig. 4 shows a general plan of the entrance to the Mersey.

From two surveys of the estuary made by Captain Hills, R.N., in 1871 and 1881, Mr. Eads prepared two sets of charts to show the areas of sandbanks which would be exposed at different hours after high tide, both for 1871 and 1881. These charts, shown by Figs. 5 to 11 inclusive on pages 196 and 197, we reproduce in the order in which they were brought to the attention of the Committee. They present some very curious facts. Fig. 5 (1881) shows an area of 3200 acres (five square miles of sandbanks dry at two hours and forty minutes after high water; Fig. 6 shows, at four o'clock, 8150 acres

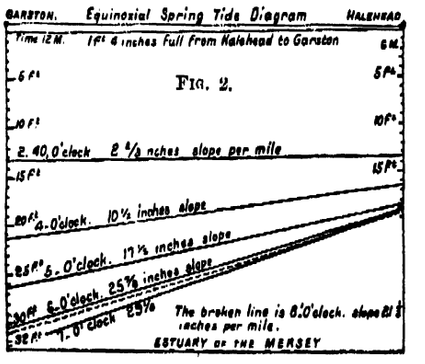


Fig. 2.

(12¾ square miles); Fig. 7 shows, at five o'clock, 11,000 acres (17¼ square miles); Fig. 8, extreme low water, shows 13,000 acres (20¼ square miles), leaving only about seven square miles of the area of the estuary between Dingle and Runcorn, covered with water. Chart Fig. 9 shows, that in 1871, at two hours and forty minutes after high tide, there were 3260 acres (5 1/10 square miles) of banks uncovered, or only one tenth of a mile more than at the same hour in

LOW-WATER NAVIGATION CHANNELS OF THE MERSEY ESTUARY.

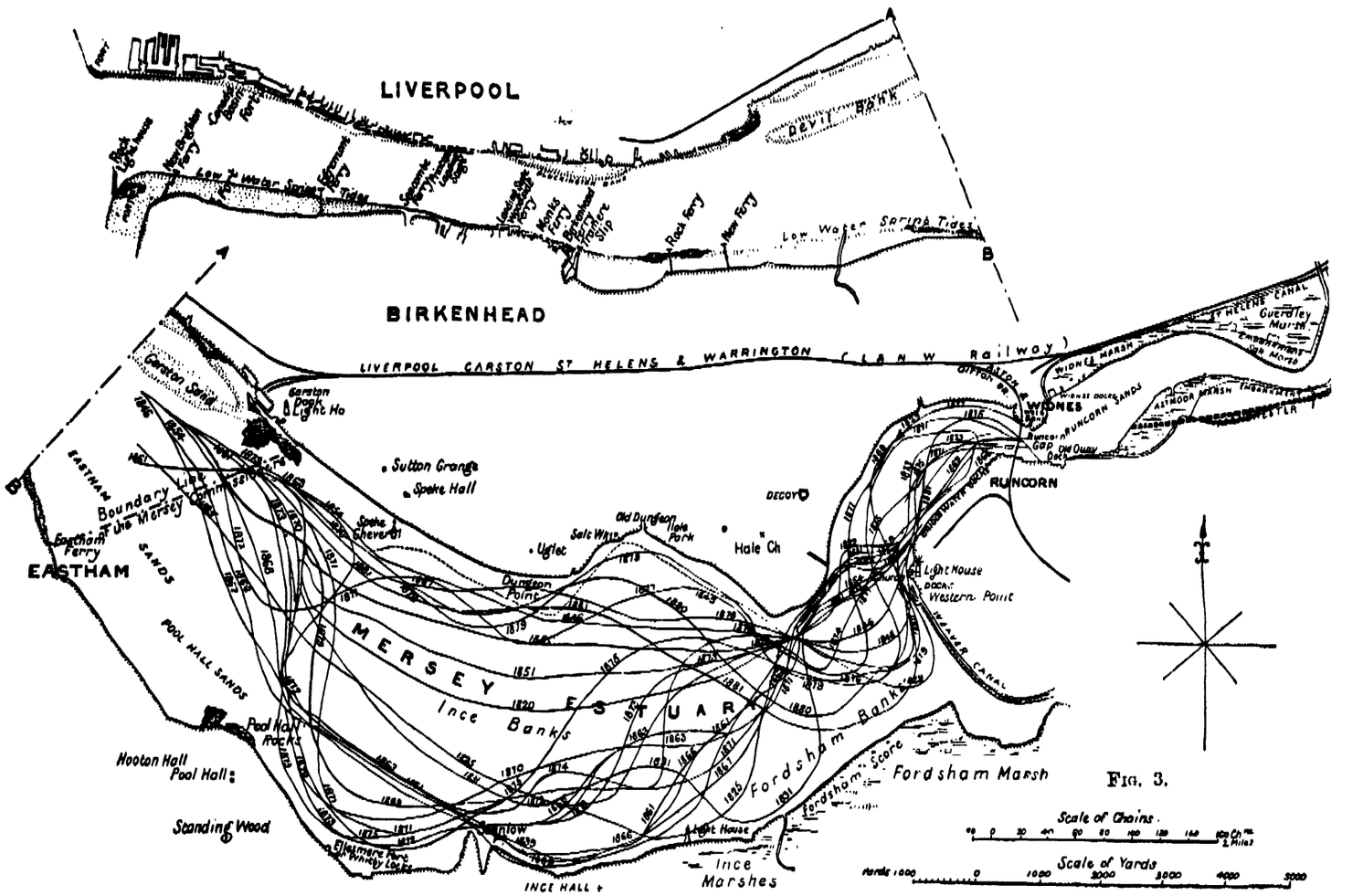


FIG. 3.

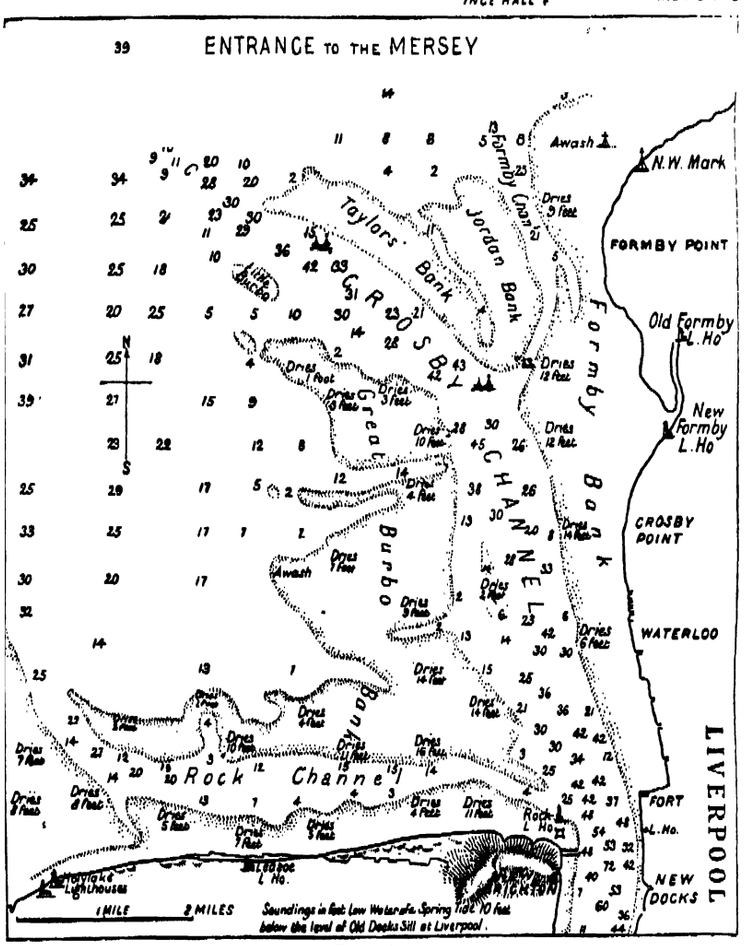


FIG. 4.

1881; Fig. 10 shows, at four hours after high tide, during the year 1871, 8470 acres (13¼ square miles) uncovered, as against 8150 acres (12¾ square miles) in 1881, and Fig. 11 shows that in 1871 at low water, there were 13,120 acres (20½ square miles) uncovered, as against 13,000 acres (20¼ square miles) in 1881. The areas, estimated from these two surveys, bear wonderful testimony to the fact that the depositing process of the high tide, and the excavating operations of the low-water currents, maintain a remarkable condition of equilibrium while preserving the tidal capacity of the estuary intact.

The low-water channels shown on the two sets of charts, however, furnish another important fact in supporting the argument of Mr. Eads, namely, that the channel in 1871 was near the Cheshire shore, whereas in 1881 it followed the opposite side of the estuary, showing a very extensive alteration made in its location during ten years. The charts of 1881 also indicate the location of the proposed estuary works. The solid lines show what portion of these works would be dry at different hours during the ebb tide. At two hours and forty minutes, a portion would be dry through the shoals then exposed, while at four o'clock they would completely intersect the low-water channel opposite Halehead, and at five o'clock they would be dry throughout their entire length. Of course the wandering of the low-water channel would be wholly stopped by the proposed works, as the chief discharges of the ebb would occur through the new passage.

The importance which attaches to the fact that the quantity of sediment which the water is capable of transporting, increases with the square of the velocity, is clearly seen in the argument of Mr. Eads, and it received very remarkable confirmation from the testimony of Dr. Burghardt, and Mr. Deacon, engineer to the Liverpool Water Works, who made a number of careful experiments to determine the quantity of sediment carried by the water at different stages of the tide. The experiments of Dr. Burghardt, which were in evidence before the Select Committee of the House of Lords, were especially conclusive. At one hour after high tide, he found that one gallon of water held only

3½ grains of sand in suspension; at 2.45 hours 19.95 grains; at four hours it held 34.65 grains, and at six o'clock 46.53 grains.

It had been claimed by the promoters that the sand composing these banks, was shifted by wave action, or what was called transposition, from side to side of the estuary, and was not caused by the fretting of the banks. This, Mr. Eads showed, was simply impossible, by explaining to the Committee the manner in which waves transport sand. This can only occur where the water is so shallow that the crest of the wave feels the resistance of the bottom. It is limited therefore by the height of the wave. The estuary is too small to make high waves possible, and this translatory wave action could not disturb sand, he believed, more than 10 ft. or 12 ft. deep in it, and at that depth it would be very slight. Besides, wave action is invariably directed towards the shore, from the fact that waves travel more rapidly in deep water than they do in shallow water, hence, if they are running parallel to the shore, the shore ends of the waves run more slowly, and the result is that the wave comes obliquely upon the shore, hence waves always carry sediment to the shore and not from it. Wave action, therefore, has a tendency to gradually diminish the tidal capacity of all estuaries by making deposits on their shores, but this is a very slow process and may be called a geological one. The proof which he adduced in support of the fact that during the two hours and forty minutes of freedom from strong current, which occurred immediately after high tide, the sediment was dropped upon the bottom of the estuary, consisted in an explanation of the manner in which solid matter is held in suspension by the water. If the finger be dipped in water and then applied to dry sand a certain amount of the sand will cohere to the finger. This is caused by the cohesion of the particles of the water to the surface of these grains of sand, and as the superfices of the grains only increase with the squares of their diameters, while their solidity or weight increases with the cubes of these diameters, the larger particles require more current and more cohesive force to hold them in suspension, therefore they are the first to fall with the slightest checking of the current. The law which controls the frictional resistance of the flow of water shows that this resistance does not increase with the weight or the depth of the water, but simply with an increase of surface of the bottom in contact with the water. Volume and slope of surface comprise the elements which produce the current. The slope of the bottom of the channel has nothing to do with creating it. There will be no current where there is no slope in the water's surface if the bed of the stream be ever so steep. The friction of the bed is the chief element which retards the current, hence friction acts like the brakes to a railway train going down hill. It regulates the velocity of the current. There being greater volume in the deep channels with the same slope of surface, there must necessarily be less proportinate resistance from friction, consequently the most rapid currents will be where the channel is deepest. During the subsidence of this 13½ ft. after high tide, there will be comparatively no current over the shoals above Garston, because of the want of slope of surface; the currents induced by the subsidence of this 13½ ft. of water will be in the deep channels and not over the tops of the shoals. Below Garston the currents during this subsidence are still stronger, because there there is a greater slope, as the tide has already fallen at Liverpool.

The low-water currents from Runcorn down to Garston during the ebb, have great rapidity. This velocity they lose to a very considerable extent below Garston, and hence they are unable to carry the chief part of their burden to any great distance below that point. Here it is dropped by the last part of the ebb. When the next ebb first commences at Garston and Halehead, the water has been relieved of its charge of sand by its comparative quiescence, and the rapid currents which are created below Garston by the subsidence of this 13½ ft. of water then take up the sand which was left there by the previous ebb. The water which first produces these currents below Garston leaves its load of sediment above there, and it is thus in condition to take up more whenever sufficient current is imparted to it, and this it gets in that part of the estuary which lies below Garston. The first of the ebb, therefore, transports the sand from below Garston to the sea, while the more energetic but smaller low-water currents, induced by the last four or five hours of the ebb, bring it from the upper part of the estuary down, where it remains until the commencement of the next ebb. It is not swept back by the incoming tide for the reason that this comes in over the shoals in Liverpool Bay with great rapidity and is fully charged with all the sand it can carry, therefore it sweeps on to the upper reaches of the estuary without being able to take up any additional load in its lower part.

It was the unanimous opinion of all the engineers who appeared in opposition to the scheme, that the proposed training walls would stop the fretting process or shiftings of the low-water channel, and that this process was absolutely necessary to prevent a reduction of the tidal capacity of the estuary, and that the depth on the bar of the Mersey depended wholly upon the magnitude of this basin. If it were reduced, the bar would become shoaler. The argument of Mr. Eads, fortified as it was by the diagrams we publish, seems absolutely unanswerable.

Mr. Eads, while before the Committee of the House of Lords, was asked the question, "What would you do, supposing you had to make Manchester a port?" He replied, "I should bring the canal down through the land to Garston, and have its terminus there." He added, "This is the impression that I have without any study whatever upon the subject." The question was repeated to him before the Committee of the House of Commons, and he replied that he had given the matter some study since the question was asked by the Committee of the Lords, and that he had seen a plan designed by Mr. G. F. Lyster, engineer to the Mersey Docks and Harbour Board, to bring the canal along down the Cheshire shore, which would avoid crossing the Mersey River. He believed that this could be done with decided benefit to many interests, and at quite as little cost as where the promoters had located it in the middle of the estuary. There the whole ten miles of it would be of no use to anybody but Manchester; whereas if the canal were brought round the Cheshire shore, it could be constructed with less money and with less uncertainty as to the cost of it. The dredging operations could be carried on without being affected by the tide. He had not sufficient data, nor had he made sufficient study of the subject, to say absolutely that he would follow the plan of Mr. Lyster without modification; but he could say, without any reservation whatever, that that plan was entirely practicable, and he believed that if it were adopted it would remove the objections which he understood the Mersey Docks and Harbour Board make to the present scheme.

CANADIAN PACIFIC RAILWAY.
No. XVIII.

Summit of the Rocky Mountains to Kamloops.

The Kicking Horse River, which owes its name to the Pass, is said to have been so named from an animal employed by Dr. Hector, who was the geologist on Captain Palliser's expedition to survey and mark out the international boundary; but it would, with far more propriety, be called the Bow River Pass, as that fine stream conducts the railway over 120 miles into the heart of the Rocky Mountains, and is only left within five miles of the summit, where it is still a rapid river 50 ft. wide and running at five or six miles an hour. At the Bend, where the railway leaves it to follow one of its tributaries, it sweeps away to the north, and up its still broad valley there is another practicable route for a road in connection with the Howse Pass completely through the mountains. The work of construction was delayed for a short time when the rails were laid to within five miles of the summit to determine which of these routes should be adopted, and when the Kicking Horse Valley was chosen the rail-laying was continued and completed to the summit before the last year's operations were concluded at the point now called Stephens. At five miles east of this the course of the railway leaves the main river and follows the lateral valley of the Bath Creek running nearly west, and four miles up this it takes its course up the valley of a still smaller creek called Summit Creek, which is followed to its parent lake in the well-defined passage at the dividing of the waters. In this picturesque mountain pass, 5300 ft. above the sea, and surrounded by the most sublime scenery, the great mountains lifting their snowy peaks on either side over a mile in height above one's head; and their huge flanks, "rock-ribbed and ancient as the sun," overlooking the narrow defile, it seems as if nature had purposely carried out this singular notch through the great backbone of America for the object to which it has been now applied. For the last 50 miles the scenery has gradually become more enchanting and stupendous; where first approached, the Rocky Mountains present an immense mineral precipice which seems to forbid any route through the almost perpendicular mountain range. As the river really discloses itself a charming variety of cliffs and mountains is exhibited, in which each separate peak seems to have an individuality distinct from all its fellows. One huge rocky mass called Castle Mountain looks down over the Bow River, which almost washes its feet as if it were the great castellated mansion of the genii of these everlasting hills. In another place the vertical sides approach each other, and remind one of a great donjon keep on each side of the pass, which one can fancy as the entrance to the mysterious heart of the majestic edifice of which they seem to be the fitting sentinels. Then a perfect cone is revealed piercing the sky, whilst perhaps a glacier hangs upon its flank in threatening danger to the regions below, and this is followed by scores of other shapes, all massive, all beautiful, all sublime, and reading an awful lesson to the beholder of the littleness of man, and of the power and majesty of Him who heaped together all these wonders, and piled up these glorious rocks to fulfil the purposes of his wise providence. Nor is it only in size and in rugged hugeness that this magnificent display of natural beauty excels anything to be seen on the other trans-continental routes, but all the smaller accessories of beauty, the rolling rapid rivers that almost meet, so near together are their sources, the forest verdure and the incomparable combinations of light and shade that constantly succeed each other, and make a passage through this remarkable valley like the display of a wonderful panorama, a vast kaleidoscope that unfolds fresh beauties at every step, and where the variety is as charming as the grandeur of the scenery is stupendous and overpowering. The Indians called these the Stony Mountains, and hence the tribe that principally inhabit them is still called the Stony Indians, or more generally Stonies.

The lovely landscapes on this Canadian Pacific should certainly weigh greatly in the choice of routes to the traveller, as the passage across this same range on the Union and Central Pacific although for several hundred miles an average of almost 3000 ft. higher than the isolated summit of the Canadian line, is the most dreary and inhospitable portion of the whole length. The summit itself is a flat level valley four miles across, along which there are three lakes, the first of which going west is the Summit Lake before mentioned as the source of Summit Creek; the middle one, Link Lake, appears to have neither exit nor entrance, no visible supply, and no outlet; whilst the third and largest is the source of the noisy, impetuous Kicking Horse River, which springs from its parent head, a wild strong stream 50 ft. wide, gaining in volume and speed as it rushes onward down the Kicking Horse Valley. Although the total length of this river is only 47 miles, it falls in this length over 2800 ft., till it finally merges its waters in the broad majestic Columbia, the great river of the west. The railway follows it for 45 miles, and along this valley the work is not only extremely heavy, but the gradients and curves are very much worse than anything yet encountered on the other portions of the route. The best gradient to be got is 116 ft. to the mile, or about 1 in 45, and this rate of descent is necessary for 17 miles in one stretch. The heaviest work is in the upper part of the valley, where for six miles it is very heavy, with three tunnels of an aggregate length of 1800 ft. and the river is crossed three times. The next ten miles are tolerably easy for work though the gradient is heavy, then in the lower part of the valley there will be two or three tunnels of at least 1400 ft., the river has to be crossed no less than eight times, and the same heavy gradient, with curves of 10 deg. or 573 ft. radius, have to be resorted to. The Columbia in this part of its course is running north-west, and as its valley is approached, the line turns in the same direction and runs along the river side for 30 miles before crossing it the first time, where the elevation of the road above the sea is 2392 ft. There are about six miles of heavy work

in the Columbia Valley along the canyon of the river, with 2200 ft. of tunnelling, and the bridge across the river will require a span of 350 ft. The line now turns west and south up the valley of the Beaver River, following this to the summit of the Selkirk range of mountains, which is reached in 96 miles from the summit of the Rockies, and about 1000 ft. lower or 4316 ft. above the sea; the same heavy gradient of 116 ft. to the mile being used for about 16 miles in this ascent, and again for nearly 20 miles in descending the western slope. The road follows from the summit the east fork of the Ille-Cilly-Waut for about 20 miles to its junction with the main river and then south-westerly for about 23 miles down the valley of the Columbia to the second crossing of that river which requires a bridge 800 ft. long. The elevation of this second bridge at grade will be 1436 ft. above the sea, and the distance about 139 miles from Stephens at the Rocky Mountain summit, whilst there is nearly 1000 ft. of a fall in the river between the two bridges. After this second crossing of the Columbia, the line rises about 400 ft. through the Eagle Pass on the Gold Range, and thence descends by tolerably easy gradients to Kamloops Lake, the total length between the summit of the Rocky Mountains to which the rails are now laid, and the end of the Government section at Kamloops, being 270 miles.

Intervening between the main range of the Rocky Mountains and the Pacific Ocean is a mountainous region of very disturbed rock formation. Whilst the main chain preserves a general parallelism to the coast line, the intermediate district is occupied in British Columbia by a confused mass of mountains without any regularity. The Sierra Nevada mountains of California, and the Cascade Range of Oregon, are not continued north of the international line with the same regularity, and have no affinity either geographically or topographically, with the Selkirk, Columbia, Cariboo, or other ranges of the British province. The country, and especially the more northern portion has been represented as resembling a "molten sea lashed with huge billows, which at the height of the storm had suddenly been petrified." These subordinate mountain ranges south of the 49th parallel, have proved to contain the most valuable metalliferous deposits in the United States, and in the prolongation of this same mountainous district into British America, there appear to be the same lithological characteristics, and the same general mineralogical features. British Columbia contains this valuable belt of metalliferous rocks for 800 miles in a north-west and south-east direction, but so far the province has laboured under many disadvantages, principal amongst which is its extreme isolation, and the inaccessibility of the known mining regions. In addition, much of the country is heavily wooded, and the surface is much encumbered with glacial deposits, which whilst they tend to produce a more fertile soil, conceal the indications upon which the explorer trusts for his knowledge of the underground minerals.

The course of the Columbia River and its principal affluent in British Columbia was somewhat puzzling to the early discoverers. The Kootenay River, rising in latitude 51 deg., runs for 100 miles in a south-east direction closely parallel to the Rocky Mountains, and receiving from a hundred rills and streams, the drainage from their melting snows. In a parallel trough to the westward, very much longer and more important, but only about 15 miles distant, commences in a long lake-like expanse, the great Columbia River, a big deep river a mile wide to commence with, and with a broad majestic sweep, scarcely betraying a current for 50 miles, runs north-west amongst its wild rocky surroundings. As the Kootenay in its southerly course comes abreast of the head of the great river, it breaks through the intervening barrier into the same trough as the larger stream, and only two miles from its head continues its southern course, the two rivers in the same natural valley never connecting, the one running north-west, the other south. The total length of this valley from the boundary where the Kootenay crosses it, to the extreme north point of the Columbia, is 294 miles long and 8 to 10 miles wide. The mother lakes of the Columbia and the connecting rivers, for 25 miles below the first railway crossing, 110 miles altogether, are navigable for any description of steamboat, the elevation being about 2850 ft. above the sea. This is one of the prettiest and most favoured valleys in the province, having good grass and soil, a fine climate, established gold mines, excellent water communication, and an easy surface for road making. The celebrated bunch grass is a feature throughout the district, and it often happens that cattle need not be fed the entire winter, although it it is not well to neglect making some provision for exceptionally cold weather. The Indians, who are now the principal cattle owners, never make any preparations for these contingencies, and leave their flocks and herds exposed all the winter.

Running north for over 100 miles and receiving a hundred tributaries from the Rocky Mountains to the right and the Selkirk Mountains on the left, the Columbia, after passing and receiving the Kicking Horse River on the right, then the Blaeberry, the stream from the Howse Pass River, and then the Beaver from the Selkirks on the left hand, ceases to be navigable from its rapids and canyons. It then abruptly turns a semicircle round the last and one of the highest peaks of the Selkirks, and commences its southern course, running for the next 200 miles in a channel from 1½ to 3 miles wide, parallel to its former course with the Selkirk Mountains to its left, and the Gold Range to the right, its total length in the province being 440 miles, of which the last 229 miles from the Death Rapids to the boundary is again navigable, and the greater part of the way by steamers of any size. This includes from the boundary to the Kootenay 31 miles, thence to the north end of Arrow Lake, 75 miles, thence to south end of Upper Arrow Lake, 17 miles, through that lake 40 miles, thence to the outlet of Eagle Pass, and the second railway crossing 29 miles, and forward 39 miles to the Death Rapids. It is said not to be impossible to take a steamer through the Death Rapids, that the Kootenay Rapids just above the junction of that river might be troublesome to navigate, and that at certain stages the Little Dalles, two miles above the railway crossing, would not be navigable. The Kootenay River, after coming into the main trough of the Columbia, runs south through an excellent valley across the boundary into the district of the United States, and continues in the same direction to the 48th parallel of latitude. Then turning round in an opposite direction to the Columbia, it runs north, crosses the international boundary a second time, and running a fine wide stream between the Purcell and the Selkirk range of mountains falls into Kootenay Lake, 65 miles long and from two to five miles wide. In the valley of the river and lower part of the lake are some of the finest lands in the province; for 50 miles from the lake it is a rich farming loam of unsurpassed fertility, strongly impregnated with lime, but it labours under the disadvantage of being flooded the whole spring and part of the summer, sadly abridging the period for its advantageous cultivation. The principal cause of this is in the outlet of the lake, which breaks through the Selkirk range in quite a narrow rocky defile, together with the immense drainage from the Rocky Mountains continued far into the summer, and the remedy proposed is two-fold, the enlargement of the outlet from the lake so as to keep its waters permanently lower, and the diversion of the Upper Kootenay from its present channel into the Columbia through the two-mile barrier that now separates them, thus making the Columbia 100 miles longer and the Kootenay the same distance shorter, and by this means sending all the Rocky Mountain drainage above this point into the larger river at once. The whole of this is a grand mining district, the affluents of both the Columbia and the Kootenay being a well-known gold mining district, whilst on the Kootenay Lake, about midway of its length, are some very extensive veins of galena that the opening of the railway will make accessible and profitable. The whole of this Kootenay district has a great future before it. The country round the mother lakes of the Columbia, and much of the Kootenay River Valley, is of great prospective importance. Divided into forest and prairie in proportions favourable to settlement, with undoubted mining resources, valuable forests, delightful climate, and admirably adapted for cattle raising, it only needs communication and settlement to make it equal to any country under the sun. The peculiar agricultural value of this district, and of most of the land east of the Frazer and in the southern parts of the province, is what is known as the "bunch" grass, which grows everywhere through the district not exceeding an elevation of 3000 ft. above the sea. This grass, which probably is the most valuable pasture grass in the world, has the peculiarity that it never ceases to grow, and though the exterior may appear dry and withered, the heart is green even in the depth of winter. In many places it has suffered from over-grazing. When closely eaten off, and not allowed to seed, the grass of course does not grow again, and then it is succeeded by the sage grass, which takes its place. This is a more stimulating food for the cattle, less nutritive than the bunch grass, but which the cattle will eat during the winter. There is a good sward higher up the hills than the limit of the bunch grass, so that practically the region is a good grazing country as high as 3500 ft. above the sea. The climate of this Kootenay district is very much more equable and milder than in any corresponding position east of the mountains, and as a general rule the winter temperature on the Pacific coast as compared with the same parallel on the Atlantic is equal to at least ten degrees of latitude in favour of the former. For example, Quebec, which is in the same latitude as the mouth of the Columbia, has a very severe winter, whilst in the latter locality it is as mild as the south of England, and not unlike Baltimore, which is ten degrees south of Quebec. The interior of British Columbia, where not too high and remote from the coast, has none of the severity that marks similar districts in the same latitude in the east, whilst the coast climate is moist and mild, not unlike England but without its bitter east winds. Of course in a large and mountainous country like this there is in one part or other, every variety of climate, but on the district traversed by the Canadian Pacific in the Kootenay portion from the Rocky Mountains to the Shuswap Lake, the climate is very much like the mountainous portion of France, whilst east of this to the Pacific it compares favourably with the south of England.

After leaving the Gold Mountains, the third and lowest of the three mountain ranges that are crossed, the line falls to the Shuswap Lake, an irregularly shaped sheet of water, the head of the South Thompson River, one portion of whose twin expansions is crossed at the Schickmouse Narrows. It then follows the South Thompson River to Kamloops Lake, at the lower end of which, at a point known as Savona's Ferry, the portion of the railway to be constructed by the company ends, and the Government line to the Pacific, one of the bonuses given for the construction of the work, commences. The three mountain ranges may be roughly taken as having an altitude above the sea of from 8000 ft. to 12,000 ft. for the Rockies, 7000 ft. to 9000 ft. for the Selkirks, and from 3000 ft. to 6000 ft. for the Gold Chain. What is known as the Kootenay district is the triangle bounded on the south by the 49th parallel, or the international boundary, east by the Rocky Mountains, and west by the Gold Range, or about the 119th degree of west longitude The Thompson Valley, or Yale district, begins to the west of this at the summit of the Gold Range, being a much lower and flatter district, and forms a distinct topographical area from 800 ft. to 1200 ft. above the level of the sea, and enjoying a climate different from either the Kootenay country or the coast. Whilst the latter is saturated with moisture, the local precipitation of rain and melted snow in the low-lying portions of the Yale district is extremely small—for instance at Spence's Bridge, on the Thompson River, 760 ft. above the sea, in latitude 50 deg. 25 min. north, and west longitude 121 deg. 48 min., the rainfall in 1875 was only 7.99 in., or including melted snow, 11.84 in., whilst at Esquimalt, on the southern part of Vancouver Island, it was 35.87 in. This small precipitation gives rise to the open or lightly timbered grass-land, so favourable for stock-raising. This portion of the country is essentially an arable district, for although cattle cannot safely winter out as they do on the ranches near the Rocky Mountains, yet the winters are neither long nor very severe, cold and rain do not co-exist, the snow is seldom very deep, contagious diseases are unknown, and there are here no class of cattle or horse thieves. Ample evidence exists as to the fertility of the soil for agriculture, but most of this farming work is subsidiary to cattle raising. Wheat yields an average of 25 bushels to the acre, and instances of particular and not average crops are well authenticated of 45 to 60 bushels of wheat, 60 to 80 bushels of oats, and 35 tons of turnips to the acre on well-cultivated farms. Still cattle will be the main export for the future, as it is at present. On this continent the tendency of wheat is to be cheaper, of cattle to become dearer. Not long since, in view of the immense herds of the western

MANCHESTER SHIP CANAL: CHARTS OF SHOALS IN THE MERSEY ESTUARY, 1881.

(*For Description, see Page* 192.)

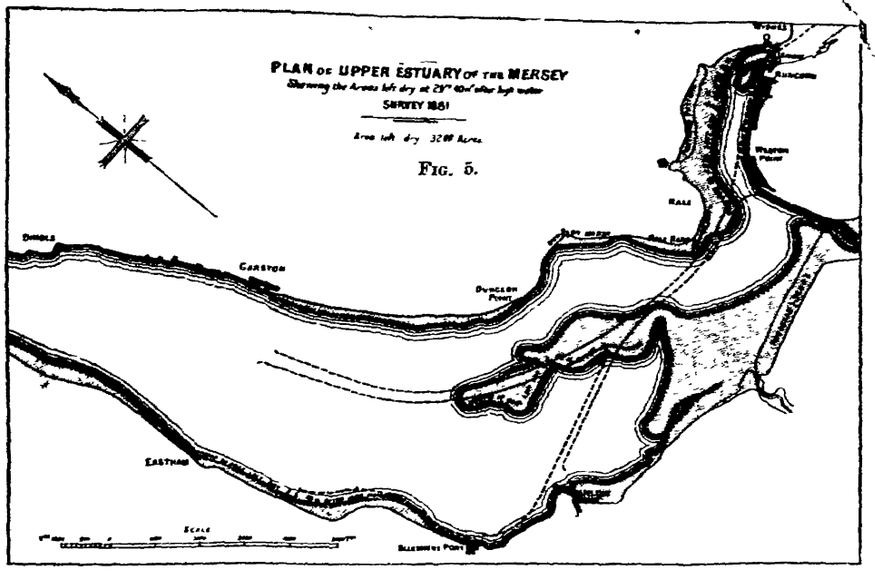


FIG. 5.

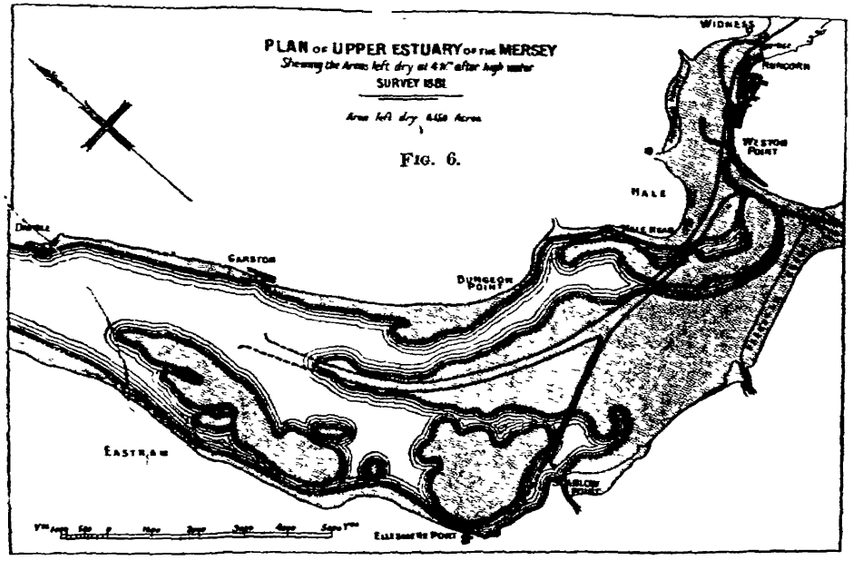


FIG. 6.

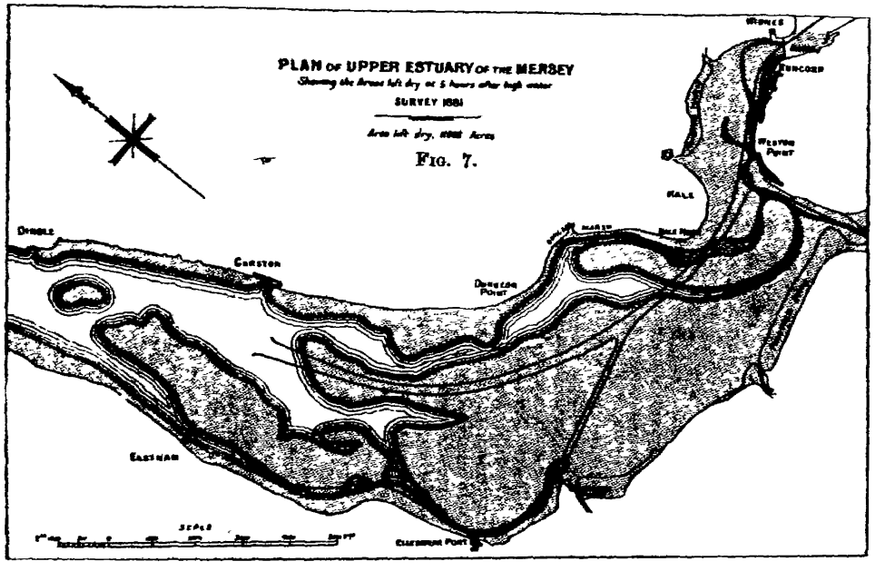


FIG. 7.

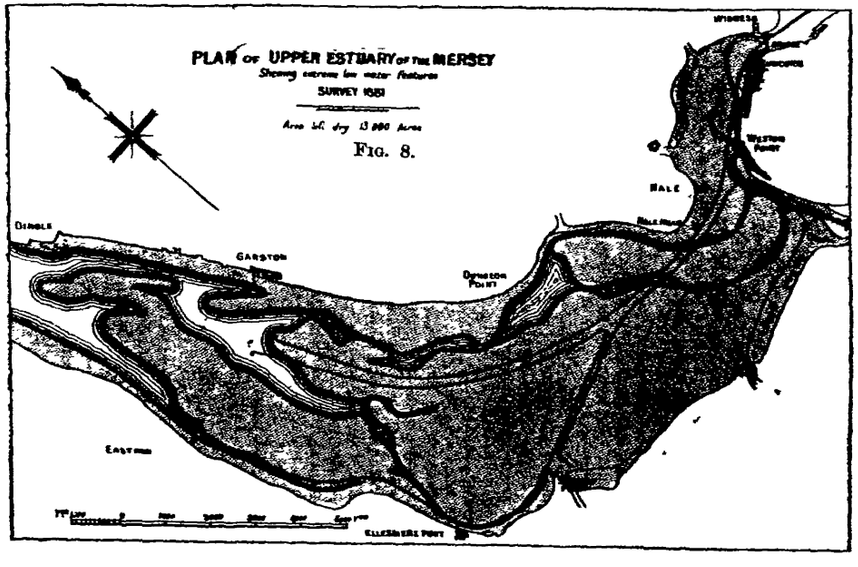


FIG. 8.

MANCHESTER SHIP CANAL: CHARTS OF SHOALS IN THE MERSEY ESTUARY, 1871.

(*For Description, see Page* 192.)

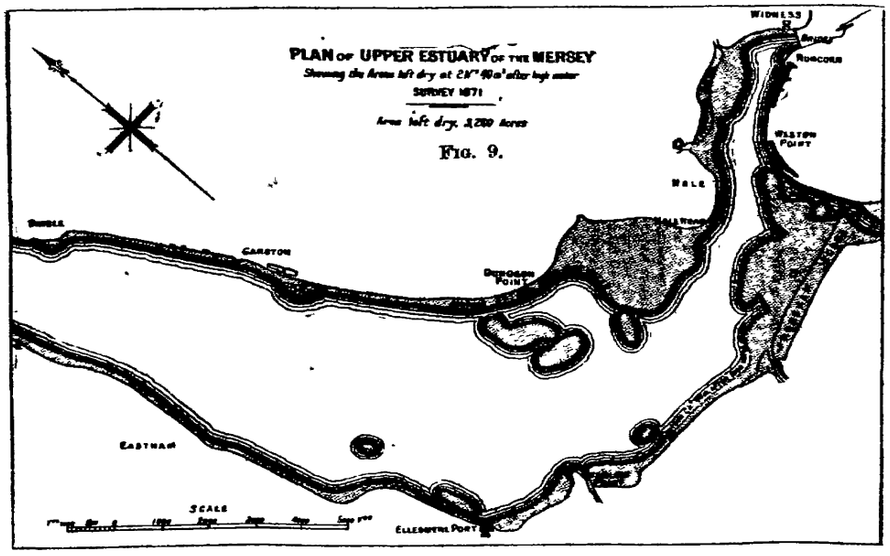


FIG. 9.

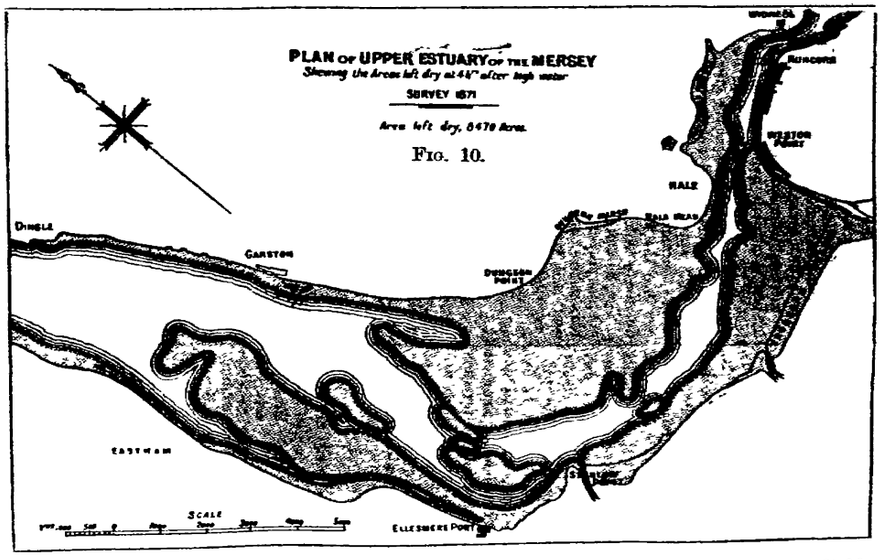


FIG. 10.

plains, it was thought that cattle would be valued soon for their hides and tallow alone, as in South America. The increase in population, the requirements of the great cities, and the beef exports to Europe, already 3000 tons per week, is reversing this notion; the lapse of a few years has shown that the western plains cannot insure cheap beef for ever. These cattle ranges are not illimitable, and the day when an indefinite increase in the size and number of the Texas and Mexican herds could be counted upon, is already passed. To the present time British Columbia has been unable to work into this trade at all, from the barrier of distance which this railway will tend to remove Even at Kamloops, which is so much more accessible than the higher Kootenay country above it, although admirably adapted for sheep it has been found that even the wool is scarcely remunerative at present to the farmer when he has paid the carriage to the seaboard.

The agricultural capabilities of British Columbia vary so much that what is true of one section is utterly deceptive in another. On the west coast of Vancouver Island there is an amount of humidity, of rainfall, and cloudy weather that makes the profitable cultivation of cereals doubtful The region again, sheltered from this excessive precipitation, including Esquimalt, the Frazer estuary and the flat lands on the east of Vancouver and the mainland, has such a fertility that were the returns not abundantly vouched, they would appear to be exaggerated and unreliable. Wheat grows here from 40 to 45 bushels to the acre; oats, 60 bushels, potatoes, 20 tons; and turnips, 25 tons. Hops, for which the climate is admirably suited, turn out from 1200 lb.

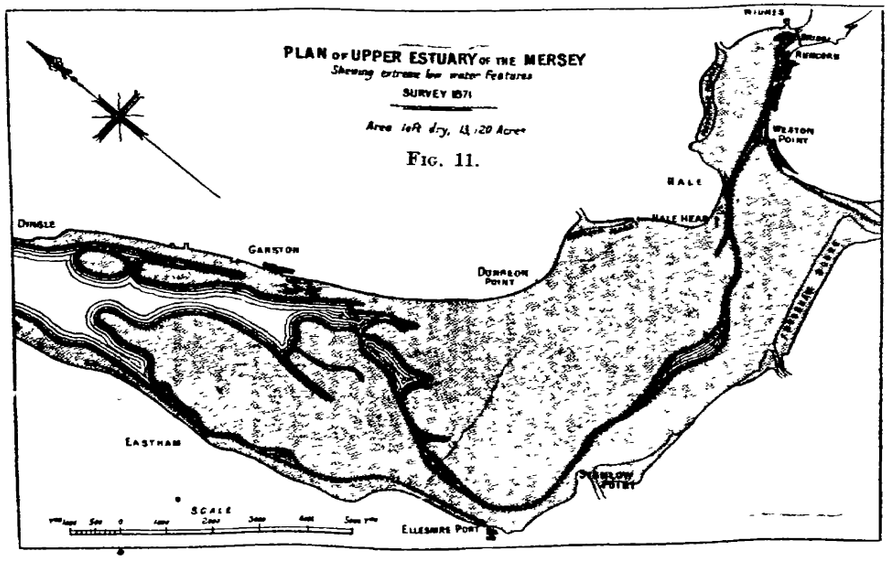


FIG. 11.

to 2000 lb per acre, probably the most profitable crop that is grown. All fruits thrive admirably, and some of them attain a size and excellence seldom found elsewhere. The drawback is that most of this land is covered with a gigantic forest growth, whic at present rates of labour is perfectly appalling to the new settler, notwithstanding the high price of farm produce. As the coast is left and the more elevated country is reached, indications of a dryer climate soon appear; the crops are less remarkable, the trees are less in size, and more open spaces appear between them In the Yale district agriculture and stock raising will both be followed, the former prevailing in the western, the latter in the eastern section, and in the Kootenay country cattle will certainly be the main dependence of the farmer. The 3000 ft. contour line above the sea may be taken as roughly indicating the upward limit of agriculture in the exterior. There are, no doubt, good farms above this elevation, and of course surrounding circumstances modify different localities, but this seems to be about the limit above which cereals cannot profitably be cultivated.

British Columbia is rich in forest wealth, and every part is well provided with excellent timber for construction and all other purposes. The coast region has at present the pre-eminence owing to the facility for export and the gigantic size of the timber, due, according to Dr. Dawson, to the mildness and humidity of the climate In this respect British Columbia, including Vancouver and Queen Charlotte's Islands, is the Arcadia of the Pacific More than half its area is covered by one of the finest forests in the world The enormous dimensions of the trees, and the richness of the foliage

must, like the groves of Calaveros and Mariposa in California, be seen to be believed. The monarch of the forest is the Douglas fir. Towering majestically in the air to an altitude of 300 ft., this valuable timber tree is the principal source from which is derived the material for building purposes, and it is also largely exported as Oregon pine. It attains its best proportions in the neighbourhood of Victoria and along the west coast of Vancouver, but it grows over the whole province from the Rocky Mountains to the Pacific. It is generally quite straight, and and though coarse-grained is exceeding tough, rigid, and strong, bearing an immense transverse strain. Few woods equal it for railway work, for frames, buildings, bridgework, and ties It is especially suitable for shipbuilding, whilst its length, straightness, and strength fit it admirably for masts and spars. Masts specially ordered are shipped 132 ft. long and 42 in. across, hewn octagonally. Along the coast it generally runs 8 ft. in diameter at a considerable distance above the ground, and reaches 200 ft or 250 ft in average height, forming prodigious dark forests. In the grounds of the Parliament Buildings at Ottawa, a section of one of these trees is 8 ft. 4 in. in diameter cut at 20 ft. above the ground The tree from which this was taken was 305 ft. in height Another valuable tree is the western cedar It grows largely along the course of the railway, especially in the neighbourhood of the Shuswap Lake. The wood is a pale yellowish or reddish colour and very durable, splits easily and is largely used for shingles and rails It abounds all along the Columbia and on the Selkirk and Gold ranges, is unknown in the dry interior plateau, but reappears along the coast and lower parts of the river valleys, where it attains an altitude of 200 ft, and a diameter of 15 ft., but the very large trees are generally hollow The white cedar is another giant of the Frazer Valley and the coast region, and was formerly largely used by the Indians in the construction of those great canoes which are the wonder of the eastern people, and which, under their management, go a long way towards explaining the early peopling of this country, and the wonderful intercommunication which from the earliest ages has existed between the Asiatic and American coasts. It is by no means necessary to suppose that the early immigrants into America had to make a long northern detour by Behring's Straits to pass from one continent to the other, twenty or thirty of them in one of these safe and handsome crafts formed out of a single cedar will make a sea voyage of considerable duration, and steer by the sun and stars when far out of sight of land. The western hemlock is another large and valuable tree found along the mountain ranges, and in the river valleys grows to 200 ft in height, yielding good timber, and its bark is used for tanning purposes as in the east. Along the shores of Kamloops and other interior waters is found the juniper or "pencil cedar," an aromatic wood, which grows about a foot in diameter, and is valuable for interior housework.

There is very little doubt that lumbering on a large scale is one of the destined future resources of British Columbia, and that the railway will find ample employment in carrying down to the coast the timber of the interior at present locked up for want of communication Some large mills have already been established on Burrard Inlet at New Westminster and other points. Four of these especially, two at each of the localities named, are already doing a very large business. The Moodyville Mill Company is now running six or eight logging camps, gives employment to 300 men, and cuts 100,000 superficial feet per day. Their sawmill is lit by the electric light, and driven by a 300 horse-power engine in addition to a turbine the company having one of the finest water powers in the country. During last season the company loaded twenty-six vessels of an aggregate tonnage of 22,522 tons, sending off 12,438,818 ft. of rough, and 2,089,039 ft. of dressed timber besides selling 1,181,293 superficial feet locally Of the quantity exported, twelve cargoes of 11,660 tons, or one-half, went to Australia, seven cargoes to South America, two to China, one to Japan, two small vessels went to the Fiji Islands, and two to England. The Hastings Mill on the same bay is a similar concern, on much the same scale, and with the same facilities for obtaining their logs and shipping their lumber. The capacity of the mill is 70,000 superficial feet per day, is supplied with logs from five camps, and employs 250 men During the year they loaded twenty-three vessels of 18,481 tons, the product being 12,228,998 ft. of rough and 1,706,420 ft. of dressed timber, of which ten cargoes, or nearly half, went to Australia, five to South America, three to China, three to South Africa, and two to San Francisco This mill shipped one stick 28 in. square and 120 ft. long without a knot or a shake in it. In one of their camps on Burrard Inlet a Douglas fir was cut 131 ft long, 54 in. in diameter at the butt, and 39 in. at the top, without a knot in the whole of it, making 9500 superficial feet of timber, and another stick 113 ft. long was 40 in. in diameter at the top, squaring 28 in, without a blemish from end to end Both these mills are close to the terminus of the Pacific Railway on Burrard Inlet. Of the two mills at New Westminster, one of them devotes its attention almost entirely to the local demand for fish boxes and timber in connection with the different canneries now so numerous throughout the province. The machinery at all these mills is extremely good, most of it quite new, of unusual size and strength, for such machinery as is in common use in the east would scarcely be able to produce boards 36 ft. long and 54 in. wide, which is no unusual size, and which are handled with a pair of circular saws working one above the other in the same frame, and the log passing between them.

THE LATE MR. WALTER NEILSON.

Mr Walter Neilson, the highly respected head of the Summerlee Iron Company, whose works have long been a prominent feature of the industrial establishments of the district of Coatbridge, near Glasgow, and whose decease was briefly mentioned in these columns in our last issue, was most intimately identified with the progress of mechanical engineering and the iron manufacture in Scotland for upwards of half a century At his death he was in the seventy-eighth year of his age, and almost up to the last he continued to take a deep interest in the various businesses with which he was connected. As a mechanical engineer he ranked high, and as a man of business he was held in much regard. Living to such a great age he was a connecting link between the present very advanced condition of things, and that which prevailed in the first quarter of the century. He was bred to his profession at the Oakbank Foundry, the works of his father, John Neilson, and his uncle was James Beaumont Neilson, the inventor of the hot-blast

Before entering upon his apprenticeship, Walter Neilson pursued his studies in the University of Glasgow, and he ever afterwards on suitable occasions gave evidence that his mind was well cultivated He was not long in becoming a highly skilled mechanic, indeed, it is said that by the time he was twenty years of age he was fit to be trusted with managerial responsibility at the Oakbank Foundry. He certainly had a more varied experience than generally falls to the lot of young engineers at the present day. Almost every kind of engineering work then required, was done in the shops over which John Neilson was the ruling spirit; and more especially did it include pumping, hauling, and winding machinery for collieries, and blowing engines and hoisting machinery for iron works; it even undertook the construction of small iron steamers (for example, the Fairy Queen, in 1830), and the engines by which they were driven.

When the hot-blast invention became a decided success, the extension of the pig iron manufacture in Scotland rapidly developed. Between 1830 and 1840 many new blast furnaces were erected, and in the year 1836 the Summerlee Iron Works were started by the firm of Wilsons and Co, the partners in which were John Neilson, of Oakbank, his son Walter (the junior partner), and Messrs. George and John Wilson, who were also connected with the chemical industries of the Glasgow district. The works began with a couple of blast furnaces in the year mentioned, the blowing engine for the same being made at the Oakbank Foundry (as was also No. 2, some time subsequently). In course of time the works extended in such a way that there were eventually eight of the finest blast furnaces in Lanarkshire. We ought to mention that Mr Walter Neilson was early installed into the position of managing partner, in which capacity he worthily acquitted himself over many years.

About the year 1870, or perhaps somewhat sooner, the original firm of Wilsons and Co. passed out of existence, and it was succeeded by that of the Summerlee Iron Company, consisting of the deceased and a brother (Mr. Hugh Neilson), and two sons. Many improvements were at various times adopted at the works in question, notably those for collecting the combustible gases from the furnaces, and turning them to profitable account, in the way that is now common in most ironmaking districts, both at home and abroad. Mr. Neilson first adopted the system invented by Mr. Addenbrooke, of South Staffordshire, and three of the furnaces are still working on that system, but as the tops are still open the whole of the gas is not utilised. Four others are quite closed in above, and are worked on the bell-and-cone system, similar to that of Messrs. Wrightson and Head, of Stockton. One of the furnaces still remains unaltered, but there is an abundance of gas to heat the blast and get up all the steam that is required on the establishment. In every direction the Summerlee Iron Works bear evidence of the skill and managerial tact of Mr. Neilson. Latterly, in the hands of his son, Mr. George Neilson, they have given evidence that the owners are determined not to be behind in adopting the most approved measures for collecting the ammonia contained in blast furnace gases, and sending it out into the market as sulphate of ammonia, the production of which has now become quite a success

The Summerlee Iron Company have very extensive mining properties in Lanarkshire, Stirlingshire, Dumbartonshire, and Renfrewshire, in which they work coal and the coal-measure ironstones, blackband, clayband, &c Their turn-out of pig iron reaches on an average 85,000 tons a year, which necessarily involves the use of a very large amount of coal and iron ore. Part of the latter, however, is Spanish hematite, which is brought to the Clyde direct in a steamer owned by the company, and called the Summerlee. They also do a very large trade in coal in the open market, amounting probably to an average of 1000 tons per day.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

The Staveley Coal and Iron Company, Limited.—The following is the twenty-first annual report of the directors. The net profit from the various business operations of the company for the year ending June 30, 1884, amounts to 39,939*l.* 13s 10d., which added to the balance brought forward from last account shows a total available profit of 64,301*l.* 7s. 6d. An interim dividend was paid in February last of 30s. per share on the A and C shares, and 5s. per share on the B and D shares, which amounted in the aggregate to 19,550*l.* It is now proposed to pay a similar dividend on the 3rd of September, carrying forward a balance of 25,201*l.* 7s. 6d. to the next account. During the past financial year the most severe competition has existed in all the trading operations of the company. The directors are of opinion that considering the adverse times, the shareholders are to be congratulated upon the result of the year's working. The new sinking into the Sutton estate has now been completed. The shafts are 310 yards deep, and the whole of the plant, machinery, and sidings have been finished in a most substantial manner. This important work has been pushed forward with the utmost vigour and success, and nearly 300 tons of coal per day are now being drawn from this estate. The Sutton hard coal will be worked in substitution of the North Staveley coal. It was intimated in the report of 1876, that a serious mining difficulty had been met with at North Staveley, and the directors, after giving much consideration to the subject, determined to avail themselves of a clause in the lease to surrender the colliery, which they did in May last. The new colliery on the Sutton estate will in a short time be in a position to turn out a larger quantity of coal than was possible from the North Staveley pit, and of better quality. The whole of the ironstone used in the furnaces during the past year has been obtained at cost price, from mines of which the Staveley Company are part proprietors. The works, machinery, and plant have been maintained in good working order. Various improvements have been made to reduce the cost of production, and it is hoped the time is not far distant when some substantial increase in prices will take place. The directors who retire are Mr. Thomas Kidley and Mr. E. Beddow who are eligible for re-election.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday, the market was again dull and lifeless, and very little business was recorded No. 3 Cleveland pig changed hands at 36s. 3d. to 36s. 6d per ton, but for some brands for export 37s. was asked. Owing to the unsatisfactory state of the home trade the lower qualities of iron are even more depressed, and No. 4 forge f.o.b. can be had at 34s. per ton. There is no new feature in the manufactured iron trade, but some of the works report specifications as more numerous than they were before the holidays. Ship plates are quoted to 5*l.* and angles 4*l.* 15s. per ton less 2½ per cent. at works. The Eston Steel Rail Works, of Messrs. Bolckow, Vaughan, and Co., Middlesbrough, remain closed, but the other steel mills in the district are fairly off for work, not being confined to the production of rails alone. In consequence of the extreme depression in the rail trade the price of hematite pig continues very low, Nos. 1, 2, and 3 being offered at 44s. per ton f.o.b. west coast ports. The prospects in the shipbuilding department are as unsatisfactory as ever. Freights remain unremunerative, and steamers seeking freights find difficulty in chartering at rates which will cover cost of working, &c. Engineers and ironfounders are steadily employed, but prices are cut very low.

Blast Furnacemen and Restriction.—A few days ago the Cleveland blast furnacemen held a meeting at Middlesbrough and passed the following resolution: "That it is desirable that there should be a federation of all trade unions with a view to regulating the hours of labour and

if possible to prevent over production, which has caused so much poverty and distress in the past." The Cleveland ironmasters continue the policy of restriction. How far they will relish the idea of the men adopting the same policy remains to be seen.

The Salt Trade at Middlesbrough.—Messrs. Bell Brothers, of the Port Clarence Iron Works, Middlesbrough, continue to work salt successfully, and are about to commence the large alkali works which they have erected close to their salt pans. Messrs. Grigg and Co., of London, have leased land at Haverton Hill and are boring for salt only a short distance from Messrs. Bell Brothers. The Newcastle Chemical Company, who were unsuccessful some time ago, have recommenced boring operations. In both instances the boring is being conducted by Mr. Vyvyan, of Whitehaven.

Slag.—Some attention is being called in this district to the rapid accumulation of slag. Bricks, roads, flags, and embankments are made of this material. Millions of tons have been used in the construction of the Tees breakwater at the mouth of the river, and vessels have been purposely constructed to carry it away from the works to the sea, where it is deposited. But the heaps, which have grown into small mountains at many of the iron works, are still growing larger, and it is apprehended that action will be taken to prevent the ironmasters from creating further obstruction by making these high slag hills higher. The ironmasters greatly desire some method of getting rid of the slag at a small cost.

FOREIGN AND COLONIAL NOTES.

The Panama Canal.—We learn from Panama that immense quantities of rock are being employed in facing a breakwater in process of construction by the Panama Canal Company for the protection of the inner basin or port at Fox River. The rains, although heavy and particularly destructive of new earthwork, do not cause a suspension of canal work, although they interfere with it greatly.

Belgian Wheels in Roumania.—It is announced that the John Cockerill Company has just obtained a rather considerable order for wheels from the Roumanian State Railways. The wheels are to be delivered at Galatz.

German Coal Mining.—The extraction of the Sarrebruck basin in July amounted to 509,665 tons, as compared with 478,042 tons in July, 1883. The sales effected in July this year in the basin were 503,987 tons.

Bridging the Dnieper.—A large railway bridge over the Dnieper, forming a portion of the railway to Ekaterinoslav, has been opened. It is one of the largest bridges in Europe.

Locomotives on the Chicago and North-Western Railroad.—At the close of May, 1884, the Chicago and North-Western Railroad Company owned 639 locomotives, as compared with 578 at the close of May, 1883, 558 at the close of May, 1882, and 476 at the close of May, 1881.

An American Girder.—A great girder which is to sustain the roof of the new Real Estate Exchange in New York, is 45 ft. long, 5 ft. high, weighs 20 tons, cost 5250 dols., and is intended to stand a strain of 250 tons. It will carry the whole of the western wall of the Marquand Building, in Liberty-street.

Belgian Steel Rails.—In the first half of this year Belgium exported steel rails to the extent of 29,700 tons. The corresponding exports in the corresponding period of 1883 were 37,040 tons.

Canadian Railways.—Surveyors have commenced the preliminary surveys of a railway which will be known as the Port Royal and Detroit River line. The country which the line will traverse in Essex county is smooth and very little grading will be necessary. There will also be very few bridges needed, and there are no swamps to go through. The eastern terminus of the line is Buffalo, and it will follow close to the lake shore, passing through all the important places until it reaches Kingsville, when a bee line will be made across the country to Windsor. The preliminary surveys on the eastern portion of the line are all completed. The line will be managed by the Delaware and Lackawanna Railroad Company. Mr. J. Cadman, chief engineer of the Lake St. John Railway, has returned to Quebec with his party from an extensive survey, which he has just completed, embracing 25 miles of new location, extending from Rivière à Pierre to a point near Lake Edward. This section is now ready for grading.

Asturian Railway.—We learn that the Asturian Railway Company has just opened a section from Busdongo to Puerte de los Pierros. The section is 6¼ miles in length, and it completes the Asturian line. The works of the Asturian system are generally heavy, 57 tunnels occurring in the course of 23 miles, their aggregate length being 13½ miles. Upon the section just opened there are also 61 tunnels of an aggregate length of 15⅝ miles. Between some of the tunnels there are embankments of great height, and for the protection of these embankments it has been necessary to construct at some points heavy defensive works.

Iron Minerals in France.—It appears that in the first seven months of this year France imported iron minerals to the extent of 790,490 tons, as compared with 956,827 tons in the corresponding period of 1883, and 836,936 tons in the corresponding period of 1882. Of the iron minerals imported into France to July 31 this year, 116,407 tons came from Belgium, 230,927 tons from Germany, 281,967 tons from Spain, 38,599 tons from Italy, 106,711 tons from Algeria, and 11,883 tons from other countries.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The warrant market opened firm last Thursday, but towards the close there were some pressing sales which sent prices down, and Wednesday's advance of 1d per ton was lost. Transactions were reported during the forenoon at 41s. 6½d. and 41s. 7d cash, also at 41s. 8½d and 41s. 9d. one month, with sellers at the close asking 41s. 7½d. cash and 41s 9½d one month, and buyers offering ½d per ton lower. In the afternoon prices declined to 41s 5½d. cash and 41s. 8d one month, at which some business was done, and buyers were offering at the close 41s. 5½d. and 41s. 7½d. cash and one month, respectively. Friday's warrant market was inactive, and only a very small amount of business was done, the close of the forenoon market being ½d per ton under that of the previous day, and the same as that of the preceding Friday. There was no meeting of the "iron ring" in the afternoon, out of respect to the memory of the late Mr. Walter Neilson, whose funeral took place that day. The market was very dull on Monday, chiefly in consequence of a disappointing return in regard to the shipments of last week, and prices fell 1d per ton from last week's close. On forenoon 'Change the prices ranged from 41s. 5½d to 41s 4½d. cash, and from 41s. 7d to 41s. 6½d one month, the close being buyers at the lowest quotations, and sellers wanting ½d. more per ton. Business was again transacted at the lower rates in the afternoon. A little more firmness was displayed in yesterday's market, and the close showed a recovery of ½d. per ton, 41s 5d. cash, and 41s. 7d. one month, being the prices at which business was done in the afternoon. Lower prices were reached to-day, transactions being reported in the forenoon at 41s 5d. down to 41s 4d. cash, and at 41s 7d. down to 41s. 6d one month, and in the afternoon at 41s 3d and 41s. 5d, respectively, with sellers at the close asking ½d. per ton higher. With the exception that the prices of warrants have gone on declining more or less continuously, and that special brands have maintained their prices, which have in some cases been further advanced, the pig iron market has been almost featureless during the past week. It is said that Coltness iron is not procurable for prompt delivery, even at the advanced prices. The tone of the market is fairly steady, but it is not one of great confidence. Some ten days or a fortnight ago hopes were entertained in several quarters that the rise in prices was imminent, but they have entirely vanished. There is no change to report in the condition of the home trade, nor are the accounts from America in any way changed, although rather better reports are coming from the Continent. The number of blast furnaces now in operation is again up to 95, as compared with 94 last week, and 115 a year ago. One has been blown in at the Gartsherrie Iron Works, and one at the Eglinton Iron Company's Works, while one has been damped out at Clyde Iron Works. Last week's shipments of pig iron from all Scottish ports amounted to 9320 tons, as against 11,484 tons in the preceding week, and 17,009 tons in the corresponding week of last year. They included 1150 tons to the United States, 1110 tons to Canada, 560 tons to Australia, &c., 275 tons to France, 635 tons to Italy, 1237 tons to Germany, 100 tons to Russia, 435 tons to Belgium, and lesser quantities to other countries. Up till last Saturday the shipments for the year had fallen off to the extent of 50,485 tons, as compared with those of the corresponding period of 1883. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores yesterday afternoon stood at 585,940 tons, as against 586,447 tons of yesterday week, showing a decrease for the week of 507 tons.

The Scotch Miners.—For some time the Executive Board of the Fife and Clackmannan Miners' Association, and the Coalmasters' Association of the same two counties, have been carrying on negotiations with a view to the establishment of a sliding scale for settling wages, and hitherto they have only taken the form of correspondence. Up till the present the two parties have been unable to agree upon the basis as to the standard rate of wages, but there is a common agreement as to the rate at which wages should fall or rise; namely, 8d per ton as the selling price at Burntisland, declines or advances 1s per ton. Of course, the two parties want to fix upon a year or portion of a year when the wages were in favour of their respective interests, and the two proposals which have emanated from the opposite sides have not met with approval on both hands; and the coalmasters now submit another proposal, which is to revert to the basis agreed upon in the year 1880, when a similar movement was on foot. They now consent to meet in conference with representatives of the men for the purpose of discussing the details of the proposed compact. It is to be hoped that some permanent good will be the result. Considering that the market has improved for east coast coals, and that an advance of prices has been obtained, the men have sent in a request for an increase on their wages to the extent of 15*s.* per cent. The Lanarkshire miners have recently sent out circulars to the coalmasters and managers in several districts of the county requesting an advance of wages, and yesterday was the day fixed for receiving replies. In only two of the districts, however, have the coalmasters noticed the circulars, and in their answers they reply that the price of coal, which has not been so low for thirty years, does not warrant a rise of wages at the present time. The miners intend to persist in pressing their claims for an advance.

The Proposed Eyemouth Railway.—An important public meeting in connection with the Eyemouth railway scheme was held in the Town Hall on Saturday evening. Mr. Gibson, of Netherbyres, presided, and Colonel Milne Home, M.P., addressed the meeting at length, setting forth the great advantages which would accrue to Eyemouth by having the port put into direct communication with the North British Railway. The meeting was largely attended, and showed a hearty appreciation of the proposed undertaking. Mr. Meik, C.E., was present, and explained the nature of the scheme, and Mr. John Dickson, fish curer, and Mr. George Collin, Jun., fisherman, spoke strongly in favour of having the railway constructed without delay, so that the full benefits of the harbour extension now being made may be reaped. There now seems every likelihood of the scheme, for which the necessary deposit has been made with the Board of Trade, being carried out. In the course of his remarks Colonel Milne Home said that the quantity of white fish landed at Eyemouth this year was 47,067 cwt., and of herrings up to August 16 there had been 16,596 crans, the estimate for the remainder of the season being 10,000 crans, making altogether 26,596 crans. The value of the white fish was reckoned at 31,280*l.*, and that of the herrings at 30,000*l.* They were getting the harbour improved, and the next thing was to have railway accommodation. The nominal capital of the company provisionally formed to get the railway constructed was 30,000*l.*, and it was intended to go to Parliament in the next ordinary session to secure the necessary powers.

Visit of the Mining Institute of Scotland to the Forth Bridge.—On Thursday of last week the members of the Mining Institute of Scotland, held their summer meeting in Edinburgh, and visited the works of the Forth Bridge. Upwards of a hundred gentlemen were present from the west of Scotland and from the eastern counties. Nearly two hours were spent at the works, where all the operations in progress were fully explained to the visitors. On returning to Edinburgh they met at dinner in the Waterloo Hotel and held a business meeting. In the course of a discussion on the report of a committee on the Harrison coalmining machine, it was stated by Mr. Roxburgh, of the Allon Coal Company, that they were getting to be more and more satisfied with the machine, and that by its aid they were able to deliver their coal at from 4d to 6d per ton better than when it was got by manual labour.

The Whitworth Scholarships.—It is worth recording that out of the twenty-five Whitworth scholarships open this year to competition in connection with the Science and Art Department of the Committee of Council on Education, no fewer than six have been gained by Glasgow students. Their names are: Andrew C. Shaw, aged 23, engineer, Glasgow, 150*l.*; J. Kerr Reid, 25, mechanical draughtsman, Glasgow, 150*l.*; John Kemp, 21, engineer apprentice, Glasgow, 100*l.*; W. A. E. Crombie, 22, marine engineer, Glasgow, 100*l.*; John Sharp, 24, draughtsman, Glasgow, 100*l.*; John Dougan, 24, engineer, Glasgow, 100*l.* As many as four of these students attended the day and evening classes at the College of Science and Art. It is stated that since the Whitworth scholarships were first instituted in 1869, such a large measure of success has never before fallen to any college or educational institution in one year.

THE MESSAGERIES MARITIMES.—The St. Etienne Steel Works Company has received an order for the plates required for a steamer building for the Messageries Maritimes.

GERMAN COAL.—The extraction of coal in the Dortmund district in the second quarter of this year was 6,598,593 tons. The corresponding extraction in the corresponding quarter of 1883 was 6,620,139 tons.

A SCALING LADDER AND FIRE ESCAPE.—The experience of the past few years has shown that when a fire occurs among high buildings, separated only by narrow lanes, the brigade is quite unable to make rapid headway against it. The power of a jet to extinguish flames depends greatly upon the force with which it impinges upon them, and when it falls in a gentle stream its effect on a fierce fire is very greatly reduced. It is, therefore, desirable that the hose pipe should be carried above the level of the fire, and the jet directed downwards, so as to preserve as far as possible the pressure of the water, and to render this possible. Messrs. E. H. Bayley and Co., of 42, Newington Causeway, Southwark, have brought out a scaling ladder, constructed somewhat in the style of a fire escape, which will reach to the great height of 85 ft., and enable the firemen to take up a most commanding position. The ladder is mounted upon a pair of large wheels in the usual way, but with a wider base, and is made in three lifts, each 34 ft. long. When fully extended the second ladder overlaps the first 8 ft. 6 in., and the third overlaps the second an equal amount, the total height being thus 85 ft. The escape is telescopic, the second ladder sliding in guides in the side timbers of the first, and the third sliding in the second. It is raised by a winch fixed to the underside of the first ladder, and the whole length can be extended by two men in 45 seconds. Upon the barrel of the winch there are wound two steel ropes, one to each of the movable ladders, and both ladders rise at once, the upper mounting at twice the speed of the lower. They can be stopped at any part of the ascent, and be fixed by dropping in a pawl. All three ladders are trussed with wire rope, and thus are exceedingly rigid, deflecting very little from the straight line when at their greatest elevation. The new escape is not designed to supersede the old one, and although it may often be serviceable in saving life, its chief object is to enable the men to attack a fire in the upper part of a high building, and as the constant tendency in towns is to build higher and higher its field of usefulness will be very great. Already the makers have received orders from the Metropolitan Fire Brigade, the Admiralty, and the Municipality of Paris, and as the merits of the new ladder become known other large towns will probably follow suit.

ENGINES FOR THE IMPERIAL GERMAN DESPATCH VESSEL "BLITZ."

CONSTRUCTED BY THE MÄRKISCH SCHLESISCHE MASCHINENBAU UND HÜTTEN ACTIEN GESELLSCHAFT, BERLIN.

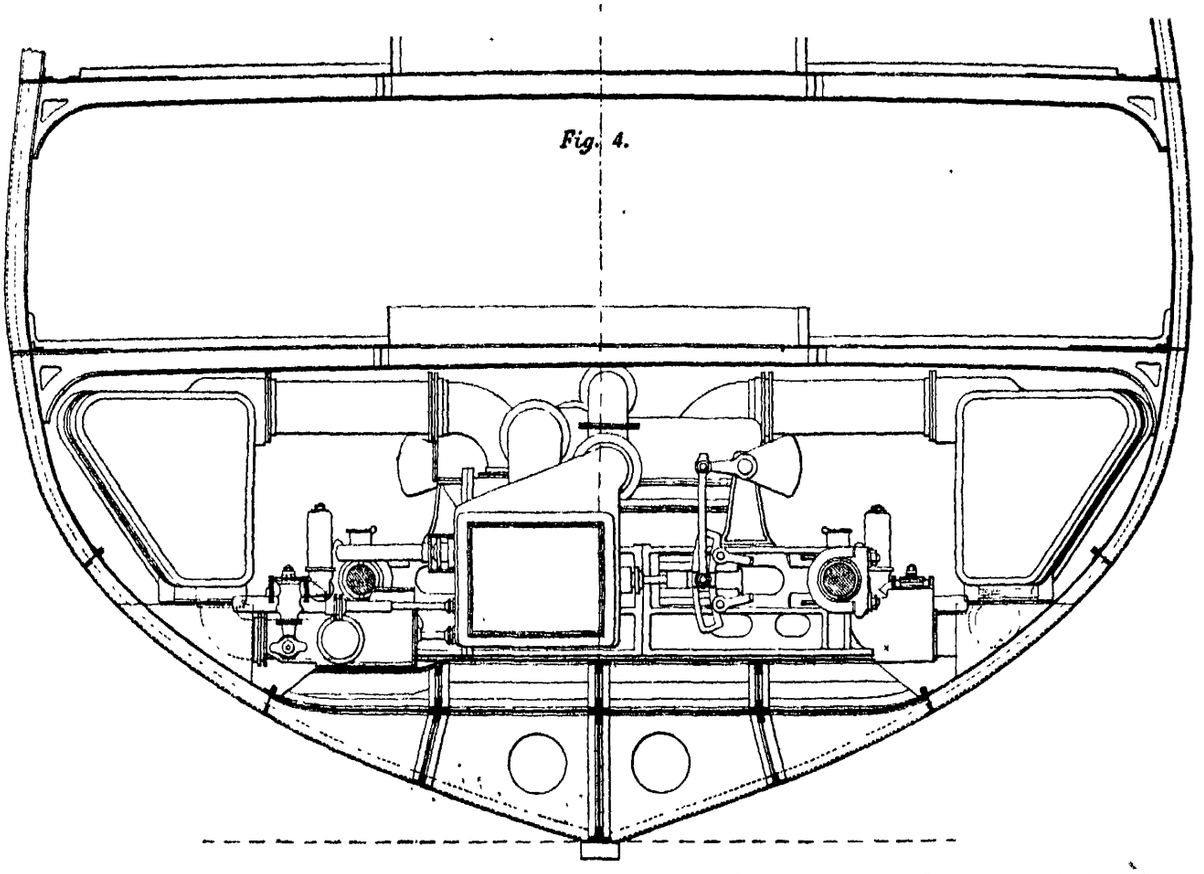
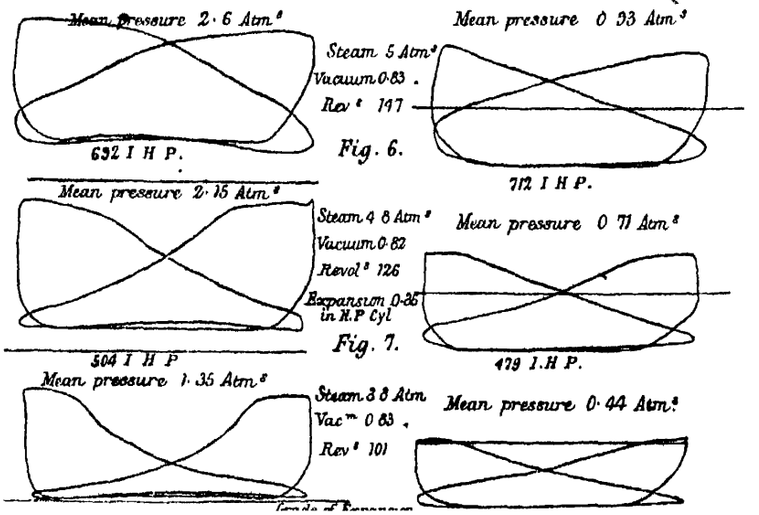


Fig. 4.



The Blitz is an unarmoured twin-screw despatch vessel of high speed, with special appliances for torpedo service. She is the first vessel built entirely of mild steel for the German Navy. The principal dimensions of the Blitz are: Length between perpendiculars, 74.7 metres (245 ft. 1 in.); beam 9.9 metres (32 ft. 6 in.), depth, measured from top of deck beams to top of keel, 6 03 metres (19 ft. 9⅞ in.); displacement, 1382 tons; mean draught, 4.05 metres (13 ft. 3½ in.); midship section, 30.2 square metres (323.2 square feet).

The armament consists of a 12.5 centimetre chase gun mounted on the forecastle, and four 8.7 centimetre guns giving broadside fire; in addition to which, an underwater tube for the discharge of torpedoes is provided.

The ship was designed by Herr Geheimrath Dietrich, Chief Constructor of the Imperial German Navy, Member of the Institution of Naval Architects (England), and built at the Norddeutsche Werft in Kiel, under the direction of Herr Otto Schlick, Mem. Inst. N.A. It may be remarked that the results of the trials show that the calculations as to speed were most carefully made, and the performance of the vessel in every respect reflects great credit on her designer.

The engines, which were designed by Herr C. Jüngermann, Mem. Inst. M.E., and Mr. P. L. Weatherhead, Mem. Inst. M.E., and Assoc. Mem. Inst. C.E., were built by the Markisch Schlesische Maschinenbau und Hütten Actien Gesellschaft (formerly F. A. Egells), Berlin, in which establishment the above mentioned gentlemen have worked in conjunction for many years, and where they have constructed during this period a great number of engines for the most important vessels of the Imperial German Navy.

The engines of the Blitz, of which we give a two-page engraving this week, together with other views on the present and opposite pages, are arranged in two groups, as shown in Figs 1 and 2. The starboard and port propellers are driven respectively by the after and forward engines; the intermediate shaft of the forward engine passing behind the cylinder covers of the after engine and over the top of its air-pump box. It will be observed that the high-pressure cylinder of the aft or starboard engine is placed at the after end of the engine room; this arrangement was rendered necessary through the extremely fine form of the ship aft. The engines were designed to develop a mean of 2700 indicated horse-power during a continuous six hours' trial, and are of the direct-acting compound receiver type, modified to suit the space placed at the disposal of their designers.

The framing is of simple and solid construction, and is clearly shown in Figs. 3, 4, and 5, on our two-page engraving. The cranks of the low-pressure cylinders are placed at an angle of 90 deg to those of the high-pressure. The main slides are worked with the usual link motion; the high pressure cylinders are provided with Meyer's expansion gear, and the alteration of cut-off in the low-pressure cylinders is attained by means of a gridiron expansion slide working on the top side of the low-pressure slide case. By using expansion valves on both cylinders, the work performed in them can, by all grades of expansion in the high-pressure cylinder, be equalised, and a very uniform motion of the engines attained at all powers.

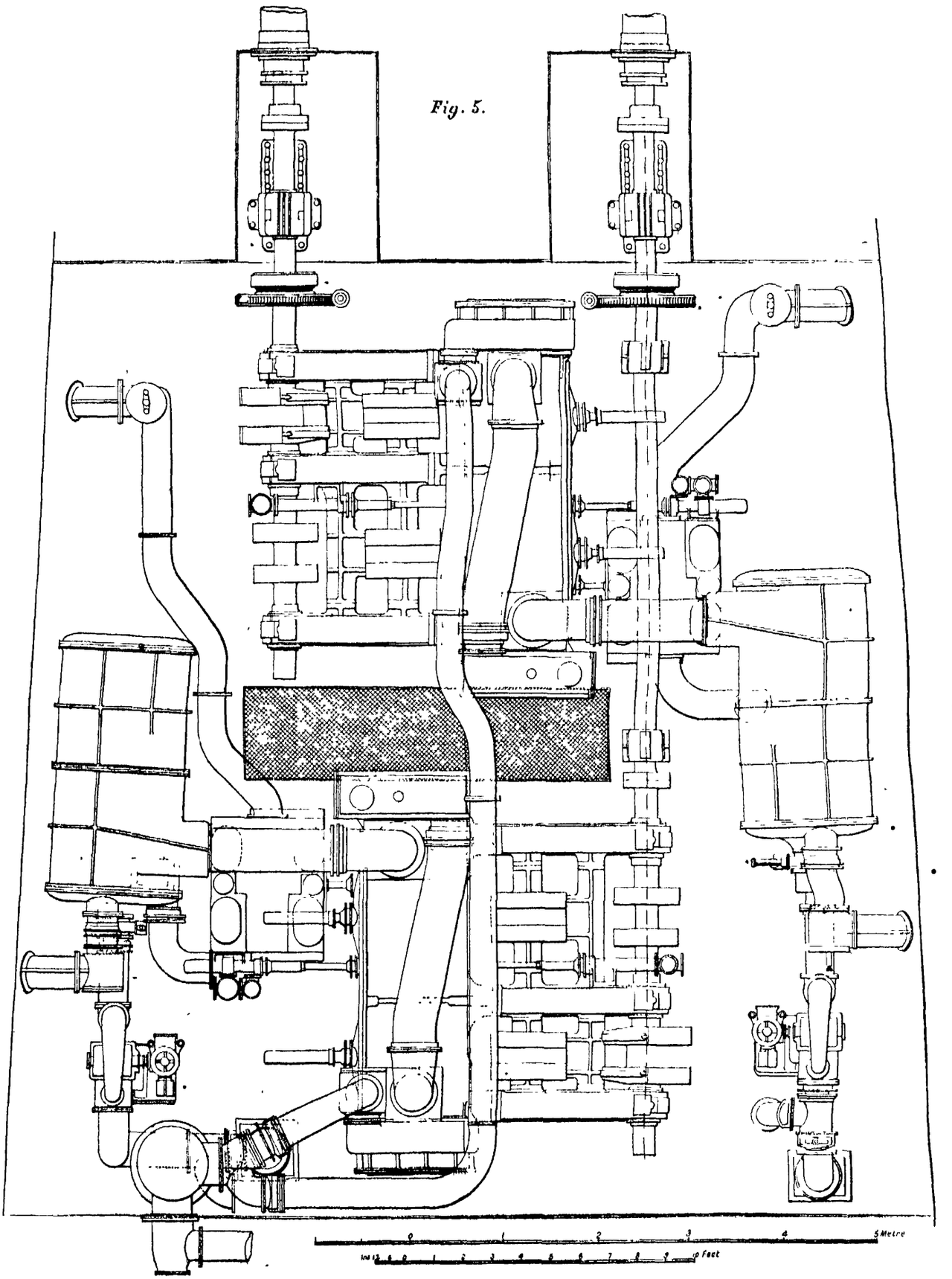
The engines are started from the platform between the two low-pressure slide cases; each cylinder is provided with a hand-starting valve, that on the high-pressure cylinder taking steam directly from the high-pressure slide case, and that on the low-pressure cylinder from the low-pressure slide case, instead of both taking their steam from the steam pipe before the main stop valve, as is often done. By this arrangement the slide valves cannot be lifted from their faces when using the hand-starting gear, as the pressure on the back must always exceed the pressure in the cylinder acting through the steam port. This is a matter of great importance in ships of war, as certain starting of the engines is absolutely necessary. The engines are reversed by means of combined hydraulic and steam gear; the cylinders and general arrangement of which is to be seen in Figs. 3, 4, and . A small hydraulic hand pump, not shown, is employed to move the valve gear when the steam is not up.

The cylinders whose diameters are respectively 900 millimetres (35½ in.), and 1.520 metres (59¾ in.), with a stroke of 660 millimetres (26 in.), are both

ENGINES FOR THE IMPERIAL GERMAN DESPATCH VESSEL "BLITZ."

CONSTRUCTED BY THE MÄRKISCH SCHLESISCHE MASCHINENBAU UND HÜTTEN ACTIEN GESELLSCHAFT, BERLIN.

Fig. 5.



steam jacketted with steam taken from the separator.

The crankshaft, which is of steel, has a diameter of 240 millimetres (9⅜ in.), and works in brass bearings lined with white metal The length of the connecting rod is 1.270 metres (4 ft. 2 in.), 3.85 times the throw of the crank.

The condensers, which have together a cooling surface of 505 square metres (5403 square feet), are placed in the wings of the ship and partake of the ship's form in order to economise space as much as possible. They are constructed entirely of brass; the tubes have a length of 2.524 metres (8 ft. 3½ in.) between tube-plates and are 17.5 millimetres (⅝ in) in diameter; they can be easily drawn on removing the after covers.

The air pumps are worked directly by rods attached to the low-pressure pistons, the cover on the cylinder end of the pump is made in halves bolted together in order to facilitate the inspection of the pump. The pump casings are of cast-iron, the liners and buckets of brass, the valves are of india-rubber and work on brass seats. The air pumps have a diameter of 350 millimetres (13¾ in). They draw through a pipe in connection with the under part of the condensers. The water is circulated through the condenser tubes by two centrifugal pumps of light construction, the fans with their casings being made entirely of brass. They are placed in the forward part of the engine-room.

The feed pumps are single acting, and attached to the side of the air pump casing; they are also driven directly from the low-pressure piston. There is one to each engine; the diameter of their plungers is 90 millimetres (3,⅝ in), the theoretical pumping capacity being thus $\frac{1}{11}$th of the volume of the low-pressure cylinders The bilge pumps are two in number, and are similar to the feed pumps, but are worked from the crank side of the low-pressure pistons, and are attached to the main frames of the engine

A separator is situated in the starboard forward corner of the engine room, from which the steam pipes branch off to the high-pressure cylinders; each steam pipe has a diameter of 280 millimetres (11 in.)

The propellers have each three blades of the Griffith form, slightly modified, and bent aft. They are 3 5 metres (11 ft 0 in) in diameter, and have a mean pitch of 3 713 metres (12 ft 2¼ in), the developed area of the blades of each propeller is 2.128 square metres (22 77 square feet)

Steam of five atmospheres pressure is supplied to the engines by eight return-tube boilers of the usual construction, their diameter is 2.96 metres (9 ft 8½ in) and length 2 9 metres (9 ft. 6½ in) Each boiler has two of Fox's patent corrugated furnaces, 940 millimetres (3 ft 1 in.) in diameter outside. The grates have a length of 1 96 metres (6 ft. 5 in) Each boiler is provided with 164 brass tubes, 2 16 metres (7 ft. 1 in.) long and 76 millimetres (3 in.) outside diameter The total heating surface of all eight boilers is 788 square metres (8431 square feet), and the firegrate surface 27.9 square metres (298.5 square feet).

The boilers are arranged in two stokeholds separated by water-tight transverse bulkheads carried up to the top deck; they are stoked fore and aft. There are two funnels, each of which serves for a group of four boilers.

The weight of engines, propelling apparatus, boilers, &c., including spare gear, with water in boilers, condensers and pipes, was specified by contract not to exceed 389 tons of 1000 kilogrammes (2203 lb.) each. The actual weights of the machinery when finished and erected on board was considerably under this figure, being as follows:

	Tons of 1000 kilos.
Engines, condensers, centrifugal pumps, pipes, and outboard valves in engine-room, floor plating, water in condensers, and pipes ...	120 6
Propellers, shafting, stern tubes, plummer blocks, &c. .	36.4
Boilers with mountings, firebars, lagging uptakes, funnels, pipes, floor plating, water in boilers, and pipes ..	219.3
Total weight . ..	376.3

On the 25th of June of last year the vessel (after having been brought to her deep load line by means of pig iron ballast (as her equipment of guns were not then finished), put to sea from the Imperial Dockyard in Kiel for her six hours' full-power trial. The trial was made under the supervision of the Government dockyard officials, the contractors were represented on the occasion by Mr. P. L. Weatherhead.

The results obtained were considered very satisfactory, the engines worked during the six hours without a hitch. Indicator diagrams were taken every quarter of an hour from both engines, and the mean power developed during the six hours was calculated from them to be 2816 indicated horse-power. The cards taken at the commencement of the trial showed an indicated power of 2908 horse-power, and during the last quarter of an hour the engines were working at 2984 indicated horse-power, the power never falling during the whole trial below that contracted for; the maximum power during this run was 3059 indicated horse-power. The mean number of revolutions was 148, steam pressure in boilers 5 atmospheres, and vacuum 0.82 atmospheres. The consumption of Westphalian coal on this trial was 1.26 kilogrammes (=2.772 lb.) per indicated horse- power.

Two trials of twelve hours' duration were made to obtain the coal consumption at lower powers with the following results. With 1200 indicated horse-power the consumption was 0.8 kilogramme (=1.76 lb.) per indicated horse-power, and at 700 indicated horse power, 1.02 kilogrammes, or 2.244 lb.

Copies of three sets of diagrams are given in Figs. 6, 7, and 8, on page 200; they were taken from the port engine on three runs over the measured mile at different speeds. The cards of the starboard engine, which are almost reproductions of them, are not given, as they afford no further interest. The results of these three speed trials are set forth in the following Table.

Mean Draught of Vessel	Midship Section in Square Feet.	Displacement in Tons.	Revolutions of Engines.	Indicated Horse Power.	Speed in Knots
4 05 metres =13 ft. 3½ in	323.2	1382	147 5	2808	16 2
			128 5	1794	14 2
			101 5	915	11 57

THE MECHANICAL EQUIVALENT OF HEAT.

To the Editor of Engineering.

Sir,—I have a little difficulty in understanding Mr. Pinnington's letter in your issue of August 15th. It appears to me that he only states a part of a case when he says: "Now, if we allow a weight to fall freely and to acquire its natural acceleration, on the arrestment of the weight the total conservation of energy acquired during the descent may be expended in producing pressure only."

To state the case fully, it appears to me that he must have added *something like this*.

But, as this pressure (acting in an upward direction on the weight) is in excess of the downward pressure due to the weight when at rest, it will in its turn propel the weight upwards, and (if no work was spent in overcoming the resistance of the air, or in producing heat, &c.) cause it to rise to the exact height from which it fell, whence passing through a phase of rest it would again descend, and the cycle would be repeated *ad infinitum*.

The latter part of his letter I do not quite understand and cannot therefore reply to.

I hope however that, as this is really beside the question raised by Mr. Pinnington, he will not now delay giving that account of his equivalent and how it is obtained, which he promised.

Yours faithfully,

Glasgow, August 18, 1884. H.

INDIAN PUBLIC WORKS DEPARTMENT.

To the Editor of Engineering.

Sir,—With your permission I cannot allow "Civil Engineer's" letter in your issue of July 18th last to pass without reply. This I have postponed while awaiting the arrival from India of the latest edition (June 30, 1884) of the Indian Public Works Department Classified List. From this I had hoped to be able to test the correctness of your correspondent's latest assertions anent the pay of non R.E. military officers employed as civil engineers. Having carefully examined this Government document, the only one so far as I know whence such information might be expected, I find it to be absolutely silent on the subject of special rates of pay for such officers. I am at a loss, therefore, to guess whence "Civil Engineer" has obtained the figures he so triumphantly parades before your readers as proof that I am making deliberate attempts to mislead them. Let us see how far his guidance may be trusted.

The summary he gives of non-R.E. military officers employed as civil engineers is correct, so far as the Classified List goes, in all but one particular, namely, there does not appear to have been more than one such military officer of the rank of superintending engineer for at least twelve months past, instead of two as he asserts.

He shows three captains as of the rank of executive engineer, third grade, each of whom he asserts draws 774 rupees per mensem against civilian pay of 650 rupees. One of these three captains I happen to know intimately, who of my own knowledge I should be prepared to swear does not draw a single *pie* of pay above 650 rupees. I have, however, written to a friend who knows him even better than I do, and he replies as follows: "Captain —— gets *nothing* extra because he is staff corps, and this is the case with *most* men of the staff corps. But I do know a Major —— of the staff corps who gets a lot *extra*. At some remote period he was called upon to elect under what rules he would serve, and he elected with the above result. This is all I know." This, therefore, entirely bears out my own impression, and the most that can be said *for* "Civil Engineer's" statement is that apparently he has generalised from a few isolated cases of officers serving under special rules not of general application. There are exceptions we all know to every general rule, and it would not be difficult to instance cases of civilian engineers serving by special agreement on exceptional rates of pay also.

I therefore see no reason for withdrawing what I before wrote, that as a general rule staff corps officers, unlike Royal Engineers, get no military allowances, but work for civilian pay pure and simple, though there may be a few exceptional cases referable to a "remote period" as expressed by my correspondent.

The only other objection taken by "Civil Engineer" to my former letter is a trifle. He still harps on the question whether or not an Act of Parliament is necessary for the discharge of military officers from Government employment. I need scarcely point out that though I admitted my former wording to be faulty if not read with the context, he is apparently too obstinate to adopt this rational method of reading it, and still prefers to distort the plain meaning of what I wrote. Perhaps, however, he will admit that a royal warrant would be necessary to effect such discharges, and that the sanction of Parliament would at least be necessary for the monetary compensation which any such scheme would involve. All I meant was that for getting rid of civilian engineers under the Government of India, no such procedure would be necessary.

Your correspondent refuses to argue with me on any other points, though this may probably be taken as an inference that he would like to do so, were the facts not too strong for him.

A Civilian Engineer not a Cooper's Hill Man.

August 20, 1884.

ROYAL CORNWALL POLYTECHNIC SOCIETY.

To the Editor of Engineering

Sir,—In your issue of 1st inst., "One of the Judges" at the Royal Cornwall Polytechnic Society's Exhibition of 1882, wrote to point out that the Jubilee gold medal was *not* awarded to Messrs. Tangye for *each* of their three exhibits, viz., the "Robson" gas engine, the "Wilson" gas producer, and the "Tangye" donkey pump, but for the extent and general excellence of their collective exhibit, and this I thought your correspondent did courteously and fairly in the interests both of Messrs. Tangye and this old and useful Society; I therefore was rather surprised to see in last Friday's (15th inst) paper, a letter signed by the chairman of Messrs. Tangyes, Limited, endeavouring to discredit that communication, and though professing to consider the matter as of exceedingly small importance, no mention is made of the fact that a lengthy correspondence took place between them and the committee of the judges on this subject of the gold Jubilee medal.

The Messrs. Tangye, Limited, were at the Exhibition named represented by a Mr. Treglown, who in a most peremptory manner told the judges *he* would not take the gold medal unless he could attach it to each article; this the Committee of the Royal Cornwall Polytechnic Society would not sanction, notwithstanding the long, friendly, and valued connection that had existed between them and the Messrs. Tangye and Co.; letters passed to and fro, but the Messrs. Tangye fathered both the language and acts of Mr. Treglown in affixing the gold medal to *each exhibit separately and so advertising them against* the decision of the judges' committee.

I can only infer that the Jubilee gold medal of the Royal Cornwall Polytechnic Society is *not* of the small importance this eminent firm make it appear to be, as their chairman quotes from the speech of the President of the Royal Cornwall Polytechnic Society to substantiate his position, but unfortunately omits a few words which bear on the subject; I must deny "that the judges felt that they (each of the three articles) were worthy of something better than the first and second silver medals" I have yet to learn that the president of any society can override the decision of the judges, and am certain it was never intended at the Falmouth Exhibition under reference.

I regret the length of this letter, but my excuse must be the welfare of the *Royal Cornwall Polytechnic Society*, the judicial awards at whose annual exhibitions, if set aside, even inadvertently, by such claims as those made by the Messrs. Tangye, Limited, will soon lose the high value they have held for more than half a century, not *only* in Cornwall but the world over.

By this post I address the chairman of the Judging Committee in the Mechanical Department for 1882, asking him to take notice of this correspondence if need be.

I am Sir, truly yours,

H. Somerset Mackenzie,

One of the Judges, R. C. P. Society's Exhibition, 1882.

4, Great St. Helens, London, August 20, 1884.

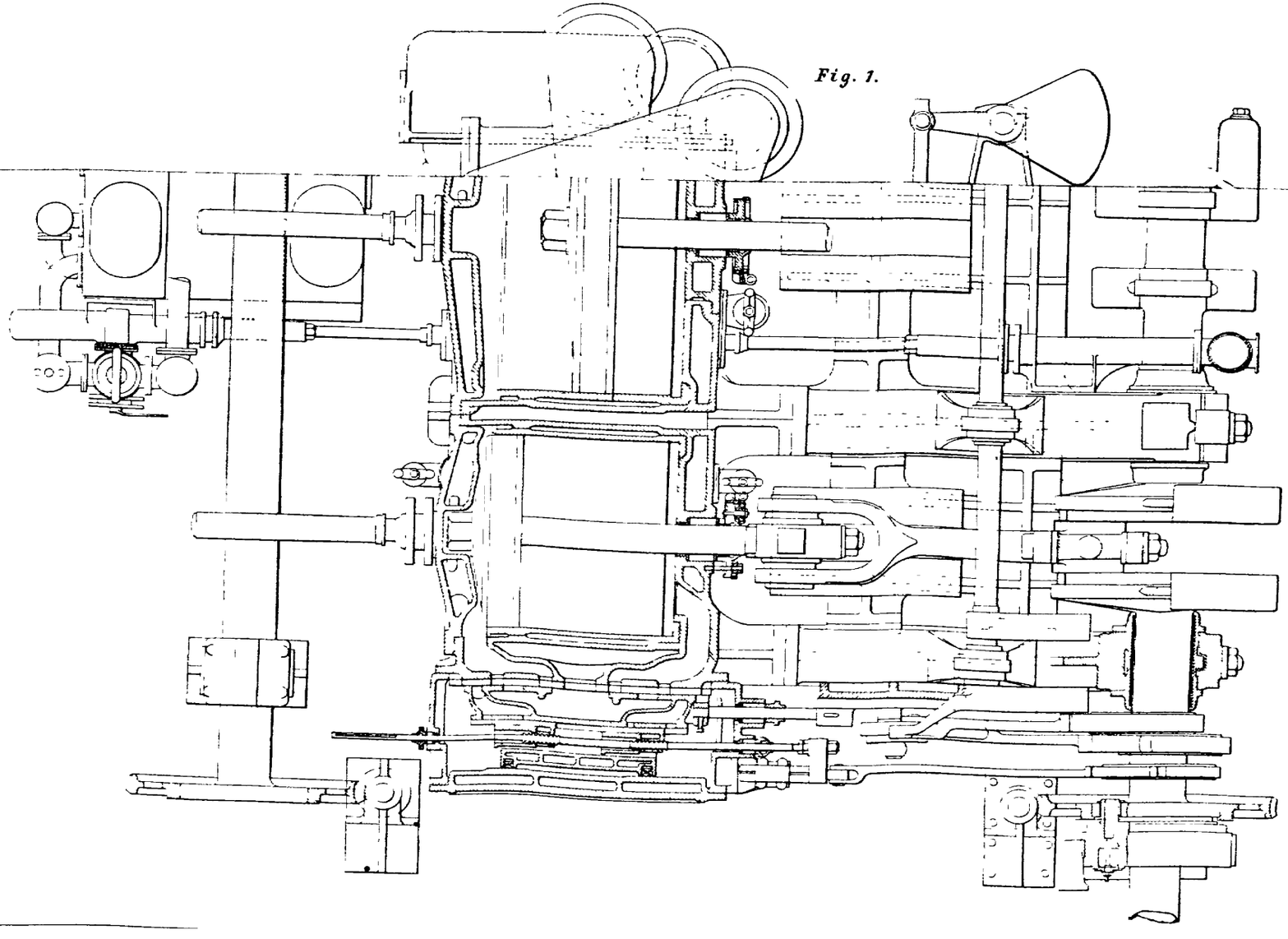
Railways in New South Wales.—The New South Wales engineer in-chief for railways (Mr. John Whitton) has been inspecting the works in progress on a line from Cootamundra to Gundagai, and on another line from Murrumburrah to Young. The excavations on the former railway are nearly completed as far as Coolac, and along the remaining portion of the line they are in a fairly forward state. The other works are progressing fairly also, and with the energy which the contractors are now displaying the line should be completed, if the weather proves favourable, by the contract date, June 30, 1885. Mr. Whitton has given instructions for another survey to be made to ascertain the practicability of placing the Gundagai railway station nearer the town. On the line from Murrumburrah to Young, the contractors will shortly be ready to commence laying a portion of the permanent way, but there is a considerable amount of work yet remaining to be done, and it is doubtful if this line will be ready to be opened at the contract date, viz., December 31, 1884

ENGINES FOR THE IMPERIAL GERMAN DESPATCH VESSEL "BLITZ."

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(*For Description, see Page* 200)

Fig. 1.



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The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant*

ENGINEERING.

FRIDAY, AUGUST 29, 1884.

THE FRENCH POSTAL AND TELEGRAPH SERVICE.

M. COCHERY, the Minister of the Postal and Telegraph Service in France, has lately presented, to the President of the Republic, a very complete and interesting report on the working of his department. A special interest attached to this document lies in the fact that it was M. Cochery himself who brought about the fusion of the two services. This union, which was effected by a decree dated the 27th February, 1878, had been urgently demanded for a long time. Previously the services were dependent on two ministerial departments, those of the Interior and of Finance, and it was found practically impossible to conduct them harmoniously and with full usefulness to the public A similar union was in preparation, or had been already accomplished, in several other countries, when the French decree of the 27th February withdrew both post and telegraphs from the departments which had respectively controlled them, and placed them in the hands of an under secretary of state, who was M. Cochery, the present minister. By hard work and good management the change was satisfactorily completed a short time after the passing of the decree (5th February, 1879), and the Ministry of Posts and Telegraphs was established, with M Cochery at the head The fact that he still retains this responsible position in a country where the tenure of office is usually short, and always uncertain, is worthy of notice, and is a strong evidence of the capacity of the minister, who, by the progress he has effected, and the services he has rendered, has placed himself outside the struggle of party, and has established a position hitherto sheltered from the storm of politics.

The report which M. Cochery has just prepared is practically the history of the administration during the past six years, it contains a great many interesting details, the more important of which we propose to analyse.

The Central Administration of the Posts and Telegraphs Ministry, as it is at present constituted, comprises six principal divisions or directions, as follows 1, the Central Bureau, 2, the general staff, 3, the counting-house, 4, material and construction; 5, the local service, and 6, the general delivery service. Above these divisions comes the General Inspection or Control, which is charged to exercise a superintendence over them The district and departmental administration comprises 1 A staff of engineers, distributed over fifteen districts, at the heads of which are the engineer directors, assisted by inspectors, sub-engineers, and controllers, for the construction of telegraph lines. 2 A departmental working service with a director of posts and telegraphs for different departments, assisted by inspectors and sub-inspectors, The bureaux of posts and telegraphs have been amalgamated almost universally, the exceptions being in a few instances where certain difficulties of installation existed. The union of the postal and telegraphic services brought about as a first result an economy of 1,152,000 francs (46,080*l.*), which was devoted to increasing the then inadequate salaries of the staff At the bottom round of the ladder is an army of 22,242 rural postmen, whose wages have been gradually increased, and who are entered in the budget of 1884 at the sum of 19,300,000 francs, or an average of about 13*s.* 6*d* per man per week. The position of city postmen has been improved in various ways, and they, as well as the country postmen, are clothed at the cost of the State Although we only refer to the improved position of these two classes of servants, the status of all the staff has been advanced. A sufficient supply of engineers for the service is assured by the creation of a telegraph school, in which the teaching is open to every one, and where are received, with the students from the Ecole Polytechnique, other pupils selected by examination from the agents of the department, and from the students of all the great State schools The technical training is completed by various auxiliary schools and by elementary courses in different towns The employés of all grades are divided as follows, the numbers in service in 1877 being added for comparison:

	1877.	1883
Postmen	24,610	30,996
Clerks	5,946	10,836
Railway clerks	1,491	2,551

The total number of agents, which was 38,256 in 1877, is now 53,879, and thanks to the amalgamation, the proportion of superior employés has been reduced from 8 per cent to 5.45 per cent.

The transport of letters and post-parcels is effected by railways, horse vehicles, and foot-messengers. The railway service is conducted by eight separate services of clerks, corresponding to the principal lines, and placed under the direction of eight superintendents. Besides these the *personnel* includes 11 inspectors and sub-inspectors, 238 chiefs of brigade, and about 1700 assistants of various kinds. The cost of this service is 9,510,916 francs (380,436*l.*), and the daily railway mileage, which has considerably increased since 1878, made on the railways by this service, is 30,250 miles. The Indian mail service is carried on the French railways, and the weight annually dealt with is 835 tons.

The following navigation lines are employed by the French Postal Department 1 The Algerian service, conceded to the Compagnie Générale Transatlantique 2 The Corsican service, conceded to the Morelli Company 3 The Calais-Dover service, worked by the South-Eastern and London, Chatham, and Dover Railway Companies 4 The Havre services, running to New York and the West Indies, conceded to the Compagnie Générale Transatlantique 5 The Mediterranean service. 6 The lines to Brazil and La Plata. 7 The lines to India and China 8 The services to Australia and New Caledonia These last four are worked by the Messageries Maritimes All these various services are worked by subventions, which have been reduced in the new contracts recently made with the concessionnaires.

The French telegraph system has been extended during the period between the 1st January, 1878, and the 1st January, 1884, by 509 new lines, classified as follows

14	International conductors	
28	,, ,,	for through communication.
158	Interdepartmental ,,	
190	Departmental ,,	

The length of the reseau has been raised since 1877 from 27,000 miles to 45,625 miles. Since 1878 several submarine cables have been laid, including one to Corsica for replacing the cable that was broken in 1862, a second cable has been fixed between France and Algeria, and several others on the coast of Tunis Their addition have increased the mileage from 830 miles to 2834 miles, and this extension is accompanied with considerable reductions in the tariffs Concessions are now being asked to aid the placing of lines between Paris and America, from the Canary Islands to Senegal, and from Cochin-China to Tonquin In addition to the foregoing, the French telegraphic system includes a cable from Paris to New York (the Pouyer Quertier Company), one from Marseilles to Barcelona, six between France and England, and one from Calais to Farro. The work of working and laying these is almost exclusively English, for at present France does not process any complete establishment for making submarine cables The Government possesses at Toulon a small factory for covering conductors, and two ships, the Ampère and the Charente, adapted for cable laying The Toulon works have been lately extended, and it is believed that at present France could lay a submarine cable of limited length It is only since the establishment of the Ministry of Posts and Telegraphs that the private lines have been subjected to fixed rules. These lines comprised on the 1st of January, 1884, a length of 4070 miles, and realised a revenue of about 10,000*l.*, notwithstanding several reductions in the tariffs. Among the private lines, there are twenty-nine belonging to newspapers and press associations.

The Ville de Paris possesses a system of over 600 miles devoted to municipal purposes, public assistance, water supplies, mairies, prisons, police, fire, and time regulation. Mention should also be made of telephone lines, which have lately been subjected to modified regulations

The French Postal and Telegraph Department comprises general and branch offices, the chief and staff of the former being appointed by the Government, while in the latter the chief only is appointed, and he himself selects the employes The number of offices which, in 1877, was 5570, is now increased to 6486, of which 412 are general offices, 5781 are branch, and 293 municipal offices The number of telegraph offices has been raised from 4541 in 1877 to 7523 at the present time, and includes 784 municipal offices, 3708 secondary offices, 2533 railway station offices, 125 semaphore stations, and 199 private offices. Of these various establishments, 3885 belong to the Postal and Telegraph Department In 1882 data were obtained showing the number of people served by each post and telegraph office in the following countries.

1. *Post Offices.*

Switzerland	980
Great Britain	2,291
Sweden	2,455
Denmark	3,145
Holland	3,235
Germany	3,607
Portugal	4,797
Austria	5,437

France	5,957
Spain	6,302
Belgium	6,391
Italy	8,175
Russia	21,013

At the present time the average number of inhabitants served by each post office in France is 5814.

2. *Telegraph Offices.*

Switzerland	2,301
Germany	4,187
Sweden	5,556
France	5,962
Great Britain	6,141
Denmark	6,268
Belgium	6,476
Austria	8,292
Holland	9,420
Italy	11,178
Portugal	21,341
Russia	31,772
Spain	42,660

The average number of persons in France now served by each telegraph office is 5140.

The number of public letter-boxes in France, which six years ago was 49,163, is now 55,240. Of these, 13,301 are emptied twice a day; 2069, three times, and 306, four times a day. Since 1877 the number of clearances have been increased as follows.

117	boxes,	5	times a day.
70	,,	6	,, ,,
62	,,	7	,, ,,
40	,,	8	,, ,,
15	,,	9	,, ,,

In Paris there are seven to eight clearances a day, and sixty-six boxes are cleared from ten to twenty-one times; the principal box of the Seine branch is emptied thirty-three times.

The transmission of money through the post has now reached very large proportions; in 1883, postal orders to the value of 544,309,231 37 francs, or upwards of 21,300,000*l* having been issued This is an increase of over 50 per cent since 1877. The postal order system for France now extends to its colonies, and issues are made to a large number of foreign countries.

The report of M. Cochery contains much interesting information on the postal service of Paris, which has of late years been greatly modified, and which now works extremely well in spite of many difficulties. These will be removed when the new post office is finished, and the department can be shifted from the limited and inconvenient temporary offices at the Tuileries to the new and commodious buildings now nearly completed. The most interesting part of the Paris postal system is the pneumatic transmission, the pipes used for which, from a mileage of about twenty in 1878, has increased to eighty-six to-day, and the present system embraces nearly the whole of Paris. This system is used exclusively for the transmission of two classes of despatches, closed and open, and the charges for which are respectively 5d. and 3d. Letters with extra payment for replies can also be sent. Last year no less than 1,844,164 despatches were delivered by this system.

At the Paris Conference of 1863, and the Berne Congress of 1874, the regulation of international rates was arranged for nations entering the postal union, the laws controlling which were settled at the congress which met in Paris on May 1, 1878. The representation of thirty-three countries having a total population of 653,000,000 participated in this meeting

The direction in which postal reform in France lies, is in the progressive reduction of rates. Whilst in this country since 1840, the penny postage system has been in operation, in France, the charges made were very heavy and varied according to distance. In 1848 a uniform tariff of 2d. was imposed, which was raised to 2½d. in 1850, reduced again to 2d. four years later, and raised to 2½d. in 1871. In 1878 the tariff was again reduced, this time to 1½d. for the whole of France. In the same year the postal card system was introduced, and liberal rates were established for the transmission of newspapers and printed matter. The telegraphic rates have passed through three different régimes First the charge for such despatches was made proportional to distance, then it was regulated with a limited number of words and a minimum charge; at present the tariff is uniform throughout France, being one halfpenny a word.

The results of all these changes have been somewhat remarkable. Since 1877 there has been an increase of 62 per cent. on ordinary inland letters, of 42 per cent. on printed matter in wrappers, of 61 per cent. in newspapers, of 124 per cent. in registered letters, and of 363 per cent. on printed matter in envelopes. Inland telegrams have increased during the same period by 194 per cent., and international telegrams by 76 per cent. Latterly some new services have been introduced, the insurance of letters containing articles of value, special rates for subscribers to newspapers, and the creation of post office savings banks, which has proved a great success. Since January 1, 1882, the parcels post system has been at work, but unfortunately at present it is not interchangeable with this country. In telegraphy an improvement now in progress is the establishment of underground lines; those of Lille, Lyons, and Nancy are complete, and in a short time Marseilles and Bordeaux will be connected with Paris.

THE SOUTH AFRICAN DIAMOND FIELDS.

We have received from Kimberley some interesting official information with reference to the course of affairs of the South African diamond fields, that is with reference to the four great mines—Kimberley, Old De Beer's, Dutoitspan, and Bultfontein. One can but be impressed with the magnitude of this department of South African industry and enterprise The Kimberley mine was troubled in 1883 with successive falls of reef, and in the course of last year, reef was removed to the extent of 1,688,914 loads of 16 cubic feet each, at a cost to the Kimberley Mining Board of 261,795*l*. The water difficulty met with in the Kimberley mine is less serious than the reef obstacle, 10,688 gallons having been raised last year at a cost of no more than 2672*l* The quantity of blue ground hauled out of the Kimberley mine last year was about 350,000 loads, and the aggregate weight of the diamonds obtained was 947,877 carats The average value of these diamonds was 22*s* per carat, giving an approximate value of 1,044,000*l*. The number of men employed, on an average, in the claims last year was 252 Europeans and 1198 natives; the average number employed on the floors was 167 Europeans and 915 natives The wages paid in 1883 averaged about the same last year as in 1882, viz, from 5*l* to 8*l*. per week to Europeans, and 30*s*. per week with lodgings and wood, but not food, to natives. The Kimberley mine is described as an almost circular opening of comparatively limited area contained within a presumably running wall of basaltic rock, and probably many hundred feet in thickness. The question of the future working of the Kimberley mine has been earnestly discussed, in consequence of the falls of reef to which we have just alluded. Opinion differs upon the subject, but good authorities appear to consider that what is required is to carry on reef removal operations concurrently with mine working, and in advance of probable reef slips. As regards Old De Beer's mine, the estimated quantity of blue ground hauled out of it in 1883 was 700,000 loads, of 16 cubic feet each The aggregate weight of the diamonds obtained was 426,728 carats. Reef was removed to the extent of 71,847 cubic yards at a cost of 25,268*l*., while the water pumped out was estimated at 10,950,000 gallons, its pumping costing 10,800*l*. There were only two slips of reef of any consequence in 1883 in Old De Beer's, but one slip caused the death of five natives. The daily average number of persons employed in the mine last year was 96 Europeans and 661 natives in the claims, and 101 Europeans and 602 natives on the floors. The rates of wages paid were about the same as those carried on in the Kimberley mine. The western portion of Old De Beer's mine is in much the same unworked condition as the western side of the Kimberley mine. The area of diamondiferous ground at Old De Beer's is very extensive as compared with the Kimberley mine; at the same time, the blue ground of Old De Beer's is not so rich as that of the Kimberley mine in the production of gems. The number of claims in the Dutoitspan mine is returned at 1531, of which 1395 were more or less worked in 1883. About one-third of the claims were worked uninterruptedly, and upwards of 400 were worked for an average of 259 days; only those claim-holders who had not proper appliances were, indeed, idle last year. It appears that seventeen more steam engines were got to work in the Dutoitspan mine last year as compared with 1882, the increase in the aggregate force at work being 105 horse-power. One mile of broad gauge and 14¾ miles of narrow gauge tramway were laid down in 1883. A valuation of the mine was made in 1883, and the total arrived at was 2,205,930*l*. The working of the mine was rather seriously interfered with last year in consequence of the unhappy prevalence of drunken habits among the native labourers, about one-third of whom are officially stated to be absent from work every Monday, in consequence of their excesses every Saturday and Sunday. The assessment of the Bultfontein mine amounts to 660,185*l*. Work was carried on earnestly in the mine during 1883. The average depth of the mine where it is worked is about 150 ft., but there are certain blocks of claims on the north and north-west side where little work has ever been done, and about forty claims which remain untouched. On the south and south-east side many claims have also been cut out by reef, and it is feared that as the mine increases in depth more will share the same fate; at the present time a few claims are so covered with reef as to remain unworkable, so that the reef question will at no distant period demand the most serious attention of the claim-owners in the mine.

THE PENISTONE RAILWAY ACCIDENT.

Following fast on the Board of Trade inquiry into the causes of the great catastrophe on the Manchester, Sheffield, and Lincolnshire Railway, and on the inquest held upon the bodies of the numerous victims to that accident, comes the report of Major Marindin. With the official conclusions arrived at, after careful and patient investigation, the public are already acquainted, for the daily press has taken up the subject with the warmth and intelligence that so important a question deserves, and both by printing Major Marindin's conclusions and commenting upon them, has shown a comforting determination that a limit shall be set to the time when life and property shall be recklessly endangered by the neglect or deliberate refusal of railway companies to provide efficiently for the safety of their passengers. We have so recently described, in these columns (see page 87 *ante*), the circumstances under which this accident occurred, that there is no occasion for us now to refer again to that part of the story. We have also in subsequent issues discussed the causes to which the accident was due, and it is this part of the subject, viewed now with the light thrown on it by Major Marindin's report, that calls for a few words of comment. We can see now how Sir Edward Watkin's special Providence has played him false, and how sorry a spectre it is, when exposed by facts and by the conclusions inevitably deduced from them, in the official report written by an experienced officer, who has no prejudice to foster, no angry shareholders to soothe, and the latter will now begin to suppose that it is not Providence who attends their chairman, but Nemesis that pursues him.

Major Marindin's conclusions upon the Penistone accident are so important, and convey so grave a warning to other railway companies than the Manchester, Sheffield, and Lincolnshire, and to other chairmen than Sir Edward Watkin, that we may be excused if we quote liberally from them.

Although, therefore, this disaster is to be attributed to a pure accident, and to one of a character not uncommon, it becomes material to inquire:

1. Whether this accident might have been prevented by any human foresight.

2. Whether there were any contributing causes which were preventible.

3. Whether the effects might have been mitigated by the use of any safety appliances in common use.

4. What precautions it would be advisable to adopt to prevent such accidents in future.

Taking these considerations seriatim:

1. I have no hesitation in stating my conviction that the accident to the crank was one which could not have been foreseen or prevented.

The growing flaw in the web of the crank was one which could not possibly have been seen, unless the big-end of the connecting rod had been taken down from the bearing or journal; and as I am not prepared to say that the flaw extended through the outer surface of the metal up to the very last moment before the web broke, it it quite possible that it might have escaped detection even under these circumstances.

The rule of the company that the cranks are to be critically examined by a competent person once a week, and monthly with the big-ends taken down, seems to have been adhered to; and it is, in my opinion, quite credible that at the time the big-end was last taken down and the whole surface of the crank exposed to view, only a fortnight previous to the accident, the flaw had not developed so as to be visible.

2. It is impossible to arrive at any positive conclusion as to what might or might not have happened under cer-

tain conditions in such a case as this, but I think it is possible, or even probable, that if the drawbar hook at the rear of the horse-box had not broken, and all the couplings held firm, some of the leading vehicles in the train at any rate might have been dragged safely along the line together with the engine, tender, and horse-box, but I do not think that, even under these circumstances, the rear vehicles could, with the brake power available, have escaped from falling over the bridge or embankment considering the speed at which they were running when they arrived at the point where the outer rail of the curve had been torn up; indeed, it is possible that the drawbar hook broke only under the enormous strain thrown upon it by the very fact of some of the vehicles behind it falling over the bank, a strain under which some coupling or headstock was certain to give way.

The proper position for horse-boxes, fish-trucks, carriage trucks, and vehicles of this description, when attached to a passenger train is, undoubtedly, at the rear of it. But the exigencies of the traffic often cause them to be placed otherwise; and as in this case the horse-box was properly equipped for running in passenger trains, with a draw-bar hook of the approved pattern, although not quite so strong as those which have been adopted within the last two years, in consequence principally of the increased strain thrown upon the couplings by the use of continuous brakes, I consider that the position of the horse-box in this train can hardly be held to have contributed to the disaster.

3. The action of the continuous brake is the principal thing to be considered under this head.

It is pretty clearly proved by the evidence that the continuous brake (Smith's simple vacuum brake) was actually applied about the time that the engine was passing the signal cabin; that is, about 2½ seconds after the crank broke, and at a point 177 yards from the centre of the over bridge, and 102 yards from the point where the line was first torn up, and where most of the vehicles afterwards ran down the embankment; and it is also certain, not only from the evidence, but from the manner in which the train was wrecked, and the distance which the engine, tender, and horse-box ran over the sleepers, chairs, and ballast after the brakes came off upon the parting of the coupling, that the speed when the engine reached the bridge was still very considerable.

Now, while I do not believe that any brake which exists could have actually stopped the train on the falling gradient in the distance available, and could thus have averted the disaster, yet it is beyond question that a quickly acting and powerful continuous brake ought in this distance to have so reduced the speed that the consequences of the accident would probably have been far less fatal; and, assuming for the moment that the vacuum brake pipes were not severed until the coupling parted behind the horse-box when the engine was near the bridge, it must be conceded that this brake did not do as much towards stopping the train as might have been expected from its recorded performances with experimental trains.

Again, when the engine was at the centre of the bridge, the rear vehicle in the train was 139 yards distant from this point, and 75 yards from the point where the line was broken up, and, although the vehicles immediately behind the horse-box could hardly have been saved when the coupling parted, yet, if the train had been fitted with an automatic brake, which would have remained on when the parting took place, it is probable that the four or five vehicles would, by its continued action, and the consequent reduction of speed, have escaped with comparatively little damage.

The explanation, however, of the apparent inefficient action of this brake may be that one or more of the brake pipes were broken or damaged some time before the engine arrived at the bridge, and if this were the case, the automatic action, had such existed, would have been so much the sooner brought into play.

It is quite impossible to say when the pipe under the tender was broken, whether in the act of getting it on the rails or before; but it was found broken when the tender was examined, and it is far from improbable that it was cut by the check rail, when this rail was thrown out and propelled through the bottom of the tank; and in this case the brakes would hardly have been in action before being released.

The value of a brake having rapid action, and, above all, automatic action, in such a case as this, can hardly be contested; and although the Board of Trade has, as yet, no power to insist upon the adoption of a continuous brake possessing these qualities, yet I would remind the Manchester, Sheffield, and Lincolnshire Railway Company that this is the second emphatic warning which has been given to them within the last six months as to the need for automatic action in the brakes used upon their line; the previous instance being on the 6th of February, 1884, when, after a carriage had left the rails when running at high speed near Dinting Station, the vacuum brake pipe was severed, the brake became useless, and the carriage was dragged along off the rails for over 350 yards further than it would have been if the brakes had remained on, at the imminent risk of falling, and taking with it the carriages behind it, over a viaduct 100 ft. in height.

4. As to the precautions which it would be advisable to take in order to prevent a recurrence of such an accident, I would remark that the giving way of a crank which is proved by the evidence and tests to have been properly made of steel of good quality, and to have been of exceptional strength and weight, and which had only run for a distance of 50,776 miles, should lead locomotive engineers to consider carefully the relative advantages of engines with inside cylinders and crank axles, as compared with engines with outside cylinders and straight axles; of steel axles as compared with iron axles; and of cranks hooped with wrought-iron bands, as compared with cranks having the additional strength provided by an increase of metal in the webs of the crank itself; and as it might assist them in their deliberations if a return were prepared showing the proportion of crank-axles and of straight axles which have failed during a given period, relatively to the number of such axles in use upon engines throughout the kingdom, I would recommend that such a return, distinguishing also between iron, steel, and hooped axles, should be prepared and issued.

It is also manifest that the more frequently cranks are examined thoroughly, the greater probability there will be that growing flaws will be detected, and I would therefore recommend that the big-ends should be taken down at the weekly examinations, instead of only monthly as at present; and as regards the Manchester, Sheffield, and Lincolnshire Railway Company in particular, I would observe that there must be considerable and unjustifiable risk in running a suspected axle under observation, when an apparent flaw has not been extended by the test to which it has been subjected, which, according to the evidence of the superintendent of the works at Gorton, is the present practice upon this line.

Major Marindin's examination resulted in an absolute determination of the initial cause of the accident, the fracture of the crank axle, and his assurance that this could not have been foreseen or prevented, is, in one sense, reassuring to the public when taken in connection with the high commendation he bestows upon the servants of the company for the efficient manner in which their duties of inspection and general management are performed. The fracture of locomotive axles, and especially of crank axles, is far more frequent than is supposed, but fortunately it is rarely attended with serious consequences, and connected with this part of the inquiry, Major Marindin's recommendation that detailed statistics of the performances and failures of different kinds of axles should be collected, has an especial value

The second point to which his inquiry was directed, is of minor interest, since it does not appear to have any practical application to the case under consideration. As he very justly points out, it is highly improbable that any coupling could, with such a sudden strain thrown upon it, hold together a train unprovided with sufficient brake power.

The real interest of the investigation centres in this latter point, and an answer to the question, "Whether the effects might have been mitigated by the use of any safety appliances in common use?" can be only a direct affirmative. Comment is almost superfluous upon Major Marindin's remarks on this part of the subject. His experience of the efficiency of certain automatic brakes justified him in referring to such appliances as being in common use, as having been subjected to the test of years, alike under the conditions of ordinary work, and the sudden demands of emergency, and no one is better qualified than he, to judge of the shortcomings of the system so unceasingly advocated by Sir Edward Watkin, and to protest against its continued use. Taken in connection with numerous strictures passed by the Board of Trade of late, the official warning has a special significance "Although the Board of Trade has, *as yet*, no power to insist upon the adoption of a continuous brake possessing these qualities (rapid action, and, above all, automatic action), yet I would remind the Manchester, Sheffield, and Lincolnshire Railway Company that this is the second emphatic warning which has been given to them within the last six months as to the need for automatic action in the brakes used on their line."

What a commentary is this grave censure on the words of Sir Edward Watkin to the crowd of anxious shareholders on a recent occasion, in reference to this very accident. "The brake used on the South-Eastern Railway was the vacuum brake, which was the very best brake out . . . In the accident alluded to (Penistone) the brake did its duty. The brake was on, and the carriages held together, and if, through Providence, the engine driver could have gone another sixty yards the train would have got into the cutting, and there might not have been a single injury."

What a commentary, too, on Mr Moon's remarks to the shareholders of the London and North-Western Railway, and to which we referred last week. On that line "the best brake in the world," the Clark-Webb chain brake, is being discarded, and replaced by a non-automatic vacuum brake, thus is this otherwise admirably managed company making "every provision to prevent accident."

Many years have now passed since the Board of Trade were enabled, from experiments they conducted, to lay down the conditions and requirements which railway brakes could be reasonably called upon to fulfil, and experience has shown how practical and sound were the recommendations they then preferred. Unfortunately many fatal experiences have also demonstrated the consequences of a disregard of the Board of Trade suggestions. Until to-day it is not the stiff-necked generation of chairmen and others in authority, who have had to pay for stopping their ears to the official advice; it has been railway passengers with their lives, and railway shareholders with their money But a limit is set to all things, and if the warnings of the Board of Trade, which have of late fallen thick and fast, remain much longer unheeded, legislation must perforce compel the adoption of those means of safety to the public which "are in common use" Then Sir Edward Watkin must put his Providence in his pocket, and with others of his kind, bow to a stronger power. Compulsory legislation is a bad thing, but it will in this case remove a greater evil, and it appears, after all, not illogical that the Board of Trade, which at present determines whether a line of railway is so constructed as to provide for the safety of the public, should not also possess the power of deciding whether the recognised appliances in common use, for insuring, as far as possible, the safety of trains conveying passengers, have or have not been employed Until this is effected, however, the public have the matter to a certain extent in their own hands, by travelling, whenever it is possible, on those railways where the chances of accident are reduced to a minimum by the use of brakes "having rapid action, and above all, automatic action"

THE HEALTH EXHIBITION.

Educational Exhibits.—No. V.

The Japanese section has been only recently opened. The more eligible rooms of the Technical Institute having been already allotted to other exhibiting bodies, this distant but interesting country has been relegated to the basement

The educational exhibits strongly remind one of European influences, modes, and appliances Several products are unmistakably national; but many of the articles are the direct outgrowth of European ideas and methods. Japan has taken the lead of Oriental nations not only in breaking with old-fashioned customs and the traditions of ages gone by, but also in selecting and adopting the improvements of western civilisation.

The bulk of the exhibits come from the male and female training colleges of Tokio, the Athens of that "land of the rising sun." The models of schools differ but little from those planned and erected by our own School Boards The substitution of specially prepared paper for glass in windows is not a matter of primary importance, but our scholastic legislators may note the care bestowed in Japan upon the formation and culture of manners The visitor will be told, in very fair English, by the Japanese representatives, that a room is set apart in the schools for teaching the principles of civility. As this room is furnished with neither benches nor seats of any kind, one may infer the high value set, in the Japanese code of etiquette, upon such accomplishments as graceful walking and bowing, accosting a friend and taking leave of him, and the like.

Science teaching seems to be conducted according to methods analogous to our own, and with similar results. This is to be expected, since many of the professors in the University of Tokio belong to the west by birth or education. The various curricula resemble ours, and strong efforts seem to be made to carry them out efficiently. Most of the school books and class work exhibited, are in the vernacular of the country, a fact which screens them from criticism or appreciation We must accept the statement of officials that the text-books are good and that the school work is all well done Not so, however, with the samples of scientific handicraft It is true they are made of the simplest and rudest materials, yet it must be confessed that, in many instances, they are exceedingly imperfect representations of instrumental appliances. It would, for instance, be difficult to predict, from inspection, what phenomena of polarisation could be seen with the Norremberg's apparatus of this collection, nor can one realise the experimental uses of an electrical conductor made out of a large cubical petroleum can and merely resting upon three beer bottles. Other strange and risible pieces of construction will be found in an equatorially (?) mounted telescope, an electrical friction machine, and a Coulomb's torsion balance. One marvels why better work is not done, or why

such ungracious specimens were ever sent to an educational exhibition.

The models of levers, capstans, the inclined plane, and the mechanical apparatus generally, are of better workmanship They, at least, may be used to roughly illustrate the principles involved. A large glass case, placed in the corridor, contains excellent and characteristic specimens of handiwork done in the female normal school of Tokio, and in the public school of Kiyoto Fu, two of the leading educational establishments of the country. There is also a large and curious collection of picture-books, moral story-charts, kindergarten toys, as well as paper cuttings and foldings made by children out of materials which are usually gorgeously coloured.

The exhibits from the Tokio University are kept in a glass case, to which access may be had on application. There are numerous books containing papers carefully written in English on a variety of scientific subjects Most of these have a local interest, and treat of such subjects as the alloys of Japan, Japanese methods of sugar making, &c. Some, too, appear to contain accounts of laboratory work, and even independent researches made by students

This same case contains a dynamometer and a spirometer for testing the strength of muscle and chest of Japanese students. The results of these individual tests of physical power are exhibted in the form of systematic tables, in which are entered the age, height, finger-reach, girth of chest, capacity of lungs, strength of arm, and weight of a number of youths varying in age from 14 to 18 years In many schools it appears that observations are regularly made of the health conditions of children and students, and certain schools carefully note the number of cases which occur of nervous or skin disease, affections of the circulatory, respiratory, or digestive organs, epidemics, &c These physico-medical registers might serve as models to our public school authorities, who give every encouragement to field sports, but who pay no attention to the registration of facts which have an important bearing upon education.

The educational appliances are not very numerous. There is an anatomical model of the human subject which is remarkably well made; it is in papier-maché, appropriately coloured and with movable parts. Besides the familiar abacus, there are two other forms due to the adaptive genius of the Japanese. Several geometrical theorems are illustrated by appropriate wooden models, the square and cube of a polynomial not being forgotten. A praiseworthy feature in arithmetical apparatus is the rational manner in which the relative value of fractions is demonstrated. There are but few samples of school furniture, and these are strongly suggestive of European manufacture. This is, of course, no disparagement. On the contrary, the earnestness displayed by the Japanese to promote the interests of their country, to establish national education on a broad and solid basis, and in so doing to profit by the experience of others, is entitled to the highest commendation. Their exhibition, despite the few deficiences which we have singled out, deserves great praise. It shows that their education department is directed by an intelligent and energetic body of men.

THE UNCHAGAH, THE GREAT RIVER OF CANADA.

Parallel to the coast line of the Pacific Ocean, and generally rising almost from its shores, the Andes and the Rocky Mountains form, for 8000 miles, the backbone of the twin continents. From Terra del Fuego in the south to the Frozen Ocean of the north, through torrid, temperate, and frigid zone, their rugged sierras, snow-capped pinnacles, or volcanic peaks, stretch in one long vast belt over one-third of the circumference of the globe; the most massive, most varied, most magnificent chain of mountains in the world. From the Gulf of Mexico to the Arctic Ocean, their general course, through North America, is a little west of north, and from the thirtieth parallel of latitude to the sixtieth, their height gradually increases, whilst the associated Cascade range interposes between them and the ocean, and pushes the main chain to a distance from the coast. The Union Pacific Railway crosses these mountains, where their breadth is 1200 miles, at a maximum elevation of 8242 ft. above the sea, and although the low pass selected for the Canadian Pacific is 3626 ft. in altitude, the road will enter the western province of British Columbia between the colossal portals of Mounts Browne and Hooker, which rise on either hand, the giant sentinels of the pass 16,000 ft. above the ocean level. Above the sixtieth parallel the mountains lose their altitude, and become more isolated, whilst a prolongation of the continent leaves a larger space between them and the western sea. At their northern extremity they tend towards the west, dipping their frozen feet into the Arctic Ocean, a thousand miles from the straits that separate Asia from America. In Canada, that is, north of the 49th degree of latitude, the axis of the mountains is roughly parallel to the Pacific from 200 to 300 miles distant, whilst the Cascade range is directly on the coast, and between the two is an elevated mountain region, much of it too rocky and precipitous to be of any agricultural value. On the eastern flank, or shoulder, towards the Atlantic, there reposes a broad sandstone belt, at an altitude near the mountains of from 2500 ft to 3000 ft above the sea, and gradually sloping from this eastward and northward, is a vast prairie district 800 or 900 miles wide, a treeless, alluvial country, of great agricultural promise, ending with a belt of primitive rocks, which forms the Atlantic and Arctic coast line.

Between the Rocky Mountain range and the Pacific, and between 55 deg. and 58 deg. north latitude, there exists a rough, hilly, forbidding district, as yet but little known, and visited only by the hardy trapper of the Hudson's Bay Company, or the no less daring and ubiquitous gold miner, who has found, on the sand bars of its numerous rivers, an auriferous reward for the hardships inseparable from its bleak position and terrible isolation. A wild wilderness of rocky peaks and granite fastnesses, it covers some 30,000 miles of barren solitude, whilst chilled by the neighbouring snow-covered mountain ranges, and its own elevation of over 6000 ft., its short summer affords but a brief interval of rushing cascade and swollen torrent, between the rigours of its long and pitiless winters.

When Sir Alexander Mackenzie, in 1795, first penetrated to this inhospitable district, his Highland followers were reminded by its rugged lineaments of their transatlantic homes, and they called it New Caledonia, but it gradually lost this name, and when again revisited by the less poetical gold seekers, who gained its dreary fastnesses, through its Pacific outlet of the Stickeen River, this Indian name became attractive to the whole country between that river and the Finlay, and it is now known with less propriety or euphony, as the Stickeen district. This wild mountain region is the birthplace of some mighty rivers. Its southern and western flanks are drained by the Babine, Stickeen, and Nasse, which all find their way ultimately into the Pacific. Its northern valleys disgorge the accumulated floods of a hundred frightful gullies and canyons into two principal streams, which again, some 200 miles from their source, unite to form the main branch of that great unknown river, which after a course of 800 miles in silence and solitude passes beyond the boundaries of British America, a majestic flood a mile in width, into the late possessions of Russia, and is at that boundary still 1000 miles by its wanderings from its home in the Behren's Sea. Circling in its course round the volcanic basis of St. Elias and Mount Edgecombe, a Hudson's Bay fort has been established at its northern bend, but from thence to where the lofty Ihaman, whose fiery summit is 13,000 ft. above the sea, casts his livid flames over the Aleutian Archipelago, the Yukou has still to be explored.

The eastern slopes of these new Caledonia mountains give birth to the still mightier Unchagah; but if the wild district of its infant activity is uncouth and repulsive, its more mature career follows brighter scenes, and is developed in a more congenial clime. For over a thousand miles it offers its ample bosom as the liquid highway through a prairie of vast extent and wonderful fertility, waiting only the arrival of immigrants to yield a worthy return to the hand of industry, and ready to respond a hundred-fold to the advances of enterprise, or the incitement of husbandry. After this promising adolescence its powerful energetic maturity is passed amidst less happy surroundings, and for 1300 miles its great fervid volume sweeps on in sullen silence amidst joyless scenes and wild desolation. It ends as it began, amidst a hopeless wilderness, useless to mankind, surrendered to everlasting and irredeemable wretchedness, until it loses itself in the chill embrace of the Polar sea, amidst fog and gloom and ice, and associated with the cruel memories of the sufferings of those who have laid down in despair to die on its far-distant and gloomy banks.

Although their sources are not 200 miles from the Pacific, the Ominica, the Oxalinca, Mesalinca, and other streams run eastward from the Stickeen district to swell the limpid but impetuous Finlay, which for 300 miles laves the western base of the Rocky Mountains, and which after running through a frightful canyon in the rocks flows for 120 miles, without any sensible change in its volume, to its final confluence with the Parsnip But the Finlay, though perhaps the longest is not the main source of the Unchagah's waters. A belt of high land not mountainous, nor even very elevated, for this watershed between the Pacific and the Arctic scarcely averages 2500 ft. above the sea, joins the mountains of the Stickeen on its southern side, and runs for 400 miles to a junction with the great Rocky range, where the Frazer, the gold-bearing river of British Columbia, attains its most northern limit Within six miles of the Frazer's waters, at this northern bend, is the little Summit Lake, in west longitude 122 deg. 40 min., and north latitude 54 deg. 14 min. It is about five miles long by four wide, and its elevation above the sea has been carefully ascertained to be only 2050 ft, whilst the highest point of the Giscombe portage, which separates it from the Frazer, is only about 100 ft. higher. The whole of this district was explored for an alternative line for the Pacific Railway, and were this route adopted, this low summit would be the highest point between the Atlantic and Pacific for the shorter Canadian route, whilst its American rival passes over a summit 800 ft. in height, and runs for 1300 consecutive miles at an elevation of over 4000 ft. above the sea level. The outlet of Summit Lake is called Crooked River, which, running generally north through gravel ridges and a sandy sub-soil, makes over 100 miles by its course, of the 60 in a direct line, between its commencement and M'Leod's Lake, into which it flows. This lake is a sort of natural canal 17 miles long and two wide, and the receptacle for a chain of lakes further west, draining the area between the watershed previously mentioned and the Crooked and Nation Rivers. These lakes all abound in fish, and their bright clear waters are surrounded, as far as the eye can reach, by an undulating well-wooded country, rising from the lake by a succession of low sandy terraces. At its foot is a small Hudson's Bay Company's fort, the only mark of the existence of man, and stretching away to the right are the distant peaks of the Rocky Mountains, wrapped in their coverlets of everlasting snow. Emerging from the lake and still running north, is the Pack River, which carries its waters into the Parsnip, the former deep, clear, and dark, the latter white and turbid with the melting snow of the mountain range. Each river is 100 yards wide, and they run for some distance in sullen silence side by side without commingling. The main stream, which has drained the Rocky Mountains for over 150 miles from the south, is named after the Cowparsnip, which grows in wild profusion on its banks. Being entirely fed by the intermittent and variable mountain springs and streams, it is subject to occasional heavy floods, and to great changes in its volume and rapidity, and hence is constantly scooping out new channels, washing away the former banks, creating new islands, and cutting and changing its bed continually. The gravel washed down from the hills, during the period of its greatest violence, is covered with mud at a subsequent stage of the waters subsidence, and in this the seeds of the willow take root and grow. These collect from the turbid river more mud, which they mat together and consolidate, and thus form banks and islands, and it is no unusual thing both on this river, and lower down on the Peace, to find willows not thicker than a finger silted up 10 ft., and holding the mud in its place. In a few years the bank is high enough above the water for the balsam poplar to thrive, which is found from the seedling of a year old to the monarch of a hundred, towering to as many feet in altitude, and with a trunk 6 ft. in diameter. As this poplar growth decays, the white spruce succeeds and the forest of the future is commenced. For forty or fifty miles between the mouths of the Pack and Nation Rivers, the channel is divided by gravel bars and islands, and the process of depositing and destroying these by the spring floods, and summer deposits of silt, and of covering them with the new forest is everywhere in progress.

The Nation has a large channel, but with a very varying quantity of water flowing from the wilderness of the Stickeen, its current is rapid and tortuous, and its banks are marked with gravel terraces, rising to 150 ft. above the usual level of its waters. The Nation and Ominica Mountains, rising their denuded heads 7000 ft. above the sea, bound the horizon to the west, and what is somewhat remarkable, the snow here never remains permanently on their summits, although a number of the peaks are above the snow level of mountains further south. The bars of the Parsnip, Nation, Ominica, and, in fact, of all these streams, have been explored for gold, and it was supposed a few years since that the Ominica especially, which runs into the Finlay, would rival Cariboo, or the Frazer, as a gold producing district. Difficulty of access in gold and fur-hunting is a small obstacle, and in 1871 over a thousand miners forced their way up the canyons of the Stickeen to the Germansen and Black River feeders of the Ominica; the usual rowdy following was after them, and Germansen, the most northernly and most remote of all the gold districts, became suddenly a town The next year fewer miners returned to it, and the more recent and most marvellous discoveries in the Cariboo offering superior attractions, its decadence was almost as marked as its rise, and unless some very signal success is again announced, the nomadic crowd and wild inhabitants of this seven years old "city" will not long continue to grace the rough waters of the Black and Ominica Rivers. The gold which was procured on these bars, and for some time in richly paying quantities, was in very fine uniform sized particles, apparently derived from drift deposits, which had been cut through, washed away, and redistributed by the present action of the rivers.

About 120 miles from the foot of the Lake M'Leod, the Finlay River, from the north-east, and the Parsnip from the south-west, running to this point from opposite quarters, and draining between them 700 miles of the western slope of the Rocky Mountains, unite their volumes. The conjoined streams are nearly 1000 ft. across, the current becomes more rapid, and they rush forward with increased velocity, directly east, towards the great rocky chain which hems them in on every side. During the ten miles between their confluence and the mountains they are constantly being reinforced by streams from half-concealed valleys on either side, combining, says Captain Butler, like a skilful general, all their forces, before making the great struggle with the powers of the mountain mass, which looming up 6000 ft. to 7000 ft in front of them in awful majesty disputed their eastern progress. Directly in front, Mount Selwyn, 7500 ft in height, named from the distinguished geologist who first ascended it, towers up from the river, and completely shuts in the deep abrupt defile, or gash in the mountains, through which the river winds its way for seventy miles through the heart of the great mountain range, as if some giant arm had cleft to its very base the Rocky Andes, and made an easy passage for the imprisoned waters to flow smoothly and tranquilly forward. Scenery of surpassing beauty and sublimity surrounds the deeply embosomed river, and from an isolated summit near the eastern portal, Butler describes a view such as few have an opportunity of witnessing

To the confluence of the Parsnip and Finlay, from which point the united stream is known for 700 miles as the Peace River, the waters of the infant Unchagah have flowed through the heavy forest peculiar to the Pacific slope. The alluvial ground is suitable for the grandest development of the different species of the pine family. In the wet swampy land the black spruce predominates, on drier and more sandy soils, the white spruce is intermixed with the aspen. Sandy and gravelly tracks are known by the thick growth of the black or Banksian pine, whilst the huge Douglas fir flourishes on any of the hill sides, where, with a dry soil, it can enjoy a humid atmosphere. In the whole 300 miles from the Lower Frazer to M'Leod's Lake this grandly wooded region, with its moist warm climate and well-watered ground, produces a forest verdure of the most luxurious type. The giant cedar and the western hemlock attain a size often of 30 ft. in circumference and over 150 ft. in height, whilst the Douglas fir towers to an altitude of 250 ft., and the maple is found 6 ft. in diameter The flora throughout is most varied and magnificent, and even the beautiful dogwood is found 40 ft. high and garlanded with a profusion of white flowers, expanding to a breadth of 3 in. in diameter As the forest is cleared off no doubt the soil will become less moist, and as Germany was to the Romans a land of swamp in summer and rigorous cold in the winter, so is much of our north-west to us; and as the removal of that forest made Germany one of the finest of European countries, so may the cutting down of our northern woods produce a similar result in the future of British America.

The marvellous passage of the mountains produces an entire change, not only in the character of the country, but in the climate, and Mount Selwyn closes the pass to the moist breezes of the Pacific In a few miles, without going south, or making any appreciable descent, the cold wet climate of the western slope is exchanged for the delicious warmth of the prairies, and the luxuriant vegetation of the spring is at least four weeks in advance of the district to the west of the mountains Mount Selwyn is the sentinel that stands at that portal of this great garden of the north-west, the future hope of America, the most prolific and glorious region of promise, which only in recent years has been discovered, and which stamps the grand north-west of Canada as the fairest heritage of the new dominion The climatic conditions of this district are as peculiar and abnormal as its position is unaccountable, and the results are the more astonishing as being directly at variance with our previous experience and preconceived opinions. The general course of the river through the mountains, and for 300 miles towards its outlet, is nearly due east, and about on a parallel of 56 deg. of north latitude, but the climate is milder than it is 3 deg further south, and 2 deg. north of this, on its lower course, we shall find it again still more favourable. On the day of the first ascent of the mountain, July 11, 1875, Selwyn found the thermometer 84 deg at its base, where the river closely hugging its rocky feet is not more than 1530 ft above the sea, and at its summit it was still 82 deg Looking east a blue sultry haze hung over the prairie and the river, whilst west the atmosphere was clearer and colder The limit of the growth of trees was 4000 ft in height, a few scattered and stunted spruces only being found in clumps a few hundred feet higher, but at its summit, the soil between the rocks was carpetted with a profusion of the most lovely Alpine plants, while the anemones and arenarias actually obscured the ground.

For six miles the river circles round the base of Mount Selwyn with a steady rapid current; for the next 50, and this where the range is the highest, its descent is only 140 ft, mostly in a continuous and not very rapid current, whilst for the last 20 miles, through a lower range of the Rocky Mountains, the river is more obstructed in its channel, a succession of low falls and rapids occur, and the descent is more impetuous, and not adapted for navigation The total difference in the level of the water through the whole pass is, however, only 270 ft., being about 1540 ft above the sea at the confluence of the Finlay and Parsnip, and 1270 ft where it finally emerges from the chasm on the eastern side of the mountains. The rocks on each side of this marvellous geological section are principally dark grey or black impure carbonaceous limestone, full of fossils, and in one place a thin seam of coal may be detected high up on the mountain side. In some instances where land-slides have laid bare the edges of the rocks, some beautifully distinct sections are exhibited, the contortions of the strata being often excessive, and almost fantastic in their striking variety. Near the lower end of the gorge, beds of sandstone supervene, some hard and grey without fossils, others softer and brown with an abundance of plant remains.

(To be continued.)

NOTES.

MAGNETISM OF THIN STEEL PLATES.

A CURIOUS and instructive experiment has just been made by M. Duter, who took a number of very thin plates or discs of tempered steel, about a millimetre thick, and from five millimetres to forty centimetres wide, and built them into piles, the adjacent plates being sometimes in contact, and sometimes separated by a sheet of paper or cardboard. These piles were then inserted in a very powerful magnetic field, and withdrawn. It was then found that they had become powerful permanent magnets; but when the individual plates were separated they seemed to have lost their magnetism. On building up the pile again the original magnetism was restored to it. It appears then that the thin plates have not really lost their polarity on being withdrawn from the exciting field Some of Professor D E. Hughes's recent experiments have a great similarity to M. Duter's

A NEW CARBON BATTERY.

A new voltaic battery has been brought out by M Tommasi and M Radiguet, in which peroxide of lead surrounds the carbon plate as it lies on the bottom of the cell The other plate is also of carbon, covered with fragments of retort carbon platinised. The two plates are placed one above the other, but separated by a sheet of parchment paper which divides the containing vessel into two compartments. A saturated solution of chloride of sodium or common salt is filled into both compartments until the upper carbon fragments are partly immersed in it The electromotive force is 0 6 volt The negative pole is that carbon plate which is not in contact with the peroxide of lead If other saline solutions, such as sulphate of ammonia, sulphate of soda, chlorhydrate of ammonia, or even dilute sulphuric acid, be used instead of the solution of salt, the electromotive force does not sensibly vary.

SUBMARINE CABLES.

The Faraday is now engaged in laying the second Bennet-Mackay Atlantic cable from Kenmare Bay in Ireland to Canso in America Dr. Muirhead is at present at the Irish station fitting up his duplex system on the cable already laid, and we understand that he will shortly proceed to America to complete the work there With both the new cables duplexed, the company will have practically four cables at their disposal to compete with the existing lines, and we believe that arrangements have been made with an American telegraph company to give them a land continental system of lines, as well as a sub-Atlantic system. The combination may therefore prove a formidable rival to the Western Union Telegraph Company if it can keep out of the hands of the present powerful monopolies. While upon this subject we may mention the singular case of a living whale, 70 ft. long, being recently caught in one of the West Coast of America Telegraph Company's cables by Captain Morton, of the company's repairing ship The whale was hauled up to the ship's bows in the cable while being repaired, and the wire cutting into its flesh caused the entrails to escape. The whale drifted to windward dead after the cable parted with the strain. *The supposition is that the whale produced the faults in the cable, which was being repaired, by getting entangled in the latter.* If so it must have been caught seven days.

THE EARTH'S MAGNETISM AT PARIS

Very careful determinations of H, the value of the horizontal component of the terrestrial magnetic field, have recently been made at Paris by M. Mascart, the well-known electrician. The measurements were made in the observatory of the Parc St Maur, and the method of Gauss was adopted as one of those giving the most correct results. This consists in oscillating a magnetised bar under the influence of the earth, then placing it a certain distance from another bar submitted to the action of the earth and noting the deviation suffered by the latter. Let

M = magnetic moment of the bar
K = its moment of inertia.
T = the duration of infinitely small oscillations.
R = the distance between the centres of the two bars.
α = the deviation of the auxiliary bar.
a = a constant determined by experiment.

If the deviating bar is perpendicular to the magnetic meridian and directed towards the middle of the bar deviated, we have

$$H = \frac{\pi}{T}\sqrt{K\frac{2}{R\tan\alpha}}\sqrt{\frac{1}{R}\left(1+\frac{a}{R}\right)}.$$

If the deviating bar remains perpendicular to the direction of the bar deviated, tan α should be replaced by sin α. It results from the experiments that the mean value of the horizontal component at the observatory of the Parc St. Maur on July 1, 1884, is H = 0 19 414 ± 0 00012 C.G S. unit. The error is probably below 0 0001.

WATER SUPPLY OF NEWMARKET

New water works have just been inaugurated at Newmarket. The works consist of a well and pumping station at South Field, in the parish of Exning, and they are designed to be capable of supplying 100,000 gallons in twelve hours. The

pumping engine is of the horizontal condensing type, and the pumps are of a three-throw description, one set drawing from the well and delivering into the softening tanks, the other drawing from the tanks and delivering into a reservoir situate on Warren Hill, at a height of about 200 ft above the main street of the town, with the capacity of holding about 250,000 gallons. The works are being adapted to allow of the use of Clark's softening process, which has the effect of reducing the hardness to about four degrees. The shaft of the well from which the water is drawn is 20 ft. deep, having two bore holes of 18 in. each, and each 40 ft. deep The works are arranged to admit of duplication of the machinery should it become necessary, and at present the engines are capable of pumping 400 gallons per minute. The water pumped from the well is conducted into two large tanks in the rear of the pumping station, from which it is conducted to the reservoir at the other end of the town Each tank is capable of containing 100,000 gallons, and adjoining these tanks is a smaller one, used for the preparation of lime water for mixing with the water newly pumped from the well. The water newly pumped is hard, and for the purpose of softening it a flow of lime water in a proportion of one to ten is continued. Each large tank is fitted with a suction float adapted for the withdrawal of surface water only. The whole length of piping laid by the company, including the mains, is estimated at about nine miles The well was sunk at South Field early in September, 1883, and the works were commenced in the beginning of December. The supply was conveniently obtained for the spring meeting of 1884, the Jockey Club stand being supplied in the Craven meeting, week early in April. The estimated yield of the well is equal to twice the present requirements of the town. The total cost of the works—somewhat increased owing to the necessity of applying to Parliament on two occasions—has amounted to 14,000*l*. The works were designed by Messrs. Easton and Co., of 11, Delahay-street, Westminster. The machinery was erected by Messrs. S. S. Stott and Co., of Haslingden, near Manchester; and the buildings, including the reservoir on Warren Hill, were carried out by a local firm, Messrs. Hook and Tebbut, of Goham. Messrs J. Young and Co., of Hertford, laid the pipes which were supplied by Messrs. J. Oakes and Co., of Alfreton, Nottingham.

Hull and Barnsley Railway.

The engineers (Messrs W. Shelford and G Bohn) report that to the 30th of June the construction of the railway proceeded satisfactorily. The number of men then employed on the line was 1900, in addition to skilled labour in connection with stations, bridges, &c. On the 5th of July, however, the contractors discharged about one-half the number of men upon the line, and on the 12th of July they removed the greater part of the remainder, leaving only 300 at present employed, and this number includes those who are engaged in sorting the plant, and upon other work for the contractors' own purposes. The permanent works now in operation are confined to the completion of the swinging bridges over the rivers Ouse and Hull, and the signals and telegraphs. The contractors are holding possession of the line, and are doing such work as is necessary for the public safety, and to prevent severe depreciation of the property. The present condition of the railways and stations is as follows: The earthwork of the main line is completed from the Junctions at North Bretton and Stairfoot, near Barnsley, to the termini at the Alexandra Dock, Dairycoates, and Cannon-street, in Hull, the last-named terminus being that recommended for temporary purposes by Mr. Grierson. The bridges are also practically complete between the same points, so that it is now possible to run a train from end to end of the railway. The permanent way is laid almost throughout between Stairfoot and the Alexandra Dock, Hull, there being only about 1½ miles of double line yet to be laid between the dock and the Lancashire and Yorkshire Railway at Hensall, and about eight miles of double line between that point and Stairfoot. The advances upon plant have been reduced by 68,390*l*. during the past half-year Passenger stations have been more or less completed at the following places, viz. . Beverley-road, Kirk Ella and Willerby, Little Weighton, South Cave, North Cave, Newport, Landholme, Eastrington, Howden, Caulton, and Upton. A commencement has been made also at Kirk Smeaton, Hemsworth, and Sandy Bridge, but the further prosecution of the two last has been deferred for the present. The goods warehouse and yard at Sculcoates, and the running shed for the engines at Springhead, proceeded very satisfactorily until the suspension of work by the contractors. At Cannon-street, Hull, the permanent carriage shed is being converted into a temporary passenger terminus, at the suggestion of Mr. Grierson. Preparations are being made for carrying out the other recommendations of Mr. Grierson, as follows, viz. : For the construction of a goods station and marshalling and sorting sidings between West Dock-avenue and Neptune-street, Hull; for the completion of the junction with the North-Eastern Railway (Victoria branch), the earthwork for which is half completed; the plans for the sidings, and arrangements for exchange of traffic with the Lancashire and Yorkshire Railway at Hensall, the West Riding and Grimsby, the Midland main line, and the Manchester, Sheffield, and Lincolnshire Railway, are under discussion with those companies, and have been for the most part settled. The junction with Swinton and Knottingley joint line is completed, excepting points and signals, and arrangements are being made for obtaining access to the South Kirkby, Monkton Main, and New Oaks collieries.

The Electric Light in the Mechernich Mines.

The electric light installation at the Mechernich Mines in its once volcanic Eifel district in Rhenish Prussia, has now had a fair trial for more than three years and has proved a complete success. The expectation that it would both facilitate the operations and increase their security, has fully been realised, and an extension of the plant is now being carried out. Messrs. Siemens and Halske, of Berlin, undertook the work, which was superintended on their behalf by Mr. Boeddinghaus. An open working 2000 ft. long, 1000 ft. wide, and over 300 ft. deep, in which 300 men and 20 horses are continually occupied, was first to be supplied with the electric light. This part of the mine is excavated in steps, the horizontal terraces being provided with rails. Ordinary lamps in globes on poles were out of the question, as blasting operations continue throughout the day and the shots would soon have made havoc of the lamps. After several trials two powerful lamps, of 3000 candles each, were erected at the upper margin of the pit where they were fairly out of the reach of the projected stones; and reflectors were fixed to throw the light down upon the steps. To find the proper positions for these powerful lamps and to avoid too dark shadows caused some difficulty. But the illumination was finally rendered most efficient, and the open pit with the light playing on the whitish grey rock affords a fine spectacle. As any interruptions, even for short periods, such as those occupied in renewing the lamp carbons, would be dangerous, the whole plant is double; each lamp receiving its current from a D_2 dynamo. No hitch of any kind has occurred, and the safety of the miners has decidedly been augmented. It was formerly not always possible for the superintendents to see whether the loose mass resulting from the blasting operations had been properly removed, and frequent minor accidents arose from the débris falling down upon the miners engaged on the step next below. The work can now be controlled much better than before when petroleum lamps and hand lamps were in use. The cost shows a saving of about 4d. per hour in favour of the electric illumination. The satisfactory results obtained in the open working induced the company to introduce the electric light down in the subterranean galleries. The ore forms little concretions of sand and galena scattered all through the rock; the whole mass has therefore to be brought to day to be disintegrated and sifted, and the mining proceeds in parallel and cross galleries, which are constantly being widened until they become 90 ft. in width, and 70 ft. in height, by sometimes 300 ft. in length. The operations in themselves would not require much light if there was not always danger threatening from loosened pieces of rock. Pitch torches were formerly employed to examine the bore holes and fissures round them after each explosion. It was a question whether the arc lamp would answer for this purpose in the smoky atmosphere. For the first experiments, arc lamps of 3000 and 1000 candles were used, with the positive carbon in the lower holder. The effect was brilliant, yet the light did not penetrate the white smoke cloud which collects at the upper wall immediately after the shot. But as the smoke settles within ten minutes, it was thought advisable to acquiesce in this interruption of a few minutes, and to use smaller lamps of 350 candles, which proved quite efficient. Of these, there are ten in use with about 10,000 ft. of lead cable, the cable being partially elastic, as the lamps with their wires have to be removed when the blasting is to take place. The lamps were originally supplied with hexagonal lanterns with obscured glass to protect the eyes of the miners. The glasses were of course soon broken, but no complaints are said to have been made about the naked electric lights. The proprietors of the mine have decided upon an extension of the installation.

NOTES FROM THE UNITED STATES.

Philadelphia, August 15, 1884.

The interest of the American iron trade centres this week on the question of the proposed restriction of pig-iron production. The latest expression of opinion is to the effect that the restriction may take place in western and southern furnaces, but for a number of reasons it is not likely to take place in the east. There has already been a very heavy restriction in both anthracite and bituminous pig-iron output, and though at present the increasing stocks of unsold material prove that the production is in excess of consumption, the furnace companies prefer to restrict to suit their own convenience. Some companies find a ready market for their production, and most others prefer to keep on. Meanwhile prices of all kinds of crude material are gradually sagging downward, and it is asserted on good authority, that a great deal of material is selling at cost prices. Certain it is, that a fair quality of No. 1 foundry has been bought within the week at 19 dols., No. 2 at 18 dols., and grey forge at 17 dols. delivered. Stocks of foreign iron are remarkably light, and there is a very trifling demand. There has been some call for special grades of Bessemer, but in very small quantities. Quotations are about as follows: 19 dols. for Bessemer, 23.50 dols. for 10 to 12 per cent.; spiegeleisen, 28 dols. for 20 per cent.; 78 dols. for 80 per cent. ferro-manganese; and 40 dols. to 42 dols. for steel blooms. Considerable sales of steel rails have been made during the past week at prices ranging from 27.50 dols. to 29 dols at mill. The Scranton and Bethlehem companies, of this State, are offering stocks at 27.50 dols., and it is rumoured that negotiations for large lots are now under way, and likely to be closed at a shading from 27 dols There is almost no profit at these prices, according to the statements of makers, but the reduction is drawing out a good many buyers, and the mills will be able to secure a good supply of work. Reductions in wages have been announced in two mills, and will probably be made in all, within a short time. There is very little movement in old rails this week, most consumers being provided for the time being. Old bullhead rails are offered at 20 dols. ex ship here; old bridge rails, 21 dols. There are several large orders for structural iron now on the market, aggregating 5000 tons; several good orders have been placed within a few days, and others are about to be placed Bridge iron has been in good request for some weeks, and the works are well supplied with orders. Prices are about as they have been, and will probably be a little firmer, on account of the filling up of the mills and the consequent decrease in competition. Quotations are about as follows: 2.10 cents for angles and plates; 2.15 cents for tank; 2.25 cents for bridge plates; 2.75 cents for tees and shell iron; 3.50 cents for beams and channels; 3.75 cents for flange iron, and 4 cents for firebox.

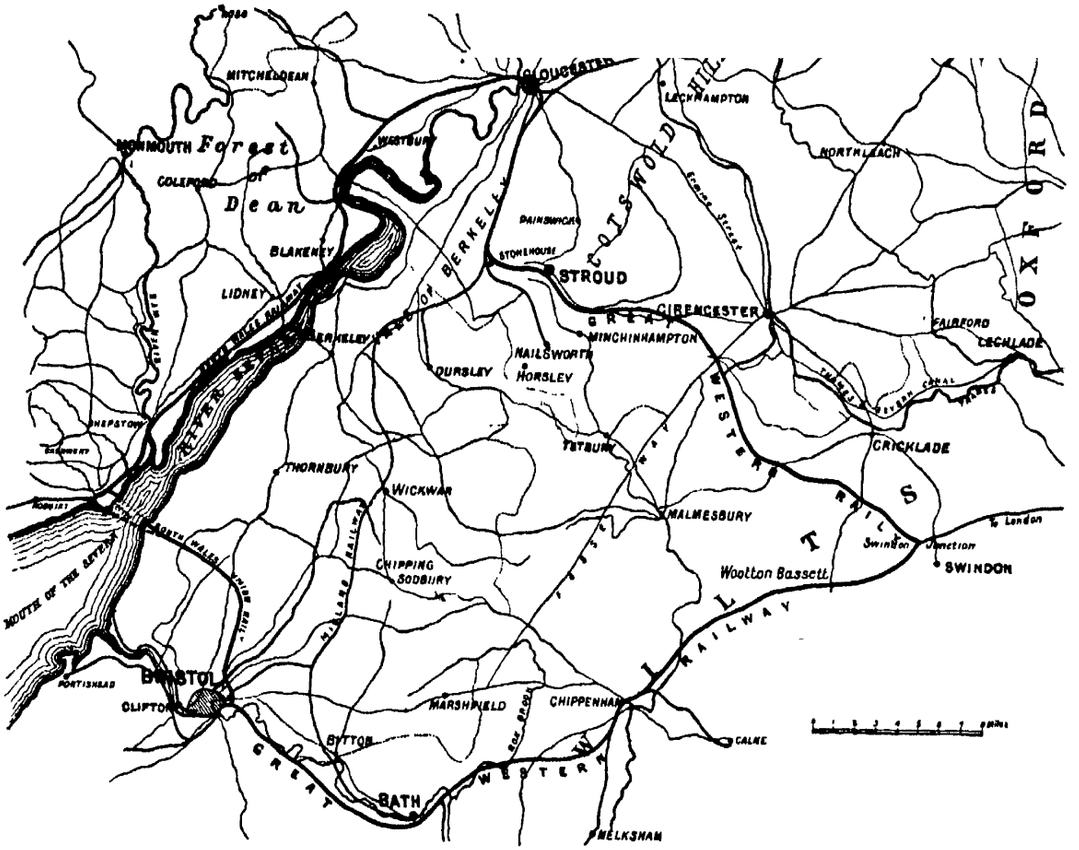
German Metallurgy.—The production of pig iron in Germany in June is officially returned at 278,877 tons. The corresponding production in June, 1883, was 274,857 tons.

The Panama Canal.—The excavation effected in July in connection with this canal amounted to 650,000 cubic metres. The excavation effected previously having been 6,603,302 cubic metres, the aggregate to July 31, 1884, was 7,253,302 cubic metres.

Fast Time for the Illinois Central Railroad.—The Illinois Central Railroad Company recently ran an excursion train over its system from McCoombe Station to New Orleans. The engine drawing the train had 5 ft. driving wheels, and the distance of 105 miles was got over in 119 minutes, being at the rate of about 51¾ miles per hour, stoppages included.

Railways in South Australia.—A large deputation recently waited on the South Australian Commissioner for Public Works, urging the construction of a railway from Riverton to Clare. The construction of this line has been agitated for a number of years, as Clare is the largest town outside Adelaide, which is unconnected with the colonial railway system. Mr. Playford gave, however, a rather discouraging reply to the deputation.

THE SEVERN TUNNEL RAILWAY.



THE SEVERN TUNNEL RAILWAY.*

By J. CLARKE HAWKSHAW.

IN former days before railways existed, one of the coach roads between England and South Wales crossed the Severn near the place where a railway tunnel is now being made. In those times travellers left their coaches on reaching the Severn at New Passage on one side and Portskewet on the other and crossed the river or estuary, which is there about 2¼ miles wide, in open boats.

Later on, lofty wooden piers were made on the banks of the Severn at the two places just named; on to these the trains now run, and passengers there leave them, and are taken across the river by steam ferry boats. The inconvenience of this journey is increased by the great rise of tide, amounting at springs to over 40 ft.

To do away with this break in the railway communication between the two parts of the country, plans were submitted to Parliament, one for the construction of a bridge, and the other of a tunnel.

In the year 1872 Parliament sanctioned the construction of a tunnel, and the work was begun in March, 1873, by the Great Western Railway Company. Shafts were sunk, and from them driftways were driven on the line of the tunnel. In this preliminary work no great difficulty was encountered, and the driftway under the river was nearly completed, only 130 yards remaining to be driven in order to effect a junction, when a large spring burst into the driftway driven landwards from Sudbrook and drowned the works under the river.

This happened on October 16, 1879; Sir John Hawkshaw, who had previously acted as consulting engineer, was appointed engineer-in-chief in conjunction with the engineer Mr. Richardson, and a contract was made with Mr. T. A. Walker for the completion of the works. Considerable progress has been made with them during the last 4½ years, and the tunnel is now rapidly approaching completion.

Site of Works.—The line selected for the tunnel is about half a mile south of the steam ferry between New Passage and Portskewet. The Severn is there about 2¼ miles wide, and is a tidal estuary rather than a river. Owing to the great rise of tide, the current is very rapid, reaching 10 to 11 knots in certain states of the tide. The bed, which is laid bare over two-thirds of the width of the estuary at low water, consists throughout of rock or shale. There are three depressions in it, the most considerable, called the "shoots," is half a mile from the Welsh shore and has a width of 550 yards, and a depth of 60 ft. at low water and 90 ft. to 100 ft. at high water.

Geology.—A section made on the line of the tunnel would disclose below recent surface deposits, a series of trias marls and sandstones lying in nearly horizontal strata on highly inclined beds of coal measure, shales, and sandstones.

On the English shore a level tract of land extends for three miles from the margin of the Severn landwards, terminating abruptly in an escarpment of trias resting on carboniferous limestone which is here brought up by a fault. This level tract lies 9 ft below high-water mark of the Severn during exceptional spring tides, and would be subject to occasional overflows of tidal water if it were not protected by an artificial bank called the sea wall. This flat is covered by a bed of rich alluvium with some peat resting on sand and gravel which lies on the irregular surface of trias marl.

The rocks exposed over the bed of the Severn when the tide is low are trias, marls, and sandstones, and a conglomerate called the dolomitic, which is found forming a bed of varying thickness at the base of the trias. This bed, generally only a few feet thick, attracts attention on account of its characteristic appearance, being formed of large rounded pebbles and boulders embedded in an equably hard matrix, the whole presenting much resistance to erosion, and being conspicuous when parts of the more yielding beds near it have been destroyed.

On the Welsh shore a low cliff of trias marl and sandstone rises about 30 ft above high-water mark, and from thence to the western end of the tunnel this formation is found near the surface covered by some sand and gravel, and in one depression by alluvium, through which the marsh shaft was sunk.

From the western end of the tunnel an alluvial flat extends similar to that met at the eastern end.

The only other formation which need be mentioned is the carboniferous limestone which crops out at the surface at Portskewet Station and also in Portskewet village, 500 yards from the line of the tunnel. This limestone extends over a large tract of high land to the north-west; much of the drainage of limestone is, as is the case in most limestone districts, by underground conduits.

The tunnel itself passes for the greater part of its length through trias mostly in the form of nearly horizontal beds of marl, much jointed, the joints often open, and yielding in many places a great quantity of water near the eastern face; the upper part of the tunnel for a short distance is in the gravel overlying the marl, then wholly in marl passing below the coal measures are reached into a compact fine grained sandstone. The passage from trias marls to the coal measures, which takes place at a distance of about a mile from the sea wall is abrupt owing to faulting. For the remaining distance under the river the rocks traversed consist of coal measure shales and sandstones, under the shoots; where the cover above the tunnel is only 45 ft. the sandstone is strong Pennant, much broken and jointed, though sometimes in massive beds; much water flowed from the open joints in this sandstone in many places.

The tunnel continues in the coal measures for a distance of about a quarter of a mile after reaching the Welsh shore, where they are found in the form of red shales and sandstones, generally very free from water. From these shales the tunnel passes gradually into the overlying conglomerate at the base of the trias. This was the most troublesome formation to tunnel through. At the middle shaft it is 26 ft thick, full of open fissures discharging a great volume of water. From the conglomerate the tunnel again passes into the trias marls, and continues in them for the remaining distance to the western face.

Tunnel.—The total length of the tunnel when finished will be 7664 yards (about 4½ miles); the length of the tunnel sanctioned by Parliament in 1872 was 4½ miles, but in 1883 an application which was granted was made to reduce the length by 13 chains by substituting with length of open cutting for tunnel at the Welsh end. This was done with a view to obtain material for making embankments for sidings at Rogiet Station, where the Tunnel Railway joins the South Wales line.

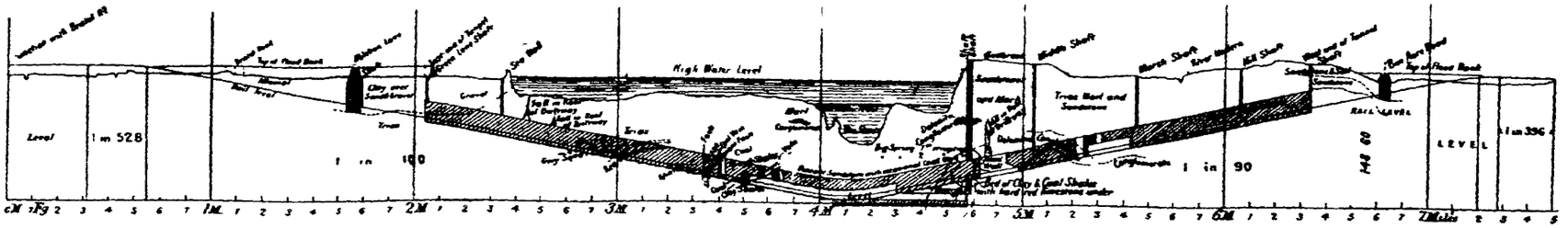
Another important alteration was made in the design after the works had made considerable progress. When Sir John Hawkshaw was appointed engineer in 1879 he recommended that the line of the tunnel should be lowered 15 ft. under the Severn in order to obtain more cover. The lowest part of the line was placed under the shoots, the deepest part of the estuary. The minimum cover then was 30 ft., which has been increased, by lowering the level 15 ft., to 45 ft. Under the shoots the line will be on the level for 12 chains. From this level piece the line rises with a gradient of 1 in 100 towards the English end and 1 in 90 towards the Welsh end. Originally the gradients were 1 in 100 each way. The gradient on the Welsh side was made steeper in order to avoid deepening the cutting at the Welsh end and so save excavation. As the heavier loads are mostly from Wales to England, this alteration of gradient will not be much felt in working the line, and as very little of the Welsh incline lies under the river there is only a short length of tunnel under the Severn which will not be lowered the full 15 ft. The English incline has been lowered 15 ft. throughout. This alteration added about 430,000 cubic yards of excavation to the cutting at the English end.

Prior to this alteration a drainage driftway had been driven from the pumping shaft at Sudbrook to the lowest part of the tunnel heading under the shoots. A second heading has now been driven at a lower level to drain the tunnel as it is being constructed. This heading is circular and 5 ft. in diameter inside the brickwork (13½ in. thick) with which it is lined throughout. Both these drainage headings are shown on the section. The tunnel is for a double line of way lined throughout with brickwork. The top is a semicircle of 13 ft. radius with curved side walls and invert as shown in the transverse section.

Brickwork.—The transverse section of the tunnel shows the lining of brickwork to be 2 ft. 3 in. thick. This was the contract section, but under the shoots under the Salmon Pool and in other parts where the nature of the ground rendered it advisable, the thickness was increased to 3 ft. in the arch and side walls. In a few places the invert was reduced to 1 ft. 10 in. and 1 ft. 6 in. in thickness. The bricks used are all vitrified. They are fro

* Paper read before the British Association at Montreal.

SECTION OF THE SEVERN TUNNEL, SHOWING PRESENT CONDITION OF WORKS.


High Water Level
Level
1 in 528
1 in 100
1 in 90
LEVEL
1 in 396
Trias Marl and Sandstone
Marsh Shaft
Middle Shaft
Hill Shaft
Low Water
Lighthouse
Rock Levels
Mud Level
Trias
Gravel
Sandstone
Conglomerate
Marl
Limestone
Shale
Coal
Fault
Level of Clay & Coal Shales
North Hard and Limestone under
Mud Level
Low Water Level
Top of Rock
Top of Tunnel
Bottom of Tunnel
Bottom of Rock
Top of Tunnel
Bottom of Tunnel
Top of Rock

PARTICULARS OF PUMPS IN USE AT THE SEVERN TUNNEL.

Name of Pump or Locality.	Diameter of Working Barrel.	Stroke	Gallons per Stroke.	Number of Strokes Allowable	Gallons per Minute.	Total Gallons per Minute
	in.	ft. in				
Ableton lane "bucket"	15 by 2	6 6	100	12	1200	1,200
Sea wall "plunger" . .	15½ by 2	7 0	114	12	1368	1,368
No. 1 bull "plunger"	26	10 0	231	12	2772	
No. 2 " " .. .	26	10 0	231	12	2772	
75 in. beam "bucket"	25	9 0	575	13	4500	
70 " " "plunger"	18 by 2	10 0	487	9	4383	
70 " " "bucket" . .	28	10 0				
New 70 in. beam "plunger"	30	10 0	518	12	6216	
" " "bucket" . .	35	9 0	375	12	4500	
" 60 in. " " .	31	9 0	295	12	3540	
Total at Sudbrook	.	.	.			28,683
41 beam bucket and side pump .	28	9 0	248	14	3472	
Horizontal plungers and side pumps .	18 by 2	8 0	198	10	1980	
Old horizontal plunger	20	7 0	95	7½	712	
New 60 in. "bucket" . . .	31	9 0	295	12	3540	
Total at 5 m. 4 c. (middle shaft)	.					9,654
Marsh "plungers"	15 by 2	6 6	100	14	1400	
22 "bull" "	15	7 0	54	12	648	
Compressed air engine .			250	2½	625	
Total at marsh . .						2,673
Hill "plungers"	15 by 2	6 0	100	12	1200	1,200
Cutting No. 2 . .	15 by 2	7 0	108	12	1296	1,296
					Total	46,074

N B.—No deduction has been made from the above quantities for slip

which was not lined, and one pumping shaft at Sudbrook intended to be a permanent pumping shaft, which is lined with cast-iron tubbing.

Driftways.—As has been already stated the driftways originally driven were bottom driftways, but owing to the alteration in the level of the tunnel they ceased to be so before the enlargement, for the permanent work was begun under the Salmon Pool, and under the shoots the arch of the tunnel was turned without sidewalls from the existing driftway. It was, however, soon found necessary to drive a new one at invert level for drainage purposes throughout nearly the whole length of the work.

The driftways were from 7 ft. to 9 ft. square. Timber was not required in them in the more compact beds of marl and sandstone and in the conglomerate.

Ventilation.—So long as the driftways from the different shafts were in progress ventilation was effected by the compressed air which was used for the rock drills, supplemented in one or two cases by pipes of larger diameter through which air was forced by blowers. After the driftways had been joined under the river a fan was provided at Sudbrook 18 ft. in diameter by 7 ft. wide, worked by an engine of 10 horse-power. This fan effectually ventilated the workings under the river. Electric light is largely used both above ground and in those parts of the workings underground where the brickwork is completed. Lights of 2000 candle-power are suspended at intervals of about ten chains in the finished parts of the tunnel; much vitiation of the air is prevented by the use of these lights.

THE BRITISH ASSOCIATION.

*Address to the Mechanical Science Section of the British Association.**

By SIR F. J. BRAMWELL, F.R.S., V.P. Inst. C.E., President of the Section.

IN a family of seven children there are two who are of paramount importance: the eldest, at the one end of the scale, important, because he is the heir, the first-born; and at the other end of the scale, the little Benjamin, important because he is the last, the youngest, and the dearest. The position of little Benjamin is not, perhaps, quite as honourable as that of the heir, and not, when the family breaks up, by any means as good; but while the family holds together, Benjamin receives an amount of attention and consideration that does not fall to the lot of any one of the intermediates, not even to the heir himself. But there is one risk about Benjamin's position, a risk that cannot appertain to the post of the first-born; little Benjamin may be deposed by the advent of a lesser Benjamin than himself, whereas the first-born becomes (if possible) still more the first-born for each addition to the family. Perhaps some of you may say, Be it so; but what has this to do with the address of the President of Section G? Those who make this inquiry, however, certainly have not present to their minds the change that has this year taken place. Up to and including the Southport meeting, Section G was the little Benjamin among the seven sons of the B.A. (I will not waste your time by giving the name of the Association in full, nor will I affront you by using an abbreviation which is occasionally improperly applied), but at Montreal appears Section H, and G becomes relegated among those uninteresting members of the family who are neither the important head nor the cherished tail. I grieve for Benjamin, and I think the present occasion an apt one for magnifying Section G. Apt for two reasons: the foregoing one, that H has deposed it from its position; the other, that we are meeting in Montreal—and in reference to this latter reason, let me ask, Is it not the fact that to the labours of the men who have been, or are (or ought to be) members of Section G is due the possibility of the meeting taking place on this side of the Atlantic?

* Delivered at Montreal.

At our jubilee meeting at York, I called the attention of the section to the fact that in 1831, when the Association first met in that city, they arrived there laboriously by the stage-coach, and that practically the Manchester and Liverpool, the Stockton and Darlington, and some few others, were the only railways then in existence. I also called their attention to the fact that in 1831 there were but very few steamers. I find the total number registered in the United Kingdom in that year was only 447. If under this condition of things, the proposition had been made in 1832 at Oxford, as it was made in 1882 at Southampton, that the next meeting but one of the Association should take place in Montreal, the extreme probability is that the proposer would have been safely lodged in a lunatic asylum, for suggesting that that which might have involved a six weeks' voyage out, and a four weeks' voyage back, could ever be seriously entertained. Further, to give once more the hackneyed quotation, some few years after this, *i. e.* in 1836, Dr. Lardner established to his own satisfaction conclusively, that no vessel could ever steam across the Atlantic the whole way. A striking instance of the mistakes made by scientific speculation; a branch of science widely differing in the value of its results from those branches which deal with absolute demonstration. Undeterred, however, by such adverse opinion, the engineers "kept on pegging away," experimenting, improving, and progressing, until the scientific speculation was met with the hard fact of the Atlantic voyage steamed the whole way by the Sirius and by the Great Western in 1838. The impossible was proved to be the possible, and from that day to this the advancement of steam ocean navigation has continued. The six weeks' voyage, sailing westward, of the year 1831, has become converted into but little over six days. And thus it is that that which would have been a mad proposition in the year 1832, became a perfectly rational one in 1882; and the deliberations of the General Committee on the proposition were not directed as to whether it would be possible to convey the members with certainty, expedition, and economy across the Atlantic, but as to whether it was expedient or not on general grounds to hold for the first time a meeting of the British Association elsewhere than in some city of the United Kingdom. I say again that the possibility of such a meeting is absolutely due to the engineer, and that therefore, on this ground, the present is an appropriate occasion to magnify G, the Mechanical Section of this Association.

It is true that the man who looks only at that which is on the surface may say, "You arrogate too much to yourselves. You ignore (to which I say Heaven forbid!) the skill and daring of your sailors. You ignore commercial enterprise. You ignore the development of iron and steel manufacture, which have enabled you to build the steamers of the present day. You ignore the increased output of the best steam coal in the world, and you attribute the whole result to the engineer." Such an objector would be in the condition of that man who, in answer to George Stephenson's question, "What is causing that railway train to move?" said, "Why, I suppose the coal that is burning in the locomotive;" and who was met by that grand and comprehensive answer, that it was the "sun," for the coals were a consequence, and not a first cause. Similarly I venture to say that the mechanical engineer may lay claim to be the central source which has vivified and given rise to the improvements in the manufacture of iron and steel, in the construction of engines, and in the development of our collieries.

There are those I know who object that Section G deals too little with pure science, too much with its applications. It may be as the members of Section G might retort, that it is possible to attend so much to pure science as to get into the unchecked region of scientific speculation, and that had the members of Section G been debarred from the application of science, the speculation of Dr Lardner might to the present day have been accepted as fact.

I have quoted it before, but it has so important a bearing on this point, and comes from a man of such high authority, that I cannot refrain from once more giving you Dr. Tyndall's views on this question.

"The knowledge of nature, and the progressive mastery over the powers of nature, imply the interaction of two things—namely, thought conceived and thought executed; the conceptions of the brain, and the realisation of those conceptions by the hand. The history of the human intellect hardly furnishes a more striking illustration of this interaction of thought and fact than that furnished by the Association of Physics and Engineering. Take, for instance, the case of steam. Without knowing its properties, the thought of applying steam could not have arisen, hence the first step was physical examination. But that examination suggested practice, and the steam engine at last saw the light; thus experimental physics was the seedling from which the steam-engine sprang. But the matter did not end here; the positions of debtor and creditor were soon reversed, for the stupendous operations of the steam engine forced men of thoughtful philosophic minds to inquire into the origin of the power of steam. Guess succeeded guess, inspiration succeeded inspiration; the ever present fact of our railways, and our power looms, and our steamships gave the mind no rest until it had answered the question, How are heat and steam, its instruments, related to mechanical power? Had the works of the engineer not preceded the work of the natural philosopher, this question would never have been asked with the emphasis, nor pursued with the vigour, nor answered with the success, which have attended it. It was the intellectual activity excited by the work which the civil engineers of England had accomplished that gave to philosophy the theory of the conservation of energy including the dynamical theory of heat. . . . The engineering genius of the future is certain to derive from this theory strength and guidance. Thus necessarily has thought originated fact, and fact originated thought. In the development of science these two powers are coequal, each in turn ceasing to be a consequence, and becoming a creative cause. The Atlantic cable also had its small beginnings in the laboratory of the physical inquirer. Here, as before, experimental physics led the way to engineering facts of astounding magnitude and skill. But here also the positions of debtor and creditor have been reversed, for the work of the engineer has caused the physical inquirer to pursue his investigations with a thoroughness and vigour, and has given to those investigations a scope and magnitude which, without the practical stimulus, would have been impossible. The consequence is that the practical realisation of sending electric messages along the bottom of the Atlantic has been an immense augmentation of our knowledge regarding electricity itself. Thus does the human intelligence oscillate between sound theory and sound practice, gaining by every contact with each an accession of strength. These two things are the soul and body of science. Sever sound theory from sound practice, and both die of atrophy. The one becomes a ghost and the other becomes a corpse."

I think all men, even although they be followers of science in its purest and most abstract form, must agree that these words are words of sound sense, well worthy of being borne in mind and of being acted on, and will, therefore, concur in the propriety of Section G dealing with engineering subjects generally as well as with abstract mechanical science. Once admitting this, I may ask—certain what the answer must be—whether there is any body of men who more appreciate and make greater use of the applications of pure science than do the members of this section. Surely every one must agree that we engineers are those who make the greatest practical use not only of the science of mechanics but of the researches and discoveries of the members of the other sections of this Association.

Section A. *Mathematical and Physical Science.*—The connection between this section and Section G is most intimate. With any ordinary man I should have referred, in proof of this intimate connection, to the fact that the President of A this year is a member of the Council of the Institution of Civil Engineers, but when I remind you that it is Sir William Thomson who fills this double office, you will see that no deduction such as I have hinted at can be drawn from his dual functions, because the remarkable extent and versatility of his attainments qualify him for so many offices, that the mere fact of his holding some one double position is no certain evidence of the intimate connection between the two. But setting aside this fact of the occupancy of the chair of A by a civil engineer, let us remember that the accomplished engineer of the present day must be one well grounded in thermal science, in electrical science, and for some branches of the profession in the sciences relating to the production of light, in optical science and in acoustics; while in other branches, meteorological science, photometrical science, and tidal laws are all important. Without a knowledge of thermal laws, the engineer engaged in the construction of heat motors, whether they be the steam engine, the gas engine, or the hot-air engine, or engines depending upon the expansion and contraction under changes of temperature of fluids or of solids, will find himself groping in the dark; he will not even understand the value of his own experiments, and therefore will be unable to deduce laws from them; and if he make any

progress at all, it will not guide him with certainty to further development, and it may be that he will waste time and money in the endeavour to obtain results which a knowledge of thermal science would have shown him were impossible. Furnished, however, with this knowledge, the engineer starting with the mechanical equivalent of heat, knowing the utmost that is to be attained, and starting with the knowledge of the calorific effect of different fuels, is enabled to compare the results that he obtains with the maximum, and to ascertain how far the one falls short of the other; he sees even at the present day that the difference is deplorably large, but he further sees in the case of the steam engine, that which the pure scientist would not so readily appreciate, and that is, how a great part of this loss is due to the inability of materials to resist temperature and pressure beyond certain comparatively low limits; and he thus perceives that unless some hitherto wholly unsuspected, and apparently impossible, improvement in these respects should be made, practically speaking the maximum of useful effect must be far below that which pure science would say was possible Nevertheless, he knows that within the practical limits great improvements can be made, he can draw up a debtor and creditor account, as Dr. Russell and myself have done, and as has been done by Mr. William Anderson, the engineer, in the admirable lecture he gave at the Institution of Civil Engineers in December last on "The Generation of Steam and the Thermo-Dynamic Principles Involved." Furnished with such an account, the engineer is able to say, in the language of commerce, I am debtor to the fuel for so many heat units, how, on the credit side of my account, do I discharge that debt? Usefully I have done so much work, converted that much heat into energy. Uselessly I have raised the air needed for combustion from the temperature of the atmosphere to that of the gases escaping by the chimney; and he sets himself to consider whether some portion of the heat cannot be abstracted from these gases and be transmitted to the incoming air. As was first pointed out by Mr. Anderson, he will have to say a portion of the heat has been converted into energy in displacing the atmosphere, and that, so far as the gaseous products of coal are concerned, must, I fear, be put up with. He will say, I have allowed more air than was needed for combustion to pass through the fuel, and I did it to prevent another source of loss—the waste which occurs when the combustion is imperfect; and he will begin to direct his attention to the use of gaseous or of liquid fuel, or of solid fuel reduced to fine dust, as by Crampton's process, as in these conditions the supply may be made continuous and uniform, and the introduction of air may be easily regulated with the greatest nicety. He will say, I am obliged to put among my credits—loss of heat by convection and radiation, loss by carrying particles of water over with the steam, loss by condensation within the cylinder, loss by strangulation in valves and passages, loss by excessive friction or by leakage; and he will as steadily apply himself to the extinction or the diminution of all such causes of loss, as a prudent Chancellor of the Exchequer would watch and cut down every unproductive and unnecessary expenditure. It is due to the guidance of such considerations as these that the scientific engineer has been enabled to bring down the consumption of fuel in the steam engine, even in marine engines such as those which propelled the ship that brought us here, to less than one-half of that which it was but a few years back. It is true that the daily consumption may not have been reduced, that it may be even greater, but if so it arises from this, that the travelling public will have high speed, and at present the engineer, in his capacity of naval architect, has not seen how—notwithstanding the great improvements that have been made in the forms of vessels—to obtain high speed without a large expenditure of power. I anticipate from the application of thermal science to practical engineering, that great results are before us in those heat motors, such as the gas engine, where the heat is developed in the engine itself. Passing away from heat motors, and considering heat as applied to metallurgy From the time of the hot blast to the regenerative furnace, it is due to the application of science by the engineer that the economy of the hot blast was originated and that it has been developed by the labours of Lowthian Bell, Cowper, and Cochrane Equally due to this application are the results obtained in the regenerative furnace, in the dust furnace of Crampton, and in the employment of liquid fuel, and also in operations connected with the rarer metals, the oxygen furnace and the atmospheric gas furnace, and, in its incipient stage, the electrical furnace. To a right knowledge of the laws of heat and to their application by the engineer must be attributed the success that has attended the air-refrigerating machines, by the aid of which fresh meat is at the end of a long voyage delivered in a perfect condition; and to this application we owe the economic distillation of sea water by repeated ebullitions and condensations at successively decreasing temperatures, thus converting the brine that caused the ancient mariner to exclaim, "Water, water everywhere, nor any drop to drink," into the purest of potable waters, and thereby rendering the sailor independent of fresh-water storage.

With respect to the application by the engineer of electrical science, it is within the present generation that electricity has passed from the state of a somewhat neglected scientific abstraction into practical use; first, by the establishment of the land telegraph, then by the development into the submarine cable, by means of which any one of us visitors here in Canada may be in instant communication with his own country, and may be so without a selfish exclusive occupation of the cable, for once more the application of science has solved that apparently impossible problem of employing a single wire to be at one and the same time the transmitter of multiple electric messages, and messages in opposite directions. Then, thanks to the application of Faraday's great discovery of induced electricity, there has been, during the last quarter of a century, the progressive development of the dynamo-machine, whereby the energy of ordinary motors, such as steam engines, is converted into electrical energy, competent to deposit metals, to (as has already been said) fuse them, to light not only isolated buildings, but extensive areas of towns and cities, and to transmit power to a distance, whether for manufacturing purposes or for the railway or tramcar; and thus the miracle is performed of converting a waterfall into a source of light, as at Sir William Armstrong's house, or into the origin of power for a railway, as at the Giant's Causeway. To the application of electrical science is due the self-exciting of the dynamos and the construction of secondary batteries, enabling a development of electricity to be continued for many hours. In the United Kingdom, general electric lighting, that is to say, the lighting of large sections of a town from a central station, has been stopped by the most unwise, because most unjust, conditions imposed by the Government General Electric Lighting Act of 1882. A new and meritorious industry, which should have been granted the same privileges as are accorded to other industrial undertakings needing Parliamentary powers, was subjected to this most unjust condition: that at the end of twenty-one years the public authority of the town or place lighted should have the option of buying the undertaking for the then value of the mere materials, and that if the authority did not choose to purchase (for it was not bound to buy), at every subsequent five year period this option should re-arise; that is to say, that a new undertaking, which would require years for its general acceptance (for the public is slow to take up a novelty), was, after the experimental and non paying stage had been passed, to be practically forthwith taken away for a mere fraction of the capital that had been outlaid if the undertaking paid, but was not to be taken away if it did not pay. Such, in spite of the teaching of Section F, is the condition to which our Government has arrived in respect of economic science. The next electrical matter I have to touch upon, that of the telephone and microphone, with which will for ever be associated the names of Graham-Bell, Edison, and Hughes, has, as regards the public use of the telephone, been all but similarly treated in the United Kingdom. It has been declared to be within the telegraphic monopoly given by Parliament to the Post Office nine years before the telephone was invented, and the power to use it depends entirely upon the grace and favour of the Post Office, a grace and favour not always accorded; and even when accorded, coupled with limitations as to distance, and coupled with a condition of payment of 10 per cent. of the gross receipts by the companies to the Post Office, as a royalty; and all this because Government has become a trader in electrical intelligence, and fears the competition of the telephone with its telegraphs.

No one in the ship-loving countries of England, Canada, and the United States can refrain from feeling the warmest interest in all connected with navigation, and we know how frequently, alas! the prosperous voyage across the wide and fathomless ocean ends in shipwreck and disaster when the wished-for shore is approached, and when the sea is comparatively shallow. Except for the chance of collision, there is in a staunch ship little danger in the open ocean, but on nearing the shore not only is the liability to collision increased but shoals and sunken rocks render navigation perilous, and it is on the excellence of the lighthouses and lightships, that (coupled with sound ings) the sailor relies. These structures and appliances are confided to the engineer, and to be efficient they require him to be able to apply the teachings of Section A in optical science, and in the case of fogs, or as regards buoys at night-time, the science of sound. I parenthetically alluded to soundings as one (indeed a principal one) of the safeguards of ships when approaching shore. It is important in these days of high speeds that these should be made with ease and without the necessity of stopping the ship, or even of diminishing its velocity. Sir William Thomson, by the application of the science of pneumatics, has enabled this to be done. Again, most important is it that the compass, midst all the difficulties attendant upon its being situated on an iron or steel structure, should be trustworthy. And here Sir William has applied the science of magnetism in his improved compass to the practical purposes of navigation.

To go to another important branch of engineering—water supply. The engineer dealing with a district to be fed from the surface will find himself very deficient if he have not the power of applying the science of meteorology to the work that he has in hand; he must know, not the average rainfall, for that is of but little use to him, but the maximum, and most important of all, the minimum rainfall over a consecutive period of years; the maximum so that he may provide sufficient channels and by-washes for floods; the minimum so as to provide sufficient storage. He must know what are the losses by evaporation, what are the chances of frost interfering with his filters and with his distributive plant.

Coming to the mathematical side of Section A, whether we consider the naval architect preparing his design of a vessel to cleave the waves with the least resistance at the highest speed, or whether we consider the unparalleled series of experiments of that most able Associate of Naval Architects, the late William Froude, carried out as they were by means of models which were admirable in their material, their mode of manufacture with absolute accuracy to the desired shape, and their mode of traction and of record, we must see that both architect and experimenter should be able to apply mathematical science to their work, and that it is in the highest degree desirable that they should possess, as Froude did, those most excellent gifts, science and practical knowledge.

Again, the mathematical side of Section A has to be applied by engineers when considering the strength and proportion of boilers, ships, bridges, girders, viaducts, retaining walls, and in short the whole of the work with which an engineer is intrusted. Notable instances of great bridges will occur to all our minds, especially meeting as we are in this continent of grand streams, Eads' St. Louis Bridge, Roeblings' Niagara Bridge, and his and his sons' East River Bridge, Gzowski's International Bridge, and going back to our own land, Fowler's and Baker's Bridge over the Forth.

Passing from Section A to Section B, there is evidently so much overlapping of these sections that a good deal that I have said in reference to Section A might properly have been reserved for Section B. The preparation from the ore of the various metals is in truth a branch of engineering; but to enable this to be accomplished with certainty, with economy, involving the not throwing away of that which is called the waste product, but which is frequently a valuable material, it is essential that the engineer and the chemist should either be combined in one and the same person, or should go hand in hand. In the manufacture of pig iron it is absolutely necessary that the chemical constituents of the ore, the fuel, and the flux should be thoroughly understood, and that the excellence of the process followed should be tested by an analysis of the slag. For want of this chemical knowledge thousands upon thousands of tons of bad pig iron have been made, and thousands upon thousands of tons were formerly left in the issuing slag. Similar remarks apply to the production of lead and of copper from the ores, and still more do they apply to that great metallurgical manufacture of the last few years—"steel." In the outset steel was distrusted because of the uncertainty of its behaviour, but the application of chemical science now enables the manufacturer to produce with precision the material required to fulfil the physical tests imposed by the engineer.

Reverting to the water engineer, the chemist and the microscopist have their sciences applied to ascertain the purity of the intended source, and, as in the case of Clarke's beautiful process, by the application of chemistry, water, owing its hardness to that common cause, carbonate of lime, is rendered as soft as the water from the mountain lake. Taking that other branch of engineering commonly coupled with water, viz., the supply of gas, the engineer is helpless without the application of chemistry. From the examination of the coal to be used, to the testing of the gas to be supplied, there is not one stage where chemical science is not necessary. The consumer requires gas which shall be as nearly as possible a pure hydro-carbon of high illuminating power, and it might well have been that a person to whom was delivered the crude gas as it issued from the retort would have said, "Certain things may be separated out more or less, but to practise on a wholesale scale the delicate operations which will be needed to cleanse the illuminating gas from its multifarious accompanying impurities is a hopeless undertaking, and must be so if for no other reason than this—the excessive cost that would be entailed." But what are the facts? Although I for one do not like to sit in a room where gas is burnt, unless special provision is made for taking away the products of combustion, the engineer of the present day, thanks to the application of chemical science, delivers gas to the consumer in a state of comparative purity (although it may have been made from impure coal) which but a few years ago would have been deemed impossible; and so far is this improvement from being attended with extra cost, that the residual products not now uncommonly all but pay the whole cost of the coal, and in some rare instances even leave a slight profit to go towards the charge for labour. Again, it is by the application of chemical science in the dynamite and the gun-cotton of the present day that the engineer is enabled to prepare submarine foundations, to blast away shoals, and to drive tunnels through rock of a character that cannot be dealt with by mere cutting machines. Equally to the application of chemistry is it due that there are hopes, by the employment of lime cartridges, of breaking down coal without that risk of igniting fire-damp which is attendant upon the use of gunpowder. I need hardly observe that much more might most pertinently be said on the way in which the engineer applies chemical science. In fact, those ways are so multifarious, that a volume might be written upon them, but I must pass on and ask you to consider how the engineer applies geological science, the science treated by Section C.

I have already spoken of the engineer supplying towns by water collected from the surface; even he, however, must have a knowledge of geology, for without it he will not know what places are apt for the huge reservoirs he constructs, nor where he can in safety make his enormous embankments. In this continent of vast lakes one feels it must excite a sensation of the ridiculous when a "Welsh lake" is spoken of, but I must ask you to believe you are in Lilliput, and to imagine that the "Bala Pond" of 110 acres in extent is really "Bala Lake," as it is called. Within a few miles of that, our friends at the other end of the Atlantic steam ferry, the inhabitants of Liverpool, are now constructing under the engineering and advice of Mr. Hawksley, a water works which will involve the formation, I believe one may safely say the reformation of a lake, practically the same area as that of Bala, of some 80 ft. in depth, and containing between the overflow and the point of lowest discharge nearly twelve thousand million gallons. This lake will be made by the throwing from side to side of the valley of a solid stone bank, 100 ft. above the ground, 140 ft. above the deepest part of the foundations, and 113 ft. thick at its thickest part. Contrasted with Lake Superior this new lake will be small, a thing demanding a microscope even, but the bursting of the wall would liberate a body of water sufficient to carry death and ruin throughout a considerable district. It is, therefore, in the highest degree important that whether he be constructing the solid stone wall, or the more common earthen embankment with a puddle trench, the engineer should so apply geological science as to insure the safety

of his work. But in those cases where the water works engineer has to derive the supply from underground sources, the application of this science is still more necessary; he must know whether he is likely to find a water bearing stratification at all—if so, where it receives the rain from heave., and the extent of the area which receives it; in what direction the water travels through it, what is the varying height of water in the different parts of the stratification giving the "head" to produce that travel; how far this height is likely to be affected by the pumping of the desired quantity; whether, if near the overflow into the sea, the pumping is likely to reverse the direction of the current, and to bring back brackish water, and whether the rocks are of such a character as to be liable to yield a water impregnated with iron or with lime, and whether these water-bearing rocks are accessible from the surface without the execution of costly and laborious work in passing through overlying stratifications of an unfit or it may be even of a dangerous character. It need hardly be said that the engineer when engaged in metalliferous mining, or in the extraction of coal or of petroleum, unless he applies the science of Section C, is but a haphazard explorer whose work is more likely to end in disaster than in success. Again, the engineer, when laying out a railway, has to consider the geological features of the country in determining the angles of his cuttings, and to determine where it becomes more economical to tunnel than to cut. Indeed, without the application of that science to engineering there are some enterprises on the feasibility of which the engineer would not be able to pronounce an opinion—a notable instance, the Channel Tunnel. The engineers, of whom I am one, said there is a material, the compact non-water-bearing grey chalk which we have at a convenient depth on the English side and is of all materials the most suitable; if that exist the whole way across, success is certain Then came geological science, and that told the engineer that in France the same material existed; that it existed in the same position in relation to other stratifications as it existed in England; that the line of outcrop of the gault lying below it had been checked across; and that, taken together, these indications enabled a confident opinion to be expressed that it was all but certain this grey chalk stratification did prevail from side to side. The engineers believed it, an intelligent section of the public believed it, and came forward with their money; large sums were expended in England and in France on the faith of the repeated declaration of the English Government (of both sides of politics) that so long as the nation was not called on to contribute towards the cost of the work, it would hail with satisfaction the improved means of communication between England and the Continent; the experimental works were carried on from both sides with the happiest results, and then, when success appeared certain, the whole work was stopped by the incredible suggestion that in the event of a war the soldiers of England, and the science of England, could not defend a couple of rat-holes, holes 14 ft. in diameter and 20 miles long, situated far below the surface of the sea, having a rapid dip from the shore to a low point, gradually rising from there to the centre of the length of the tunnel, so that the English end could be flooded with sea-water in twenty-five minutes up to the soffit of the arch at the dip; and in consequence of this incredible and most-to-be-ashamed-of scare it is due that one of the finest instances of civil engineering work in connection with the science of geology, and as I believe one of the most useful works that has ever been proposed, has been put a stop to.

To come to Section D, the botanical side of it is interesting to the engineer as instructing him in the locality and quality of the various woods that he occasionally uses in his work. With regard to that most important part of the work of D, which relates to "germs" and their influence upon health, the engineer deals with it thus far: he bears in mind that the water supply must be pure, and that the building must be ventilated, and that excreta must be removed without causing contamination; thus the water works engineer, the warming and ventilating engineer, and the sewage engineer can (and do) all of them profit by the labours of Section D, and can by their works assist in giving practical value to the pure science of that section.

Section E. *Geography*.—Probably in these days, when our kingdom at home and the old countries near us are all but full of the works of the engineer, there are few who take a greater interest in geography than he does, and I am quite sure there are none who make a more useful application of geographical knowledge for the benefit of mankind at large than does the engineer. Almost at the outset of this address I claimed to magnify Section G, on the ground that without the aid of its members we should not have had that practical lesson in geography which we have received by our visit here, a lesson that no doubt will be continued and amplified by many of us before we return to our homes. Whether it be by the ocean steamer or by the railway train, the enterprising geographical explorer is carried to or through countries which now, thanks to the engineer, are well known and settled, up to the beginning of the unknown and not settled; and thus his labours are lightened, he consumes his energies only upon his true work, brings back his report, which is, as I have said, studied by the engineer with a view to still further development, and thus turn by turn the geographer and the engineer carry civilisation over the face of the world.

Now to come to Section F, which treats of economic science. The matters with which this section deals—birth rate, death rate, the increase or the diminution of populations, the development of particular industries in different localities, the varying rates of wages, the extent and nature of taxation, the cost of production, the cost of transport, the statistics of railway and of marine disasters, the consumption of fuel, and many matters which come within the purview of F, are of importance to the north-west. Guided by the information given by the representatives of this section, he comes to the conclusion of having a particular object in view should or should not the works undertaken. With the information derived from the past he judges of the future; he sees what provision should be made for prospective increase of population or of industries; he sees the chances of the commercial success of an undertaking or of its failure, and he advises accordingly.

I do not propose to say anything about Section H, for I have dealt with it as being still included within D.

I trust I have now established the proposition with which I set out, viz., that not only is Section G the section of Mechanical Science, but it is emphatically the section of all others that applies in engineering to the uses of man the several sciences appertaining to the other sections, an application most important in the progress of the world, and an application not to be lightly regarded, even by the strictest votaries of pure science, for it would be vain to hope that pure science would continue to be pursued if from time to time its discoveries were not brought into practical use.

Under ordinary circumstances I should have closed my address at this point, but there is a subject which at this, the first meeting of Section G after the meeting at South port, must be touched upon. It is one of so sad a character that I have avoided all allusion to it until this the very last moment, but now I am compelled to grapple with it

In the course of this address I have had occasion to mention several names of eminent men, many of them happily still with us, some of them passed away; but I doubt not you have been struck by the absence of one name, which of all others demands mention when considering physical science, and still more does it come vividly before us when considering the application of science to industrial purposes I am sure I need not tell you that this name, which I can hardly trust myself to speak, is that of our dear friend William Siemens, whose contributions to science, and whose ability in the application of science, have for years enriched the transactions of this section, and of Sections A and B, for in him were combined the mechanic, the physicist, and the chemist.

But a brief year has elapsed since he quitted the presidential chair of the Association, and, with us at South port, was taking his accustomed part in the work of this and of other sections, apparently in good health, and with a reasonable prospect of being further useful to science for many valuable years to come. But it was not to be; he is lost to us, and in losing him we are deprived of a man whose electrical work has been second to none, whose thermic work has been second to none, and whose enlarged views justified him in embarking in scientific speculations of the grandest and most profound character Whether or not his theory of the conservation of the energy of the sun shall prove to be correct, it cannot be denied that it was a bold and original conception, and one thoroughly well reasoned out from first to last.

I feel that were I to attempt anything like the barest summary of his discoveries and inventions, I should set myself a task which could not have been fulfilled had I devoted the whole of the time I had at my command to the purpose I had, indeed, thought of making his work the subject of my address, but I felt that his loss was so recent that I could not trust myself to attempt it There is no need for me to dwell further upon this most painful topic He was known to you all, he was honoured and loved by you all, and by every member of this Association he had so faithfully served, and over which he had so ably presided; and he enjoyed the respect and esteem of the best intelligence of England, the land of his adoption, of the Continent, his birthplace, and of Canada, and of the United States, whose populations are always ready to appreciate scientific talent and the resulting industrial progress It is not too much to say that few more gifted men have ever lived, and that with all his ability and talent he combined a simplicity, a modesty, and an affectionate disposition that endeared him to all

I am sorry to conclude my address to you in this mournful strain. I have endeavoured to confine my allusions to our dear friend within the narrowest limits, but if I have overstepped these I trust you will forgive me, remembering that "out of the fulness of the heart the mouth speaketh."

THE FORTH BRIDGE.*

By B. BAKER.

Two years ago I read a paper on the proposed Forth Bridge at the Southampton meeting of the British Association. Until the other day I had not since glanced at the paper, and a re-perusal was in many respects suggestive; for during the past two years the works have progressed, and some of the theories advanced in the first paper have been put to the test of actual practice. In one respect the re-perusal was a painful one, for the opening sentence contained a reference to Sir William Siemens, and I was reminded of the loss of a friend who took the greatest interest in the Forth Bridge, and whose vast experience and matured judgment could always be drawn upon in times of doubt or difficulty.

Taking up the narrative of the proceedings from the date of my last paper, I may state, in the first place, that five tenders were submitted for the construction and erection of the bridge, the amounts varying from 1,487,000*l.* to 2,301,760*l.*, and that the contract was finally let to Messrs. Tancred, Arrol, and Co., on the 21st of December, 1882, for 1,600,000*l.*, which was within 5000*l* of the estimated cost of the work as prepared by Mr. Fowler and myself for Parliamentary purposes.

* Paper read before the British Association at Montreal.

Company (Limited), in liquidation, further dividends amounting to 5s. in the pound.

Pembroke Dock.—The Acorn, of eight guns, 850 horse-power, building for the English Government at Pennar Works here, is expected to be launched next week.

The Dinas Colliery.—The Dinas Colliery Company has struck the 9 ft. seam of steam coal in the Storehouse main ..ft. clear hea.. above high wa.. 361 ft above the ..ERING" ILLUSTRATED PATENT piers consists of a gro.. concrete piers, 40 ft in RECORD. 60 ft to 70 ft. in diameter at.. LLOYD WISE. pier is about 70 ft below low wa..ATIONS PUBLISHED DURING is 18 ft at ordinary springs. In the ..T 23, 1884. 120 000 cube yards of masonry, and in t.. about 45,000 tons of steel. *Drawings is stated*

Operations were commenced in January, 18.. *mentioned, the* works have now been some twenty months in pro.. *Names,* and about 170,000*l* have been expended in plant and tem.. porary works, and 200,000*l* in the permanent works of the bridge. At South Queensferry an area of about 20 acres of ground has been laid out in shops and yards for the manufacture of the 1700 ft. span steel girders and for other purposes. These shops are in direct communication with the North British Railway, and are connected by an incline and winding engine with a temporary timber viaduct 2200 ft in length and 50 ft in width, extending from the South Queensferry shore to the first of the groups of four cylindrical iron caissons which constitute the lower portions of the main piers of the bridge At Inch Garvie, stores and offices have been built, and as this is an exposed island in the middle of the Forth the staging for the pier work is of iron pinned to the rock. Similarly at North Queensferry, on the Fife side of the Forth, stores, offices, and iron staging have been erected.

The state of the works at the present time is as follows

PLANT

The plant includes 14 steam barges, launches, and other vessels, 22 steam, 12 hydraulic, and 38 hand-power cranes; 28 single and double engines for shop machines, hydraulic work, air compressing, electric lighting, pumping, and other purposes, also gas furnaces for heating the steel plates, a 2000 ton hydraulic press for bending them, and planing machines, multiple drills, hydraulic rivetters, and other specially designed tools too numerous to mention Having reference to the novelty and magnitude of the work and the amount of preliminary preparations required, it may be considered that fair progress has been made during the past twenty months.

No special difficulties were encountered in founding the viaduct piers, notwithstanding their exposed position. Except in two cases the piers rest on the rock, and they were executed in half-tide or whole tide cofferdams, which call for no special remark The cofferdam for the south cantilever end pier was necessarily a very substantial structure, being a quarter of a mile from the shore. It measured 126 ft. by 75 ft over all, and had a double row of whole timber poles, with 4 ft of puddle between them, and internal struts, chain cable ties, and external raking struts and piles of great strength and solidity A highly satisfactory bottom on boulder clay of rock-like hardness was found at a depth of 35 ft below high water. The masonry of the viaduct piers and cantilever end piers consists of an Aberdeen granite facing, averaging a little over 2 ft. in thickness of rock faced work, backed up with cement concrete or with rubble masonry set in cement, and bonded, about every 12 ft in height, with courses of large stones carried across the entire area of the piers

The main piers have on the whole, perhaps, given more trouble than was anticipated On the Fife shore the whinstone rock bottom falls with a rapid slope of about 1½ to 1 to deep water, and it was necessary to step this slope for the masonry Diamond drills worked from an iron stage were employed for the subaqueous blasting, but the removal of the rock proved a most tedious affair, and a substantial timber and clay cofferdam had, after all, to be constructed for one of the piers With some trouble the other pier was built within a makeshift half tide dam, made up partly of the 60 ft diameter permanent iron caisson below low water, with a temporary iron caisson attached to it, the whole made tight to the rock as far as might be with concrete and clay filled in between the caisson and a few buckle plates At Inch Garvie similar delay and trouble were experienced in carrying out the shallow piers. Some of the work could only proceed at low water of spring tides, and it generally happened to blow hard just at that long waited-for moment Tidal work, and even half tide work, are proverbially slow and worrying; but we were all determined that, as the rock varied in quality, no foundation should be put in until the bottom had been laid dry. By perseverance and patience this has hitherto been accomplished, and we have the satisfaction of knowing that both the rock foundation and masonry are unexceptionable in strength and solidity. In our shallow rock foundations at the Forth we had much the same problem to deal with as Stephenson encountered, thirty years ago, when building the fine bridge across the St Lawrence at this city, and our contractors dealt with it in much the same way I am not concerned to defend the operations, as such details are usually left to those responsible, namely the contractors. Where speed is required I am satisfied that in most cases pneumatic appliances offer incomparable advantages over cofferdam work on a rock bottom. French contractors generally resort to pneumatic caissons of ordinary type in depths exceeding 15 ft, but have employed, with great advantage, modifications known as the *caisson-batardeau*, the *bateau-plongeur*, &c., in depths as little as 6 ft. The six weeks required to build a pier with the aid

of pneumatic appliances may often be taken up in stopping the leaks of a cofferdam or rock bottom. English contractors are not much accustomed to pneumatic appliances, other than an ordinary diving dress, and rarely resort to them. A diving bell with shaft of access and air lock was provided and mounted on traveller complete at the Forth, and compressed air drills were fitted in the working chamber, but no use has hitherto been made of the apparatus.

The lower part of the South Queensferry main contains sists, as already stated, of a group of four the one caissons 70 ft. in diameter. In the case the present was allowed of sinking open-topped ge, but he further inside, but, after experiencing the ine, that which the the boulder clay, we were all readily appreciate, and ferable to resort to the pneumatic process. Or pressure that it was to the slope of the clay the four depths, ranging from our caissons will be sunk to thus The caissons, which were built on shore, launched afloat into their position, are 70 ft. in diameter at the cutting edge, and have a taper 1 in 46 to facilitate sinking. At 1 ft. above low water, which is the top of the permanent work, the commencement of the granite-faced masonry, within the caisson is 60 ft. A working chamber 7 ft. high is provided at the bottom of the caisson, the roof of which is supported by four strong lattice girders 18 ft. deep, and cross girders 3 ft. deep spaced 4 ft. apart. An internal skin 7 ft. distant from the external skin, and vertical diaphragms, form pockets which can be filled with concrete at any point where, owing to the slope of the ground and the varying hardness of the silt and clay, a heavier pressure is desired to force down the caisson. Three shafts, 3 ft 6 in. in diameter, with air locks at the top, pipes for admitting water and ejecting silt, and other of the usual appliances, are provided. The air locks for passing out the clay and boulders as designed by Mr. Arrol and myself have, instead of the usual hinged doors, two sliding doors like horizontal sluice valves, across the 3 ft. 6 in. shafts, which are worked by little hydraulic rams, or by hand, and are interlocked like railway points and signals, so that one slide cannot be opened until the other is closed. Mounted on the side of the air lock is a steam engine which, by means of a shaft passing through a stuffing-box in the side of the air lock and a drum inside, winds up the excavated material in skips containing one cubic yard. The operation of hoisting, opening slides, and discharging is rapidly performed, so the two locks have a large working capacity. A third air lock, with side doors, ladder, and hoist, is also provided for the men. The air compressing plant consists of three engines with steam and air cylinders 16½ in. in diameter by 24 in. stroke, ample power being furnished by boilers of the locomotive type erected on the staging.

Reference has already been made to the two shallow piers at Inch Garvie, but there are also two deep piers which, being on a very irregular and sloping rock bottom, have required much consideration. It was finally decided to level a bed roughly with bags of sand, and to float out pneumatic caissons, and excavate the rock until a level bed was cut. Probably Mr. Fowler and I would not have adopted this precise plan if we had been contracting, although we might have resorted to the pneumatic process, but as M. Coisseau, a contractor of great experience in such work, offered to sub-contract for the sinking of the caissons at fair rates, we did not object. These caissons are 70 ft. in diameter at the bottom, and the rock slopes from 14 ft. to 19 ft. in that length, the lowest point being 75 ft. below high water.

All of the pneumatic caissons will be filled with concrete up to low water mark, the mixture being 27 cube feet of broken whinstone, 7 cube feet of sand, and 5½ cube feet of cement, which together make a full yard of concrete, having a crushing resistance of about 50 tons per square foot.

Above low water the cylindrical piers, which are 49 ft. in diameter at the top, 55 ft. at the bottom, and 36 ft. high, consist of the strongest masonry, the hearting being flat bedded Arbroath stone with both horizontal and vertical bond, and the facing Aberdeen granite, the whole set in two to one cement mortar, and built in the dry within temporary wrought iron caissons. In the shallow piers where the rock is stepped the masonry is carried down to the rock itself, and wrought iron hoops 36 in. by 1½ in. bind the bases of the piers. At the top of all the piers 18 in. by 1½ in. hoops, and midway down 18 in. by ¾ in. hoops, are also built in, and it is believed that these cylindrical masses of masonry are as completely monolithic as can be attained or desired. In each cylindrical pier there are forty-eight steel bolts 2½ in. in diameter and 24 ft. long to hold down the bedplates and superstructure of the main spans.

A few words now as to the manufacture of the superstructure. About 42 miles of plates have to be bent for the tubular compression members, and the best method of doing this became a question of great practical importance. Bending cold did not answer, as the true curvatures could not be so attained. Theoretically, a 10,000 ton hydraulic press would be required to bend, truly, our 16 ft. by 1½ in. thick steel plates, and practically a 3000 ton press was of no use. Heated in a gas furnace, the plates bent readily, but distorted considerably and irregularly in cooling. Covering with ashes, packing up, and a variety of expedients were tried before the proper method was hit upon, which was to bend the plates hot and to give them a straightening squeeze afterwards when cold. Uniform heating is secured by admitting the gas near the door and midway along the furnace, and an important incidental advantage of the use of tubular compression members thus is that every plate gets relieved from any internal strains which may have been set up by shearing or improper usage at the steel works, which is of the greater moment as steel having the comparatively high tensile strength of 34 to 37 tons per square inch is used for the compression members.

Some alarm was occasioned at the works by certain 1½ in. thick plates cracking like cast iron on being bent cold to the first progressive radius of 6 ft. I felt certain, however, that the material was not at fault, as our inspectors rejected shearing from every plate by bending it round a test of 1½ in. after being made red hot and cooled in tenaver. On investigation I traced the cause of the fracpower in the local damage the plates received from shearing, or for at the damage consists in is an unsolved riddle. It perforce extend more than ½ in. from the edge, because as at Sing to that extent relieves the plate and yet it affects power entire width, for the 4 ft. 6 in. plate snapped as applied as the 1 in. wide strip sheared from it. Neither the dr it arise from "nicking" by bad shearing, because enalaking the plates red hot cures the evil, though the me "nicking," if previously existent, remains as visible as ever. Practically, the important point of interest to bridge builders is that with planed edges and drilled holes we have had no mysterious fractures, but the Forth Bridge plates have behaved as a material having as the higher limit a tensile strength of 37 tons per square inch and an elongation of 17 per cent. in 8 in. should behave. Our specification for steel in compression is 34 tons to 37 tons with an elongation of 17 per cent., and for steel in tension 30 tons to 33 tons with 20 per cent. elongation. The strength rarely varies as widely as the stated limits, and the elongation averages some 3 per cent. more. One of the plates which fractured from sheared edges when bent cold was tested by me in a variety of ways. A specimen made red-hot and cooled in water at 80 deg. stood 38.3 tons per square inch and elongated 21 per cent. Another specimen made hot and allowed to cool in air stood 36.6 tons and also elongated 21 per cent., whilst one planed from the plate direct without heating failed with 34.3 tons, but extended 25 per cent. For practical purposes, therefore, it mattered little how the plate was treated, provided the effect of the shearing was eliminated by planing or by heating.

When bent, the plates are planed at one edges in the usual way, and at the curved ends by a specially designed radial machine. They are then, with the internal stiffeners, temporarily built into a tube round a mandrel, and drilled through plates, covers, and bars at one operation. Four specially-designed annular drill frames, surrounding the tubes, and furnished each with ten traversing drills, capable of attacking every hole, travel along lines of railway in the building yards, so laid out that four lengths of tube, each of about 400 ft., can, if desired, be dealt with at once. In a 16 ft. length of 12 ft. diameter tube there are about 1600 holes to drill through from 2½ in. to 3½ in. thickness of steel, which operation takes about fifty-two hours' working of the drills. Continuous working is, of course, not possible, as the machine has to be advanced every 8 ft., which is the shift of the butts in the plating of the large tubes.

Over the piers the arched tubular lower member forms a connection with the upper bedplates, the vertical and diagonal tubes, and the lateral and vertical cross bracing, so that considerable thought had to be given to the details at this point. A full sized model was prepared, and different modes of arranging the junctions were set out and modelled. Finally it was decided to gradually change the tubular lower member into a box form with one rounded upper corner, where it meets the skewback or part over the pier, and by internal vertical and horizontal diaphragms, to make the latter a cellular structure of enormous strength and stiffness, offering facilities for attachments in any required direction. Several layers of plates form the bottom of this skewback, and constitute what may be termed the "upper bedplate" of the bridge. The "lower bedplate" consists of similar layers of plates rivetted together and bolted to the pier; and the two bedplates are free to slide on each other within certain limits to be referred to more particularly hereafter. The layers of plates run longitudinally and transversely, to meet the different stresses; and, after the edges are planed, the plates are fitted together, clamped between girders, and drilled by special machines through their whole thickness. About 1000 lineal feet of 1½ in. holes have to be drilled in each bedplate, which in practice with the 8-drill machine, takes about eighteen days, including stoppages. In the upper bedplates holes about 11 in. square, with corners rounded to a 3 in. radius, are required, in some instances, to clear the nuts of the holding-down bolts, and these are cut readily by a simple tool devised by Mr. Arrol. In other cases, 12 ft. diameter recesses, 2 in. deep, have to be bored for what may be termed a huge key or dowel, which will connect the upper and lower bedplates, but allow a slight rotation; and this also requires a special tool.

The tension members and cross bracing generally consist of box lattice girders which are drilled by travelling machines of similar type to those already referred to in connection with the tubular members. All of the rivets are of steel, having a tensile strength of about 27 tons, an elongation of about 30 per cent., and a shearing resistance of from 22 tons to 24 tons per square inch. It is hardly necessary to state that hydraulic rivetting will be used throughout. The nuts and washers of the holding-down bolts and some other parts are of cast steel, having a tensile strength of 30 tons per square inch, and an elongation of 8 to 10 per cent. It may be interesting to mention that the contractors have used steel in preference to iron in some parts of the temporary works, and that at their request the 168 ft. span viaduct approach girders were changed from iron to steel with a view to save expense.

The two years' additional consideration given to this bridge since the date of my first paper has led to no modifications of importance in the design, or in the weight of steel required for the construction, a satisfactory result which is largely due to the care and ability of my colleague, Mr. Allan Stewart, who has had charge of the detailed calculations and designs from the inception of the undertaking. Originally the cantilevers had a varying batter towards each other from 1 in 7½ at the piers to vertical at the ends, where they meet the central girder. We have now made the central girders slope inwards and maintained the batter of 1 in 7½ throughout, thus getting rid of the previous "winding" which somewhat complicated the details of the cantilever, and at the same time preserving and emphasising the pyramidal form of cross-section characteristic of the design. In models of the bridge a feeling of great solidity results from this feature, as will be the case no doubt in the bridge itself, of which a geometrical elevation necessarily gives but a poor idea.

We have also modified the attachment of the superstructure to the piers. Formerly the intention was to put an initial stress upon the 12 ft. tubes between the double piers as described in my first paper, and to bolt the superstructure rigidly to the masonry. Now we secure the superstructure to one only of the four cylindrical piers in each group by the great circular key already referred to, and permit a certain amount of sliding on the others. Owing to the enormous size of the structure elastic deformations which may be neglected in ordinary cases have to be provided for. A very great deal of consideration has been given to this important point, and the calculations have necessarily been complex and tedious, but we think we have now made the best disposition attainable to resist all possible and improbable hurricanes striking the bridge locally or throughout the whole span, and all variations of temperature likely to be met with at the Forth.

The question of clothing the tubes between the piers with some non-conducting material will be left for future settlement after the movements under changes of temperature have been registered by the tube itself. Fortunately we are not troubled with Canadian variations of temperature and the correspondingly great changes of form in metallic structures. At the new Clyde Viaduct in a length of 376 ft. the observed annual range is 2 in., or a fraction over half an inch in the 100 ft., and this is an open lattice construction, whilst the Forth Bridge horizontal members between the piers are closed tubes. Obviously during the early stages of erection, before much weight comes on the bedplates, the tube will be practically free to expand and contract. Ultimately, when the whole weight of the completed structure rests on the piers, the friction between the two surfaces of the upper and lower bedplates will probably be sufficient to prevent movement except under extremes of temperature and heavy wind pressure of rare occurrence. The attachment of the superstructure to the piers partakes thus of the character of a safety friction clutch. Movement will not occur under ordinary circumstances, and if an excessive shock from some unforeseen cause arise on the superstructure, it can only be transmitted to the masonry of the pier through the sliding surface of the upper and lower bedplates. Should a wave of deflection from the impact of a tornado pass along the great cantilever, as some critics suggest, then it would be arrested by skidding, as an express train is arrested, and not by running into a buffer stop.

Provision is made for lubricating the surfaces, and as the result of experiments made by myself during the past two years, probably some crude petroleum will be applied to the bedplates every time paint is applied to the rest of the bridge. Calculations have been made of the extent of sliding and of the stresses on the piers under the twisting action of a hurricane blowing on one cantilever, whilst the balancing cantilever is in a dead calm, and various coefficients of friction have been assumed. During erection sliding can, if desired, be made practically free by carrying one cantilever further out than the balancing one, and so relieving two out of the four bedplates of weight. In the completed bridge the position of the bedplates could be adjusted by temporarily loading the end of a cantilever.

Experiments on friction vary considerably, but when such large surfaces as 2200 square feet, which is the joint area of the four bedplates of each main pier, are concerned, there would no doubt be an equalising effect which would make the proper coefficient of friction for the bedplates approximate to the mean of the results obtained with a number of experiments on small areas. The coefficients obtained by Morin for iron on iron greased ranged from .09 to .115, and with the grease wiped off, .16 to .19, the pressure being about 27 tons per square foot, or considerably greater than that on the Forth Bridge bedplates. On a large scale the mean values of coefficients for different surfaces are derivable from launching ways of ships, brake experiments, and other data. In launching ways the coefficient must be singularly small, for with declivities of ¼ in. to 1 in. in the foot, ships not only start, but acquire a velocity of ten miles an hour or more very quickly. In some of Mr. Denny's experiments it would appear that even with this flat slope the velocity acquired was fully half that which a body would attain falling freely, so the retarding friction during motion must be very small. Again, the coefficient of friction at starting could not exceed .06, but of course in ordinary launching ways the pressure per square foot, and the character of the surfaces are different to those in the Forth Bridge, though the total weight of the moving mass may be the same, and the facts are worth mentioning on that account. Brunel's broadside launch of the Great Eastern in 1857 affords, however, valuable data directly applicable to our sliding bedplates, for the weight of the ship was 12,000 tons, and the launching ways were iron on iron somewhat rough on the surface, and imperfectly lubricated or not lubricated at all. As a result of experiments with a small section of the launching ways, the inclination was made 1 in 12, as it was thought a small force would then start the ship, and a similar force restrain it from acquiring undue velocity, the observed coefficients of friction ranging from .136 at starting to .067

at moderate velocities. On commencing the launch an estimated force of about 500 tons was required to assist gravity on the 1 in 12 incline, hence the starting coefficient with the 12,000 ton load would be about .125 as in the model. Again, when started, the 1 in 12 was more than sufficient, for the vessel ran on some 3 ft. or 4 ft., and, spinning round the handles of the winches, injured five men. Subsequently, however, owing to want of rigidity in the ways, rusting of the rails, or some other disturbing cause, considerable trouble was experienced, and successive additions had to be made to the hydraulic presses during the three months occupied in the launch. For the last 30 ft. or 40 ft. Brunel estimated the power required, inclusive of gravity, at one quarter of the weight, or double that which started the ship at the top of the launching ways.

Railway trains are not as heavy as ships, but afford valuable data as to the coefficient of friction of steel on steel under severe pressures, such as must obtain at the point of contact of the tyre with the rail. Captain Galton's experiments show that the coefficient varies widely with the speed and other elements, being sometimes as little as .05. With dry rails the adhesion of the driving wheels indicates a coefficient of about .20 to .25, and with wet rails, .15 to .20. Probably with "greasy" rails it would not exceed the .10 arrived at by Morin fifty years ago as an average.

Calculations of the stresses on the piers have been made upon the hypothesis that coefficients of .10 and .25 obtain on different bedplates at the same moment in the manner most unfavourable to the structure. A variety of other assumptions and test calculations have been made. As a final result we are opinion that the maximum stress on the masonry of the main piers will be something between 9 tons and 12 tons per square foot. To attempt a closer approximation would only serve to advertise our incapacity to appreciate the complex character of the problem and the uncertainty of some of the data. So far as compression is concerned, our concrete, which has a crushing resistance of 50 tons per square foot, would thus give a factor of safety of at least four. The solid Arbroath stone piers are, of course, of far greater strength both as regards compression and the shearing and possibly tensile stresses to which the piers may be subject under the extreme hypotheses made as to force and distribution of wind.

Very valuable data as to the ability of a massive rubble pier in cement to resist a heavy lateral force were afforded by the experimental arch of 124 ft. span and 7 ft. rise built in Paris some fifteen years ago. The thrust of the arch was about 1400 tons, and treating the abutment as an elastic solid, the stress upon the masonry would range from 14.7 tons compression to 8 7 tons tension per square foot. To ascertain the ability of cement concrete to resist heavy shearing and tensile forces I tested a number of concrete beams having different proportions of cement. Such concrete as that used at the Forth developed a tensile strength under transverse stress of about 10 tons to 12 tons per square foot, so that it was from no inherent weakness in the concrete that masonry was substituted for it in the 36 ft. upper length of the main piers. Our reason for its adoption was that we believed by using natural flat bedded Arbroath stone set in two to one cement mortar, with both horizontal and vertical bond, we made certain of obtaining practically a monolith, whilst with concrete, however careful the inspection, there might be cleavage planes of perhaps dangerous extent in places. The special stresses on the piers arising from the cantilever system of construction have received, as I have already said, our most close consideration, and we doubt not that the desired factor of safety of four will be obtained as regards all shearing, tensile, and compressive stresses to which the masonry may be conceived to be liable under any reasonable hypothesis which can be framed.

Happily, we are relieved from all anxiety as to the foundations, since the piers rest either on rock or on a boulder clay, which for all practical purposes is as hard as rock. It may be mentioned, however, that the heaviest load at the base of any of the 70 ft. diameter caissons, including the tilting action of a 56 lb. per square foot wind, is about 24,000 tons, or at the average rate of a little over 6 tons per square foot, deducting nothing for the water displaced by the pier.

(To be continued.)

DIAMOND DRILLING IN NEW SOUTH WALES.—Diamond drills were employed in New South Wales in 1883 in boring for both coal and water, and on the whole the work done was satisfactory. Coal was proved in five different places, viz., at Dora Creek, near Cooranbong, 6 ft. 3½ in., at Lake Macquarie, 23 ft. ½ in. in the aggregate; at Teralba, 40 ft. 11 in. in the aggregate; at Stanwell Park, near Bulli (two bores), and in one the seams measured 31 ft. 2½ in., and in the other 8 ft. 3½ in. in the aggregate. While boring for coal on the west side of Lake Macquarie, a supply of fresh water was tapped at a depth of 197 ft., which rises to a height of some 30 ft. above the surface, which is 20 ft. above the lake level. One bore was put down in search of a deep alluvial deposit of tin, but it was not successful. The district where the bore was employed includes a large extent of country containing deep deposits of stream tin requiring to be prospected. With coal measures occupying 23,950 square miles, with such deposits of coal as there are in the colony, and with an output exceeding 2,500,000 tons per annum, and rapidly increasing, it would be difficult to conceive how the drills could have been much better employed. Water augers were put down at Bourke, Girilambone, and Gunnedah, and supplies of fresh water were found in different localities of these places. In other parts of the colony borings for water were made, but the results were not so successful.

NOTES FROM THE SOUTH-WEST.

Lloyd's Committee at Penarth.—Representatives of Lloyd's Committee paid a visit on Thursday to the works of the Penarth Shipbuilding and Ship-Repairing Company (Limited), at Penarth. They were shown over the establishment by R. Munroe, the manager. The committee minutely inspected the hydraulic machinery for hauling ships up the slipway, consisting of three hydraulic cylinders, which can be used either separately or together, according to the size of the vessel. They are worked from the accumulators of the Penarth Dock Company, at a pressure of 750 lb. to the square inch. The slipway is fitted up with Chadburn's repeating telegraph, which conveys the orders from the berthing master upon the jetty to the man in charge of the machinery in the hydraulic house. The slipway is capable of taking in and hauling up vessels 310 ft in length, and of 2250 tons displacement. The machinery in the boiler shop is of massive construction, and was manufactured by Messrs. Craig and Donald, engineers, Johnstone-on-Clyde The gridiron is 384 ft. long, and can take on vessels up to 3500 tons displacement. There is also a new jetty for vessels to lay alongside when only requiring internal or deck repairs. The company has had 812 steamers and ships on the slipway and gridiron since they commenced operations four years since. The premises are fitted up with the electric light throughout.

Gas at Bristol.—The directors of the Bristol United Gas Company announce a reduction in the price of the company's gas from July 1 In future the price of gas to consumers within the city boundaries will be 2s. 4d. per 1000 ft., instead of 2s. 6d. which they have hitherto paid; to consumers in the districts beyond the borough boundary, 2s. 6d. instead of 2s. 9d., except at Westbury, Shirehampton, and Avonmouth, in which places the prices to be paid will be 2s. 10d. instead of 3s. 2d. The usual allowance of 2d per 1000 ft. will be also made to consumers of over a million feet per annum.

Cardiff.—The steam coal trade has remained practically unchanged. Small steam coal continues to go off freely, and for the better qualities there is a brisk demand. In the patent fuel market a recent improvement is maintained. There is no change in the iron ore market. Last week's clearances comprised 131,430 tons of coal, 3490 tons of patent fuel, 1530 tons of coke, and 10 tons of sheet iron. Of iron ore there arrived 1800 tons from Bilbao, and 3760 tons came to hand from other sources.

Milford Docks Company.—The directors of the Milford Docks Company state in their half-yearly report that the arbitrator has ordered the receivers to restore possession of the docks to the company on the 31st instant. "Under these circumstances a contract has been arranged with Messrs. S. Pearson and Son, of London and Bradford, for the completion of the docks within twenty-one months from the date of the commencement, and the directors must now take steps to raise the required sum of 200,000*l*. This will be effected by the creation and issue of the A Debenture Stock (authorised by the Milford Docks Act of 1883), which will be a first charge on the company's property."

Newport.—In the steam coal trade prices remain unaltered. As regards manufactured iron there is no change to report; the market still continues in a depressed condition. Last week's coal clearances amounted to 40,625 tons There were also sent away 100 tons of coke to St. Nazaire From Bilbao there arrived 10,493 tons of iron ore, and 800 tons of pyrites came to hand from Huelva.

The Forest of Dean.—A slight improvement continues to mark the Forest coal trade, the demand for house coal being its best feature During the half-year ending June 30, 1884, the total sale of coal was 367,084 tons, as against 302,902 tons in the corresponding period of 1883, and 359,258 tons in the corresponding period of 1882. These figures show an increase of 64,782 tons over 1883; and 8426 tons over 1882. The considerable difference between 1883 and 1884 is no doubt largely attributable to the fact that during February and March of the former year, the five principal collieries suspended operations owing to wages difficulties. In regard to the iron trade there is nothing new to report. The same dulness prevails and prices are as low as ever. During the half-year ending June 30, 1884, the iron ore sales were 23,829 tons, as against 30,045 tons during the corresponding period of 1883, and 25,017 tons during the half-year ending December 31, 1883. These figures exhibit a total decrease upon the half-year of 6216 tons, as compared with the first half of 1883, and 1188 tons less as compared with the half-year ending December 31. The tin-plate trade of the district shows a fair amount of activity.

Newport (Alexandra) Dock Company.—To show how the trade at the Newport (Alexandra) Dock has increased, we have only to give returns for the first halves of the last two years. In 1883, the total shipments of coal were 866,663 tons 7 cwt. Time occupied, 14,665 hours; average per day, 5555 tons. In 1884, the total shipments were 983,414 tons 3 cwt. Time occupied 12,235 hours 46 min.; average per day, 6303 tons 18 cwt. Total increase, 116,750 tons 16 cwt. In 1882, 2221 vessels entered the port, representing a tonnage of 1,141,539, of these, 1167 were steamers. Compared with 1882, there was a decrease in the number of vessels, but an increase of 60,620 in the tonnage. Newport possesses two docks, both of which are now under the management of the Alexandra Dock Company. Active steps are being taken to enlarge the Alexandra Dock.

Avonside Engine Company, Limited.—Messrs. Spain Brothers and Co. have been authorised by the Court to pay to the debenture holders of the Avonside Engine Company (Limited), in liquidation, further dividends amounting to 5s. in the pound.

Pembroke Dock.—The Acorn, of eight guns, 850 horse-power, building for the English Government at Pennar Works here, is expected to be launched next week.

The Dinas Colliery.—The Dinas Colliery Company has struck the 9 ft. seam of steam coal in the Storehouse shaft.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF SPECIFICATIONS PUBLISHED DURING THE WEEK ENDING AUGUST 23, 1884.

The number of views given in the Specification Drawings is stated in each case after the price, where none are mentioned, the illustration is not illustrated.

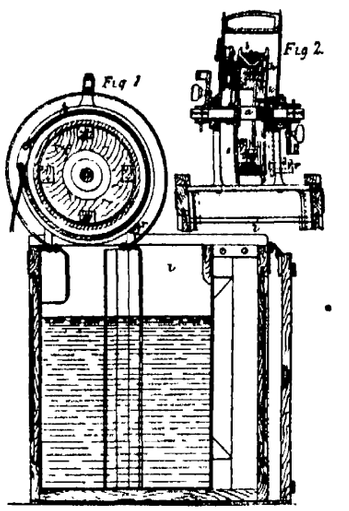
Communications are communicated from abroad, the Names, and Addresses of Communicators are given in italics

Copies of Specifications may be obtained at 88, Cursitor-street, Chancery Lane, E.C., either personally, or by letter, enclosing amount of price and postage, and addressed to MR. H READER LACK

NUMBER OF APPLICATIONS FOR PATENTS.

	1884	1883	1883
Aug. 19th	41		4
,, 20th	33	15	7
,, 21st	40	29	—
,, 22nd	38	16	5
,, 23rd	30	14	10
,, 24th		18	10
,, 25th	30	13	5
Total for week	210	105	41
Total from January 1st to Aug 25th (inclusive)	11,018	4123	1980

5675. Navigational Sounding Apparatus: Sir W. Thomson, Glasgow [8d. 12 *Figs.*]—The sounding wire is carried upon a grooved wheel which is provided with means for clamping or releasing it from the shaft on which it is mounted Referring to the illustrations, the wire drum or wheel *b* is constructed of a grooved ring carried on a disc *c*, secured to the shaft *a* A ring *f* of wood is attached to the inner face of the disc *c*, and blocks *g* of hard wood are attached to the outer periphery of the ring *f* The wheel *b* is free to rotate between the oblique faces of the ring *f* and of the blocks *g* An iron disc *h* upon the axle *a* has attached to its inner face a disc of wood *i*, the edge of which bears against the inner oblique face of the wheel *b*, the face being recessed out sufficiently to admit the blocks *g* The discs *h* and *i* are slid along the shaft by means of the nut *k* provided with an arm engaging with a bolt *n*, brackets or clips secured to the disc *h* project into a circular groove in the nut *k*. It will thus be seen that by turning the shaft in a direction for hauling in, the nut *k* will traverse along the shaft *a*, and the wheel *b* will be frictionally geared to the shaft *a*, at this stage the bolt *r* is disengaged The counter, showing approximately the length of

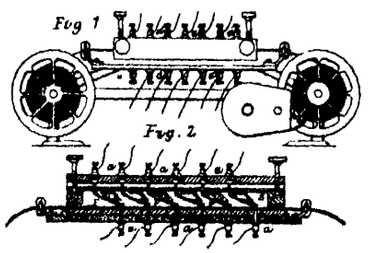


wire out, is actuated by a pinion kept running on the non rotative axle during the egress of the wire by an arm attached to the pinion and bent at an angle towards its outer end, which end is placed in a notch in the outer edge of one side of the wheel *b* At intervals between casts, and when out of use, to preserve the wire and ironwork of the machine, it is kept immersed under lime water in a box or tank *O* provided with mountings to support the machine over it firmly in a convenient position when raised out The handles of the machine are constructed so that portions of them can be taken off The apparatus for measuring the depth consists of a glass tube similar to that described in Specification 3452 of 1870, one end of this tube is open and the other is closed, and it is coated with a solution of aniline blue or other substance suitable for showing the height to which liquid is forced into the tube by the pressure. To dry the tubes they are placed in a brass vessel surrounded with hot water and connected to an aspirator by which a partial vacuum is formed. (December 8, 1883)

5794. Poles or Standards more Especially Useful for Wire Fencing: W. T. C. Bruce and A. Still, Liverpool. [4d. 2 *Figs.*]—This consists of a hollow pole formed of sheet iron compressed together at two opposite sides, so as to be in cross section of a form resembling the figure 8. (December 18, 1883)

5867 Telegraphic Transmitters and Electric Circuit Controllers: E. A. Brydges, London. (*W. F. C. M. McCarty, New York*). [6d. 5 *Figs.*]—A series of contacts are controlled by a perforated fillet itself controlled by a motor and

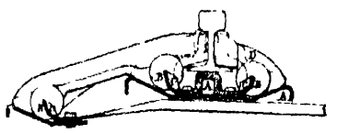
are adapted to distribute a message or current to a number of points Referring to the illustrations, the contact arms F normally acted upon by springs *i* are connected to the binding posts *a* and bear upon a series of contacts connected to the binding posts a^1 The circuits between the posts *a* a^1 are controlled by the perforated band *p* of insulating material, operated



by clockwork mechanism or other motor, which is stopped or released by a magnetic trip or by manually operating a trip, or by other suitable means An adjustable guide casing determines which line of perforations in the band controls the circuit contacts It will thus be seen that a message once prepared may be simultaneously transmitted over any number of circuits and the same fillet may receive any number of messages (December 19, 1883)

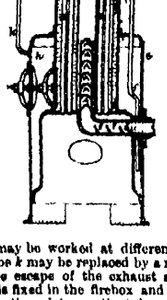
5839. Lowering, Raising, and Releasing Ships' Boats: C. J Fox, Birkenhead. [8d 9 *Figs*.]—The boats are slung fore and aft and side by side from a framework which extends athwartships from side to side over and across the ship's deck. The two athwartship beams of the framework are supported by stanchions, and each is provided with a rail or equivalent, on which runs a wheel or block to which is attached the boat tackle At each of the four ends of the beams, there is provided a folding davit arranged so that they will swing inboard and be parallel to the ship's side when not in use. These davits, when outboard, become continuations of the athwartship beams, and are provided with rails forming continuations of the rails on the beams The runners for each end of the boat may be connected together, and form a carriage from which the boat is suspended, and which may be worked by a rack and toothed wheel mechanism. (December 20, 1883)

5839. Longitudinal Sleepers and Fastenings for Railways: E G. Holtham, London. [6d 5 *Figs*.]—The sleeper is constructed with an upper central part on which the rail seats and a lower wider corrugated part bearing on the ballast with upwardly sloping ribs arranged to enter and be keyed in recesses formed in chair jaws Referring to the illustration, the upper or central part A may form a continuous seat for the rail, and the lower wider part A' is preferably corrugated longitudinally as shown, and has an extended bearing surface upon the ballast; it is made discontinuous to admit of the sleeper being applied to curves, and the top part may be notched. The rail is secured between jaws D which rest on the sleeper and



have sloped recesses that embrace the edges B of the upper part of the sleeper, and are wide enough to admit the tapered keys C It will be seen that as no holes are required for the attachment of the jaws, they can be attached at any part of the length The two lines of rails are connected at suitable points by tie bars extending under both sleepers and some distance beyond them, the outer jaws being provided at these points with lengthened tails secured to the outer ends of the tie bars The fishplates are secured to the sleepers in the same manner as the jaws. (December 22, 1883)

5871. Locomotives for Tramways, &c.: J. W Hartley, Stoke-on Trent. [6d 8 *Figs*.]—The illustration shows a vertical form of boiler especially applicable to locomotives for tramways, &c. One or more tubes X are carried up from the crown of the firebox of a vertical boiler through the top, and are inclosed in a cylindrical shell *s*, whereby they are isolated from the lower steam space The cylinder *s* is filled with water, and its upper portion is perforated with holes to allow the steam to pass into the annular space *d*, and other holes allow the water from the space *d* to flow back down channelled plates or tubes to the top of the firebox The water level in the space *d* is slightly above the tubes, and this space is provided with an overflow pipe *f* The steam spaces *d* and A are connected by a tube *k* The pipe *f* and tube *k* may each be provided with stop-cocks so that different



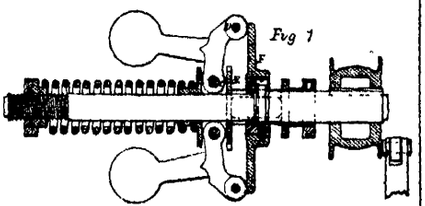
parts of the boiler may be worked at different pressures, or the stop-cock in the tube *k* may be replaced by a reducing valve In order to render the escape of the exhaust steam invisible and noiseless, a tube *u* is fixed in the firebox and is fitted internally with a series of deflecting plates, or the tube may be carried round the top of the firebox. The exhaust steam, immediately after leaving the cylinders, may be passed into a tank fitted with a number of small tubes, through which the air is allowed to pass freely, or is drawn through by a fan, the heat extracted from the exhaust steam being utilised to increase the combustion and economise fuel. The uncondensed steam is discharged under water into another tank by means of a perforated tube or a number of small tubes (December 27, 1883).

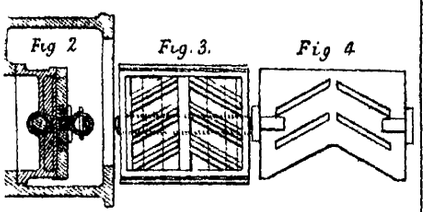
5903. Obtaining Oil, &c., from Minerals, &c.: J. McCulloch and R. MacVicar, Calderbank, Lanark. [6d. 4 *Figs*.]—The minerals are caused to descend slowly down long vertical retorts, of at least 40 ft in height, to gradually increasing heats, steam being introduced at the lower parts. (December 28, 1883).

5906. Grinding Swords, Files, &c., from Copies: A. Greenwood, Leeds. [8d. 9 *Figs*.]—Supposing the article to be ground is comparatively flat, a template corresponding to its profile supports a frame mounted on a horizontal axis and carrying the emery wheel, and forms a rest for the "dumb tool" The article to be ground is fixed upon a table carrying the template; this table is supported in slides, and is reciprocated from an adjustable crank pin The work is traversed under the emery wheel, while the template or copy passes to and fro under the "dumb" tool For articles of cylindrical form, the work is mounted between centres upon the oscillating frame. (December 29, 1883).

5909 Measuring and Continuously Recording Physical Power. A. G. Meeze, Redhill, Surrey. [1s 2d. 22 *Figs*.]—The apparatus appears to be designed to measure power by means of the following fact That when power is transmitted from one revolving shaft to another by means of elastic extensile belting, the difference of velocity between the tight and slack parts of the belt is proportional to the power transmitted from one shaft to the other The integrator, according to one modification, consists of a spindle with a suitable counting device, epicyclic gear, a secondary spindle carrying a friction disc or cone driven by elastic extensile belting from a pulley upon the first spindle and a friction piece adapted to be moved to or from the centre of the disc or cone, so as to retard and control the velocity of the secondary spindle. The apparatus may be utilised to measure the power of motive power engines, the power transmitted by revolving shafting, or communicated by driving belts, the quantity of electrical energy passed through an electrical conductor, the power exerted by winds or other fluids in motion, and indirectly the quantity of such fluid passed through pipes (December 29, 1883).

5920. Centrifugal Governors and Expansion Gear: W Hartnell, Leeds. [8d. 15 *Figs*.]—The governor levers are bent to a right angle or slightly acute angle, and their centres are pivotted to a slide on the governor spindle. The weight is at one end of the lever and the other end is provided with a friction wheel which rests against a fixed disc, a spring pressing the slide so as to close the weights The expansion gear consists of a slide valve on the main valve, both valves having oblique ports oppositely inclined at each end Fig 1 shows the governor The lever is connected to the slide E by the pin C. The end at D is furnished with a friction wheel which rests against the disc F owing





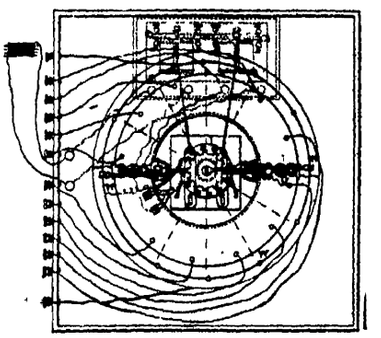
to the pressure of the spring G. The sliding collar beyond the abutment is cast in one piece with the slide carrying the levers, Figs 2, 3, and 4 show the valves. By means of levers and connecting rods, the motion of the slide E (Fig. 1) causes the valve rod to be twisted, operating the finger J and lowering or raising the cut off valves, thus varying the expansion of steam in the cylinder The lever connected to the valve rod K traverses with it. The governor lever has an adjustment for altering its effective length, the friction wheel being arranged to be traversed in a slot. (December 29, 1883)

5939. Electro-Motor Engines for Railways: F. M. Danchell, Maidstone. [6d 5 *Figs*.]—This refers to engines of the kind described in Specification 398 of 1883. The wheels which run on the ordinary rails are driven from the electromotor by means of friction gearing, one object being to reduce the speed Frictional driving wheels upon the motor spindles are applied, with suitable means of regulating frictional contact between each two bearing wheels. The engine runs between a bottom rail or rails which support the weight and a top rail or rails which guide and steady the train, and convey the current to the motor. (December 31, 1883).

5944 Combination Steam Engine: H. Howaldt, Districhsdorf, Kiel, Prussia. [6d. 4 *Figs*.]—The first cylinder of a set of two pairs arranged alongside of each other receives live steam and delivers its exhaust steam to the second cylinder, from which it escapes into a receiver, where it may be reheated by live steam or hot gases. This steam passes at the right moment to a third cylinder, which exhausts into a fourth cylinder. Three sets of cylinders may be employed instead of two. The piston rods are all connected to cranks on the same main shaft. Each pair of cranks are at an angle of 180 deg., the second pair being at an angle of 90 deg. to the first, or the three pairs are at an angle of 60 deg (December 31, 1883).

5952. Gas Retort, Steam Boiler, and other Furnaces for Generating Heat: J. Dempster, Eland, Yorks. [6d.]—A series of zig-zag flues are arranged at one or both sides of the furnace, one end of each flue being in connection with the furnace, whilst the other end is open to the atmosphere, but in connection with the usual flues for removing the heat. The bricks forming the flues have steps formed in them so that when put together they have openings or flues at right angles to each other The spent gases pass through one of these flues, the atmospheric air passing through the other, being thereby heated, and enters into the upper part of the furnace, mingles with the carbonic oxide, is ignited, and materially consists in heating the retorts, the air entering the furnace by narrow tapering horizontal slits formed in the brick. (December 31, 1883).

5964. Telegraphic and Telephonic Apparatus: D. Sinclair and J. L. Corbett, Glasgow. [6d 5 *Figs*.]—A series of the instruments are arranged on a single wire connecting a number of telegraphic stations with a central station, the arrangement being such that when one station is placed in communication with the central station the remaining stations are cut off from such communication. The instrument consists of a box or casing in which are fitted two electro-magnets arranged to act on separate ratchets secured to two concentric but insulated spindles, a pointer being fixed preferably to the central spindle and being arranged to act on a contact-making or current-closing device fitted on each of a series of indicators G arranged radially around the spindles. A single wire W connects the instrument and one magnet to the central exchange, and the other magnet is in circuit with the local battery X, and when a subscriber rings and causes the indicator connected with his wire to fall and pass through a notch in an insulating disc, and by



making a contact with wedge-like pieces on a second disc to close the local battery circuit, it acts on the ratchet of the hollow spindle and causes it to be turned to the extent of one tooth, preventing the other indicators from making contact. The wedge-shaped pieces on the second disc are connected to the trunk line The indicator also lifts a light spring, connected to the subscriber's wire, out of contact with the indicator coil The attendant at the central exchange then speaks to the subscriber in the ordinary way and connects him to the desired subscriber. To connect the subscriber with a subscriber on the same or a similar circuit the attendant sends a number of currents through the line until the pointer is brought opposite the number corresponding to that subscriber; the pointer depresses the spring, closing the circuit to earth, and comes in contact with a spring connected to the trunk wire, the two subscribers being placed in communication The attendant when the conversation is over brings the pointer to its zero position, causing a contact to be made which operates the ratchet and brings the insulating disc round one division. (December 31, 1883).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

BOYLE'S VENTILATORS.—Messrs. Robert Boyle and Son, ventilating engineers, of 64, Holborn Viaduct, and Glasgow, have been awarded the highest and only prize (silver medal) given for ventilators at the International Exhibition, London, for their patent self-acting air pump ventilators and system of ventilation.

HULL ALEXANDRA DOCK.—Mr. Abernethy reports that the masonry of the lock is more than two thirds completed, and the caisson will be fixed *in situ* during this month, which will allow the immediate removal of the cofferdam from the entrance. Two pairs of the lock gates are completed ready to be placed *in situ*, and the remaining pair is in progress. The masonry of the dock walls and jetties is so far advanced that they may be completed within a period of four months. The graving docks are complete, and the placing of the gates at their entrance is in progress. The excavation of the dock is so far advanced that it may be completed within a period of three months. The hydraulic engine-house is complete, and the pumping engine-house will be completed within a month, and the engine and boilers fixed in their places. The chief works at the docks have been suspended since the 12th of July last, but if the works are resumed at an early date, and carried on vigorously, the dock can be opened for traffic early in the spring of 1885.

ENGLISH COAL IN GERMANY.—Coal from the Ruhr is now competing with English coal in the Hamburg market. Every year about 1,350,000 tons of English coal reach Germany by the North Sea, of which Hamburg takes about three-quarters, as the freight from the Tyne is said to be about 1s. per ton lower than by rail from the Ruhr. Ruhr coal, however, is beginning to get a footing at Hamburg, owing to a reduction in railway rates, and also to a connection with some of the steamer companies. In 1875 the imports of coal from the Ruhr at Hamburg were only 60,000 tons, while last year they were over 475,000 tons; during the same period the imports of English coal had been well maintained, thus showing that the competition so far had not materially affected this branch of the trade. Westphalian coal is making progress to the detriment of English at Berlin. The coalowners of the Ruhr, indeed, state that they could relieve Germany from the annual coal tribute of 300,000*l.* paid to England if they could obtain a reduction in the railway rates of from 3s. to 5s. per ton at Hamburg.

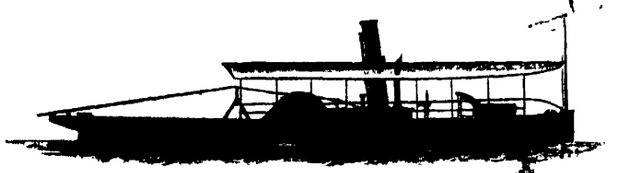
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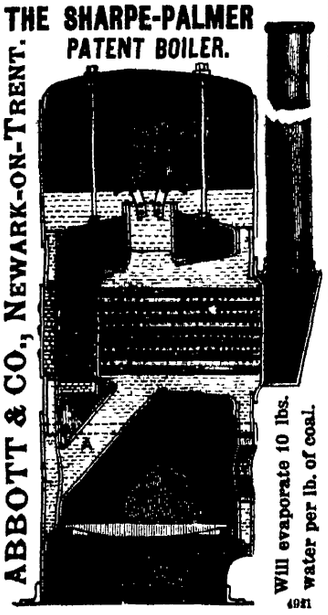
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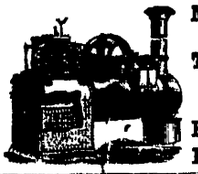
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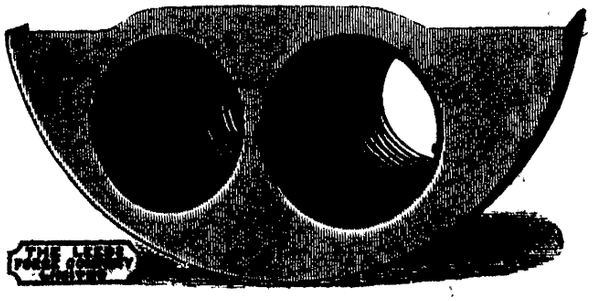
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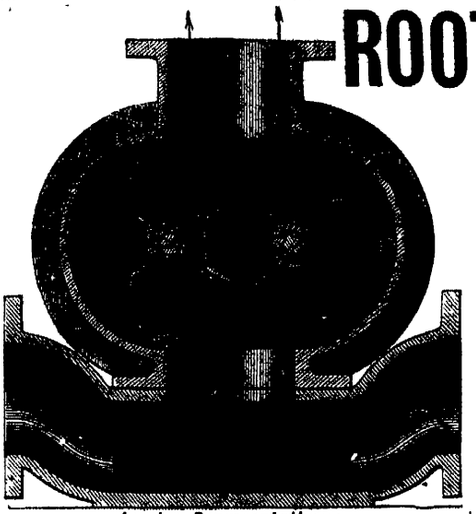


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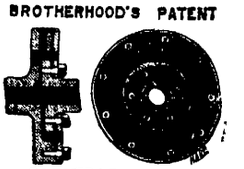


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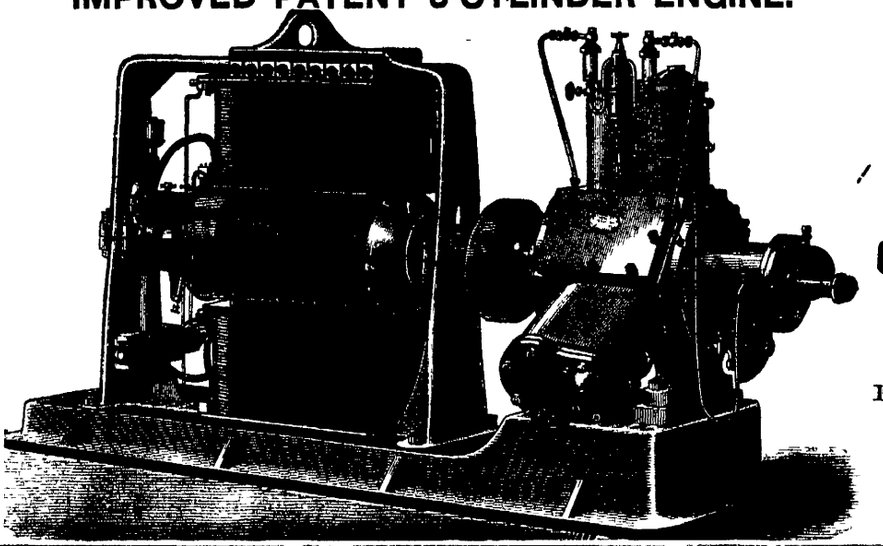
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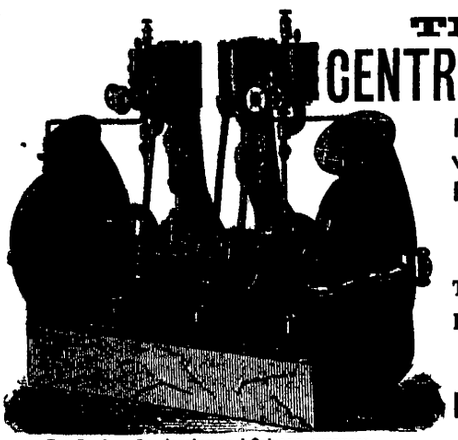
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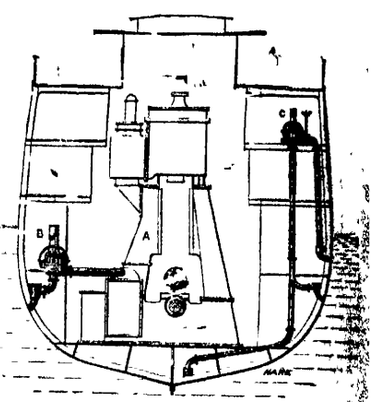


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Patent Carboniser, Destructor, Concretor, Firman's Dryer, Harescoegh's Dryer, Double Effect Dryer, Odour Tight Sanitary Cart, Cinder Screen, Pail-Washing Apparatus; Improved Charcoal Closets.

SEE FUTURE ADVERTISEMENTS. 5076

S. OWENS & CO.

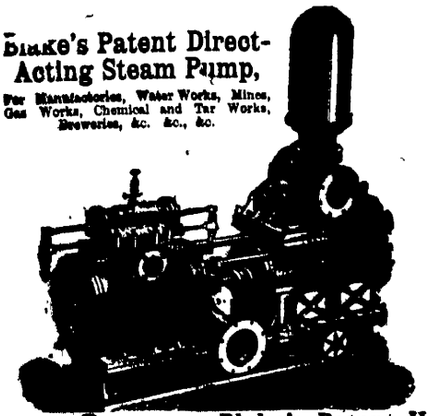
HYDRAULIC AND GENERAL ENGINEERS, WHITEFRIARS STREET, LONDON,

SOLE LICENSEES AND MANUFACTURERS FOR GREAT BRITAIN OF

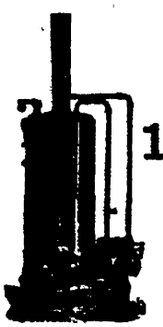
BLAKE'S Patent DIRECT-ACTING STEAM PUMP.

Blake's Patent Direct-Acting Steam Pump,

For Manufactories, Water Works, Mines, Gas Works, Chemical and Tar Works, Breweries, &c. &c., &c.



More than 16,000 in Use.



Blake's Patent Direct-Acting Steam Pump and Vertical Boiler Combined.

Blake's Patent Direct-Acting Compound High and Low Pressure Steam Pump.

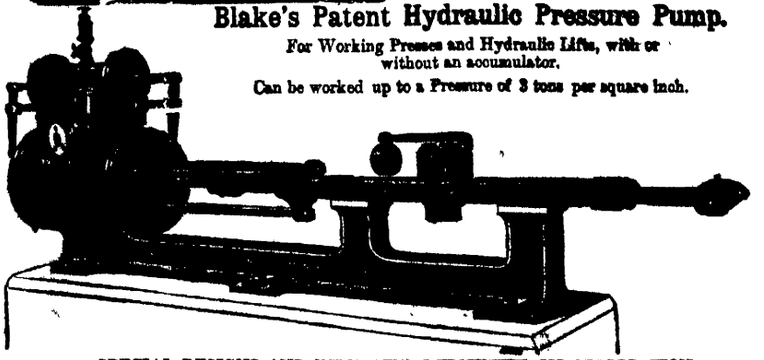
With combined or independent Condenser, attaining the greatest economy in consumption of fuel, for Water Works, Irrigation Works, Drainage of Mines, &c



Blake's Patent Hydraulic Pressure Pump.

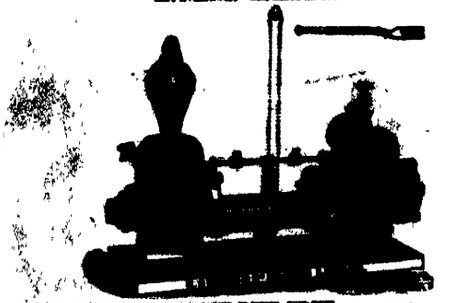
For Working Presses and Hydraulic Lifts, with or without an accumulator.

Can be worked up to a Pressure of 3 tons per square inch.



Blake's Patent Boiler Feeder.

Fitted with hand power lever, for use when steam is not available. All sizes in stock.



SPECIAL DESIGNS AND ESTIMATES FURNISHED ON APPLICATION.

DESCRIPTIVE PAMPHLET AND PRICE LIST FREE. 5030

JAMES FARMER & SONS,

ADELPHI STREET IRONWORKS, SALFORD, MANCHESTER,

MAKERS OF

STEAM ENGINES, BLEACHING, FINISHING, DYEING & CALICO PRINTING MACHINERY,

WIRE MACHINERY

Consisting of Continuous and other Rolling Mills, Wire Pointing Machines, Wire Looms, Wire Testing Machines, Wire Blocks, &c.



COPPER TUBE ROUGHING LATHE.

BRASS & COPPER TUBE MILLS.

Wrought Iron TUBE MACHINERY.



PATENT DRYING AND PULVERISING MACHINE.

COMPLETE PLANT FOR

LINOLEUM MACHINERY

Two and Four Yards wide.

"PATENT"

Drying & Pulverising MACHINE

For Excrementitious Matter & other Materials and Compounds.

MACHINERY IN GENERAL.



POWER WIRE LOOM. 4880

FOR BRICK, TILE, & PIPE MACHINES,

JOHN WHITEHEAD & CO.,

ALBERT WORKS, PRESTON, LANCASHIRE,

HAVE BEEN AWARDED

FOURTEEN PRIZES by the Royal Agricultural Society of England,

INCLUDING THE SOCIETY'S SPECIAL SILVER MEDAL FOR SUPERIOR EXCELLENCE.

Also Awarded the PRIZE MEDALS of the INTERNATIONAL EXHIBITIONS of LONDON, 1851, 1862, and 1874; PARIS, 1855, 1856, 1867, and 1878.

ILLUSTRATED CATALOGUES FREE ON APPLICATION. 4907

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

Bell's Asbestos Works, Southwark

S.S. "Rimapuha," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure 110 lbs. | Vacuum 26 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record

Yours obediently,

D HENDERSON, Chief Engineer, S.S. 'Rimapuha.'

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 26th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods, I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory

Yours truly,

Mr J. Bell. G H. CLARKE, Sup. Engineer

Department of the Director of Navy Contracts, Admiralty, Whitehall, 20th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Spiral Cloth Asbestos Packing to sample submitted.

Elastic core square. | Elastic core ,,,,,,round.

To Mr John Bell. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 60 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To Bell's Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality

I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depots and not through agents or factors.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metal; and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 30 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates 186 deg.

" Covering 94 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering —

Offices of the Wimbledon Local Board, Wimbledon, Nov 20th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering —Yours truly,

" W SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

Mr John Bell, Southwark, S.E Gunnislake, Cavistock, 8th April, 1884.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us I should add that the crane runs on high gantries, and is fully exposed to all weather I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered though it has not since been used. I can most strongly recommend the material —I am, Sir, yours faithfully,

W J CHALK, Assoc. M. Inst, C.E., Engineer and Manager

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be beat by hand to the form required without packering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ⅛ in. to 3 in. wide, and any thickness from 1 16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and ¼ millimetre to 25 millimetres thick.

Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts, Admiralty, Whitehall, S.W., 17th May, 1884.

Sir,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,

Mr John Bell. Director of Navy Contracts

BELL'S ASBESTOS EXPANSION SHEETING, Patent

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanized Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by cut

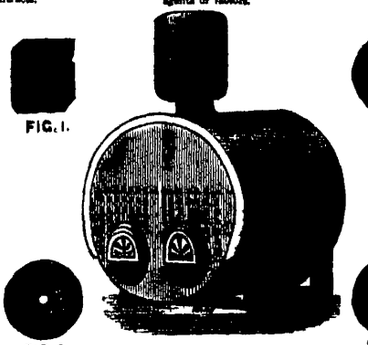


FIG. 1.



FIG. 2

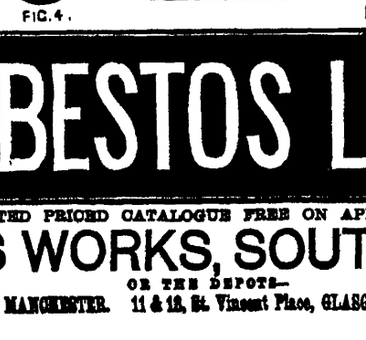


FIG. 4.



FIG. 3.

BELL'S "ASBESTOS LUBRICANT" REGD.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

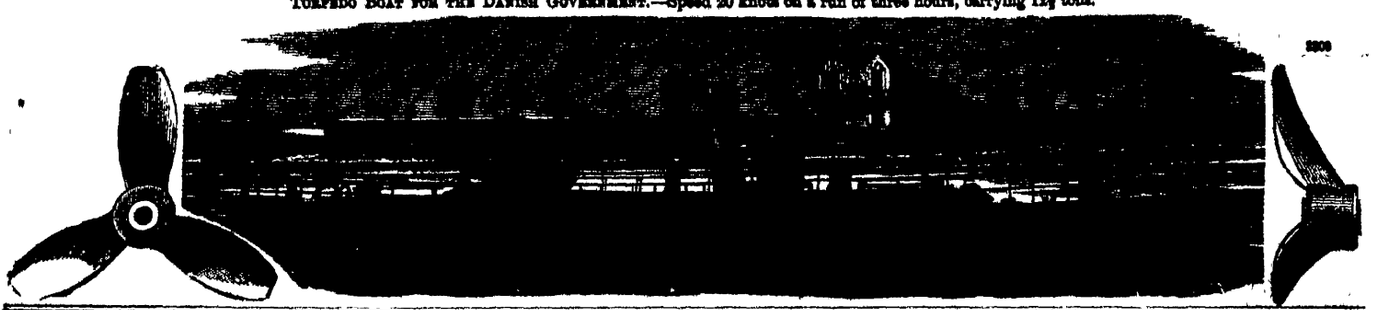
OR THE DEPOTS— 4908

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 12, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

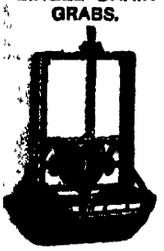


THOS. McCULLOCH & SONS, KILMARNOCK.
Makers of Pumping, Winding, and other STATIONARY ENGINES, TANK LOCOMOTIVES, TIN WORKS, and COLLIERY PLANT, ETC. MACHINERY

JOHN I. THORNYCROFT & CO.
STEAM YACHT AND LAUNCH BUILDERS,
CHURCH WHARF, CHISWICK, LONDON, W.
YACHTS AND LAUNCHES FOR SEA OR RIVER SERVICE, from 25 to 100 feet in length, and Speeds from 10 to 25 Miles per Hour
Thornycroft's Patent Screw Propellers made for all sizes of Vessels. Efficiency superior to any hitherto brought out.
TORPEDO BOAT FOR THE DANISH GOVERNMENT.—Speed 20 knots on a run of three hours, carrying 12½ tons.



SINGLE CHAIN GRABS.



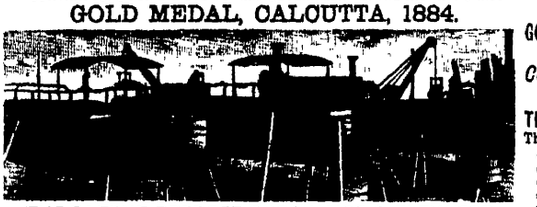
SUPPLIED TO ORDER WHEN PREFERRED

WORKS: Holderness Foundry, HULL.

PRIESTMAN BROTHERS.

CONTRACTORS FOR BARGES TO H.M. GOVERNMENT & THE INDIAN BOARD.
GOLD MEDAL, CALCUTTA, 1884.

AWARDS
DIPLOMA of HONOUR AMSTERDAM, Paris, Melbourne, Adelaide.
Contractors for Dredgers to
THE ENGLISH GOVERNMENT
THE CROWN AGENTS FOR THE COLONIES
The German Government
" French Government
" Italian Government
" Cape Government
" Danish Government
" Chinese Government
" Chilian Government

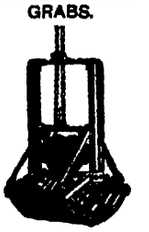


THE PATENT DREDGER EXCAVATOR & ELEVATOR.

LONDON OFFICE: 52, QUEEN VICTORIA STREET.

AWARDS
GOLD MEDAL FISHERIES LONDON, Sydney, New Zealand, Tynemouth.
Contractors for Dredgers to
THE INDIAN BOARD
THE MERSEY DOCK & HARBOUR BOARD
The South Australian Government
" New Zealand Government
" Spanish Government
" Victorian Government
" New South Wales Government
" Dutch Government
" Queensland Government

DOUBLE CHAIN GRABS.

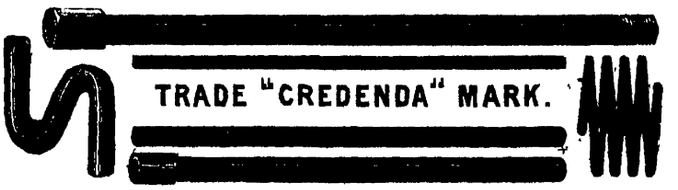


PARTICULARS, SHOWING GREAT ADVANTAGES, ON APPLICATION. 5057

—:PATENT:—

COLD-DRAWN SEAMLESS

THE CREDENDA COLD-DRAWN SEAMLESS STEEL TUBE COMPANY, BIRMINGHAM.



BIRMINGHAM WORKS & OFFICES: LEDSAM STREET, MONUMENT LANE STATION.
LONDON OFFICE: 4, WATER LANE, GT. TOWER STREET, E.C.
4900

FOR BOILERS AND STAYS, HYDRAULIC PRESSES, AIR RESERVOIRS,

STEEL TUBES.

BORING RODS, COUPLINGS, BUSHES, SPINDLES, COLLARS, BICYCLES & OTHER USES.



The "CLYDE" STEAM and BALLAST PUMPS.

"CLYDE" STEAM PUMP (STANDARD PATTERN).
LIST OF STANDARD SIZES

Size Double-Acting	Steam Cylinder diam.	Pump Cylinder diam.	Stroke	Price, with Gun Metal Valves, Plunger, &c
	in	in	in.	£ s. d
1	4	2½	4	17 15 0
2	4½	2½	4	21 10 0
3	4½	3	4½	26 10 0
4	5	3½	5	30 0 0
5	5½	3	5½	37 10 0
6	6	3½	6	29 10 0
7	7½	4	7½	41 0 0
8	8	4½	8	53 0 0

For Feeding Marine and Stationary Boilers, Pumping Water Supply to Railway Stations, Mansions, Warehouses, Mines, Dye Works, Breweries, and for use as Stationary Fire Engines, and for General Contractors' Purposes, for Tar and other Thick Liquids.

"CLYDE" STEAM PUMP (PATTERN A).
LIST OF STANDARD SIZES.

Size	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Capacity per hour	Suitable for Boiler.	Price, with Gun-Metal Valves and Plunger
	in.	in	in.	Galls.	HP.	£ s. d.
0A	3	1½	3	240	20	16 0 0
1A	4	2½	4	960	50	19 10 0
2A	4½	3	4	1320	85	22 10 0
4A	5	3½	5	1680	125	26 10 0
6A	6	3½	6	2250	175	32 0 0
8A	8	4½	8	4275	300	56 10 0

The "Clyde" Connecting Rod Steam Pump, with Swivel-box, capable of working horizontally, vertically, or in an inverted position.



"CLYDE" BALLAST PUMP (PATTERN B).
LIST OF STANDARD SIZES.

Size.	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Suction and Delivery Pipes diam.	Discharge in Tons per hour.	Price.
	in.	in.	in.	in.		£ s. d.
1B	6	6	6	4	40 to 80	30 0 0
2B	6½	6½	6	4½	47 ,, 94	35 0 0
3B	7	7	9	4½	55 ,, 110	37 10 0
4B	7½	7½	9	4½	63 ,, 126	60 0 0
5B	8	8	10	5	70 ,, 140	65 0 0
6B	8½	8½	10	5½	85 ,, 170	70 0 0

This Pump is very compact, and works with the greatest steadiness. The crosshead is of cast steel, and so arranged that it can be readily detached from the pump piston rod, if the engine is required to work alone. The Pump is reversible, that is, by merely changing the position of the Valves the suction can be converted into delivery and *vice versa*. 4729



TRADE DISCOUNTS AND FURTHER PARTICULARS ON APPLICATION.

LOUDON BROTHERS,
BOTHWELL STREET, GLASGOW. AND UPPER THAMES STREET, LONDON.

Manchester Depot: 5, Todd Street, Corporation Street.
Cardiff Depot: T. BEER, 7, Bute Docks.



LOCO. PATTERN, SINGLE LEVER.

THE HANCOCK

INSPIRATOR

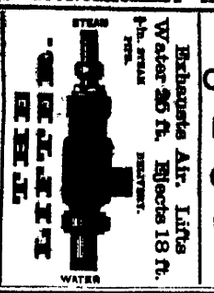
60,000 IN USE.

FIRST AWARD, Sydney, 1879.

THE SIMPLEST PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND RELIABLY.

No Adjustment.
Draws Water at 140°.
All Sizes lift water 25 ft.
Delivers to Boiler up to 212°.

ESTIMATES FOR FIXING COMPLETE with Guarantee to start in good working order, and all information on application to—



Feeds through Heaters.
Can be used as a Pump only.
No Valves or Wearing Parts.
Can be examined instantly.

THE HANCOCK INSPIRATOR CO., 108, Upper Thames St., London, E.C.



STATIONARY PATTERN. 5115

Henry Bessemer and Co., Limited,

Manufacturers of Cast Steel,

SHEFFIELD.

FORGINGS

In Steel of any size.—Quotations given either for uses or finished complete.

STEEL CASTINGS

Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0.30 per cent. carbon, and to bear a tensile strain of 34 tons to the square inch.

TYRES AND AXLES.



SOFT CAST STEEL

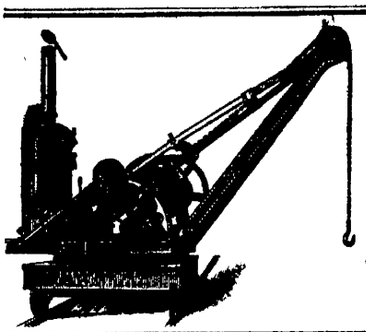
In bars and rods, for general use in Engineering Works.

BLOOMS, BILLETS, & SLABS

Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,

Of superior quality. 5137



EXORS. OF WM. BALMFORTH,

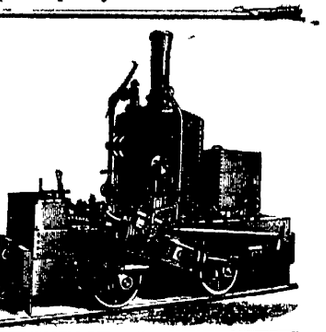
RODLEY, NEAR LEEDS.

MANUFACTURERS OF

LOCO. STEAM CRANES, CONTRACTORS' LOCOS.,
TRAVELLERS, HOISTS,
AND ALL KINDS OF LIFTING MACHINERY.

4697

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes.





THE COALBROOKDALE COMPANY, LIMITED

MAKERS OF

STEAM ENGINES,

HORIZONTAL AND VERTICAL,
AND
OTHER MACHINERY.

MAKERS OF

STEAM PUMPS.

PARKER & WESTON'S PATENT
PUMPING ENGINES for Mines, Sewage and Water Works.
BOILER FEEDERS and SLIP PUMPS.

AGENCIES { LIVERPOOL - 19, SWEETING STREET.
MANCHESTER, 29, PRINCESS STREET. 5130

WORKS & OFFICES, COALBROOKDALE, SHROPSHIRE.

THE MERSEY FORGE, LIMITED

LIVERPOOL,

MANUFACTURERS OF



CRANK SHAFT FOR No. 206.
Forged Weight, 24 tons 11 cwt.; Finished Weight, 15 tons 8 cwt. 2 lbs.

Marine and other Crank Shafts,

STERN AND RUDDER FRAMES,

FORGINGS OF ALL KINDS

IN IRON AND STEEL.

WORKS: GRAFTON STREET.

Town Office: 5, Harrington Street. 4033

BRICKMAKING MACHINERY.

THOMAS C. FAWCETT, OLD VICTORIA FOUNDRY, MANOR ROAD, & BURMANTOFTS FOUNDRY, CROMWELL ST., LEEDS,

Maker of Patent Semi-dry & Plastic Brickmaking Machines,



Steam Presses, Pugmills, Solid and Perforated Bottomed Clay Pans, Clay Rollers, Clay Mixers, and Sieves,

BOILERS, ENGINES, MARINE AND STATIONARY

SHAFTING AND MILLWRIGHT WORK,

DRUMS AND PULLEYS OF ALL SIZES,

SPUR, BEVIL, MITRE,

And other Wheels by Patent Moulding Machine.

ILLUSTRATED CATALOGUES FREE. 4033



POINTS & CROSSINGS

FROM EVERY SECTION OF RAIL.

Portable Railways and General Railway Plant.

HARTLEY & ARNOUX BROS.

STOKE-ON-TRENT.

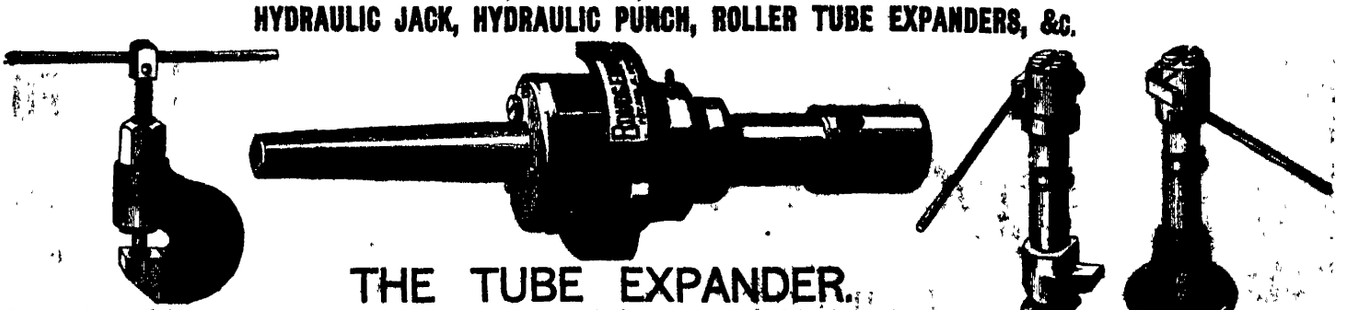
4026

RICHARD DUDGEON,

114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF HIS

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, &c.



THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "DUDGEON'S ROLLER TUBE EXPANDERS," R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only are stamped as under:—

R. DUDGEON, N.Y., Patd. Feb. 5th, 1867, on the Guide-ring of each Tool, WITHOUT WHICH NONE ARE GENUINE.

These can always be obtained at R. Dudgeon's English Depôt, 114, Fenchurch Street. If more convenient to get them through Merchants care should be taken to specify "*Dudgeon's* own make" on the Order, but as R. Dudgeon observes with regret that *imitations* bearing his *stamp counterfeited* are being sold as his, he would respectfully recommend both Merchants and Users requiring Expanders of his make to apply direct. In urging this he merely seeks to secure the identity of what is made by himself, by which he is content to stand or fall.

R. Dudgeon takes this opportunity of returning thanks for past favors, either by orders or recommendations, and it being his intention strictly to maintain the Quality and Workmanship so essential for such a Tool as the Expander, begs to solicit a continuance of the same. 3945

CATALOGUES AND PRICE LISTS ON APPLICATION TO R. DUDGEON, 114, FENCHURCH STREET, LONDON, E.C.

[18 PRIZE MEDALS.] THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED, [18 PRIZE MEDALS.
62 WEST REGENT STREET, GLASGOW.
SANTIAGO, 1875, 1. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1884, 1.



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 4794

100 TO 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

Crossley's Patent TWIN-ENGINES. Impulse every revolution. The steadiest running Gas Engine yet made.

THE "OTTO." GOLD MEDAL at Crystal Palace, & HIGHEST AWARD at Paris Electrical Exhibitions.



New Patent SELF-STARTER. Best, Safest, and simplest made, may now be applied.

CROSSLEY'S NEW VERTICAL ENGINE. Requiring little floor space

¼ TO 100 HP. IND. MANY IMPROVEMENTS. OVER 15,000 IN USE.

LONDON: 24, POULTRY, E.C. GAS ENGINE GLASGOW: 58, UNION STREET 4775

CHEAP GAS FOR MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·3 lb. per ind. H.P. per hour.

THE DOWSON ECONOMIC GAS COMPANY, Ltd., 3 Gt. Queen St., Westminster, S.W. 4883

JESSOP'S CRANES

For Particulars see last Week's "ENGINEERING," or WRITE FOR HANDBOOK.

J. JESSOP & SON, LEICESTER. 5118

Or 113, CANNON STREET, LONDON.

Engineers & Machinists, TAYLOR & CHALLEN, BIRMINGHAM, Founders & Smiths.

Makers of MACHINERY for the PRODUCTION of TUBES, BOLTS AND NUTS.

COINS, GUNPOWDER, SMALL ARMS, CARTRIDGES.

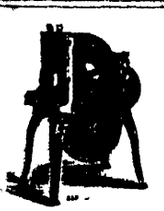
MAKERS OF STEAM ENGINES, SHAFTING—Patent and other Shaft Fittings. CAST IRON PULLEYS, &c.



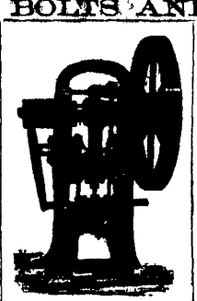
TABLE PRESS.



HORIZONTAL PRESS.



EXTENDING PRESS.



HEADING PRESS.



PRESS WITH TURNTABLE.



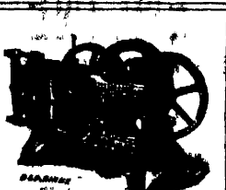
COINING PRESS.



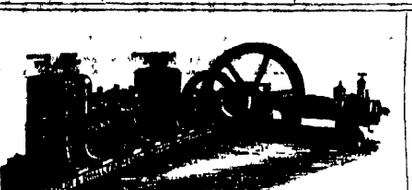
PRESS to STRIKE MEDALS and SINK DIES.



PUNCHING & SHEARING PRESS.



NUT FORGING PRESS.



METAL ROLLING MILL AND ENGINE.



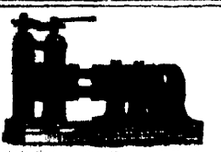
DISC SHEARS.



DRAWING PRESS. 4181



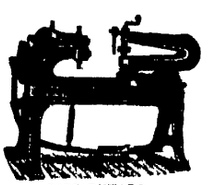
ROLLING MILL with Wedge Adjustment.



ROLLING MILL with Screw Adjustment.



TRIMMING LATHE.



DISC SHEARS.

PATERSON & COOPER,

ELECTRIC LIGHT ENGINEERS AND CONTRACTORS,

76, LITTLE BRITAIN, LONDON. Steam Factory: POWNALL ROAD, DALSTON.

Complete Sets of Electric Lighting Machinery and Fittings for Lighting Hotels, Public Buildings, Factories, Mills, Ships, &c., &c.

ESTIMATES FOR INSTALLATIONS FREE OF CHARGE. EXPERIENCED MEN SENT TO ALL PARTS OF THE COUNTRY.

Licensees of the "Clarke and Bowman" Arc Lamp, and of Joel's Storage Batteries.

PATERSON & COOPER'S DIRECT CURRENT "PHŒNIX" DYNAMOS.

No. 1.—For	16	20 candle-power Lamps,	or	2	Small Arcs,	or	1	Large Arc		£36
No. 2.— „	30	„ „		3	„ „		2	„ „		54
No. 3.— „	75	„ „		7	„ „		4	„ „		80
No. 4.— „	120	„ „		12	„ „		7	„ „		120
No. 5.— „	200	„ „		24	„ „		14	„ „		180
No. 6.— „	300	„ „								250
No. 7.— „	500	„ „								400

4006

Awarded a First-Class CERTIFICATE OF MERIT at Manchester, and a First-Class DIPLOMA OF MERIT at Tynemouth.

PATENT DIAGONAL ROCKING FIRE-BARS

—(Can be Fixed in a Few Hours.)— ARE ECONOMICAL, DURABLE, SMOKE-CONSUMING. —(No Attachment to Boiler necessary.)—

Numerous Official Tests show an average economy of over 10 per cent. These Patent Bars last Years where ordinary Bars last only Months.

Recently supplied to the order of the eminent builders of the engines and boilers of the most powerful Ironclad afloat for use in the whole of the furnaces, to work with "Forced Draught," MAKING THE THIRD Ironclad fitted. Used by the most eminent Engine and Boilermakers (Marine and Land), Railways, Home and Foreign Governments, &c. 5119

Agents having connections among Steam Users Required in Principal Towns. — Particulars of the Manager at the Offices, 259, Gresham House, E.C.

REGISTERED TRADE MARK

"PHOSPHOR BRONZE"

The Best and Most Durable Metal for Bearings and Bushes of every Description; Hydraulic Pumps, Pinions, Valves, &c. &c. Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c.

SOLE MANUFACTURERS UNDER SEVERAL PATENTS. 1475

The PHOSPHOR BRONZE COMPANY, Limited, Sumner & Emerson Streets, Southwark, London, S.E.

Calcutta, 1884.—HIGHEST AWARD.



THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

Baker's Patent Rotary Pressure Blower and Gas Exhauster

—:o:—

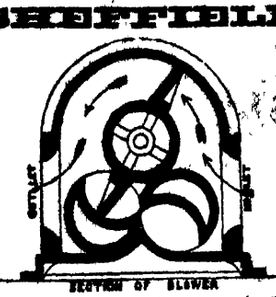
BAKER'S PATENT ROTARY PUMP.

—:o:—

HALL'S PATENT STONE BREAKER.

—:o:—

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

General Machinery of Every Description

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 400

CHARLES CHURCHILL & CO.,

AMERICAN MACHINERY AND TOOL IMPORTERS,

21, CROSS STREET, FINSBURY, LONDON, E.C.

ESTABLISHED IN 1862.



C. C. & Co. have just removed to much larger premises with ample show rooms and warehouse, and will carry a greatly increased stock of all the best American tools.

SOLE AGENTS FOR

THE ONLY GENUINE AMERICAN MORSE TWIST DRILL,

WITH CENTRE GRINDING LINE, STOCKS AND DIES, REAMERS AND MILLING CUTTERS,

Stephens' Patent Vices, Horton Chucks, Cushman Chucks, Westcott Chucks, Sweetland Chucks, Stanley Rule & Level Co.'s Planes, &c., &c., Gould's Manufacturing Co 's Pumps, and a great variety of New American Tools.

New Catalogue for 1883 just issued, 215 pages Quarto, sent on receipt of One Shilling in Stamps.

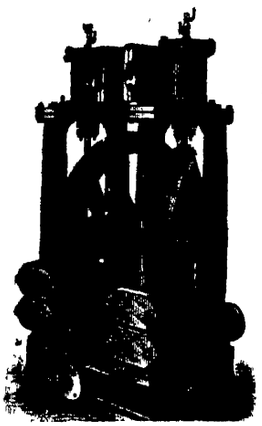
(THE LARGEST CATALOGUE OF AMERICAN TOOLS EVER PUBLISHED IN GREAT BRITAIN.) 4124

W. NEILL & SON,

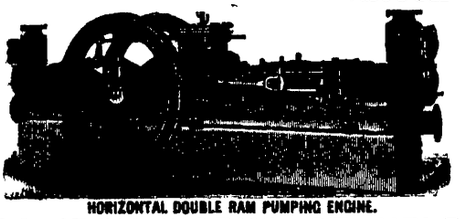
ENGINEERS, IRON & BRASS FOUNDERS, BOILER MAKERS, &c.

MANUFACTURERS OF

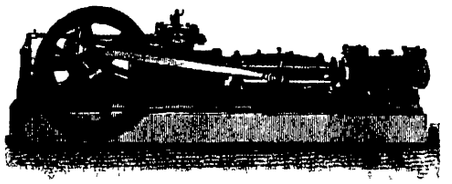
PUMPING ENGINES, BLOWING ENGINES, STEAM ENGINES, AIR COMPRESSORS, and VACUUM PUMPS.



DOUBLE RAM PILLAR PUMPING ENGINE.



HORIZONTAL DOUBLE RAM PUMPING ENGINE.



BLOWING ENGINE AND AIR COMPRESSOR. 4253

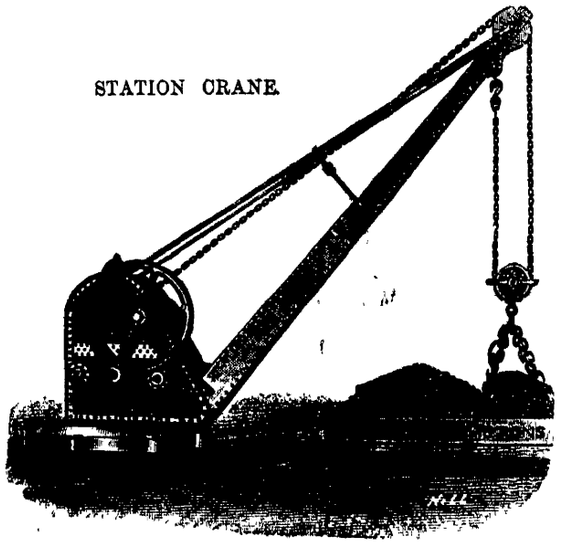
BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.

COWANS, SHELDON & CO., LTD.

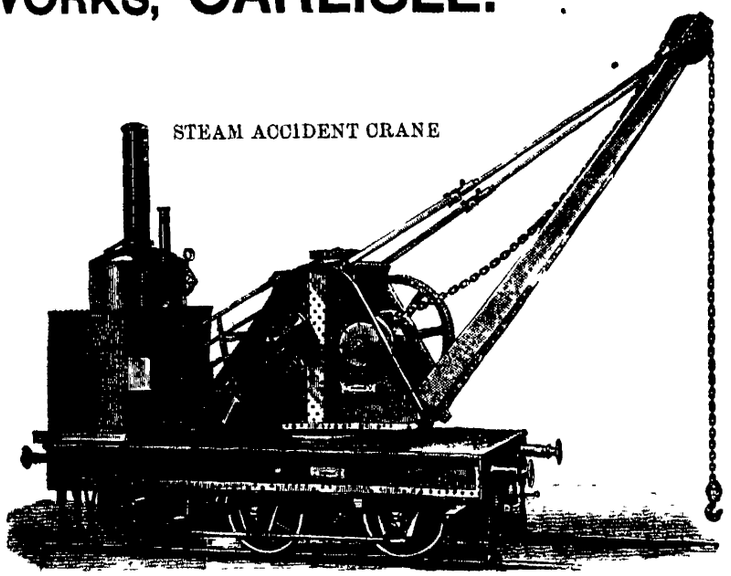
ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.

STATION CRANE.



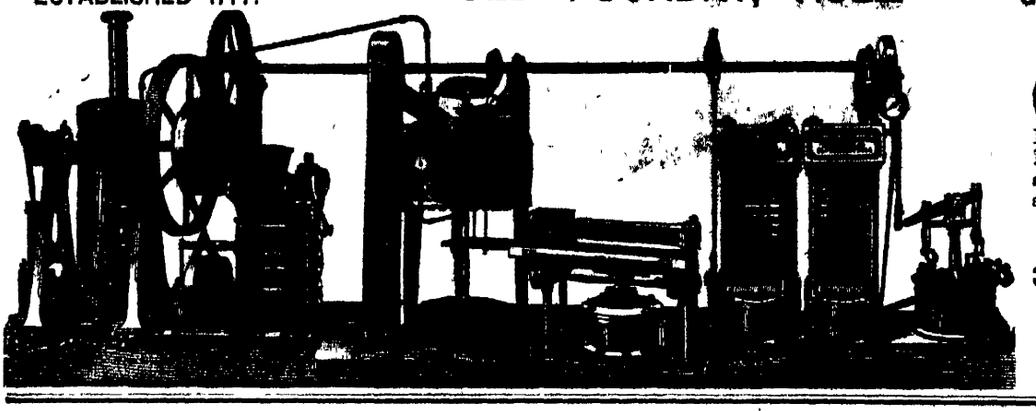
STEAM ACCIDENT CRANE



TURNTABLES, CRANES, MASTING SHEERS, AND TRAVERSERS OF EVERY DESCRIPTION BY STEAM, HAND, OR HYDRAULIC POWER.

ROSE, DOWNS & THOMPSON

ESTABLISHED 1777. OLD FOUNDRY, HULL. GOLD MEDAL, CALCUTTA.



MAKERS OF THE

ANGLO-AMERICAN

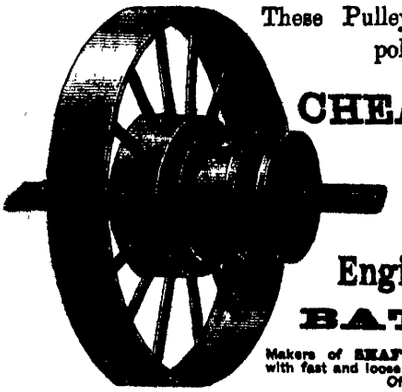
OIL-MILL MACHINERY

For crushing Linseed, Cotton Seed, Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent. in labour and power, and 2 to 4 per cent. in Oil.
(See *Engineer*, May 6, 1881, and Nov. 23, 1883.)

300,000 TONS OF OIL SEEDS,
PER ANNUM,
Are Crushed by Mills made on this system by us. 5127

CATALOGUES FREE.

TURNED WROUGHT IRON PULLEYS.



These Pulleys are **TURNED IN A LATHE**, and not polished on a Grindstone like those generally sold.

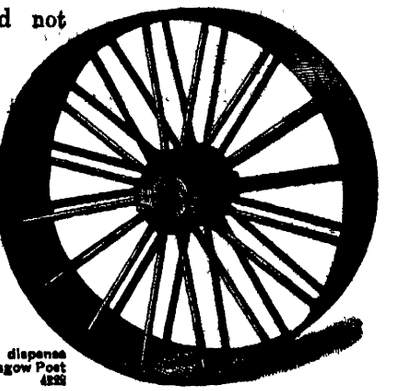
CHEAP, STRONG, AND TRUE.

Illustrated Circular Post Free.

J. BAGSHAW & SONS,

Engineers, Ironfounders & Millwrights,

BATLEY, YORKSHIRE,



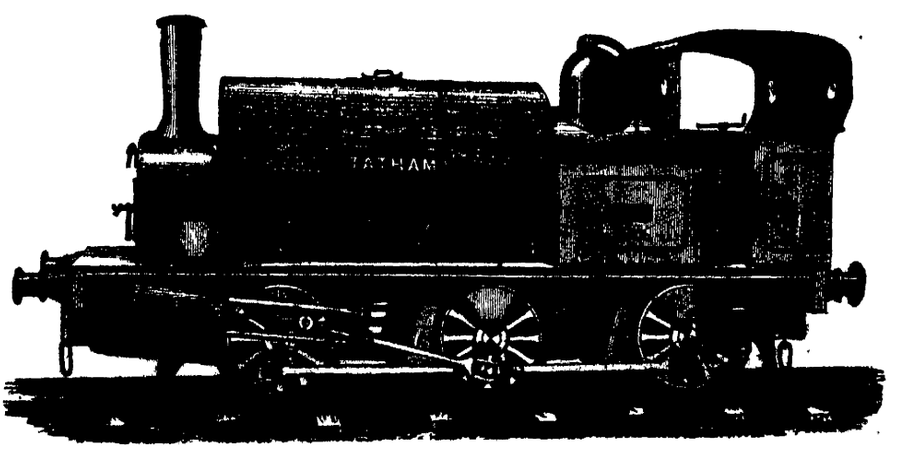
Makers of **SHAFTING** and **FRICTION PULLEYS** for Electric Lighting Machinery, which dispense with fast and loose Pulleys: one Pulley answers for both. In use at L.&S.W. Railway, Nine Elms, Glasgow Post Office; King's Cross Station; and all principal Factories home and abroad. 4128

ESTABLISHED 1860.

HUDSWELL, CLARKE & Co.,

RAILWAY FOUNDRY, LEEDS.

PRICES and SPECIFICATIONS on Application.



FOR CASH or DEFERRED PAYMENTS.

LOCOMOTIVE TANK ENGINES

OF ALL SIZES AND TO SUIT ANY GAUGE OF RAILWAY,

For Main Line or Branch Railways, Contractors, Ironworks, Collieries, &c.

CRANES! CRANES!

SEE HALF-PAGE ADVERTISEMENT AUGUST 22nd, Page 33.

RAILWAY PLANT!!

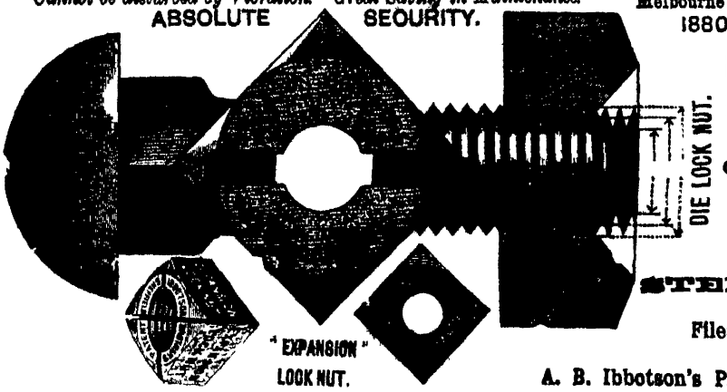
SEE HALF-PAGE ADVERTISEMENT AUGUST 8th. Page 33.

RANSOMES & RAPIER, 5, Westminster Chambers, LONDON, S.W., and Waterside Ironworks, IPSWICH. 5051

Patent Steel Lock Nuts and Steel Fish Bolts.

Cannot be disturbed by Vibration. *Great Saving in Maintenance.*

ABSOLUTE SECURITY.



FIRST-CLASS MEDALS, LONDON, PARIS, SYDNEY, ADELAIDE, &c.

18 GOLD MEDALS Melbourne Exhibition, 1880–81.

ONLY FIRM awarded GOLD MEDALS for Nuts and Bolts, Buffers, Couplings, Cradles, Springs, Steel Sleepers, Rail Joints, &c.
GOLD MEDALS for Steel, Files, Saws, Steel Forgings, Railway Appliances, &c.

IBBOTSON BROTHERS

AND COMPANY, LIMITED,

GLOBE IRON AND STEEL WORKS

SHEFFIELD.

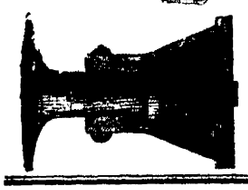
Manufacturers of

STEEL OF EVERY DESCRIPTION

STEEL FORGINGS, AXLES, &c., RAILWAY SPRINGS OF ALL KINDS.

Files (Hand Cut only), Saws, Edge Tools, and Patent Automatic Central Coupling Buffers.

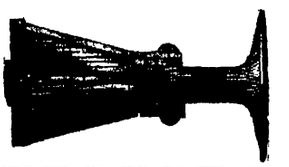
A. B. Ibbotson's Patent Steel Die and Expansion Lock Nuts, and Steel Bolts, Railway Fastenings, &c., &c.



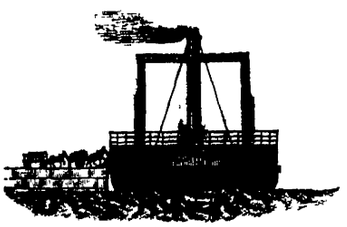
GEORGE TURTON'S PATENT WROUGHT IRON BUFFERS,

AND PATENT COMPOUND CAST STEEL SPRINGS. {4120 3813

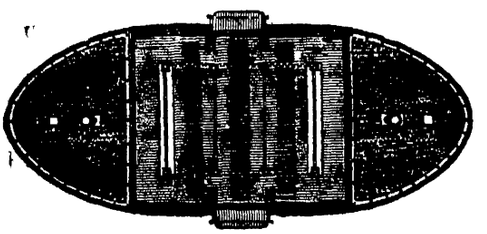
LONDON OFFICE: 4, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W.



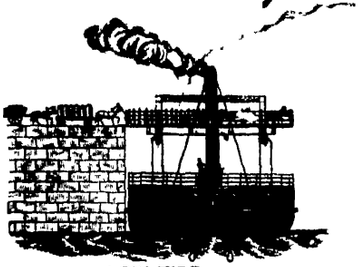
PATENT ELEVATING STEAMER,



HIGH TIME.

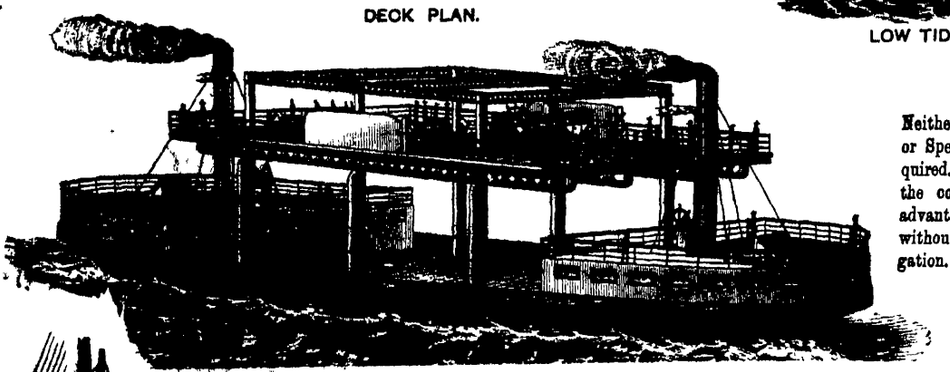


DECK PLAN.



LOW TIME.

For Ferry Traffic, to Land and Embark Passengers, Carriages, Wagons, and Cattle on same level as Pier or Quay, irrespective of the rise and fall of tide. Also for Landing and Embarking Troops, Horses, and Artillery.



Neither Slips or Pontoons, or Special Berths are required. At a fraction of the cost it has all the advantages of a Bridge, without obstructing Navigation.



LANDING TROOPS.

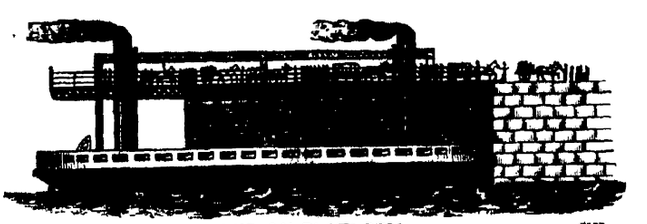
W. SIMONS & CO.,

SHIPBUILDERS & ENGINEERS,

RENFREW,

SCOTLAND,

CONSTRUCTORS.



END ON PLATFORM.

5347

ESTABLISHED 1839. ESTABLISHED 1839.

JOHN MUSGRAVE & SONS, Ltd.

GLOBE IRON WORKS, BOLTON,

Manufacturers of the only Patent Safety Starting, Turning, or Barring Engine

Makers of STEAM ENGINES up to 3,000 HP.

With Patent Automatic Cut-off Motion. Adaptable to Stamper Valves, Slide Valves, and Corliss Valves, which can also be applied to existing Engines

STEAM HAMMERS.

On Condie's principle, with Patent Valve Motions, from 3½ cwt. to 25 tons.

Wrought-Iron and Steel STEAM BOILERS with drilled rivet holes only.

MILL-GEARING IN ALL ITS BRANCHES.

LARGE ROPE OR BELT DRUMS UP TO 35 FEET DIAMETER

BLEACHING MACHINERY.

ALSO THE ONLY MODERN PLATE-GLASS MACHINE MAKERS. 4790

GOODFELLOW & MATTHEWS,

(LATE B GOODFELLOW ESTABLISHED 1838)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEAR

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS

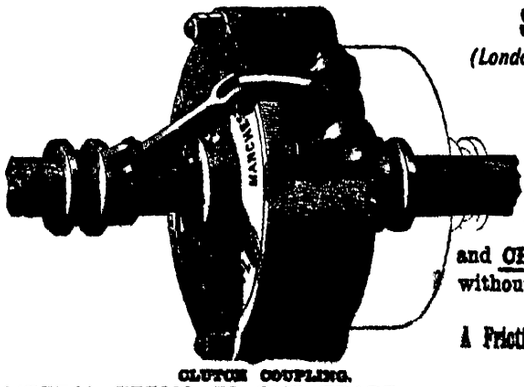
CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINE

FLY-WHEELS ROPE AND BELT PULLEYS, &c TURNED TO ANY SIZE FORGINGS OF EVERY DESCRIPTION 5000

MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.



CLUTCH COUPLING.

— PATENT —

FRICTION CLUTCH.



CLUTCH AND PULLEY

These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

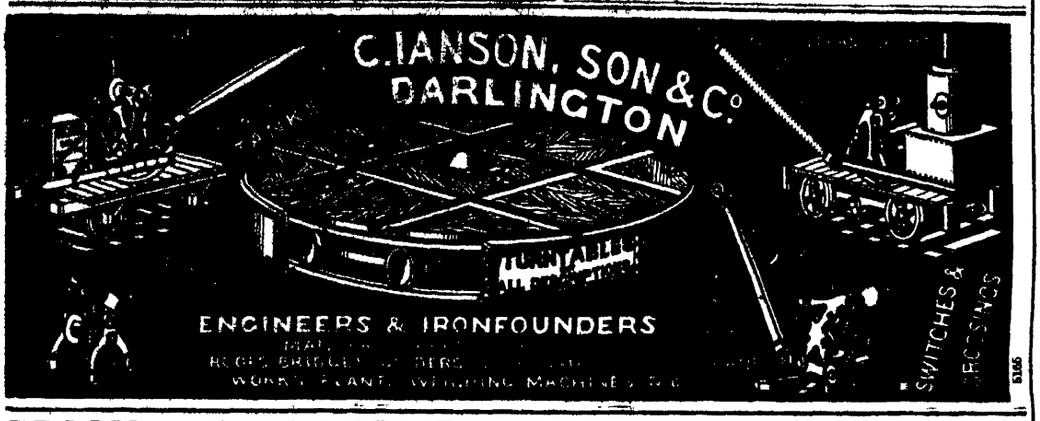
A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.

LIBERAL TERMS TO THE TRADE.

PRICES ON APPLICATION.

"HOWELL'S" SPECIAL SELF-HARDENING STEEL FOR TURNING TOOLS.

4782



5186



MAIN LEATHER DRIVING BANDS.

JOHN WHITE & SONS,

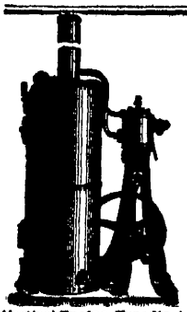
Machine Belting of all descriptions, Hard and Soft Spinning and Drawing Roller Hides, Combing or Apron Leathers for Silk, Wool, Jute, Flax, &c.

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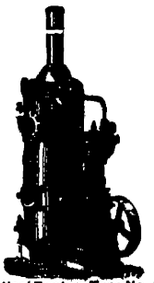
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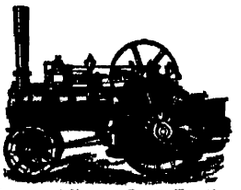
Traction Engine with Finishing Thrashing Machine and Straw Elevator on the Road.



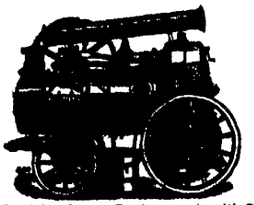
Semi-Portable Steam Engine made with Single or Double Cylinders, 2½ to 35 Horse Power.

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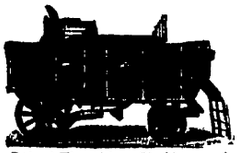
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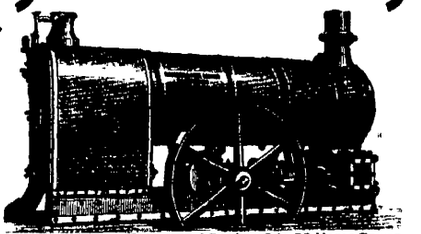
Improved Narrow Gauge Traction Engine, or Agricultural Locomotive.



Patent Portable Steam Engine, made with Single or Double Cylinders, and from 2½ to 35-HP.



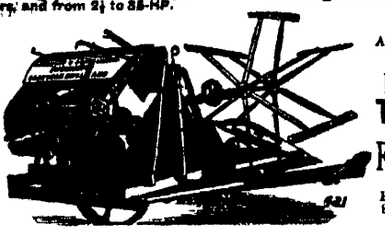
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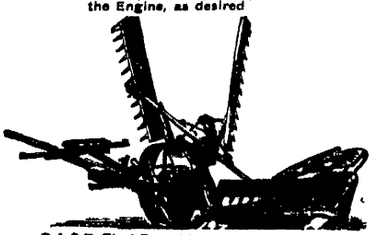
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4 × 3 = 12 ,,	6½ × 3½ = 16 ,,	8 × 6 = 29 ,,	10 × 5 = 36 ,,
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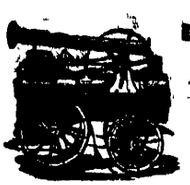
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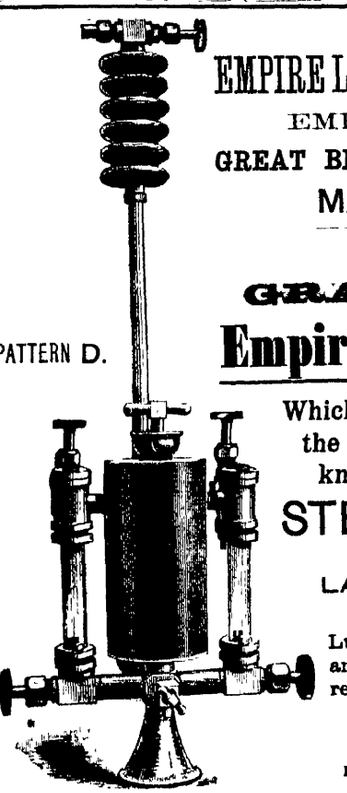
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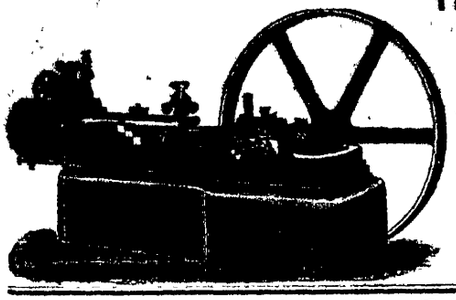
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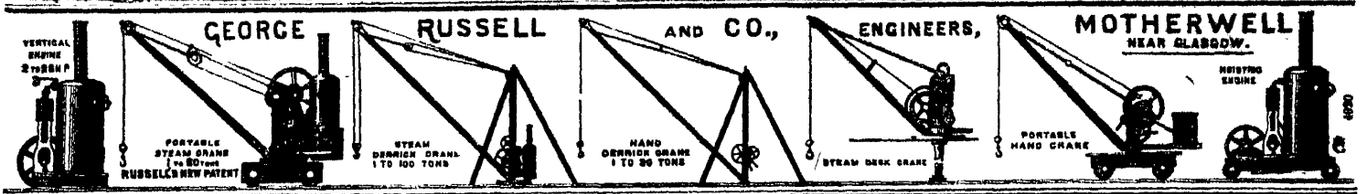
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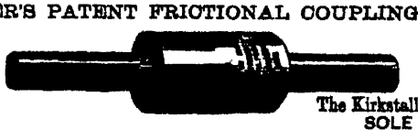
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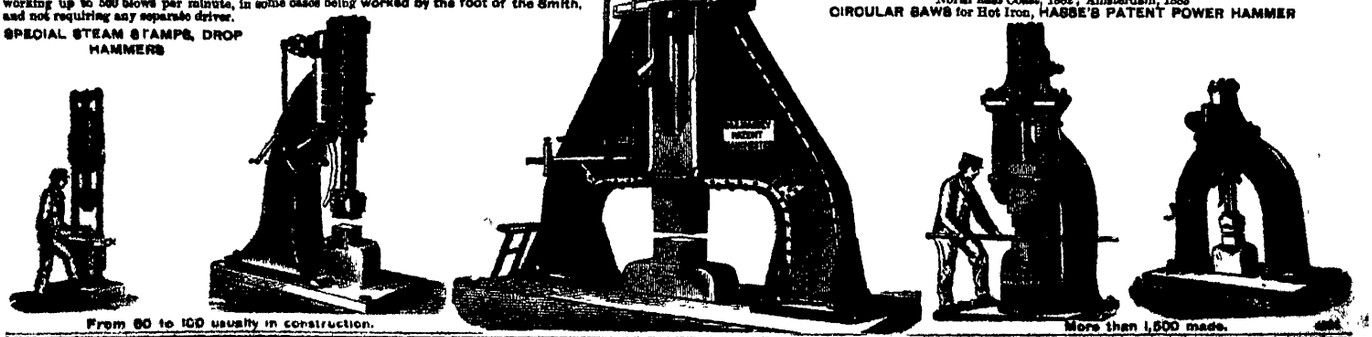
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See Illustrated Advertisement, page 27

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RECEIVED THE *ONLY* PRIZE MEDAL PARIS 1878
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See their Illustrated Advertisement, page 43

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See Illustrated Advertisement, page 11

Patent Spring Safety Valves.
THOMAS ADAMS,
WORKS OF THE "ANT AND BEE"
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SEE LARGE ILLUSTRATED ADVERTISEMENT, AUGUST 15, PAGE 44 4872

Stannah's Pendulum Pumps.
For Prices see alternate weeks 3238

Steel Hydraulic Cylinders.—
HENRY BESSEMER & CO, Limited,
SHEFFIELD
See Advertisement last week, page 31 3627

Tweddell's
Hydraulic Rivetting Machines
14, DELAHAY STREET, WESTMINSTER, LONDON, S W 4597
See Illustrated Advertisement last week, page 47

L. Sterne & Co., Limited.
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Clerk's Patent
Self-Starting Gas Engine.
H.GHEST AWARD,
BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881
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(VICTORIA UNIVERSITY) ENGINEERING COURSE A detailed Syllabus of the COMPLETE COURSE in ENGINEERING will be forwarded on application The next Session COMMENCES on the 7th OCTOBER G 727

J HOLME NICHOLSON, Registrar

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In the Laboratory metals and alloys are examined mechanically with the aid of powerful testing machinery, as well as chemically Extraction and manufacturing processes investigated and assays and analyses made

A few free entries to the division of studies (day or evening) are obtainable through the City and Guilds' Institute G 484

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For further particulars apply at the College, Tabernacle Row, E C, or at the Office of the Institute, Gresham College, E C G 775

Technological Examinations.

The NEXT EXAMINATION will be held on MAY 20, 1885

Teachers desiring to form Classes should apply at once to the Director, at the Office of the Institute, Gresham College, London, E C G 776

PHILIP MAGNUS, Director and Secretary

University College, Bristol.

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The SESSION 1884 85, BEGINS on OCTOBER 7th The Department of Engineering includes separate courses for those intending to become Civil, Mechanical or Electric Engineers, or Surveyors or Architects

Students in Mechanical Engineering who study during the six winter months at the College, can spend the rest of the year in the workshops and offices of various firms in and near Bristol

Surveying and Field work occupy a prominent place in the Civil Engineering Course during the Summer Term, and arrangements have been made with leading Civil Engineers and Architects for the entry into their offices of Students who have passed through the respective courses

Information with regard to the lodging of Students can be obtained on application

Calendar, containing full information, price 1s, by post 1s 3d For Prospectus and further information apply to

ALFRED E STOCK, G 720
Registrar and Secretary

TENDERS

INDIA OFFICE,
4th September, 1884

BY ORDER OF THE SECRETARY OF STATE FOR INDIA IN COUNCIL

INDIAN STATE RAILWAYS

The Director General of Stores for India is prepared to receive

Tenders from such Persons as may be willing to SUPPLY—

40 LOCOMOTIVES,

To be delivered in instalments by the 31st March, 1886

The Conditions of Contract may be obtained, on application to the Director General of Stores, India Office, Westminster, S W, and Tenders are to be left at his Office at any time before Two o'clock p m on Tuesday, the 23rd September, 1884, after which no Tender will be received

A ABERCROMBIE JOPP, G 706
Director General of Stores

THE SOUTHERN MAHRATTA RAILWAY COMPANY, LIMITED

The Board of Directors of the Southern Mahratta Railway Company, Limited, are prepared to receive

Tenders for the Supply of

IRON UNDERFRAMES, UNDERFRAME and BODY IRONWORK and FITTINGS for First, Second, and Third Class Carriages, Composite Carriages, Horse Boxes, and Brake Vans, as per Specification and Drawings to be seen at this Office Tenders are to be delivered in sealed envelopes, addressed to the Secretary, marked "Tender for Underframes, &c," not later than Twelve o'clock, at noon, on Wednesday, the 17th September, 1884

The Company is not bound to accept the lowest or any Tender

By order of the Board,
Secretary's Office, EDW Z THORNTON,
31, Lombard Street, E C, Secretary
8th August, 1884 G 606

EBBW VALE LOCAL BOARD

IRON AND WARE PIPES, AND PIPE LAYING

The Ebbw Vale Local Board are prepared to receive

Tenders (1) for the Supply of

CAST IRON SOCKET PIPES for the purpose of supplying water to Beaufort, and (2) for Hauling, Laying, and Jointing the same The Tenders must be separate

The Board also invite Tenders (1) for the Supply of Cast Iron Socket Pipes for the purpose of supplying water to the Wain Ilwyd and Steel Works Districts, and (2) for Hauling, Laying, and Jointing the same The Tenders must be separate

The Local Board are also prepared to receive Tenders for the Laying of Glazed Hardware Socket Pipes for surface drainage at Cwm and Steel Works

Plans and Specifications, and other particulars, may be obtained from Mr T J THOMAS, the surveyor for the Local Board, Ebbw Vale

Tenders to be sent into the undersigned on or before Monday, the 15th September, 1884

JOHN E. WARD,
Newport, Mon, G 748
23rd August, 1884. Clerk to the Boar

MIDLAND RAILWAY —NORTHERN DIVISION.

TO CONTRACTORS AND BUILDERS

The Directors of the Midland Railway Company are prepared to receive

Tenders for the Supply and

DELIVERY of THREE WROUGHT IRON GIRDERS, FLOOR, &c, for Bridge over the river Dore, at Branchieff

Plans and Specifications may be seen, and Form of Tender and particulars obtained on application to Mr A A LANGLEY, Engineer, Midland Railway, Derby, on and after Tuesday, 2nd September

Sealed Tenders to be sent in, addressed to the Secretary of the Way and Works Committee, Midland Railway, Derby, not later than Nine a m on Thursday, 18th September

The Directors do not bind themselves to accept the lowest or any Tender, nor to pay any expenses attending the same By order,

JAMES WILLIAMS, Secretary
Derby, 2nd September, 1884 G 789

BOROUGH OF WEST BROMWICH

MAIN DRAINAGE WORKS SECTION No 2. CONTRACT No 2

The Corporation of West Bromwich are prepared to receive

Tenders for the Construction

of about 633 yards of 9ft, 761 yards of 2ft 9in and 476 yards of 2ft 6in CIRCULAR BRICK SEWER, also for the Laying and Jointing of about 1105 yards of 30 in, 291 yards of 33 in, 513 yards of 30 in, 15 yards of 24 in, and 90 yards of 15 in CAST IRON SOCKET PIPES and the Laying of 247 yards of 9 in EARTHENWARE PIPE SEWER, together with all Manholes, Ventilators, and other works

The Drawings may be seen at my Office on and after the 12th inst, and Copies of the Specification, Bill of Quantities, and Form of Tender obtained on paying of Two Guineas, which will be returned on receipt of a *bona fide* Tender

Tenders to be sent in on the proper form, together with the Bill of Quantities and Schedules fully priced in, on or before Tuesday, the 23rd instant, endorsed "Tender for Sewage Section No 2 Contract No 2"

The Corporation do not bind themselves to accept the lowest or any Tender

JOHN T EAYRS, Assoc M Inst C E,
Town Hall, West Bromwich, Borough Engineer
3rd September, 1884 G 790

COMMISSIONERS FOR MAKING IMPROVEMENTS IN THE PORT OF CALCUTTA

NOTICE

Tenders are invited for the

SUPPLY of 6000 tons of PORTLAND CEMENT, to be delivered at the New Dock Works, Calcutta, before December, 1885

Contractors may tender for the whole or any quantity they can deliver within that time, and must state the quantity to be delivered monthly, and when delivery will commence

Full particulars of the cement to be supplied, and the tests contractors will submit to after delivery in Calcutta, must be given with each Tender Payments will be made only after delivery at the Works in Kidderpore, Calcutta, and on a certificate from the Commissioners' Engineer that the cement is up to the standard guaranteed by contractors, and accepted by the Commissioners

The Tenders will be received up to Wednesday, the 8th October, and should be submitted under sealed covers, marked "Tender for Portland Cement"

Tenders submitted from England should be dispatched by the mail leaving London on Friday, the 12th September

The Commissioners do not bind themselves to accept the lowest or any Tender

By order of the Commissioners, G 745
WM DUFF BRUCE,
Vice Chairman

PERTH GENERAL STATION

CONTRACT FOR WORKS

The Perth General Station Committee are prepared to receive

Tenders for the Enlargement

of the GENERAL STATION, PERTH

The Drawings and Specification may be seen at the Office of Messrs BLYTH & CUNNINGHAM, C E, 135, George Street, Edinburgh, from Monday, the 8th of September, till Saturday, the 13th of September, and from Thursday, the 18th of September, till Friday, the 26th of September, and at the Office of the Secretary to the Perth General Station Committee, Perth, on Monday, Tuesday and Wednesday, the 15th, 16th and 17th of September when an Engineer will attend to point out the Site of the Works to Contractors

Forms of Tender, with copy of the Specification and duplicate copies of the Schedule may be obtained from the Engineers, on payment of Four Guineas

The successful contractor shall pay the cost of the measurements

Sealed Tenders, addressed to the undersigned, and marked "Tender for Works," must be lodged with him on or before Friday, the 26th day of September next

The Committee do not bind themselves to accept the lowest or any of the Tenders

ROBERT MORISON,
Perth General Station, Secretary
25th August, 1884 G 771

TO IRONMASTERS, BROKERS AND OTHERS

The Oakerthorpe Iron Works

FOR SALE BY TENDER —These works comprise two blast furnaces, with hot air stoves, blowing engine, steam boilers, with the necessary substantially erected buildings, loco shed, weigh houses and machines, sidings on the Main Midland Line, eleven miles from Derby, never failing supply of water, raw material and labour plentiful and cheap, the necessary fixed and loose plant are included Owing to the death of proprietor, the entire works are FOR SALE, and having been lately thoroughly overhauled and put into good order, can be set to work quickly if desired A very low figure will be accepted to close the estate —Full particulars and orders to view may be obtained upon application to Messrs WHEATLEY KIRK, PRICE and GOULTY, 52, Queen Victoria Street, London, E C G 713

TENDERS FOR GASHOLDER

The Directors of the PRESTON GAS COMPANY are prepared to receive

Tenders for the Erection of a

TELESCOPIC GASHOLDER, about 150 ft diam Sealed Tenders, endorsed "Tender for Gasholder," and addressed to the Chairman of the Company, must be delivered on or before Wednesday, the 10th September next Plans and Specifications may be seen at the Office of the undersigned on and after the 14th inst

Gas Office, Preston, HENRY GREEN,
8th August, 1884 Engineer

APPOINTMENTS OPEN.

It is intended to Appoint

PROFESSORS of METALLURGY and of MECHANICAL ENGINEERING in the Technical School in connection with FIRTH COLLEGE, Sheffield The remuneration will depend on the qualifications of the appointed, but will in no case be less than £300 per annum, and will in a portion of the respective class fees, together with For further particulars apply to the Secretary REGISTRAR, from whom applications, stating experience and qualifications must be sent, with the names and addresses of two referees, before 20th September, 1884 Testimonials of at least three

ENSOR DRURY, Registrar
Sheffield G 704
Firth College, Sheffield

To Young Engineers.—Em-

ployment as Assistant Manager is OFFERED to a young man in a prosperous old-established engineering concern, combining an investor of £5,000 marine and land purposes, principally boiler making, for a rising seaport in Yorkshire tected by patents; for learning under an experienced Special opportunity L, 8, Ladbury Road, Notting head engineer - A Hill, London, W G 787

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Draughtsman, accustomed to

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Agents Wanted.—To En-

gineers, Hardware Agents, &c —The Bower Barff Rustless Iron Company, Limited, REQUIRE the services of competent AGENTS to represent them in the various Manufacturing Districts — For particulars apply to the SECRETARY, 23, Queen Victoria Street, London, E C G 771

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CIPAL TOWNS in Great Britain and Ireland, to introduce to Factories, Mills &c, a well known and highly successful low tension system of ELECTRIC LIGHTING A liberal commission given Those with some electrical engineering knowledge preferred — Apply E M F, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W C G 769

Lists of Berths Vacant or

WANTED See "ENGINEERING REVIEW," weekly 1d — E & F N SPON, 16, Charing Cross, London, or of all News Agents 5262

SITUATIONS WANTED.

Wanted, Re-engagement by

a Mechanical Engineer, experienced in electrical work, fair draughtsman, well versed in French, German, Italian, acquired abroad, advertiser had for the last 4 years charge of workshops in an engineering college, good references —Address, W S 3, Humbs Terrace, Westcombe Park, Blackheath, London G 741

Wanted, an Appointment as

Manager or Assistant Manager to an Engineering Firm, with a view to future partnership, by a Gentleman of experience —Address, FREE J BROWN, Gloucester Villa, Ealing, W G 755

Wanted, Re-engagement as

Foreman Boiler Maker, well up in Portable, Vertical and Cornish Boiler Work Seven years' reference from last employer Age 43 —Address H, 2, Swan hill Villa, Rathbone Road, Old Swan, Liverpool G 783

A Modern Trained Mechanical

Draughtsman, experienced in Bridgework, Locomotives, General Engineering and Surveying, DESIRES to CHANGE his present situation —Address to H H C, 17, Dartmouth Street, Westminster, S W G 785

A Young Swiss, with a

thorough theoretical knowledge of technical machinery, who for over two years was engaged in turbine and mill building works, DESIRES an ENGAGEMENT in England as Designer, in view of improving his knowledge of English Advertiser is thoroughly conversant with French and German — Address, A 889, care of RUDOLF MOSSE, Zurich, Switzerland G 754

Young Man, who has just

completed apprenticeship, SEEKS SITUATION in Engineer's Office, has some knowledge of drawing, and is willing to give services without salary for a time — Address, S P, Offices of ENGINEERING G 792

PARTNERSHIPS.

Partnership Required in a

good firm of Country Millwrights and Engineers, by a Gentleman having a good home and foreign connection, and some valuable patents which have already brought in good profits — Address, PATENTEE, care of JOHN W TRIST, Esq, 62, Old Broad Street, London G 705

Civil Engineer, 20 years' pro-

fessional and commercial experience, desires to JOIN a well-established connection, or would take up *bona fide* business having remunerative prospects.— Address, M.I.C E., 7, Little Queen Street, S.W G 625

To Civil Engineers in practice.

—The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright.

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Wanted, Two Lever Punching

MACHINES, second-hand, to punch up to ¾ in plates —Address G 746, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W C G 746

Specialty Wanted to Manu-

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For Sale, One Pair of

Compound Surface Condensing
MARINE ENGINES AND BOILER,
130 HP Nominal 5290
F GILMOUR & CO, Engineers, Glasgow.

For Sale, Largest Stock in

England, Engineers' Machine Tools, Steam Hammers, Steam Engines, Wood working Machinery, all sizes, best materials and workmanship, low prices, send for stock list —SCOTT BROTHERS, Halifax

For Sale, 9 in. Double Cylin-

der PORTABLE ENGINE, by Clayton and Shuttleworth, in good condition, being replaced by larger engine —Apply to STRACHAN & CO, Frome Hall Mills Stroud, Gloucestershire 5282

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a Branch Shop, Lathes, Drilling Shaping, Slotting, Punching and Shearing, Planing and Screwing Machines, and all the usual loose Tools, at very low prices —For particulars apply to GOOD & MENZIES, Green Lane Foundry, Hull G 782

For Sale, being superseded by

engines of higher power, a pair of High Pressure Condensing STEAM ENGINES Cylinders, 26 in diam, 3 ft 6 in stroke, with cold water pump for same —Can be seen at work at the Manufactory of the LONDON PORTLAND CEMENT CO, Ltd, Northfleet, Kent, to whom enquiries may be addressed G 534

TO CONTRACTORS, HARBOUR BOARDS, &c

For Sale, at Wicklow Harbour

Works, an 8 ton Russell Self Propelling Steam Derrick Crane, with 60 ft jib, 10 ton Cameron ditto, with 72 ft jib, Priestman Steam Travelling Crane, for "B" size grab, two specially strong Priestman Grabs, Punching and Shearing Machine, Chaplins' Locomotive, several large Iron Skips, several tons 6 in, by 6 in. Angle and Tee Iron, 40 tons Steel Rails, large quantity sound sawn Pitch Pine, three good Barges, one specially good rectangular Barge, on which Priestman Crane works. — Apply to JOHN JACKSON, Harbour Works, Wicklow Ireland, or 9, Victoria Chambers, Westminster 5122

To be Sold, a large sized Second-

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On Sale, One Pair Vertical

ENGINES, indicating 520 horse power, three BOILERS, 30 ft by 7 ft —All can be seen working at the LANCASHIRE COTTON SPINNING CO, Ltd., Heyside, near Oldham G 497

20-ton Overhead Traveller for

SALE, or in Exchange for Machine Tools 54 ft. span, wrought iron girders and double purchase crab, rope driven —NEWALL & CO, Bristol G 748

Ready for Early Delivery, at

Low Prices for Cash, 20 and 25 HP. Horizontal Engines, Improved Five Cutter Moulding Machine, Irregular Moulding Machine — Apply, H HANDS, Eagle Works, Popham Street, Nottingham G 765

To Tramway Promotors,

DIRECTORS, ENGINEERS, &c.—FOR SALE, a Quarter or Third SHARE in a valuable (Patented) TRAMWAY RAIL, which is secured without keys, bolts, or fishplates, and costs considerably under other systems, rails can be renewed without disturbing the permanent way —For further particulars, principals only, or their solicitors, apply, in the first instance, by letter, to A B, 48, Watling Street, London, E.C. G 744

Good Four-Horse Portable

Engine, and 6 ft. Mortar Mill; also Patent Woodford Centrifugal Pump, with extra lengths of framing and pipes. In good condition, cheap — Apply by letter, to JOHN LEA, 104, Queen Victoria Street, London, E.C G 773

40 HP. Nominal Semi-Port-

ABLE ENGINE and BOILER combined, 14 in. cylinders, 20 in. stroke, with reversing motion, pump and injector; working pressure, 120 lb.; new; in stock; price £635.—THOMAS PECKETT, Atlas Engine Works, Bristol. G 712

For Immediate Sale, at low prices for cash.

SECOND-HAND

LANCASHIRE BOILER, 18 ft 3 in by 7 ft diameter.
VERTICAL CROSS TUBE BOILER, 7 ft. 6 in by 2 ft. 8 in diameter.
TANK LOCOMOTIVE, 4 wheels coupled, cylinders 10 in. by 20 in.
A New 9 HP CHAPLIN'S LOCOMOTIVE
A Dozen HORIZONTAL ENGINES, with cylinders from 9 in to 10 in diameter (New)
5 ft. 6 in FACE PLATE LATHE, by Whitworth
RAIL STRAIGHTENING MACHINE, with engine attached, by Collier
No. 6 ROOT'S BLOWERS, by Thwaites.
Two No. 4½ PATENT BLOWERS, by Ellis.
Two SCOTT WHEEL MOULDING MACHINES
10-ton RAILWAY WEIGHING MACHINE.
STEAM WINCHES, from 5 in. to 7 in cylinders

For prices and full particulars of any of above apply to "PHILLIPS' MONTHLY MACHINERY REGISTER," Newport, Mon 4904

Engineering Works for Sale in London, to be disposed of, owing to a dissolution of partnership, fitted up with first-class modern machinery and tools, conveniently situated near the city —Apply to N GREW, Esq, C E, Dash wood House, New Broad Street, London G 794

Hornbeam Plank, all thicknesses, dry, warranted English growth, very large stock, cops cut to any pattern at moderate prices. — J KEEN, 264, Waterloo Bridge Road, London, S E. 5191

Gas Engine Patents. — For SALE or LICENCE, the French and Belgium Patents, already secured for a valuable Gas Motor Engine of 12 I HP, can be seen working — Address, GAS ENGINE, care of LEE & NIGHTINGALE, Advertising Agents, Liverpool G 697

16 HP. Portable Steam ENGINE, high class, new, with or without link motion reversing gear, FOR SALE on advantageous terms 8 HP PORTABLE STEAM ENGINE, high class, new, FOR SALE, cheap for the quality, with a 6 ft pan Mortar Mill and a 5 ft by 2 ft 6 in Saw Table complete —For price, or to view, apply to BARROWS and STEWART, Engineers, Banbury, Oxon 503

Compound Surface Condensing MARINE ENGINES FOR SALE, cylinders 10 in and 20 in diameter by 12 in stroke, fitted with Payton and Wilson's patent circular balanced and double-ported slide valves, and link motion reversing gear —Address ALEX WILSON & CO, Vauxhall Iron Works, Wandsworth Road, London, S W 4968

Tank Locomotives, 4 or 6 wheels coupled Specification and workman ship equal to Main Line Engines — Apply to R. & W HAWTHORN Engineers, Newcastle on-Tyne

See Advertisement last week, page 42 4954

Locomotive Tank Engines always in stock or progress —HUDSWELL, CLARKE and CO., Railway Foundry, Leeds, Sole Makers of RODGERS' PATENT WROUGHT IRON PULLEYS See Illustrated Advertisement, page 36

Locomotive Tank Engines for Main Line Traffic, Short Line, Collieries, Contractors, Iron Works, Manufactories, &c., from a superior specification, equal to their first-class Railway Engines, and specially adapted to sharp curves and heavy gradients, may always be had at short notice from Messrs. BLACK, HAWTHORN, and Co, Locomotive, Marine, and Stationary Engine Works, Gateshead-on-Tyne 1524

Engineers' Tools for Sale. — One 6 ft long by 2 ft 6 in sq Planing Machine One 8 ft long by 3 ft. 6 in square, Planing Machine One each 11 in and 12 in stroke Slotting Machines One each 6 in 8 in and 11 in stroke Shaping Machines 6 in 8 in 10 in and 12 in centres Screw Cutting Lathes Also Punching Machines, Screwing Machines, &c LOUDON BROTHERS, 156, Upper Thames Street, London, and 111, Bothwell St, Glasgow G 757

Cranes! Wagons! Rails!

Four 5 ton Steam Derrick Cranes, 50 and 60 ft double jibs
Nine 3 to 4 ton Hand Derrick Cranes
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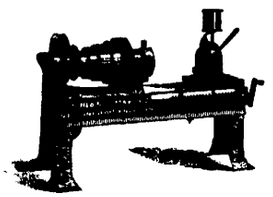
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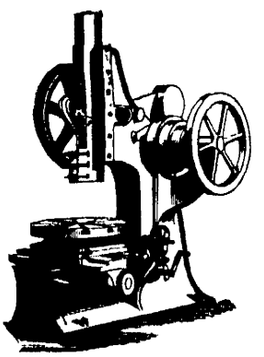
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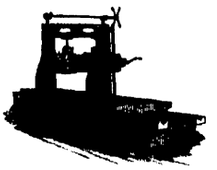
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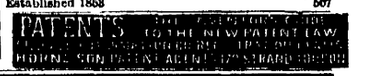
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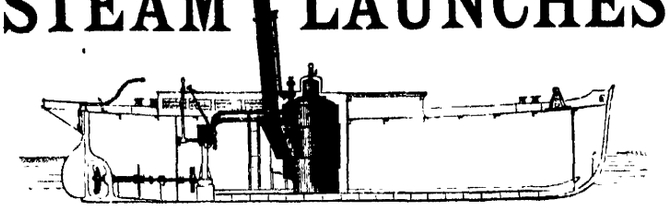
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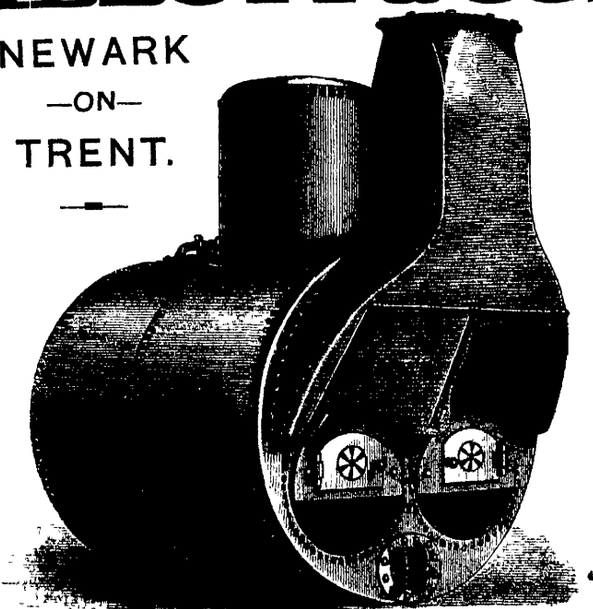
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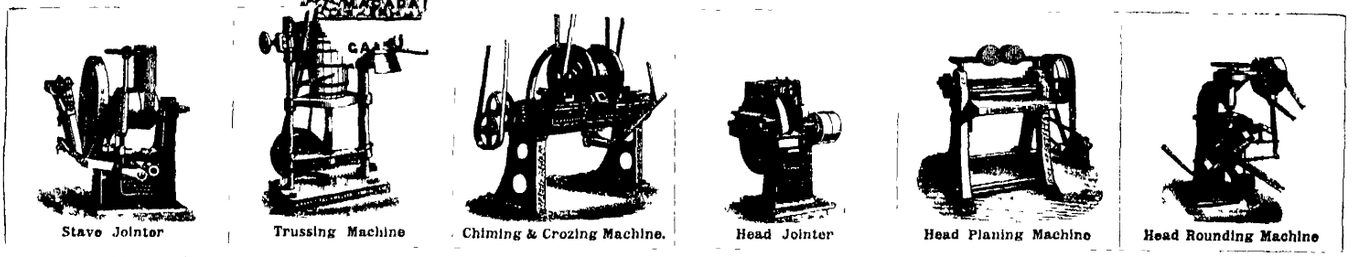
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De Bergue & Co. Ltd	
Desnoyelle Aine	6
Dennis T. H. F. & Co	1
Des Vignes G. F. G	1
Dick Alexander	17
Dick Kerr & Co	1
Dixon Isaac	1
Donkin B. & Co	1
Douglas and Grant	1
Drysdale & Co	2
Duncan Bros	10
Eadie Jas. & Sons	10
Earnshaw A. & Co	8
East Ferry Rd Engineering Works Co. Ltd	14
Empire Ventilator Co	4
Employers Liability Assurance Corporation Ltd	24
Engelbert & Co	6
Evans Jos. & Co	8
Fielding & Platt	1
Firth Jos. & Co	1
Flooding A. B., & Co., Ltd	1
Fleming Thos. Son & Co	18
Forrest & Son	1
Forsyth Miller & Co	16
Fowler J. & Co	41
Francis & Co	1
Galloway W. & J. & Sons	1
Gandy Mantle	26
Gerard & Co. Ltd	14
Gilbanks Riddell C., & Co	40
Gilda A. K	41
Gilmer W. F. & Co	1
Glasgow Hydraulic Engine Co	9
Gooding Universal Joint Co	46
Glover & Dobson	37
Goodfellow & Matthews	18
Goodwin James & Co	8
Graves Tull & Lakin	19
Green Edward & Son	48
Grehame & Craven	20
Hacke A. & Co	10
Headland W. & Co	1
Hamm, Donald & Wilson	6
Hannan & Buchanan	1
Hannay's Marine Appliances Co. Ltd	1
Hanson W	15
Hardingham G. C. M	24
Hart & Co	17
Harper's Ltd	9
Harris and Mills	4
Hartley & Co	8
Hathorn Davey & Co	1
ditto ditto	14
Hawthorn R. & W	1
Hayes Edward	48
Hayes J	1
Heenan & Froude	1
Hepburn & Gale Ltd	16
Hett J. & Co	1
Hick Hargreaves & Co	46
Hill & Smith	8
Hind & Son	19
Hodgkinson & Co	17
Hodgkinson & Co	24
Holden & Brooke	17
Holland & Street	26
Horn & Son	4
Hornsby R. & Sons Ltd	21
Horton J. & W	11
Hudson R	18
Hudswell Clarke & Co	45
Hunslet English Company	1
Hunter & Hett	1
Indiarubber Cutta Percha & Telegraph Works Co. Ltd	18
Invention Patent Light Association	4
Ivel Foundry & Engineer Co	1
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Jamieson Patent Cooking Co	11
Jessop Joseph & Son	9
Jessop W. & Sons	9
Johnson & Phillips 1 & 12	
Jordan J. B., Son, & Co	20
Jones	26
Kaye Joseph & Co	21
Kemp J	1
Kennedy M	19
Kell Thos. & Son	1
Kendall & Gent	5
Kerr Stuart & Co	5
Kirk W. Tyne & Goulty	4
Kirkstall Forge Company	14
Kitching Bros	17
Lancashire Patent Rifling and Boring Co	1
Lang & Co	1
Langdale Jno	19
Landore Siemens Steel Co	1
Lang J. & Sons	1
Lawes F. & Co	14
Lewis R. & Sons	1
ditto ditto	4
Lindsay J. B. & Co	19
Lloyd & Lloyd	1
ditto ditto	1
Lockwood & Carlisle	19
Lowcock Arthur	31
Lyon J. & Co	19
Lysaght John Ltd	17
Macfarlane W. & Co	1
Manchester Water Meter Co. Ltd	17
Manning, Wardle & Co	2
ditto ditto	21
Marshall Sons & Co. Ltd	40
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Martin W. A. & Co	24
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Mather & Platt	1
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M'Dowall John & Sons	1
M'Neil C. D	18
Meadows J. & Co	19
Mead J. M. & Co	24
Measures Bros. & Co	44
Merry Tetley Ltd	21
Messer & Hooper	1
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Middleton Co	1
Midland Railway Carriage and Wagon Co. Ltd	5
Miller & Capt	2
Mirrlees & Co	1
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Mosley D. & Co	1
Muller H. J	1
Mumford & Moulton	1
Murdoch Wm. & Sons	1
Naylor Vickers & Co. Ltd	1
Nelson H	11
Nettlefolds Ltd	17
New D. & C	1
Nicholson T. & Co	1
North British Rubber Co. Ltd	1
Oil Co	1
Oakey J. & Sons	1
Oates J. & J	14
Oldham H. Bros	1
Olrick Lowe & Co	1
Ditto ditto	1
Ormerod Grimshaw & Co	1
Owens F. & Co	14
Page F. & Co	48
Palmer W. & Co	1
Parkes & Co	48
Parsons C. A	1
Patent Shaft & Axletree Co	20
Patent Tube Co. Ltd	1
Patent Tube Co. The	1
Peel M. & Co	26
Penrose & Co	20
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Potter John H	26
Price's Patent Candle Co	26
Pumps Co	6
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Ransomes & Co	6
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Reddaway & Co	1
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Redpath Dorman Long & Co. Ltd	8
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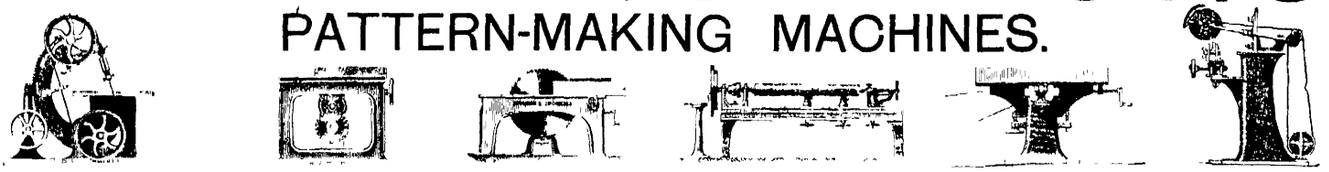
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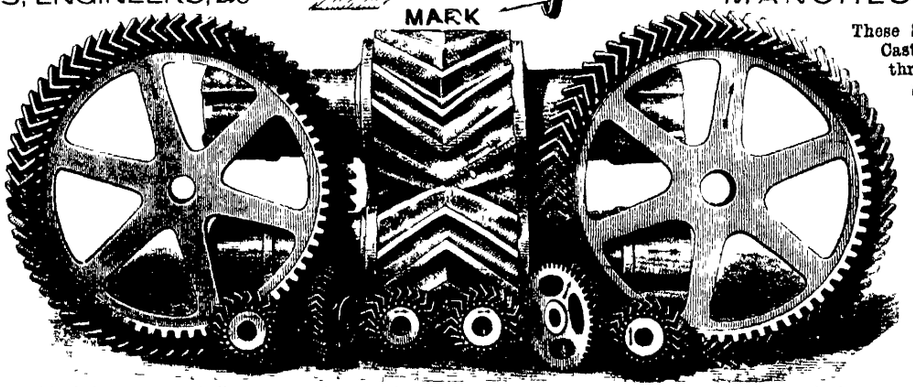
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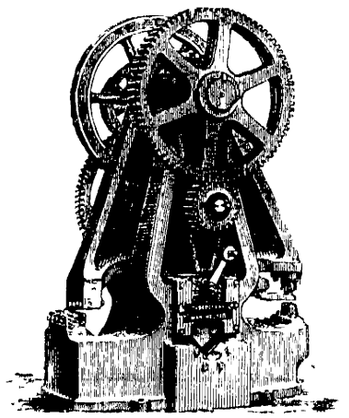
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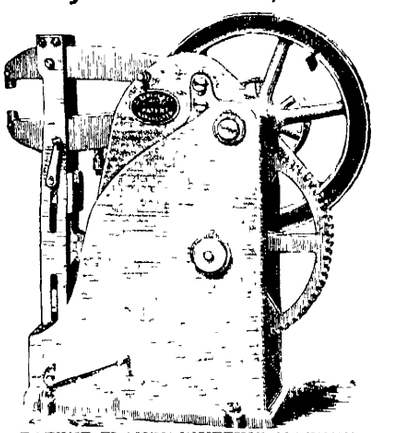
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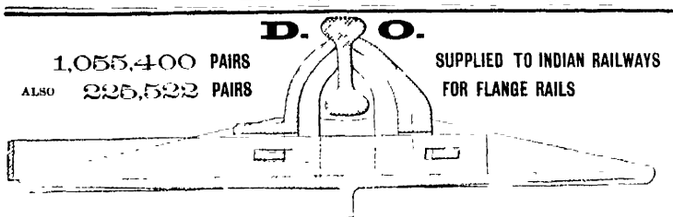
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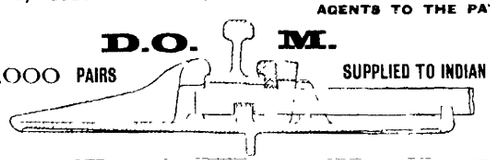
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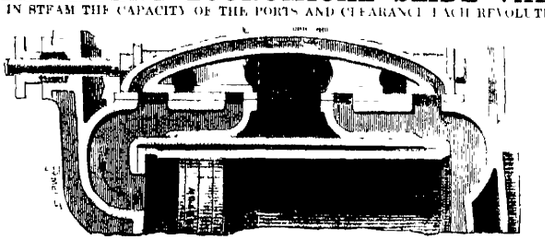
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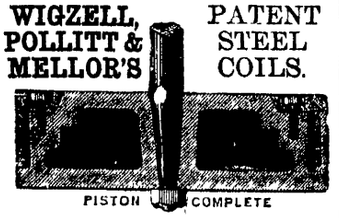
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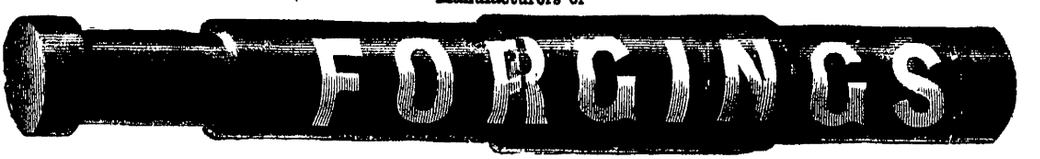
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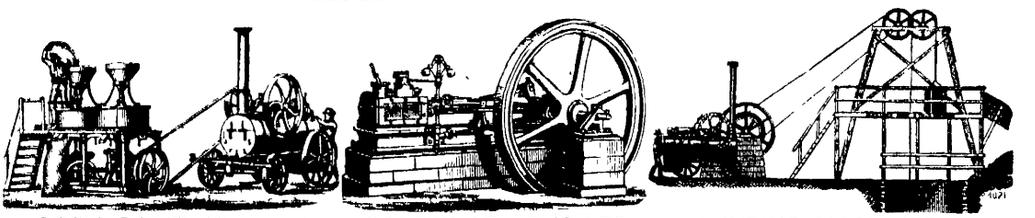
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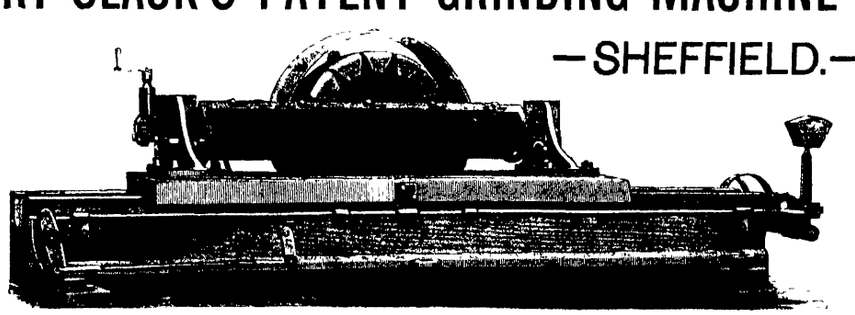


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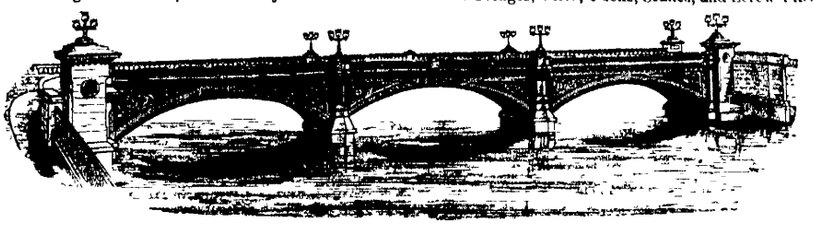


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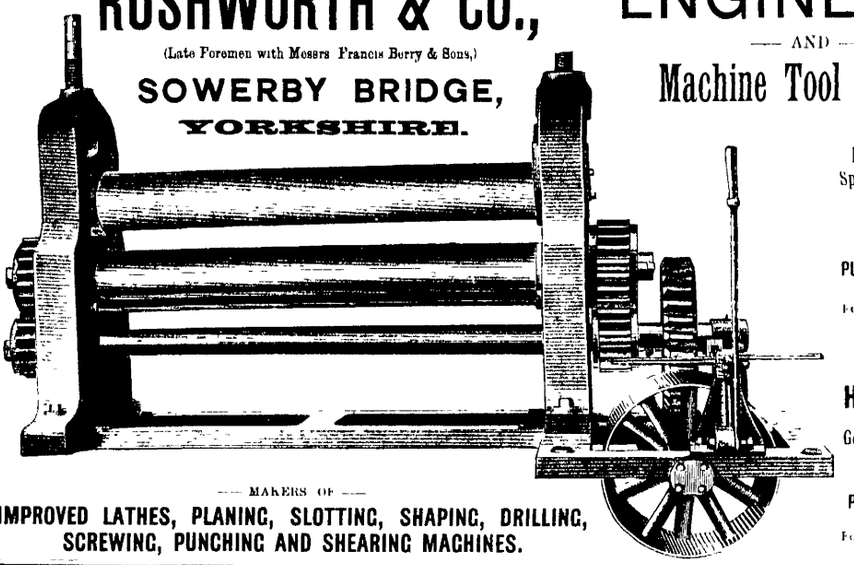


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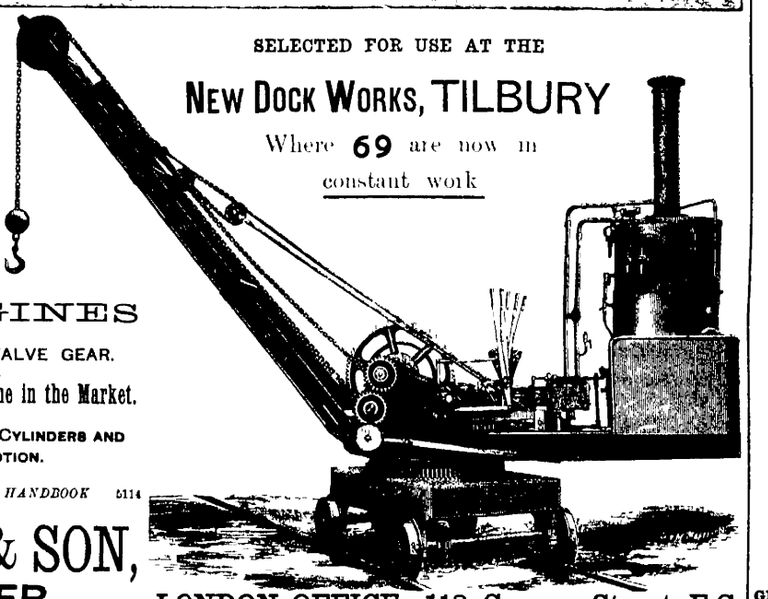
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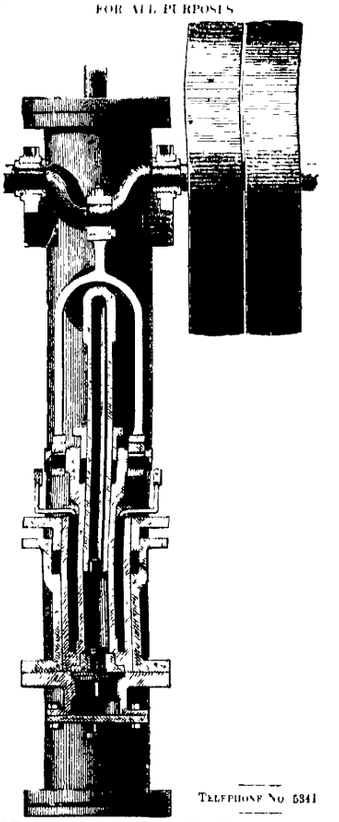
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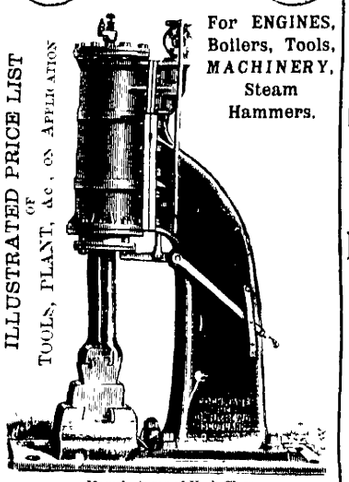
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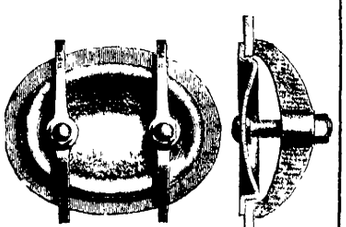
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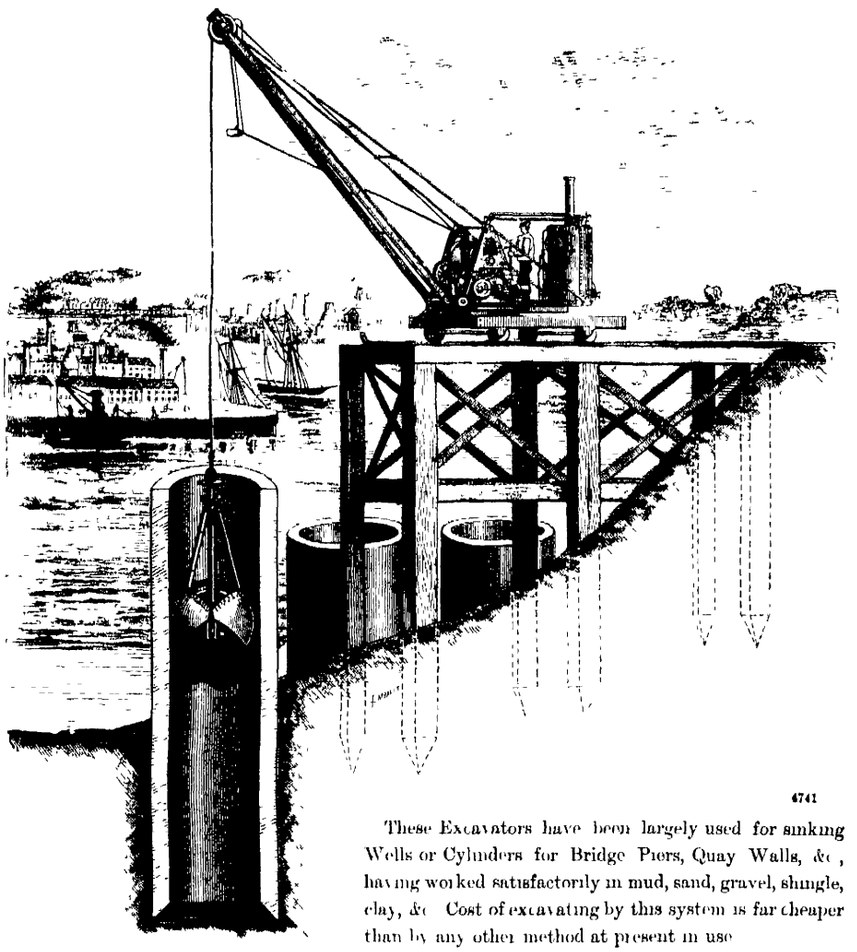
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4741

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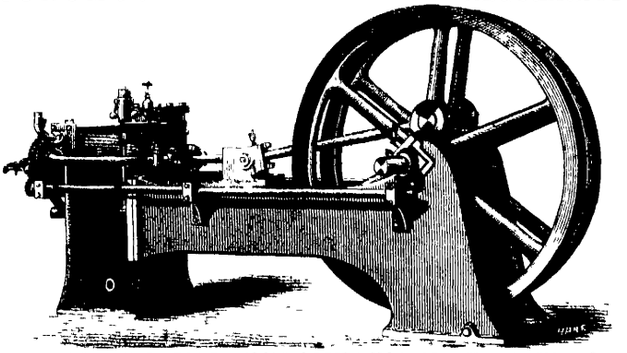
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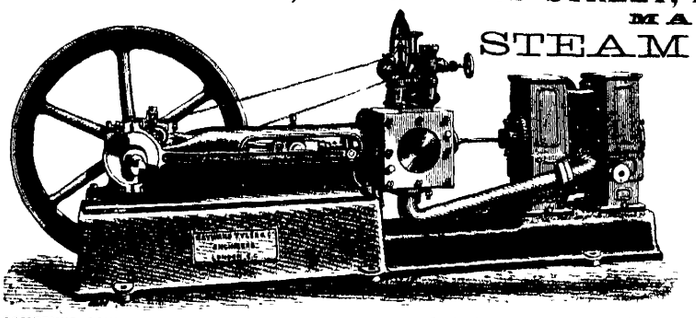
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4930

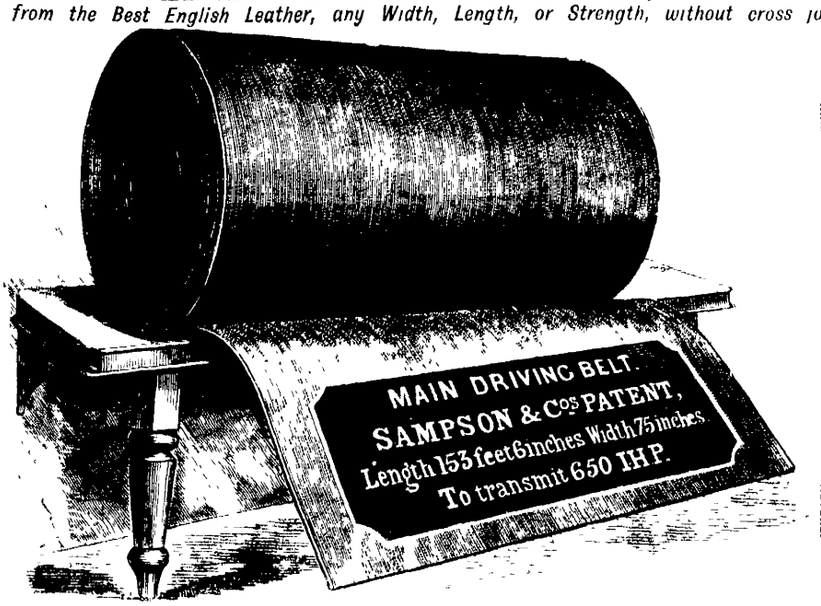
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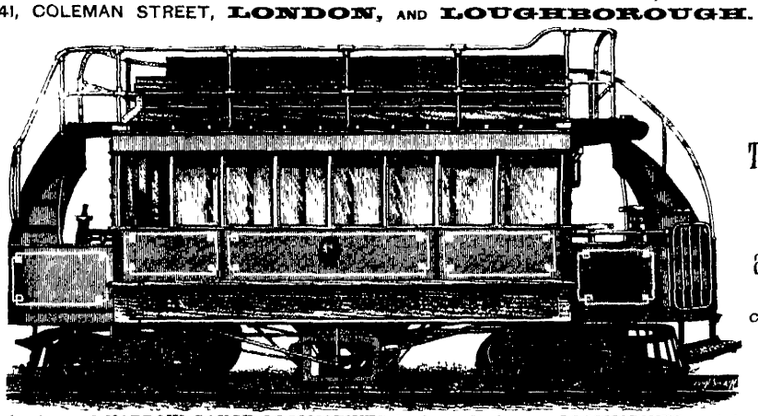
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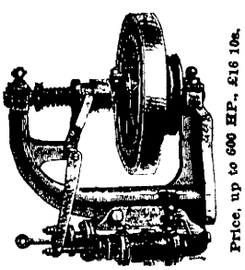
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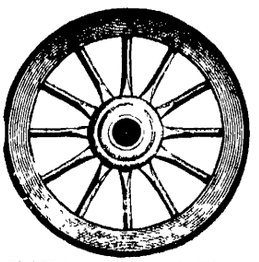
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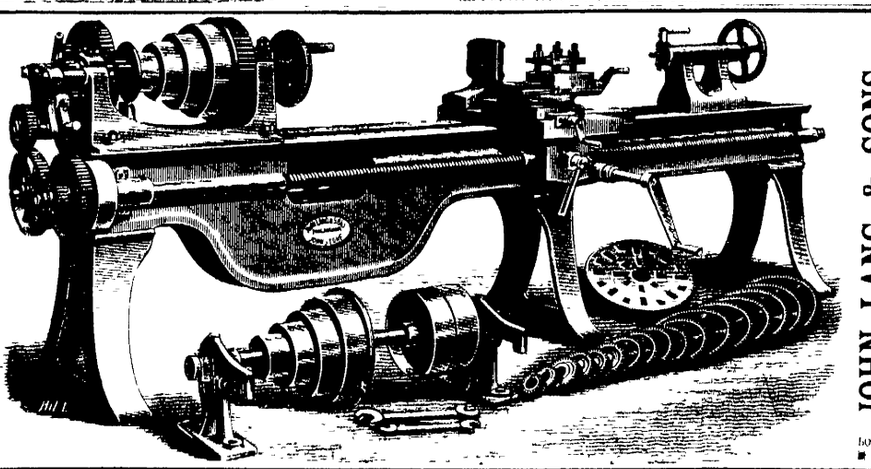
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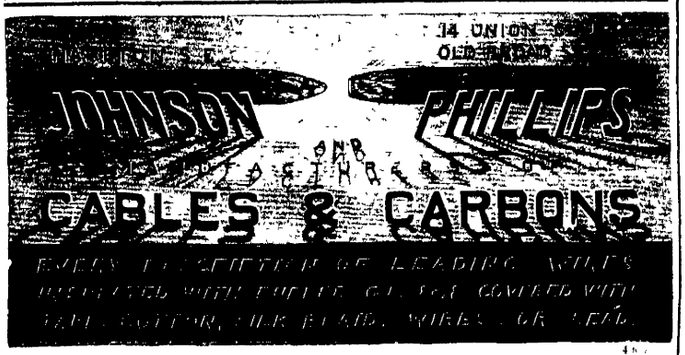
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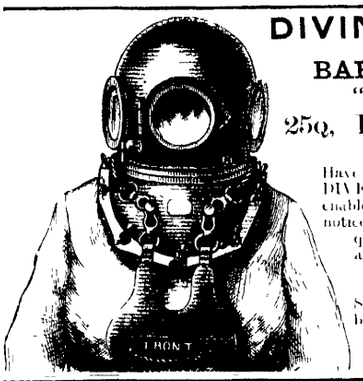
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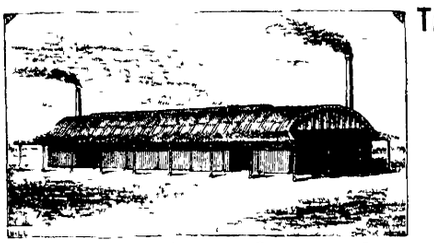
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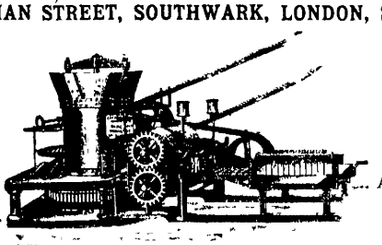
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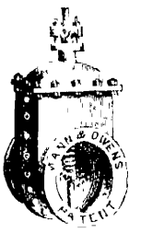
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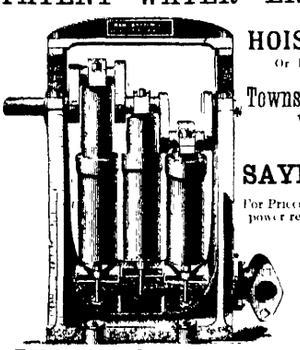
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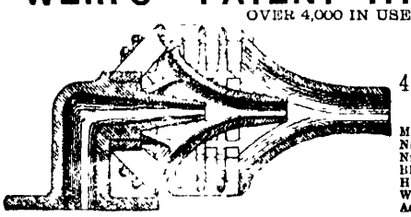


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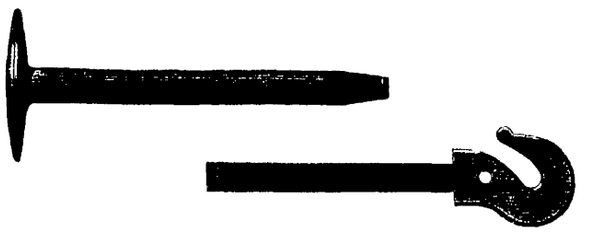


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MENZIES & BLAGBURN, KING STREET, NEWCASTLE ON TYNE WM REID & CO., 5, NEW LONDON STREET, LONDON, E.C. A & R. BROWN, WATERLOO ROAD, LIVERPOOL. R HUGHES & CO., FULTON STREET, DITTO W S VON ESSEN, ENGINEER, HAMBURG, AGENT FOR SCANDINAVIA & GERMANY 5281



Apply—THE KIRKSTALL FORGE CO, near Leeds. 4030

THE BOWLING HOOP OF EVERY DESCRIPTION IN IRON OR STEEL

STEEL CASTINGS

THE BOWLING IRON Co LTD
BRADFORD YORKS
ORIGINAL PATENTEES AND SOLE MAKERS

4567

MACHINE-MOULDED WHEELS,

— ALSO —

SHAFTING PULLEYS, PLUMMER BLOCKS,
WROUGHT IRON COLLARS, &c

ELIZA TINSLEY, *Engineer and Ironfounder,*
GREAT BRIDGE, STAFFORDSHIRE. 4717

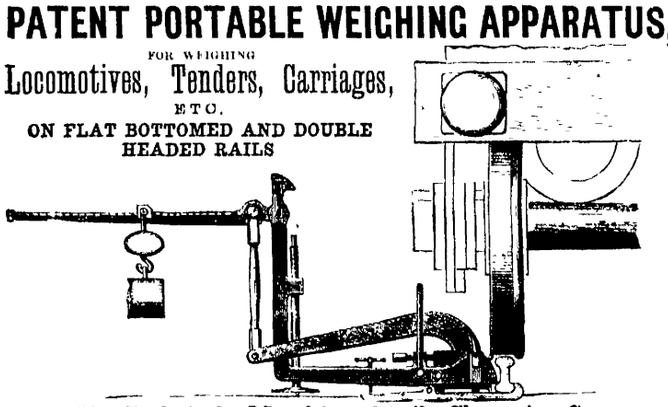
The Cheapest CONTINUOUS CURRENT DYNAMOS in the Market
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6 Lamps of 20 C.P	Price £10 (No 05)
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PATENT PORTABLE WEIGHING APPARATUS,

FOR WEIGHING
Locomotives, Tenders, Carriages,
ETC.
ON FLAT BOTTOMED AND DOUBLE HEADED RAILS



Sole Makers } The Sachsische Maschinenfabrik, Chemnitz, Germany.
Sole Agents and Licencees (to whom apply for prices and further information),
JAMES SCOTT & SON,
Engineers & Exporters of all kinds of Machinery, 10, Tib Lane, Cross Street, Manchester 5278

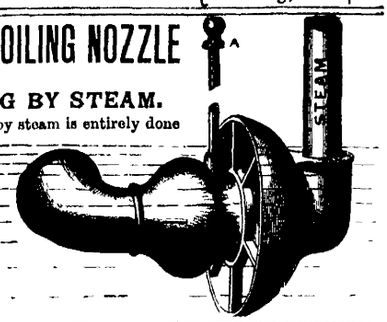
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The objectionable noise when boiling by steam is entirely done away with, and the liquor Heated or Boiled QUICKLY, ECONOMICALLY, and SILENTLY.

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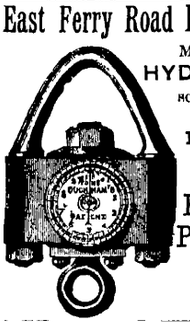
— MAKER OF —

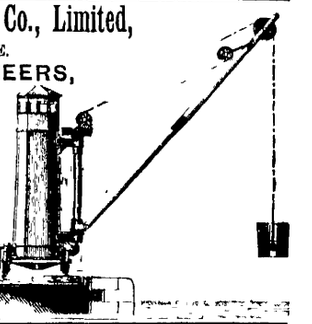
SUGAR, RICE AND FLOUR MILLS,
STEAM ENGINES, Boilers,
LINOLEUM MACHINERY.

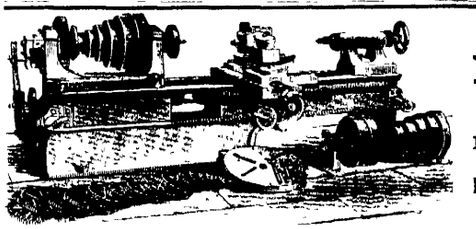
SUGAR MACHINERY

JAMES LANDALE,
Engineer, KIRKCALDY, N.B. 4945

East Ferry Road Engineering Works Co., Limited,
MILLWALL, LONDON, E.
HYDRAULIC ENGINEERS,
SOLE MANUFACTURERS OF
Parkes's Patent Portable Hydraulic Cranes, Lifts, and Hoists.
F. E. Duckham's Patent Suspended Weighing Machines. 5123







SPECIALITY IN
LATHES.

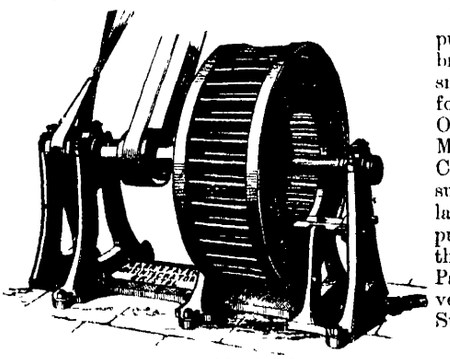
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Makers of all kinds of
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For Foot or Power 5220

"CARR'S DISINTEGRATOR,"

Registered Trade Mark, No. 6380.

AWARDED BRONZE MEDAL, PARIS UNIVERSAL EXHIBITION, 1878.

CARR'S PATENT DISINTEGRATOR.



This Machine effectually pulverizes by the combined influences of percussion and of centrifugal force, Iron, Zinc, and other Ores, Asphalte, Artificial Manures, Phosphates, Fire Clay, and many other substances. It is also largely in use for the pulverization of Coal for the manufacture of Coke, Patent Fuel, &c; and is very effective for mixing Sugar.

These Machines are capable of reducing to a fine granular powder from 50 to 200 tons per day (according to size) of any unfibrous material Machines made to order from 18 inches diameter, to suit special requirements of purchasers, these small machines being specially adapted to the requirements of Chemical Manufacturers for Mixing and other purposes

No Agents All Machines will in future bear the Registered Trade Mark ("Carr's Disintegrator") in three places—viz on Bedplate, and on outside Face of each Cage

A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee, 2523

PHILIP TRIGGS, Albion Chambers, BRISTOL.

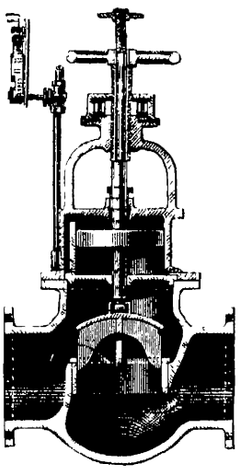
TATE'S PATENT

Electric Valve-Closing Apparatus

FOR STEAM ENGINES.

Medals Awarded AT THE INDUSTRIAL EXHIBITION, BRADFORD, 1882.

INTERNATIONAL FISHERIES EXHIBITION, LONDON, 1883.



THIS *APPARATUS* IS LARGELY USED ON STATIONARY ENGINES WITH THE GREATEST SUCCESS.

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PLANING, SLOTTING, SHAPING, BORING, DRILLING, AND SCREWING MACHINES.

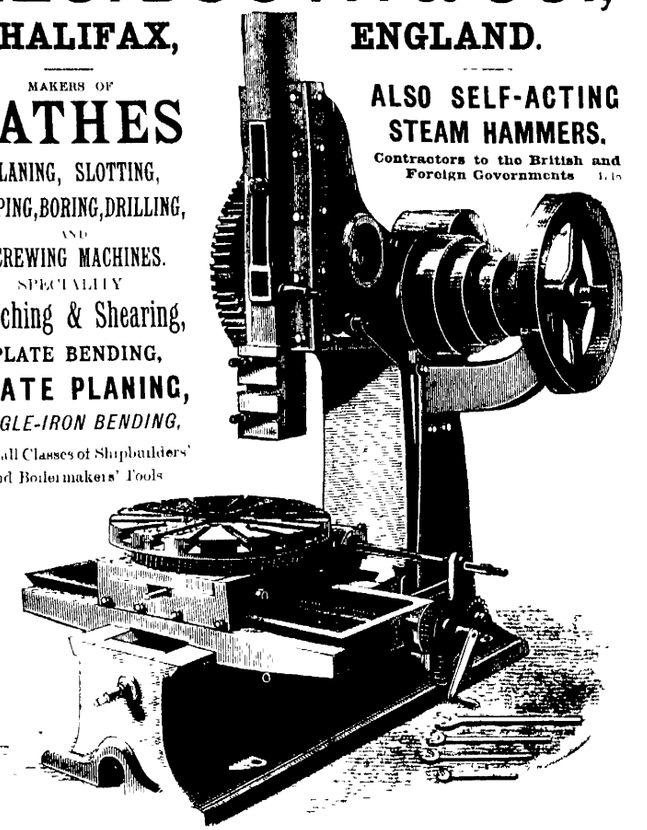
SPECIALITY

Punching & Shearing, PLATE BENDING, PLATE PLANING, *ANGLE-IRON BENDING,*

And all Classes of Shipbuilders' and Boilermakers' Tools

ALSO SELF-ACTING STEAM HAMMERS.

Contractors to the British and Foreign Governments 4180



HANSON'S SPECIALITIES

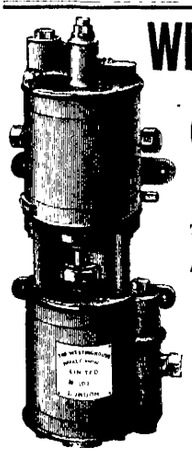
Steam Pumps, Steam Engines, Steam Winches, Steam Dryers, Steam Traps, Steam Reducing Valves, Steam Purifying Apparatus for Boilers, Water Engines and Hoists for Warehouses.

WILLIAM HANSON,

QUEBEC WORKS, BRADFORD.

LONDON OFFICE: 37, WALBROOK. 5270

(See Illustrated Advertisement August 15th, page 11)



WESTINGHOUSE PATENT AIR PUMPS

Upwards of 12,000 in use in all parts of the World.

CHEAP! SIMPLE! DURABLE! EFFECTIVE!

Occupy very little room, and work equally well for AIR, VACUUM, OR WATER.

Two sizes for Air and Vacuum are kept in Stock, but either can be adapted so as, with a given pressure of steam, to compress air to any required density

ALL PARTS ARE WORKED TO STANDARD GAUGES.

WATER PUMPS, working on the same system, are made to order

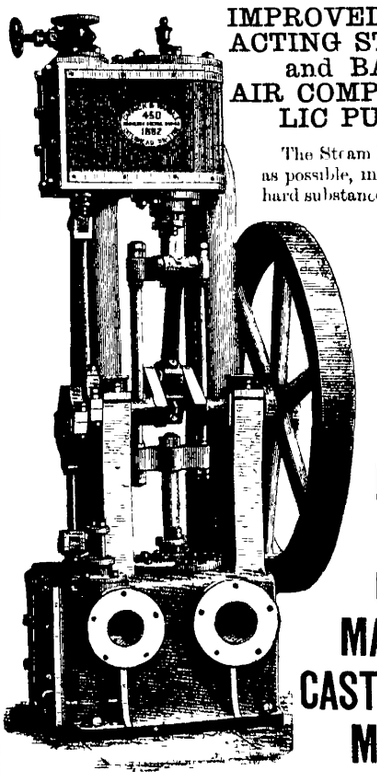
Prices on application to

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CARRICK & WARDALE,

Redheugh Engine Works, GATESHEAD.



IMPROVED SINGLE & DOUBLE ACTING STEAM FEED, BILGE and BALLAST PUMPS, AIR COMPRESSORS, HYDRAULIC PUMPS & PRESSES.

The Steam Pumps as illustrated are, as nearly as possible, incapable of being choked save with hard substances, and in working it has been found that shavings, waste, corn, small coals, &c., pass easily through, which renders them eminently suitable for ballast pumps for ships.

They are largely used in Chemical Works, Breweries, &c., where ordinary lifting valve pumps are readily choked, and by Railway Companies for supplying water at watering stations.

MAKERS OF EVERY DESCRIPTION OF CHEMICAL WORKS MACHINERY AND CASTINGS, HYDRAULIC MACHINERY, &c. 5124

THE STEEL COMPY. OF SCOTLAND,

LIMITED.

(SIEMENS PROCESS).

150, HOPE STREET, GLASGOW.

MANUFACTURERS OF

Steel Rails, Plates, Angles, Beams, Bars, Hoops, Forgings, Steel Castings, Blooms, &c. 1091

I. & W. BEARDMORE,

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MANUFACTURERS OF

STEEL PLATES, SHEETS AND BARS

(Siemen's Process) and

IRON SHEETS, PLATES AND BARS

FOR SHIPS, BOILERS BRIDGES, &c

	Ship	Boiler	Special	Extra Fine
BRANDS	P S Steel	P SS Steel	P SB Steel	P SB Steel

FOR COMBUSTION CHAMBERS

Boiler End & Furnace Plates, Flanged & Welded. Special Steel for Anti-Collapse Rings & Welded Tubes.

IRON AND STEEL FORGINGS OF ANY DIMENSIONS FOR MARINE ENGINES AND OTHER PURPOSES

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Belfast, 67, Donegall Street — H. H. BUTLER
Hamburg, Hopfensack No 11 — Wilh. RUMP
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4715

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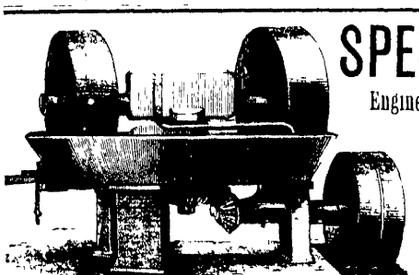
Malleable Iron (or Steel) Castings.

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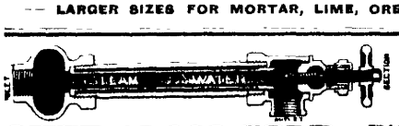
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FOR

LOAM, COAL, OR BLACKING

3½ ft pan, 5 cwt. Rollers £17
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STEAM TRAPS

OVER 13,000 SOLD. VAUGHAN'S PATENT WATER
SILVER MEDAL AWARDED. EJECTOR OR STEAM TRAP
POSITIVELY THE ONLY RELIABLE APPARATUS EVER MADE

Satisfaction Guaranteed.
Simple. Cheap
Saves broken joints, broken cylinders, broken pipes
Absolutely reliable.
Unvarying.

CAN BE APPLIED TO

Steam Engine Piping	Steam Hammer Pipes and Cylinders
„ „ Cylinders	Heating Pipes
„ „ „ Jackets	Heating apparatuses of all kinds
„ „ Valve Casings	&c., &c., &c

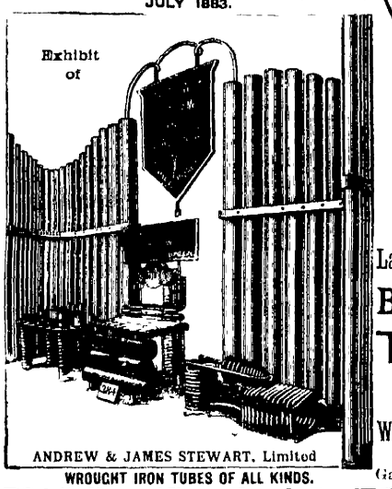
VAUGHAN & SON, ROYAL IRONWORKS, WEST GORTON, MANCHESTER.

CONTRACTORS TO H.M. GOVERNMENT,

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ANDREW & JAMES STEWART, Limited
WROUGHT IRON TUBES OF ALL KINDS.

ANDREW & JAMES STEWART, LTD.

Clyde Tube Works,
GLASGOW AND **COATBRIDGE.**

Address
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Lap-Welded
BOILER TUBES
OF IRON & STEEL

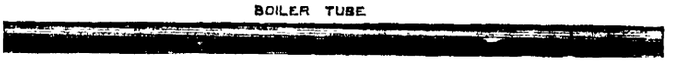
WROUGHT IRON TUBES FOR 5105
Gas, Steam, Water, &c., &c

THE WELDLESS STEEL TUBE COMPY.,

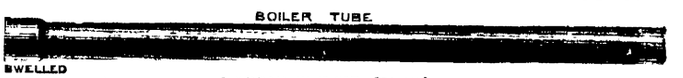
ICKNIELD PORT ROAD, BIRMINGHAM,

MANUFACTURERS OF

BOILER TUBE.

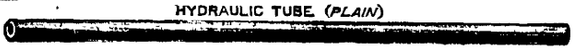


BOILER TUBE.



SWELLED

HYDRAULIC TUBE. (*PLAIN*)



HYDRAULIC TUBE WITH HEXAGON SOCKET SCREWED WITH RIGHT & LEFT HAND THREADS



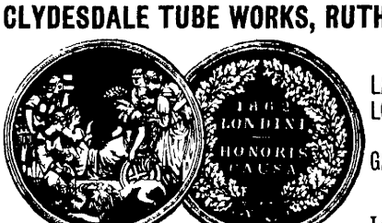
PATENT WELDLESS STEEL TUBES

For Boilers, Hydraulic Presses, Ferrules, Boring Rods, Bushes, Shafting Couplings, Spindles, Collars, and other uses.

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LAP WELDED IRON BOILER TUBES.
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GAS, STEAM & GALVANIZED TUBES.
STEEL TUBES. 5106

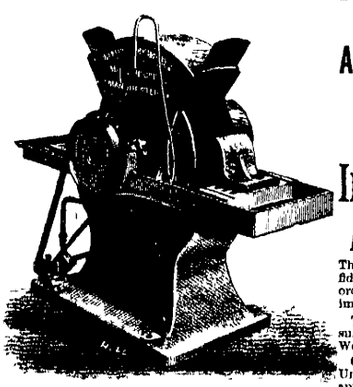
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SLACK'S EMERY WHEEL & MACHINE CO., Ltd.,

LIME BANK WORKS,

ARDWICK, MANCHESTER.

ROBERT LUKE & MOUNTFORD SPENCER,
Managing Directors.



Attention is invited to the New

Improved Tool Grinders,

SPECIALLY

ADAPTED FOR ENGINEERS' TOOLS.

These Machines are made in six sizes, and are confidently recommended as being much superior to an ordinary grindstone — grinding more rapidly and imparting a much better edge to the tool

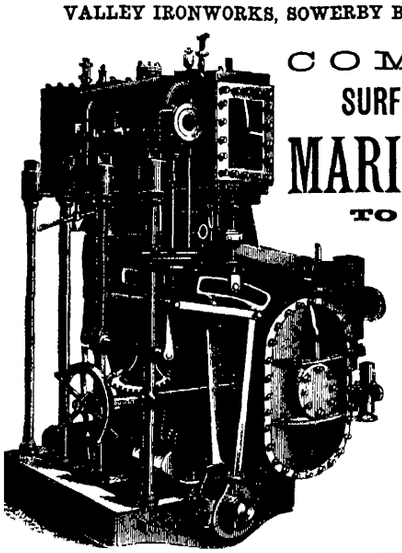
These Machines can be fitted with wheels specially suited for Brass Finishers' Tools, and also for Grinding Wood working Tools of all kinds

Catalogue, with illustrations of above and of many Universal and Special Emery Grinding Machines on application 4389

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Manufacturers of



COMPOUND

SURFACE CONDENSING

MARINE ENGINES

TO 1,000 I. HP.

High-Class Workmanship.

ALL LATEST IMPROVEMENTS

Specially to secure

Best Economical Results.

ENGINES

Always to be seen in progress

BOILERS

In Iron or Steel 4054

THIS alloy is an improved brass, hard durable, and strong as mild steel possessing a beautiful golden colour; when melted it produces sound castings of fine grain, it can be forged hot and cold and takes a very high polish

DELTA METAL IS BEING LARGELY USED FOR ALL KINDS OF MACHINERY

DELTA METAL.

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THE DARLINGTON STEEL & IRON CO., LTD.

BESSEMER STEEL RAILS from 10 to 84 lbs. per yard.

STEEL AND IRON FISH-PLATES,

PATENT FLEXIBLE, CLIP, ANGLE, AND OTHER SECTIONS.

ROLLED STEEL SLEEPERS.

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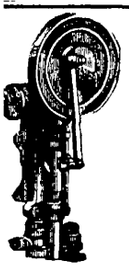
STEEL ANGLES, TEES, CHANNELS, BULBS, and BARS of other SECTIONS,

For Shipbuilding and Constructive purposes.

Guaranteed, if required, to stand the Admiralty or Lloyds' Tests.

STEEL CASTINGS OF ALL DESCRIPTIONS.

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MANCHESTER 27, CORPORATION STREET, Messrs. BARNINGHAM BROTHERS, Agents. 5109



ALEX. WILSON & CO.,

VAUXHALL IRONWORKS, LONDON, S.W.,

MANUFACTURERS OF

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HIGH-PRESSURE SCREW ENGINES, COMPOUND SCREW ENGINES, Patent SURFACE CONDENSING ENGINES,

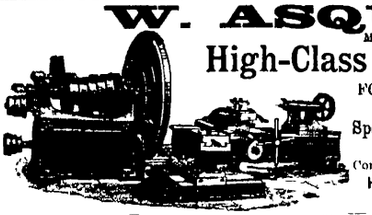
PATENT PADDLE ENGINES, HOISTING MACHINERY

4212

ILLUSTRATED PRICE LISTS ON APPLICATION.

W. ASQUITH,

MANUFACTURER OF



High-Class MACHINE TOOLS

FOR ENGINEERS, SHIPBUILDERS, BOILER MAKERS, &c. &c.

Special and General Machine Tools of the largest dimensions.

Contractor to the British and Foreign Governments

HIGHROAD WELL WORKS, HALIFAX. 4517

WOOD ENGRAVING

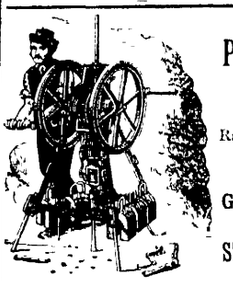
Draughtsmen & Engravers on Wood

HARE & Co

31 ESSEX STREET STRAND LONDON

ESTIMATES ON APPLICATION

5236



MACDERMOTT & GLOVER'S

Patent Percussive Rock Perforator (Improved)

FOR HAND LABOUR ONLY

IN HARD ROCK.

FOR MINES, QUARRIES, AND GOVERNMENT CONTRACT WORK.

Rate of Penetration in Granite 1¼ to 2 inches per minute.

PRICE £50 COMPLETE.

FOR FULL PARTICULARS APPLY TO—

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ALBERT IRON WORKS,

ST. JAMES'S RD., LONDON, S.E., Sole Manufacturers; or to

M. MACDERMOTT, 25 & 26, PUDDING LANE, LONDON, E.C. 5250

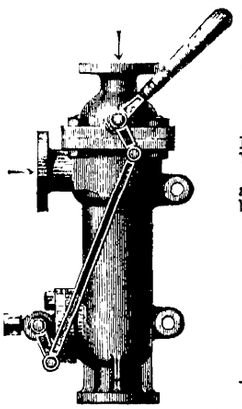
TELEPHONE No 4,664

N.B.—A Machine can always be seen at work (without notice) at the Albert Iron Works

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KÖRTING'S

PATENT UNIVERSAL



INJECTOR.

Works equally well non-lifting or lifting, with High or Low steam pressure, with Hot or Cold Water.

Forces the water into the Boiler considerably above boiling point, thereby increasing the durability of the Boiler.

IS STARTED BY SIMPLY TURNING ONE LEVER.

STEAM JET ELEVATORS.

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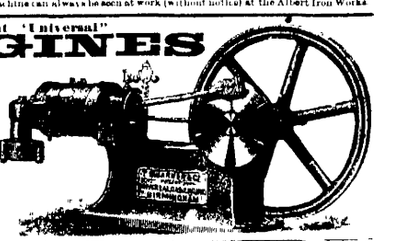
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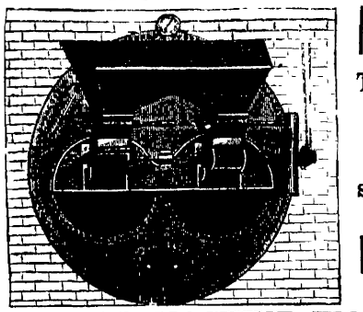
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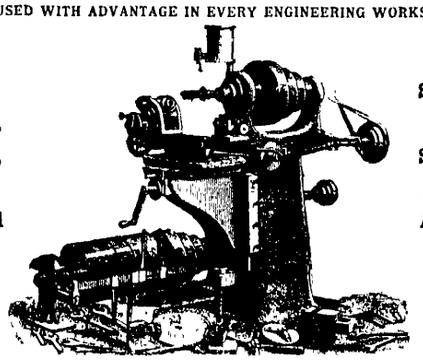


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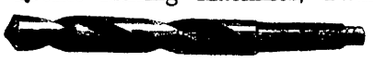
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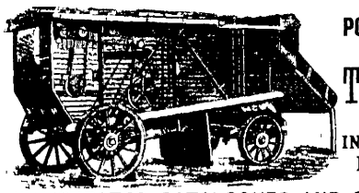
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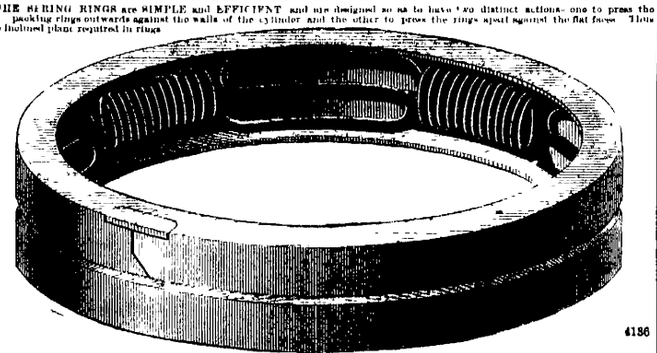
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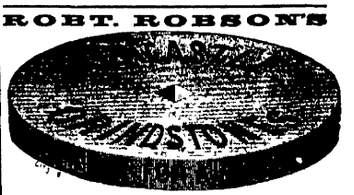
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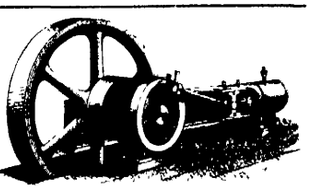
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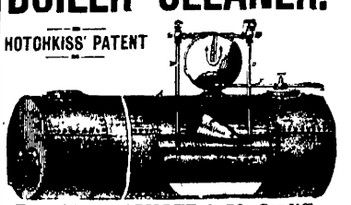


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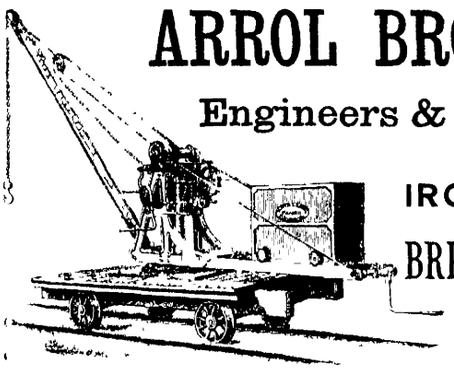
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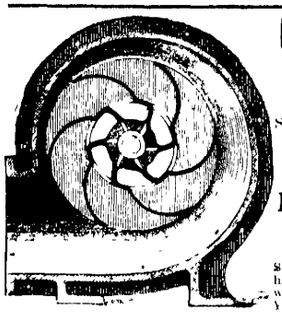
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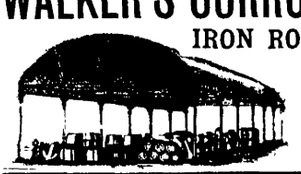
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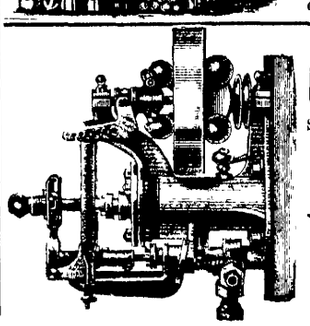
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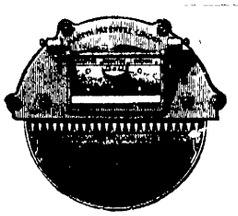
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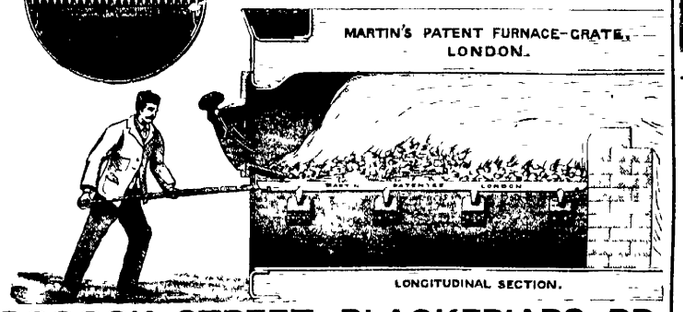
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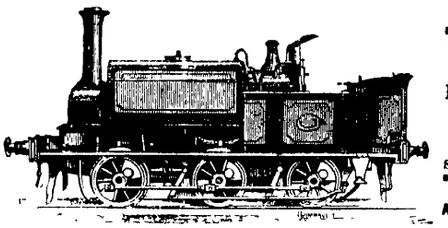


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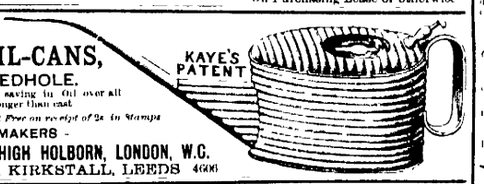
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These Oil cans in addition affording a great saving in Oil over all others are much stronger than cast

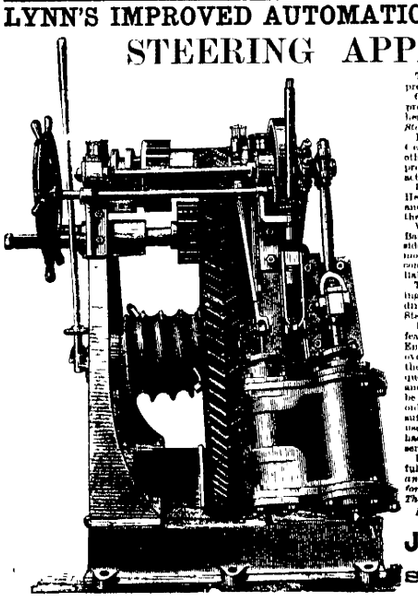
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This Machine is the strongest and most compact at present in the market

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The Gear is perfectly automatic the Engine responding to the action of the Steersman instantly in either direction so that a course can be steered by Steam as by Hand power

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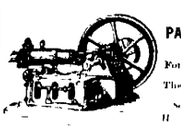


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Sizes, 1 to 500 Lights and above

Prices, **16 GUINEAS** upwards



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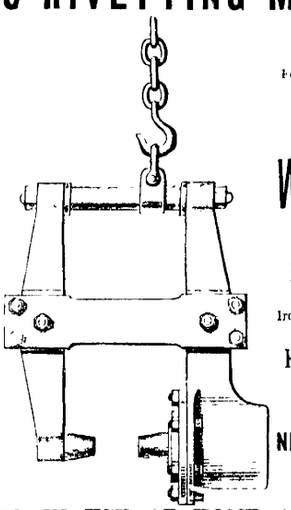
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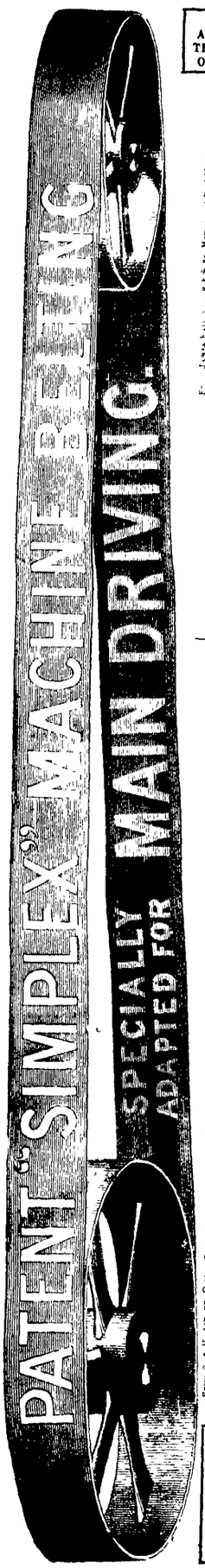
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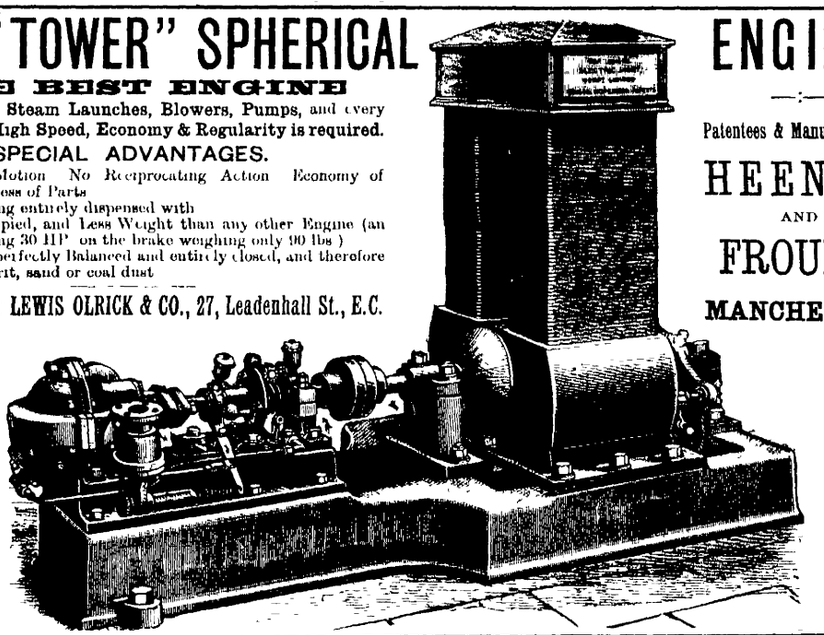
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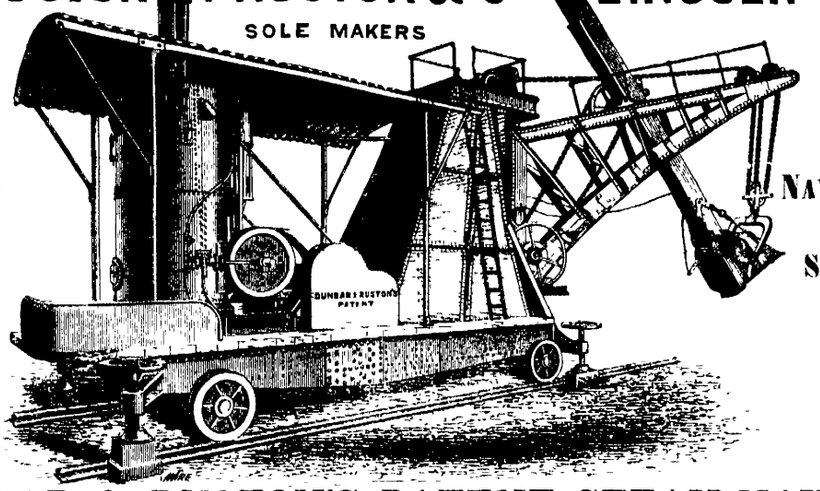
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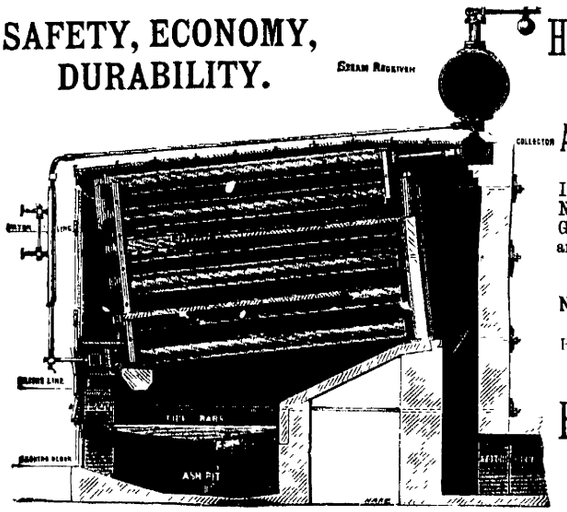
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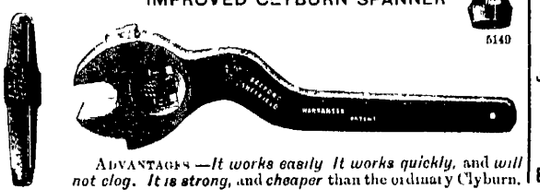
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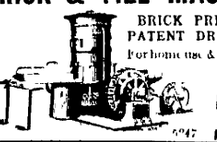
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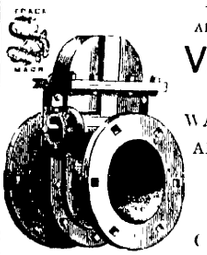
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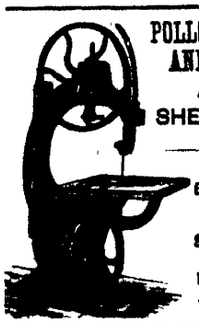
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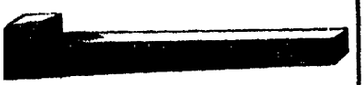


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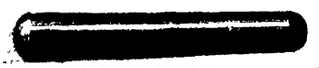
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— THOUSANDS IN USE AT HOME AND ABROAD. —

	SINGLE ACTING.							DOUBLE ACTING.						
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Diameter of Pump..	1	1½	2	2½	3	5	6	5	6	8	8	8	10	12
Gallons per hour .	60	97	150	165	220	440	787	900	1200	1440	1800	2600	3600	12400
HP. of Boiler	4	6	8	12	21	30	45	60	80	110	130	180	250	750
Hand Lever, extra.	7/6	7/6	9/6	9/6	10/6	12/-	15/-	15/-						
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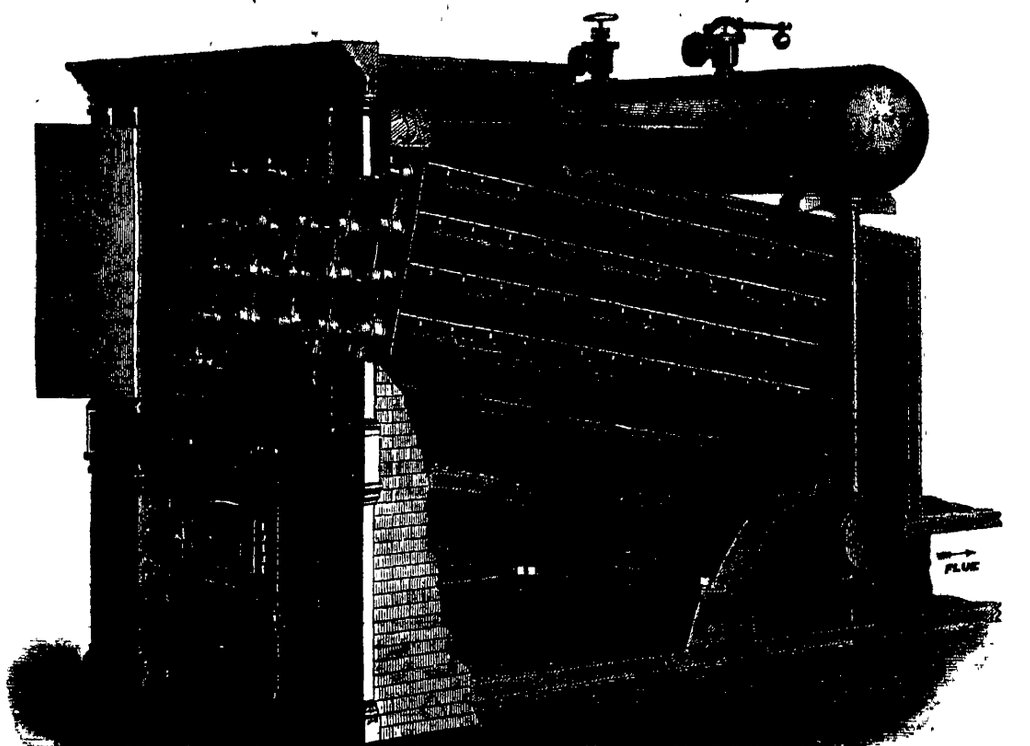
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Established 1844. COATBRIDGE, NEAR GLASGOW, Manufacturers of



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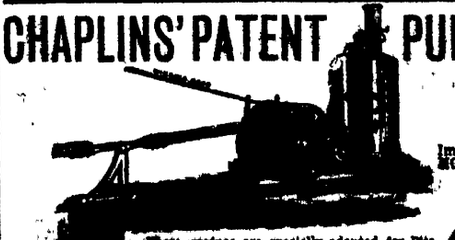
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HARDINGHAM'S PATENT SECTIONAL BOILER.
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CHAPLINS' PATENT PUMPING AND WINDING ENGINES,
For Winding or Pumping, either separately or combined.



PORTABLE WINDING ENGINES, on Carriage and Wheels,
With One or Two Drums, suited for Pit Sinking, &c.

Improved STEAM EXCAVATOR or "NAVVY," STEAM CRANES, HOISTS, LOCOMOTIVES, and others of our CHAPLINS' Patent STEAM ENGINES and BOILERS
ALWAYS IN STOCK OR IN PROGRESS.

These engines are specially adapted for Pits, Quarries, &c. They are exceedingly simple in arrangement, and no Foundation or Chimney Stalk being necessary, they can be erected or removed with very little trouble or expense, and are well adapted for home or foreign use. Sizes from 5 to 25 horse-power.

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CORNWALL ENGINEERING WORKS.

In the first volume of ENGINEERING, on page 86, there is a short description of Messrs. Tangyes' Engineering Works as they then existed, which even in those comparatively early days constituted an establishment of considerable importance. From time to time our pages have also recorded many of the valuable contributions to engineering practice which have emanated from the celebrated Soho shops. It is needless to say that since the year 1866, when the account we have referred to appeared in these columns, great changes have taken place, and, indeed, but a very small part of the original Soho establishment now exists. On page 218 we give a plan of the Cornwall Works, as they appear at present, and which cover an area of about 20 acres. Perhaps no better idea of their large extent can be formed than by studying this plan, especially when it is remembered that the whole of the shops marked in are crowded with machine tools, and the requisite appliances for working them, or such other plant as may be necessary for carrying out the various operations assigned to the respective departments. Many of the buildings are two or three stories high; for instance, the two large new engine-shops on the left of the general offices in the Cornwall-road have three floors occupied in producing engines of various types; on an average over 2000 hands in all are employed. Perhaps, however, the best testimony to the importance of this establishment is the work that is turned out, for there can be but few places on the face of the globe where machinery is used in which the productions of the Cornwall Works will not be found in some form or another. We will, without further comment, lay before our readers the result of notes we took during a recent visit to Soho.

Starting from the drawing office above the general offices to the left of the men's mess-room, we pass to the first floor of the building, marked "engine shop" on the plan. Here we find a department set apart as a small tool shop, and used for turning and fitting small parts and light work generally. Above this is a floor for brasswork, containing about fifty machine tools, principally lathes and milling machines. There are two or three capstan lathes for making the valve seats of "special" pumps. These will each take six tool-holders, the cutters for which are machine ground. The roughing, screw-cutting, boring, facing, and inside screw-cutting are done in these lathes. There are also three lathes of special make for hydraulic pump work. They have sliding beds so as to take pieces of considerable length. In this shop there is a gas arrangement for tempering and forging small tools, which is found very useful. Gas is also used here for brazing and soldering. Here are turned out all hydraulic pumps, stop valves, and all brasswork for hydraulic presses. The internal brasswork for "special" steam pumps and steam engines, all lubricators, brass, engine and boiler fittings, and other brass machine work is prepared here also. Two steam hoists serve this shop, one communicating with the ground level below, and a second with the store from which the fitters are supplied.

Keeping on the same level we pass a store used for light parts of gas engines and governors, and then to the first floor of the long new building, also marked "engine shop" on the plan. This, at the time of our visit, was hardly finished, so far as getting all the tools in place was concerned, but it is intended to be used for general light machine work. It is supplied with a steam hoist worked by a Willans engine. The ground floor of this shop is used for making steam engine governors. Here are the necessary tools, consisting of lathes up to 14 in. centres, drilling machines, mostly with twist drills, and other machine tools.

Below the shops we have been describing is the gas engine department, where the special form of this class of motor which Messrs. Tangye have introduced is erected, the parts being made in the machine shops above. All these shops are driven by a pair of horizontal condensing engines with 16 in. cylinders and 28 in. stroke. They have an ordinary jet condenser, and are fitted with variable expansion gear. The shafting here, and, indeed, all the modern shafting, runs in flexible bearings. The fitting shops have hand travelling cranes running the entire length. Under the first shop mentioned is a floor below the ground level, which is used for storing heavy castings, and which also contains a few heavy tools for turning flywheels, &c.

Passing to another part of the works we come to the crane shop, which contains many tools, most of them specially designed for the purposes for which they are required; for instance, the jib bottoms have the hobs bored for short pins, and the sides faced in one machine without being shifted. There is also a lathe for turning both journals of crab axles. The headstock is in the centre, and there are a couple of capstan head rests, each with four cutters. There is also a large vertical boring machine that will bore crab sides, working two bars at once, and which is specially arranged to suit the nature of the work. Cranes of all kinds are turned out in this shop, such as jib cranes of all kinds, foundry cranes, hand-power hoists, crabs, winches, and overhead travellers. The latter are made up to 50 ft. span, and of any practicable lifting power.

Next to the crane department is the "special shop" where the steam pumps, which form one of the chief items of manufacture, are made. A large pillar drilling machine is a noticeable tool. In this the valve seats for "special" pumps are bored and milled. There are also lathes, slotting machines, slot drilling machines, and many other tools, including a four-spindle horizontal boring machine, which will take four pump barrels at once. There is also a four-spindle lathe for turning piston and pump rods, the slide rest being fitted with four tool-holders. There are several boring machines of different kinds; some will bore and face pump cylinders at one setting, and will take 11 ft. between centres. There is also a hydraulic testing machine for proving the castings before they are taken to the boring mill. There are in all over 400 machines of various kinds in this shop

Passing to the pattern shop, we find some very good machines. There are circular saws of various kinds, dimension saws, and cross-cut and rip saws, which will turn out the work ready for glass papering. We may here remark that great attention is paid to the patterns made at the Cornwall Works, which are all very finely executed, no trouble being spared in order to get a good finish. This, no doubt, is a wise provision considering how many pieces are here cast from one pattern, reproduction being the leading feature in the economy of the establishment. A large building in the centre of the premises is set apart for storing the stock patterns, a service which requires considerable attention owing to the large number of patterns in use.

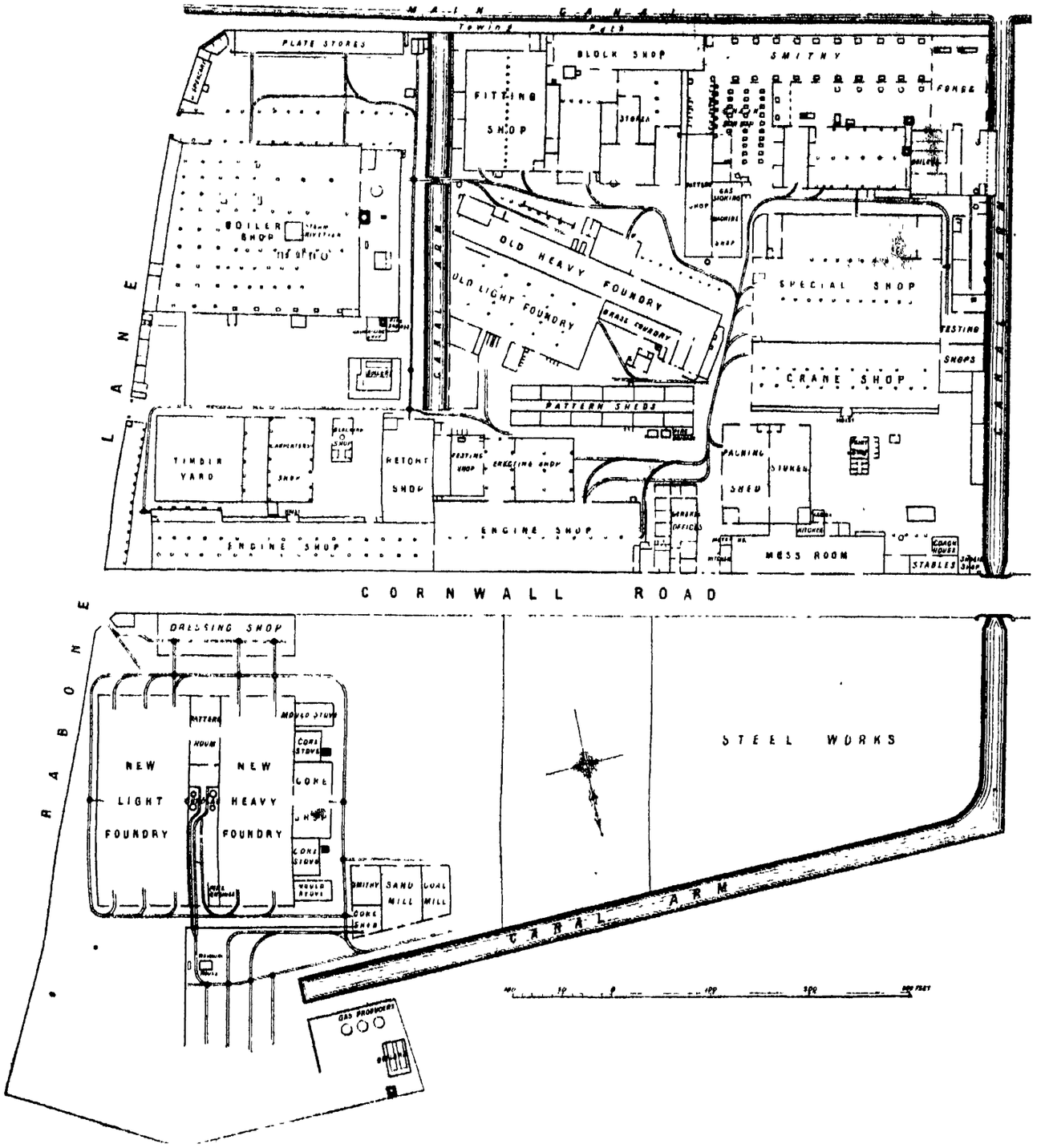
The block shop, which is situated on the main canal, forms an important department in the works. Here are made the Weston differential pulley blocks so well known. These are tested from 5 cwt. to 4 tons. Brake blocks of various sizes tested from 1 to 3 tons; "dynamic" pulley blocks tested to as high as one ton; rope blocks with eccentric brake on Hewitt and Goff's patent are also produced in this shop. The other descriptions of blocks are what are known as the London pattern, which are made single, double, three-fold, and four-fold; and with sheaves from 2½ in. in diameter and ⅜ in. width of groove, up to 19 in. in diameter and 3½ in. width of groove. In these blocks each plate forms a support to the spindle. Gin blocks, snatch blocks, clump blocks, malleable cast-iron dead eyes and other fittings of this kind, all of course of metal, are also made or finished here. Messrs. Tangye supply a large number of blocks for use in the Royal Navy. These are made of cast steel, and have wrought-iron hooks and straps. They also make a block in which the frames and sheaves are of malleable cast iron, the hooks and pins being of wrought iron. They are galvanised, and are made up to 9 in. diameter of sheave, and will take a 5 in. rope. From the block shop we pass to the chain-making department, where there are a large number of fires. In another building the blocks and chain are put together so as to form sets of pulley blocks. Here also the chain is brightened by being placed in an iron revolving cylinder, firstly with pieces of coke and afterwards with leather cuttings. In this building is a special combined punching press and shears, with clever automatic feed, for turning out the side plates of wrought-iron blocks. There is also a press for stamping out pitch chain blanks from merchant iron or steel, the latter material being generally used. It also has a well-designed automatic feed. The sides and some other parts of the wrought-iron blocks are mostly stamped by a hydraulic press, of which there are three or four in the block shop. These are fitted with different tools for the various pieces required. Adjoining the block shop is a large shop principally occupied by the milling machines used in turning out the various small parts required for steam engines, pumps, &c. An ingenious copying machine is mostly used for forming the milling cutters used in the shop. A horizontal shaft works in a sleeve which pivots on trunnions. The shaft carries at the end a revolving cutter. The template is fixed to a slide which also carries the work, and in this way the cutter is made to follow the contour of the template. Other machines are used for cutting the parts of engine governors, cutting keyways, slots, ratchets, facing jack bases, and many other purposes. Packing glands for engine cylinders are also turned out by milling machines. They are mostly made of iron and brass bushed and form an excellent job They are kept in stock and supplied separately as a list article. Messrs. Tangye adopt milling tools for a large variety of purposes throughout their shops, the nature of the work bringing out the full advantages of these handy labour-saving machines. In cases where a single part has to be duplicated so often it pays to make a special tool. Some of the milling cutters used in the shop we are referring to were built up of several parts, in fact there seemed to be no difficulty in getting any shape, so long of course as no undercutting was required Another point in favour of this class of work is that no great skill is required on the part of the operator. Many of the machines we have referred to were attended to by young lads from about 15 to 18 years old. In this shop also were several four-spindle drilling machines with twist drills which we believe are hand ground. There were also vertical nut-shaping machines, screwing machines for nuts and bolts, and a variety of other light machine tools.

The general smithy is in the corner of the premises formed by the main canal and one of the arms that runs up into the works. Here are several fires and some small steam hammers, olivers, and spring hammers—the latter used for drawing down the points of block hooks There is also a circular saw for cutting hot iron. At the end of the principal smithy is a larger steam hammer used for working up scrap, or for stamping larger blanks, such for instance as those for punching boars. There are also steam shears for cutting up scrap. This hammer is supplied with steam by a boiler fired by waste gases from the furnace At the back of the smithy is a range of six Lancashire boilers. Hook-bending is made a special feature, hydraulic machines being laid down by which hooks for blocks and other work are formed at one operation, a hook of 2 in. iron being bent in about 30 seconds. An apparatus for blackening and hardening iron should also be noticed. There are several other small smiths' shops in different parts of the premises which are used for local work. The bar-iron store is placed close by the smithy Here is a machine for cutting 4 in. iron of square section cold Close to this again is a forge where there are several drop presses used for stamping out smaller parts of engines, such as governor balls, mitre wheels, joints for engine rods, spanners, and a large variety of work of this description. Further on is a building containing heavy tools for bending iron in various ways, such as for engine cranks, &c. Silver melting pots are made here by forcing them by hydraulic power on dies.

The department marked "fitting shop" on the plan is a large square building. Here most of the hydraulic machinery is turned out. Amongst a number of other tools there is a large three-spindle shaft lathe, which will take 30 ft. lengths between centres. There are also several lathes of different kinds specially designed for particular work One was employed in turning a grooved flywheel used for rope driving. Another has two face plates and two slide rests on each side, so that four cutters can be at work at one time, two separate pieces being chucked at once.

There is also a Whitworth planing machine with revolving tool-holder and screw traversing motion, together with a Whitworth brake lathe, which is mostly used for boring hydraulic cylinders. In this shop there are a large number of tensile testing machines in progress. These are a regular list article with Messrs. Tangye. We should also mention that at the time of our visit a large anchor and cable testing machine, 64 ft. in length, was in progress of erection, which had been ordered for the proving house at Netherton. In the same shop was a four-cutter boring machine for jack cylinders. It has a vertical automatic feed, the table rising on four pillar guides. The lighter tools are placed in

PLAN OF THE CORNWALL ENGINEERING WORKS (TANGYES LIMITED), BIRMINGHAM.



galleries above. Here is a machine twist drill grinder by Thompson, Sterne, and Co., and also a Sellars machine for the same purpose, together with a gritstone machine for the shifting cutters of tool-holders. There is also a machine for cutting leather radius pieces for rounding angles in foundry patterns. This "angling" is spoken very highly of, and it is said that with it three times as much straight work and ten times as much curved work can be turned out by a pattern maker in the same time, whilst a far better finish is obtained. The "patent angling" is a list article with Messrs. Tangye, who use it on all their own patterns.

The jack shop is also an important department at the Cornwall Works, and indeed it is probably as much by their hydraulic jacks as by anything else that the Brothers Tangye first became famous. The jack shop is not shown on the plan, it being on an upper floor above the crane shop. Here we noticed a three-spindle double-geared drill in which the spindles traverse, and the work is fed up automatically on the table. There was also a three-spindle screw-cutting lathe for cutting square threads on jack-lifting screws. We also noticed a four-spindle lathe for cutting jack-traversing screws; and also a double-ended lathe for turning hydraulic rams.

In this shop punching bears are made and fitted, together with rail benders. The special hydraulic shears for cutting wire rope up to 6 in. are also made here.

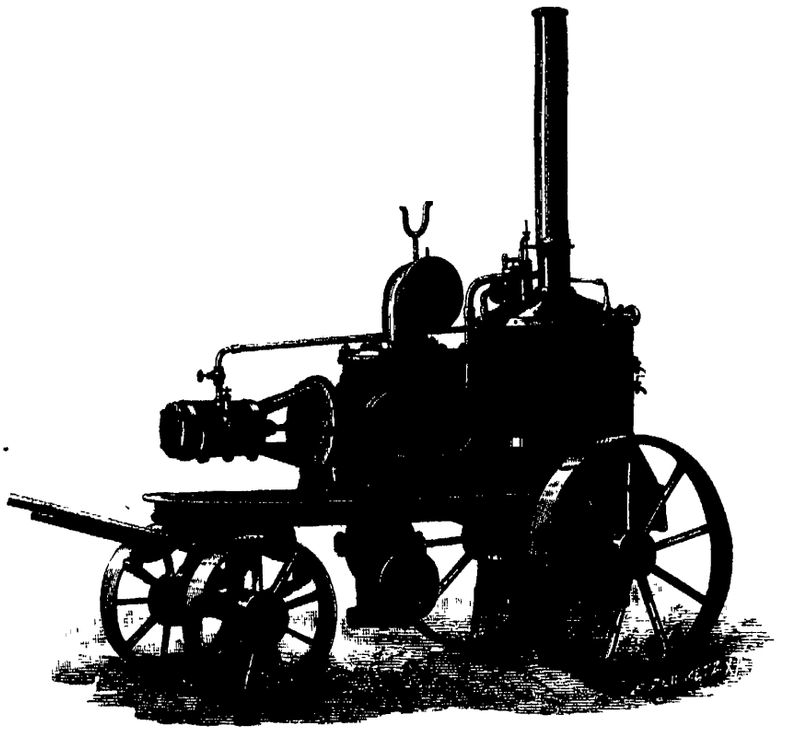
the engine erecting shop, where there
many intended for electric
we come to the retort shop.
retort mouthpiece and the
fittings for the Wilson gas producers are turned out. For the former work there is a special tool of exceedingly ingenious design, which it would be impossible to describe without illustrations. There are also here drilling machines, lathes, and other machine tools. Large steam stop valves, steam traps, and receivers are also made here. Close by is a range of four Lancashire boilers, and next to them are the steam pumps for fire service, and the hydraulic pumps and accumulators for works' use.

The boiler shops cover a large space, the many varieties of boilers made by this firm being constructed here. These consist of the ordinary Lancashire and Cornish boilers, besides locomotive, marine, vertical, Kesterton, colonial boilers, Marston's patent, and other kinds. At the time of our visit the ordinary R.T. marine boiler appeared to be principally in demand. There are in these shops one hydraulic and one steam rivetter, besides
machines, and the usual drill-
shearing machines with other
. There is also a
ing press and a steam hammer for flanging fire-

PORTABLE STEAM PUMP.

CONSTRUCTED BY MESSRS. J. EVANS AND SONS, WOLVERHAMPTON.

(*For Description, see Page* 221.)



boxes of vertical boilers, a large circular hearth being attached. The timber yard and carpenters' shops are placed in this part of the works, and call for no special notice. The foundries, it will be noticed, are placed in the centre of the premises. These constitute the oldest part of the works. At the time of our visit they were still in work, but new foundries were being rapidly finished (and, indeed, to some extent were in use) on the north side of the Cornwall-road. These, we understand, contain all the best modern appliances. The old foundries do not call for any special notice.

In connection with the Cornwall Works, although we believe not altogether under the same management, is Tangyes' Machine Tool Company, Limited, and the steel works which is marked on the plan. There is much of interest in both these departments, but we must leave them for a future occasion. In a short notice like the present it is manifestly impossible to do justice to Messrs. Tangyes' vast establishment. Perhaps the best lesson to be learnt from an inspection of their works is the value of good organisation and the advantages afforded by reduplication of articles, when special tools are adapted to particular kinds of work. It is this principally that enables the Soho firm to turn out excellent work at so moderate a rate.

CANADIAN PACIFIC RAILWAY.
No. XIX.

KAMLOOPS TO THE PACIFIC.

IN 1879 tenders were opened for the construction of four sections of the Pacific Railway in British Columbia, extending from Emory's Bar to Kamloops, 120 miles, the whole of which were subsequently let to Mr. D. O. Mills, and a couple of years later the piece from Emory's Bar to the Port Moody terminus, 86 miles, was contracted for by Andrew Ouderdonk, under whose management practically the whole 215 miles has now been finished. This section was to be constructed by the Government, and handed over to the Pacific Company as part of the bonus for the completion of the other sections of the line.

Fraser River in point of magnitude and commercial importance is second only to the Columbia on the north-west coast of America. Unlike the Columbia, its entrance from the Pacific is free from that danger to life, and vessel, and cargo, which so painfully distinguishes the larger stream. A sheltered strait, scarcely 15 miles wide, receives its waters, whilst the Island of Vancouver acts as a natural breakwater to protect this from the storms of the Pacific. The river reaches the sea by two channels, either of which is navigable for any sized vessel; these unite 15 miles up, and in neither of them is there any bar or tidal disturbance as in the Columbia As the river is approached the increasing muddiness of the water gives evidence of the immense quantity of detritus brought down by its waters, and of the strength of the current which keeps it so long in suspension The river has a length of from 700 to 800 miles, and in this distance, in one part of its course or another, it runs towards every point of the compass. For over 100 miles it drains the western slopes of the Rocky Mountains, the general course of the tributaries varying from north to west. All of these unite at Fort George in latitude 54 deg. north and about 122 deg 60 min west longitude, where the elevation of the river is 1690 ft. above the sea level, and whence its course is generally south, varying towards the east to Lytton, where it receives the waters of the Thompson, its principal tributary, and where the elevation is about 700 ft. above the sea level. Its course forward is first south to Emory's Bar, and then west to the ocean. The river is navigable for vessels of any size to New Westminster, 15 miles from its mouth, above which two lines of stern-wheel steamers continue the navigation, the one to Douglas on Hudson's Lake, 115 miles from New Westminster, and the other up the main river to Yale, about 100 miles. For 65 miles the route is common to both, as far as the confluence of the Harrison River, up which and the Harrison Lake, 50 miles from the Frazer, is the town of Douglas. From this point a good wagon road has been cut 400 miles to Williams Creek, crossing the Frazer River at Lillooett, 109 miles from Douglas by this route, and 40 miles above Lytton by the River Frazer. The head of navigation in the main river in the earlier days of steam navigation was Hope, 85 miles from New Westminster, but roads were not then in existence up the Frazer, and every mile that goods could be taken by water was a double saving, so steamers of larger power were constructed to go always to Emory's Bar, and generally to Yale, 15 miles above Hope; but between these last two points is a dangerous "riffle" as it is locally termed, so that to avoid this the railway construction commenced just below Emory's Bar, and five miles below Yale.

Yale is the lower part of the neck of the Frazer Valley, below which is the Lower Frazer or New Westminster district, and above is the long rocky canyon or gorge, through which the river forces its way through the Cascade range of mountains, which answers to the Coast range in the United States further south. Through this the waters boil and rush with uncontrollable fury, and below it they gradually tame down to the head of the tide, 60 miles above the mouth, below which the waters sweep forward deep and tranquil to the sea; for the last 100 miles of its course the river has an average width of half a mile. At Lytton, 53 miles above Yale, the Thompson River comes in from the east, the largest tributary, and the outlet of a large district of different climatic and topographical character altogether. The centre, and most probably soon to be the largest town of this upper and dryer region, is Kamloops, situated at the junction of the North and South Thompson Rivers, where both unite in Kamloops Lake, about 240 miles from the proposed terminus at Port Moody on the Pacific, and 235 miles from the point to where the rails are now laid at the summit of the Rocky Mountains. Kamloops is situated at the upper end and on the south side of the Kamloops Lake, at the point opposite to which the North Thompson comes in from the north, and from which the lake and its tributary waters will afford a navigation of some hundreds of miles in different directions. Not only will this be the centre of a large agricultural district, but the mineral and forest wealth to be developed is of a most important character. The North Thompson is especially rich in both these natural qualifications, and the extensive coal deposits on its banks will certainly be most extensively wrought when the railway is completed. It is not always easy in these deposits to say where true coal ends and lignite begins. The coal here is between the two, and lies in a higher geological series than carbonaceous seams are generally found in other parts of the world.

The railway line which follows the south side of the South Thompson from Shuswap Lake to Kamloops maintains its due west direction along the south shore of Kamloops Lake to Savona's Ferry for about 25 miles, and forward down the Thompson River for 15 miles further, where it turns south-west and then south to Spence's Bridge, 42 miles from Savona's Ferry. Here the line crosses the Nicola River, an important tributary of the Thompson and the outlet of a large and promising farming district Continuing along the Thompson in a south-west direction it enters the Frazer Valley at Lytton, 25 miles from Spence's Bridge and 71 miles from Savona's Ferry, and its course forward for the next 130 miles is closely parallel to the great wild river of British Columbia From Lytton to Emory's Bar, 58 miles, the greater portion of the river is a wild tumultuous burst of waters rushing and foaming along its contracted rocky bed deeply cut into the mountain range, and rising when at its flood, 60 ft. or 70 ft above its normal height. Six miles below Lytton the railway crosses the main river on a cantilever bridge recently erected, detailed drawings of which are given on page 226, and on our two-page plate The river here thunders through a rocky canyon 125 ft at ordinary high water below the level of the rails, but when the summer floods are passing through, its height is then 60 ft. above this, and the uproar of its torrent is something fearful. The erection of anything like a scaffolding or false works in this situation was out of the question, and hence the advantage and propriety of the cantilever system, by which temporary constructions over the river are unnecessary. This would have been the first bridge on this principle erected in America had it not been for the very long time that was occupied in bringing the ironwork across the Atlantic, the vessel occupying within two days of six months on the voyage, during which time the Canada Southern Bridge across the Niagara was ordered, built, and opened for traffic. The span of the Frazer River bridge, from centre to centre of the cantilevers, is 315 ft. The two levers are each 210 ft. long, and they carry between them a girder 105 ft., so that from the anchorage at each end the truss support is 525 ft. The centre of each cantilever is carried by a stone pier 72 ft. high from the rock on the river bank, and the outer ends of the levers are held in position by an anchorage in the

abutment founded on the solid rock of the river bank All the piers, links, centres, and the lower chords of the cantilevers are of Siemens-Martin steel, whilst the other parts of the truss are the best refined iron. The bedplates and anchorages are of cast iron; the weight of the whole being 243,000 lb. of steel, 941,000 lb. of wrought iron, and 40,000 lb. of cast iron, or about 546 tons altogether. The strains are calculated to carry a train the full length of the bridge, weighing 2500 lb. to the foot run in length, with two locomotives at the head, each weighing 55,000 lb, on three pairs of drivers, not over 14 ft wheel base in addition. The wind strain is calculated for the full surface of both trusses and a train showing a side exposure of 10 ft in height and the full length of the bridge. The bridgework was made by Hawks, Crawshay, and Co., of Gateshead on-Tyne, and the contractor for its erection was Mr A. Ouderdonk.

At a distance of 23 miles south of this bridge is Boston Bar, a rather celebrated place in the old gold mining days of the province. The work on this section is very heavy through the rocky flanks, and skirting the rugged side of the river which foams and frets below, five large gullies, each from 75 ft. to 100 ft. deep, have to be crossed for lengths of from 400 ft to 600 ft. each, and an awkward tunnel through a projecting headland From Boston Bar to Yale, 24 miles, the work is heavier still; there are altogether fourteen tunnels and three heavy bridges, and the line is exposed in places to slips and land slides that have to be guarded against. Yale and most of the villages up the Frazer were originally either Hudson Bay posts or were created in the first rush of the gold mining fever when different companies took possession of the different "bars" along the river, and where a number of claims were "located" on the same bar, more or less of a village at once sprung up in the neighbourhood Yale owes its origin to both these causes, and takes its name from Mr. J M. Yale, an officer of the Hudson's Bay Company, to whom belongs the merit of first inducing the Indians to turn their attention to work as a means of getting a living. At Fort M'Lauchlan, on Milbank Sound, he first set them regularly to work taking large stumps out of the ground, and wooding up the steamboats, they then became boatmen, ploughmen, fishermen, and almost everything else His instructions have not been lost upon them, last year Mr Ouderdonk paid 40,000 dols in wages for Indian labour, and the two large steam mills on Burrard's Inlet paid 18,000 dols. At Mitla Katla there is sawmill run entirely by the Indians, and their work in connection with the large salmon fisheries and canning establishments is equal to any procurable. The result is, that whilst all the other Indian races, almost without exception, are stationary or retrograding in numbers and social position, the Indian races in the south of British Columbia are increasing in population and resources, and are gradually assuming the dress, manners, and ambitions of civilised life.

The word "bar" in mining phraseology means a bed of gravel containing "gold" and left dry at the low stages of the river, and two of the best of these bars for gold washing were Emory's Bar and Hill's Bar, both not far from Yale. A vast amount of gold was washed out here in 1858 and subsequent years, and was only abandoned by white men when the best of it was gone over and the proceeds fell to less than 5 dols per day per man, but the Chinese still remain, and are every year more or less to be seen washing the gravel when the water is low enough. Yale is 110 miles from the mouth of the river and called the head of steamer navigation; for some miles below this, the channel is contracted between the great mountains that inclose it on both sides, and as the traveller ascends the river, the scenery becomes grander and more majestic. Mountains towering up into and above the clouds, rise in mighty grandeur from the river sides. Some of these are almost perpendicular brown rock, others of different formation show the stratification along their bare sides where slips and denudations have taken place, whilst others again are covered with a heavy forest and higher up are clothed with perpetual snow. The river turns and twists, extends and contracts, as if in suspense and agony lest at any moment some of the great rocky buttresses should fall from their fastenings and dam up the great stream that struggles to find its passage amongst them. To the lover of the picturesque, the rough mountain and the torrent, Yale and its vicinity afford every beauty that can be desired. Hope, 15 miles below, is on the east side of the river, and consequently left out in the present railway connection, but it is a very beautiful place, where the channel between the mountains is a very narrow one, and their huge bulk approaches on each side so closely to the river, that the sun has scarcely an opportunity of casting his glorious rays upon the troubled waters between them The best known argentiferous deposits in the province are near to Hope, about six miles distance up the mountains, but still in the Frazer Valley. The lodes probably traverse an outlier of the cretaceous formation which caps the Cascade rocks of this region. They are formed in an awkward locality for access, at an elevation of 5000 ft., and so far have not been extensively worked. Below Hope the river runs west, and the railway continues closely skirting its north bank till within a few miles of New Westminster, when it leaves the Frazer Valley, and, crossing the low lands of the Pitt River marshes, reaches its western terminus at Port Moody on Burrard's Inlet. It was for some time a question whether this place or New Westminster should be the terminus, but the choice has been decided in favour of Port Moody, the general opinion concurring in the correctness of the selection; and it is now decided to put down a branch line to the ex-capital, which, for the present, will answer every purpose.

New Westminster, situated just above the bifurcation of the two outlets of the Frazer, and fifteen miles from their mouths, was selected as the site of the capital of the province when British Columbia was first organised by Colonel Moody, late Commissioner of Lands and Works, partly for the strategical excellence of the situation, and partly for the good anchorage in its front, and for its admirable position for controlling the trade, and it continued as the capital of the province until the amalgamation of the two provinces of British Columbia and Vancouver's Island made one of the two capitals unnecessary, and Victoria was chosen as the seat of Government for both. As the site of a large city, its position is defective, as the slope on which it stands is inconveniently steep, but it is the largest place upon the mainland at present, and the second largest in the province, whilst its wonderful agricultural surroundings and its growing industries, will always make it a most important place, and probably a successful rival to either Victoria or Port Moody. Between the city and the mouth of the river are the wonderful delta lands of the Frazer formed by the deposits brought down by the river, and probably the richest farming and garden land in the world. From a pamphlet published "under the direction of the Minister of Agriculture" in 1883, called "British Columbia, its Climate and Resources," we read of these lands, page 56 "Wheat has not been extensively cultivated, but as much as 62 bushels of fall wheat have been harvested from a measured acre. The hay crop is generally heavy, 3½ tons to the acre being not uncommon. From one farm were produced, oats 75 bushels per acre, wheat 50 bushels per acre, hay 3½ tons; all of which found ready sale at the following prices per ton. Hay, 12 dols. to 16 dols, wheat, 40 dols; barley, 30 dols.; potatoes, 30 dols, &c." Of another municipality it is said: "The settlement comprises 40,000 acres of rich delta land of deep black earth, yielding surprising crops of timothy, oats, barley, wheat, and fruits From harvested crops at several well-known farms, the yield per acre is about as follows: Wheat, 40 bushels, oats, 60 to 65; barley, 40, turnips, 40 to 50 tons. An instance is known of a yield of 3 tons of timothy in the twelfth crop, and of 80 bushels of wheat per acre." Of a third municipality it is stated that "as high as 100 bushels of oats have been harvested off a single acre of dyked land." It may interest the farmers of England to know that this land, with a frontage on the river, is held at 25 dols. per acre, say, 5*l.* sterling, but that which lies back from the river, and therefore not quite accessible, may be bought at a lower figure. The size and luxuriance of the vegetation is also worth a remark. During last season timothy grass was cut in the neighbourhood of Port Hammond 7 ft. in height, and the average of the crop was 5 ft. 7 in. Pumpkins grow to 70 lb. weight each, squash 58 lb., vegetable marrows 9 lb., carrots run 3 lb. to 4 lb. each, potatoes 2 lb. to 3 lb., onions, 1½ lb., Swedish turnips, 48 lb, cauliflowers 12 lb., mangolds 20 lb., and pears 2 lb. each. Cauliflowers have been known to run as high as 37 lb., and cabbages as much as 60 lb. each.

In one special industry New Westminster is likely to remain unrivalled; the Frazer River salmon is now known everywhere, and although the fisheries of British Columbia are still in their infancy, there are already fourteen large canning establishments within 15 miles of the city. In an ordinary season they put up 300,000 cases (48 tins each), representing 1,500,000 dols There are at least six distinct species of salmon (and it is said a seventh that does not ascend the river), and they are so numerous that a hundred fathom drift net has taken 853 salmon in ten hours. In 1876 there were only three canneries in the province, which produced 8247 cases In 1882 there were shipped 250,000 cases valued at 1,247,000 dols., the salmon fishery regularly employing 3000 hands. The regular Frazer River canning establishment is worthy of a visit. One of the newest of these is the Richmond Cannery, in the North Arm, 12 miles below New Westminster The main building is 200 ft. long by 75 ft. wide, of which 50 ft. wide is two stories high, and the other 25 ft. is on a long wharf facing the water side. The machinery and plant are all new and first-class in every particular, and the cost of the whole ready for work, was 40,000 dols. The Delta Cannery has its main building 150 ft. by 120 ft., with a 10 ft. wharf round three sides of it. Besides these are separate buildings for the engine room and boiler house, the lacquer house, the coal sheds, the store for finished cases, the net house, and generally three or four boarding-houses. During the fishing season, which commences about the first week in July, they employ forty boats, each manned by four Indians, two for the day and two for the night fishing, making a total of 160 Indians. Then there are 150 Chinamen engaged in the different departments of the canning, and about twenty white men as heads of the various departments, in addition to these there are a large number of Indian women steadily employed on the nets, which average from 120 to 150 fathoms in length, and cost a dollar a fathom. In other words the average net is 900 ft. long by 16½ ft. deep. It requires fifty of these for a cannery putting up 1000 cases per day, and it stands a month's work, when it is thrown aside as useless. Each company has generally four camps, each with forty Indians and one white man at its head. Every morning the company's steamer visits each camp, and brings away the fish in a scow towed along for the purpose The cleaning and cutting house, a building about 70 ft by 25 ft, is provided generally with an overshot waterwheel which draws the fish-laden cars from the wharf to the cleaning troughs, where the water issuing from the wheel sweeps away with tremendous force all the offal into the bay, leaving no dirt or smell behind. Much of this cleaning and cutting is done by machinery, which cuts up the fish the exact size for the cans, and saves most of the labour, the whole being managed with the greatest care and most scrupulous cleanliness, a copious supply of fresh cold water being of the first importance.

The general fisheries so far have been neglected for the salmon, the available capital having been principally drawn into this business, but there is one exception in the fur seal, the fishing of which yields about 200,000 dols. per annum. This valuable animal is not found on the Atlantic coast, being especially a product of Pacific waters. During the last season, ten schooners, aggregating 483 tons, were used in this fishery, with 46 sailors and 292 Indian hunters, requiring for their use 146 cedar canoes.

Port Moody, the point selected for the terminus of the Pacific Railway, is situated at the extremity of the southern arm of Burrard's Inlet, a parallel sheet of water to the Frazer, and overland about five miles north of New Westminster. It is by water 75 miles from Victoria, and opposite to the mouth of the inlet, and 30 miles across the Gulf of Georgia, is Nanaimo, the present centre of the coal trade of the province, and from which a railway will shortly be under construction to Esquimalt and Victoria in Vancouver's Island. In the commodious harbour of Nanaimo, vessels of any size can load within a short distance of the mines, at the excellent wharves owned by the different collieries. Burrard Inlet itself is about 12 miles in length, has an anchorage of from 10 to 3½ fathoms for nearly three miles, with no winds or currents save the ebb and flow of the tide. Between the town site and the sea, are two "narrows," both of which are free from danger, the tidal current passing through the first from three to eight knots per hour, and through the second from three to seven. The ship channel is sufficiently wide in either of them, and they serve to

effectually deaden any storm or waves outside. The town site is plentifully supplied with running streams, has a sloping, gravelly, and sandy beach, and is favourable for docks, for the construction of wharves, or any other purpose required at an important railway terminus. The land on both sides of the inlet is generally densely wooded, bearing in profusion the large Douglas pine, which has already become an article of considerable export. There is ample space here for the requirements of a city and a port, the water is deep enough for the largest steamers, the access at all times, day or night, is all that could be desired, the scenery is magnificent, the climate unexceptionable, and immediately opposite is the grandest supply of coal at present known upon the Pacific Ocean. Extensive preparations have already been made for the future commerce that is shortly to crowd these shores, amongst the rest a wharf 1370 ft in length and 153 ft. in breadth at the middle. This is substantially built, resting on 1723 piles from 12 in. to 20 in. in diameter, well braced and stayed in every direction, and the whole front presenting a solid timber wall 14 in in thickness. The lowest depth of water along the front, excepting where it slopes back to the shore, is 26 ft. At the back and around this, is laid out the incipient town which already begins to show the formation of its squares and blocks, and long lines of broad and well-graded streets.

The most important feature in this Canadian Pacific terminus is the immediate proximity of a deposit of coal, the advantage of which in these days of steam it is impossible to over-estimate The coal at Nanaimo is said to have been discovered about 1850 by the Indians, and shortly afterwards the Hudson's Bay Company commenced working it Up to November, 1859, there were no regular records kept of what the mine turned out, but it was said that up to that time 25,000 tons had been extracted In 1861 the company sold this mine to the Vancouver Coal Company, and up to the end of 1863 this company shipped 69,473 tons, as stated in their first report, made in March, 1864. In the Nanaimo district there are now three companies at work, the Vancouver Company, working the Douglas, Chase River, and Fitzwilliam mines, known collectively as the Nanaimo Colliery, the Wellington Collieries, belonging to Messrs Dunsmuir, Diggle, and Co., and a new concern worked by the East Wellington Coal Company, called the Harewood Colliery. The principal working of the old company at Nanaimo is at Chase River, which is worked by a slope 500 yards long At the bottom, this coal is 4 ft. in thickness, varying to 6 ft, lying at a slope of from 10 deg to 45 deg This mine and the Douglas are now connected underground, forming a very large colliery, and part of these workings are under the sea at the head of Nanaimo harbour The Fitzwilliam mine is a new work, and will be, when finished, a shaft 600 ft deep, the coal being brought to the surface by a powerful pair of engines with 30 in. cylinders and 7 ft. stroke. Some distance to the north of this, a [illegible] ft, 16 ft in diameter, is being sunk, which worked by a double engine with cylinders 16 in. by 4 ft. All this machinery, with boiler and appliances, came out from England in 1882. The coal in this new establishment is from 6 ft to 12 ft. in thickness, and of the same good quality as the old workings The Wellington Collieries are a little north of Nanaimo, but the same class of coal. The principal colliery has a slope 1000 yards long, worked by a powerful double engine at some distance from the mouth, and the coal is extracted from four levels, two on each side of this main road. The seam is from 6 ft. to 10 ft. in thickness, and of excellent quality. There are two other slopes besides this, one of which (No 3) is a new working altogether at the low side of a heavy down throw or fault in the seam, so that it is altogether distinct from the other two, although probably the same seam, here, however, from 8 ft. to 11 ft in thickness. Another new working is called No 4 shaft, 633 ft. in perpendicular depth, the seam in this shaft being 10 ft. in thickness. For the year ending December 31, 1882, this colliery turned out 230,710 tons of coal, of which 188,569 were exported, the total number of hands employed were 601, of which 285 were Chinese. The Nanaimo Colliery during the same period turned out 51,429 tons, of which 43,842 were exported, employing 273 men all told. Both these collieries have a locomotive railway from the mines to these wharves, whilst the Harewood Company, which has not yet sent in their returns, are working their coal to the wharf by a wire tramway. The total output of Vancouver coal for 1882 was 282,139 tons, being the highest yield so far attained.

The principal market for this coal is San Francisco, and another portion is now being shipped to Wilmington, in Southern California, for the supply of the railways and other consumers in that district Although there is plenty of coal in the United States on the Pacific coast, yet the superior quality of the Nanaimo coal permits them to bring it the much further distance, and to face a heavy import duty. The coals suitable to supply the United States Navy were thoroughly tested by the War Department some years ago, to find out which fuels gave the best results, and it was found that to raise the same steam, it took 1800 lb. of Nanaimo coal, 2400 lb of Seattle coal from Washington territory, 2000 lb. of Coos Bay coal in Oregon, and 2600 lb of Mount Diablo coal from California, showing that as far as the Pacific coast is concerned, the Nanaimo coal has a marked superiority over all others. Of the coal used in San Francisco (883,000 tons in 1882) about one-fifth comes from Nanaimo, being retailed at 12 dols per ton, about the same quantity comes from England as ballast for grain-laden vessels, and nearly another fifth comes from Australia, the balance being the cheap and inferior Oregon, Washington, and California coal, which can be retailed at 6 dols per ton

Along the Gulf of Georgia another important coalfield quite as good, and probably much more extensive, exists at Comox Mr Richardson, of the Geological Survey in 1872-73, made a number of most careful measurements over the whole of this area, the outcrops stretching over 30 miles of country and coming down to the water side. There are nine seams known, with an aggregate thickness of 16 ft, the lowest and thickest being 7 ft In another section at the Union Mines, ten seams were proved with an aggregate thickness of 29 ft, the thickest seam being 10 ft, and this section is only a small part of the known productive area. Mr Richardson estimates that there are an average of 16,000,000 tons per square mile for at least 300 square miles in the Comox district Comox and Nanaimo are not the only known coal measures in Vancouver's Island, and on the mainland Dr. Dawson gives a list of over thirty localities where either coal or lignite exists In the Nicola Valley, crossed by the Pacific Railway, he examined in 1875 a 6 ft seam of lignite, which he believed can be traced in a continuous seam for over 100 miles Another large coal area exists in the North Thompson Valley, the seam being 8 ft in thickness, but at present none of these are worked Nor of all the other minerals, iron ore, silver, lead, copper, platinum, can there be any favourable account given of any actual workings, all for some reason or another waiting undeveloped for the railway or something to turn up.

LITERATURE.

Strains on Braced Iron Arches and Arched Iron Bridges, Illustrated Graphically. By A S HEAFORD London Spon. 1883.

THE motive of this sincere and laborious little work is mentioned thus in the preface. "As I have never seen or heard of any work wherein the solution of the arch was arrived at purely by the parallelogram of forces, I am tempted to submit the result of my researches," also, "Ever since I entered the profession of engineering, which is now twenty-four years ago, I have always had one fixed idea that if the parallelogram of forces were applicable in solving the strains on any one structure, it should be equally applicable in the solution of others, the only difficulty being how it should be applied"

The author applies his methods to certain cases, which are these. Example 1: A semicircular braced rib of equal width of ring, loaded uniformly at points equidistant along the curve. Example 2 · A very similar case with diminished or increased load. Example 3. A case very similar to Example 1 with altered bracing. Example 4: A case very similar to Example 2, but with bracing as in Example 3. Example 5, like Example 1, but having double lattice and omitting the radial bracing. Example 6. Much like Example 5, with the middle apex of bracing not at the extrados, but at the intrados of the crown.

Then the author supposes he departs from the arch and enters on the arched bridge He takes two examples Example 1 A curved rib of rather flat curvature having its upper member horizontal, bracing vertical and diagonal, load equally distributed along the upper horizontal member. Example 2. Similar to Example 1, the last, but with different bracing, in this no verticals, but a single triangulation Warren. Example 3 Similar to Example 2, the last, with similar bracing, but the apex of triangulation in the middle is on the intrados instead of the extrados of the crown

It is strange that the author did not learn in his twenty-four years' experience that the cases in which the load is equally distributed on each side of the crown are the easy cases, and that the cases where there is a hinge at the crown, limiting the position of the horizontal thrust at the crown, are also easy cases, in both of which the principles of simple static resolution might be applied A temporary rigidity for purpose of argument may be fairly assumed, or a balance of deformation on each side of the crown

All the more difficult cases involve the consideration of the elastic deformation, an absence of knowledge of the position of the line of thrust at the crown, and all the various effects of partial loading, culminating in that condition least favourable to the curved rib at any and every part of it The mere polygon of force, whether graphic or analytic, applies to a rigid condition, or to a very nearly rigid condition perhaps, which may exist merely at the bearings of an elastic curved rib

We hope that on the next occasion Mr Heaford will direct his labours with the help of the knowledge already gained by the scientific members of his profession he will then probably achieve something more useful For the present we ascribe every credit to his good intentions and to his toil, in the future we may have an opportunity of noticing his more effective work for the good of the community.

Year Book of the Scientific and Learned Societies of Great Britain and Ireland Giving an Account of their Origin, Constitution, and Working Compiled from Official Sources With Appendix, comprising a List of the Leading Scientific Societies throughout the World First Annual Issue. London Charles Griffin and Co. 1884

This volume, which fills a very real want, is divided into fifteen sections The first fourteen deal with societies in the United Kingdom, giving particulars of over five hundred of them, arranged in classes according to their objects, and the last section is a list of over fourteen hundred foreign societies Every care has been taken to insure accuracy The notices have been compiled from data furnished by the respective societies, and in the great majority of cases, proofs have been submitted to the officials for correction It is proposed that in the future annual issues there shall be incorporated the titles of papers read before, or published by, the various societies, with the names of the authors. When this is done the volume will become a scientific directory, chronicling the work and discoveries of the year, and enabling the worker in one branch to try his hand in all that interests him in kindred lines of research. We trust that it will meet with an encouraging reception

EVANS'S PORTABLE "CORNISH" STEAM PUMP.

THE engraving on page 219 represents a "Cornish" steam pump and boiler as supplied by Messrs. Joseph Evans and Sons, of Wolverhampton, to the Birmingham Corporation Water Department It is constructed according to Tonkin's patent, and has cylinders 6 in and 10 in in diameter respectively, with a stroke of 12 in. The pump has been specially designed for low lifts in emptying mains, water pipes, pipe or sewer trenches, and for irrigation purposes, and is of the double acting plunger type, to adapt it for pumping gritty or dirty water It is fitted with Evans's improved rotating rubber disc valves and with top and bottom valve doors to render them accessible By means of a three way cock fixed in the exhaust pipe the exhaust steam can be turned either into the funnel or into the suction chamber underneath the pump, where it is condensed and creates a vacuum. A grid is fixed in the suction pipe to prevent stones, &c., getting into the pump, and a cover is fitted to the bottom of the suction chamber for clearing out any rubbish that may have accumulated. The boiler is vertical, with cross tubes, and is fitted with an injector and lagged with mahogany The pump and boiler are fixed on a strong wrought-iron frame carried on springs and mounted on strong wrought-iron travelling wheels. The shafts are made of wrought iron tube,

BAXTER'S ANCHOR GEAR.

THE Brazilian armour-clad turret-ship the Riachuelo, which is now lying in the Thames completing her equipment and outfit of sea stores, before proceeding to her destination, is a very efficient warship, combining as she does many of the qualities which the advanced knowledge and experience of the present day now render obtainable.

In the earlier days of our armour-clads, the main object aimed at seemed to be to enable them to give and take hard blows with as little injury to themselves as possible. Since then a demand has arisen for greater speed and larger endurance under steam, and for the possession of these qualities in conjunction with quickness of manœuvring and a minimum draught of water. The latter enable vessels to pursue their opponents into shallow waters and intricate channels, and to make more effectual use of their running powers in the open sea. Much has also been done to enable them to get quickly under steam, and torpedo boats even, which are carried by some of them, are supplied with steam directly from the main boilers of the ship which enables them to be made ready for action in an incredibly short space of time. There is one quality, however, which conduces in no small degree to the efficiency of a fighting ship, which until very recently had not received the attention it deserved, viz., that of being able to come quickly to, and to quickly leave, an anchorage, and the power of working the anchors and cables with quickness, power, and certainty.

Much had been done in the way of improvement of capstans and windlasses in our vessels of the mercantile marine, as well as in ships of war, but it was mostly small and gradual improvement in the principles that had been in existence from time immemorial, and it was not until Mr. S. Baxter of the firm of Messrs. S. Baxter and Co., of 18 and 19, Great St. Helen's, London, brought his long experience in the requirements of ships in this particular, to bear in perfecting his patent vertical windlass and stockless anchor, and his method of working them, that the subject was thoroughly grasped or understood.

This system, which has now been carried out in the Riachuelo, is a very striking example of what can be accomplished by the application of correct principles and mechanical skill to things in every-day use.

Her cables are worked directly on to, and around vertical cable holders, which enables them to lie in a line a very little above the surface of the deck, by which the violence of the strains that both the cable gear and the structure of the ship are liable to when the anchor is breaking ground, is reduced to a minimum, and the strain of the cables is taken up by circular friction plates in such a way, within the body of the cable holders, that by the action of a small hand lever, the cable holders, and consequently the ship, can be relieved of the whole or any part of the strain at any instant; and by the same means the cables may be drawn in or let out link by link, smoothly and easily, without, if necessary, interfering with the speed or direction of the driving engine during the operation of raising the anchor.

One great advantage of the vertical cable holders is that the cable can be so readily thrown off them; and while one is being used for hauling in, the other may be used for running out, or for hauling cable from the lockers, and either will form a perfect cable stopper if required, by screwing the friction plates tightly down by a simple action of the hand lever.

The holders are worked by vertical shafting which passes through the deck, and to the ends of which are attached wormwheels and a horizontal wormshaft, which is also the crankshaft, worked directly by a two-cylinder horizontal driving engine, and the whole of this driving machinery is in this instance placed beneath the deck beams under the cable holders. The wormshaft for working the cable holders also works the capstan, so that by an arrangement of friction clutches, the capstan may be worked by hand, and may be made to work the cable holders and the anchors and cables, if steam should not at any time be available.

The whole arrangement of the cable holders is so compact and so simple that any ordinary sailor can in a few minutes remove any of the working parts for overhauling or cleaning.

The anchors of the Riachuelo weigh 66 cwt. each, and are the result of much careful thought; they are without stocks and are made of cast steel in several parts; and here Mr. Baxter has again, by a bold and ingenious novelty, in the form of the crown piece, succeeded in overcoming the grave objections that existed in the earlier stockless anchors.

In whatever way these anchors take the ground, as soon as the strain comes on them, it is found that the flukes are certain to take firm hold, and the greater the strain the deeper and more secure the grip; and it has been found quite impossible by the swinging of the ship in a tideway, or by any other means, for the flukes to be wrenched out of the ground. The only way to make them loose their hold is by bringing the shank into a vertical position in the operation of lifting.

One of the most noticeable features of the whole arrangement is the manner in which the anchors are

ANCHOR GEAR FOR THE IRONCLAD "RIACHUELO."

CONSTRUCTED BY MESSRS. S. BAXTER AND CO., ENGINEERS, LONDON.

Fig 1.

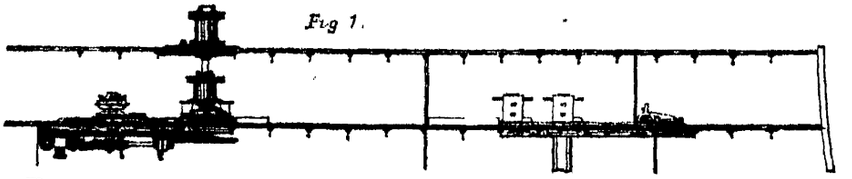


Fig 2.

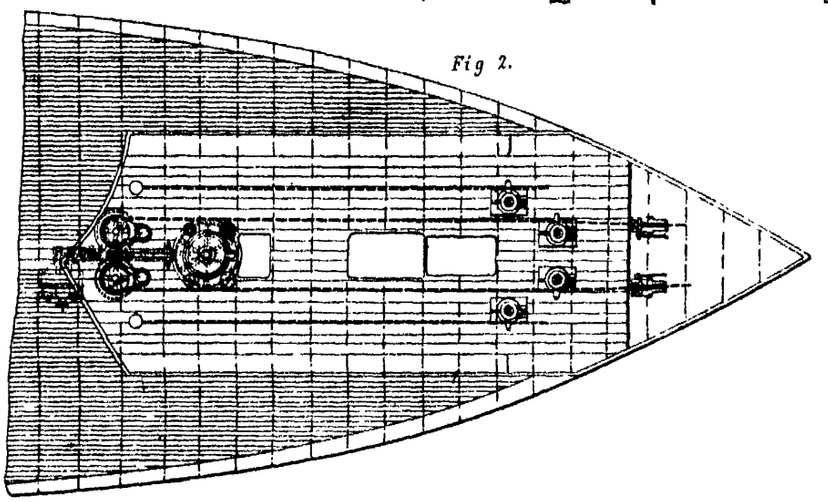


Fig. 3.

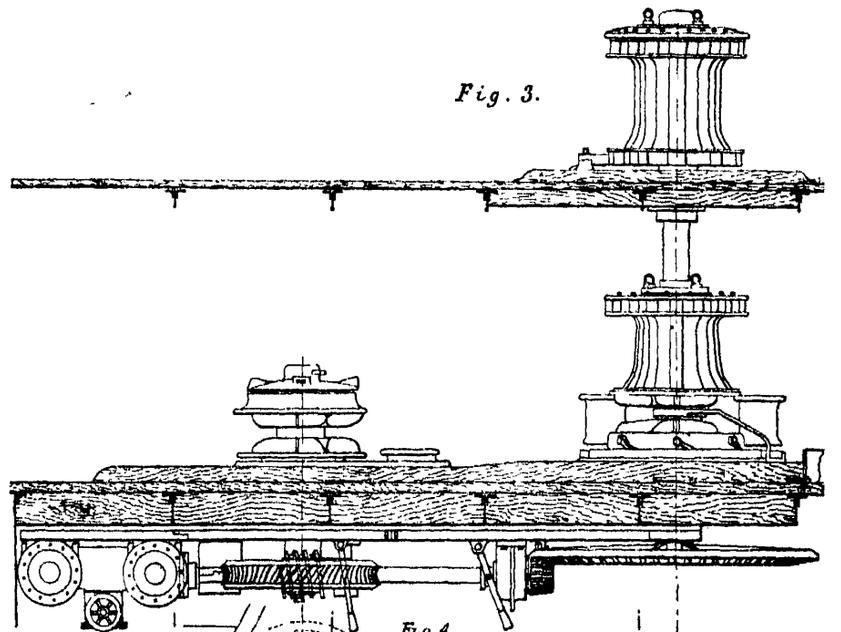
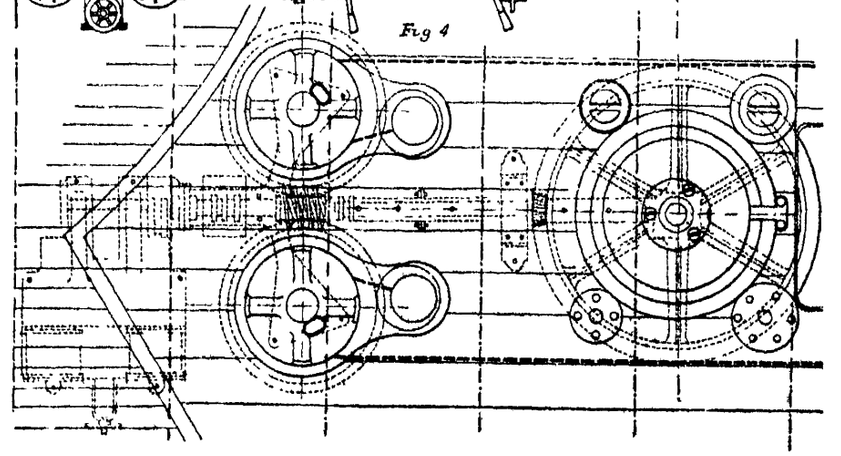


Fig 4



LECKEY'S SUNSHINE RECORDER.



FIG. 1.

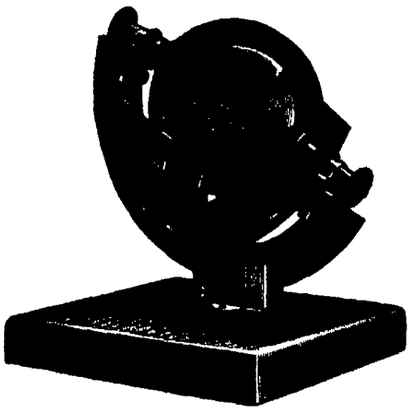


FIG. 2.

TABLE SHOWING DURATION OF SUNSHINE IN 1881, 1882, AND 1883. (APSLEY GUISE, BEDFORDSHIRE).

MONTHS	Sun above Horizon	1881. Sunshine A.M	P M	Total	Per Cent	1882 Sunshine A M	P M	Total	Per Cent.	1883 Sunshine. A M	P.M	Total	Per Cent.
	hours	h m.	h. m	h. m		h m	h m	h m.		h m	h m	h m	
January	259	82 5	81 30	63 35	24 5	19 40	18 55	38 35	14 9	29 36	26 19	55 55	21 6
February	279	18 36	19 9	37 45	13 6	23 14	24 3	47 17	17.0	39 33	38 32	78 5	28 2
March	367	64 15	67 45	132 0	35 9	70 22	63 53	143 15	39 1	73 49	63 46	137 35	37 6
April	415	78 7	92 3	170 10	41 0	88 50	72 55	156 45	37 8	70 5	68 20	138 25	33 4
May	482	108 25	110 35	219 0	45 4	116 33	127 47	244 20	50 7	94 42	76 33	171 15	35 6
June	494	95 49	79 21	175 10	35 4	67 58	67 22	135 15	27 4	85 7	95 38	180 45	36 6
July	497	117 10	105 35	222 45	44 8	95 27	87 58	183 25	36 9	75 52	60 43	136 15	27 4
August	450	71 30	62 45	134 15	29 9	73 27	79 53	153 20	34 1	89 53	88 37	178 30	39.7
September	377	41 7	58 3	99 10	26 3	71 33	61 12	132 45	35 2	55 5	67 45	122 50	32.5
October	323	59 58	62 57	122 55	37 4	30 20	34 30	78 50	22 5	48 35	34 20	82 55	25.2
November	265	40 48	30 22	71 10	27 0	43 40	28 30	72 10	27 3	40 50	40 45	87 35	33 1
December	243	28 40	25 40	54 20	22 4	22 3	15 22	37 25	15 4	14 50	8 55	23 45	9 8
	4456	756 30	745 45	1502 15	33 7	736 2	682 20	1418 22	31 8	723 37	670 13	1393 50	31 3

housed and stowed. Their peculiar form enables their shanks to be drawn with the cable, completely within the hawsepipe of the ship, the outside of which is enlarged for housing the flukes, and the lower part of the hawsepipe is so formed that the anchor on being hauled in, is unfailingly tripped into such a position that it houses itself. All that then remains to be done is to lower an iron cover over the outside of the hawsepipe, and the whole is then covered in a snug and effectual manner.

This arrangement of housing and stowing the anchors obviates the necessity of catheads and fish davits, with all the complicated gearing for fishing and stowing as ordinarily used. This is not only a great saving of expense, but enables the whole operation to be performed in about half the time than that required by the ordinary system.

As an instance of this, a time trial was made some days ago, when each of the lower anchors were let go and hauled in again and stowed in the short space of forty-five minutes, and a further and rather striking instance of the efficiency of the system in this respect occcurred when the ship was about to enter the dock, after the last trial trip The s.s. Eldorado being first in turn to come in, was signalled to lift her anchor and come on, and the Riachuelo was also signalled to lift her anchor and follow. The Riachuelo very soon after received a second signal to come on at once, which she did, the dock master explaining that he gave the second order, as he could see she had slipped her anchor ; the fact was she had lifted her anchor and hauled it into the bow and stowed it out of sight, while the other ship with the ordinary gear was still heaving away at hers.

The Brazilian authorities have shown a proper appreciation of the merits of this invention by adopting it in its entirety ; and it is also satisfactory to hear that our own Admiralty have ordered this system to be carried out in the new armour clads, the Benbow, Rodney, Howe, and Camperdown, which are now under construction ; and there is no doubt that it will be very soon largely adopted in other warships, [as well as by the leading shipowners of our mercantile marine.

THE UNIVERSAL SUNSHINE RECORDER.

A SMALL instrument, known as a sunshine recorder, is now being exhibited in the Meteorological Annexe of the International Health Exhibition, by Mr. R. J. Leckey, of 3, Lorton-terrace, Ladbroke-road, W. In our illustrations given above, Fig. 1 is an instrument adapted for latitudes of over 34 deg., whilst Fig. 2 shows another form that can be adjusted for any latitude.

This sunshine recorder is the result of Mr. Leckey's endeavour to carry out Professor Stokes's ideas, it being fitted with the latter's zodiacal frame. The balls are 4 in. in diameter and are made of the finest optical glass.

An instrument of this nature was designed about thirty years ago by Mr. J. F Campbell, of Old Kensington, and was known as "Campbell's self-registering sun-dial." In this a ball of glass was mounted concentrically in a wooden bowl, an exact hemisphere, turned internally to the focal radius of the ball In this way the inside of the bowl would be burnt by the focal point of the sun's rays ; whereas if clouds or haze should intervene the wood would be left intact. The records given by this instrument were not sufficiently defined, the lines resulting from each day's observation overlapping each other, so that a fresh bowl would be required for each day. A second instrument was designed which had a metal bowl in place of one of wood, strips of cloth or card which could be renewed daily marked with hour lines being fitted inside. A difficulty, however, arose in this case, as the distance between the hour lines is required to vary with the sun's declination, and in order to adapt the strips to the bowl they have to be cut to different curves according to the time of the year.

In another form of instrument the ball was supported by a frame, the record being taken on a slip of card held in a slide hoop parallel to the equator and at a distance of the focal radius from the centre of the ball. At the changes of seasons this instrument requires adjustment both as to focal distance and as to the position of the slide hoop with respect to the equator, the adjustment for focal distance being imperfect, especially in the mornings and evenings of long days

In order to overcome these difficulties Professor Stokes, of Cambridge, proposed an instrument in which the bowl should be replaced by a zodiacal belt. If this belt of the spherical surface on which the focal point travels in the course of the year, be supposed to be divided into three equal zones of equal width by two planes parallel to, and equidistant from, the plane of the equator, then each zone of the spherical surface may, without sensible error, be replaced by a zone of a surface to which a flat card can be bent accurately to fit. The middle zone, as thus altered, is a portion of a cylinder, and serves for about a month at each equinox. The extreme zones are frustra of cones, the apices of which fall on the polar axis of the sphere, and serve for the summer and winter months respectively. These

irface of the hemi- burning power of the glass ball. The cards are accurately divided into hours and half-hours, and when set to the noon mark on the inside of the frame, actually convert the instrument into a correct sun dial.

We understand that the Meteorological Council have placed this instrument in all their stations, and it has been supplied to many stations in Canada, on the Continent, and in India, besides which numbers have been sent to private individuals When mounted in a position where it receives the whole range of the sun, it will record from 92 to 95 per cent of the bright sunshine of a continuously bright day. The Table given above records the duration of sunshine for the years 1881, 1882, and 1883, according to data obtained with one of these instruments by Mr. E E Dymond, F R. Met. Soc , at Apsley Guise, Bedfordshire. The instrument was placed on rather elevated ground exposed to the sun through its entire course, and little, if at all, influenced by local causes It will be noticed that during the year 1881 there was a trifle over one [illegible] following years were not quite so favourable. It may be remembered that 1881 was a good fruit year, and the detailed records show that there was good sun at the end of March and early in April, which had the effect of setting the blossom, whilst the hot weather of July served to ripen the fruit. The information thus obtained, is only a single example of the use of this instrument, but it is needless to multiply instances of the great advantage that a record of sunshine is likely to prove to the agriculturist and meteorologist.

Mr. Lecky has published a small hand-book, from which we have quoted the details of his instrument.

THE FORTH BRIDGE.*

By B. BAKER.

(Concluded from page 215.)

As it is impossible to produce the working drawings of the bridge on the present occasion, a short tabular statement of some of the leading features may be desirable

	tons.
Steel in main cantilevers	40,000
,, centre girders	1,600
,, viaduct approach	2,800

Cantilevers, 680 ft. projection ; 343 ft and 40 ft. deep. Bottom member of cantilever, a pair of tapering tubes.

Distance apart centres at piers	120 ft.
,, ,, ,, ends	31.5 ,,

Tube at piers, 12 ft. in diameter, 1¼ in. thick, 830 sq. in. area.
,, ends, 5 ft. ,, 8 ,, 120 ,, ,,

Top member of cantilever, a pair of tapering box lattice girders.

Distance apart centres at piers	33 ft.
,, ,, ,, ends	22.25 ,,
Girder at piers, 12 ft. by 10 ft.	500 sq. in. net area.
,, end, 5 ft. by 3 ft.	60 ,,

Columns over piers, 12 ft. diameter, 368 to 468 sq. in. area.

Diagonal struts (tubes), 8 ft. to 3 ft. diameter, 198 to 73 sq. in. area, and 337 ft. to 74 ft. long

Diagonal ties (box lattice), 8 ft. to 3 ft. deep, 163 to 67 sq. in. net area, and 327 ft. to 82 ft long.

Horizontal wind bracing (box lattice), 11 ft. to 3 5 ft. deep, 88 to 20 sq. in. area, 142 ft. to 40 ft long.

Vertical wind bracing (box lattice), 4.75 ft to 2.5 ft. deep, 84 to 28 sq. in. area, 160 ft. to 60 ft. long.

Central girder, 350 ft span, 51 ft. and 41 ft. deep; bottom members, 32 ft. apart centres, 142 sq. in. net area ; top members, 22.25 ft. and 19 ft. centres, 139 sq. in. gross area.

Internal viaduct, lattice girders with spans of 39 ft to 145 ft.

Floor, buckle plates and trough girders.

Wind fence, close lattice work, 4 ft. 6 in. high

Viaduct approach, lattice girders, under rails continuous over two 168 ft. openings, 22.5 ft deep, 16 ft apart ; floor and wind screen as for internal viaduct. Masonry piers 25 ft. by 8 ft. at top, and 50 ft. by 20 ft at base.

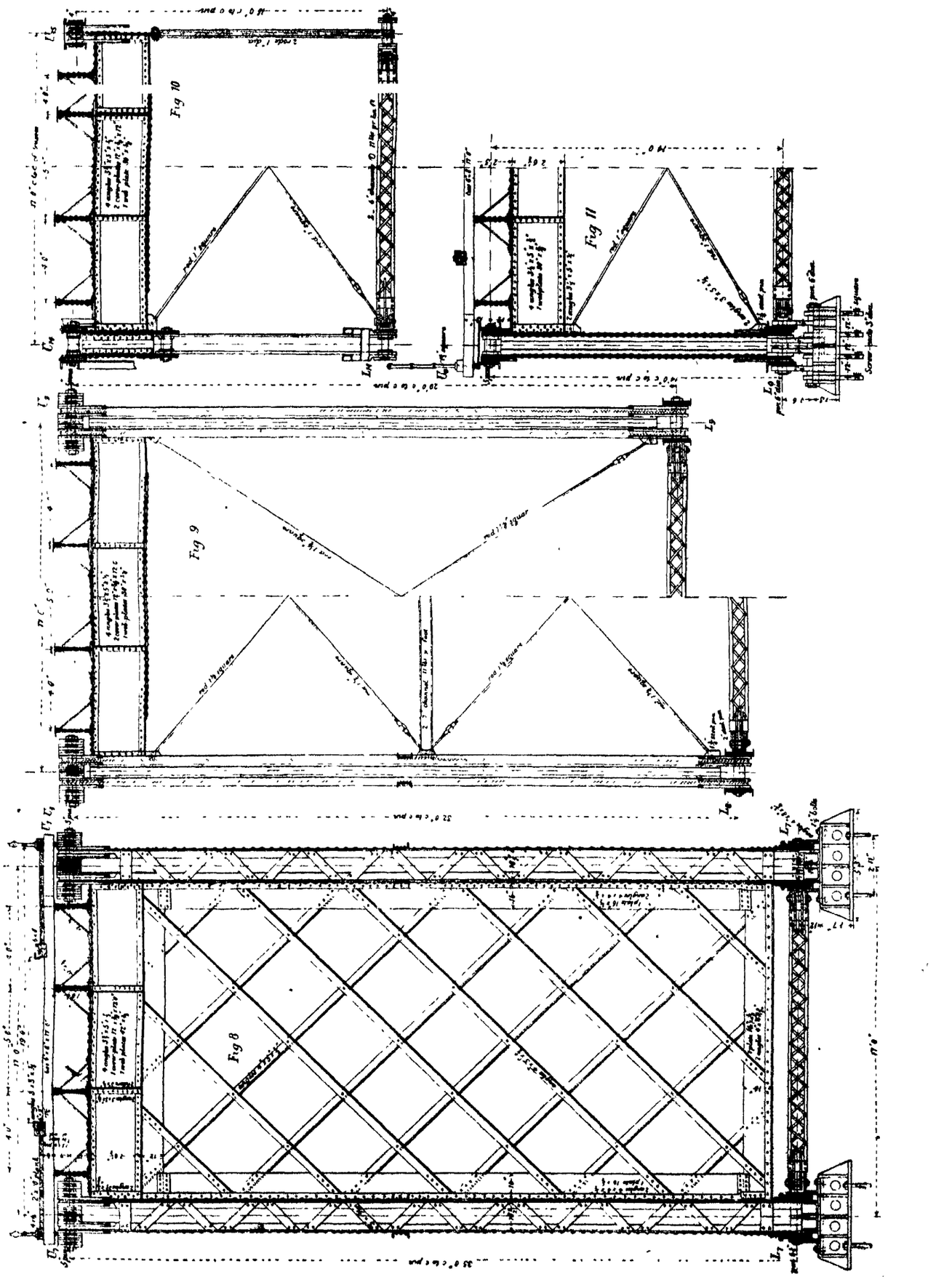
Rolling load (1) trains of unlimited length on each line of rails, weighing one ton per foot run ; (2) trains on each line made up of two engines and tenders, weighing in all 142 tons, at the head of a train of sixty short coal trucks of 15 tons each.

Wind. A pressure of 56 lb. per square foot, striking the whole or any part of the bridge at any angle with the horizon, and acting square or obliquely upon an area equivalent to twice the plane surface of the front girders, with a deduction of 50 per cent. in the case of tubes. The total wind pressure so derived amounts to 2000 tons on the 1700 ft span, and 7900 tons on the whole superstructure included between the two cantilever end piers. The following Table shows the magnitude and intensity of the heaviest resultant stresses in tons on some of the principal members from dead load, live load, and wind, distributed as already described :

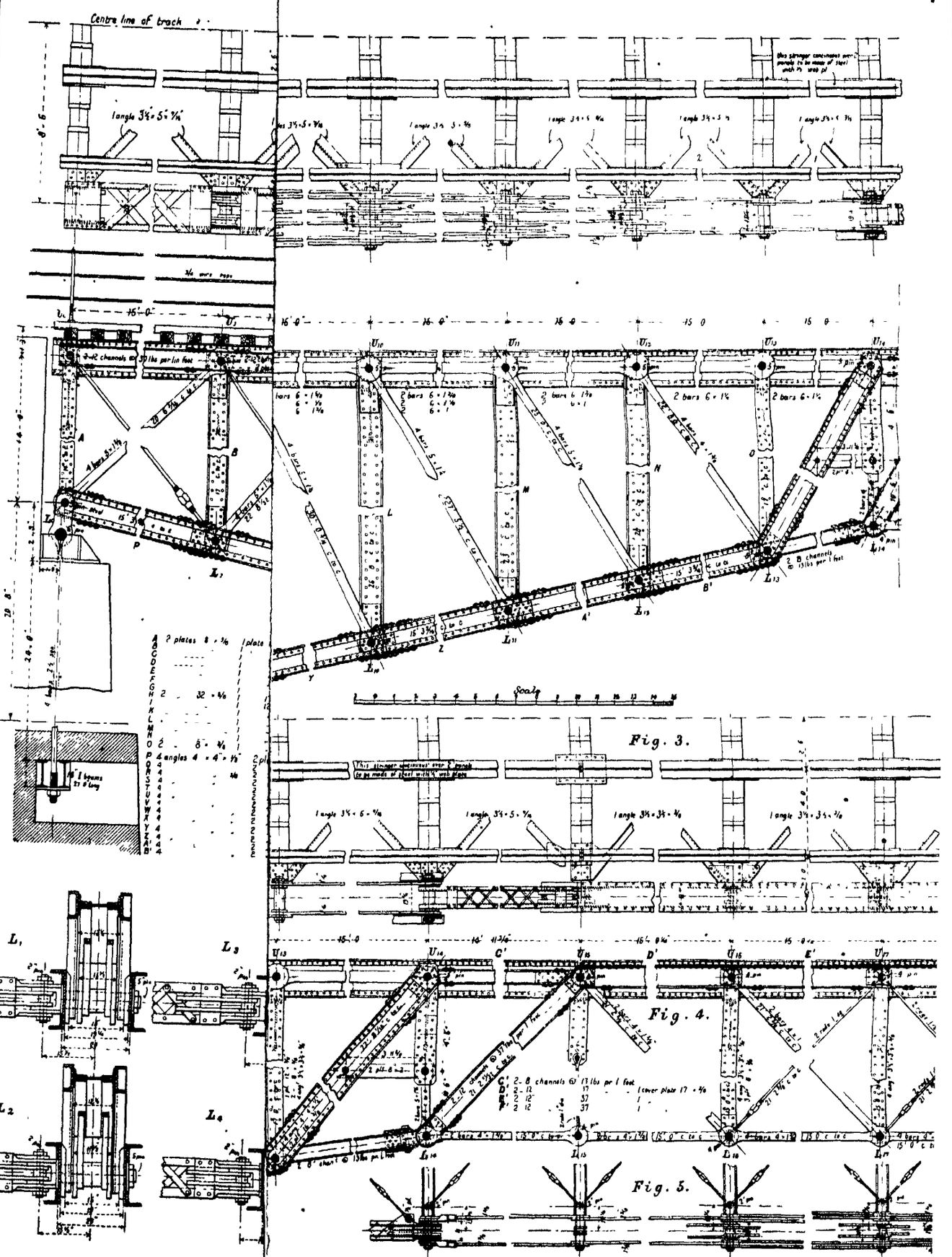
* Paper read before the British Association at Montreal.

THE CANADIAN PACIFIC RAILWAY; BRIDGE OVER THE FRAZER RIVER.

(For Description, see Page 219.)



FRAZER RIVER.



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The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

ENGINEERING.

FRIDAY, SEPTEMBER 5, 1884.

THE METROPOLITAN WATER SUPPLY.

THE London water companies have a long catalogue of sins laid, and truly laid, to their charge. The fluid they deliver to their consumers, and exact exorbitant rates for, is most unpleasantly hard; its purity is open to the gravest doubt, while its appearance and taste are such as to render it a continual source of wonder how the Blue-Ribbon Army can maintain its forces on a war footing. Yet, serious offenders as the companies are against public health and comfort, it is somewhat hard that they should have to bear the blame of every sanitary blunder with which this great city has been afflicted. In the summer, and particularly if it be a dry one, every weak point in our system shows itself, and immediately a large proportion of the public, and a considerable part of the daily press, fix the blame of every difficulty and annoyance on the water supply. If the Thames is low between Teddington and Richmond, and the dwellers in the charming villas on the bank find their boats aground on the mud, the blame is laid on the pumping stations above, which, it is averred, intercept one-half the flow. If the smell at Crossness and Barking is more than usually nauseous it is attributable to the same reason, and every one who hears of it is glad to add his share of censure against what are probably the best-abused corporations that ever existed. During such an outcry good service is done to both sides by an impartial statement of the real facts of the case, such as has just been issued by Colonel Sir Francis Bolton, the official water examiner under the Metropolitan Water Act, 1871, in his monthly report for July last. The companies have all large capitals invested, and are indued with powers within certain limited areas, each of which contains a water supply such as it is, of which they must make the best. As the witness said, "they must live," and their living is gained by collecting water and delivering it to the consumer, and if they do this in the most efficient manner possible, they will probably, while vested interests continue to receive the high consideration they do at present, be held free from serious blame. Once, indeed, they did consent to efface themselves for a consideration, and leave the field open for more ambitious schemes, but the metropolitan ratepayer turned pale at the Bill, and the golden opportunity slipped past. Sir Francis's report shows what is being done to render the present supply as pure as possible, and what still remains to be accomplished. It commences by a table of the sources of supply stating that 55 per cent. of our water is derived from the Thames and springs in the Thames Valley, 33 per cent. from the River Lea, and 12 per cent. from wells, and after a few statistics it goes on to say that in view of the possible introduction of cholera into London, the eight companies had been asked whether, in addition to their ordinary precautions for insuring purity, they could suggest any improvements or increased precautions capable of being taken during the present summer.

SUPPLYING CAPACITY OF THE METROPOLITAN WATER WORKS.

No	NAME	Average Daily Supply	Number of Supplies	Number of Houses on Constant Supply	Reservoirs for Unfiltered Water	Filter Beds	Maximum Rate of Filtration per Square Foot in Gallons per Hour
					acres	acres	
1	Kent Water Works	12,023,529	61,453	28,789	none	none	
2	New River	33,915,000	141,847	22,906	100	16½	1½
3	East London Water Works	40,690,435	145,078	125,188	222	29½	1½
4	Southwark and Vauxhall Water Works	23,934,786	102,808	11,833	17	14½	1½
5	West Middlesex Water Works	15,773,122	64,769	15,936	37	12	1½
6	Grand Junction	16,464,513	49,233	31,086	17	10½	2
7	Lambeth Water Works	18,492,000	77,980	20,657	31	7½	2½
8	Chelsea Water Works	11,356,000	32,998	3,934	40	6½	1½
	Total	172,649,384	675,066	269,279	464		

One and all the companies replied that their arrangements were perfect. Some were giving special attention to the cleaning of filter beds and reservoirs, but beyond that there was nothing that could be done to improve their plant or process. The water as they delivered it to the consumer was perfectly satisfactory, but as soon as it entered his premises deterioration commenced. The domestic cistern was a universal source of contamination, and was left uncleaned month after month, and all the paraphernalia of settling reservoirs and filter beds were rendered useless by the supineness of householders. Unfortunately this is only too true. The account the companies give of themselves may be taken with a good many grains of salt, but it is certain that the fierce light which has been turned upon them of late years, has produced an enormous improvement, and without radically remodelling their systems, it would be difficult to carry the purification much further than they do. But a very short inspection is sufficient to show that the best water in the world would be rendered unwholesome by a passage through 90 per cent of the existing cisterns, which are little better than aquaria for the propagation of bacteria. It is not our intention, however, to be led into a digression on this subject. Scores of columns have been written about it, and scores more will follow with no better result, for the resources of an ordinary household are not sufficient for the task of effecting a thorough cleansing of the water tank, and most householders prefer a course of slow poisoning to the presence of plumbers on the premises. Happily the report shows that there is every prospect that within a reasonable time the cistern may be relegated to its proper duty of feeding the bath and flushing the water-closets. All the companies are exerting themselves to give a constant supply, as will be seen by the following Table, and in the districts already under the new system no one need drink stagnating water if he will only go to the expense of a tap of the pressure pipe within his house:

It would thus appear that the best is being made of the water which is to be found in the district, and it remains to inquire in what state it is when it arrives there. The last annual report of the Thames Conservancy shows that much improvement has been effected, but it is far from reassuring to learn that there is still a trifling discharge of sewage at Henley, and part of the sewage at Staines still flows into the river. All other town drainage has been diverted or purified, which means, we suppose, that the solids in it have been precipitated, and the remainder, in a condition more or less clean, has flowed into the river, but whether the germs of disease which it contained have elected to stay with the mud or go forward with the water no one knows. Fortunately, Nature is kinder to us than we deserve, and in a few miles of flowing water exposed to the light and air she effects the destruction of sufficient evils to decimate a city.

But if the state of the Thames is such as to cause anxiety, the condition of the Lea is worse. Its banks, above the intake of the water company, are studded with towns and villages. There is Luton, Wheathampstead, and Hatfield above the intake of the New River Company. All these places have efficient systems of precipitation and irrigation, and water taken above Ware Lock gives an analysis, of which Dr. Dupré says "It has all the characteristics of a fairly pure river water, showing no signs of *recent* sewage contamination." The italics are ours. Below the intake of the New River, and above that of the East London Company, the state of affairs grows worse. First comes Hertford with 7500 inhabitants; it deals with its sewage by chemical processes, but Mr. L. Flower, the sanitary engineer to the Lea Conservancy, states that the works pollute the river. Next comes Ware and Stansfield with sewage farms and irrigation systems, and then follow Rye House, Broxbourne, Wormley, Cheshunt, and Waltham Abbey with different systems more or less open to suspicion. Besides these towns and villages there are a number of tributary streams whose banks are dotted with houses and hamlets, so that it does not require any great stretch of imagination to suppose that a great deal enters the River Lea which escapes the notice of the most active sanitary officer. Still the analysis shows no evidence of it, for it is practically the same at the intakes of the two companies.

The question of the diminution of volume of the Thames by the pumping operation is dealt with in a letter from Mr. John Taylor to the water examiner. At the date of his communication, after two dry winters and a spring of unusual drought, there were about 410,000,000 of gallons per day passing the Lambeth Works below Thames Ditton, and about 415,000,000 running over Teddington Weir. The water companies abstract 80,000,000 gallons, and thus reduce the quantity from 495,000,000 to its present volume, or by about one-sixth. Mr. Taylor points out that much of the water enters the river directly from the basin, and

not from tributary streams, and he has found that between Maidenhead and Windsor there is an accession of 136,000,000 gallons per day, although no tributary stream joins the river within those limits He therefore argues that the river is the outflow of an immense porous basin, and when its level falls from dry weather or pumping, the gradient is increased, and the underground flow quickened. From this he concludes that the companies do "not diminish the river by the actual amount taken out, because it is largely compensated by the flow from the basin" The paucity of water between Richmond and Teddington he attributes to the training of the river, and the widening and scouring of the channel, which thus allows the tides to run up much more rapidly, and to fall away as quickly.

The conclusion to be drawn from the report is that matters are probably in as satisfactory a condition as they are likely to be while Londoners are satisfied to be supplied with artificially purified water The companies do the best they can with the doubtful fluid they draw from the river, but it is not to be believed that this state of affairs can continue much longer. The increased demands of a growing population will tax the Thames beyond the compensating power of its underground reservoirs, while a growing knowledge of sanitation will cause the people to reject polluted sources of supply, and to insist upon uncontaminated gathering grounds being found Already the large towns of the north, with their active municipal life, have done this. Glasgow has tapped Loch Katrine, Liverpool derives its supplies from the river Vyrnwy, and Manchester has obtained command of Thirlmere against the time when its present sources fail to supply the demand, and London will have to follow suit. The cost will be fearful, for the effects of long years of indifference and neglect will have to be paid for, and monopolies which ought never to have been permitted will have to be bought up Still the question of expense must be met sooner or later, for it is certain that the population will outgrow the present supply, and it would be absurd to adopt any half measures when a new source has to be sought.

THE WEATHER OF AUGUST, 1884.

August has been a very fine and hot month in all parts of the British Isles, except the extreme west and north, where the weather has been more cloudy and less hot. The mean atmospheric pressures and temperatures at extreme positions to which the Isle of Man is central, were as follows

Positions.	Mean Pressure	Difference from Normal	Mean Temperature	Difference from Normal
	in	in	deg.	deg
North	29 86	above 0 05	55	nil
South	30 03	,, 05	64	above 2
West	29 91	,, 02	58	below 1
East	30 00	,, 10	62	above 3
Central	29 99	,, 09	61	,, 2

The amount and frequency of rainfall are roughly represented by the following results.

Places	Rainy Days	Amount	Difference from Normal
		in	in
Sumburgh	14	2 84	below 1 15
Scilly	12	1 43	,, 1 20
Valencia	21	4 18	,, 0 46
Yarmouth	9	2 58	above 0 82

Pressure has exceeded the normal values, the most so in the east and central districts Temperature has also exceeded the normal values except in the west of Ireland. The resultant of the daily general directions of the wind is S S W, the normal resultant is W. There was a good deal of S.E. wind in the early part of the month, which is the warm wind of the season. There was a good deal of N W. wind in the latter part, and this is the cold wind. Thus there was a partial compensation of temperature. All the month had been fine and hot until the 25th when the N.W. wind set in, and the temperature was in many places 30 deg lower than on the previous day. This cooler weather continued to the end of the month The highest temperature, 97 deg, was registered at Sydenham on the 11th, the lowest, 39 deg, at Kilkenny on the 20th The temperature rose to an unusual height on the 11th at many stations, for instance, Hillington 93 deg, London 92 deg., Greenwich 94 deg., York 87 deg There was generally a large duration of sunshine, and prevalent dryness. The only day on which much rain fell was the 12th, when thunderstorms were general, Yarmouth had 1.85 in., Leith 1.63 in., Ardrossan 1 50 in Thunderstorms occurred every day from the 8th to the 13th, also on the 24th, chiefly in Great Britain The barometric column attained 30 2 on several days, but was only as low as 29.4 in. in the north on the 29th.

The intense heat of the first part of the month ripened the corn so quickly that harvest in England was much earlier than was expected; and the weather continued the most favourable that could be imagined for harvest. Wheat and potatoes have done well Estimates of the crops, average 29 bushels of wheat, 35 of barley, 40 of oats, 27 of beans, 26 of peas, 5 tons of potatoes, and 1½ tons of hay per acre. The *Times* of the 21st stated, "This is a season to be remembered. We never had such a harvest in respect of the following combination of favourable conditions. The cereal crops exhibit a minimum of fungoid disease and insect depredations; a continuance of almost uninterrupted sunshine reaching to tropical temperature has enabled a major portion of England to secure its produce with a despatch scarcely equalled in memory; and with the exception of some local thunderstorms, rainfall has benefitted the corn rather than otherwise . . Judgment is within the mark in saying that the beaming sun has augmented the total yield of wheat, barley, and oats by millions sterling"

An estimate of clear bright days gives 17 to the south and east districts, and only 6 to the west district, and of overcast days 17 to the west, and only 3 to the central district, where the sky seems to have been most frequently in an intermediate condition between clear and overcast, which may be termed cloudy. The duration of bright sunshine, for the five weeks ending September 1st, in percentage of its possible amount, was 40 for these islands generally. Channel Isles, 59; south-west England, 50; south England, 49, east England, 46, central England, 45; north-west and north-east England, also east Scotland, 38; west Scotland, 33; south Ireland, 32; north Ireland, 25, north Scotland, 22.

THE HYDRAULIC ENGINEERING COMPANY.

These works, which will be visited by the members of the Iron and Steel Institute during the approaching meeting at Chester, have been established for over fifty years as an engineering establishment, but it was not until about ten years ago that the joint stock company now owning them, was constituted, and hydraulic machinery was made a special feature. Since that time contracts have been executed for installations of hydraulic plant for most of the principal railways and dock companies of this country. Entering the premises by the main gates, we pass firstly into the principal turning and fitting shop, where there are the ordinary machine tools required for the production of hydraulic machinery There are two lathes, used principally for turning hydraulic rams; one of these will take pieces 35 ft. in length and 20 in in diameter, a ram 24 ft. long and 18 in in diameter being turned on the occasion of our visit A second lathe, placed close by, has 28 in. centres, and will take 24 ft in length. This is used for turning the large 24 in. rams, and also for boring hydraulic cylinders; these are bored very accurately in a horizontal position, a projecting ring of metal being cast on, which is turned up in the lathe and held in a wood or iron "steady." There is a face-plate lathe, 3 ft. 9 in. centres, which will take 12 ft. in the pit; it is a good deal used for accumulators, and will take a length of 25 ft. 6 in. with a diameter of 6 ft. A horizontal boring machine, by Messrs Buckton, of Leeds, has been made specially for boring the cylinders of Brotherhood's engines, in which the three cylinders are in one casting, and are equidistant from each other. In this case, of course, the boring bar cannot be carried through and steadied on the outer end, and there is an exceptionally long bearing on the headstock, in order to compensate for this, and so steady the overhung boring bar. The table is circular, and is divided off in such a way, that it will revolve so as to bring each cylinder to the exact position required for boring, and no resetting is therefore necessary. In this shop twist drills are used, and also tool holders with movable cutters; wherever practicable, these are ground by one of Messrs. Smith and Coventry's grindstone machines. A slot-drilling machine is used for keyways, &c. Around this shop there are galleries for the smaller machine tools for brass finishing and other light work. In the erecting shop, adjoining the machine shop, the most noticeable feature at present is a three-cylinder compound vertical pumping engine, which is intended for the London Hydraulic Power Company's station at Blackfriars. A general view of this engine was published by us on page 101 of the current volume. It has one high-pressure cylinder 19 in. in diameter, and two low-pressure cylinders 25 in. each, with a stroke of 2 ft. The valve gear is of the Correy type, the expansion valve being forced down by the pressure of the steam acting on an area equal to the valve rod, as soon as the trigger gear is tripped by the cams, which are regulated by a governor, and by a chain from the accumulators. The pumps are 5 in. in diameter and in a line with the steam cylinders, having their plungers coupled direct to the piston-rods, the crankshaft being driven by forked connecting rods. The pumps are to deliver into two accumulators 20 in. in diameter and 23 ft. lift, loaded to give a pressure of 700 lb. to the square inch in the mains. We understand there is also a set of engines like these, made by this company, now working at Barcelona Harbour.

This erecting shop, as well as the machine shop last described, are both served by rope-driven travelling cranes, one by Messrs Cravon Brothers, the other having been made on the works A second erecting shop has just been opened adjoining the one in question. This, however, is ultimately intended for a machine shop, when the second erecting shop will be placed elsewhere.

In the testing department there is a hydraulic intensifier, of which illustrations are annexed, Fig. 1 being an elevation and Fig. 2 a plan. When it is required to test a pipe or other article, represented by *g* in the engraving, connection is made by the pipe *h*, and the valve *a* having been opened, the piece under test is filled with water at the pressure in main by means of the pipe *e*. The inner cylinder *b* is also charged at the same time In order to get the intensified pressure required for the test, water at the main pressure is admitted to the ram *a* by means of the valve *c*, which opens communication between the branches *f* and *l*. The area of *a* is larger at the bottom than at the top part, which works in *b*, and in this way any additional pressure can be obtained within the limits of the apparatus The valve at *d* is a non-return valve, and *k* is the lever by which the valve *c* is worked. To release the pressure, the lever *k* is pushed right over, when the ram *a* is exhausted through the pipe as shown on the plan. It will be seen from these particulars that there are considerable advantages in this apparatus, and we have no doubt its use will be more widely extended as it becomes better known. By it any piece to be tested can be filled up at once with water at the pressure carried in the hydraulic main, and the higher test-pressure can then be applied by simply opening a valve

It may be mentioned that all work intended for the 700 lb standard is tested to 2500 lb.; and it will be seen that in cylinders of larger size, such as those of 2 ft in diameter, considerable power is required to hold the rams in during the test. For this purpose a pair of bolts, 8 in in diameter and 36 ft. long, have been forged, and on these a pair of cast-iron crossheads slide, the latter being held in position by collars forged at intervals on the bolts, so as to take varying lengths of cylinders. These bolts, massive as they appear, have only a fair margin of safety, when used for the purpose of testing the larger work.

The foundry is placed at the side of the yard, and contains two fine hydraulic cranes, which command the whole shop, and are capable of being brought over the large central casting pit, situated in the centre of the building. They are each of 10 tons capacity, and are of the usual type made by this firm, having horizontal jibs, which serve as a roadway for racking in and out the carriage to which the suspending hook is slung. The racking and turning, as well as the lifting, is by hydraulic power. The lifting rams are telescopic, so that with lighter loads the small ram can be used, affording a saving of water and increased speed. For exceptionally heavy loads, increased power can be reached by the use of higher pressure, which is obtained by means of a different accumulator, placed in another part of the works. This has three vertical cylinders, the rams of which support the usual weight-case. By means of the 700 lb. pressure in the hydraulic rams, the three rams rise together, and when at their full height an automatic arrange-

ment disconnects the accumulators from the original source, and either, by exhausting the central cylinder, affords a pressure of 1000 lb. on the two outer cylinders, or by exhausting the latter, gives a pressure of 1500 lb. on the central cylinder. The recharging from the original source at 700 lb. pressure is automatic. The centre casting pit referred to is lined with sheet iron, and will take the largest rams and cylinders. There are also three hand cranes in the foundry. There are two cupolas, each fitted with the Voisin belt, to take the blast; this is said to give highly satisfactory results. The cupolas are served with a hydraulic hoist.

On the opposite side of the road is a large boiler shop, where the masts, jibs, pedestals of cranes, and other plating are made, together with the framing for cages of lifts, and work of a similar description. There are the usual smiths' fires, bending rolls, a plate-planing machine, and the ordinary plant required for the work.

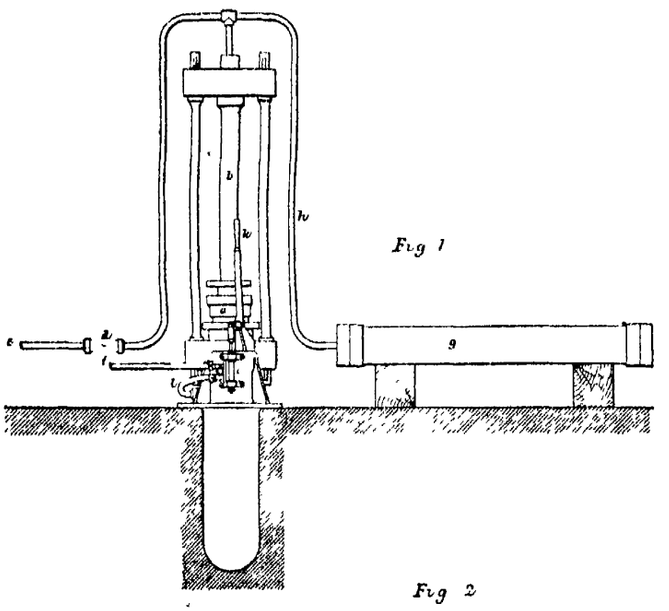


Fig 1

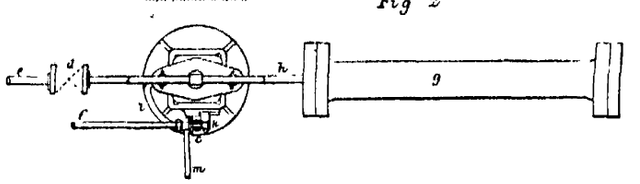


Fig 2

There are also in this department a Tweddell's hydraulic shearing machine, and a Tweddell's hydraulic punching machine; the Hydraulic Engineering Company are the sole makers of these tools. There is a pair of pumps, with a differential accumulator, for working these machines, as well as a hydraulic rivetter, which is in this shop.

Returning to the other side of the works we pass to the smiths' shop where there are two small steam hammers, and other usual appliances. The pattern shop is close by, and has machinery of an ordinary description. The pattern store is placed for the present on some new ground, situated on the canal close by, which the company has recently acquired.

A light railway is laid down on the premises, and hydraulic capstans are placed at intervals for hauling heavy pieces. The yard is served by overhead travelling cranes, and there are other cranes in positions where required.

Hydraulic cranes of all kinds, both fixed and movable, and hydraulic lifts for goods and passengers, appear to be the chief production of this company. Amongst other work turned out by the company, we may mention some very complete grain warehousing machinery made by the company for the Hull Docks.* The Tweddell hydraulic punching, shearing, and bending machines of which they are sole makers, have had an extensive sale, more especially abroad, and have been supplied to the French, Italian, and Spanish Governments besides many private shipyards.

The goods lifts made at these works are either with chains or on the direct-acting principle, but the passenger lifts are always, if possible, made direct-acting, the company laying great stress on the desirability of this system, in cases where the sacrifice of life may result through accident.

We noticed several lifts in course of construction. A number of these, we were informed, are intended for some large residences that are now being erected on the Kensington Court Estate. There are about thirty in all, and they are on the direct-acting principle, intended for personal use as well as for general household purposes. They will be worked by hydraulic power, from an adjacent branch establishment of the London Hydraulic Power Company. The woodwork for the cages of these lifts, which we had an opportunity of examining later on, at the works of the makers, Messrs W and F Brown and Co, of Chester, is of polished ash and walnut, and has been made by some excellent woodworking machinery, recently imported from America by this firm.

There are also now in course of construction, at the Hydraulic Engineering Company's works, several lifts with Ellington's patent hydraulic balance. Two of these have lately been fitted up at the First Avenue Hotel, and two more are in progress, which are intended for the Hôtel Métropole.

* For illustrations and particulars of this see ENGINEERING, vol. xxxv., p. 107.

ELECTRIC LIGHTING AT THE INTERNATIONAL HEALTH EXHIBITION.

No. IV.

IN our previous articles on this subject (see pages 551 and 572 of our last volume, and page 90 *ante*) we dealt with the leading features of the display at South Kensington, and with one or two of the largest exhibits. We now continue our notice, beginning with some of the less imposing, but not necessarily less interesting, of the systems which are at work.

Messrs Gerard and Co., of 82, Hatton Garden, E.C., show two continuous current dynamos, each supplying twenty-four incandescence lamps of 50-candle power in Messrs. Doulton's Ceramic Pavilion. The direct current machine, which is represented by Fig. 1 on the following page, is formed of a hollow cast iron cylinder, very exactly bored in the interior, within which there are fixed four electro-magnets arranged in the form of a cross. The polar extensions of these magnets inclose a cylindrical cavity within which the armature is situated. The framing of the machine carries upon each of its faces a cross-piece, upon which is mounted a bearing for the steel shaft that carries the armature. This latter is in the shape of a cross, and has its branches wound with insulated wire, until the whole assumes approximately a cylindrical form. The magnets are arranged in series or in parallel, or they may be wound in the so-called compound manner, but in any case the opposite poles are of like name.

The branches of the armature are of sheet metal; they are magnetised in the contrary sense to the field magnets, under whose influence they are for the time being, and are alternately north and south, each north pole having a south pole at either side of it. The wire is wound in series and lies in planes parallel to the shaft, the ends are soldered to a commutator which consists of a cylinder divided into four segments, of which each opposite pair are connected together. Two brushes placed at right angles press against the commutator and collect the current. In the series machines the current all passes round the field magnets. In the shunt machines a fraction of the current only, depending upon the external resistance, circulates in the field magnet coils. By the rotation of the armature the polarity of its branches are reversed each quarter revolution, and this gives rise to a continuous current which is increased by the direct induction in the convolutions of wire passing before the field magnets. The generators manufactured by M. Gérard form a series as follow:

1. The type marked 0 0 is designed for the purposes of education and demonstration, and is fitted on a stand with a handle and flywheel by which it can be turned. This machine gives a current of 1½ ampères with an electromotive force of 6 volts. By its aid the fundamental experiments of electro-dynamics can be shown, and it is usually used in conjunction with various accessories for illustrating the caloric, magnetic, chemical, and physiological effects of currents.

2. The type marked 0^1 0^2 0^3 is also provided with a crank handle, or with a treadle. It is suitable for laboratory use, and gives a current of 3 ampères with an electromotive force of 20 volts, at a speed of 2500 revolutions, requiring about $\frac{1}{6}$ horse-power to drive it. It can feed three 10-candle lamps, or one 25-candle lamp.

3. The types which follow are larger, and are marked 0, 1, 2, 3, the particulars are given in the subjoined Table:

Numbers	Volts	Ampères	Revolutions	Number of Incandescence Lamps			Horse Power
				10 c p	25 c p	50 c p	
0	35	7	2500	6	3	2	½
1	60	10	1800	16	10	6	1
2	75	15	1800	28	18	12	2
3	100	20	1600	50	30	20	3

The simplicity of construction of these machines renders them economical producers of electricity, as regards first cost.

M. Gérard has also designed an alternate current machine, of which the general appearance bears a resemblance to the Siemens machine. In this the field magnets are formed of two series of oblong bobbins mounted upon a double framing, in the centre of which is the armature. This machine can feed twenty-four arc lamps, or 144 lamps of 50 candle-power, or 240 lamps of 25 candle-power. The Gérard arc lamps and many other details of the system have already been described in these columns, and passing over these we shall confine ourselves on this occasion to his newly invented incandescence lamps.

The Gérard incandescence lamp has already met with great success both in domestic and ornamental lighting, and its use is on the increase. Unlike the arc lamp, in which no further economy seems possible to be effected, the incandescence lamp is far from having attained perfection, and it is to be expected that, as improvements succeed each other, its life will grow gradually longer, and its cost will be diminished. There are no reliable figures as to the duration of the Gérard lamp, but from its construction it would appear that, as regards cost, it may compare favourably with its rivals when it comes to be manufactured on a large scale. In this lamp there is no filament of carbonised vegetable. The incandescent part is composed of rods of carbon manufactured like the pencils of arc lamps. These rods, the diameter of which varies according to the type of the lamp, but is always very small, are arranged in the shape of an inverted V. The ends are connected by means of a carbonaceous cement, which resists perfectly the heating effect of the current. The branches of the V are fixed by

means of the same cement into two small cylinders of carbon mounted on the platinum wires. These wires, embedded in a rod of enamel, pass through the neck of the exhausted globe which forms the lamp, and are soldered to two collars of copper which are fixed by screwing upon the neck of the lamp. The whole is mounted in a simple holder formed of two elastic copper clips.

The simplest forms of lamp are shown in Figs. 2 and 3, and upon this model M. Gérard has constructed various modified forms, which differ in the diameter and length of the carbons, in the method of

FIG. 2.

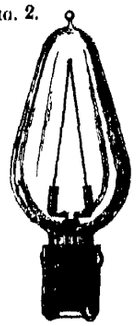
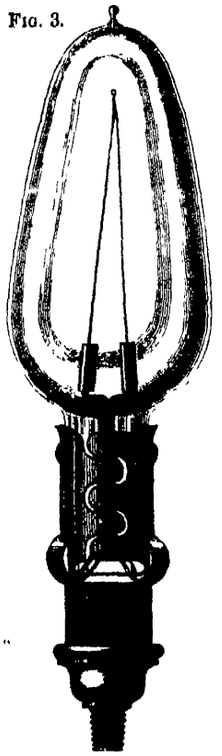


FIG. 3.



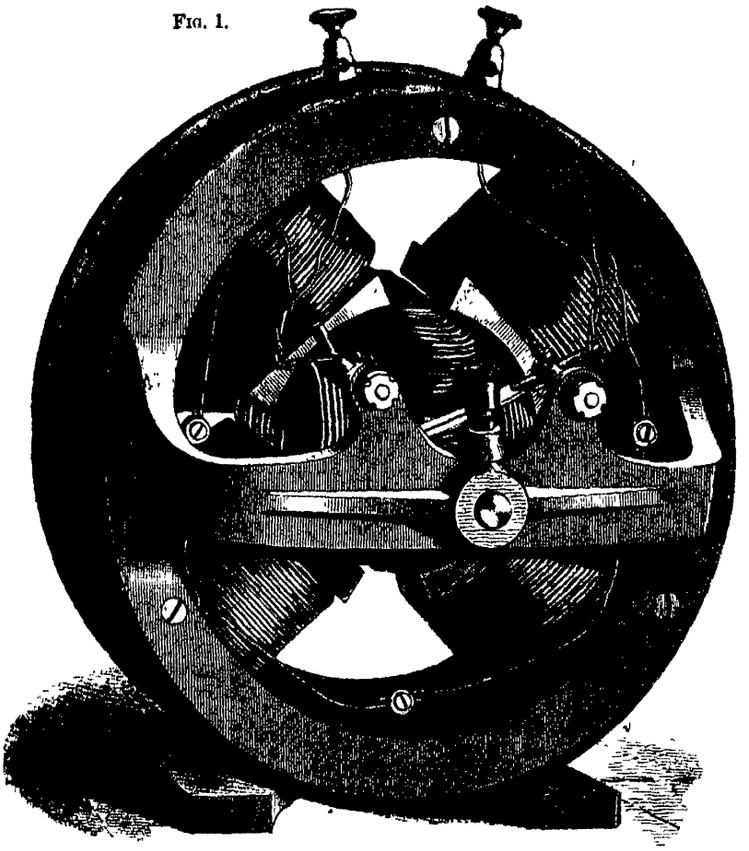
their arrangement, and in the size of the globe The particulars of these lamps are given in the following Table.

Numbers	Candle Power	Volts	Ampères	Price.
				francs.
00	8	6	1	5
0	10	20	1½	8
1	25	20	2	10
2	50	40	2½	12
3	100	50	5	13
4	200	60	7	16
5	400	70	7 and 8	30
6	800 to 1000			125

If we except the types of great intensity of which, the manufacture is complicated and the construction delicate, it will be seen that the ordinary types are simple and easy to make.

Messrs. Paterson and Cooper, of Little Britain, Aldersgate-street, E.C., show two of their "Phœnix" dynamo machines, of the size known as No. 3. One of them feeds eight Clark-Bowman arc lamps, and the other forty Bernstein incandescence lamps of high candle-power, many of them taking nearly 100 watts. The Phœnix machine has an armature wound on the Gramme or Pacinotti principle, upon a hollow cylinder built up of thin iron rings placed side by side, but insulated from one another. These rings are held together by bolts passing through them from end to end of the series, and are supported by gun-metal arms radiating from bosses keyed on the shaft opposite each end of the cylinder. Each ring has teeth or projections on its periphery stretching out towards the poles of the field magnets to increase the induction on the core. In in so far as the armature is wound on a drum or cylindrical core. But in the Maxim machine the rings which compose the core are separated by air

FIG. 1.



spaces to permit of a constant current to carry off the heat, while projections on the inside, pointing towards the axis, are added for the same purpose. In the Lumley dynamo the rings have projecting spokes inside reaching to a gun-metal hub for the purpose of getting rid of the heat by conduction. By both these arrangements the symmetrical distribution of the lines of magnetic force in the armature core is interfered with, and while much heat is dissipated, the evolution of heat is probably increased. In Messrs. Paterson and Cooper's dynamo there is no special provision for carrying off the heat, and the makers claim that the proportions they have adopted for the magnets, pole-pieces, and armature core are such that the temperature never rises to a point where it can be injurious. By similar means they are enabled to prevent visible sparking at the commutator. This latter is a most important point, as it is the commutator which gives all the trouble with direct current generators, and if it can be relied upon to work smoothly the machine can be intrusted in unskilled hands. The arc lighting machine in the Exhibition has now been running three months, and the commutator hardly shows any signs of abrasion. These dynamos are made simple and compound wound, and are manufactured in various sizes up to 60 electrical horse-power.

The Consolidated Electric Company, Limited, of 67, Cowcross-street, E.C., do not join in lighting the buildings, but have a stand in the Western Gallery where they display their apparatus. The distinctive feature of their system is a secondary battery invented by Messrs. Beeman, Taylor, and King. The plates consist of a narrow tape or ribbon of lead rolled into a flat spiral, every twelfth convolution being made with a crimped layer to give increased permeability to the whole. The edges are burned together to form a solid framework, and to provide a conducting bar for the passage of the current. The cells are "formed" in the Planté manner without the use of red lead, and weigh when finished about 80 lb., their capacity being 250 ampère-hours, and their electromotive force from 2 to 2.2 volts. They are arranged in series of a sufficient number to suit the lamps with which they are to be used, and a number of such groups are arranged in parallel according to the amount of current required. The Consolidated Company offer these batteries chiefly as a means of electric distribution for incandescence lighting, in order that the great cost of full-sized copper leads for the whole installation may be saved. Their plan is to employ at the central station, dynamos giving a moderate current of high potential, and to carry it through the district by conductors of small section. The district is divided into numerous sub-districts, in each of which there is erected a secondary battery which can be charged by the current from the dynamo, and then serves to feed the lamps in the adjoining houses. The connection first from the battery to the dynamo, and then from the battery to the houses, is effected automatically by what is called a rocking switch, controlled by a master cell. In this master cell the hydrogen plate is rather less than in the other cells of the battery. It is covered by a hood or bell, and when the plate is fully charged and begins to give off hydrogen, the gas is collected in this hood under a flexible diaphragm, upon which rests a contact lever. As the diaphragm expands under the action of the gas, the contact lever makes connection with an electro-magnet in the rocking switch to change the position of its contacts and transfer the battery from the line circuit to the local circuit. During the time that the charging is in progress the cells are arranged in series, the primary current passing through them one after another, but when they are connected to the lamps they need to be disposed in compound parallel. To effect this change the rocking switch is provided with two rows of cups, eighteen in each, containing mercury. One row is fixed at each end of the board on which the mechanism is mounted, and in the centre there is supported a balanced beam provided at each end with contact pieces corresponding to the cups. Sixteen of the cups at one end of the base are connected alternately with the positive and negative poles of

the groups of batteries, and the two remaining cups are connected respectively to the positive and negative poles of the charging main. These sixteen cups, alternately positive and negative, are in connection with the sixteen cups at the other end, the arrangement being such that these latter are divided into two groups of eight each, one of which is positive and the other negative. The two remaining cups, one at each side, are connected to the local supply mains. The contact pieces on the rocking beam are in the form of prongs which dip into the mercury cups. On the charging side they are in pairs insulated from each other, and when down they connect the positive end of one group of cells to the negative end of the next, and so on. At the other end of the beam they are in two sets, one of which consists of half the cups, which are (say) positive to one supply main, and the other connects the remaining eight to the other main.

When the battery is fully charged and the distension of the diaphragm sets the switch in operation the beam rocks on its centres. It first short-circuits the charging main, so as to practically cut out the battery and then breaks all the contacts, so as to prevent all possibility of the charging current entering the houses. It next connects the batteries to the local mains, and the operation is complete. Each local battery is of course in duplicate, so that while one half is being filled the other may be in action. The system is in operation in Colchester, and the company claim that the use of this system of distribution has effected great economy in the cost of the installation, both as regards the conductors, and the generating plant, which runs the whole day storing energy for the evening demand.

Messrs. Oppermann Brothers, of 172, St. John-street, E.C., have not, so far as we remember, appeared at any previous electrical exhibition. They show an alternating current machine, which although new has a very familiar air, for the field magnets follow the design of the Ferranti generator, and the armature resembles the strip-wound machines of Messrs. Siemens Brothers. The framing is cast in two pieces with the cores of the electro-magnets in position. Upon these there are slipped bobbins of insulated wire so arranged that each pole has a pole of the opposite name at either side of it, and in front of it. Between the two sets of magnets there rotates an armature consisting of two discs mounted upon a shaft, and carrying a number of flat oval coils of ribbon copper. These coils are wound upon themselves without any core, with a layer of insulating material between the adjacent convolutions, and are clipped at one end between the two discs on the spindle, so that at a casual inspection the armature appears to be of the Ferranti type. The ends of the coils are connected to two collector rings which run in contact with segmental blocks from which the current is led away to the lamps. These are 260 in number, and are arranged four in series, the machine giving a current with an electromotive force of 200 volts, and the lamps requiring 50 volts each. The generator is excited by a small dynamo of the Gramme type.

Messrs. Clark and Bowman, of Brixton, whose arc lamps we have already described and illustrated,* illuminate the west corridor with ten lights, the current being generated by a Phœnix dynamo. Mr. S. J. Mackie lights part of Old London with five Lea lamps,† and forty incandescence lamps fed by Gramme machines. This system has already been described in our columns.

THE UNCHAGAH, THE GREAT RIVER OF CANADA.

(*Continued from page* 207.)

AT the foot of the portage is an old post of the Hudson's Bay Company, not now used, called the Hope of Hudson; and 40 miles east of this, where the river is clear of the Rocky Mountains, is the old Fort St. John. Just below this a large river, called the Pine, comes in from the mountains on the south, and up this valley, and a corresponding depression in the main chain, the survey was carried for the railway which led to the discovery of a low pass in the Rocky Mountains, only 2440 ft. above the sea, and 1186 ft. lower than the Yellow Head Pass. The Pine River is a stream 150 yards wide, flowing with a rapid current of five to seven miles an hour in the bottom of a valley a mile and a half wide, sunk to a depth of 800 ft. and 900 ft. below the surface of the prairie. Amongst the rocks on the east branch four seams of bituminous coal are exhibited, lying nearly horizontally in the bank of the river, amongst massive grey limestone interstratified with beds of dark shale, with numerous plant remains, mostly the stems and branches of trees, the bark being represented by a thin streak of bright coal, and the woody fibre being always decayed away and replaced with sand. The survey for the railway made the distance between the mouth of the Pine River and the Summit Lake, near the Frazer, 172 miles, which is considerably less than one-half the distance by the river with the acute elbow where it joins the Finlay, and the tortuous channel of the Crooked Creek. Another Pine River, which was explored by Professor Selwyn, comes into the main stream at Fort St. John from the north, and the character of the land is the same fine undulating prairie that is found all along the Peace River. He says in his report: "The country is covered with the richest herbage of astonishing luxuriance, and I have seen nothing that at all equals it on the Saskatchewan (three to four degrees further south), both the soil and the climate here being considerably better."

Below Fort St. John, 70 miles distant, is Dunvegan, the principal Hudson's Bay station in this district, standing on the north side of the river, and 800 ft. above it. The river opposite Dunvegan is 550 yards wide, flowing in a deep valley 2½ miles across, 700 ft. below the average level of the prairie, which is here unbroken as far as the eye can reach. The old French voyageurs called this place, which was formerly the limit of the operations of the original Fur Company, the Fort of the Grande Prairie, but the Scotch followers of Mackenzie, who spent the winter here in his memorable journey across the continent, and left it to discover the passage through the mountains, the Finlay, and the Frazer, called it Dunvegan, in memory of the old Scotch stronghold to which some of them had been attached. This is the future centre of the wealth of the north-west. For hundreds of miles the great river here flows with a placid, even current of from two to three miles an hour, with its surface unbroken excepting by an occasional wooded island, sweeping eastward in over graceful curves. To the north, a thick forest protects it from the hyperborean blasts; to the west the Rocky Mountains shelter it from the cold Pacific breezes, and relieve the surcharged clouds of their aqueous burden. Coal, salt, gypsum, sulphur, and sal-ammoniac are products of neighbouring localities drained by affluents of the river. Limestone is abundant, and underlies the whole, whilst sandstone of excellent quality for building is exposed at every bluff, and almost at each bend in the river. On either side stretches the great rich prairie buried under a profusion of uncropped herbage, a soil of unsurpassed fertility, a mild salubrious atmosphere, a wild flora of astonishing rankness, wonderful variety, and tropical luxuriance. Wild peas and vetches grow to an enormous height, and form in places almost impenetrable thickets, whilst grasses of a hundred species cover the whole region with a thick mass of vegetation from 3 ft to 5 ft. in height. Owing partly to the length of the days, and cloudless skies supplemented by heavy dews, and possibly to the great diurnal range of of the temperature, which varies from 45 deg. at sunrise to 80 deg. at noon, the growth of everything is extremely rapid. The surveying party were regaled on July 21 on new potatoes, fully grown, planted on May 1. The oats and barley put into the ground at the same time were then 5 ft. high, and the grass when cut was over 3 ft. in length. Professor Macoun, the botanist attached to the Geological Survey, says. "It would be folly to attempt to depict the appearance of the country, as it was so much beyond what I ever saw before that I dare hardly make use of truthful words to portray it. The country passed over to the north-west bears a vegetation similarly luxuriant, and Rainy River and Little Slave Marshes (200 miles to the south-west) are the only regions known to me that are in any way comparable to it. The soil must be exceedingly rich to support such a vegetation year after year, and the early summer temperature must be high for it, at this period, to be so far advanced." From the diary that has been kept at the Hudson's Bay fort it appears that from the middle of April to the first week in November the ground is fit for the plough, that the winter is actually shorter on the Peace River than in Manitoba, and that 1200 miles north-west of Fort Garry a milder temperature prevails than at that point. Mr. Marcus Smith, acting chief engineer to the Pacific Railway, describes the same country, which he approached from the south. "Stretching away," he says, "east, west, and north as far as the eye can reach, there appears a vast undulating grassy plain, rising in places to slowly rounding hills. During three days, whenever the trail was left, great difficulty was experienced in forcing a way through thick masses of grass and pea vine, 3 ft. to 4 ft. in height, and sometimes reaching nearly to the horses' backs. This character of country extends for 400 miles in length and 300 in breadth."

Three hundred miles south of Dunvegan, and within the Rocky Mountain range, rises the great Arthabasca, in volume not much inferior to the Peace River, and in length, till they both debouch into the Arthabasca Lake, not less by its course than 1000 miles, although a direct line from its head to its outlet would not exceed 600 miles in length. But it sweeps through the prairie like a bow bending to the south, and as the Peace below Dunvegan turns north, the included district between the two is in one part 600 miles across. The whole of the land between these, so far as known, is of the same luxuriant, prolific description. Midway between them, in latitude 55½, and between the parallels of 114 and 116 of west longitude, is Lesser Slave Lake, a magnificent sheet of limpid water, 75 miles long and 10 wide, surrounded by a district of surpassing fertility. The Hudson's Bay Company have for years turned out their horses here for the whole winter, a proceeding that in any of the older parts of Canada would insure their destruction, but in this north-western climate they grow fat in their winter quarters, and are captured again in the spring in the best condition. The wild grasses here grow 6 ft. in height, and so thick that in the early summer a horse can scarcely force himself through them. Sheltered by these they revel in their hybernal feeding ground, regardless of the snow or the cold, which, however, as compared with other districts 5 deg. and 6 deg. further south, can never be equally severe.

About 70 miles below Dunvegan, the river, flowing with the same regular current, and with its channel 600 ft. below the prairie level, turns north-east, and receives the waters of the Smoky River, a large affluent 300 miles long, running north from the Rocky Mountains, of which it drains a considerable length of their eastern slopes. Like the parent stream, it runs in a broad valley cut through the prairie to a depth of 600 ft. and 700 ft. below the surface, and it unwaters over 5000 square miles of country, a large part of which is the same rich alluvial land that borders the Peace River. It derives its name from a peculiar smoke, or "bocannes," which rises in places from the ground, and has hitherto been supposed to be derived from the spontaneous combustion of beds of lignite underlying the district. This seems now to be disproved, and the bocannes are probably derived from the combustion of beds of sulphurous shales. The high banks of the river, frequently exposed by land slides, nowhere indicate the presence of coal or lignite. Where the fires have burnt out, the cliffs present varied shades of red, yellow, and white, and where the vapour is still issuing from the ground there are patches which at a distance look like snow and sulphur, dead white and brilliant yellow; the analysis of this residuum shows nearly equal proportions of free sulphur and of sal-ammoniac. There is, however, still an unexplained phenomenon in the cause of these subterranean fires, and the material upon which their energy is exerted. Below Fort St. John the shales are seen on the river bank coated with a white efflorescence; this also has been assayed by Mr. Christian Hoffmann, the chemist of the Geological Survey, who found in it 51 per cent. of sulphate of soda (Glauber's salts) and 27 per cent. of sulphate of magnesia (Epsom salts), the residue being water with a little sulphate of lime.

The Unchagah below its confluence with the Smoky River turns north, and the Grande Prairie, with its rich alluvial covering of herbaceous wealth, is exchanged on its west side for a dense forest and a poorer soil, but to the east it still retains its agricultural capabilities, whilst the climate is in some respects even more mild and favourable. The height of the banks of the river is however gradually reduced, and from 800 ft., the elevation of the prairie over the river at Dunvegan, it is not over 200 ft. in height at Battle River 200 miles lower down, and at the Vermillion, 200 miles still further

* See ENGINEERING, vol. xxxvii., page 77.
† *Ibid.*, vol. xxxiv., page 627.

north, the banks are little over 50 ft. above the ordinary river height The scenery is however still very beautiful, and the red sandstone cliffs rise on either side, weathered into the most fantastic shapes and of an endless variety. The gravel beaches in the bed and on the sides of the river now cease, and the channel winds about in the summer amongst fringes of sandbanks, which melt gradually into grassy slopes, first on one side of the river and then on the other. The course of the river in this northern reach is singularly tortuous, and though generally north, at its confluence with the Battle River, 130 miles below the Smoky, and which comes in from the south, the main river is itself running south, and its affluent, turning round in sympathy, enters the main stream from the south-east In consequence of the sharp bends in the river, which are so excessively tortuous that, at one place, called Wolverine Point, it describes nearly a circle, the melting ice forms apparently heavy "jams" across the channel, and the marks on the banks indicate that in some parts the water has been raised 30 ft. above its normal level, before the "jam" has given way, or the rising water has forced an outlet for the imprisoned floods. Below Wolverine the current, which has been constant from Hudson's Hope at three to four miles per hour, ceases, and from this to 100 miles below Vermillion is imperceptible.

Vermillion is an important post of the Hudson's Bay Company, and its white buildings are anxiously looked forward to by the voyageurs, whose frail canoes and boats, adapted for the ordinary up-river navigation, are often found sadly deficient in strength and stability for the great waves that frequently agitate the bosom of the Unchagah, here fully a mile in width. The fort is almost the most northernly point touched by the portion known as the Peace River, being in latitude 58.45, nearly 3 deg north of Dunvegan, but Professor Macoun found barley and vegetables further advanced, the former having been cut on the 6th of August, fully ripe, although sown on the 8th of May, or just ninety days in the ground. The heads were from 4 in to 6 in in length, and full of large grains of a beautiful colour, and both wheat and barley as good samples as he had ever seen, and scarcely inferior to the parcel grown in latitude 59 deg , which took the prize at the Centennial Exhibition. The country round the post is a plain elevated from 50 ft. to 100 ft above the river, covered on the western side, as far as the eye can reach, with an aspen forest, which extends back to the Cariboo Mountains 40 miles distant. On the east bank is the prairie, the soil a rich alluvium, and the subsoil a mixture of gravel and red clay, which gives its name to the river at the confluence of which with the Peace the fort is situated. Where the ground has been burnt over it is covered with a thick growth of raspberry bushes, and the flora shows that the climate here is milder and warmer than at Dunvegan or St. John.

(To be continued.)

THE HEALTH EXHIBITION.

EDUCATIONAL EXHIBITS.—No. VI.

THE Technical College, Finsbury, has a large and interesting collection of exhibits. They come, in great measure, from the laboratories of this young but vigorous institution, and have, therefore, a much greater value than the sets of apparatus, fresh from the makers' workshops, which we find in certain other parts of the Educational Section.

The Finsbury College was founded in the beginning of the year 1883. In the opening address, the director, Mr. P. Magnus, sketched the object and scope of the foundation, stating that whilst the utilitarian side of education has been kept constantly in view, "the methods of instruction adopted are such as will, at the same time, stimulate and develop the reasoning faculties of the pupil."

It is now conceded that any branch of science efficiently taught has an educational as well as a technical value. The methods followed in the Finsbury College seem eminently calculated to insure this twofold advantage; for, however useful may be assisting at lectures and demonstrations, taking notes, and submitting them to professors for revision, they are not here considered sufficient and final. All this work, which is indeed excellent, is supplemented by actual experiments and precise measurements made by the young men themselves in the workshops and laboratories of the institution. Individual effort is stimulated and attention maintained by making them work in groups of two or three, and requiring each to give a detailed account of the apparatus and arrangements, to tabulate results and interpret observations, to plot curves from the numerical data obtained, &c. The aim of the professor in the chemical laboratory is likewise to accustom the students to observe accurately and explain correctly, rather than to make them proficient analysts.

After two years of such thorough instruction in the elementary principles of mechanics, physics, chemistry, and some of the more technological subjects, the student is well prepared to enter upon the advanced courses of the Central Institution.

The exhibits from the Finsbury College cannot but prove interesting both to the student and the teacher of science. The one will find a series of models illustrating familiar propositions, whilst the other cannot fail to derive some profit from apparatus and appliances which embody the ingenuity of experienced teachers.

In the mechanical section there are well-made and workable models designed to make clear the principles involved in the parallelogram and polygon of forces, as well as the resultant, in magnitude and position, of two like parallel forces There are also the familiar forms of apparatus for studying the laws of sliding friction, of spiral springs, of centrifugal force, the moment of inertia, and the times of oscillation of vibrating bodies.

These models are all made with a view to the wear and tear to which they will be inevitably subjected. The visitor will not fail to notice that each carries a slip containing printed instructions relating to the manner of carrying out the particular measurement for which it is intended. This appears to be a commendable method for young, inexperienced students; with those who are more advanced it would seem better to encourage thought and elicit ingenuity by requiring them to collect and suitably put together the apparatus which they need for their investigation

The section of heat contains a collection of apparatus used in determining the specific heat of bodies, the relation between the pressure and temperature of air under constant volume, and its expansion under constant pressure.

There is a large and beautiful model of Otto's gas engine, as also a sectional model of a steam engine constructed especially to show valve motion.

The electrical section is especially interesting The instruments are, in most cases, arranged in sets, each of which illustrates some particular measurement. Thus the student of electricity may examine the apparatus and connections for measuring the resistance of conductors, the charge of the ohmic resistance with temperature, the heat developed in a conductor by the passage of a known current, the distribution of magnetism in a permanent bar magnet, and the magnetic intensity produced at the end of a soft iron bar by a constant current flowing through a coil placed at different parts of the bar

The theory of the galvanometer is stripped of its greatest difficulties by two models so contrived that fairly good numerical data illustrating the law of sines and of tangents may be obtained with a little care.

In various parts of the rooms attached to the collection from the Finsbury College, will be found specimens of modelling and wood carving done in the Technical Art School, Kennington. This school belongs to the City and Guilds of London. It provides courses of drawing, painting, modelling, and engraving. Several of its students are engaged during the daytime in the Lambeth potteries of Messrs. Doulton.

Nor are the advantages of the Finsbury College confined to day students. Evening classes have been opened in which instruction is given in physics, mechanical engineering, the application of chemistry to the leading industries. Special facilities are also afforded for forming classes adapted to the wants of masons, cabinet makers, lithographers, decorators, and designers of all kinds.

The Finsbury College has already given a considerable impetus to technical studies; and, in connection with the Central Institution, which will be opened in January next, will supply that thorough training which will stimulate industries, and enable our artisans still better to hold their own against the foreign competition which is beginning to be so keenly felt.

NOTES.

THE WORLD'S TELEGRAPHS.

THE telegraph appears to have made more progress in the United States than in any other country. The number of American telegraph offices in 1882 was 12,917, and the number of telegrams forwarded during the year was 40,581,177. The number of telegraph offices in Great Britain and Ireland in 1882 was 5747, the number of telegrams forwarded being 32,965,029. Germany had 10,803 offices, the number of telegrams forwarded being 18,362,173. France had 6319 offices, the number of telegrams forwarded being 26,260,124. Russia had 2819 offices, the number of telegrams forwarded being 9,800,201. Belgium had 835 offices, the number of telegrams forwarded being 4,066,843. Spain had 647 offices, the number of telegrams forwarded being 2,830,186 British India had 1025 offices, the number of telegrams forwarded being 2,032,603. Switzerland had 1160 offices, Italy 2590, and Austria 2096. The number of telegrams forwarded in these three last-mentioned countries was 3,046,182, 7,026,287, and 6,626,203 respectively.

THE BRITISH IRON TRADE.

The returns of the British Iron Trade Association show that the make of pig iron in the United Kingdom for the half-year ending June 30, amounted to 3,991,220 tons, against 4,138,225 tons in the same period of 1883, showing a decrease of 147,005 tons. Five districts only exhibit an increase—West Cumberland, Lancashire, Lincolnshire, Northamptonshire, and Notts. The chief falling off is in Cleveland and Scotland, which are accountable for 93,083 tons and 42,956 tons respectively, while Derbyshire figures for 37,902 tons. During the same period the stocks of pig iron have increased 10,429 tons, the amount at the end of the half-year being 1,425,343 tons. The total consumption for the half-year has been 3,980,791 tons, being at the rate of 7,961,582 tons per annum, or 487,786 tons per annum less than in 1883. The production of Bessemer steel ingots during the first half of 1884 was 637,843 tons, while in the whole of 1883 it was 1,553,380 tons. The steel rails amounted to 426,415 tons, against 1,097,174 tons during the previous twelve months. The returns of forge, foundry, hematite, and spiegel iron are not sufficiently complete to afford materials for a comparison with the last year's output.

HEATING EFFECT OF ELECTRIC CURRENTS.

An interesting paper on this subject has been communicated to the Royal Society by Mr. W H. Preece With bare platinum wires of small diameter, the general law governing the ratio between the current strength and the diameter of the wire, when the latter is raised to a definite temperature, and where radiation is free, appears from Joule's law to be that the current should vary as the diameter $\times \sqrt{\text{diameter}}$ or $c = d\sqrt{d}$. Both the results of Mr. Preece's experiments tend to show that the current varies as the diameter. Platinum wires are however liable to flaws which practically reduce their effective diameter. Mr. Preece has also determined the strength of currents which produce self-luminosity in wires of different kinds and sizes. These currents were measured by finding the difference of potential at the ends of a thick German silver wire, whose resistance was .0157 ohms inserted in the circuit. The results with copper, Swedish wrought iron, German silver, and platinum wires, showed that the law $c = d\sqrt{d}$ held very well for all these wires, except with those of platinum, the point of low red heat being taken as the fiducial point. The temperature of a wire which becomes self-luminous has been given by Draper as 977 deg. Fahr., and by Daniell as 980 deg. Fahr. The exception in the case of platinum may account for its exception to the law in the former experiments. Mr. Preece infers from his experiments that electric light wires should be made large enough to avoid the possibility of heating them above normal temperature, otherwise points of danger are easily reached by increments of currents.

A GERM FILTER FOR WATER.

The tendency of research is to show that the germs believed to cause so many diseases are not found in the air, except under exceptional circumstances, but exist chiefly in water. This is probably due to the fact that rain and filtration eventually bring the products of fermentation and decomposition into the watercourses. Water may, therefore, be considered as one of the principal

agents in the propagation of such diseases; and M. Chamberland has recently turned his attention to the production of a microbe filter, which would purify water not only from its mineral but its animal impurities. M. Pasteur has employed a porous vase of baked porcelain to separate microbes from the medium in which they are generated, and this is the basis of M. Chamberland's filter. The latter has observed that water filtered through one of these vases contains neither microbes nor their germs; and the proof of it is that such water can be added in any proportion to susceptible liquids without causing any change in them. The apparatus of M. Chamberland, which was recently brought before the French Academy of Sciences, can be fitted directly to any water pipe, and acts by the pressure existing in the latter. Under a pressure of about two atmospheres, which is the pressure in M Pasteur's laboratory, M Chamberland obtains with a single porous tube or "filtering candle" (as he calls it) 20 centimetres long and 25 millimetres in diameter, some 20 litres (about 4 gallons) of pure water per day, that is to say, a sufficient quantity for the uses of an ordinary household. By multiplying the number of candles or filter pipes, so as to form sets or "batteries" of them, a supply of pure water sufficient for a school, hospital, works, or barracks, can be obtained. The filter, therefore, is of a practical kind, and being simple and inexpensive, will supply a much felt want. The filter is cleaned by brushing its external surface, and plunging it into boiling water, or by heating it directly in a fire to destroy the organic matter lodged in it; and properly cleaned, the same tube will last indefinitely. While upon this subject we may mention that electricity has been suggested as a means of ridding water of microbes, and a filter which electrifies the water has actually been designed and constructed.

A Fixed Astronomical Telescope

A modification of Lœwig's great telescope has been devised by M. Hermite, and submitted to the French Academy of Sciences. The instrument mounted as an equatorial comprises two parts, one movable the other immovable. The immovable part is a telescope tube directed parallel to the axis of the world. The movable part comprises the objective and divers accessories which allow the observation of all parts of the celestial vault by aid of two movements communicated to them at will by toothed wheels, one of these wheels receives the parallactic movement The objective is placed, not perpendicularly to the axis of the tube as in the ordinary telescope, but parallel to that axis and in a box of triangular section with the tube of the telescope entering one of its walls with gentle friction. The wall perpendicular to the latter carries the objective, and the third wall inclined at an angle of 45 deg. carries a plane mirror on it which receives the rays coming from the objective and reflects them up the interior of the telescope tube to the ocular lens The box is closed laterally to forbid the introduction of outside rays. It follows from this construction that by turning the box round the tube of the lunette or telescope tube, the observer can see all points of the sky situated on the celestial equator This movement of rotation corresponds, therefore, to that of an equatorial round the axis of right ascension. To obtain the second movement of rotation corresponding to that of an equatorial round the axis of declination, a new box carrying a mirror inclined at 45 deg. to the objective can be moved circularly round the latter This box is open in front of the mirror; consequently the first or interior mirror and the objective can move in a plane perpendicular to the tube of the lunette, while the second or external mirror which receives all the rays before they are sent to the observer possesses two movements, one in a plane also perpendicular to the tube of the lunette, the other in a plane at right angles to this latter movement. As in M. Lœwig's instrument the observer can be comfortably seated at his work, the tube of the lunette can be constructed in masonry if necessary, and as only the movable part, which is very small, requiring protection, the expense of a dome is saved.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, August 22, 1884.

THE drop of steel rails to 27 dols. to 27.50 dols. in small lots, and something less for large lots, has resulted in the placing of a good many heavy orders, aggregating from 125,000 to 150,000 tons, within the past two weeks. The market is very unsettled, and it is rumoured that 25 dols. have been accepted in Pittsburgh, but this rumour gains no credence here It is probable that 26 dols. has been the basis on which some of the large business has been done, and there are now several parties negotiating for considerable stocks for late fall or winter delivery, and very low prices only will be paid by them. But, with all the business done and in prospect, there will not be enough to keep all the steel rail making capacity employed The question of a suspension of pig iron making in all the furnaces of the country during September, is still talked of, but it is not likely that anything will come of it. There are too many furnace companies who would refuse to join in any such movement There has been a good deal of speculative inquiry for pig iron within a few days, but the prices offered for standard and special makes are as low as those at which the most inferior stuff is selling, and the companies making good irons are determined to obtain present prices or accumulate stocks. Fair qualities of foundry iron have sold at 19 50 dols for No. 1, and 18 dols for No 2, with forge at 17 dols Most of the business reported is in very small lots, for immediate requirements, owing to the feverishness of the market, and the dull demand for finished products. A good many bar mills are idle, and others are working single turn, but it is generally believed that there will be an improvement in demand, which will warrant starting up double turn by the middle of September, or the 1st of October at latest Foreign irons are in very light request. There has been some inquiry and a little demand for special makes of Bessemer, which have sold at 20 dols to 21 dols; ordinary makes, 19 dols to 19 50 dols. nominally Spiegeleisen would sell at 27 dols for 20 per cent, but is quoted 1 dol higher, and no sales are reported. Arrivals of Scotch iron are growing lighter, and there is very little demand here The demand for bridge and construction iron continues steady About 3000 tons have been ordered within the week; there are some good sized specifications now before our manufacturers, and they expect to be kept fully employed throughout the fall There is a general decrease of orders at the car works, and within a week or two three or four of the larger works have shut down, but Pennsylvania works are better fixed, and are most of them busy The Baldwin Locomotive Works in this city now employ 2000 hands, instead of 3000 as a few months ago They are turning out six or seven of their fine locomotives each week, and are at present completing an order for 25 for Australia The ship yards are not as full of orders as usual Shipbuilders report very few heavy orders, but along the Delaware a great deal of tonnage is being constructed for the Gulf and Pacific coast traffic The Cramps are at present employing 1600 men, and are completing some very fine vessels for the Morgan line, to ply between New York and New Orleans.

INEFFICIENT CONTINUOUS BRAKES.

To the Editor of Engineering

SIR,—The recent accident which occurred near Redditch, on the Midland Railway, once more directs attention to the danger and inefficiency of their so called *automatic* vacuum brake, more generally known upon the railway as the "two minute leak-off system" Major Marindin's report has now been published, and the facts appear very simple The leading and trailing wheels of an engine having a long rigid wheel base left the line when running round a very sharp curve. I saw the permanent way and the engine after the accident, but both seemed to have been in good order; but it is the absence of brake power to which attention should be directed

A non automatic steam brake was fitted to the driving and trailing wheels of the engine, and to all six wheels of the tender The whole of the carriages were fitted with the leak off system. This brake is *supposed* to be under the control of the driver, guards, and self acting in case of accident. The facts, however, furnish a very different account.

It has often been pointed out in articles which have appeared in your columns that this brake has but *one* store of power, therefore if it be used *once* that power is exhausted, and the brake leaks off of itself in less than two minutes. In practice it very frequently leaks off and is rendered useless while a train is still running, the final stop is then made by the steam brake on the engine and tender only. Such an amount of time is required to obtain another store of power with the ejectors that the brake is perfectly useless if required for a second or third application. In cases where several signal boxes or junctions are near together, a driver uses his *one* store of power to slacken at the first, then signals are lowered, and the train runs forward to the next box *without* there having been time to obtain a second vacuum. Major Marindin reports, "The evidence, as well as the distance run by the engine after leaving the rails, shows that the automatic vacuum brake was of very little service, owing to want of power It had been used just previously to check speed at the signal box, and, as often happens, when required again immediately it was found wanting"

The question has often been asked whether the directors of the Midland really know and understand the dangerous character of the brake employed upon their trains? It has been generally supposed that they do, but recent circumstances appear to throw some doubt upon the subject. One of these gentlemen called upon me a few days ago to ask for impartial information as to the construction, practical working, and defects of the brake, also asking why failures are constantly mentioned in ENGINEERING, *Engineer*, *Railway Review*, and other papers, yet that from the Board of Trade returns this brake would appear almost perfect. There is, and can be, but one explanation, viz., the failures are not reported to the Board of Trade, and the directors appear to be quite in the dark Sooner or later this "leak off" system will cause a fearful disaster, it has already given many serious and emphatic warnings; it is therefore to be hoped the directors will take steps to remove such a dangerous appliance without waiting for further loss of life, accident, or failure.

I have, &c.,

CLEMENT E STRETTON.

40, Saxe Coburg-street, Leicester, Aug. 30, 1884.

THE ROYAL POLYTECHNIC SOCIETY OF CORNWALL

To the Editor of Engineering.

SIR,—Will you kindly allow me to say a few words in reply to Mr H S. Mackenzie's letter in your issue of August 29th? Mr Mackenzie charges me with omitting words from the quotation I made from the President's speech in announcing the awards, and infers that the words which he says I have omitted would have altogether altered the sense I beg to say I have not omitted a single word, but have given the President's words absolutely as they were reported. My quotation was made from an entirely independent source, viz., the *Western Daily Mercury* of Plymouth, and with all respect to Mr Mackenzie, I place infinitely greater reliance upon a report in the public press, which is obviously entirely disinterested, than upon a report which may have been added to, or subtracted from, to suit opinions and circumstances arrived at *after* the President's address was delivered It would be an insult to the President to doubt that he knew his own mind, and also that he knew what he was talking about when he spoke the words which I have quoted from the *Western Daily Mercury*.

I am, Sir, yours respectfully,

RICHARD TANGYE,

(Chairman, Tangyes Limited).

Cornwall Works, Birmingham, Sept 3, 1884.

QUEEN CHARLOTTE'S ISLANDS.

To the Editor of Engineering

SIR,—I have read your description of Queen Charlotte's Islands with great interest, and have no doubt that they are able to support a large population

I would take the liberty of calling your attention to the way land is sold in such colonies, as for instance Australia and New Zealand, where each colonist is allowed to buy a square mile for himself and the same area for each of his children at the rate of 1*l* per acre, and thus even the largest colony is fully occupied by a comparatively small number of people, all later comers having no better chance than in the old world, because the first colonists know as well as possible that the value of the land will increase and buy more than they use in hopes of selling it at a large profit.

Now, why does the Colonial Government sell the land? They have got it, why do they not keep it and lease it out on rents that are to increase with the value of the land? The interest of the leaseholder could easily be guarded, and he might cultivate, build on, and improve the land with as great security as if he had bought it. He would be a farmer only with the difference that he paid his rent to the Government instead of paying it to a private individual, he would have all the advantages of the former in not having to invest capital in buying land, and the Colonial Government would have a great and increasing yearly income, that would cover all their expenses without the necessity of imposing any other taxes.

Such a course would involve no hardship to any one; there are at present, as far as I understand, no landowners, and the advantage is so evident that it cannot fail to commend itself to every one that takes an interest in the development of these splendid colonies The money that in other countries is wasted to keep a small part of the nation in an unnecessary and injurious luxury would there be applied to cover the public expenses, build railways, and execute other public improvements, while the colony could enjoy absolutely free trade and freedom from any other kind of taxation

T. A. H.

THE UTILISATION OF SLAG

To the Editor of Engineering

SIR,—I notice that in your last week's issue, your Middlesbrough correspondent calls attention to the ever-growing accumulation of slag in that district, and states that the ironmasters greatly desire some method of getting rid of it at a small cost He says that although bricks, roads, flags and embankments have been made of this material, and although millions of tons have been used in the formation of breakwaters, yet the heaps grow into mountains, and the mountains are constantly increasing Now it is not probable that any use will be discovered that will absorb the slag already in existence. But for the future there will be an opening for very large quantities in the manufacture of Portland cement, according to my process, which has been more than once noticed in your columns and which will shortly be put in practice on a large scale in more than one centre of the iron industry. Hitherto cement has been almost exclusively manufactured on the banks of the Thames and the Medway, from chalk and river mud, the latter supplying the silica and alumina. Good Portland cement is a compound

of silicate of lime and alumina in about the following proportions: Lime, 62; silica, 22 alumina, 8; oxide of iron, 8; potash, soda, magnesia, &c., 5. Now slag contains about 38 per cent. of silica, 22 per cent. of alumina, and 31 per cent. of lime, without any of the organic matter which gives ordinary cement its dark and objectionable colour. When slag sand, obtained by running melted slag into water, is mixed with chalk or limestone and burnt at a moderate temperature, it produces a pure white cement which will compare in every respect with the best manufacture on the Medway. It is much stronger, as has been shown by repeated tests, while the cost of manufacture is less, because since the slag has been so thoroughly burnt in the blast furnace it does not again need a *high* temperature, and no hard clinker is produced to be ground with difficulty.

The demand for Portland cement is constantly growing in this country, while the export trade is enormous, and the two together could absorb very large quantities of slag every year. In the Middlesbrough district the manufacture could be carried on under most favourable conditions; slag is to be had for nothing, coal is cheap, and limestone easily obtained, while there is every facility for traffic either by sea or land. I should at all times be pleased to furnish any further information as to the details of the process.

I am, Sir, yours truly,
FREDERICK RANSOME.

Rushmere Lodge, Lower Norwood, September 2, 1884.

INDIAN PUBLIC WORKS DEPARTMENT.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent "A Civilian Engineer not a Cooper's Hill Man" wishes to know where the actual rates of pay of officers of the Public Works Department are to be found. He will find them in the published "Civil Lists" of the several local Governments and administrations which give the actual pay of all officers serving under said Governments.

The "remote period" is the year 1870, not so very remote after all. Staff corps men then in the department got the option of serving under the rules under which they joined; but six who joined between 1871 and 1875 receive consolidated pay, and as regards these six I was in error, but I may remark that your correspondent did *not* write "as a *general rule* staff corps officers get no military allowances;" what he did write was, "They are men who . . . . work for ordinary pay without any military allowance," the fact being that only about 25 per cent. do so.

The classified list for December last shows one staff corps man as superintending engineer *second class*, and one third class (temporary rank), therefore my statement was perfectly correct.

With reference to your correspondent's last paragraph I am quite willing to meet him any day this month in London, and go through the whole of his statements with him, as the facts are very strongly in my favour, but to do so through the columns of your paper, even if you *permitted it*, and *to give all proofs* would be extremely uninteresting to your readers, besides taking up considerable space.

September 2, 1884. CIVIL ENGINEER.

THE MECHANICAL EQUIVALENT OF HEAT.

TO THE EDITOR OF ENGINEERING.

SIR,—Allowing "H." the elastic rebounds he writes of, or equivalent heat pulsation on arrestment of a free descent, I wish to distinguish betwixt these, and the weight raised, dashers moved (as in Joule's experiments), or gaseous motions (heat pulsations) produced, *during* a restrained descent.

The work done *during* a descent gives us Joule's mechanical equivalent (or, rather, ought to do). This, and the pressure experienced on arrestment of a descent, makes *total* work done, but I want to distinguish between the two *portions* of the total work.

Yours truly, G. PINNINGTON.

23, Chichester-street, Chester, September 1, 1884.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The warrant market was a turn better last Thursday, and ½d. of the previous day's decline was recovered. Business was done both in the forenoon and in the afternoon at 41s. 3½d. and 41s. 4d. cash, also at 41s. 5½d. and 41s. 6d. one month, the top prices ruling at the close of the afternoon market. Friday's market was steady, with transactions done on forenoon 'Change at 41s. 4d. and 41s. 3½d. cash, also at 41s. 6d. and 41s. 5½d. one month, the close being buyers at the lower quotations, and sellers wanting ½d. per ton more. Business was done during the afternoon at 41s. 5½d. and 41s. 5d. one month, also at 41s. 3½d. cash, with sellers at the close asking 41s. 3½d. cash and 41s. 5½d. one month, and buyers offering ½d. lower per ton. Notwithstanding an unfavourable report in regard to the pig iron shipments during last week, there was a somewhat firmer market on Monday, and the close showed an advance of 1d. per ton over last week's closing quotations. Transactions were reported during the forenoon at 41s. 3d. and 41s. 3½d. cash, also at 41s. 5d. and 41s. 5½d. one month, the top quotations being asked by sellers at the close, with buyers offering ½d. per ton under. In the afternoon market 41s. 3½d. cash and 41s. 5½d. one month were paid, and subsequently there were sellers at 41s. 4d. and 41s. 6d cash and one month respectively, with buyers at ½d. lower per ton. The warrant market was again strong yesterday, and a further advance in prices was secured, the close showing a gain of 1½d. per ton over the previous day's closing prices. In the morning business was done at 41s. 4½d. and 41s. 5d. cash, also at 41s. 6d. and 41s. 6½d. one month, and the close was sellers at 41s. 4½d. cash and 41s. 6½d. one month, and buyers at ½d. per ton under. The afternoon quotations were 41s. 4½d. to 41s. 6d. cash, and from 41s. 6½d. to 41s. 7½d. one month, the market closing with sellers at 41s. 6d. and 41s. 8d. cash and one month respectively, and buyers at ½d. per ton less. Business was done to-day at 41s. 5d. up to 41s. 6½d. cash, and at 41s. 7d. up to 41s. 8½d. one month, the top quotations ruling at the close in the afternoon, with buyers near. As a rule the warrant market is very inanimate, for although a considerable quantity of iron changes hands from day to day practically all the business that is doing consists of the operations of the "trade," as the public still decline to take any interest in warrants, and without their support the market, in the present condition of trade, always inclines to droop after each little "spurt." Almost all the reports that are coming to hand, both from the Continent and from the United States, continue to be of a most unsatisfactory nature, there being no improvement in the demand sufficient to justify the expectation of an alteration for the better in the immediate future. So far very few orders of any consequence have been received from abroad to meet autumn requirements. Several of the special brands of pig iron continue firm in price, and some of them are rather scarce, but it is not anticipated that up till the close of the shipping season there will be any change in that respect. There are 94 blast furnaces in actual operation this week, one having been damped down at the Ardeer Iron Works (Messrs. Merry and Cuninghame's). At this time twelvemonth there were 114 furnaces blowing. Hematite pig iron is very much depressed, so much, indeed, that it is considered that the makers must be incurring heavy losses in selling at the present quotations. The shipments of pig iron from all Scottish ports last week amounted to 9539 tons, as compared with 9320 tons in the preceding week, and 15,683 tons in the corresponding week of last year. To the United States there were shipped 1250 tons; to Canada, 750 tons; to Australia, &c., 100 tons; to France, 150 tons; to Italy, 100 tons; to Germany, 1585 tons; to Holland, 145 tons; to Belgium, 130 tons; and to other countries lesser quantities. The stock of pig iron in *Messrs. Connal and Co.'s* public warrant stores stood at 585,077 tons yesterday afternoon, as against 585,940 tons yesterday week, the decrease for the week being 263 tons.

New Dredger for Ayr.—The great increase in trade of the harbour of Ayr having rendered it necessary that dredging operations should be carried on more extensively, the Ayr Harbour Trustees resolved some time since to procure a large new dredger, at a cost of about 17,000*l.* Messrs. M'Knight and M'Creadie, shipbuilders, Ayr, have taken the contract for the dredger, and they have sublet the contract for the machinery to Messrs. W. Simons and Co., Renfrew.

Troon Harbour.—With the view of improving the harbour at the port of Troon, on the Ayrshire coast, the Duke of Portland, who is the superior, has resolved to spend upon it a sum of about 10,000*l.*

Lanarkshire and Ayrshire Railway.—The capital of the company recently formed to construct a continuation of the Caledonian Railway system to Ardrossan and other Ayrshire ports has been fully subscribed, and the construction of the main line and of the Irvine and Kilbirnie branches will be proceeded with simultaneously. The new works, it is understood, will be commenced early next year.

Clyde Shipbuilding Workmen.—Last Friday there was a very large pay-off in Messrs. James and George Thomson's shipyard at Clydebank, and considering the number of hands at present idle, the prospects of trade for the ensuing winter are certainly very bad, and but little hope is entertained amongst the men of the prospects reviving. Numbers of the men have recently left the district for Liverpool, Belfast, and other places. Messrs. Caird and Co., Greenock, have also lately paid off a large number of hands. Yesterday the rivetters in Messrs. Russell and Co.'s Kingston Shipbuilding Yard, Port-Glasgow, struck work on account of notice having been received from the employers that it was their intention to make a reduction in their wages.

Trade at Kirkcaldy.—The various branches of the engineering trade at Kirkcaldy continue to be in a languid condition, and the closing of the Kinghorn shipbuilding yard is seriously felt in the district. Messrs. Douglas and Grant have got some fairly good orders in hand, and there is an expectation of more being booked by and by.

Clyde Shipbuilding Trade.—Last month's launches of new shipping on the Clyde gave a total of 26,981 tons, or nearly 10,000 tons under the turn-out in the corresponding month of last year, but 16,281 tons over the output in August, 1871. For the past eight months the totals are: 194 vessels and 196,594 tons. In the corresponding period of 1883 the output was 262,210 tons.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday, the market was again in a stagnant condition, there being no sign of a change for the better. No. 3 g.m.b. was offered at 36s. 3d. and 36s. 6d. per ton f.o.b., and special brands continued to command 37s. The shipments of iron are disappointing, the total exports of pig from Middlesbrough during the month of August being 16,600 tons less than during the same month last year. This month, however, there is an improvement, 6000 tons having been exported on the first day. It is expected that they will be maintained on a large scale.

The Make and Disposal of Pig Iron.—To-day the Cleveland Ironmasters' Association issued from their offices at Middlesbrough the official returns showing the make and disposal of pig iron in the Cleveland district, which comprises the whole of the North of England, during the month of August. Of 156 blast furnaces, 98 have been in operation, and they have produced a total of 201,763 tons, an increase of 42 tons on the previous month. The total stocks now stand at 292,594 tons, an increase of 15,075 tons. The stoppage of the Eston Steel Works has contributed largely to this fact. There has been a great decrease in shipments, only 71,815 tons having been exported from Middlesbrough as compared with 88,485 tons in the corresponding month last year.

The Wages Question.—The manufactured iron trade is so depressed that the employers are again seeking relief in reducing the cost of production. They have given notice of a reduction of 5 per cent. in wages. The men in the North of England have met this request by demanding an advance of a like amount. On Monday the Board of Arbitration will meet at Darlington, and will consider the whole question with a view to settling it amicably. Should they be unable to come to terms, they will refer it to an arbitrator.

The Steel Trade.—For five weeks the great steel works of Messrs. Bolckow, Vaughan, and Co., at Eston, Middlesbrough, have been closed for want of orders, and a large number of men have been out of employment. It was hoped that the works would be opened on Monday, but owing to the difficulty in obtaining orders of any description, the date for recommencing operations at this extensive establishment cannot at present be fixed. Meanwhile, new plant has been put down, and the company will be able to produce any quality of steel.

Shipbuilding and Engineering.—There is no prospect of better trade for shipbuilders this year. There is a good deal of general work going on in the engineering shops, but marine builders are getting very short of orders. Iron-founders are pretty well employed.

The Coal and Coke Trades.—The fuel trade is steady, and prices are unchanged.

NOTES FROM THE SOUTH-WEST.

Viaducts on the Cornwall Railway.—At the half yearly meeting of the Cornwall Railway Company, the chairman stated that in the joint committee of the Great Western and Cornwall Railway Companies the representatives of the former predominated by eight to four. The latter were pressed to continue the reconstruction of the viaducts, and the question arose whether it was competent for the joint committee to insist upon its being done, or whether the Cornwall Railway directors would do as they pleased. That was one of certain points which was submitted to arbitration. The arbitrator decided that the joint committee had the power, when necessary, to order the reconstruction of viaducts, and that the Cornwall Railway Company should provide the cost. With regard to the Largin and Coombe St. Stephen's viaducts the *directors had consented to their being constructed*, but they passed a resolution that no further reconstruction should be insisted upon by the committee for five years unless it was found necessary after calling in a Board of Trade engineer.

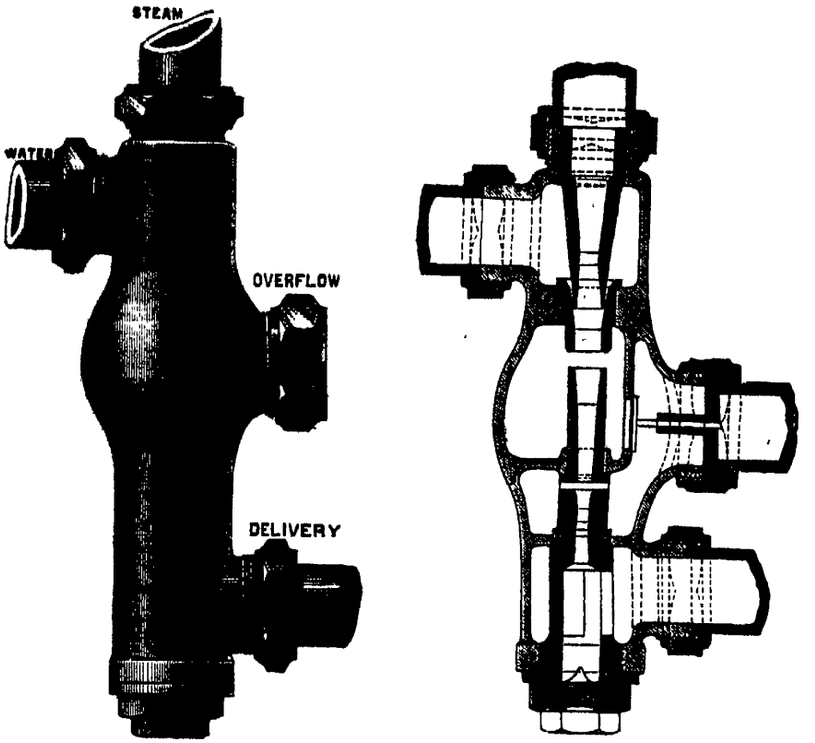
Colliery Enterprise at Neath.—The Lower Resolven Colliery Company, Neath, recently proved a seam of first-class steam coal above their Resolven seam. Since then they have proved another seam of coal of equally good quality, and have completed an incline of about 1000 yards from the openings on the mountain to their colliery yard. Wednesday was selected for bringing down the first journey of coal from the new seams. Mr. R. Attenborough, of Reading, the proprietor of the colliery, was present, with Mr. N. Corbyn, the company's general manager.

Bristol Docks.—We learn that the Bristol Docks Committee has appointed Mr. F. B. Girdlestone general manager of the united Bristol Docks undertaking.

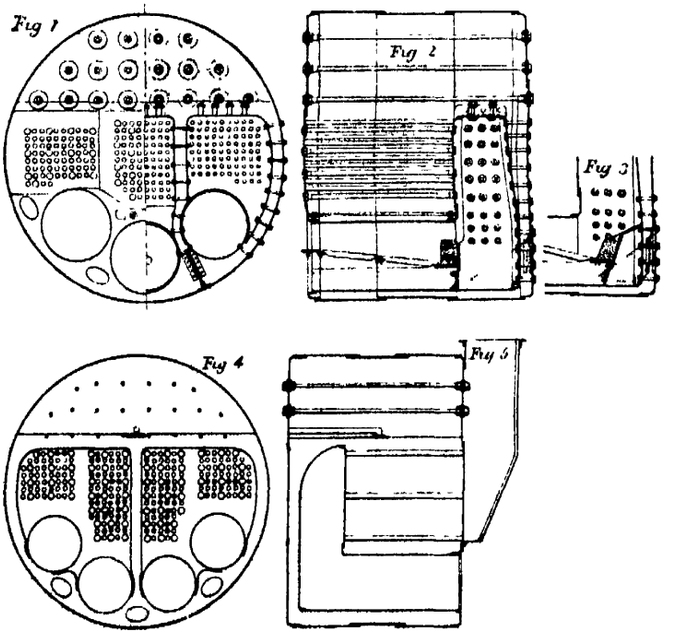
Pontypridd, Caerphilly, and Newport Railway.—The half-yearly meeting of this company was held on Friday, at 60, Gracechurch-street, London. Mr. J. C. Parkinson, managing director, presided. The chairman, in moving the adoption of the report, said since the last meeting, the railway had been completed, and was now in perfect working order, with a double line of rails, capable of carrying any amount of traffic likely to be shipped at Newport. From causes of a temporary character, there had been some annoying obstruction at the Bassaleg end of the railway. This had brought out clearly the wisdom of the course adopted last year, when Parliament, in spite of a determined opposition, granted the company powers for continuing its line direct to the Alexandra Docks, thus giving Newport an independent access to the great coalfields of South Wales. This new portion of the railway and the necessary sidings and adjuncts were in course of construction, and would be completed early in the ensuing year. By these means, and by virtue of an important working agreement with the Taff Vale Railway, which had been entered into for a long period of years, Newport had been made practically part of the Taff Vale Railway system, giving that efficient line an additional port, and providing independent and unfettered access to and from Newport from the Rhondda and other valleys.

THE ENGINES OF THE TUGBOAT "SAMARA."—In our issue of June 27th last, we published the drawings and description of the compound engines of the tugboat Samara, and we inadvertently credited the builder of the vessel, Mr. D. P. Shipoff, Kostroma, Russia, with the construction of the engines, instead of Mr. A. P. Blummer, Kolomna Locomotive Works, Russia.

HOLDEN AND BROOKE'S INFLUX INJECTOR.



THE CORROSION OF MARINE BOILERS.



INFLUX INJECTOR.

THE starting of almost all injectors used for feeding boilers requires a considerable amount of manipulation and nice handling; indeed, this and their propensity to "knock off" when at work, seriously affects the extent of their use. As non-lifters steam has to be carefully and slowly turned on until the water "seizes," and when the water has to be lifted, the operation is further complicated by the introduction of spindles, levers, or other equivalent devices requiring additional attention, and subject to derangement and wear. In the charge of a competent man, this starting would not be a serious question if the injector could be relied upon to continue working uninterruptedly, but where its action is liable to frequent momentary interruptions, as when on a rough road, and when the water in the tanks of locomotives, tram engines, &c., is low, giving rise to splashing, or where the feed-pipe may be exposed by the rolling of a steamboat, the repeated stopping of an injector becomes a serious matter.

In such cases, as steam is blowing away, the injector has to be stopped, and if restarted, the whole cumbrous manipulation has to be gone through again, and this no matter what the attendant is occupied with at the time or how often it may occur. On tramway engines, where there is no stoker, fatal accidents have frequently occurred through the driver's attention being thus diverted.

To meet these difficulties Messrs. Holden and Brooke have brought out their patent "influx" injector. It is started by merely opening the ordinary boiler steam cock—quickly or slowly—and acts equally well as a non-lifter or a lifter, in the latter cases lifting its water 10 ft. or 12 ft. even in the smallest sizes (where a Giffard injector would lift only 3 ft.), and in some cases as high as 15 ft. There are no spindles, levers, or other moving parts in its construction, and its entire handling is a matter of absolute simplicity. When at work its action is purely automatic, and if interrupted by any such cause as air in the feed pipe, splashing water, &c., the stoppage is quite momentary, and the instrument continues working with steam full on. This feature is entirely peculiar to it, and constitutes the value of the invention.

The sectional view explains this automatic action. In the first place the "lift" is obtained by dividing the combining cone into two parts, whereby the steam is enabled to escape with ease The rush of steam through the upper portion of the combining cone forms a powerful vacuum in the water chamber, consequent upon its unobstructed escape through the aperture in the combining cone and small valve at the side. In an ordinary spindle injector a small jet of steam is first introduced to obtain the vacuum, but which, owing to the weakness of the jet, is not nearly so powerful A vacuum thus always exists while steam is on, so that should the injector lose its water, it immediately draws it up again and re-starts. All this occurs instantaneously and without loss of steam or water. When at work a powerful vacuum exists in the chamber round the aperture in the combining nozzle whereby the valve is drawn on to its seat and tightly held there. This improved action is therefore not obtained at the cost of simplicity, and the rapidly extending use of these injectors on locomotives, steam trams, steamboats, and all classes of boilers, attest to their utility.

Messrs. Lewis Olrick and Co, of 27, Leadenhall-street, London, are the sole licensees for the south, and showed three of these injectors at work at the Textile Exhibition in the Agricultural Hall.

CORROSION IN MARINE BOILERS.

*On the Causes and Remedies of Corrosion in Marine Boilers.**

By Mr. J. HARRY HALLETT.

MARINE engineers are all striving in various ways to attain increased economy of fuel in steamers. Among other means of doing so, triple-expansion engines of high initial pressure are being introduced, which appear to be gaining much favour, and will no doubt in time supersede the ordinary two-cylinder type. The increased pressure of steam evidently renders it necessary to be still more guarded than hitherto as to the deterioration of boilers. Steel boilers are now in very general use, and there can be no doubt as to their efficiency; but the writer's experience is that they are equally liable with iron boilers to corrosive influences. On careful scrutiny he has found in steel plates severe corrosion concealed by a very slight scale, upon the removal of which the plate has proved to be covered with a black substance, probably a black oxide of iron. In many cases a casual inspection may fail to detect this. Internal corrosion is well known to be most erratic in its action; it attacks the metal in different parts of a boiler, in different ways, and from various causes. The principal sources of corrosion, however, may be discussed under the two heads of defective design and defective management, which is equivalent to saying that an ordinary marine boiler will hardly be subject to corrosion at all, if well designed and well managed.

Design.—The most frequent fault of design which bears upon corrosion is the want of sufficient space for allowing a thorough examination to be made of every part of a boiler. The tubes are often so far out in the wings that it is impossible to get down to look at the sides of the furnaces, or so close to the furnace crowns that there is no room to get over these. In the accompanying engravings, Figs. 1 and 2, it would be preferable to allow at least 9 in. between each furnace crown and the bottom row of tubes, especially as this row is not useful as heating surface when placed so close down to the crown.

The manholes are often inconveniently placed and made too small, which always affords an excuse for a want of proper attention on the part of the men in charge. Manholes should always be fitted in the wings if the size of boiler will allow. A manhole at the bottom of the back end, as shown in Fig. 4, is also to be recommended. There can be no doubt that the best way to prolong the life of a boiler is to watch it carefully and constantly, so as to note the commencement of deterioration and take steps to check it. In any part which cannot be seen it is impossible to know what is going on.

Another fault of design, which easily escapes notice until too late, is the pitching of the steam-space stays, so that one or perhaps several of them, come over a space, instead of over a tube, thus rendering the effective use of the scaling tool very difficult or even impossible in that particular vertical space. With the object of securing the conventional 20 square feet of heating surface per horse-power, the tubes are sometimes too closely pitched, which causes bad circulation, besides rendering the spaces liable to become soon choked with scale. The tubes should never be less than 1¼ in. apart, both vertically and horizontally.

Management.—The first point to be looked to in the management of a boiler is the circulation. In an ordinary multitubular marine boiler, such as is shown in Figs. 4

* Read at the Cardiff meeting of the Institution of Mechanical Engineers.

and 5, the circulation takes place by the water ascending from the furnace crowns, and from the sides, backs, and *fronts of* the combustion chambers, and descending at the wings; the tubes do of course somewhat obstruct the upward current. There can be no doubt that the coolest places *in the boiler are those where the circulation is most* defective, as is naturally the case below the level of the firebars. The water in this part of the boiler always contains the greatest percentage of solid matter, and here the greatest deterioration may therefore be expected to be found.

Double-ended boilers are not only subject to the same corrosive action as single-ended ones, but being longer they are also more prone to suffer from racking strains, due to the difference of temperature between their upper and lower parts. One method of reducing this difference as far as possible, is to fit the internal feed pipe so that it is led along on a level with the upper tubes, so as first to warm the water inside it, and is thence carried down so as to discharge the warmed water in a horizontal direction at the bottom of the boiler.

The scum pipe should be fitted with a pan, as shown in Figs. 4 and 5, shaped like an inverted saucer, and placed just above the level of the water for the scum to collect under it; and it should always be blown off upon raising steam, and also about once a day when under way. The blow-off cock should either be attached at the bottom of the boiler, or else an internal pipe should be fitted to it, reaching down to the very bottom.

Salt is not deposited until the density of water exceeds $\frac{1}{16}$ by the salinometer, that is, until there is more than 4 lb. of salt in 32 lb. of water; beyond this proportion the deposition of salt then begins upon the furnace crowns, &c. It is recommended that the opportunities occurring from time to time by the engines being stopped should be taken advantage of for pumping up the boiler to the top of the gauge glass, and then blowing it down to the bottom of the glass. This repeated about twice or thrice on each occasion will work wonders. The great usefulness of this plan arises from the fact that while the engines are stopped there is little or no steam being made, and therefore no solid matter is being deposited from the water; so that the extra feed-water pumped in at that time does much more to freshen the boiler than it would if the engines were at work. When in charge of the engines of a steamer on a voyage from England to Rangoon, calling at several ports on the way, and thence to Venice, the writer kept water in the boilers continuously during the whole round, that is to say the boilers were never entirely run out and refilled, but were blown down from time to time as above described. They were under steam about seventy-two days, and upon being opened out at the end of that time had only a slight scale upon them of uniform thickness, and no indication of pitting or corrosion.

The mode of treatment adopted by the writer for new boilers is to have them well washed out before filling, then to run them up, and when they are filled with water up to the normal height, to throw into each through the top manhole about a bucketful of common soda. When steam is raised to about 30 lb. per square inch, blow out a little through the scum cock. Before adding any more water, start the feed donkey, and let it deliver for some time over the side of the ship, so as to get rid of any dirt, &c., in the pump; this is a very useful precaution to observe whenever the feed donkey is employed. After starting the main engines, let them run at first with the feed-water overflowing from the hot-well into the bilges; this will clear the condenser. When under way, it is advisable to use the blow-down cocks sparingly.

The appearance of the water in the gauge-glass shows at a glance the state of the water in the boiler; if the glass is at all dirty inside, that is proof positive of the water not being clean enough; and this can be cured by the use of the scum cock. In a double-ended boiler a scum pipe should be fitted at each end. The scum pipes are sometimes so fitted that their position can be altered to suit the trim of the ship, which is a point of far more importance than is generaly imagined. After a run, when steam is finished with, the water should be blown out from the bottom, and the boilers then kept thoroughly dry. Before refilling they should be carefully swept down inside, and washed out.

There is no doubt that one of the most active causes of deterioration in boilers is the want of proper care in their treatment. Cases have come under the author's notice of boilers being blown down as far only as the level of the bottom manholes, and refilled, without care being taken to draw the water out of the bottoms. This process having been frequently repeated, the water at the bottoms became so impregnated that the heads of the rivets and the lower half of the compensating rings round the manholes were corroded away, while the other parts of the boilers were in good condition. Many good boilers are ruined through careless management, and the makers are wrongly charged with allowing their work to come from the shop not properly finished.

Another example, out of numerous cases met with, is that of a pair of boilers which were fitted some little time ago with hydro-kineters, or internal steam jet nozzles for stimulating the circulation of the water in the cooler spaces below the furnace flues. Upon a recent examination the valves of these appliances were found to be hard and fast, in consequence of carelessness in supervision. Another great evil is raising steam too quickly, and blowing out under too great a pressure, which cannot be too strongly condemned.

Corrosion in the upper parts of the boilers is principally caused by the introduction of oil, tallow, and other greasy substances from the engines. In all the steamers with which the writer is connected, he has discarded the use of all oil or other lubricant in the cylinders, with the most satisfactory results.

Various remedies have been suggested for preventing corrosion; among others, air extractors, and circulating tubes. Zinc has been tried, both cast and rolled, and some engineers report favourably on its use; but to make it effective, very large quantities must be used, as it so quickly oxidises, and thus loses its protective qualities. *The electrogen of Mr. Hannay's invention, which is* rapidly gaining favour, is a very simple little appliance, and, as far as the writer has experimented with it, is very effective. The principle upon which it works is the setting up of a small galvanic battery in the boiler, by means of a ball of zinc cast upon a copper bar, and then hammered to make it more impervious to the action of the water; on each end of the copper bar a wire is soldered, and the two wires are again soldered to different parts of the boiler so as to obtain metallic contact. Boilers which had shown a tendency to corrosion looked quite healthy in a very short time after these appliances had been fitted to them.

Marine boilers are not troubled with much external corrosion, especially modern boilers, because much more care is now taken in fitting them into the ships than was formerly the case. They are now properly coated, and are not fitted too close down to the bottom of the ship, plenty of room being allowed for access to the seams. But that all the mischief to be contended with is not confined to the waterside of the boiler is shown by the following incident: Some four and a half years ago the writer was called in to survey a boiler that had exploded and killed the chief engineer and fireman. Upon examination it was found that the bridges had been built up close to the backs of the combustion chambers, as illustrated in Fig. 3; the dirt, &c., had been allowed to accumulate for some time, and corrosion had been going on upon both sides of the plate without being noticed. After the accident, when all had been cleared away, the iron was found to have oxidised so much that in some parts it was barely $\frac{1}{16}$ in. thick; hence the explosion. The backs had been so built up for the express purpose of economising fuel; but experience goes to prove that this is a fallacy, and many cases could be mentioned where similar bridges have been taken out without making any difference in consumption of fuel, except that, if anything, the economy has been in favour of their absence. There is nothing like cleanliness to prolong the life of a boiler.

When a vessel is to be laid up, a good plan is to pump the boiler full up to the very top of the dome, and keep it so until it is again required. Another method of preserving a boiler not in use is to empty it and clean it thoroughly, then close all the manhole doors except one at the bottom, put in a small stove full of burning coke, and close up the bottom door quickly. The object of both these methods is of course to exclude air as thoroughly as possible.

ON A NEW VOLTMETER.*

By CAPTAIN CARDEW, R.E.

IT is quite unnecessary at the present day to dilate on the extreme importance in electric lighting, especially by incandescence, of keeping the pressure or volts on the lamps constant within very small limits. The necessity for this must have forced itself on the notice of all who have had any experience of this lighting. However perfectly the dynamo may be compounded or the engine governed, it is very desirable that the engine driver should have an electric pressure gauge to which he can refer as readily as to his steam gauge. The instruments about to be described were originally designed for the use of engine drivers, and are adapted to the meanest capacity. At the same time they give perfectly trustworthy readings.

There are two ways of measuring the difference of potential or volts between the terminals of a dynamo or any other points in an electric circuit, which we may call the statical and dynamical methods. The former, or measurement of the force of attraction between bodies charged from the two points respectively, is too delicate for the purpose in view, and the latter, or measurement by means of a current produced by connecting these points by a conductor, was therefore adopted. Now, when a current is passing in a conductor it creates a magnetic field in its vicinity by which an effect can be produced on other bodies. The measurement of the current is usually made by observing this effect on another body. This method may fail from two causes:

1. Other things may affect the body obscuring the effect of the current.

2. Owing to a change in the condition or position of the body, the effect of the current on it may be altered.

These were obvious objections to intrusting this method to an engine driver in a room full of dynamos and iron machinery, but the current energy produces another effect. It developes heat in the conductor, which causes an expansion of volume to take place in it. This effect of the current energy appeared likely to offer a solution of the difficulty.

The instrument now before you is the outcome of many experiments made with the view of utilising this effect for the exact measurement of the current passing, and thus of the difference of potential existing between the points to which the instrument is applied.

This instrument is extremely simple in principle and construction. It consists essentially of a very fine platinum silver wire, .0025 in. in diameter, enclosed in a brass tube.

The difference of potential to be measured is applied at the ends of the wire, which is heated by the current passing through it. The wire expands on being heated, but is kept stretched by a spring or weight, and the expansion is indicated by suitable apparatus.

The heat produced in any conductor, not containing an electromotive force, by any difference of potential applied to the ends is equal to $\frac{V^2}{R}$ per unit of time, where V is the difference of potential in volts, and R the resistance in ohms. The resulting temperature of the conductor for any difference of potential depends on the temperature and the rate of motion of the particles of the surrounding medium. It will be seen from this that the absolute stretch of the wire, which would accurately measure its rise of temperature, would not be an accurate measure of the current passing through it, or of the volts producing that current. Even when no current was passing the instrument would not maintain an accurate zero, since alterations of atmospheric temperature would affect it.

These defects are obviated by the use of the brass tube enclosing the wire.

The coefficient of expansion of brass for temperature is sensibly the same as that of platinum silver.* Hence, so long as they are both at the same temperature, the zero is unaffected by any alteration of it, or the variations in length of the wire are compensated. When, however, a current is passed through the wire its temperature is raised above that of the surrounding tube, and a perfectly regular current of heat is established between the wire and the tube since all external draughts are prevented. It is therefore the difference of temperature between the wire and the tube that is measured, and this is necessarily constant for the same difference of potential, except for the fact that the resistance of the wire varies slightly with its temperature.

This variation in the resistance has the effect of causing the reading for any volts to be slightly higher on a cold day than it is on a warm one, but as the alloy of platinum and silver used only varies .035 per cent. per degree Centigrade, this error is not worth consideration as long as the surrounding air is at an ordinary temperature.

The considerations guiding the choice of a wire for the purpose were as follows:

1. It must absorb a minimum of energy, therefore the wire should be as fine as possible and of a high specific resistance.

2. It must follow all variations in the volts with extreme rapidity, and must therefore be formed of a metal of low specific heat and must offer a large surface for its mass.

3. The material must not be liable to oxidation even at a high temperature.

4. The coefficient of variation of resistance for temperature must be very small.

5. Its elasticity and tensile strength must be high. A fine platinum silver wire best answered these conditions.

The instruments are practically instantaneous in their indications and quite dead beat.

Having determined by these considerations the most suitable material and size of wire, the next point to determine was the number of volts that could safely be put on any length of it. With this view one foot of the wire was taken, and the number of volts required to make it just visibly red in a dark room determined to be 21. As the rise of temperature for any volts varies as V^2 it is evident that 10 volts would only raise 1ft. to rather less than $\frac{1}{4}$ the amount required to redden it. Experience has shown that this rise does not permanently alter the wire.

The working maximum number of volts is therefore taken at 10 per foot. For 200 volts therefore 20 ft. of the wire is required, but this length need not necessarily be contained in the instrument, although it is advisable to use the same kind and size of wire throughout.

The instruments are generally made to work to 120 volts, and a sufficient length of wire supplied in a metallic box to extend the readings to any required number of volts.

For ordinary purposes it is quite sufficient to extend the limits to which the instrument will measure by putting an incandescent lamp in circuit with it. Thus an instrument for 120 volts has a resistance of about 360 ohms, and if an Edison lamp be added it will easily read to 200 volts.

In order to save the instrument from fusion by excess of current a safety fuse is placed in the circuit. This consists of a short length of finer platinum silver or iridium platinum wire.

As regards the application of the instrument to alternating currents, the pressure which it will indicate with these is the equivalent useful pressure of difference of potential—that is to say, it indicates a difference of potential which, with a continuous current, would, if applied to the same wire, do the same amount of work per unit of time. This is evidently what is required to be known for all industrial applications. Of course the absolute difference of potential with an alternating current is continually varying between certain positive and negative limits much higher than the industrial mean, passing in each period of variation through the value 0.

The instrument, however, while indicating the industrial mean follows the variations of pressure sufficiently to emit a musical note corresponding in pitch to the number of alternations per unit of time.

In the more portable instruments on this principle the extension of the wire is multiplied so as to give a reading over a large dial by delicate wheelwork. This necessarily introduces some complication and chance of error, although the force of the spring is sufficient to easily overcome the friction.

For a standard instrument, not intended to be carried about, it was worth while to eliminate this chance.

In considering this the use of a beam of light as an

* Paper read before the British Association at Montreal.

* More perfect compensation is obtained by making two-thirds of the tube of brass, and one-third of iron or tinned iron.

index naturally suggested itself. As the natural motion in this case was rectilinear, and not angular as in a reflecting galvanometer, it was obvious that the best arrangement was a kind of magic lantern by which a greatly magnified image of a portion of the wire should be projected on a screen.

Two very fine cross wires are fixed on the wire within the field of the lens, which of course appear in the magnified image on the screen. The distance between the images of these cross wires constitutes the base line which is always kept of a certain length, so many feet or inches, by slightly moving the screen or instrument. When the volts are applied the cross hairs move down by the extension of the wires, their images of course move up, the upper one soon disappears, but the reading is taken from the lower one, and having once standarded the instrument with a certain base line we can at once obtain the volts corresponding to any movement of the lower image by reference to the curve. The instrument in this form then is one of elementary simplicity and yet may be called scientific. Here is a rough arrangement to illustrate the principle. It consists of the tube with the wire down the centre terminating in a spring, the lens arranged with the wire and cross hairs in focus, the dark lantern of course separate from the tube to avoid error from the heat given off by it and the screen. The instrument has not been standardised but we will take readings on the portable instrument at the same time.

In order to make a direct reading instrument of this, that is to say measure off the volts at once, it is sufficient to mark them off from the curve of the instrument on a piece of stiff card or slip of wood of the exact length of the base line.

This form of instrument can be made moderately portable by attaching a camera body to the tube, the image of the wire being received on a ground-glass screen with a scale marked on it. In this case the tube should act as a support to the camera, as the wire can be pulled up as well as down.

The instrument can readily be made to register ordinary variations of electric pressure on mains by simply fixing a very small incandescent lamp—the size used for surgical purposes answers well—on the wire, so that the currrent through the wire passes also through the lamp and renders it luminous. These lamps are made to take a current of about one-fourth ampère which gives a good extension to the wire, the maximum current it can safely take being rather under one-third ampère. The image of the filament of the lamp which in this case is nearly a straight line is thrown by the lens on a sheet of paper sensitised by the bromide process, all other light being carefully excluded; so long as the volts remain constant the filament will simply produce a magnified image of itself, but any variation of the volts by causing the lamp to slightly shift its position will produce a vertical elongation of the mark.

After each night's work the paper can be developed, fixed, and examined, and the limits of variation of potential for the whole time obtained by simple measurement.

As the companies undertaking house-to-house lighting will be liable to fine if a certain limit of variation is at any time exceeded, registering instruments of this kind will become a necessity.

The only other form of this instrument which is worth mentioning as promising to have a distinct use, is a pocket form with tube not more than a foot long in which the readings are taken by observing the movement of the wire with a simple microscope. In this case the wire is not pulled by one end, but in the middle, a very slight actual extension being sufficient to produce a perceptible sag in a stretched wire. This idea was suggested to the inventor by Dr. Muirhead.

THE HEAT-CONDUCTING POWER OF MATERIALS.

*On a New Method of Measuring the Heat-Conducting Power of various Materials, such as Cotton, Wool, Hair, &c.**

By J. J. COLEMAN, F.I.C., F.C.S.

IN the last edition of the "Encyclopædia Britannica" Sir William Thomson calls attention (in the article "Heat") to unsatisfactory and inaccurate figures which have been put forward by Peclet as to the conducting power for heat of various solids. In regard to metals proper, more correct results have been achieved by the late Principal Forbes, of Edinburgh, Professor Tait, and others. In all treatises upon heat Peclet's figures relating to the conducting powers of fibrous and spongy substances, such as cotton, wool, sawdust, &c., are assumed as correct, and possibly they may be, but they are deficient in giving practical information to those who require to construct insulated cold chambers for the preservation of ice, and similar technical purposes.

I have therefore had occasion to make a number of experiments on the subject, which, besides their practical utility, I venture to think are of scientific interest. The apparatus used in my first series of experiments, which were commenced in June, 1883, consisted of 10-in. cubes of thin tin-plate filled with ice, placed inside 18-in. cubes of thin tin-plate, the space between the two cubes being filled with the substance to be tested. (See Figs. 1 and 2.) A number of these cubes were placed side by side in a room kept at a uniform temperature of about 60 deg. Fahr., the ice melted per hour being drawn off and measured, from which the quantity of heat penetrating into the ice was easily calculated. It will be seen that this apparatus in its general features resembles the "Lavoisier Calorimeter," designed for measuring specific heat, but I am not aware that this principle has been adopted before for measuring thermal conductivity. The results of the experiments are summarised in Table I.

* Read before the Philosophical Society of Glasgow.

TABLE I.—EXPERIMENTS COMMENCED JUNE 14, 1883—4.45 P.M.

Ice Melted with different Insulators Measured in Cubic Centimetres.

DATE.	Sil. Cotton.	Hair Fel	Charcoal.	Wood Shaving	Breeze.	Wood and Air Space	Temp Fahr Outside Boxes
	Cub. Cent. Ice Melted	Cub. Cent. Ice Melted.	Cub Cent Ice Melted	Cub Cent Ice Melted.	Cub. Cent. Ice Melted	Cub Cent Ice Melted	Fahrenheit.
June 15, 10 a.m	893	807	800	745	1025	1560	deg 63
,, ,, 6 p.m ..	250	305	330	350	703	780	66
,, 16, 10 a.m	815	940	948	985	1810	2220	71
,, 18, 10 a.m	1065	1245	1278	1335	2513	3000	
	1540	1640	1670	1750	3050	3375	
	2605	2385	3143	3085	5563	6875	

Relative Conducting Power for Heat Calculated from above Data.

Silicate cotton .. .	100	Wood shavings	125
Hair felt .	117	Gas works breeze	230
Charcoal	120	Wood and air space	280

TABLE II.—EXPERIMENTS COMMENCED JANUARY 17, 1884—10.15 P.M.

Ice Melted with different Insulators Measured in Cubic Centimetres.

DATE.	Silicate Cotton		Cotton.		Wool.		Infusor. Earth.		Charcoal		Sawdust	
	Cub. Cent. Ice Melted.	External Temperature Fahr.	Cub Cent. Ice Melted.	External Temperature Fahr	Cub. Cent. Ice Melted.	External Temperature. Fahr	Cubic Cent. Ice Melted.	External Temperature Fahr.	Cub. Cent. Ice Melted	External Temperature Fahr	Cent. Cub Ice Melted	External Temperature Fahr
		deg		deg.		deg		deg		deg		deg.
Jan. 18, 8 a m to 11 a.m.	225	98	252	97	345	97	350	98	440	98	440	98
,, 2 p.m.	360	100	385	99	340	99	390	100	430	100	445	100
,, 5 p m	275	101	355	101	430	101	390	102	445	102	460	102
,, 6.30 p.m.	85	96	105	95	175	96	185	96	195	97	205	97
	945	..	1097		1290		1285		1510		1540	

Relative Conducting Power for Heat Calculated from above Data.

Silicate cotton	100	Infusorial earth	136
Cotton wool	122	Charcoal .	160
Sheep's wool . .	136	Sawdust	163

Or the above Results Combined with those in Table I.

Silicate cotton	100	Charcoal	140
Hair felt	117	Sawdust ..	163
Cotton wool	122	Gas works breeze .	230
Sheep's wool .. .	136	Wood and air space ..	280
Infusorial earth	136		

No observations were taken until the vessels charged with ice had been about eighteen hours in the constant temperature of the room, thus allowing equilibrium to be established. The melted ice was then carefully drawn off from the solid ice by the india-rubber pipe *x*, provided with a clip, at 10 a.m. of the 15th of June, and the results

Fig 1

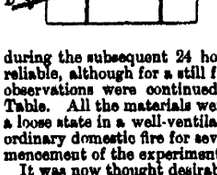
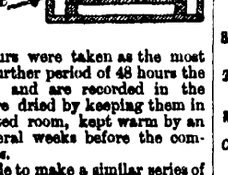


Fig 2



during the subsequent 24 hours were taken as the most reliable, although for a still further period of 48 hours the observations were continued, and are recorded in the Table. All the materials were dried by keeping them in a loose state in a well-ventilated room, kept warm by an ordinary domestic fire for several weeks before the commencement of the experiments.

It was now thought desirable to make a similar series of experiments in a room kept at a temperature of about 100 deg. Fahr. These were commenced on the 17th of January, 1884, and continued until the 19th, and the results are recorded in Table II. herewith. The water drawn off during the first ten hours is not included in the Table, which is confined to the results obtained between 11 a.m. of the 18th and 6.30 p.m. of the same day. Silicate cotton stands again at the head of the list; and it may be as well to explain that this interesting substance resembles cotton wool in appearance, and is produced in large quantities by blowing steam into melted blast furnace slag. It is therefore a glassy fibre.

As it was an interesting matter to compare sheep's wool and cotton wool accurately, care was taken that the weight of material used in each case was exactly the same for a given space filled up, 3 lb. The figures of conductivity obtained represent the warmth of garments of equal thickness and equal weights. Of course, if with the two materials the weight of the garment per square foot is identical, but the thickness different from a different style of manufacture, then these figures will be modified.

As for technical purposes, charcoal is confined between walls of wood. A larger experiment was made in the room kept at 100 deg., the inner vessel of ice measuring 22 in. cube. This was surrounded by an outer layer of charcoal, 3 in. thick, and an outer wall of wood (deal) 1 in. thick. It was found that under these circumstances the ice melted at the rate of about 1 lb. per twenty-four hours for every superficial foot of insulation.

Although silicate cotton stands at the head of the list as an insulator, 10 in. thick being equivalent to, say, 12 in. or 15 in. of wood charcoal, it by no means follows that it is always the best substance to use. To begin with, it is four times, or perhaps six times, as costly as charcoal, and has the fault of being friable and liable to fall into powder, especially if used on board ship, from the incessant motion of the vessel when out at sea.

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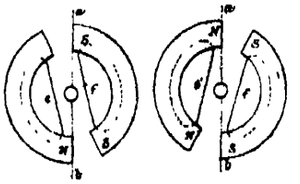
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DYNAMO-ELECTRIC MACHINES.

859. S. P. Thompson, Bristol. Electric Motors. [6d.] *January 7, 1884.*—*In order to automatically regulate the speed, the effective lead of the brushes is varied by winding each field magnet with two sets of coils wound on separate cores, so as to assist one another in producing the same polarity at their common pole-piece. One of these coils is arranged in series with the armature, and the other as a shunt to the armature or to the armature and series coils. These coils act on the two ends of the pole-piece, and any change in the relative strength of the currents in the coils will alter the position of the effective pole in the pole-piece, and thus the lead of the brushes.* (*Sealed May 27, 1884*).

2041. E. B. Bright, London. Dynamo-Electric and Electromotive Engines. [4d. 7 *Figs.*] *January 24, 1884.*—The inventor in order to avoid the neutral spaces between the opposite poles of the exciting magnets, causes the magnetic field to be completed throughout an entire circle divided into two parts by a sharply defined line, the whole of the armature coils being thus rendered productive. Fig. 1 shows the application to a ring type of machine, the pole-pieces N S N S being so fixed in relation to each other that when one of the coils of the armature is passing from the end of the pole-piece of one polarity on one side

of it, it is at the same time coming before the pole-piece of opposite polarity on the opposite side. The coils of the field magnets



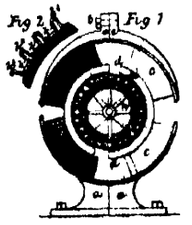
are shown at e e' f f' of D section; a b is the neutral line. (*Sealed May* 2, 1884).

4651. A. N. Thorin, Stockholm. Dynamo-Electric and Magneto-Electric Machines. [4d. 4 *Figs.*] March 10, 1884.—The armature of this generator is wound, as shown in Fig. 3, with a series of coils T. Each coil consists of two layers placed one upon the other. The coils are arranged to lie partially one upon the other, and are held together by a band u and a ring v, they



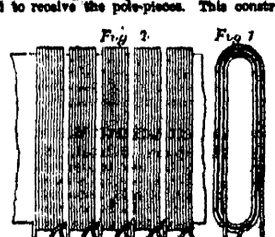
are connected up as shown. The armature coils may be formed by winding the insulated conductor into the form of a spiral which is afterwards flattened and then bent to a circular form, each coil having thus but one turn of wire. The armature is secured to its shaft by means of rings between which the wire of the armature is held. (*Sealed June* 20, 1884).

4721. W. R. Lake, London. (*C. Richter, Camden, N.J., U.S.A.*) **Dynamo-Electric Machines.** [6d. 9 *Figs.*] March 11, 1884.—The objects are to construct the stationary magnets so that the helices shall occupy the most effective parts thereon, and the armature so that it shall have large magnetic surface, free ventilation, and suitable devices for the reception of the coils. Referring to Fig. 1, the field magnets a a consist of two convexo-concave pieces formed of two complete castings bolted at b b, and provided with inwardly extending flanges c, which come close up to the consequent points and form cores whereon the wire is wound. The polar extensions d are of curved



shape, each being common to two or more flanges c. Slots are provided for the passage of air when the armature is in motion. The iron wire of the armature is wound, at right angles to the axis of rotation, upon a frame A cast in two parts, which are secured together by soldering. The space between the ribs of the frame is packed with wood which is given a cylindrical form, and is removed after the core is wound, a large cooling surface being thus exposed to the air. The layers of wire are separated by pins leaving air spaces right through the armature. A number of concentric iron wire rings h^1 (Fig. 2), having radial projections h^2, and intervening channels for the reception of the coils, are fixed upon the periphery of the core. The brushes are mounted upon a movable frame carrying indicators to represent the position for the desired current. (*Sealed June* 20, 1884).

7022. W. H. Gedge, London. (*C. J. Van Depoli, Chicago, Ill., U.S.A.*) **Dynamo-Electric Machines.** [8d. 9 *Figs.*] April 30, 1884.—The cores of the field magnets are constructed of iron plates threaded on two bolts, washers being placed between each two plates. These plates are then placed in a mould and the back plate is cast on, the spaces between the plates being filled with sand during casting. The free ends of the plates are then planed to receive the pole-pieces. This construction, it is



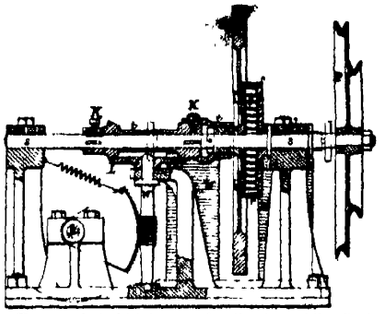
stated, does away with all hacking. The coils of the field magnets are made up of a cable consisting of a number of individually insulated fine wires. The current from the generator is regulated by including more or less of these separate wires in circuit. The inner ends of the coils of the two magnets are connected respectively to the two brushes bearing upon the commutator, and the outer extremities are connected to insulated contacts. A solenoid in the circuit operates a bar so as to connect more or less of these contacts. The armature is of the drum or Maxim type. The core comprises a number of iron bars rivetted, parallel to the armature shaft, to the inside of two rings so as to form a hollow cylinder, a space being left between each two bars. A number of separate rings of galvanised iron wire are then wound transversely upon the cylinder and a number of iron bars equal in number to the bars on the inside of the rings are arranged on the outside of the rings and the whole is then wound with insulating material. The core is then wound and connected to the commutator as in the Gramme ring, except that a loop is taken from the centre of each coil to a segment of the commutator, there being thus twice the number of commutator sections as coils. Fig. 1 shows the loop taken from the centre of one coil, and Fig. 2 shows five coils connected as above, 1, 2, 3, 4, &c., being the sections of the commutator. There may be two circuits on the armature; one, containing a less number of coils than the other, being employed for exciting the field magnets. Insulated iron bars placed between the coils are received in insulating grooves in end flanges mounted upon the armature shaft, the armature being held perfectly concentric with the shaft. (*Sealed August* 12, 1884).

8686. E. H. Dunstan, London. Ring Armatures of Electric Machines. [4d. 13 *Figs.*] June 25, 1884.—Separate wedge-shaped saddle pieces of iron are fixed between the coils and project a little beyond their external faces. (*Accepted July* 29, 1884).

4695. W. P. Thompson, London. (*J. B. Wayne and J. R. Markle, Detroit, Mich., U.S.A.*) **Driving Dynamo-Electric Machines.** [4d. 4 *Figs.*] March 11, 1884.—In order to equalise the speed of the armature of a generator driven by a reciprocating engine, a friction pulley is attached to the crank-shaft of the motor, and engages with a friction pinion on the armature shaft or on a countershaft provided with a heavy belt pulley and driving the armature. (*Sealed June* 20, 1884).

CURRENT REGULATOR.

2614. A. Jamieson, Glasgow, and S. Alley, Polmadie, Renfrew. Electric Governors. [6d. 3 *Figs.*] February 6, 1884.—This is an electrical governor for regulating the current by means of the speed of the driving engine. A metallic disc is rotated between the poles of magnets excited by a shunt from the generator; the changes of resistance to the disc's rotation, produced by changes in the current and the rotary velocity, is utilised to adjust the throttle valve or equivalent part of the driving motor. Referring to the illustration, the shaft s is driven from the engine by means of the pulley P. The copper disc D is secured to the shaft by means of a volute



spring V, one end of which is secured to the rim r of the disc boss, and the other to the shaft s, and rotates between the poles of shunt magnets M. The boss of the disc is screw-threaded, and works in the end of a screwed sleeve t forced to rotate with the shaft s by screws K working in grooves. The sleeve is provided with bevel surfaces, one or other of which, according as it is on one side or other of its mid position, comes in contact with a similar bevel surface L, and rotates it and the shaft W in one direction or the other. The shaft W operates by the worm and sector, as shown, the rocking shaft R, which is connected to the throttle valve or equivalent part of the motor. (*Sealed May* 2, 1884).

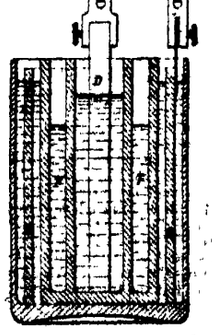
GALVANIC BATTERIES.

2485. E. Fairfax, London. Galvanic Battery. [4d. 4 *Figs.*] January 30, 1884.—This galvanic battery has two similar electrodes of carbon electrically excited by the action of sulphuric acid or caustic soda, the acid being kept apart from the alkali by a porous cell. (*Sealed April* 29, 1884).

6682. In a subsequent specification (3d., February 27, 1884) nitric acid and hyposulphite of soda, sulphurous acid or analogous substance, are respectively substituted for or added to the caustic soda and sulphuric acid, in order to absorb the hydrogen and oxygen generated; or bichromate of potash may be added to the sulphuric acid (*Sealed June* 6, 1884).

5365. E. H. Courtenay, London. Voltaic Batteries. [4d. 2 *Figs.*] March 24, 1884.—In order to prevent the rapid wasting away of the zinc it is coated with asbestos prepared with an aqueous solution of gum lac. (*Sealed August* 12, 1884).

7264. J. Imray, London. (*W. Wenzel, Vienna.*) **Voltaic Cell or Element.** [4d. 5 *Figs.*] May 5, 1884.—The voltaic cell or element is divided by porous partitions into three compartments, the additional compartment being charged with strong sulphuric acid. The water and nitrous vapours from the nitric



acid pass through the porous partition to the sulphuric acid. The illustration is a section of the cell. The positive element B is immersed in nitric acid contained in one compartment, the negative element D is immersed in an alkaline or other solution in another compartment, and the sulphuric acid is contained in the annular space F between the two. (*Sealed August* 15, 1884).

SECONDARY BATTERIES.

4782. S. Kallenberg, Berlin. Secondary Battery. [8d.] March 12, 1884.—Iron or steel is coated by electrolysis with peroxide of lead, and is combined with a leaden electrode in a solution of a suitable salt of lead. The iron is not acted upon. (*Sealed June* 20, 1884).

8297. In a subsequent specification (4d., March 26, 1884) it is stated that carbon may replace the iron or steel. (*Sealed June* 27, 1884).

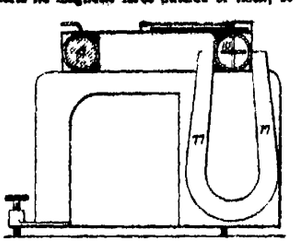
SECONDARY GENERATOR.

2444. W. R. Lake, London. (*L. Bellmann, Vienna.*) **Conduction and Conversion or Change of Tension of Electric Currents and Apparatus therefor.** [6d. 16 *Figs.*] April 2, 1884.—According to one modification of the apparatus, it comprises a central iron bar or cylinder surrounded by a coil, the ends of which are connected to collectors. This coil is surrounded by another coil, the ends of which are connected to the cable that conducts the primary current to the apparatus. A series of iron cylinders are arranged symmetrically around the central cylinder, and are wound with coils connected to the collectors, so that the current flows through these coils in one direction, and through the inner coils of the central cylinder in the opposite direction. The ends of the cylinders are connected by iron bars. The collectors are connected to the outside circuit. Commutators for causing the primary current, if continuous, to alternate and for commutating the secondary circuits, may be employed. (*Sealed July* 8, 1884).

GALVANOMETERS.

1662. C. D. Abel, London. (*S. Bousu, Biella, Italy.*) **Galvanometers.** (4d. 8 *Figs.*) January 18, 1884.—The oscillations of the needle are neutralised by means of a ring of magnetic metal so arranged as to act directly upon the needle or upon a piece of metal attached thereto. (*Sealed April* 29, 1884).

3669. J. Blyth, Glasgow. Galvanometers. [6d. 6 *Figs.*] March 13, 1884.—An endless solenoid, formed by taking a straight solenoid of insulated copper wire and bending it into a circular form, acts on a suspended magnetised needle placed within the solenoid at any point in its circular centre line. Such a solenoid, it is stated, forms a closed magnetic shell, and consequently exerts no magnetic force outside of itself, so that the



use of the instrument does not tend to produce any change in it or in permanent magnets combined with it. The illustration shows one modification. The endless solenoid 8 is coiled upon a wooden annulus, a part of the core, where the small needle 10 is placed, being removed. The permanent magnet 17 is placed with its poles at the inner and outer sides of the solenoids. In another modification the axis of the needle is continued downwards, and has another small needle placed between the poles of a permanent magnet. (*Sealed June* 6, 1884).

AUTOMATIC SWITCH.

3106. H. H. Lake, London. (*J. W. Dyer, Philadelphia, U.S.A.*) **Apparatus for Protecting Electric Circuits and Instruments therein from Injury by Excessive Charges Produced by Lightning or otherwise.** [6d. 3 *Figs.*] February 11, 1884.—Two coils of wire are carried upon the same core and act upon an armature. The line wire, having the receiving instruments on it, is in circuit with the coil of highest resistance. The armature first operates mechanism to throw the low resistance coils into circuit, and insure the grounding of the line, and then to break the original line circuit close to the receiving instruments when the line becomes overcharged with electricity. (*Sealed May* 27, 1884).

PHOTOMETERS.

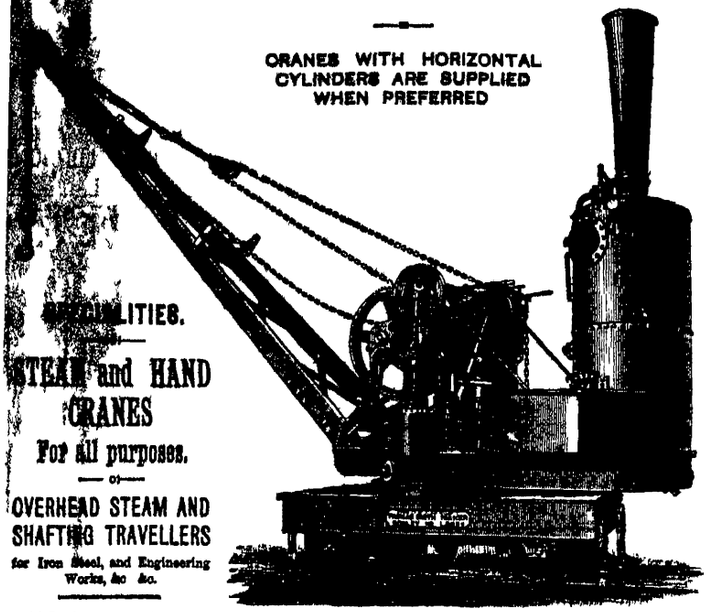
2942. W. R. Lake, London. (*C. E. Fritts and D. H. Hopkinson, New York, U.S.A.*) **Preparation of Selenium for, and the Manufacture of, Selenium Cells for Electrical Purposes and Apparatus therefor.** [4d. 15 *Figs.*] February 19, 1884.—A material which is both pervious to the radiant energy, and offers a free passage for electric currents, is arranged on one or both sides of selenium formed in thin sheets so that the radiant energy acts on the surfaces or through the entire mass of the selenium in the same direction as the electric current. The selenium is prepared by heating it between blocks and pressing the plates together to bring it to the required shape, melting the selenium, and again applying pressure and allowing it to cool slowly. (*Sealed May* 20, 1884).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1867 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

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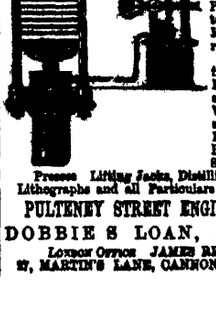
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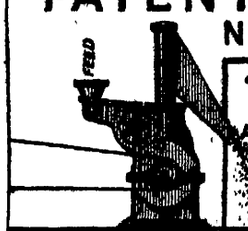
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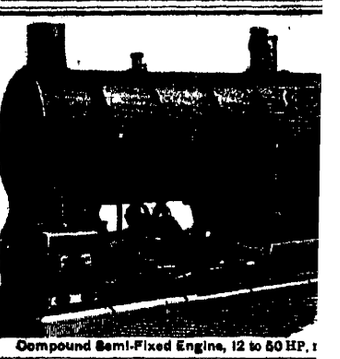

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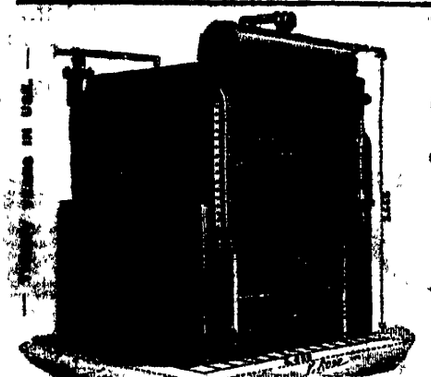
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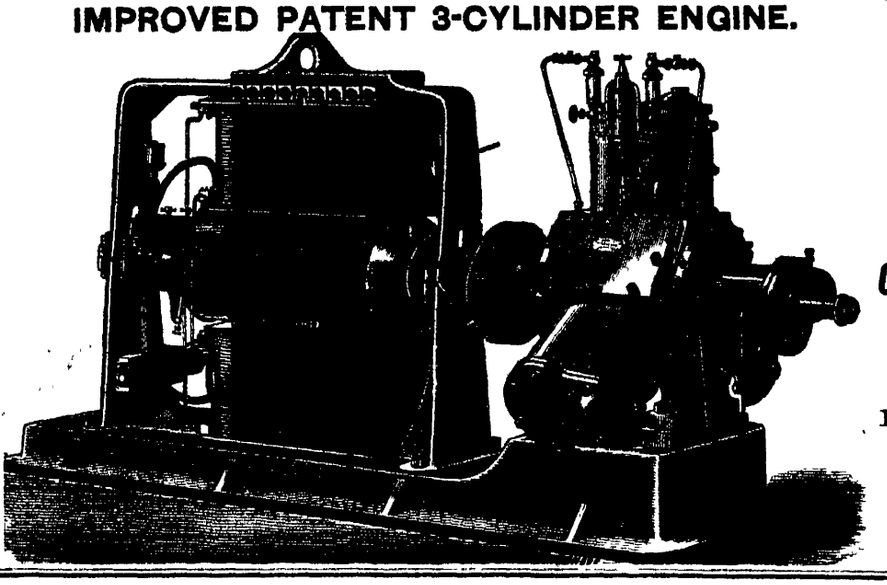
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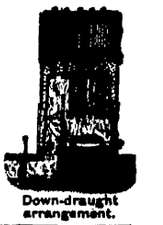
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...ssure in lbs. per sq. in. A	3700	3000	3700	3200	2800	3700	2700	2800
...with 40lbs. steam .. B	4900	3400	4900	4200	3700	4900	3500	3750
...am. Steam Inlet .. Ins.	1½	1½	2½	2½	3	3	3	3½
" Exhaust Outlet .. "	1½	2	2½	3	3½	3½	3½	4

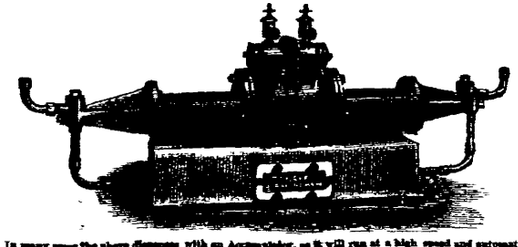
...These are the pressures at which the pumps will run delivering approximately the quantities stated ...lbs. B. Are the pressures for which the pump is suitable when working a Hydraulic Press, and at ...h it will nearly pull up.

The above and other sizes quoted for on application. 153

TANGYES'

"SPECIAL" HYDRAULIC PRESSURE PUMP

For Working Accumulators, Hydraulic Presses, Testing Pipes, &c., &c.



In many cases the above dispenses with an Accumulator, as it will run at a high speed and automatically "slow down" on the pressure increasing, thus avoiding danger to Hydraulic Presses, or other Machinery, in-separable from the use of an Accumulator, where a long fall will suddenly develop a largely increased strain and at times lead either Press or Pipes.

This pump is specially suited for requirements where it is necessary that the pressure upon the material be maintained for a lengthened period, as it continues to work at such a slow speed as merely supplies leakage and so makes up for the "give" of the material.

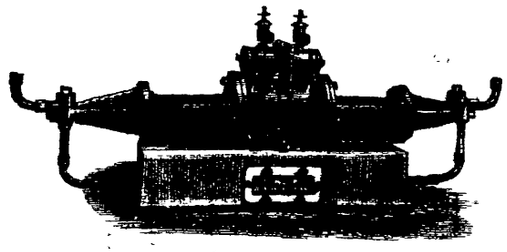
Diam. Steam Cylinder . Ins.	9	10	12	14	16	12	13	21
" Plungers .. .. "	1	1	1	1¼	1¼	1½	1½	2
Length Stroke .. .. "	9	12	12	15	15	15	15	24
Gallons per hour	110	200	300	310	450	460	620	860
Pressure in lbs. per sq. in. A	3700	2000	3700	3200	2800	3700	2700	2800
with 40lbs. steam .. B	4900	3400	4900	4200	3700	4900	3500	3750
Diam. Steam Inlet .. Ins.	1½	1½	2½	2½	3	3	3	3½
" Exhaust Outlet .. "	1½	2	2½	3	3½	3½	3½	4

A. These are the pressures at which the Pumps will run delivering approximately the quantities stated in tables. B. Are the pressures for which the pump is suitable when working a Hydraulic Press, and at which it will nearly pull up.

The above and other sizes quoted for on application. 154

TANGYES'

"SPECIAL" HYDRAULIC PRESSURE PUMP



This arrangement is for lighter pressures than that shown on page 154, but the description given there applies equally to this.

The Pumps are made strong enough for pressure up to 2000 lbs. per square inch.

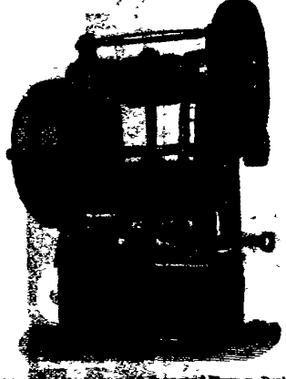
Diam. Steam Cylinder. Ins.	5	8	10	12	12	14	14	16	16	18	21	21
" Plungers .. .. "	1¼	2	2	2	2½	2½	3	3	3	3½	3½	4
Length Stroke .. .. "	12	12	12	12	15	15	15	15	15	15	24	24
Gallons per hour	455	810	810	810	1270	1270	1840	1840	1840	2500	3500	3360
Pressure in lbs per sq. in. with 40 lbs steam	720	410	650	980	600	880	550	760	980	670	980	720
Diam. Steam Inlet .. .. Ins.	1½	1½	1½	2½	2½	2½	2½	3	3	3	3½	3½
" Exhaust Outlet .. .. "	1½	1½	2	2½	2½	3	3	3½	3½	3½	4	4
" Pump Pipes .. .. "	1	1	1½	1½	1½	1½	2	2	2	2½	2½	2½

The above and other sizes quoted for on application. 156

TANGYES'

GEARED HYDRAULIC PRESSURE PUMP

As Supplied for H.M. Government.



...arrangement consists of ... Pumps, with Patent Gold Plungers, Double Safety Valve and connec... Accumulator, Steel ... and Patent ... Cross-head Connecting Rods, fitted with bronzes and ... Wheels, Pinions, ... and shifting gear, and Spur Pinion, working in spur ... fitted, Engine ... by 16 in. wide and 20 in. deep, ... Pumps are capable of ... per hour, at a pressure of 2 tons per square inch, to ... per hour, at a pressure of ... per square inch.

Price £280 156



TANGYES' SCREW RAIL BENDER, OR "JIM CROW"

Made of best Hammered Scrap Iron. Machine-cut Square Thread Screw.

Size	No 1	2	3	4
Price .. .. .. £.	2 10	3 10	5 0	7 0
Diameter of Screw	2 ins.	2½ ins.	3 ins.	3½ ins.
Span .. .. "	15 "	20 "	24 "	24 "
To bend Iron Rails up to .. per yard	20 lbs.	30 lbs.	50 lbs.	90 lbs.
" Steel Rails "	20 "	45 "	65 "	90 lbs.
Weight .. approximate	60 "	95 "	140 "	180 "

This Bender can be made to suit any section of Tram Rail.



TANGYES' HYDRAULIC RAIL BENDER, OR "JIM CROW"

Made of best hammered Scrap Iron. Can be worked in any position.

Size	A	B	C
Price .. .. .. £.	7	9	11
To bend Iron Rails up to .. per yard	50 lbs.	90 lbs.	
" " Steel Rails " .. .. "	45 "	65 "	90 lbs.
Weight .. .. .. approx.	100 "	150 "	200 "

This Bender can be made to suit any section of Tram Rail. When ordering, a section of the rail should be sent. 148

TANGYES' HYDRAULIC SHAFT STRAIGHTENER

For Straightening Shafts in the Lathe.



A bar passing through an eye in each of the Straps, not shown in engraving, is supplied for convenience of lifting the machine, by means of Pulley Blocks, on and off the Lathe.

Diam. Ram	Will take Shafts	Weight	Price
3½ ins.	3 ins. diam.	2 cwts.	£16
5 "	4 "	3½ "	22
6½ "	5 "	6 "	30

Price includes Straps.

TANGYES' IMPROVED RAIL STRAIGHTENER



No.	To bend Steel Rails	To bend Iron Rails	Price
1	45 lbs. per yd.	60 lbs. per yd.	£12
2	90 " "	90 " "	22

In ordering, state gauge of rails or if required for roads. 149

[COPYRIGHT. ENTERED AT STATIONERS' HALL.]

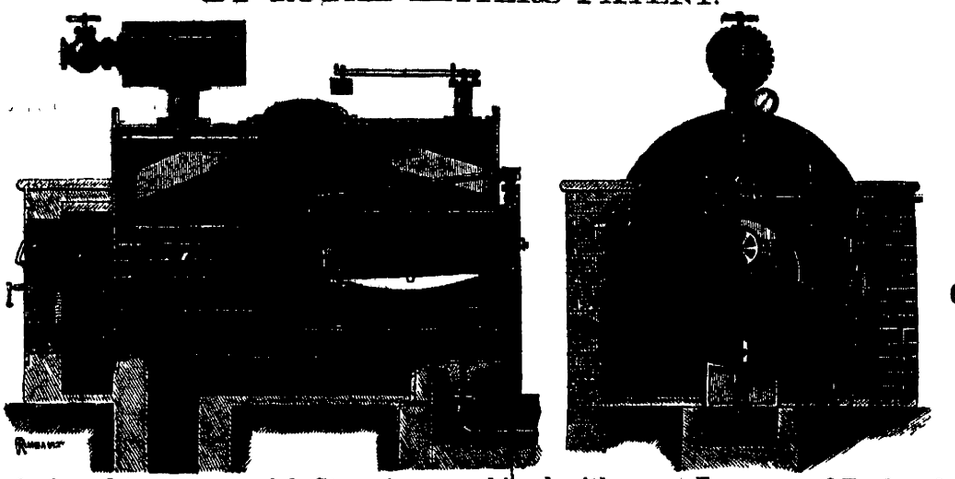
JOHN BELLAMY, Millwall, LONDON,

SOLE MAKER OF

BELLAMY'S PATENT IMPROVED MULTITUBULAR BOILER.

BY ROYAL LETTERS PATENT.

Well Adapted for Export.



Suitable for every description of work.

Specially designed to secure quick Steaming, combined with great Economy of Fuel and Space.

Steady in work, no priming, easily accessible all over for inspection, requires no expensive brickwork setting. Confidently recommended to all users of Steam Power as the most economical and effective Steam Generator yet introduced.

PRICES AND FULL PARTICULARS UPON APPLICATION. CAN BE SEEN AT WORK AS ABOVE.

CORNISH, LANCASHIRE, and every description of STEAM BOILERS in IRON or STEEL.

WROUGHT IRON TANKS AND CISTERNS.

Iron and Steel Buoys, Steam Pans, Coolers, Salt and Sugar Pans. Every description of Riveted Wrought Iron Work made to order. 4923

BELLAMY'S PATENT HORTICULTURAL BOILER FOR GREENHOUSES, CHURCHES, AQUARIA, &c.

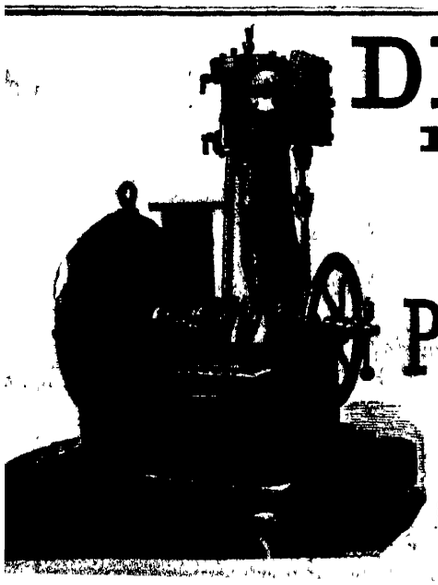
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CENTRIFUGAL PUMPING MACHINERY

FOR IRRIGATION,

Suitable for India, Egypt, and Elsewhere.

SIMPSON AND COMPANY, of PIMLICO, LONDON, have on EXHIBITION, close to the Water Companies' Pavilion, a CENTRIFUGAL PUMP capable of delivering 10,000 Tons of Water per Hour.



DRYSDALE & CO.

LONDON ROAD, GLASGOW.

DIRECT-ACTING

Vertical Centrifugal

PUMPING ENGINES

FOR

Circulating or Ballasting Purposes.

—:o:—

RECEIVED AWARD AT THE NORTH-EAST COAST EXHIBITION, TYNEMOUTH, 1882. 4981



CENTRIFUGAL PUMP

JOHN LYSAGHT, Limited,

IRON ROOFS & BUILDINGS,

DESIGNS AND ESTIMATES UPON APPLICATION.

GALVANIZED CORRUGATED AND PLAIN SHEETS.
GALVANIZED STEEL SHEETS FOR WORKING UP.
GALVANIZED WIRE, WIRE NETTING, TANKS, &c.
WROUGHT AND CAST IRON GIRDERS, COLUMNS, &c.

BRISTOL: ST. VINCENT'S GALVANIZED IRON WORKS
WOLVERHAMPTON: SWAN GARDEN MILLS.
LONDON: 28, GRACECHURCH STREET, E.C. 4663

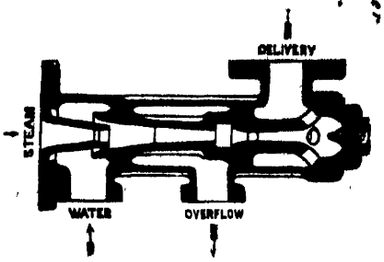
Gresham's Patent Improved Giffard's Injectors

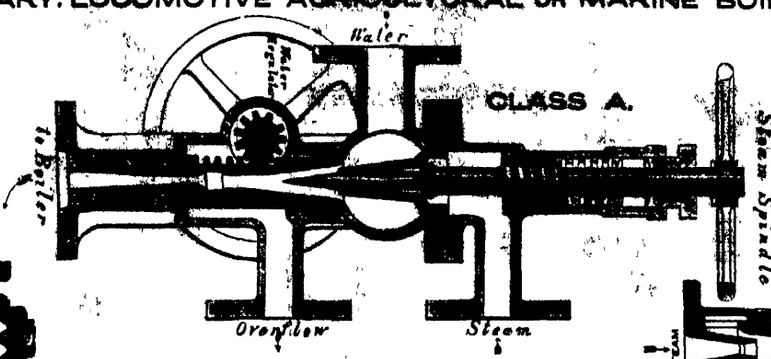
FOR SUPPLYING STATIONARY, LOCOMOTIVE AGRICULTURAL OR MARINE BOILERS WITH WATER

CLASS C 2.

Combining and Receiving Cones removable without breaking pipe joints.

(GRESHAM'S PATENT.)



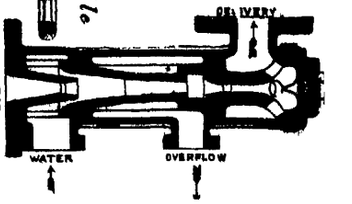


CLASS A.

CLASS G

All Cones removable without breaking any pipe joints.

(Steward & Gresham's Patent.)



The above and every other class of Injector, Ejector, and Elevator in stock and in progress; also Brass Fittings for Locomotive and other Boilers.

Sole Manufacturers: GRESHAM & CRAVEN, ENGINEERS, MANCHESTER,

Who are also the only Manufacturers of Ejectors and Brass Fittings for the Vacuum Brake Co., Ltd.

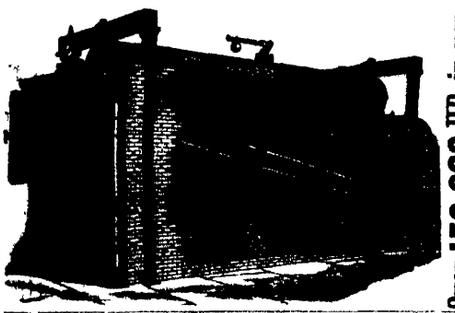
AGENTS.—LONDON: A. L. SACRÉ, 60, Queen Victoria Street, E.C. GLASGOW: WILLIAM LESTER, 58, Renfield Street.
NEWCASTLE-ON-TYNE: TANGYE BROS., St. Nicholas Buildings. BIRMINGHAM: TANGYES LTD. NOTTINGHAM: SMITH BROS. & Co., Hyson Green. 5089

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(NEW YORK & GLASGOW)

PATENT

WATER-TUBE STEAM BOILER.



Over 150,000 HP. in use.

Safe, Economical (as to space and fuel), and Durable; Having Perfect Water Circulation, and Spacious Steam-room; Easy of Transportation, and perfectly Accessible for Cleaning external and internally.

For Illustrated Circular and full particulars apply to our European Offices,

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3, VICTORIA BUILDINGS, DEANSGATE, MANCHESTER.

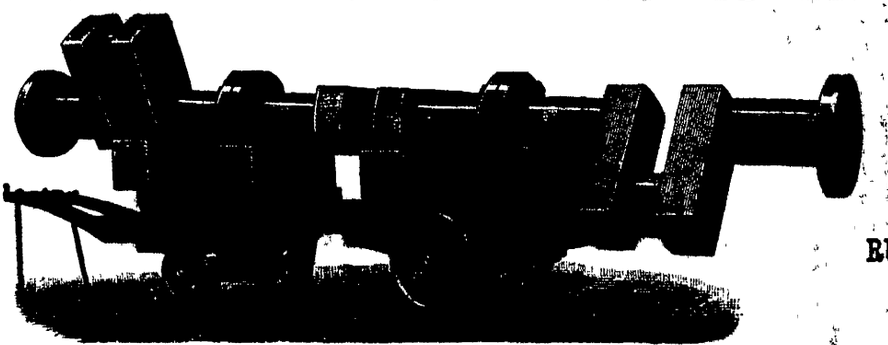
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FORGINGS OF ALL KINDS IN IRON & STEEL.



CRANK SHAFT FOR S.S. No. 98.
FORGED WEIGHT, 60 Tons. FINISHED WEIGHT, 44 Tons 9 Cwts.

STERN AND RUDDER FRAMES.

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ENGINEERS, LEEDS,

Makers of the heaviest class of Machinery used in the manufacture of **IRON** and of **STEEL** by the Bessemer and Siemens processes.

COGGING, RAIL & PLATE MILL ENGINES.

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STEAM HAMMERS.

Hydraulic Cranes and Capstans. 5965

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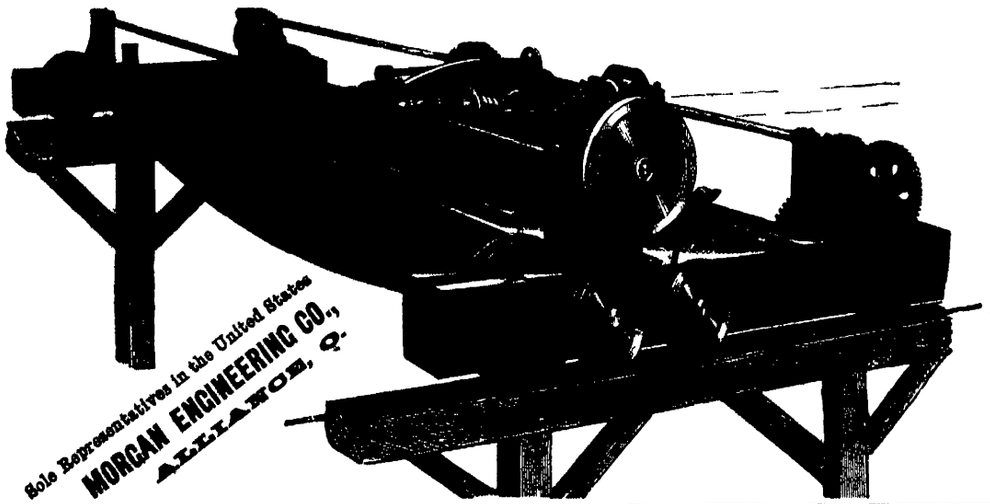
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STEAM, HAND, AND HYDRAULIC, FIXED, PORTABLE OR LOCO

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Boilers.
All types of Land and Marine, and in all sizes



STEAM ENGINES
Of all types and powers for Mills Mines Water Works &c

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PUMPING MACHINERY,
Combined or separate

IRON BRIDGES,
Iron Roofs and Girder Work of all kinds 4044

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THE COALBROOKDALE COMPANY, LIMITED

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MAKERS OF
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PARKER & WESTON'S PATENT
PUMPING ENGINES for Mines, Sewage and Water Works.
BOILER FEEDERS and SLIP PUMPS.

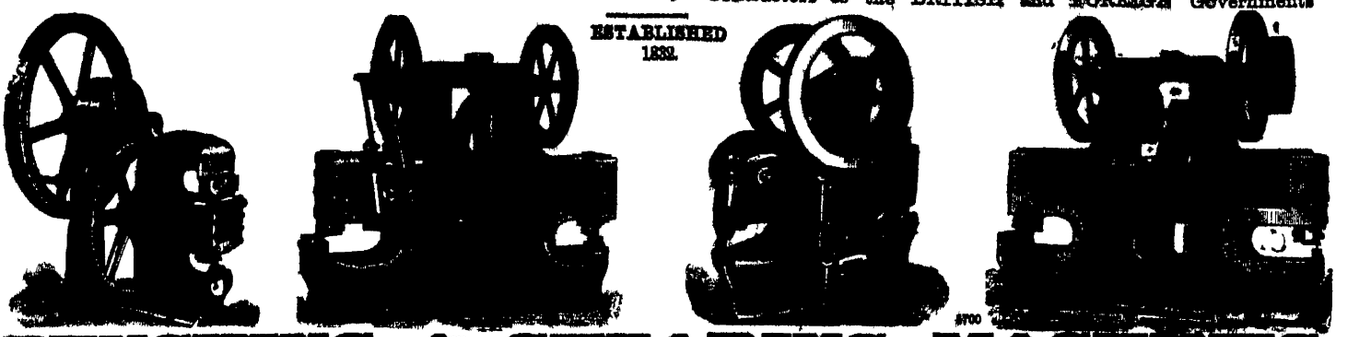
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Contractors to the BRITISH and FOREIGN Governments

ESTABLISHED 1832.



PUNCHING & SHEARING MACHINES.

HANNAY'S PATENT

ELECTROGEN

FOR PREVENTING
CORROSION AND SCALE
IN ALL KINDS OF
STEAM BOILERS.

HANNAY'S MARINE APPLIANCES COMPANY, Ltd.,

67, GREAT CLYDE STREET, GLASGOW.

WALKER BROS., ENGINEERS AND BOILER MAKERS, Pagefield Iron Works, WIGAN,

MANUFACTURERS OF LOCOMOTIVES.

WALKERS' PATENT

AIR-COMPRESSING ENGINES

For COLLIERIES STEEL WORKS &c and as supplied to HER MAJESTY'S GOVERNMENT for INDIA

WALKERS' PATENT GUIBAL VENTILATING FANS,

For Mines Collieries, Tunnels, Sewers, &c. Diameters from the smallest size up to 50ft With Simple or Compound Condensing Engines.
MAKERS OF THE GUIBAL, SCHIELE (his latest Patent) AND WADDLE FANS

STEAM HAMMERS, Patterns up to 30 tons FORGE and ROLLING MILL PLANT WINDING, HAULING, and PUMPING ENGINES IMPROVED FEED PUMPS for BOILERS.

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HORIZONTAL AND VERTICAL, STATIONARY, AND LOCOMOTIVE BOILERS.

Iron and Steel Forgings. Horizontal and Vertical Engines, Condensing and Non-Condensing Roofs, Girders, Bridges, Pit Cages, &c., and all kinds of Iron and Steel Work.

WALKER'S Patent, as adapted to Bessemer Blowing Engines, is now in successful operation at the following Steel Works, and is about to be applied to other Engines for similar purposes :—

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,, The DOWLAIS IRON CO., Dowlais.
,, CHARLES CAMMELL and CO., Cyclops Works, Sheffield.
,, The DARLINGTON IRON and STEEL CO., Darlington.
,, The WEARDALE IRON and STEEL CO., near Durham.

And to 150 other Engines for a variety of purposes throughout the country.

The advantages afforded by the application of the Patented Valves to Bessemer Engines, are a greater endurance than has yet been attained by valves worked automatically (eccentrics, &c., for the valves not being required), and an almost perfect

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5, Westminster Chambers, LONDON, & Waterside Ironworks, IPSWICH,

MAKERS OF ALL KINDS OF RAILWAY PLANT,

INCLUDING

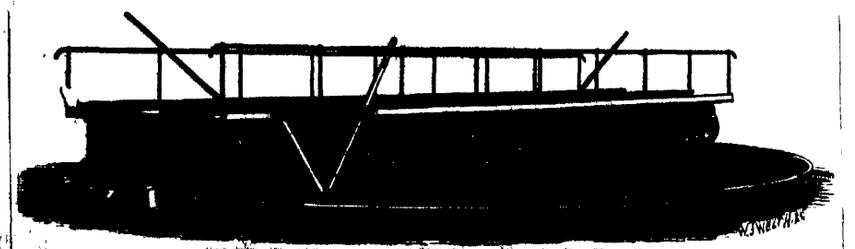
SWITCHES,

CROSSINGS,

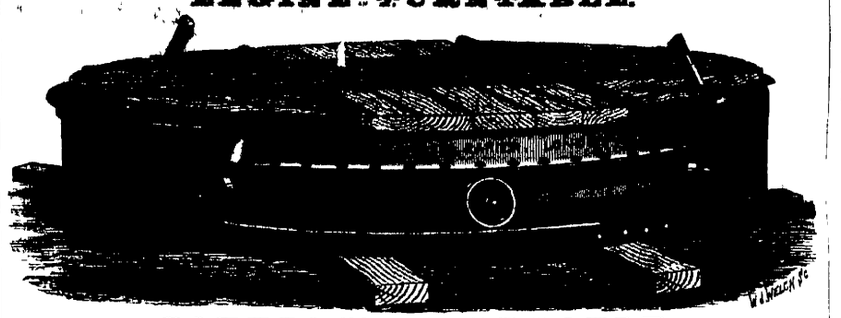
Engine Turntables,

CARRIAGE TURNTABLES,

TRAVERSERS.



ENGINE TURNTABLE.



CARRIAGE TURNTABLE.

INCLUDING

SIGNALS

HYDRANTS,

PUMPS,

TANKS,

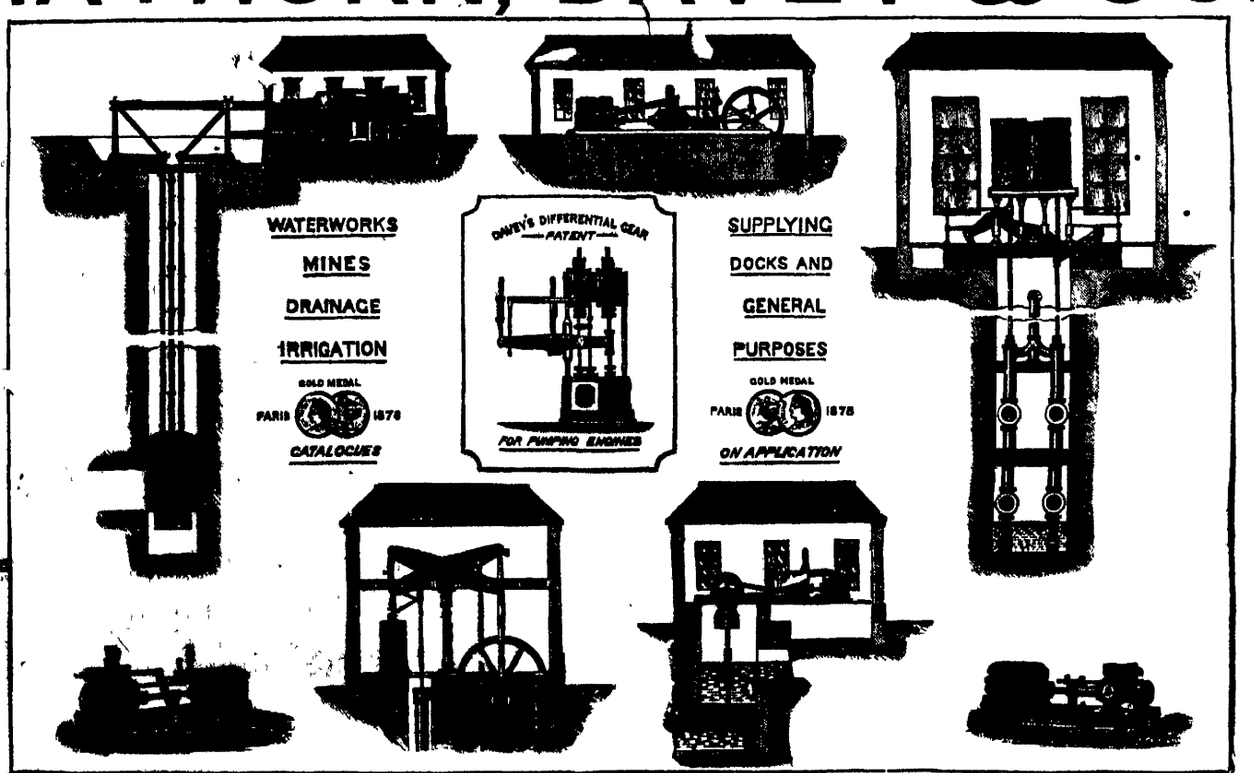
WATER CRANES

ALSO ALL KINDS OF

STEAM AND HAND CRANES.

Prices and Illustrations on application to RANSOMES & RAPIER, 5, Westminster Chambers, London. 5053

HATHORN, DAVEY & CO.,



4973

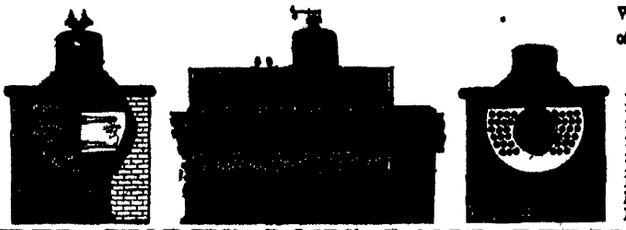
SUN FOUNDRY. LEEDS.

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts
8. Great Economy in Boiler Space
9. Will Burn either Tan, Brasss, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft. long,	5ft. 0in.	diameter,	20-horse power.
10ft. ,,	5ft. 6in.	,,	30 ,,
12ft. ,,	6ft. 0in.	,,	40 ,,
13ft. ,,	6ft. 6in.	,,	50 ,,
14ft. ,,	7ft. 0in.	,,	60 ,,
15ft. ,,	7ft. 6in.	,,	70 ,,
16ft. ,,	8ft. 0in.	,,	80 ,,
17ft. ,,	8ft. 0in.	,,	90 ,,
18ft. ,,	8ft. 0in.	,,	100 ,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

BRASS & COPPER TUBES

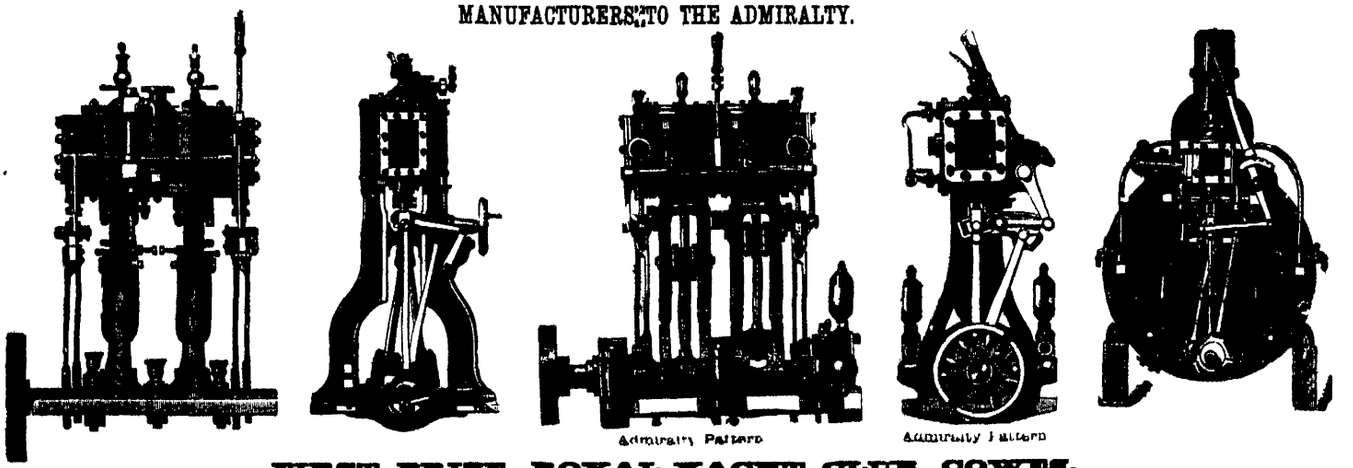
SEAMLESS & BRAZED, FOR BOILERS, SURFACE CONDENSERS &c 4837

BRASS & COPPER WIRE, SHEETS &c.,

BIRMINGHAM BATTERY & METAL CO., BIRMINGHAM.

PLENTY & SON, EAGLE IRONWORKS, NEWBURY, BERKS.

MANUFACTURERS TO THE ADMIRALTY.



FIRST PRIZE, ROYAL YACHT CLUB, COWES.

PATENT ENGINES AND BOILERS FOR SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &C. 4837

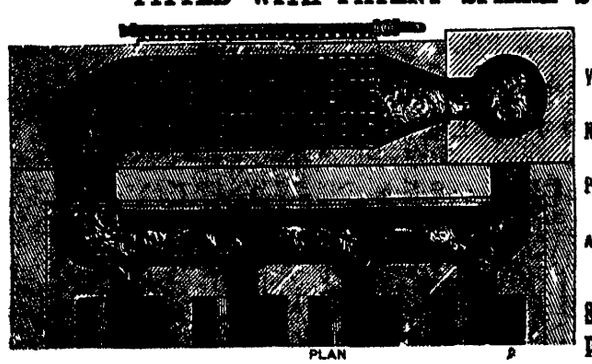
Simple, High-pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works.

Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(FOR UTILISING THE WASTE HEAT FROM STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION


PLAN

SPECIAL ADVANTAGES.

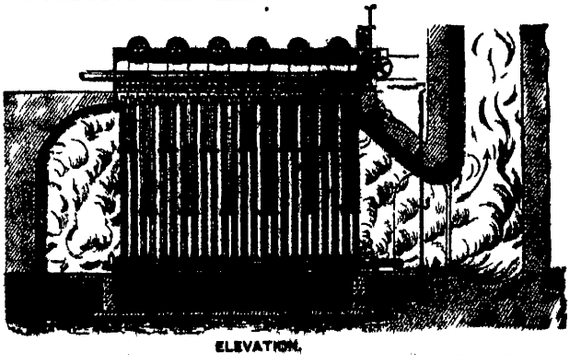
Vertical Pipe Castings. Guaranteed sound and perfectly true.

New Patent Spiral Scrapers The most effectual removers of soot

Patent Reversing Gear. Never sticks or gets out of order

ALREADY IN OPERATION TO HUNDREDS OF STEAM BOILERS.

Saves from 20 to 25 per cent. of the fuel.

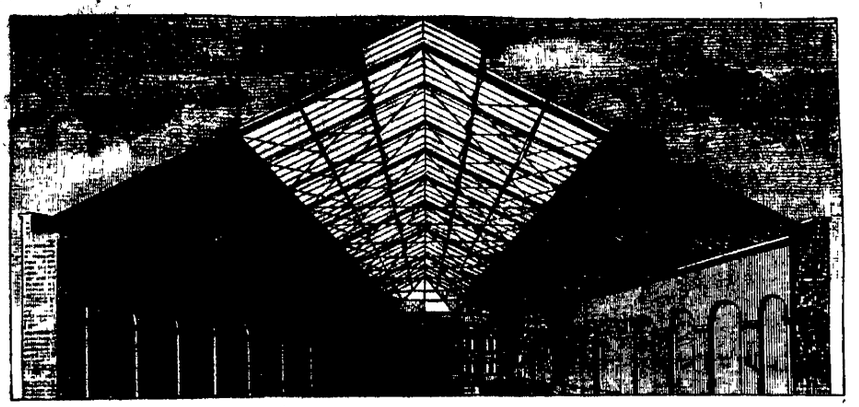

ELEVATION.

N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and abroad.

PRICES, TESTIMONIALS, AND FURTHER PARTICULARS ON APPLICATION TO 4880

ARTHUR LOWCOCK, (PATENTEE & BOILER MAKER), Coleham Foundry, Shrewsbury, England.



From Photo. of ROOF, 80 ft. span (in IRON and STEEL), recently erected by MOREWOOD & CO., suitable for Railway Stations, Sheds, and general purposes.

Roofs and Buildings
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WOODFORD IRONWORKS,
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CORRUGATED AND GALVANISED SHEETS,
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Manufacturers of every description of Roofs and Buildings in Iron and STEEL for Forges, Rolling Mills, Railway Stations, Goods Sheds, Yards, Docks, Stores, and General Purposes.
Special Curved Corrugated Iron Roofs without Framing for moderate Spans.
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ANNEALING AND GALVANIZING POTS.
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DESIGNS AND ESTIMATES ON APPLICATION. 4909

Paris, 1878.—GOLD MEDALS AWARDED.—Melbourne, 1881.

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MANUFACTURERS OF

EVERY DESCRIPTION OF TOOL STEEL & STEEL CASTINGS,

Cast, Shear, German, Spring, Blister & Sheet Steel for all purposes.

Files of First Quality.—Steel Lagging Plates for Cylinders.—Steel Boiler & Ship Plates & Forgings of all kinds.

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From 1 Cwt. to 50 Tons, for every kind of work,

Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.

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Steam Engines for Mills, Ironworks, Collieries, &c.

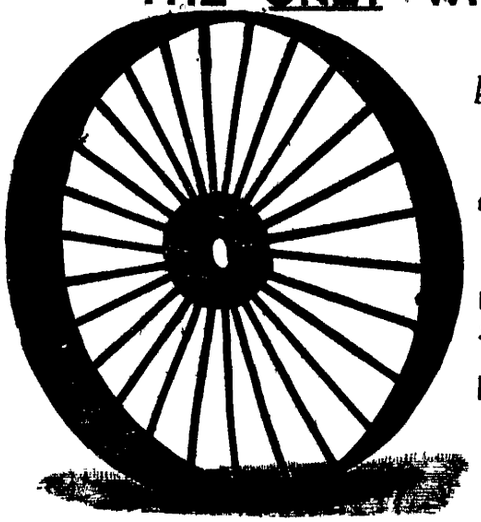
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WROUGHT IRON PULLEYS

WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.

THE ONLY WROUGHT IRON PULLEY MADE.



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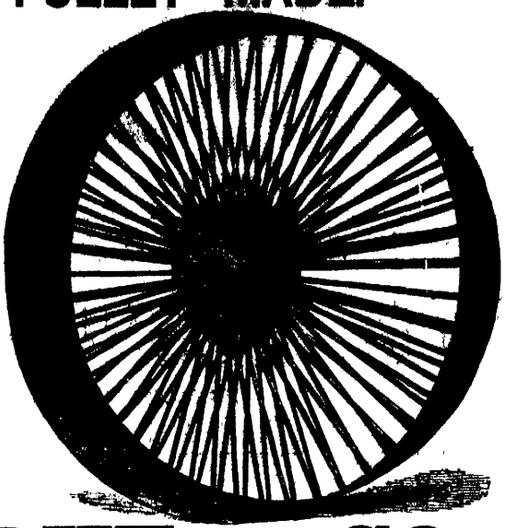
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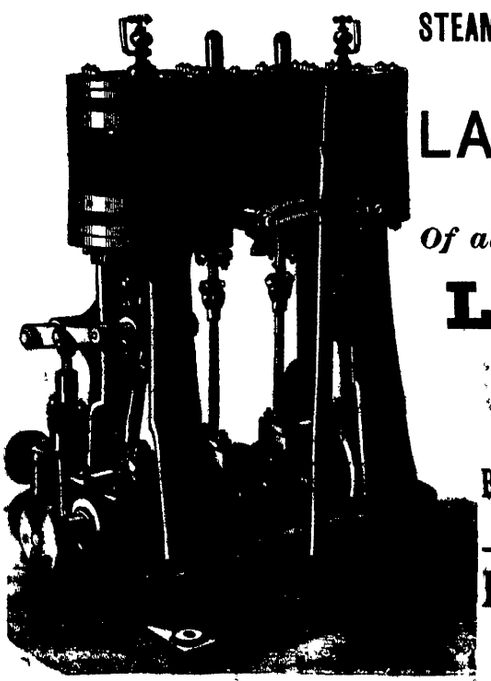
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STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,

And every Description of Ship Fittings.

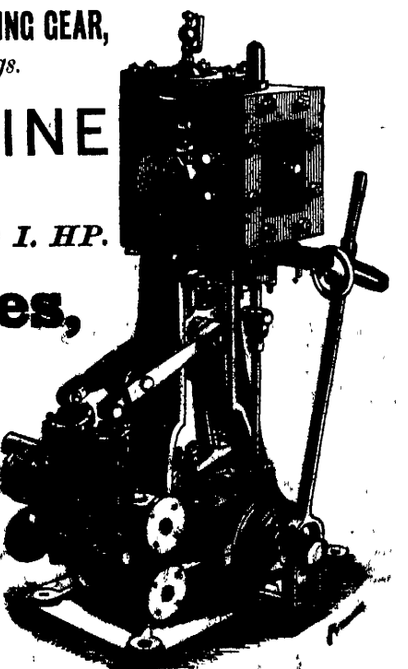
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Of all Sorts and Sizes up to 1,000 I. HP.

Launch Engines,

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Patent Valve Motion.



Builders of LAUNCHES, BARGES, & YACHTS

UP TO 100 FEET LONG.

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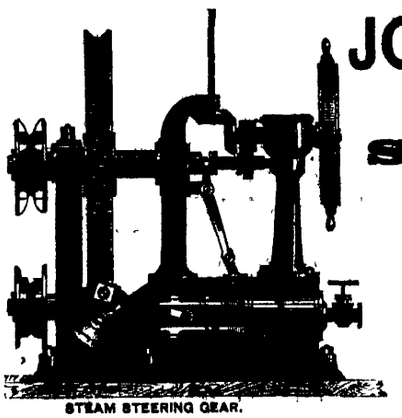
DUMBARTON.

In the above the reversing is accomplished with single eccentric for each cylinder, and the numerous complications and working joints of link motion are dispensed with, while all the properties of same are retained, and the steam and exhaust openings at ends of stroke are the same always, whether in full gear or not.

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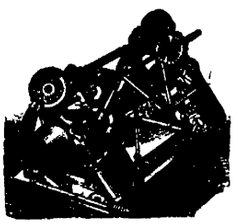
GEO. ANGUS & Co. NEWCASTLE-ON-TYNE 13, BILLITER STREET, LONDON. LIVERPOOL. And BUTE DOCKS, CARDIFF.

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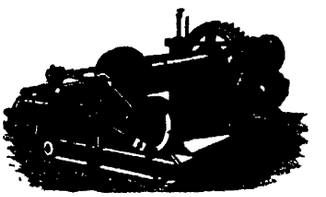


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VERTICAL STEAM WINCH.



HORIZONTAL STEAM WINCH

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MANUFACTURERS OF STEAM CRANES, OVERHEAD TRAVELLERS, STEAM PUMPS, &c.

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

S.S. "Rimapaka," Royal Albert Dock, 13th May, 1884.

Bell's Asbestos Works, Southwark.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure.....125 lbs. Vacuum.....29 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,
D. HENDERSON, Chief Engineer, S.S. "Rimapaka"

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department,
Grimsby, April 10th, 1884

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,
G. E. CLARKE, Sup. Engineer.

Mr J. BELL.

Department of the Director of Navy Contracts,
Admiralty, Whitehall, 26th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core.....square. Elastic core. ....round

To Mr JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been reported that 1 16 in. thick of incrustation causes a waste of 18 per cent. of coal; ⅛ in., 60 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

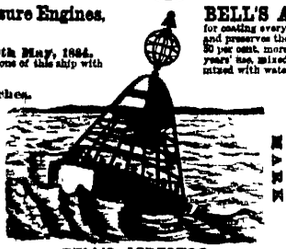
Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and shafting Engines at the above Colliery, and during that period we have had used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,
THOMAS WINTER, Colliery Engineer.



TRADE MARK

— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depots and not through agents or factors.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up, adheres to metals and preserves them from rust, prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates 186 deg.
" " Covering 84 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 90 lb of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov 26th, 1883.

"Dear Sir.—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly,
" W SANTO CRIMP, C E, F G S "

The Tamar and Kit Hill Granite Company, Limited,
Mr JOHN BELL, Southwark, S.E. Gunnislake, Tavistock 8th April, 1884

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the cranes run on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,
W J CHALK, Assoc. M Inst, C E, Engineer and Manager

BELL'S ASBESTOS & INDIA-RUBBER-WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be beat by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ⅛ in. to 3 in. wide, and any thickness from 1-16th in upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

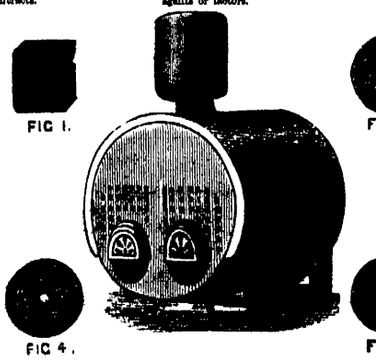


FIG 1.

FIG 4.

FIG. 2

FIG. 3

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and ¼ millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts,
Admiralty, Whitehall, S.W., 17th MAY, 1884.

Sir,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,
Mr JOHN BELL. Director of Navy Contracts

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REG'D.

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THE READING IRON WORKS, LIMITED, READING, BERKS.

THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

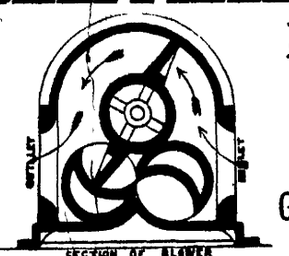
Baker's Patent Rotary Pressure Blower and Gas Exhauster

—:o:—

BAKER'S PATENT ROTARY PUMP. HALL'S PATENT STONE BREAKER.

—:o:—

CRUCIBLE STEEL CASTINGS. General Machinery of Every Description.



SECTION OF BLOWER

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4663

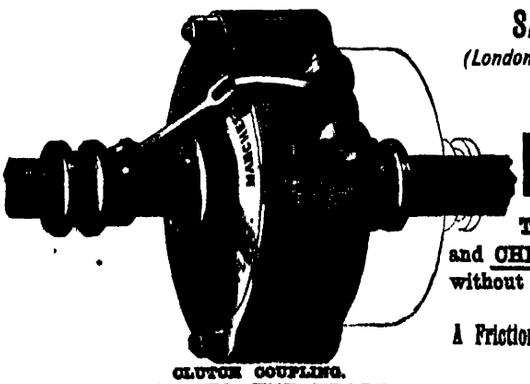
MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.

— PATENT —

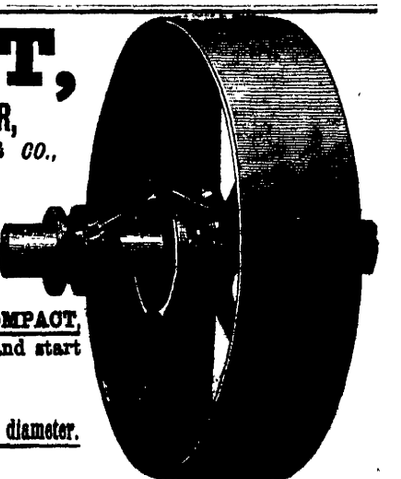
FRICTION CLUTCH.



CLUTCH COUPLING.

These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.



CLUTCH AND PULLEY

LIBERAL TERMS TO THE TRADE. PRICES ON APPLICATION. 5289

GOODFELLOW & MATTHEWS,

(LATE S. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS.

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 4666

R. HORNSBY & SONS, Limited,

[Established 1815.] General and Agricultural Engineers, Ironfounders, Boilermakers, &c. [Established 1815.]

MAKERS OF IMPROVED STEAM ENGINES OF EVERY KIND, FROM 2½ TO 100 HP.

PORTABLE

With Inside or Outside Cylinders.

SEMI-PORTABLE

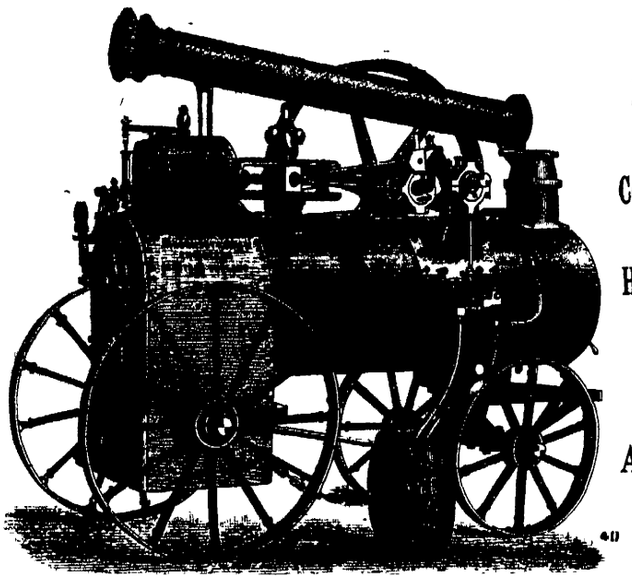
With Inside or Outside Cylinders.

VERTICAL

With Cross-Tube Boilers.

VERTICAL

With Vertical Tubular Boilers.



HORIZONTAL STATIONARY

Both Simple and Compound, with or without Condensers

Compound Undertype Stationary

And with or without Condensers

HORIZONTAL WINDING ENGINES

Both Direct-Acting and with Gearing

TRACTION ENGINES.

HORNSBY'S PATENT

Automatic Expansion Gear

Can be fitted to most of their Engines.

BOILERS: LANCASHIRE, CORNISH, VERTICAL, CROSS-TUBE, MULTITUBULAR, EGG-ENDED, ETC., ETC.

The New Hornsby 1884 Twine Binder, winner of the First Prize of £100 of the R.A.S.E., and the First Prize of £100 of the Highland and Agricultural Society of Scotland (being the two largest prizes ever offered), besides other high-class Awards.

For Particulars of the most modern improved and successful Agricultural Machinery, including the R.A.S.E. First Prize Mowers, Reapers, Ploughs, Dressing Machines, Corn Screens, Turnip Cutters, Root Pulpers, &c., SEE ILLUSTRATED CATALOGUES in English, French, German, Spanish, Russian, &c., sent GRATIS and POST FREE on application

PLOUGH SHARES OF CHILLED CAST IRON, WROUGHT IRON, MALLEABLE IRON AND STEEL, OF PATTERNS TO SUIT EVERY VARIETY OF WORK, AND MADE TO LOCAL PATTERNS IF DESIRED.

At the most important Exhibitions and trials since 1874, R. HORNSBY & SONS' Specialities have gained 527 PRIZES, including 65 Gold Medals, 117 Silver Medals, and 309 FIRST PRIZES.

SPITTLEGATE IRON WORKS, GRANTHAM. 4965

London Office: 84, LOMBARD STREET. Telephone No. 1294. South African Depot: EDINBURGH BUILDINGS, DOCK ROAD, CAPE TOWN

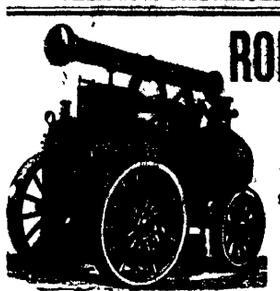
LIGHT FORGINGS.

BRAKE WORK.

WAGON IRONWORK.

GLASGOW HYDRAULIC FORGE CO., LIMITED, Sentinel Works, Polmadie, Glasgow, and Canal Road, King's Cross, London. 5135

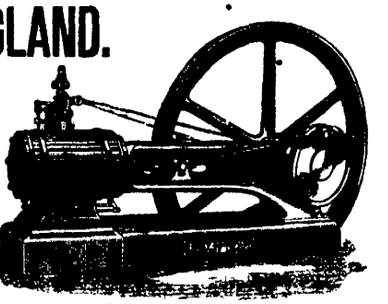
ROBEY & CO., ENGINEERS, LINCOLN, ENGLAND.



SUPERIOR PORTABLE ENGINES 2½ to 50 HP.

First PRIZE for PORTABLE ENGINES, Melbourne Exhibition, 1881.

PARIS, 1878, GOLD MEDAL.



HORIZONTAL FIXED ENGINE, 4 to 60 HP

☞ References can be given to upwards of 8 000 Engines now at work



VERTICAL STATIONARY STEAM ENGINE AND BOILER Combined, of all Sizes, from ½ to 16 HP.

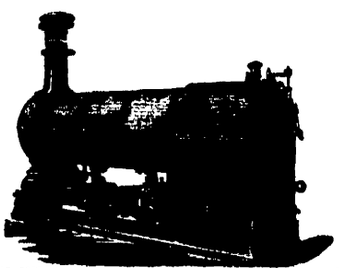


The Patent "Robey" Mining Engine, 4 to 50 HP.

Prices and full Particulars of the Machinery here illustrated on application to the Manufacturers

ROBEY & CO., Engineers, Lincoln, England.

London Office: 117, CANNON STREET, LONDON, E.C.



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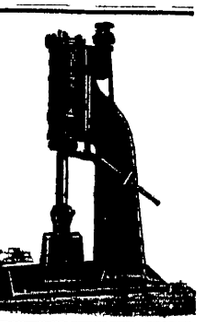


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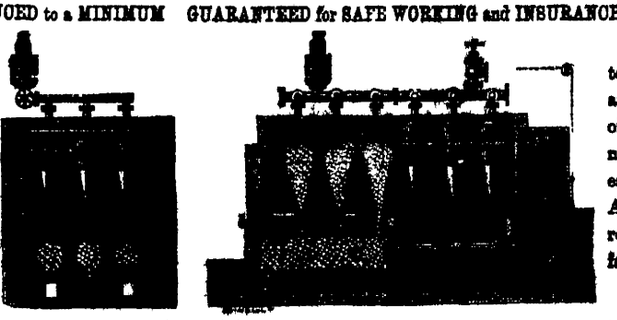
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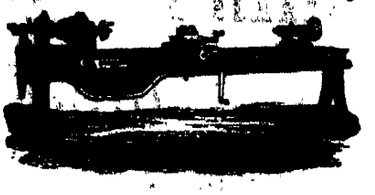
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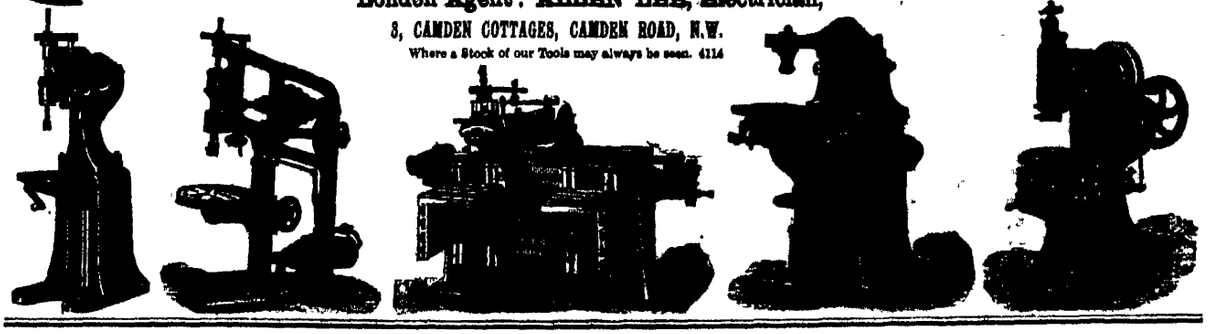


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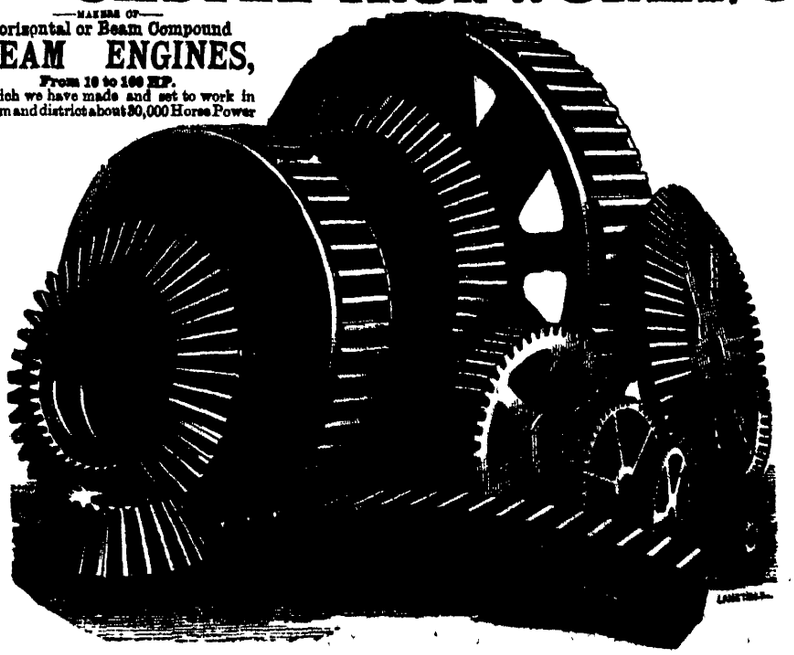
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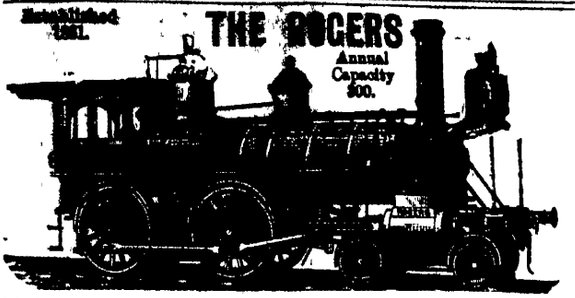
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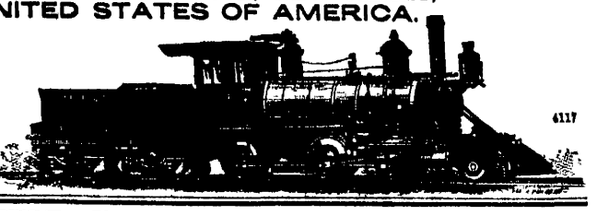
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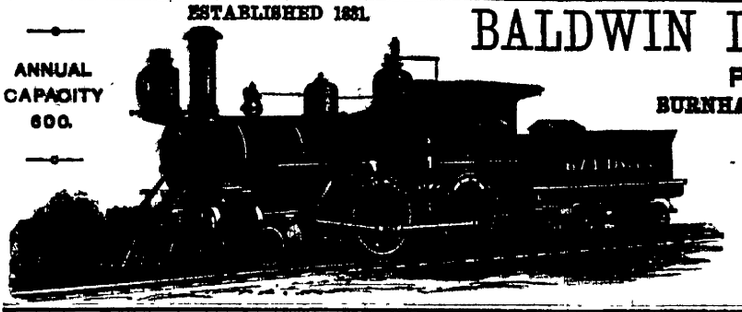
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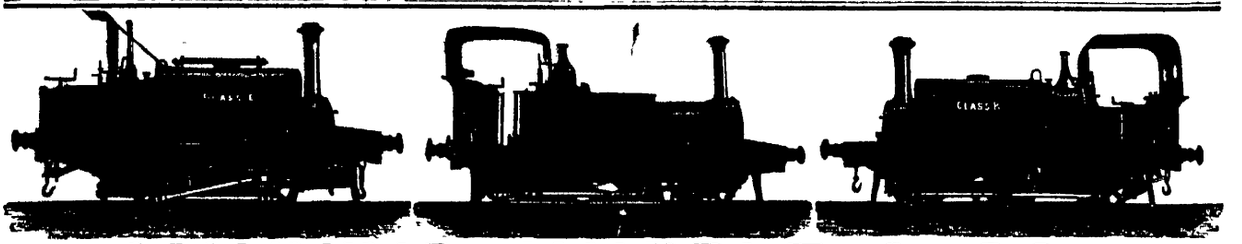
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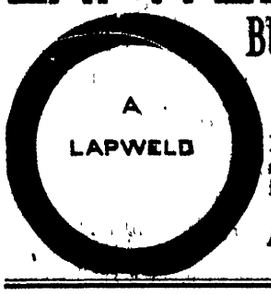
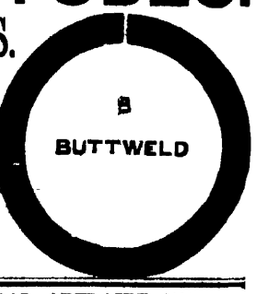


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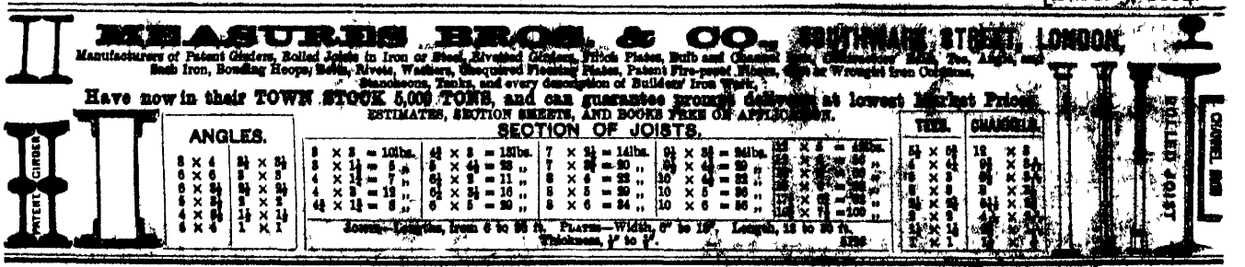
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4 × 4	1 × 1

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8 × 4½ = 9 ,,	6 × 4½ = 12 ,,	7 × 4 = 16 ,,	6½ × 4½ = 30 ,,
4 × 1½ = 7 ,,	5½ × 3 = 11 ,,	6 × 6 = 22 ,,	10 × 4½ = 32 ,,
4 × 3 = 12 ,,	6½ × 3½ = 16 ,,	8 × 5 = 30 ,,	10 × 6 = 36 ,,
4½ × 1½ = 8 ,,	6 × 5 = 20 ,,	8 × 6 = 34 ,,	10 × 6 = 36 ,,

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2 × 2	4 × 1½
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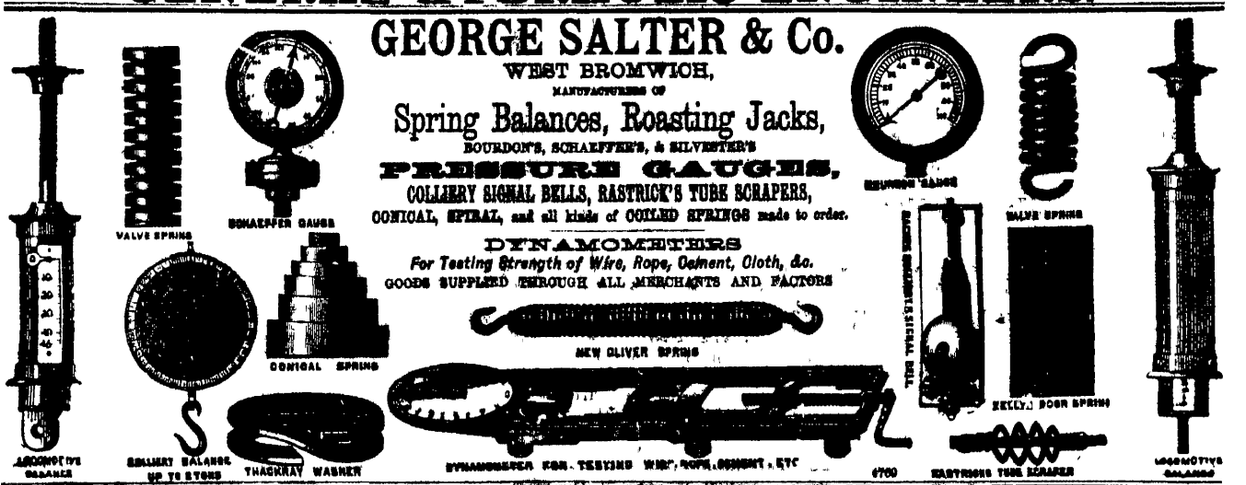
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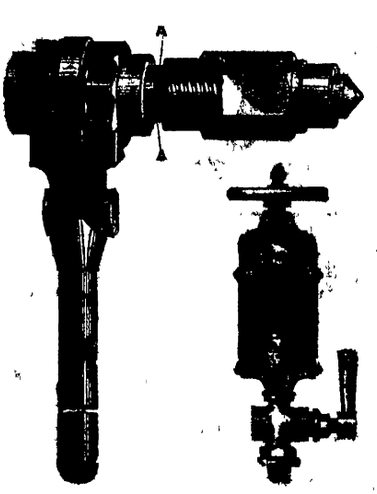
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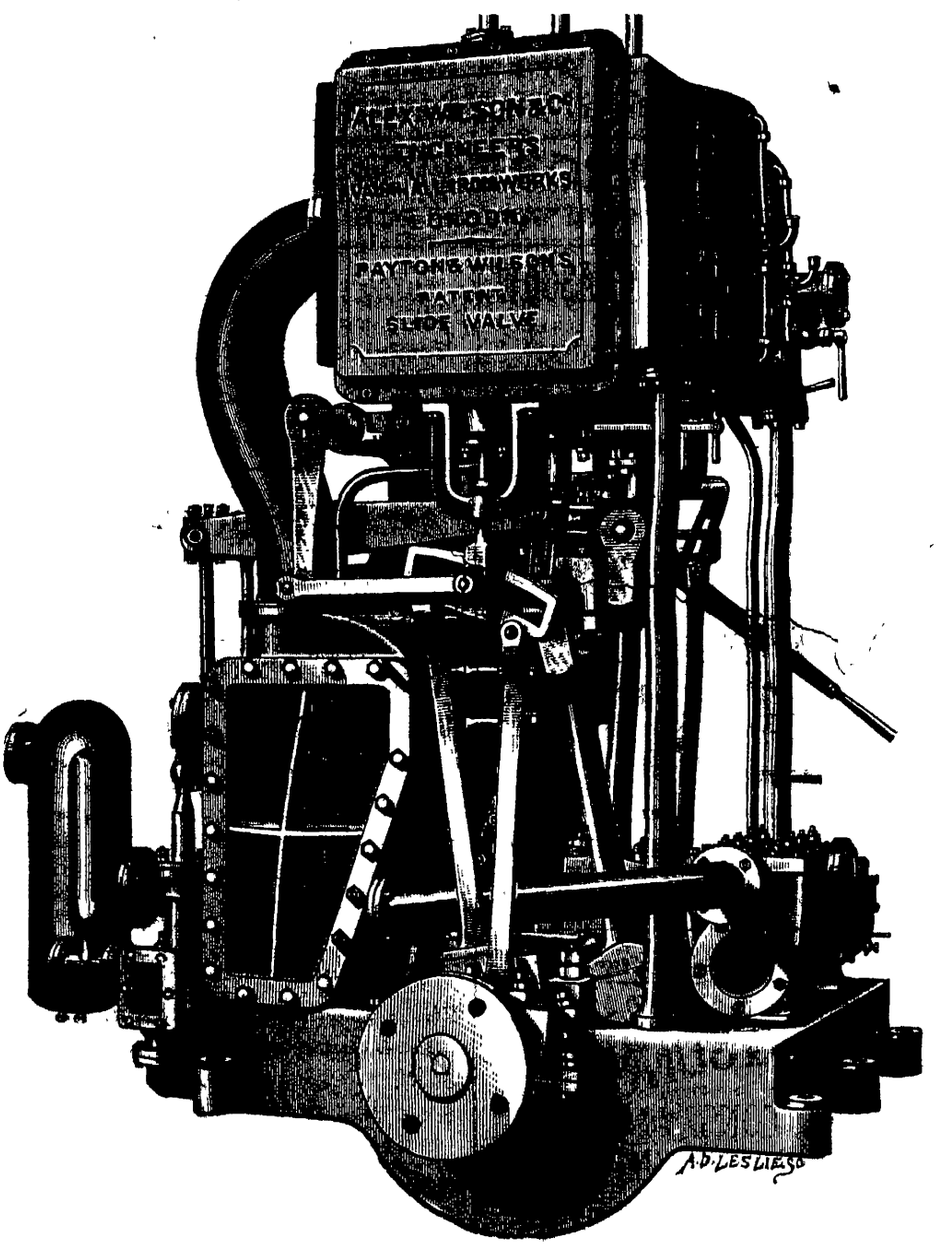
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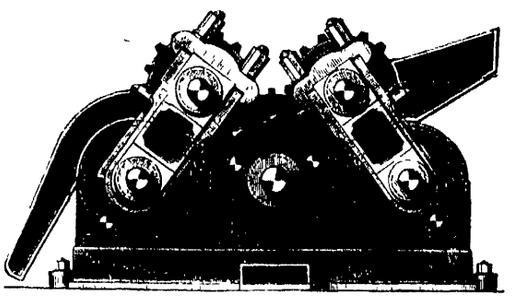
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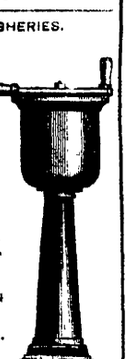
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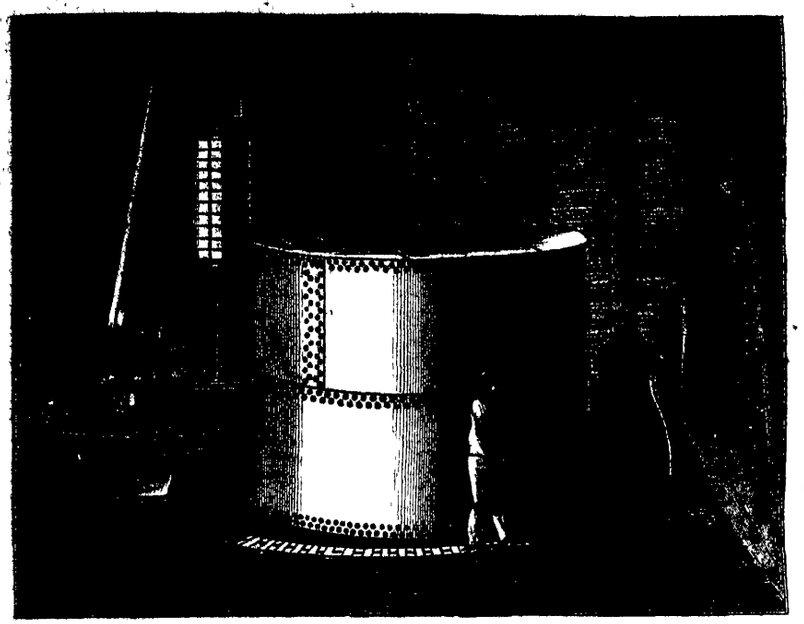
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1884.

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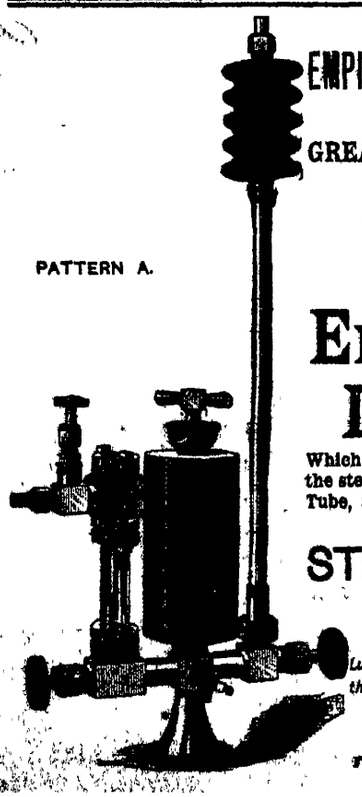
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GRANDISON'S

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Which shows each drop of oil passing into the steam through the medium of a Glass Tube, and is the BEST APPARATUS now known for Lubrication of

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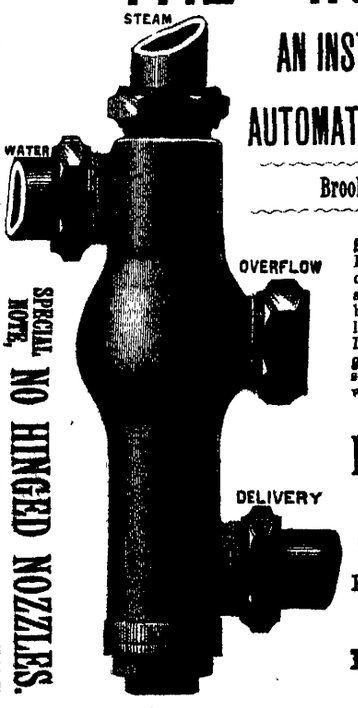
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Lubricators sent on approval to any part of the kingdom, and references given to users in all parts of the inhabited world.

4703

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AN INSTANTANEOUS STARTING

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List on application.



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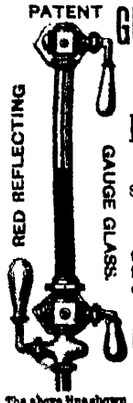


GOLD MEDAL, PARIS, 1878.

GAUGE GLASSES
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ENAMELS
For Iron, Cast-iron, Copper, &c.

PATENT GUILBERT MARTIN
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Showing through the water a Broad Red Line.

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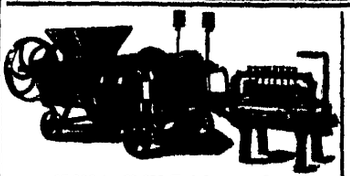
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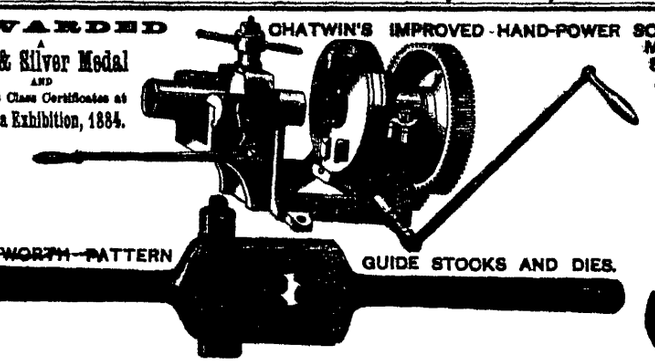


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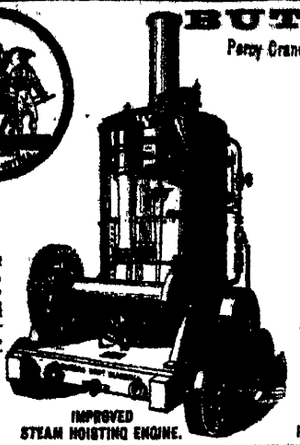
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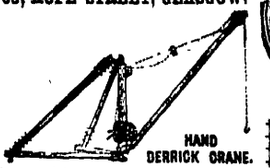




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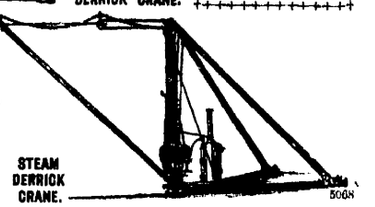


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5068

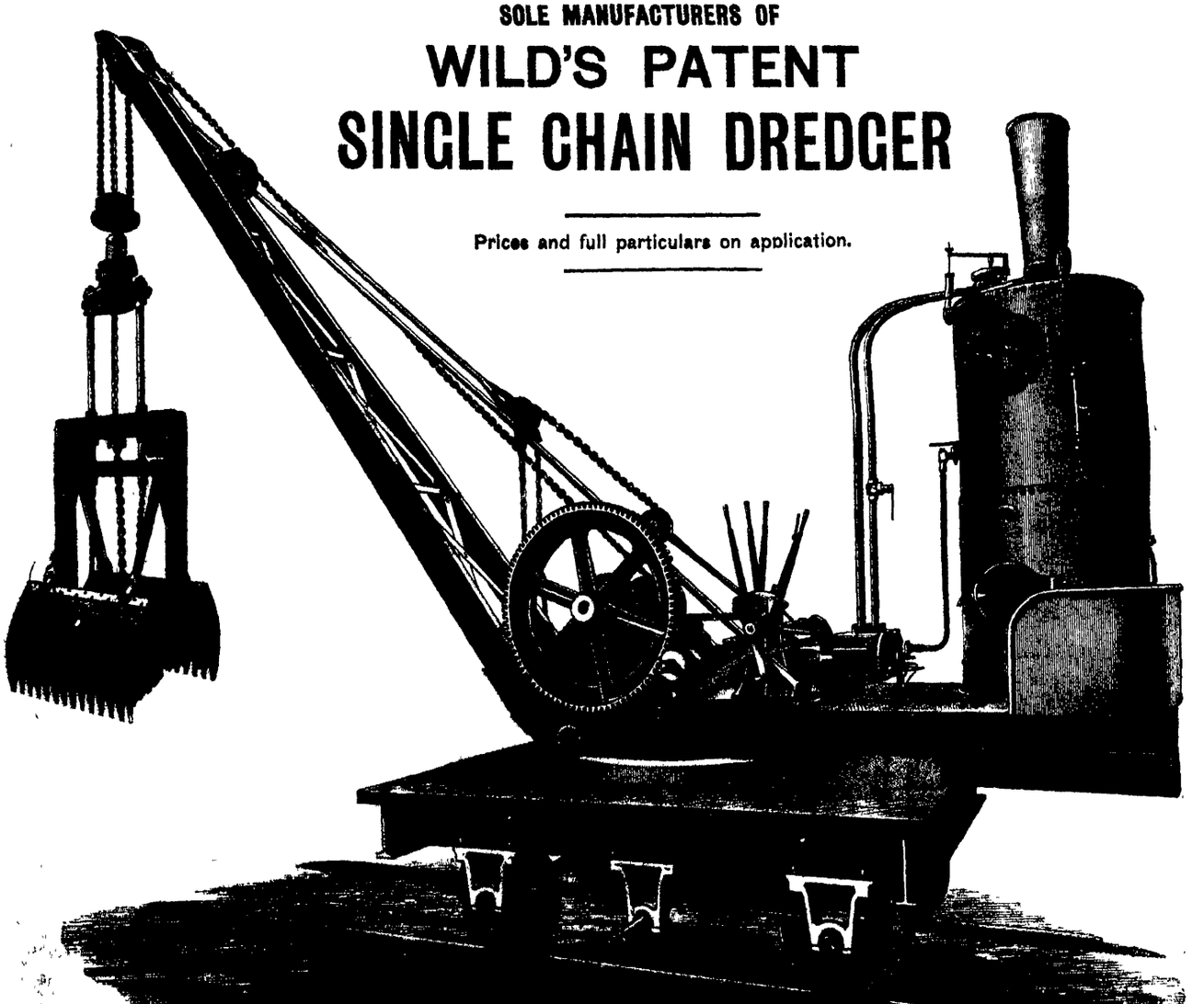
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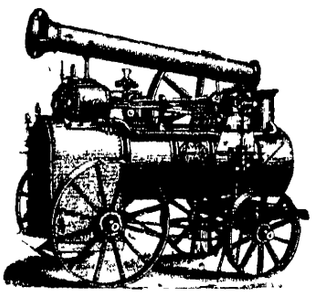
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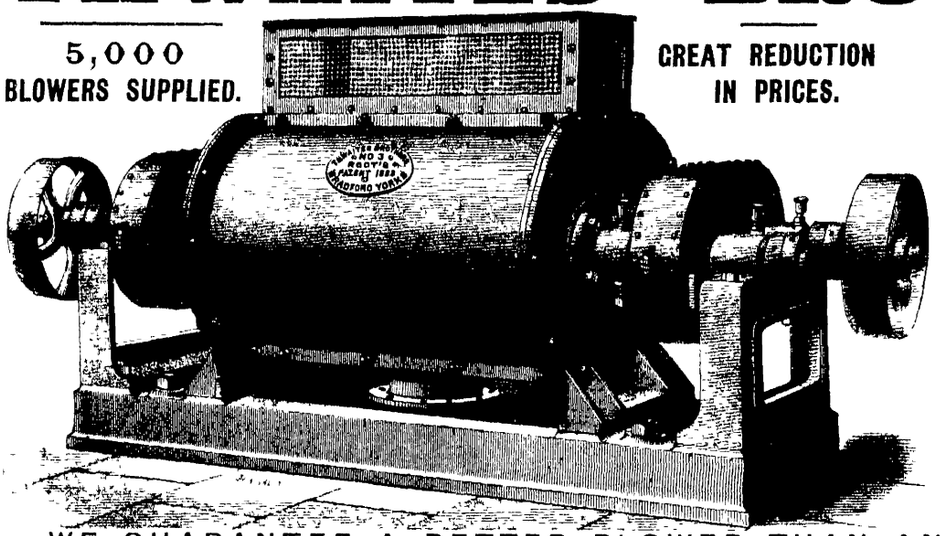
CALCUTTA EXHIBITION, 1884—FIVE GOLD AND THREE SILVER MEDALS.
AMSTERDAM EXHIBITION, 1883 – THE DIPLOMA OF HONOUR.
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New 1884 Pattern, either for Cold or Hot Air or Gas

ADVANTAGES CLAIMED.

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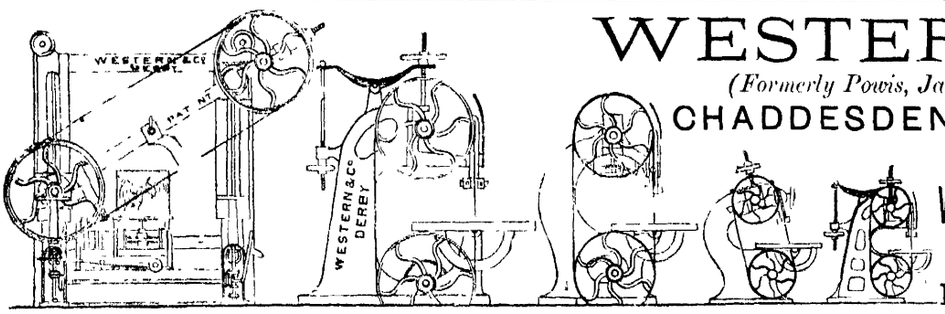
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FIRST CLASS CERTIFICATE AND SILVER MEDAL,
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WE GUARANTEE A BETTER BLOWER THAN ANY OTHER MAKER. 4301



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Engineers and Makers of

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LONDON OFFICE 4216
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IMPORTANT TO USERS OF BELTING.

GANDY v. REDDAWAY AND OTHERS.

Advertisements have been issued and largely circulated in this country and abroad by Mr Maurice Gandy, in which he gives prominence to our name without mentioning the whole of the facts in connection with the above action It is therefore necessary for us to inform the Users of Belting that the ACTION of

GANDY v. REDDAWAY & CO. and Others was dismissed as regards us, WITH COSTS TO BE PAID BY GANDY to

F. REDDAWAY & CO., the Patentees and Sole Makers of REDDAWAY'S BELTING.

We claim to manufacture the BEST and STRONGEST Cotton Belting in the Market, by Machinery of special construction and of our own invention.

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SOLE MAKERS OF 5062

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—: F. REDDAWAY & CO., PENDLETON, MANCHESTER :—

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PRINTED ON THIN PAPER FOR FOREIGN CIRCULATION.

[Registered at the General Post Office as a Newspaper.

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An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, WC

VOL. XXXVIII.—No. 976.] *LONDON: FRIDAY, SEPTEMBER 12, 1884* [PRICE 6d BY POST 6½d

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manufactured by

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WORKS NEW BILTON AND NEWBOLD 4867

Locomotive Tank Engines

designed and constructed by

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See their Illustrated Advertisement, page 42

Locomotive Tank Engines,

TRAMWAY ENGINES AND CARS

Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough. 5206

See Illustrated Advertisement last week, page 11

R. E. Crompton and Co.,

ELECTRIC LIGHT ENGINEERS,

MANSION HOUSE BUILDINGS, E.C. 4812

See Advertisement August 22, page 12

Over 15,000 "Otto" Engines

AT WORK,

Using 25 to 75 % less Gas

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Any other Engine.

Crossley's Patent Self-Starter,

Safest, Best, and Simplest made, may now be applied 4776

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V & CO 'S Steel Boilers work well in salt water

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HENRY BESSEMER & CO., Limited,

SHEFFIELD

See Advertisement, page 51 3627

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Iron Roofs, Sheds, Buildings, Houses Best work, reduced prices Dixon's special CURVED IRON ROOFS are the most economical for spans up to 45 ft Catalogues, Designs, Estimates, on application ISAAC DIXON Windsor Iron works, LIVERPOOL 4832

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See Illustrated Advertisement last week, page 25

A First-Class Lubricant.

"Engelbert's Lubricator."

SEE ADVERTISEMENT LAST WEEK,

Facing and of Rea Hive Matter 4919

Hunter and English, ENGINEERS AND MILLWRIGHTS

IRON AND BRASS FOUNDERS, BOW, LONDON, E

DREDGING MACHINERY

HYDRAULIC MACHINERY

"WILLIAMS'" PATENT CAPSTANS

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Having Special Stock, Shipments and Repairs executed very rapidly 4084

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CROWN TUBE WORKS, WEDNESBURY

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The Patent Corliss Engine And PATENT CORLISS GEAR ENGINE, with special Improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N B These engines are made Horizontal or Beam, Condensing, Non Condensing, and Compound Also makers of Rice Mills, and Paper Mills, and General Engineers Machinery shipped or trucked direct from the premises 3590

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See Illustrated Advertisement last week, page 27

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Thomas Kell and Son, Lithographers, &c., execute every description of Lithography, Chromo lithography, Engraving, and Printing, Engineering, Architectural, and Pictorial Drawing in best manner Paper Drawing, photo lithography, &c —40, King St., Covent Garden, W C 3462

Steam Cranes

Thomas Smith,

STEAM CRANE WORKS, OLD FOUNDRY, 4345

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See Illustrated Advertisement last week, page 25

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Bread-Making Machinery

In Bakery Section 4755

London Mutual Boiler Insurance COMPANY, LIMITED Established in 1874 for the INSURANCE and PERIODICAL INSPECTION of all kinds of Land and Marine Boilers throughout the United Kingdom.—For particulars apply to the Secretary 17, Queen Victoria Street, London, E C 4759

The Assured are secured against loss from claims established under the Employers' Liability Act, 1880

The "Differential" Pumping ENGINE.—DAVEY'S PATENT for Draining Mines, Water Supply of Towns, Irrigation, Supplying Docks, Pumping Sewage, and General Pumping Purposes

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H, D, & Co have Patterns of "Differential" Engines of all sizes from 5 to 500 horse power, and have facilities for supplying very powerful Engines and Pumps at a short notice 4750

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MANCHESTER 4818

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See Illustrated Advertisement last week page 14

Dredgers and Excavators.—

HIGHEST PRIZE AT TYNEMOUTH

FOR

HYDRAULIC DREDGERS

Bruce and Batho,

9, VICTORIA CHAMBERS, 4743

WESTMINSTER, S W

See Illustrated Advertisement last week page 10

L. Sterne & Co., Limited. ENGINEERS,

Sole Makers of

Clerk's Patent Self-Starting Gas Engine.

HIGHEST AWARD,

BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881

GOLD MEDAL,

CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882

Strong's Patent Feed-water Heaters and Purifiers,

WITH

STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels, Emery Machines, Spiral Springs.

The Crown Iron Works, GLASGOW.

The Crown Iron Works (Hollinwood), MANCHESTER

10, Victoria Chambers, WESTMINSTER.

City Office and Show Rooms, 40, CANNON STREET, E C.

10, Rue Laffitte, PARIS

International Inventions

EXHIBITION, London, 1885
DIVISION I, INVENTIONS DIVISION II, MUSIC

Patron
HER MAJESTY THE QUEEN
President
H.R.H. THE PRINCE OF WALES, K.G.

Applications to Exhibit must be made on Printed Forms which will be supplied on application to the SECRETARY International Inventions Exhibition, South Kensington, S.W. These must be filled up and returned to him on or before the 1st November, 1884. G 835

Owen's College, Manchester

(VICTORIA UNIVERSITY) ENGINEERING COURSE. A detailed Syllabus of the COMPLETE COURSE in ENGINEERING will be forwarded on application. The next Session COMMENCES on the 7th OCTOBER. G 727

J. HOLME NICHOLSON, Registrar

King's College, London —

DEPARTMENT of ENGINEERING and APPLIED SCIENCES.—NEW STUDENTS will be admitted on TUESDAY, 30th September.

The Course of Study provides practical education for those who intend to engage in engineering, surveying, architecture, telegraphy, and the higher branches of chemical and manufacturing art.

For the Prospectus apply, personally or by post card, to J. W. CUNNINGHAM, Esq., Secretary. G 701

University College, Bristol.

ENGINEERING DEPARTMENT

PROFESSOR H. S. HELE SHAW

The SESSION 1884-85, BEGINS on OCTOBER 7th. The Department of Engineering includes separate courses for those intending to become Civil, Mechanical or Electric Engineers, or Surveyors or Architects.

Students in Mechanical Engineering who study during the six winter months at the College, can spend the rest of the year in the workshops and offices of various firms in and near Bristol.

Surveying and Fieldwork occupy a prominent place in the Civil Engineering Course during the Summer Term, and arrangements have been made with leading Civil Engineers and Architects for the entry into their offices of Students who have passed through the respective courses.

Information with regard to the lodging of Students can be obtained on application.

Calendar, containing full information, price 1s., by post 1s. 3d. For Prospectus and further Information apply to

ALFRED E. STOCK, G 726
Registrar and Secretary.

TENDERS

INDIA OFFICE
11th September, 1884

BY ORDER OF THE SECRETARY OF STATE FOR INDIA IN COUNCIL

INDIAN STATE RAILWAYS

The Director General of Stores for India is prepared to receive



Tenders from such Persons

as may be willing, to SUPPLY—
2770 Tons of STEEL RAILS, 50lb. per yard, and
200 Tons of STEEL FISHPLATES.

The Conditions of Contract may be obtained on application to the Director General of Stores, India Office, Westminster, S.W., and Tenders are to be left at his Office at any time before Two o'clock p.m. on Tuesday, the 23rd September, 1884, after which no Tender will be received.

A. ABERCROMBIE HOPE, G 837
Director General of Stores.

BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY COMPANY

The Directors are prepared to receive, up to Noon on Thursday, the 18th instant,

Tenders for the Supply of the

following STORES, viz.:—

CLASS A
WAGON IRON WORK
MISCELLANEOUS PAINT STORES
CLASS B
BRACINGS GIBS AND COTTERS
PLAIN STATIONERY
CLASS C
CURLED HORSEHAIR
CLASS D
LIFFTRICKS, &c.
WROUGHT IRON COUPLING CHAINS &c.
STEEL TUBES
WEIGHING MACHINES

Tenders must be made on Forms, Copies of which, with Specifications can be obtained on application at the Company's Offices, 45, Finsbury Circus, E.C., on payment for Class A, 7s. each, Class B, 10s. 6d. each, Class C, 5s. each, and Class D, 2s. 6d. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

By order
J. PITT KENNEDY, Officiating Secretary.
Offices, 45, Finsbury Circus, London, E.C.
5th September, 1884. G 820

MIDLAND RAILWAY—NORTHERN DIVISION

TO CONTRACTORS AND BUILDERS

The Directors of the Midland Railway Company are prepared to receive

Tenders for the Supply and

DELIVERY of THREE WROUGHT IRON GIRDERS, FLOOR, &c., for Bridge over the River Dore, at Beauchieff.

Plans and Specifications may be seen, and Form of Tender and particulars obtained on application to Mr. A. A. LANGLEY, Engineer, Midland Railway, Derby, on and after Tuesday, 2nd September.

Sealed Tenders to be sent in, addressed to the Secretary of the Way and Works Committee, Midland Railway, Derby, not later than Nine a.m. on Thursday, 18th September.

The Directors do not bind themselves to accept the lowest or any Tender, nor to pay any expenses attending the same. By order,

JAMES WILLIAMS, Secretary.
Derby, 2nd September, 1884. G 789

TO BUILDERS AND CONTRACTORS

The Directors of the Sheffield United Gas Light Company are prepared to receive

Tenders for the Erection at

their Effingham Street Station, of a RETORT HOUSE, about 200 ft. by 75 ft. The Tenders to include the whole of the Concrete, Brick, Stonework and Slating, but not the Ironwork, which will form a separate Contract.

Plans and Specifications may be seen on application to the Company's Engineer, Mr. J. T. KEY.

The Directors do not bind themselves to accept the lowest or any Tender.

Tenders marked "Tender for Retort House (Brick work)," must be delivered to the undersigned, not later than Tuesday, the 23rd inst.

HANBURY THOMAS, Manager.
Gas Offices, Commercial Street, Sheffield,
8th September, 1884. G 814

TO ENGINEERS AND IRONFOUNDERS

The Directors of the Sheffield United Gas Light Company are prepared to receive

Tenders for the Supply and

FIXING COMPLETE of the CAST AND WROUGHT IRONWORK in connection with a RETORT HOUSE, 200 ft. by 75 ft., about to be erected at their Effingham Street Station.

The material required will include Cast Iron Columns, Ornamental Cast Iron Girders, English rolled Wrought Iron Girders for Floor, Composite, Cast, and Wrought Iron Roofing, &c.

Plans and Specifications may be seen on application to the Company's Engineer, Mr. J. T. KEY.

The Directors do not bind themselves to accept the lowest or any Tender.

Tenders marked "Tender for Retort House (Iron work)," must be delivered to the undersigned, not later than Tuesday, the 23rd inst.

HANBURY THOMAS, Manager.
Gas Offices, Commercial Street, Sheffield,
8th September, 1884. G 815

PERTH GENERAL STATION

CONTRACT FOR WORKS

The Perth General Station Committee are prepared to receive

Tenders for the Enlargement

of the GENERAL STATION, PERTH.

The Drawings and Specification may be seen at the Office of Messrs. BURTT & CUNNINGHAM, C.E., 145, George Street, Edinburgh, from Monday, the 8th of September, till Saturday, the 13th of September, and from Thursday the 18th of September, till Friday, the 26th of September, and at the Office of the Secretary to the Perth General Station Committee, Perth, on Monday, Tuesday and Wednesday, the 15th, 16th and 17th of September when an Engineer will attend to point out the Site of the Works to Contractors.

Forms of Tender, with copy of the Specification and duplicate copies of the Schedule may be obtained from the Engineers, on payment of Four Guineas.

The successful contractor shall pay the cost of the measurements.

Sealed Tenders, addressed to the undersigned, and marked "Tender for Works" must be lodged with him on or before Friday, the 26th day of September next.

The Committee do not bind themselves to accept the lowest or any of the Tenders.

ROBERT MORISON,
Perth General Station, Secretary.
26th August, 1884. G 671

TO BOILER MANUFACTURERS

The WATFORD LOCAL BOARD OF HEALTH invite

Tenders for an ordinary Lan-

CASHIRE BOILER for their Waterworks. Specifications can be had on application to NEIL MCDOUGALL, Esq., 67, King Street, Manchester, or the Clerk. Sealed Tenders, endorsed "Tender for Boiler," to be delivered at the Offices of Messrs. SIMMONS, TOWNER and WARREN, Solicitors, 66, High Street, Watford, on or before 19th September, 1884. G 807

H. M. TURNER, Clerk.

BOROUGH OF GATESHEAD

The Quay Committee invite

Tenders for the Supply and

ERECTION of a CRANE on the Gateshead Quay capable of lifting 40 Tons, and also Tenders for one (if preferred by the Committee) capable of lifting 50 Tons. The work is to include the necessary foundations in both cases.

A section of the Quay Wall and other particulars will be supplied on application to the Borough Engineer, Town Hall.

Tenders, addressed to the Quay Committee, should be sent to the Town Clerk not later than the 23rd September.

The Committee do not bind themselves to accept the lowest or any Tender.

J. W. SWINBURNE,
Gateshead Town Hall, Town Clerk.
8th September, 1884. G 812

TO CONTRACTORS

GREENOCK HARBOUR TRUST

HYDRAULIC RAMS AND SLUICE PADDLES for Entrance Works of the "James Watt" Dock.

The Trustees are prepared to receive

Tenders for the Supply of

NINE SETS OF HYDRAULIC RAMS AND SLUICE PADDLES for above Entrance Works.

Specifications and Form of Tender, with Drawing attached, may be obtained at the Engineer's Office, on deposit of £1, which will be returned to all Contractors whose Tenders are lodged and properly filled in.

Sealed Tenders, marked "Tender for the Supply of Hydraulic Rams, &c.," must be lodged with the undersigned, on or before Saturday, the 27th day of September.

None other than the printed Form of Tender will be received by the Trustees. The Trustees do not bind themselves to accept the lowest or any Tender.

Any further information may be obtained from WALTER ROBERT KINIPLE, Engineer to the Trustees, 17, West Blackhall Street, Greenock, and 2, West minster Chambers, London, S.W.

THO. WILSON, Clerk.
Greenock,
8th September, 1884. G 808

BOROUGH OF WEST BROMWICH

MAIN DRAINAGE WORKS. SECTION No. 2.
CONTRACT No. 2.

The Corporation of West Bromwich are prepared to receive

Tenders for the Construction

of about 633 yards of 3 ft., 761 yards of 2 ft. 9 in. and 476 yards of 2 ft. 6 in. CIRCULAR BRICK SEWER, also for the Laying and Jointing of about 1165 yards of 30 in., 291 yards of 33 in., 513 yards of 30 in., 15 yards of 24 in., and 20 yards of 15 in. CAST IRON SOCKET PIPES, and the Laying of 247 yards of 9 in. EARTHENWARE PIPE SEWER, together with all Manholes, Ventilators, and other works.

The Drawings may be seen at my Office on and after the 12th inst., and Copies of the Specification, Bill of Quantities, and Form of Tender obtained on payment of Two Guineas, which will be returned on receipt of a *bona fide* Tender.

Tenders to be sent in on the proper form, together with the Bill of Quantities and Schedules fully priced in, on or before Tuesday, the 23rd instant, endorsed "Tender for Sewage Section No. 2 Contract No. 2."

The Corporation do not bind themselves to accept the lowest or any Tender.

JOHN T. KAYES, Assoc. M. Inst. C.E.,
Town Hall, West Bromwich, Borough Engineer.
3rd September, 1884. G 790

APPOINTMENTS OPEN.

Wanted, in a Civil Engineer's

Office, a good Mechanical DRAUGHTSMAN, experienced in designing sluice work and pumping machinery.—Apply by letter, stating age, salary, and references, to Mr. E. FILLITER, 16, East Parade, Leeds. G 827

Wanted, a quick and accurate

DRAUGHTSMAN, accustomed to marine engine details; young man preferred. State salary, experience and references to W. GRAY & CO., Central Marine Engineering Co., West Hartlepool. G 810

Wanted Immediately, a Good

DRAUGHTSMAN, accustomed to large hydraulic cotton presses.—Address, HYDRAULIC, care of W. H. SMITH & SON, Advertising Agents, Manchester. G 836

Foundry Foreman Moulder

WANTED, for Midland Counties (non society) thoroughly practical, for jobbing foundry; must be well up in piece work prices, and competent to take entire charge. State age and previous situations held, with salary and full particulars. Applications treated confidently.—Address, G 805, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 805

A Foreman Moulder of large

general experience, is REQUIRED for an Australian Foundry. A liberal engagement will be made with a thoroughly suitable man.—Address, with copies of testimonials only, in the first instance, to SYDNEY, 94, Ebury Street, S.W. G 809

Lists of Berths Vacant or

WANTED. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London, or of all News Agents. 5262

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A M.I.C.E. seeks an Appoint-

MENT, any responsible position, 19 years' practical experience, general engineering, designing, quantities, specifications, &c. Specialities: high speed engines, 800 revolutions per minute, centrifugal pumps and compound rotative pumping engines for water, irrigation, and sewage works. Duty of 1.5 lb. coal 1nd HP. per hour realized by engines designed by advertiser. Highest references.—Address, VELOX, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. G 813

Draughtsman, accustomed to

Loco and Marine Engines, SEEKS EMPLOYMENT (temporary or otherwise), London or vicinity preferred.—Address, T. F. S., 2, Shady Villas, Erith. G 831

Marine Engineer of good ex-

perience as seagoing engineer, chief draughtsman, and works manager, desires ENGAGEMENT as Superintendent of Steam Ships or Manager of Works. First class references.—Address CLYDE, Offices of ENGINEERING, 35 & 36 Bedford Street, Strand. G 822

Young Man, who has just

completed apprenticeship SEEKS SITUATION in Engineer's Office, has some knowledge of drawing, and is willing to give services without salary for a time.—Address, S. P., Offices of ENGINEERING. G 819

To Mechanical or Railway

Engineers or others.—The Guardians of a Youth who has a taste for drawing, and has obtained a South Kensington Certificate, are desirous that he should be ARTICLED to a Mechanical or other Engineer, where there is a prospect of future employment. A moderate premium would be paid.—Address, stating terms and particulars, to O. P., *Guardian* Office, Nantwich, Cheshire. G 806

PARTNERSHIPS.

An Engineer, with a complete

plant and good business, is desirous of taking a PARTNER with about £800 capital; engineering knowledge not necessary, advertiser being practical.—For further particulars, apply to Mr. BRADSHAW BROWN, Auctioneer, &c., 50, Fenchurch Street, E.C., and Millwall, E. G 834

To Civil Engineers in practice.

—The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright.

WHEATLEY KIRK, PRICE and GOULTY, 52, Queen Victoria Street, London, E.C. 5292

WANTED, &c.

Wanted, One or Two Sets of

Second hand PORTABLE RIVETTING MACHINES, equal to new, either Arroll's, Tweddell's or New's system. State price and particulars.—Apply, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 804

Crane Wanted, New or Second-

hand, capable of lifting from 30 to 50 tons, radius of not less than 25 ft., hand power.—FRED J. BOWLES, Superintendent, Falmouth Docks. G 826

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FACTURE, by Firm having extensive Works and Foundry, near London. Exceptional facilities offered.—Address Y. J., at C. H. MAY & Co.'s General Advertising Offices, 78, Gracechurch Street, London. G 839

"Engineering."—Wanted,

a Copy or Copies of Jan. 11th, 1884. Good price given.—Address, B. R. L. S., Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London. G 786

Agents Wanted, to push First-

class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool. 5283

Lists of Machinery Wanted or

on SALE. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London, or of all News Agents. 5262

FOR SALE.

For Sale, One Pair of

Compound Surface Condensing
MARINE ENGINES AND BOILER,
130 HP. Nominal. 5299

F. GILMOUR & CO., Engineers, Glasgow

For Sale, a Great Bargain,

a self contained TUBULAR BOILER, quite new, capable of generating 80 indicated horse power.—Apply to J. BOURNE, College of Practical Engineering, Muswell Hill. G 813

For Sale, 9 in. Double Cylin-

der PORTABLE ENGINE, by Clayton and Shuttleworth, in good condition, being replaced by larger engine.—Apply to STRACHAN & CO., Frome Hall Mills, Stroud, Gloucestershire. 5282

For Sale, on account of Closing

a Branch Shop, Lathes, Drilling, Shaping, Slotting, Punching and Shearing, Planing and Screwing Machines, and all the usual loose Tools, at very low prices.—For particulars apply to GOOD & MENZIES, Green Lane Foundry, Hull. G 782

For Sale, being superseded by

engines of higher power, a pair of High Pressure Condensing STEAM ENGINES. Cylinders, 26 in. diam., 3 ft. 6 in. stroke, with cold water pump for same.—Can be seen at work at the Manufactory of the LONDON PORTLAND CEMENT CO., Ltd., Northfleet, Kent, to whom enquiries may be addressed. G 534

For Sale, by the Mortgagees,

the NORTHFIELD IRON WORKS, Rotherham, Yorkshire (Freehold). 22 puddling furnaces, 18 in forge train, 14 in. bar mill, guide and hoop mills, "Colliers" tyre mill. Railway and canal to works.—Apply to Messrs. MACREDIE & EVANS, Chartered Accountants, Sheffield. G 828

For Sale, Steel Launch, Twin

SCREW (in progress and nearly finished), 55 ft. long by 13 ft. beam, 6 ft. 6 in. deep, draught 3 ft. 6 in., engines 10 in. and 15 in. by 14 in. strokes. No wood work fitted, can be shipped in three sections, designed for high speed and light draught.—For Specification and price apply to LOUDON BROTHERS, 111, Bothwell Street, Glasgow, and 166, Upper Thames Street, London. G 818

For Immediate Sale, at low

prices for cash
SECOND HAND
LANCASHIRE BOILER, 18 ft. 3 in. by 7 ft. diameter.
VERTICAL CROSS TUBE BOILER, 7 ft. 6 in. by 3 ft. 3 in. diameter.
TANK LOCOMOTIVE, 4 wheels coupled, cylinders 10 in. by 20 in.
A New 9 HP. CHAPLIN'S LOCOMOTIVE.
A Dozen HORIZONTAL ENGINES, with cylinders from 3 in. to 10 in. diameter. (New.)
5 ft. 6 in. FACE PLATE LATHE, by Whitworth.
RAIL STRAIGHTENING MACHINE, with engine attached, by Collier.
No. 6 ROOTS BLOWERS, by Thwaites.
Two No. 44 PATENT BLOWERS, by Ellis.
Two SCOTT WHEEL MOULDING MACHINES.
10-ton RAILWAY WEIGHING MACHINE.
STEAM WINCHES, from 5 in. to 7 in. cylinders.

For prices and full particulars of any of above apply to "PHILLIPS' MONTHLY MACHINERY REGISTER," Newport, Mon. 4804

"Engineering."—For Sale,

VOLS. XVII., XVIII., and XXI., in cloth covers, quite clean.—Address, D. J. BLAIKLEY, 104, Iverson Road, N.W. G 802

Gas Engines for Sale, in

capital working order. One 3 HP., French make, Lenoir's patent. One 8 HP., English make.—Apply at 128, Minories, E. G 832

One First-class Boiler, 30 ft.

long, 7 ft. diam., two flues, excellent fittings. Made by Pollett. Guaranteed for 60 lbs. pressure. £110.—Apply to C. H. DERRISFORD, 12, Bank Street, Cross Street, Manchester. G 829

To Shipbuilders, &c.—To be

SOLD, a great bargain, now lying in Hull (must be removed at once) NEW PLATE BENDING MACHINE, to bend plates 15 ft. wide, driven by 10 HP. Horizontal Engine, with reversing motion, top roller 24 in. diam., bottom rollers 18 in., top roller to raise or lower by self-acting power motion, weight about 35 tons. A low price accepted of an immediate purchaser.—Apply, W. ASQUITH, Tool Manufacturer, Highroad Well Works, Halifax. G 833

TO BONE AND SEED CRUSHERS AND MANURE MANUFACTURERS

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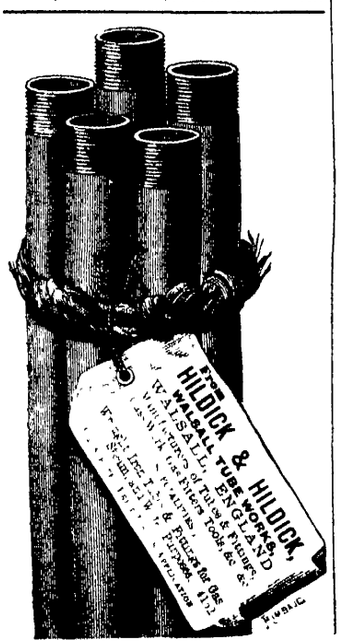
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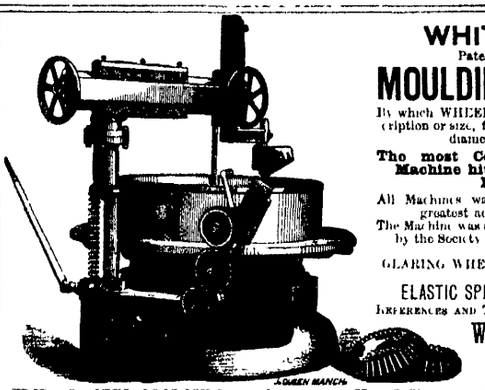
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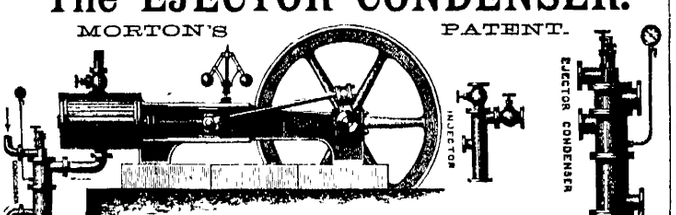
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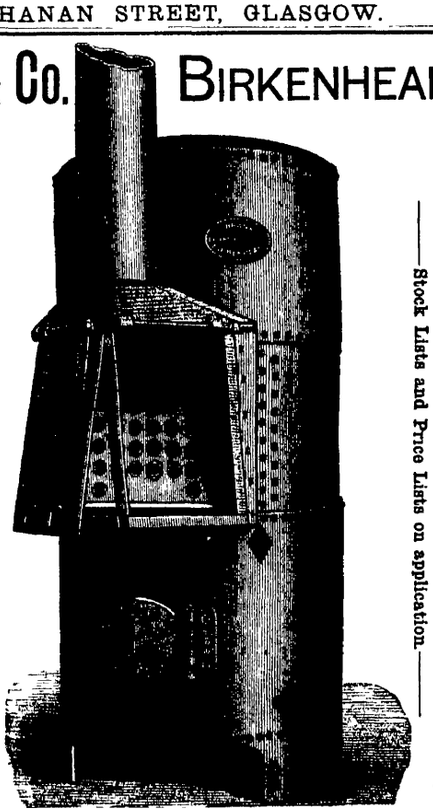
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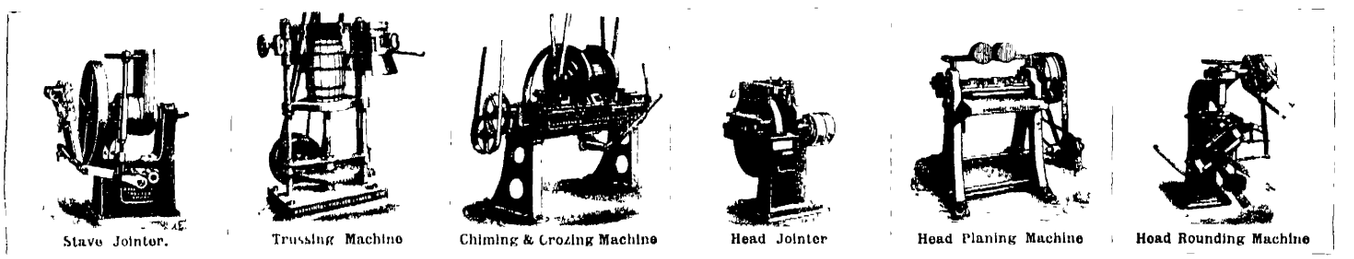
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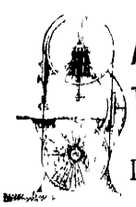
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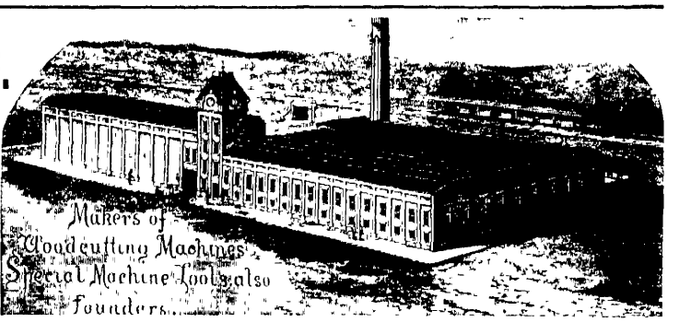
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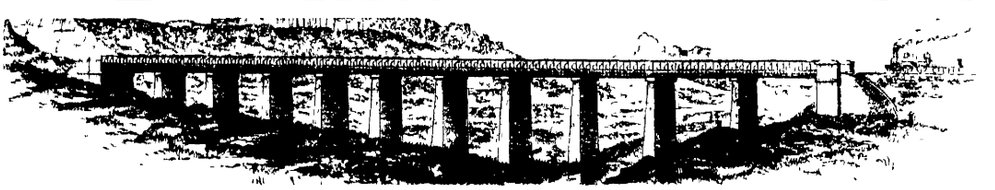
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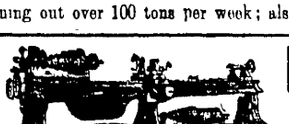
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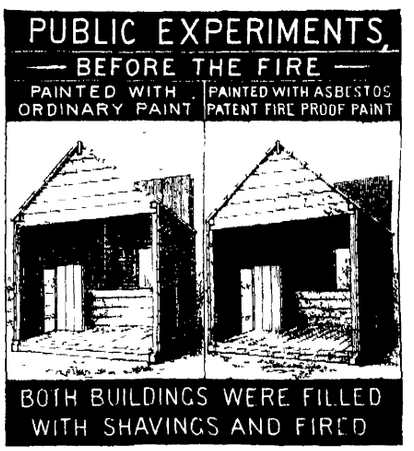
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Similar trials to demonstrate that Woodwork coated with it will offer an effectual resistance to flames were made, with results equally successful to those shown in the engravings, on the following occasions:

LONDON (Crystal Palace)—Before the Lord Mayor and distinguished company, January, 1882
LONDON (Westminster Palace)—Before the Chairman of the Metropolitan Board of Works, Government Officials Architects, etc., August, 1882
LONDON (Alexandra Palace)—August, 1882
LONDON (International Fisheries Exhibition)—By invitation of the Executive Committee of the Exhibition Three times, February and March 1884. Witnessed by H.R.H. the Prince of Wales, the Speaker and Members of both Houses of Parliament, and over 100 Representatives of the Press
STOCKHOLM—In the presence of the King of Sweden, Prince Karl and Suite, also Captain Halsten, Chief of Fire Brigade, Representatives of the Army, Admiralty, State Railways, and Municipal Authorities, May 1883
AMSTERDAM—Before the Minister of State and Municipal Authorities, August, 1883
And at various times before the Lord Provosts and Magistrates of Edinburgh and Glasgow, and the Mayors and Corporations of Manchester, Liverpool, Birmingham, Stratford on Avon, and other towns



From **THE TIMES**, January 16, 1883

"These results are highly satisfactory and fully demonstrate the value of the Asbestos Paint as a fire resisting medium in respect of its application to the several stages and effects, or, in fact, to any other structures or their fitting."

THE TIMES, in referring, on February 4, 1884, to the late Great International Fisheries Exhibition, said:

"This is a precaution which the heat of the rooms evidently necessary, but the Exhibition buildings will, of course, be carefully watched and guarded and *not moreover, be thoroughly coated by the United Asbestos Company with their non inflammable paint, a composition which, as was shown yesterday to those who visited the ground, enables common wooden shed to resist the effects of flaming shavings and petroleum.*"

From the **STANDARD**, May 19th, 1884

"The natural antagonism between fire and water was exemplified on Saturday morning in a more than usual phase. Fortunately, owing to the difficulty of ignition the Asbestos painted walls, the fire was put out by the aid of a portable engine in five minutes from its discovery. It is not desirable to have any repetition of such tests of the fire proof qualifications of the Paint, but it is satisfactory to know it has in this instance kept its character free from reproach."

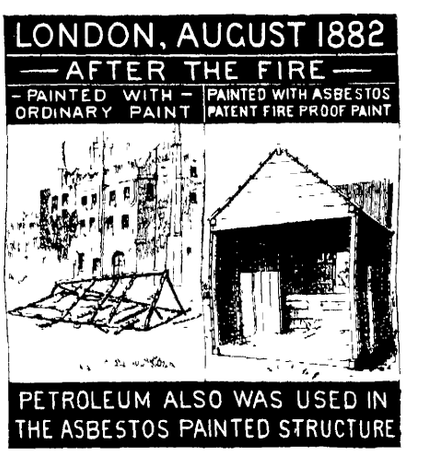
From the **DAILY CHRONICLE**, May 19th, 1884

"FIRE AT THE HEALTH EXHIBITION.—On Saturday morning a fire broke out in one of the exhibitor's stands in the central annexe which runs parallel with the gallery in which the opening ceremony took place. The fire, which was confined to the stand where it originated, was speedily extinguished, the unfireproofed Paint with which the wooden walls of the building are coated effectually barring the progress of the flames."

From the **DAILY TELEGRAPH**, May 19th, 1884

"FIRE AT THE HEALTH EXHIBITION.—Early on Saturday morning a fire broke out at one of the exhibitor's stands in the central annexe of the Health Exhibition. The fire, which was confined to the stand where it originated, was speedily extinguished."

b. The Paint attacked by the fire had been exposed to the wear and tear of over six months.



HUNDREDS OF EQUALLY FAVOURABLE PRESS NOTICES

IMPORTANT TESTIMONIALS.

INTERNATIONAL FISHERIES EXHIBITION S. Kensington, London, S.W. 10th November, 1883

Dear Sirs,—With further reference to your letter of the 10th inst., I beg to inform you that I have duly laid the same before my Committee, and I am directed by them to express to you their entire satisfaction with the way in which your paint has stood the exposure to the weather, and the wear and tear of six months, though happily the qualities which you claim for it, and which the Committee have every reason to believe exist from the tests which they witnessed previous to the opening of the Exhibition, were not called into requisition.—I am, dear Sirs, yours faithfully,
F. CUNLIFFE OWEN, Secretary
Messrs. the United Asbestos Company, Limited

From H.M. INSPECTOR OF EXPLOSIVES, Home Office, May 26th, 1882:—

"I have no doubt that the Patent Fire proof Paint will be of great value in preventing the spread of fire in wooden buildings."

From the SECRETARY OF STATE FOR INDIA, Sept. 19th, 1882:—

"I have to inform you that the samples of Paint which you have sent in have been satisfactorily tested."

ROYAL ITALIAN OPERA, Covent Garden, London, May 19th, 1884

Dear Sir,—In answer to your inquiries, I beg to say that I have read the accounts in various newspapers of the late fire at the Stadt Theatre in Vienna and the lamentable result. I have also observed in one of the accounts that certain fire resisting liquids were in use at the Theatre, but proved to be of no avail. I have therefore thought it right to make a further test of the Fireproof Asbestos Paint supplied by your Company to this Theatre in the beginning of 1882 with which all woodwork in the vicinity of the stage was painted. With this view I had a piece of wood detached—this was partially covered with Asbestos Paint only. I had the wood placed in a hot furnace with a fierce fire, and left there for some minutes. The result was that the bare portion of the wood was consumed immediately, but the painted part remained comparatively uninjured. I observed that a similar result was the case at the recent fire at the Health Exhibition where the Asbestos Paint appears to have entirely stopped the progress of the fire. It appears from the various accounts that none of your material was used at the Vienna Theatre, and I should be glad to learn from you that such is the case.—I am, dear Sirs, yours very faithfully, (Signed) ERNEST GYE, Managing Director
The United Asbestos Company, Limited, 161, Queen Victoria Street, E.C.
N.B.—This Company's Paint was not used on any part of the Stadt Theatre.

CRYSTAL PALACE CO., Crystal Palace, S.E., 18th June, 1884

Dear Sirs,—In answer to your letter of the 2nd inst., I have to say that the Asbestos Paint applied by your Company two and a half years ago to the woodwork of the Great Staircase at the Crystal Palace is, to all appearances, as good and sound as when first put on, and although untouched it has not been put to a practical test. I have reason to believe, from experiment which has been made, that the Paint has not lost any of its fire resisting qualities.—Yours faithfully,
WM. CALDWELL, Secretary
The United Asbestos Company, Limited

Amongst the numerous buildings which have been wholly or partially protected with this Paint we may mention

GREAT INTERNATIONAL FISHERIES EXHIBITION BUILDINGS (over 40 tons of paint were used on these buildings, and the work insured at a reduction of 75 per cent. in consequence)
HOUSES OF PARLIAMENT, Westminster. RESIDENCE OF H.R.H. PRINCE OF WALES, Sandringham
THE BRITISH MUSEUM. THE SOUTH KENSINGTON MUSEUM
HAMPTON COURT PALACE. ROYAL ITALIAN OPERA, Covent Garden
STAGE OF SHAKESPEARE MEMORIAL THEATRE, Stratford on Avon
THE BOROUGH LUNATIC ASYLUM, Birmingham. CURZON HALL, Staples, Barnsley, and
CANVAS SCREENS at the CRYSTAL PALACE, Sydenham. ALHAMBRA THEATRE, ROYAL
WALKER'S AMMUNITION SHEDS, Birmingham

SPECIALLY RECOMMENDED FOR WOODEN BUILDINGS

Of every description, especially Cotton Mills, Factories, Warehouses, and for the proofing the underside of floors, attics, lofts, &c., which, if not fireproofed, carry the flames. Timber should be dry when the Paint is applied, and outside work done, if possible, in fine weather, so that the Paint may dry well off and hard, which it does very quickly. The Paint is delivered carriage paid, *ready for use*, with necessary instructions, and can be applied by ordinary workmen.

PRICE 38s. per cwt., grey or stone colour; other colours 45s. per cwt. f.o.b. London, Hull, Liverpool, Bristol, or Glasgow, in 5 cwt. lots. Packages cost price. Cash or London reference should accompany foreign orders.

IMPORTANT. This Company was the first to make and introduce Asbestos Fireproof Paints to the public. The process of manufacture was patented, but as in the case of all valuable inventions, competitors, similar in name but greatly inferior in quality and value, are being foisted on the public, and as instances have recently come under our notice where loss and disappointment have resulted therefrom, buyers who want the genuine article should, particularly when ordering through merchants, specify our brand.

ASBESTOS OIL PAINTS

For Ironwork, Bridges, Stations, and General Outside PAINTING, are invaluable. They have been proved to withstand the action of foul atmospheres, sulphur, gases, smoke, etc., etc., better than any paint known. Not after long, but final and severe tests, have been specified for general outside painting by the leading Railway Companies. Dry 4 per cent. lighter, these Paints are more durable than ordinary paint.

See next issue for particulars of our ITALIAN ASBESTOS MILLBOARD and ITALIAN ASBESTOS and INDIARUBBER WOVEN SHEETING TAPE and RINGS for Joints of all kinds. Italian Asbestos Patent Woven H.P. Gland Packing. New Italian Asbestos Tooled Cloth Packing, with Indiarubber Core (strongly recommended), and every description of Asbestos Goods.

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161, QUEEN VICTORIA STREET, LONDON, E.C.

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MANCHESTER: 35, CORPORATION STREET. | LIVERPOOL: 47, SOUTH JOHN STREET. | BIRMINGHAM: OLEMENT STREET. | GLASGOW: 52, ST. ENOCH SQUARE.

FLAX HOSE PIPE.

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RICHARDS & Co.,

ABERDEEN,

ARE THE

Original and Sole Makers

OF THE

CELEBRATED

Vaucher Hose

Owing to inferior makes having been STAMPED with the word Vaucher in imitation of our Hose, we have registered a

NEW TRADE MARK,

And hereby call attention to the fact that the

GENUINE VAUCHER

will in future be

Stamped every 30 ft.

with our stamp, thus :-

VAUCHER'S

PATENT.

AND WE WARN OUR FRIENDS AGAINST IMITATIONS

RICHARDS

AND CO.,

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LONDON WAREHOUSE: 250

45, BREAD STREET, E.C.

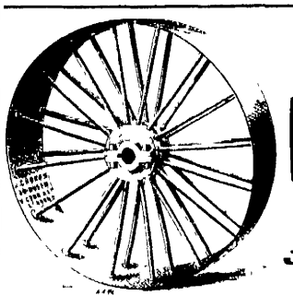
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VALVES, WASHERS, PACKING, SHEETING, BELTING, HOSE, TUBING, MATTING, WATERPROOF &c.

GEORGE MACLELLAN & CO.,

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Branches: GLASGOW 55, ROBERTSON STREET; LONDON 126, BISHOPSGATE STREET, WITHIN.; MANCHESTER 12, LANCASTER AVENUE; LIVERPOOL 27, WATER STREET; SUNDERLAND 6, Tavistock Place, Borough Rd. 5031



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DRIVING PULLEYS

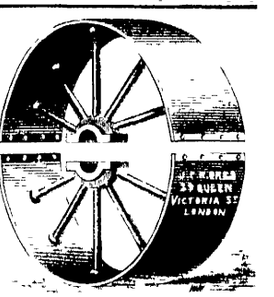
AND

"VICTORIA"

LEATHER BELTING.

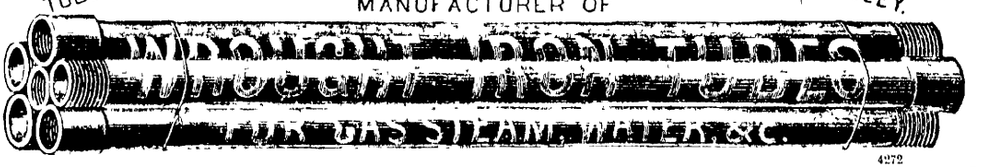
J. C. R. OKES, M.I.M.E.,

39, QUEEN VICTORIA ST., LONDON, E.C. 6050



ATLAS TUBE WORKS. **H. P. SKIDMORE,** NETHERTON NEAR DUDLEY.

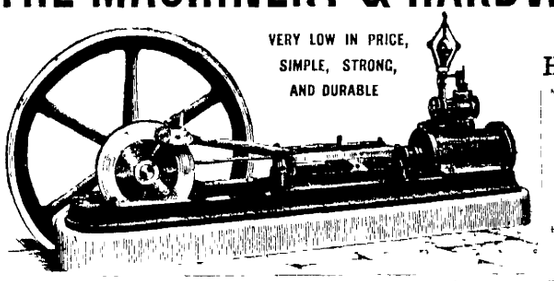
MANUFACTURER OF



4272

THE MACHINERY & HARDWARE COMPANY, LTD.

147, QUEEN VICTORIA STREET, LONDON, E.C.



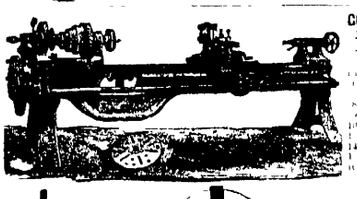
VERY LOW IN PRICE, SIMPLE, STRONG, AND DURABLE

Horizontal High Pressure Steam Engines

Nominal HP	Cylinder and Stroke	Diam of Fly Wheel	Price	Nominal HP	Cylinder and Stroke	Diam of Fly Wheel	Price
	in in	ft in	£ s		in in	ft in	£ s
4	6 by 12	6	41 10	14	12 by 24	7 0	80 10
6	7 „ 14	6 6	49 0	20	14 „ 28	8 6	115 10
7	8 „ 16	6 0	47 10	24	15 „ 30	8 6	142 0
9	9 „ 18	7 0	58 0	28	16 „ 32	8 7	147 10
12	10 „ 20	6 6	68 10	32	18 „ 36	8 9	191 10

Full size Cylinders with cone governor. Double Acting. Slide, good Lever set to separate Pumps. Fly wheel and Pedestal Feet. Set complete, all finish. Finished case style Engine Lathe. Manchester

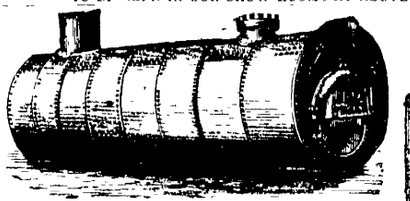
TO BE SEEN IN OUR SHOW ROOMS AT ABOVE ADDRESS



GOOD CHEAP LATHES

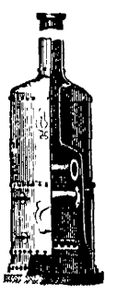
Class B Slide Screw cutting	Slide Surface
£ s	£ s
6 0	4 0
7 10	5 0
9 15	6 10
11 0	7 10
13 0	9 0
16 0	12 0
19 0	16 0

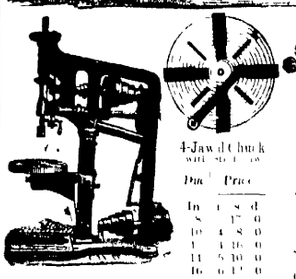
Throw 12 in. 3 ft. Bed. With 18 inches Gap Bed Centres Extra £1



CORNISH BOILERS, One Flue

hp	4	6	8	10	12	14	16	20	25	30	hp
£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s	
	31 0	42 0	46 0	58 0	65 0	75 0	85 0	92 0	109 0	127 0	153 0	228 0	





Cheap Drilling Machines.

Admit

18 inches Double Geared	£27 10
40 in. „	£41 0
48 in. „	£4[illegible] 0

Other sizes quoted on application

4-Jaw Chuck with [illegible]

Dia	Price
in	£ s d
⅛	17 0
10	4 8 0
1	4 16 0
14	5 10 0
16	6 17 0
18	8 14 0
20	8 16 6
24	11 0 0
28	15 0 0
30	18 5 0
36	18 5 0



CIRCULAR SAW BENCHES, With Rising and Falling Tables

Table inches	Will take Saw diam	Price £ s d
48 by 24	24 in	16 10 0
4 „ 28	30 in	20 0 0
62 „ 32	36 in	24 10 0
72 „ 36	42 in	32 10 0

VERTICAL CROSS TUBE BOILERS

hp	2	3	4	5	6	8	10	12	14	16	18	20 hp
£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s	£ s
	1 0	1 0	0 25	10 41	0 45	0 4	0 50	10 65	10 46	0 85	0 88	0 99	0 107	0 116	0

PRICE LISTS and COMPLETE CATALOGUES on application

The various sizes of these Lathes Drilling Machines, Chucks, Saw Benches and a few sizes of the Engines are invariably

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AT THE MACHINERY AND HARDWARE COMPANY, LIMITED,

147, Queen Victoria Street, and 235, Upper Thames Street, LONDON, E.C.

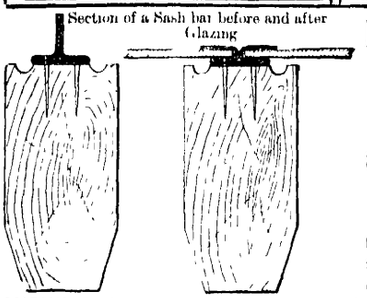
THE ABOVE OR ANY OTHER MACHINES CAN BE OBTAINED UPON THE

PURCHASE HIRE SYSTEM

From THE MACHINERY PURCHASE HIRE COMPANY (in connection with the above Company),

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"SIMPLEX" LEAD GLAZING.



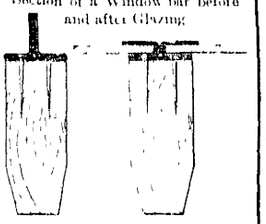
Section of a Sash bar before and after Glazing

NO IRON, ZINC, OR PUTTY USED.

No Special Contract required for its adoption.

SUITABLE FOR ALMOST UNIVERSAL APPLICATION.

N B – The Lead Strips, which are the special feature of this System, require no Skilled Labour to fix, breakages can be repaired by anyone, and ALL OUTSIDE PAINTING IS DISPENSED WITH.



Section of a Window bar before and after Glazing

Write for Prospectus and Testimonials

1556

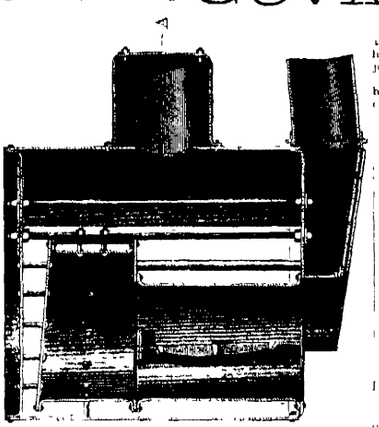
SOLE MANUFACTURERS OF THE PATENT LEAD STRIPS

GROVER & CO., Ltd., Engineers, &c., Britannia Works, WHARF ROAD, N.

LINDSAY BURNET & CO.,

MOORE PARK BOILER WORKS,

[TELEGRAPHIC ADDRESS "BURNET, GLASGOW"] GOVAN, GLASGOW.





Constructed entirely of Siemens Mild Steel all flanging and riveting done by hydraulic machinery and rivet holes bored out with twist drills in every way a first class job.

Price includes Uptake and Funnel Man and Sludge hole Doors, Furnace Front Plate and Bearers. A Lloyd's certificate of Test supplied at an extra charge of £1 1s.

PRICE LIST Delivered free by Glasgow

Working Pressure per Square Inch	Length of Shell	Diameter of Shell	Price of Boiler	Diameter of Flues	Heating Surface	Grate Surface	Weight of Boiler	Price
lbs.	ft.	in.	ft.	in.	sq. ft.	sq. ft.	cwts.	£
90	4	6	4	0	2	1	9	116	50	85
90	4	6	6	6	3	0	1	15	55	94
80	4	9	4	6	3	3	0	175	75	120
80	5	0	4	0	2	3	1	180	78	134
80	5	6	4	6	3	0	2	225	90	154
80	6	0	4	6	3	9	2	265	95	174
80	6	0	5	0	4	0	2	301	104	190
80	6	0	5	6	4	3	2	348	114	230
					Two flues					
100	7	0	5	6	4	3	2	6	409	148	310
					Two flues					
90	8	0	5	6	4	3	2	6	492	171	390

Larger Sizes up to 11 ft. diameter quoted for on enquiry.

IN CLASS OF BOILER QUOTED FOR

The Combustion Chamber crowns are in one plate, welded and flanged the riveting is done by hydraulic power and the rivet heads are so pitched to fitting, the furnaces are also welded and flanged and in large sizes have Adamson's seam in middle.

BRASS AND COPPER

TUBES.

Seamless Tubes

For Boilers, Condensers, Refrigerators, and high class Engineers' Work.

These Tubes are made of approved materials, and by recently perfected machinery

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of best quality for all purposes

ORNAMENTAL TUBES.

SHEETS.

Hard and Soft Rolled

of various Sizes & Gauges

Strips

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Drawn to order of a variety of Sections.

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Cut to order

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Bell Wire.

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RIVETS & NAILS.

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Rivets & Washers

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Tacks & Brads.

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Stamped & Spun Goods

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SOLID DRAWN TUBES.

With Hemispherical Ends in one piece

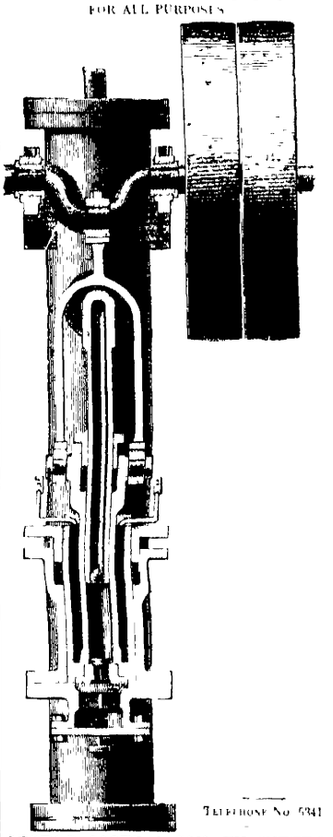
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HOWARD LANE & CO.,

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F. W. SCOTT'S PATENT AIR COMPRESSOR

FOR ALL PURPOSES



TELEPHONE No. 5341

GEORGE SCOTT & SON, ENGINEERS,

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JAMESON'S COKING PROCESS

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Over 800 ovens are already at work or arranged for by owners of over 10,000 ovens.

At a nominal cost this process saves the volatile products of coal and rich burning gas, and gives increased yield of coke of improved quality

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THE BOWER-BARFF RUSTLESS IRON COMPANY, LIMITED.

Furnaces now in constant operation in London IRON FOR TREATMENT TO BE CONSIGNED TO THE COMPANY

SKIN MARKET PLACE, BANKSIDE, S.E.

Rain Water and Builders' Castings Bower Barffed, supplied from London Stock 5088

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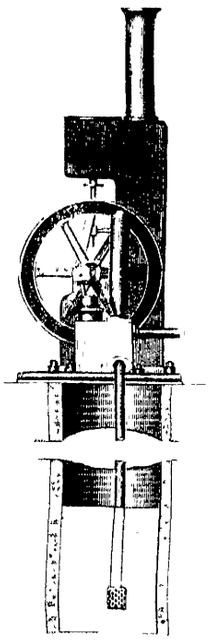
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Manufacturers of all kinds of Slide Lathes, Planing, Shaping, Slotting, Boring, Drilling, Punching, Shearing, Bending, and Screwing Machines, suitable for every class of Engineers and Shipbuilders 4088

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HATHORN, DAVEY & CO., LEEDS.



THE MOST ECONOMICAL SMALL MOTOR FOR PUMPING WATER & DRIVING SMALL MACHINERY.

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THE RAILWAY SLEEPER SUPPLY COMPANY, LIMITED,

Creosoting Works & Saw Mills,

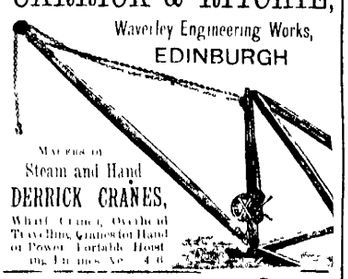
AT

HENDON DOCK, SUNDERLAND,
ALEXANDRA DOCK, GRIMSBY
AND
VICTORIA DOCK, HULL.

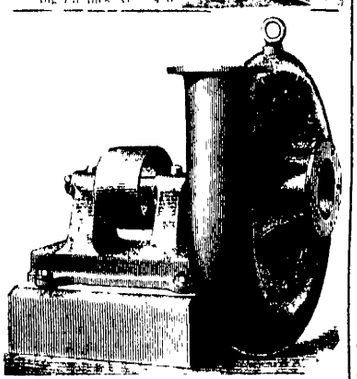
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Steam and Hand
DERRICK CRANES,
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MANUFACTURERS OF

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CRANK SHAFTS,

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FORGINGS

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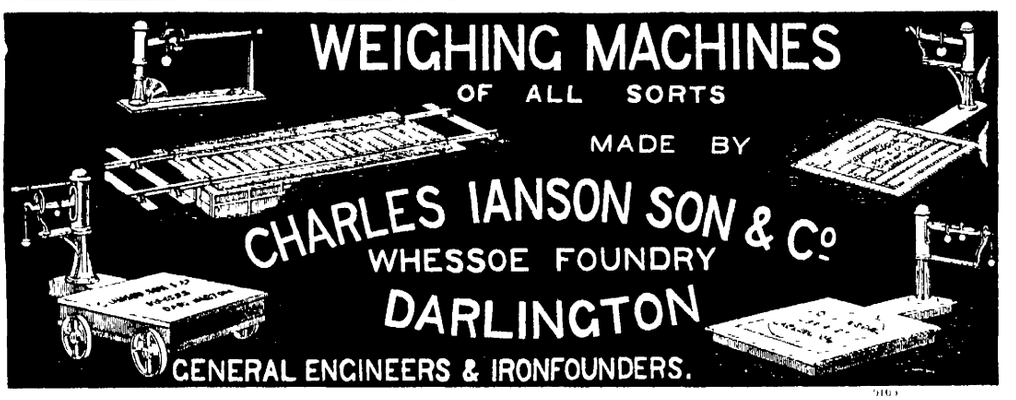
IN IRON AND STEEL.



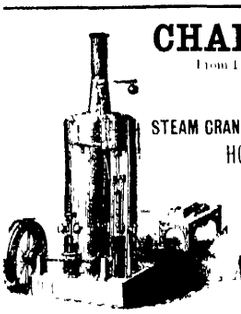
Weight, 25 tons 10 cwt

WORKS: CRAFTON STREET.

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5160



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STEAM CRANES, PORTABLE OR FIXED, FOR WHARF OR RAIL STEAM AND HAND DERRICK AND OVERHEAD TRAVELLING CRANES

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Manufacturers of all kinds of Blister, Shear, Spring and Cast Steel, FILES, SAWS, &c.

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Manufacturers of all kinds of Wrought Iron, Lap welded and Butt-welded TUBES of every description. FITTINGS, &c, Also

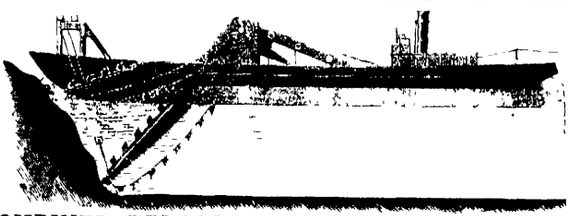
HOWELL'S PATENT HOMOGENEOUS METAL AND CAST STEEL TUBES.

SPECIALITY { IRON AND STEEL COPPER-COATED TUBES. 4782

DREDGING SPECIALITIES.

DREDGERS to dredge in front, in centre, or at sides.

DREDGERS for abroad shipped in pieces, or made for steaming to any part of the world



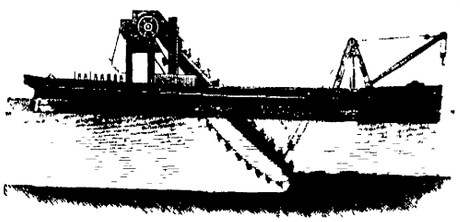
DREDGERS for River Bar, Dock, Canal or Harbour.

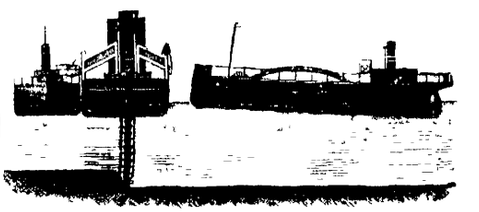
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PARTICULARS ON APPLICATION TO

FLEMING & FERGUSON

PAISLEY, N.B. 4707

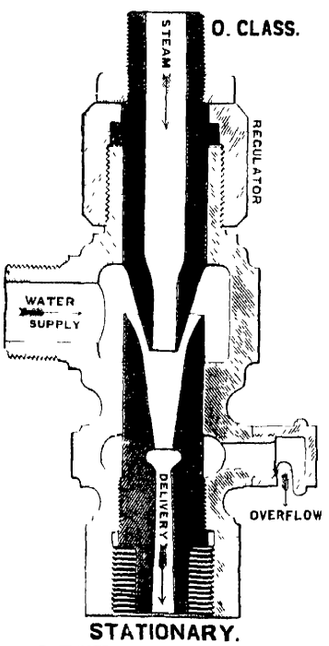
Mr. William Knowles' Patent Automatic Supplementary Governor,

FOR SECURING AND MAINTAINING AUTOMATICALLY ALMOST PERFECT ACCURACY OF SPEED IN STEAM ENGINES UNDER VARYING LOADS AND STEAM PRESSURES.

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STATIONARY.

WE beg to inform Engineers, Shippers, and Steam Users, that HALL'S PATENT INJECTORS were the first invented, and are the only thoroughly "AUTOMATIC" Boiler Feeders in the market. These high-class goods certainly have no equal for instantaneous starting and re-starting; they work at from 2 lbs. to 200 lbs. steam pressure, either lifting or forcing, and will start three times quicker than any other. They are exceedingly simple and reliable under all conditions. During the past six years 10,000 have been sold, calling forth universal approval from all parts of the world; and although during this period no less than seven so-called "Automatic" Injectors have been brought before the public, HALL'S Injectors are universally acknowledged perfect.

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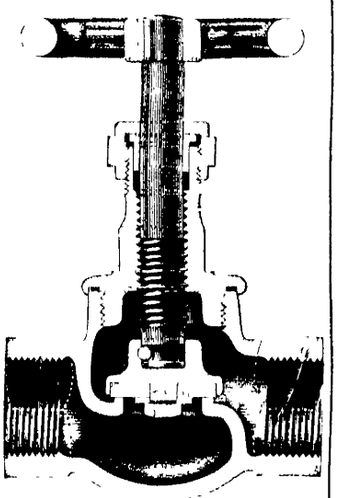
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LEEDS Messrs. S DIXON & SONS, Leeds Old Brass Works
HULL, &c Messrs. G CLARK & SONS, Water House Lane
HOLLAND: Messrs. R S. STOCKVIS & SONS, Rotterdam.
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They hold perfectly tight under great pressure. The Patent Seating can be renewed at will, without removing the body of the valve or breaking the pipe joints. While the price is only that of an ordinary gun metal valve, they will last very much longer

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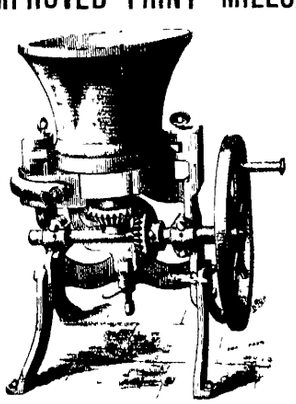
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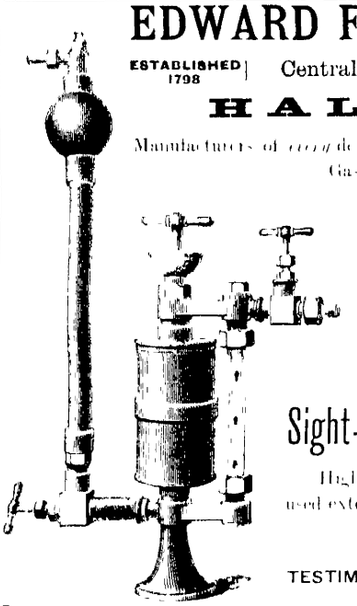
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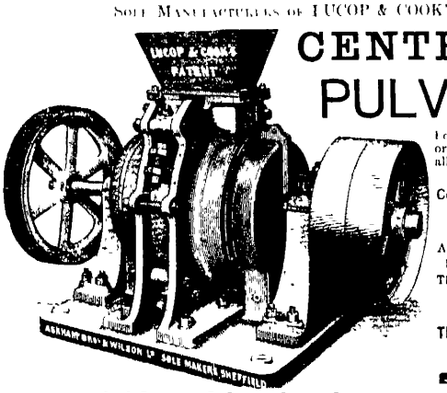
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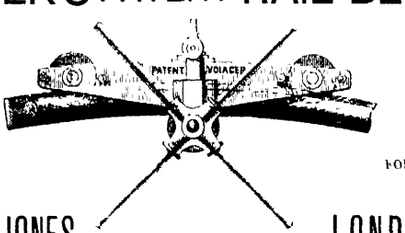
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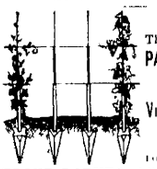
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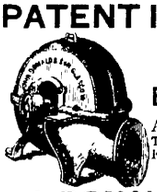
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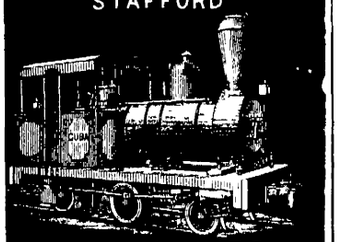


ALL SIZES in STOCK To Blow from 8 to 100 Smiths' Fires, and to melt from 8 cwts to 10 tons Metal per hour 5070

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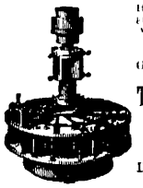
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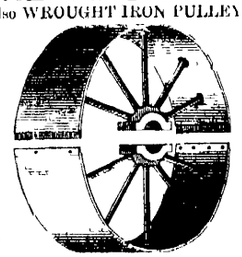
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LEFFEL'S IMPROVED PATENT
AMERICAN
Double Turbine Water-Wheel.



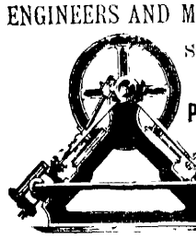
It is applicable to all heights of fall (acting, by actual amount of power with the last from one-eighth of water
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Steam Engines of every description to drive one or more of the above machines, fitted with One, Two, or Three Cylinders
SPECIAL QUOTATIONS GIVEN,
Also references to firms in England and Scotland where these Machines are working 4355

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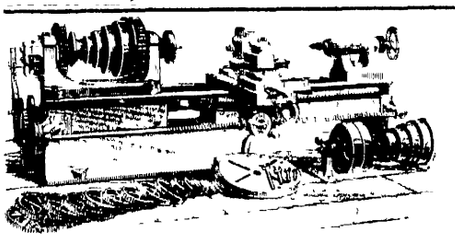


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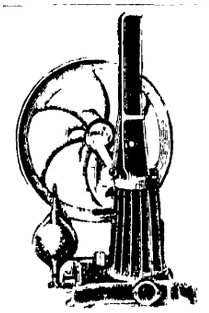


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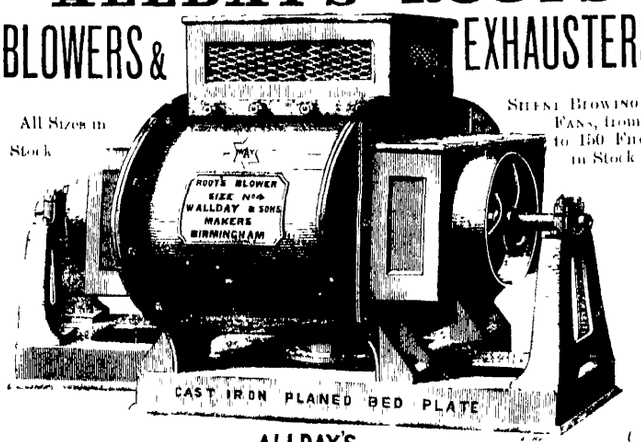
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PRICES AND PARTICULARS ON APPLICATION 4331

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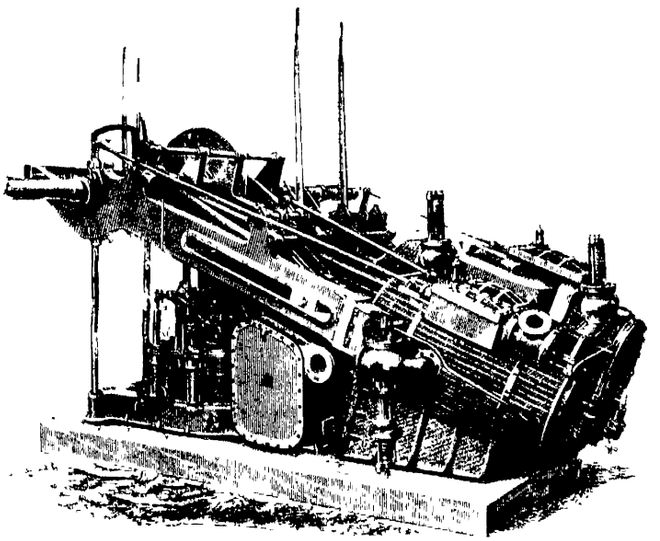
ENGINEERS, GREENOCK,

MAKERS OF RANKIN'S PATENT

2-CYLINDER DISCONNECTING COMPOUND ENGINES

4-Cylinder Disconnecting Triple-Expansion Engines,

FOR PADDLE AND TWIN-SCREW STEAMERS.



The principal advantages claimed for these Engines, as compared with the ordinary 2-cylinder Compound and 3 or 4-cylinder Triple Expansion Engines, are—

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SUPERIOR EFFICIENCY AND LESS TEAR AND WEAR

FULL PARTICULARS AND PRICES ON APPLICATION

[illegible] 2-cylinder Compound Engine [illegible] sets of the above fitted [illegible]

ARROL'S PATENT PORTABLE HYDRAULIC RIVETTING MACHINES,

FOR

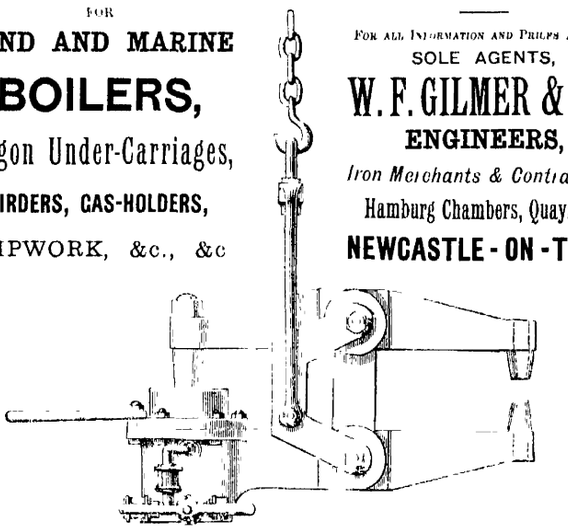
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LARGE NUMBER IN USE AT HOME AND ABROAD

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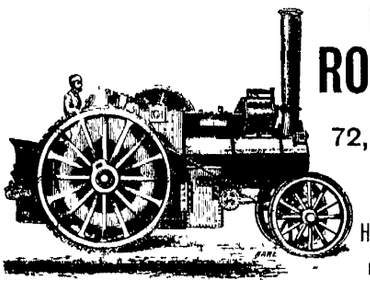
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Haulage by Steam on Common Road is 50% cheaper than by horses.

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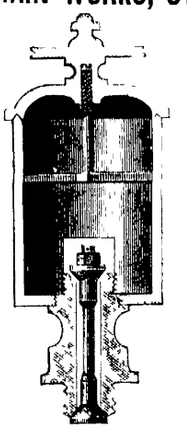
PATENT

Self-Acting Adjustable Lubricator.

TIPTON HALL CHAIN WORKS, STAFFORDSHIRE.

A Clear Saving of 50 per cent. in Oil, Tallow, or Grease.

Cannot get out of order.



Perfectly Clean in working.

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2 in., 2½ in., 3 in., 3½ in. 4 in.

Prices on Application.

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Patented in Great Britain and Ireland, Germany, France, Belgium and the United States

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1 The LOWERING of all loads is UNIFORM and REGULAR, and is independent of the operator
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Sole Manufacturers and Patent Proprietors 4179

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OF EVERY description Manufactured by

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SAFETY VALVES for Land and Marine Boilers

TURNBULL'S VALVES PATENT

MANUFACTURERS to the ADMIRALTY



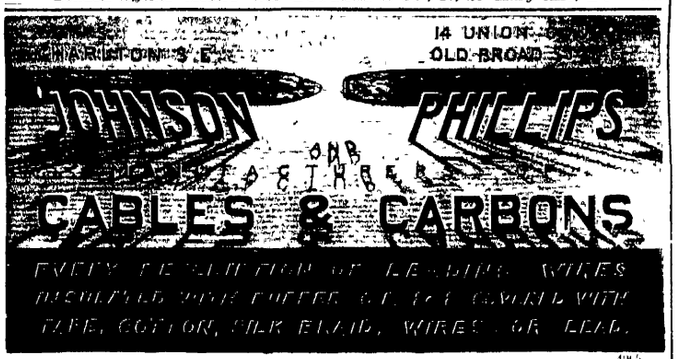
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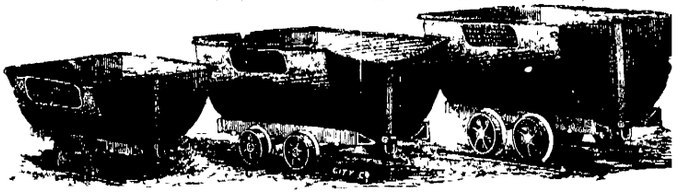
LIGHTEST, STRONGEST, AND MOST CAPACIOUS MADE.

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THOUSANDS IN USE BOTH AT HOME AND ABROAD.

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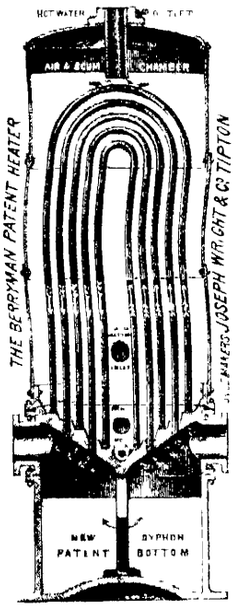
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THE WELL KNOWN BERRYMAN HEATER AND INTERHEATER, ARE NOW FITTED WITH OUR NEW PATENT SYPHON BOTTOM AND OTHER IMPROVEMENTS, SAVING FROM 15% TO 50% OF COALS, BOILER POWER, WATER & LABOUR

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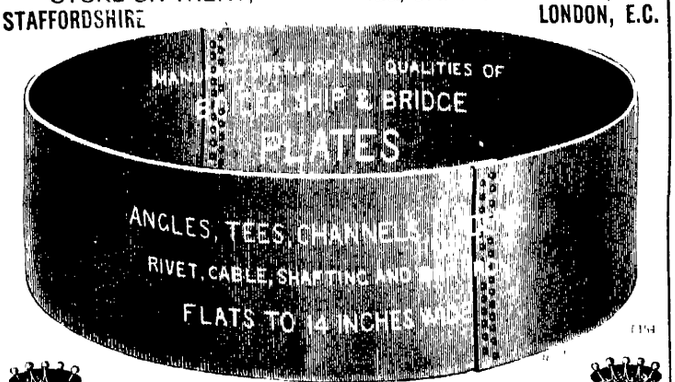
Piston Rods, Slide Rods, Motion Bars, Crank Shafts, Propeller Shafts, Axles, Wire Billets, Spades and Shovels, &c., &c. 6288

Gold Medals Melbourne 1881 Paris, 1878 First Class Medals Paris, 1855, London, 1862,

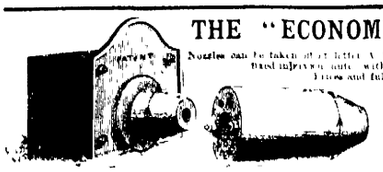
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THIS alloy is an improved brass hard durable and strong as mild steel possessing a beautiful golden colour, when melted it produces a sound castings of fine grain it can be forged hot and cold, and takes a very high polish

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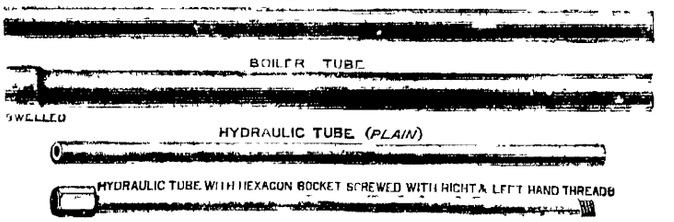
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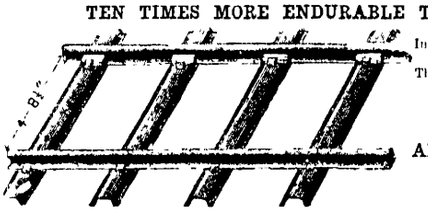


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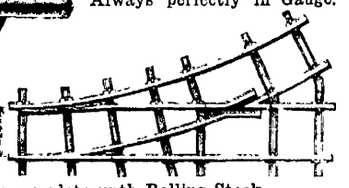
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The first and only Cross Sleeper in use upon English Railways with Flat bottomed Rails
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Can be shifted without damage
Always perfectly in Gauge.



THE MOST SIMPLE AND PERFECT FASTENING

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Aylesbury 1876
Highland Society (Gold Medal) 1876
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Royal Manchester, Liverpool and Lancashire 1878
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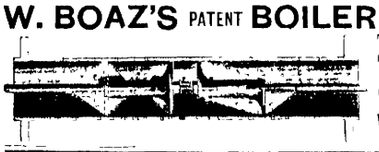
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THE GRATEFUL testimony of all the leading Engineers and Boiler Makers who have used the Patent Self-feeding Boiler Tube Cleaner is sufficient guarantee of its efficiency and economy.

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For 2in. to 2½in. tubes, 1-16, 1-8, 5-16, 3-8, 7-16, 1-2 inch diam.
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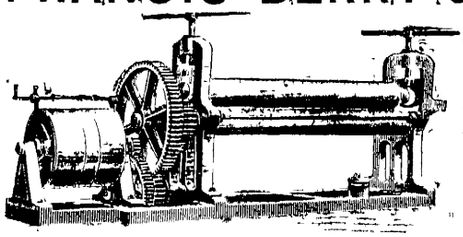


PLATE BENDING MACHINE

SOWERBY BRIDGE, ENGLAND,

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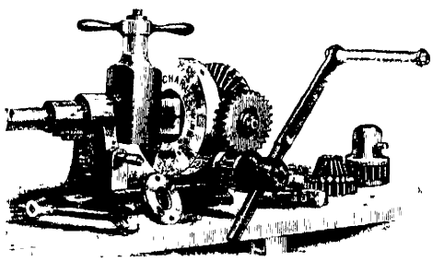
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DETAILED PRICE LISTS ON APPLICATION.



DETAILED PRICE LISTS ON APPLICATION

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Simplicity of the screwing arrangement, whereby the most inexperienced can screw any size of tube, and to any length of threads.
An arrangement, by which the dies are instantaneously readjusted and are made self centering, so that *accuracy* and uniformity of size is assured.

The Best Material and Workmanship is used throughout 4706

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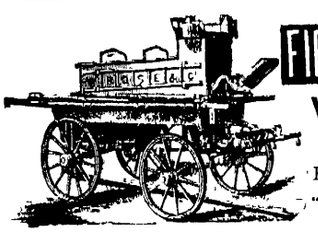
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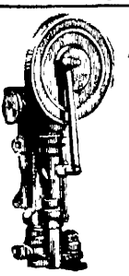
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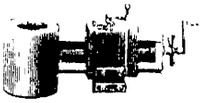
PATENT PADDLE ENGINES, HOISTING MACHINERY

1212

ILLUSTRATED PRICE LISTS ON APPLICATION

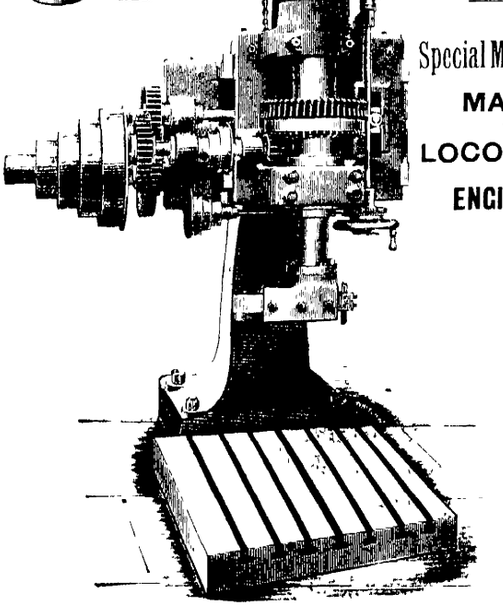
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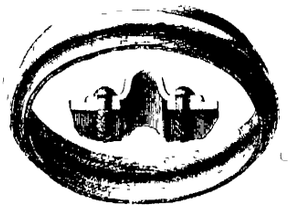
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Weldless Steel Expansion Hoops for Boiler-Flues



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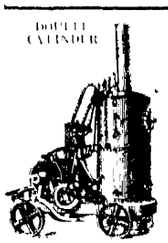
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"1st September 1881

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I am Yours faithfully E A BLOCK Secretary

To W M McIville, Esq Port Adelaide Dock Company, Limited

W. M. MELVILLE,

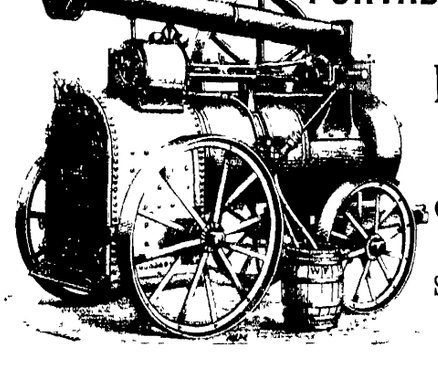
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Boilers of All Kinds.

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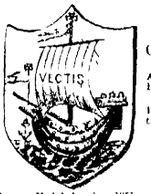
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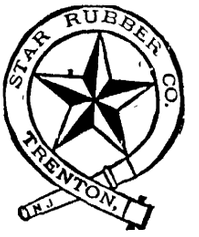
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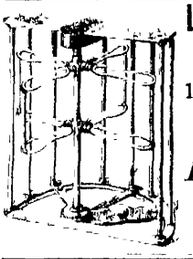
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as Headquarters for Europe and the Continent, where there will be always a Stock of Goods suitable for the different trades We beg to call your attention to the Price List which will be forwarded on application, and should you do us the favour of comparing our Price and quality of Goods with other Companies we are thoroughly confident that, by giving us a small Sample Order you will be convinced of the HIGH STANDING OF THE STAR RUBBER COMPANY of which our Goods and our Price List speak for itself We would call your special attention to the Medals which we obtained at the Test Melbourne Exhibition for the superior qualities of our

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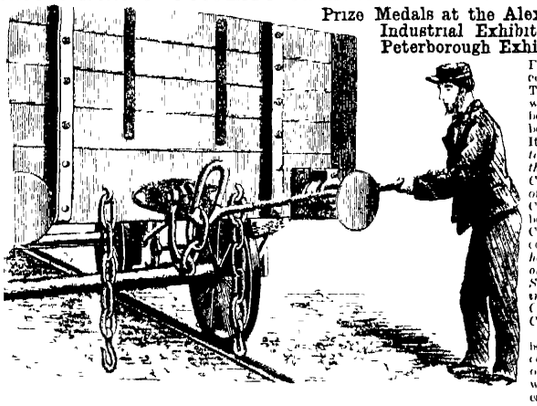
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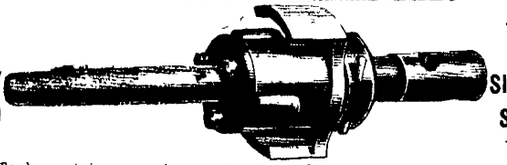
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EVERY TOOL WARRANTED.

PRICES GREATLY REDUCED



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LEATHER BELTING.

CURRIERS, 56, 57 & 58, *HIGH STREET*, AND St Paul's Works, SHADWELL, LONDON

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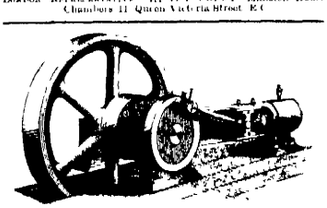
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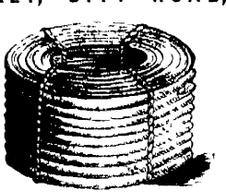
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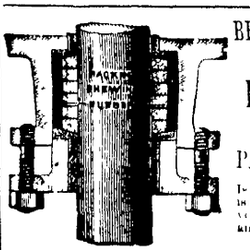
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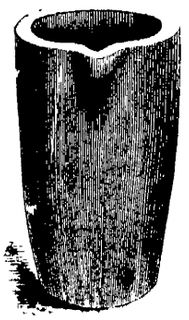


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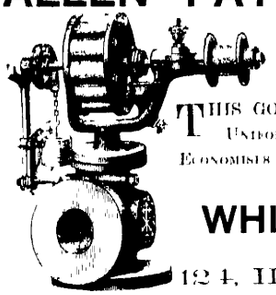
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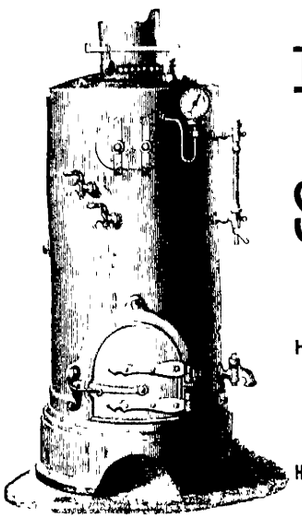
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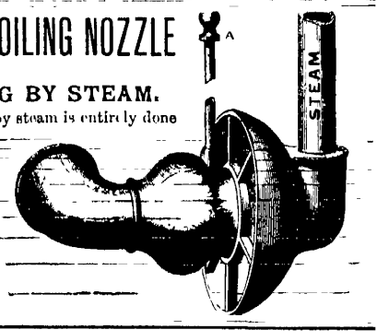
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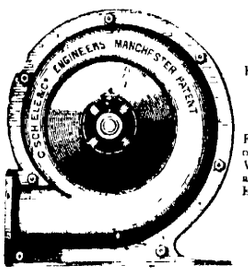
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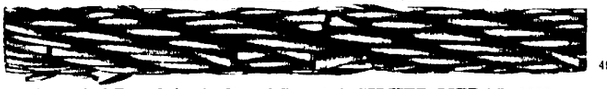


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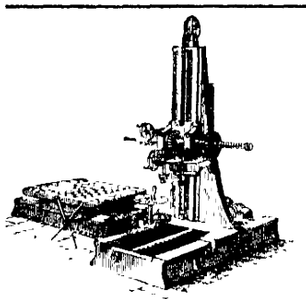
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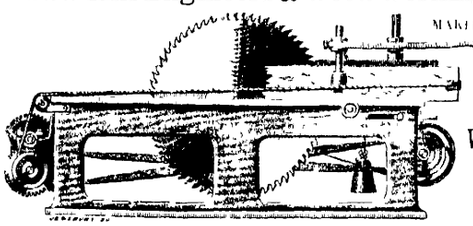
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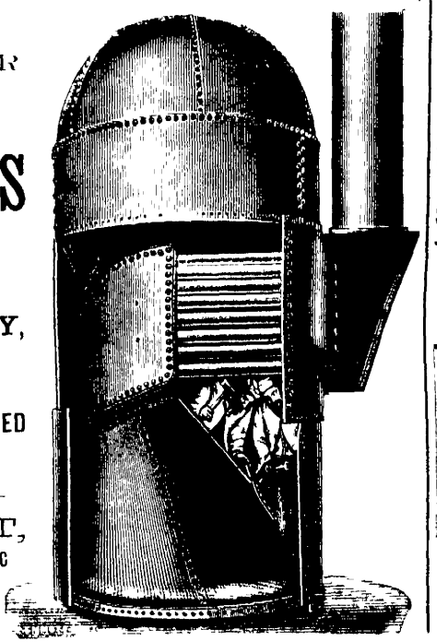
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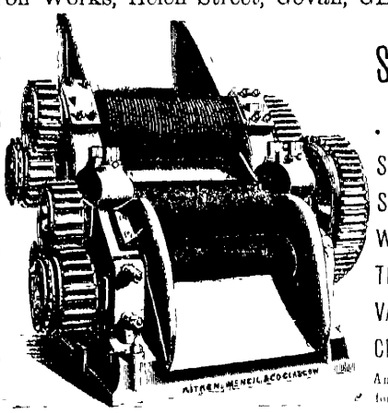
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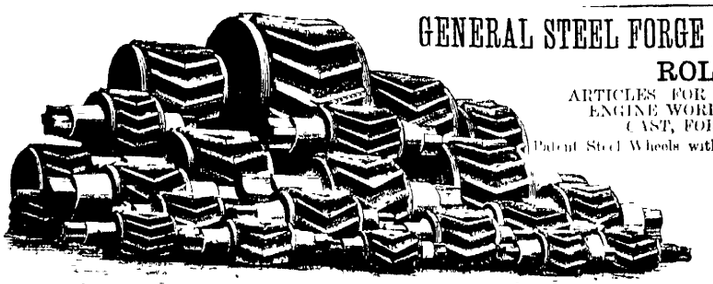
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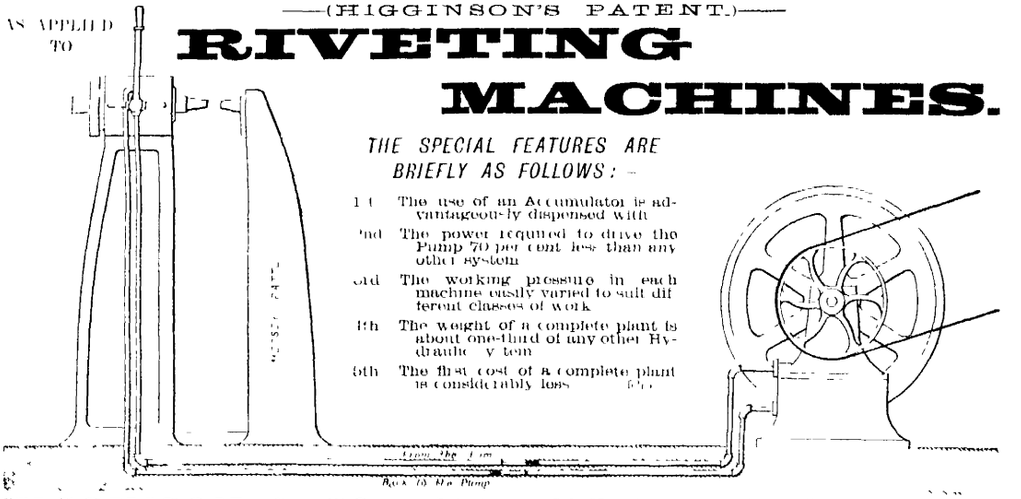
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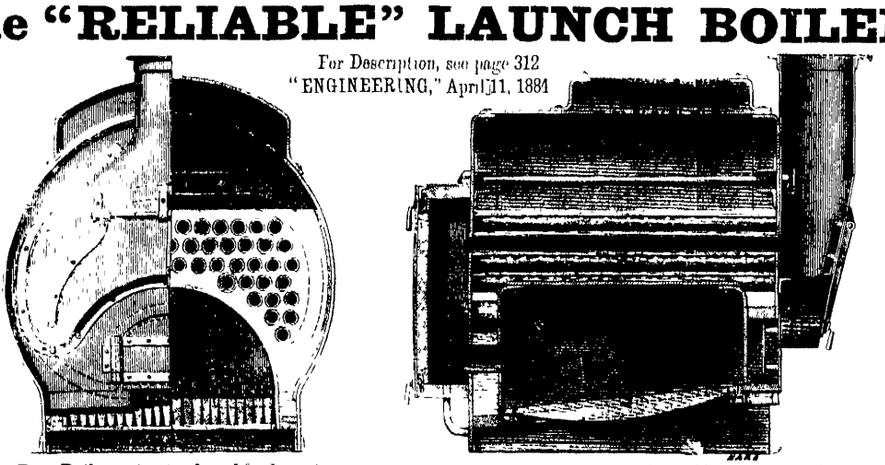
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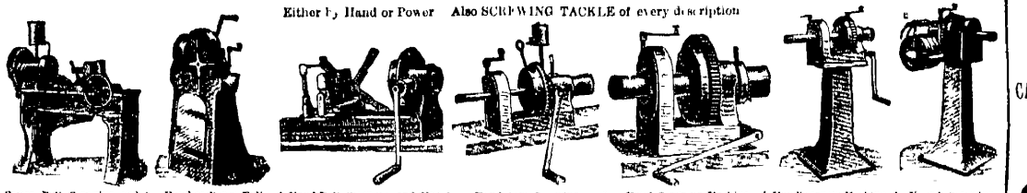
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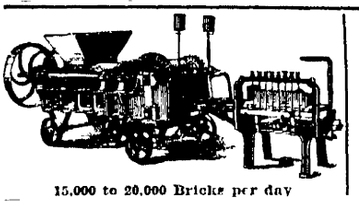
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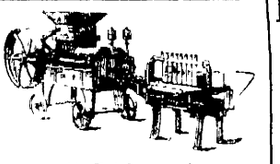
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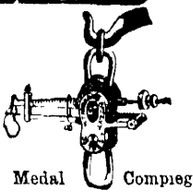


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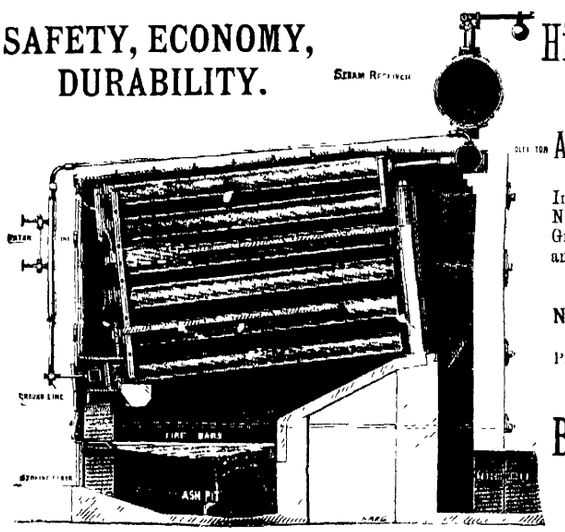
Thomson's Patent Winch Block

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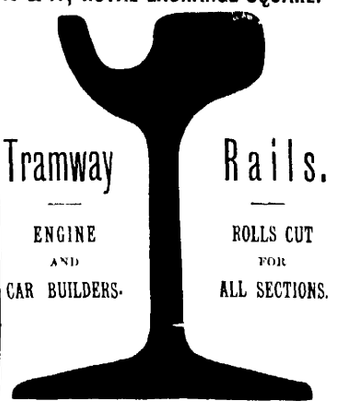
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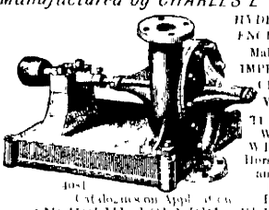
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Catalogues on Application

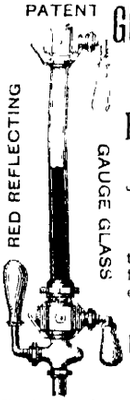
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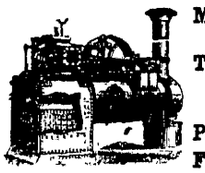
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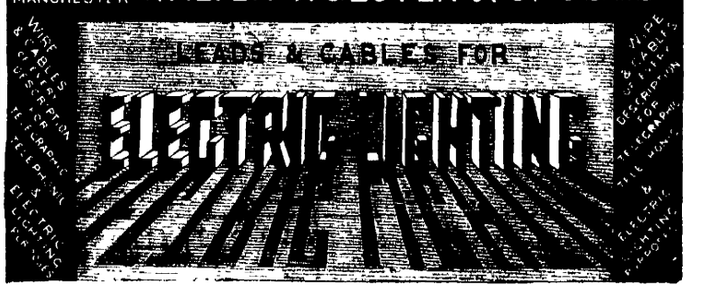
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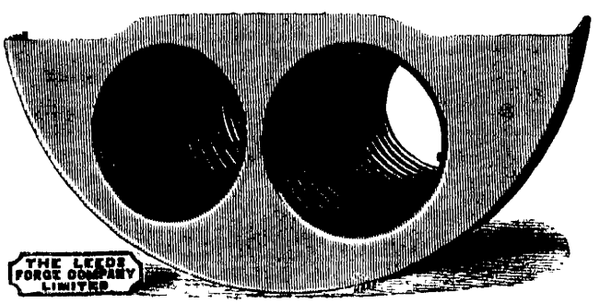
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"Leeds Forge" Special Siemens Mild Steel Plates for Boilers. Flanged Work for Marine Boilers | SAMSON FOX, C.E., Managing Director. 4909

LITERATURE.

The Patents, Designs, and Trade Marks Act, 1883 By W. R Bousfield, M.A., Barrister at Law London H Sweet. 1884.

In this excellent work the author has endeavoured as far as possible to deal in a clear and precise manner with all doubtful clauses of the new Act The conclusions arrived at, in all cases, appear to be those most consistent with the discussions which took place in the Houses of Parliament during the different stages of the Bill and with its avowed objects, and we are of opinion, after a careful perusal of the work, that in the greater number of cases they will be upheld should any of the doubtful clauses come before the courts

The book (after the usual short preface and table of contents) commences with an introduction embracing 47 pages and divided into three parts The first part deals with patents, the second with designs, and the third with trade marks.

The first chapter on patents treats of the prerogative of the Crown to grant Letters Patent under the Great Seal, the true and first inventor, and the theory of the patents under the present Act. From it we learn, that a document in the form of the Queen's Letters Patent sealed with a certain seal gives, by virtue of the Act, the patentee the same rights as would have been conferred by the Queen's Letters Patent of the same tenor The certain seal referred to is the seal of the Patent Office, which is now substituted for the Great Seal

The second chapter gives the procedure for obtaining a patent, the proceedings for which the author divides into two periods, viz, from the date of application to the date of acceptance of the complete specification, and from the latter date to the sealing of the patent, the different steps being concisely indicated in a clearly arranged table

The third chapter relates to proceedings where the grant to a patent is opposed and the details of procedure in opposition The available grounds of opposition are limited by the Act to three, viz (1) Fraud, (2) a prior patent, and (3) a prior application From these the author infers that want of novelty in an invention is no longer a ground upon which opposition can be based, unless that want of novelty is shown by a prior English specification, he also shows that the practice of "racing for the seal" is effectually abolished, so that the sealing of the patent of a second applicant will not prevent a prior applicant also obtaining the seal In any case of opposition to the sealing of an application it is now necessary that notice be given within two months from the date of the advertisement of the acceptance of the complete specification

The fourth chapter treats of the law as to amendments of Letters Patent and specification which has been considerably altered by the Act The provision for the amendment of the title of an invention, provided for under the old law, is omitted from the present Act, possibly on account, as the author states, of the provision for the official examinations This chapter further treats of the three different kinds of amendments permissible under the Act, viz, by way of disclaimer, by way of correction, and by way of explanation, under the latter of which the author includes the supplementing generally of an imperfect description, and apprehends that where an amendment is merely by way of correction or explanation, and does not affect the original claim, the patentee may bring an action, and recover damages, for infringement of date prior to the amendment. In the following sub-section of the Act the words in parenthesis are inserted as giving its true reading The amendment (if in accordance with the provisions of the Act) shall, in all courts and for all purposes, be deemed to form part of the specification The author also assumes that an amendment by way of disclaimer pending an action would generally be allowed only upon terms of the plaintiff paying costs subsequent to the issue of the writ (except costs incurred by the defence of non-infringement, &c), if the defendant, within a certain time from the amendment, should elect to submit to an injunction.

The conditions of validity of a patent are considered in the fifth and last chapter of Part I of the introduction The grounds on which a patent under the Act might possibly be held to be, or to have become, invalid are ranged under four heads, viz (1) That the patent does not satisfy the requirements of the Statute of Monopolies, under which the following would be good objections. (*a*) That the patentee was not the true and first inventor, (*b*) that the invention was not subject matter for a patent, (*c*) that the invention was not new, and (*d*) that the invention was not useful (2) That the grant has been made upon a false suggestion of the patentee, such as a false declaration or an incorrect description, (3) that the requirements of the Act (1883) and rules made there under have not been complied with, and the author notes here that the validity of a patent under the Act in no way depends on the existence of foreign patents for the same invention, and (4) that some of the conditions or provisoes of the patent have been violated, such as non-payment of the prescribed fees

Part II (Designs), after a few general remarks, contains the procedure on application for, objections to, and effect of, registration, and the conditions of validity and maintenance of copyright

The third part of the introduction contains a few general observations on trade marks, the kinds which may be registered, the classification of goods in regard to which they can be registered, the procedure on application, official objection and opposition to registration, concurrent applications in respect of the same mark, the effect of registration, conditions of validity and maintenance of rights, and Sheffield marks

The remainder of the work contains a reprint of the Act 1883 as finally passed, and an appendix including the rules under the Act and the forms given under the rules, a judicious selection of useful notes and cross references being interpolated with the text in their proper sequence We note with pleasure that great care has evidently been taken in preparing the index which is very complete and well arranged, the different headings being in a large clear type

We can heartily recommend this work to all interested in patents, professional and unprofessional, by the latter class it will, we are sure, be welcomed on account of its clear and lucid style and the special facilities afforded for reference to all points on which information may be required

---

Particulars of Marine Engines, Boilers, &c Partick, Glasgow John Toulmson, 182, Dumbarton road

This is a convenient memorandum book intended for the use of marine engineers and superintendents, and designed to contain the full particulars of the engines under their charge Each page comprises twenty one blank lines, and is ruled in vertical columns which are to be filled in by the user of the book The first column is always for the name of the vessel, and the remainder are headed with the names of the parts of which the particulars are to be entered As an example of the extent to which the subdivision of the parts of an engine is carried out we will give the headings of a page Opening the volume at random we come on a page having three main divisions and fourteen subdivisions The former are "valve gear," "cut off," and "crankshafts," and the latter (1) section of links, travel of links, diameter of reversing cylinder, stroke, diameter of handwheel, travel of link, (2) high pressure, middle pressure, low-pressure, and (3) diameter, length of journal, diameter of crank-pin, length of crank pin, radius of crank Sixteen pages are required for the enumeration of all the particulars of a steamer, and these are repeated five times in the book, with ample space between them for notes, so that the volume will easily serve for a very large fleet, and will accommodate the information usually spread through many note books, and which is not always to be found when wanted It is printed on capital paper and strongly bound, while its size is just within the limits of a somewhat capacious pocket

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RUSSEL'S LEACHING PROCESS

By T Egleston, Ph.D

For a number of years it has been evident that neither the smelting nor the amalgamation processes have given satisfactory results That either the loss of the precious metals was too great, or that the process itself was too costly to allow of the treatment of rebellious or poor ores For this reason attention has been turned to the lixiviation processes which have been successfully introduced in a number of works for treating ores, to which no other process seemed to be applicable But even these processes fail where the quantity of base metal, especially lead, increases beyond a certain amount as these metals are dissolved by the hyposulphites, and are consequently precipitated with the precious metals causing a loss of the reagent and making the bullion too base Some of the ingenious methods which have been devised for separating the base metals have been described elsewhere,* but none of them answer the purpose where the quantity of lead is large How to treat an ore which contains too little lead to smelt and too much to lixiviate, has been one of the most difficult of the metallurgical problems

In the simplest case the lixiviation processes in use require that the silver in the ore should be transformed into a chloride, since metallic silver, or any other of its compounds, except the chloride, are but slightly soluble in the hyposulphides of sodium or calcium Hence there is always a loss in silver, as it is impossible so to conduct the chlorination that all of the silver shall be converted into chloride How to extract more of the precious metals, or how to separate that contained in the tails, has been the important question which seems to have been solved by Mr E H Russel, of Park City, U S A He has discovered a solvent for the compounds of silver other than the chloride, which acts only slightly on this salt, so that after leaching out the chloride the tails may be treated In some cases the ore is not chlorurised, but only roasted to drive off the excess of sulphur, or in the case of slightly rebellious or of oxidised ores they are not roasted at all, but treated directly He finds that the lead dissolved from the roasted or unroasted ore can be separated from the solution as lead carbonate without the loss of any of the other metals This discovery is so important, and its application is so easy, that although a paper fully discussing this subject was read by Mr C A Stedefelt at the Chicago meeting of the Mining Engineers, we have thought it of interest to present the matter in a different form, acknowledging our indebtedness for details to Mr Stedefelt's paper, referring at the same time for other details to the paper already cited above

What is and always has been needed is a process applicable to impure or poor ores, or to both poor and impure ores, as these are those which are most commonly found The prices of labour, fuel, and transportation, together with the richness of the ore, will always determine whether smelting processes can be employed, but these we suppose to be out of the question The problem is how to treat an ore to which neither fusion nor amalgamation, either on account of the insufficiency of the capital or the actual or probable richness of the tails render it inexpedient to treat by any of the usual processes For such ores Mr Russel proposes a process composed of seven operations

1 Crushing the ore and roasting it with or without salt in any of the furnaces generally used

2 Lixiviating the roasted ore with hyposulphite of soda

3 Treating the lixiviated ore with the extra solution of sodium and cuprous hyposulphite

4 Precipitation of the lead by carbonate of soda

5 Precipitation of the gold, silver, and copper

6 Treatment of the sulphides

For poor ores, according to their composition, the process would be somewhat modified by either modifying the roasting or not roasting at all, and if there were no chlorides present, doing away with the roasting and first lixiviation altogether, and commencing at once with the extra solution

1 Crushing and Roasting the Ore

(*a*) *Crushing*.—Up to within a short time the almost universal instrument used for crushing was the stamp mill,† which has attained its greatest perfection in the United States A recent examination of nearly all the greatest dressing works of Europe shows that on the Continent it is being gradually abandoned for rolls, some of the works having abandoned it altogether, while others are only waiting their extensive repair to take the stamps out There is little doubt that the unintelligent use of rolls in the early days on Lake Superior had much to do with the prejudice against them in the United States It seems to be almost certain, however, that we shall then come back to them, as they are already being introduced in the west For purposes of lixiviation there seems to be no doubt that they are superior They not only give a pulp of more even fineness, but it contains less slimes, which, for purposes of lixiviation, is important, as the liquors should pass evenly through the ore and

* "Leaching Gold and Silver Ores in the West," Transactions of American Institute of Mining Engineers, 1883

† "The Ball Stamp," *Metallurgical Review* vol II.

attack all parts of it. With rolls a much closer hand-picking and sorting can be made. Too little attention is generally given to hand picking in the West, owing probably to the fact that much richer ores are treated there than here. Apart, however, from the consideration of the much greater equality of the grains of ore, and the less formation of slimes, is the important consideration of cost. For the erection of rolls, the cost is not only much less, but the parts themselves are simpler and less likely to get out of order. The steel of which the outside of the roll is made can be used until there is danger of its cracking from pressure, and even then be replaced with but little cost of time and labour, so that the useful effect of the material is much greater than with stamps. The amount of repairs required, on account of the simplicity of the parts, is much less, and much less skilled labour and fewer men for the same output are required. There is also but little doubt that the actual output per horse-power of the roll is greater, as there is no necessity in most cases in order to chlorurise the ore perfectly, to have it very fine; and as a very fine ore interferes with rapid filtration there seems to be no doubt of the superiority of rolls over stamps for crushing ore that is to be lixiviated. Rolls have been successfully used for some months at the Bertrand *Mill in Nevada**, and are being introduced elsewhere, and where very fine crushing is not required will no doubt take the place of stamps as they have done elsewhere. Even in the case of a very finely impregnated ore it is a question whether it will not be advisable to treat the ore first in rolls, and when all has been extracted from it which can be at that grade of fineness, to treat the residue with stamps as is now done in one of the largest dressing works in Europe. This, we believe, has never been done for lixiviation works, and except in the case of gold very finely disseminated in the gangue would hardly be advisable. There has been too little experience with the lixiviation process to know whether such a case would be likely to occur. In all the cases where rolls properly constructed and managed have been brought into competition with stamps, the latter have been taken out as soon as they were worn enough to require extensive repair, and rolls have taken their place.

(*b*) *Roasting the Ore.*—The problem to be solved in all the processes where it is necessary or advisable to *transform the metal into a chloride* by roasting it with salt has been how to perform this operation so as to give a high percentage of chlorides. This has been especially necessary up to the present time with the lixiviation processes, since metallic silver and most of the other compounds of silver in the absence of soluble salts of copper are but slightly soluble in the hyposulphite solutions used for lixiviation. This difficulty and the impossibility of producing a bullion free from lead when it has been present in the ores, has prevented the introduction of the lixiviation process, because in amalgamation, even when the chloruration has not been perfect, metallic silver, if present, will be acted on by the mercury, and many of the silver compounds will be decomposed at its expense, so that while the loss in mercury will be somewhat greater than it otherwise would be, the loss of silver will be less. The necessity of a high chloruration of the ore has stood in the way of the introduction of the lixiviation process, more especially as the presence of any considerable quantity of sulphurets, especially of blende, increases the difficulty and prolongs the time of roasting. It has, therefore, been the practice in many of the mills† to discharge the ore in such a way that it remains hot in heaps for several hours, and thus increase the chloruration effect without prolonging the time of action in the furnace and consequent danger of decomposing some of the chloride already formed. In the investigations which I have been making during the last three or four years, I have always found that in ordinary roasting, when the temperature was very high, or the operation prolonged, the amount of the precious metals extracted was always less than when the time was limited and the temperature low. Mr. Russel has come to the same conclusion, and discovered, in addition, that the loss in silver in chlorurising roasting is always less when the proportion of salt is high. It seems, therefore, desirable to perform the roasting of the ore as quickly as possible, and to allow the ore from the furnace to remain for some time in heaps before using it. For this purpose the Stedefelt furnace seems to be best adapted, as the roasting may be as short as desirable, while the chlorurising action may be prolonged at pleasure. The necessity of a perfect chloruration in this process is not so great as in the other lixiviation processes which use only a simple hyposulphite solution, for should any of the metallic silver fail to be acted on by the salt, or any of the sulphide or other compounds fail to be decomposed, so that it is left in the tails, it will be dissolved in the extra solution. It has been found that in certain poor ores the use of salt may be dispensed with altogether and the ore only subjected to an oxidising roasting and then lixiviated. Oxidised ores may, in certain cases, be treated without even roasting. The extraction is not perfect, but when the price of salt or fuel is high it may be cheaper to bear a small loss in silver rather than to pay the expense of salt and of roasting. When, however, the silver is contained in lead carbonate, the ore must be roasted, as lead carbonate is insoluble in the lixiviating solutions.

* "Leaching Gold and Silver Ores in the West," Transactions of American Institute of Mining Engineers, 1883.

† *Ibid.*

2. Lixiviation of the Raw or Roasted Ore with Hyposulphite of Soda.

The tanks which are generally used for this purpose are made of wood painted with asphalte. Mr. Stedefelt proposes to construct very large ones made either of Portland cement reinforced with iron or of bricks saturated while hot with coal tar, or of asphalte concrete, protecting the bottom and sides with a lattice-work of wood so as to prevent injury from the falling in of the ore or shovelling it out. The discharge pipes are made of rubber and enter the bottom and rise in the tank and are kept in position by a float. While the solution is working they are raised out of the liquid. When they are to be discharged they are kept just below its level by the float. Pinch cocks are sometimes used on them to regulate the flow of the liquid. The main conduits are made of iron painted inside and out with asphalte. The solutions are admitted to the tanks by rubber hose.

The pulp is first treated with water; when this is admitted above* on an ore which has been roasted with salt, it always contains some silver, and is allowed to flow into and out of a tank containing scrap iron where the copper and most of the silver is precipitated. After the leaching with water has been done, the hyposulphite is turned on. It should contain from 1.35 to 1.50 per cent. of the ordinary hyposulphite of soda in water to which sufficient sulphuric acid has been added to neutralise any caustic soda it may contain. All the salts of silver except the sulphide are more or less attacked by this solution. Its object, however, is to dissolve out the chloride which is either in the ore or has been formed by roasting. When chloride of silver is contained in considerable quantities in the ore associated with other minerals it is sometimes leached out and the residue either treated or concentrated and sold. The salts of copper and lead are also dissolved. The complete solution of the lead, however, requires a concentrated solution. As the solvent power of the liquor for the precious metals is not increased by concentration it must be made dilute, and as lead is more soluble in cold than in hot solutions, and as any considerable quantity of lead dissolved in the hyposulphite solution decreases the solvent power, the dilute liquor is heated to a temperature between 25 deg. and 50 deg. Cent. In this way the most of the precious metals and the least lead will be dissolved.

The liquor is allowed to remain on the ore long enough to dissolve out most of the chloride of silver, by which time all the other salts, except the sulphide, will have more or less attracted, some of the gold and most of the copper dissolved. The liquor is now drawn off and the pulp is ready for the extra solution. If the ore is crushed so fine as to make the liquor pass through it slowly, it may be forced through by using a stand-pipe or a force pump. To be sure of the quickest and easiest solution, it is well to make the liquors pass through the ore several times by draining the tanks and pumping up the liquor, or by arranging some system by which it will run out of one tank into the other by gravity. Such an arrangement expedites the solution and diminishes the amount of labour. If the pumps used are made of wood, they should be saturated with asphalte; rubber or hard lead answers the purpose better.

* "Leaching Gold and Silver Ores in the West," Transactions of American Institute of Mining Engineers, 1883.

3. Leaching the Lixiviated Ore with the Extra Solution of Sodium and Cuprous Hyposulphite.

Mr. Russel has discovered that if ores of silver are leached with sodium, cupreous hyposulphite, formed by adding copper sulphate to sodium hyposulphite, not only native silver, but sulphide of silver and its compounds of arsenic and antimony will be dissolved. This extra solution, however, while it acts energetically on the other compounds of silver, is a much poorer solvent for the chloride of silver than the ordinary hyposulphite solution. The compounds of gold are also dissolved, but the solvent power of the solution for gold is not increased by the addition of the cupreous sulphate, while it is very much increased for silver and its compounds, except the chloride.

The material left in the tails which has not been dissolved by the previous solution may be treated by this extra solution so as to extract a considerable percentage of their precious metal contents. Ores roasted without salt, or the raw ores themselves, may also be treated, and a very considerable percentage of the precious metals contained in them be extracted. This extra solution is made by dissolving 18 parts of sodium hyposulphite and 10 parts of copper sulphate in a small quantity of water, and mixing the solutions, decanting the liquid from the precipitate, washing it, and then redissolving it in water containing from 1 to 2.5 per cent. of sodium hyposulphite. The solution so prepared may be used for several successive charges, and only turned into the precipitation tanks when the cupreous hyposulphite is nearly exhausted. It may also be made by adding so much of the saturated solution of copper sulphate to the sodium hyposulphite as would be required to make a standard solution. This solution is not permanent. A considerable portion of the cupreous hyposulphite will commence to separate at once, and as it is the solution, and not the precipitate, which acts, its value will be rapidly destroyed. The more concentrated the solution, the more rapidly the precipitate will form. Hence it is much more advantageous to form the precipitate first, and then dissolve it, and in this way to form the permanent solution. The amount required to form the standard solution is 1 per cent. copper sulphate to 2 per cent. sodium hyposulphite, as more copper sulphate forms a precipitate, and renders the solution weaker. Dilute standard solutions at a temperature of about 50 deg. Cent. act more energetically than stronger solutions at a higher or lower temperature. Extra solutions made from calcium hyposulphite act as energetically as those made from sodium, while the potash compound is much less powerful.

The solution is let on to the ore from above, filters through, and is pumped up again several times, in order to dissolve out as much as possible of the metals, by pumps made of hard rubber or lead. As all of the solutions must be heated to get the best effect, this is done with coils of lead pipe placed in the tanks, through which steam is made to pass, which thus keeps the solutions at the proper temperature. The quantity of silver dissolved out from the ore will depend on the surface exposed to the liquid. Hence the ore should be as fine as possible, without being so fine as to be in the shape of mud. If the roasting has been properly done, it will always be greater than the assay, as the solutions have longer time to act on the large scale than on the small. The question might be asked, Why not dispense with the first lixiviation altogether and use only the extra solution? The results of a large number of experiments have shown that in almost every case when the two solutions were used one after the other, more of the precious metals were extracted than when only one was used.

Sometimes it may be worth while to treat raw ores, especially when they contain much native silver, by the extra solution first. It has been found that silver may still be extracted from the tails of the amalgamation process by the extra solution, and it is probable that when ore can be amalgamated directly, lixiviation can take its place. There is, however, one class of ores which cannot be treated without previous roasting; these are those in which the silver is contained in carbonate of lead.

In the use of both solutions the system of lixivia-

tion adopted at Agordo for leaching copper ores could be advantageously used. Here the fresh water is added to the ores which have already been treated three times, and the strong solutions, nearly or quite ready for precipitation, are put on the fresh ores. Such a system is especially adapted to poor ores which are to be treated directly. Both the ordinary and the extra solution should be used fresh. If kept unused for any length of time sulphates are formed by the action of the air, and the solution loses its solvent power.

It appears as the result of trial, that part of the silver in the roasted ore exists as sulphate. Mr. Stedefelt has proposed for such products as are now treated by the Ziervogel process, a much less careful and consequently a cheaper roasting for sulphate of silver,* and then to add to the ore, after it has been leached with hot water without removing it from the tanks, the extra solution. All the silver in the ore, except such as was contained in any fused or fritted product, which ought not to be there at all if the temperature has been properly regulated, would be dissolved This would make the complicated process now used on the Ziervogel tub residues unnecessary, and would probably be much more satisfactory in its results.

4. PRECIPITATION OF THE LEAD BY CARBONATE OF SODA.

Mr. Russel has discovered that the carbonates of lead are not soluble in the hyposulphite solution, while other salts of lead, silver, and copper are. If sodium carbonate, therefore, is added to the solutions drawn from the leaching tanks the lead will be precipitated, while the other metals will remain in solution. The separation of the lead is so complete that no trace of it remains. The carbonates of calcium, iron, manganese, and zinc are also soluble. Any soluble salts of these metals, which were contained in the ore or that were formed in the first stages of roasting, would be decomposed in the last stages of the roasting, or if they were not they would be washed out in the first wash of water, and would not be found in the pulp. To effect this separation of the lead it is most convenient, as well as economical, to make use of the ordinary commercial soda ash, which can be procured at a low price almost anywhere. This substance is, however, never pure. Is is likely to contain besides the carbonate of soda, both caustic soda and sodium sulphide which, if present in the solution, would precipitate the silver in the lead. To remove this the solution of soda ash is first dissolved in water containing 1.50 per cent. of sodium hyposulphite, then boiled with sulphur, which forms sodium hyposulphite and polysulphide with the caustic soda. The polysulphides are then precipitated with copper sulphate. Copper sulphide is formed, and this is insoluble in the hyposulphite solution. This separation of lead makes the use of sodium hyposulphite absolutely necessary. Calcium hyposulphite cannot be used because the calcium would be precipitated with the lead.

To effect this separation the liquors are drawn off into separate tanks and the necessary quantity of the purified sodium carbonate added to the solution. Mechanical agitators should be used to make the mixture perfect, these can be arranged so as to be worked with but little expense. The lead carbonate settles very rapidly and in less than an hour the clear supernatant liquor can be decanted into the precipitating tanks. When sufficient lead carbonate has accumulated it is collected, dried, and sold. Where it has no value the gain is still great, as the lead would have to be precipitated by sodium sulphide, a more costly reagent, but the net gain is in having the sulphides of silver and copper free from lead.

5. PRECIPITATION OF THE PRECIOUS METALS.

The copper, silver, and gold are precipitated from the hyposulphite solution by sulphide of sodium; this is necessary because any calcium entering the solution would be precipitated with the lead of the sodium carbonate. The sodium sulphide is prepared by boiling sodium hydrate with sulphur, and as the hydrate is readily soluble, the formation of the sulphide is much more easily effected, and the solution itself is much more effective as a precipitant than the calcium sulphide, which, however, in any case could not be used in the presence of lead, whose hydrate is not so soluble. The sodium sulphide, besides, can be heated to 100 deg. without much detriment, as it decomposes slowly, while the calcium sulphide can only be heated to a low point without decomposing. The solution so prepared contains considerable sodium hyposulphide, and as this salt is formed from the sulphide by the precipitation of the metals, it grows stronger by use. The solutions should be used at once, as after a time the dilute solutions lose their power.

6. TREATMENT OF PRECIPITATES.

After every precipitation the supernatant liquor is drawn off to be used over again and fresh liquor containing metals in solution is let into the tanks; when a sufficient number of precipitations have been made, the sulphides are withdrawn and dried, as at the Bertrand Mill,* or better, are put through a filter press If they are to be roasted the sulphides must be first dried and then carefully oxidised, so as to leave sulphur enough to form a matte with the copper which will be very rich in silver. If they are to be dissolved by the process proposed by Mr Stedefelt, they are added without previous drying to the sulphuric acid at 66 B. to which sodium nitrate has been added. Some silver chloride will be formed from the impurities contained in the reagents, and this with the gold will remain undissolved. The sulphur which collects is used in the formation of the sodium sulphide The escaping nitric acid is caught in a coke tower The silver sulphate is reduced with copper to metallic silver and melted. The copper sulphate is crystallised, a part of it is used in the extra solution, and the rest either sold or precipitated with iron. The residue of gold and silver chloride is allowed to accumulate and is treated by itself when there is enough of it

As compared with fusion or amalgamation processes this process offers all the advantages of a lixiviation plant, and in addition the possibility of making fine bullion free from lead, with a much higher extraction of the precious metals so far as the preliminary experiments, which have been made on a large scale, can show. Its chief advantage lies not so much in the extraction of the precious metals from ores which are ordinarily leached, for, although carefully conducted operations always give a higher extraction by the Russel process, the difference is but slight in some cases, as it does in the treatment of ores which would not ordinarily be leached, and which can be treated with only an ordinary roasting or perhaps with no roasting at all.

THE WEAVER NAVIGATION.

THE River Weaver, although naturally an insignificant stream so far as navigational purposes are concerned, has, by the application of engineering skill, been converted into one of the most important non-tidal waterways in the kingdom. It rises at Ridley Pool, in the south-west of Cheshire, and is 51 miles long, from its source to its confluence with the estuary of the Mersey at Weston Point. It is navigable as high as Winsford, or for a distance of 21 miles The area drained by the river is about 550 square miles, which is equivalent to nearly one-half of the county of Chester. The plan on page 242 shows the course of the river, and the localities which it serves. The attempt to make the river serviceable for traffic may be said to have commenced with an Act of Parliament obtained in 1721, since which date various powers have been obtained at different times. Although the River Weaver is of great interest to the engineer, it is hardly of less interest from an economic point of view. Its affairs are administered by a body of trustees, 105 in number, who are composed of the principal landowners of the county. The chairman of this somewhat numerous trust in Lord Delamere, Colonel France-Hayhurst being deputy-chairman. Mr Lionel B. Wells, M.I.C.E., is engineer, and Mr. T. B. Hughes general manager. The surplus earned by tolls, over that required for keeping up the navigation, is handed over to the county, and in this way considerable sums are obtained for reducing the rates. That any enterprise, in which there is only a philanthropic stimulus to a profit, and which has 105 masters, should be carried on so successfully, is in itself sufficiently surprising, and denotes a state of masterly activity on the part of the majority of the 105, which, no doubt, is highly conducive to the despatch of business. When, however, we remember that the enterprise depends for its success on meeting the active competition of two or three railway companies for the carriage of goods, our respect for the management is still further increased It should be noted, too, that the governing assembly is self-elective, and is therefore amenable only to the moral influence of public opinion. It is, indeed, to this fact of self-election that the success of the administration of the trust is attributed by many. If this view be correct, one cannot help speculating whether a more august body of legislators could not be improved by the application of a similar elective principle.

The chief improvements to the navigation have been carried out during the last nineteen years. Mr. E. Leader Williams, whose name has lately come so prominently before the public in connection with the Manchester Ship Canal scheme, was then engineer to the Weaver Trust, and he designed a series of alterations, for the purpose of accommodating larger craft, and giving facilities for steam towing. Mr. Williams also designed the hydraulic lift at Anderton, to which we make reference later on.

The staple produce of the Weaver Valley is salt, of which over 1,000,000 tons are annually carried over the navigable waters. About 800,000 tons are taken to Liverpool, the rest being consigned to other ports. The increasing importance of the salt trade of the county is said to be largely due to the improvements in the river Its greatest width is 110 ft., and its least width is 70 ft The depth of water to Northwich is not less than 10 ft in any part, and vessels 220 ft long can get as far as this point There are two viaducts, those of Dutton and Sutton, each with a height of 60 ft. from the surface of the water, all other communication across the river being made by swing bridges. Above Northwich there is a depth of water of 9 ft 6 in. to Winsford; there the navigation stops The locks above Northwich will not take vessels over 88 ft long. The largest vessel that ever passed down the Weaver was a steamer named the Woodcock, which had been built at Witton Brook. She is 520 tons burthen, and 152 ft long by 23 ft. wide. There are now fifty-two steam lighters engaged in carrying salt down the Weaver to Liverpool. These are fine vessels, carrying 300 tons of salt. The propelling machinery is generally placed right aft, the lines being very full in the after part in order to support the weight. The Weaver is far before the Mersey in point of navigable facilities, and could take vessels of 500 tons could they get as far as the entrance at Weston; indeed, all the arrangements have been made by the Weaver Trustees in the confident belief that the estuary of the Mersey must be improved, and that they will then be able to utilise the 15 ft. of water they have over the sills of their locks. The most interesting works upon this navigation are the aqueduct and boat lift at Anderton. These works were some time ago described by Mr. Sidengham Duer in a paper read before the Institution of Civil Engineers, and the following description, as well as the two-page plate which we publish this week, are reproduced by permission from the Transactions of the Institution

In what is called the Anderton basin, there is an island in the River Weaver which was fixed upon as the best site for the lift. It was decided that the water of the Trent and Mersey Canal should be carried in an aqueduct, at its normal level, across the river between the bank and the island, and that the boats should be lifted and lowered between the end of this aqueduct and a cutting from the main river into the island

The works constructed at Anderton consist of a basin opening into the Trent and Mersey Canal, a wrought-iron aqueduct to lead the water of the canal from the basin across an arm of the river to the end of the lift pit, a double hydraulic lift, situated on the island, capable of lifting from the level of the water in the river to that in the aqueduct or canal, and a channel cut through the island from the lift pit to the main bed of the river, for barges to pass to and from the lift and the river.

Fig. 1 shows a side elevation, and Fig. 2 a plan of the works. Figs. 3 and 4 are cross sections of the lift and aqueduct. Fig. 5 gives some details of the arrangement of the gates for the aqueduct and troughs, as well as the method of making the joints between the aqueduct and troughs. Fig. 6 is a section of one of the syphons for insuring the proper depth of water in the troughs; and Fig 7 gives some details of the main valves for working the apparatus, and of the method of controlling them.

* "The Boston and Colorado Process," ENGINEERING, vol. xxii., pages 199, 246, 269, and 317.

* "Leaching Gold and Silver Ores in the West," Transactions of American Institute of Mining Engineers, 1883.

The aqueduct is of wrought iron, 162 ft. 6 in. in length, and 34 ft. 4 in. in width, in three spans of 30 ft., 75 ft., and 57 ft. 6 in. A central web divides it into two channels, each 17 ft. 2 in. wide. This central web and the sides of the aqueduct are 8 ft. 6 in. deep, and form continuous girders, which carry the aqueduct, and the water, 5 ft. 3 in. deep, contained within it.

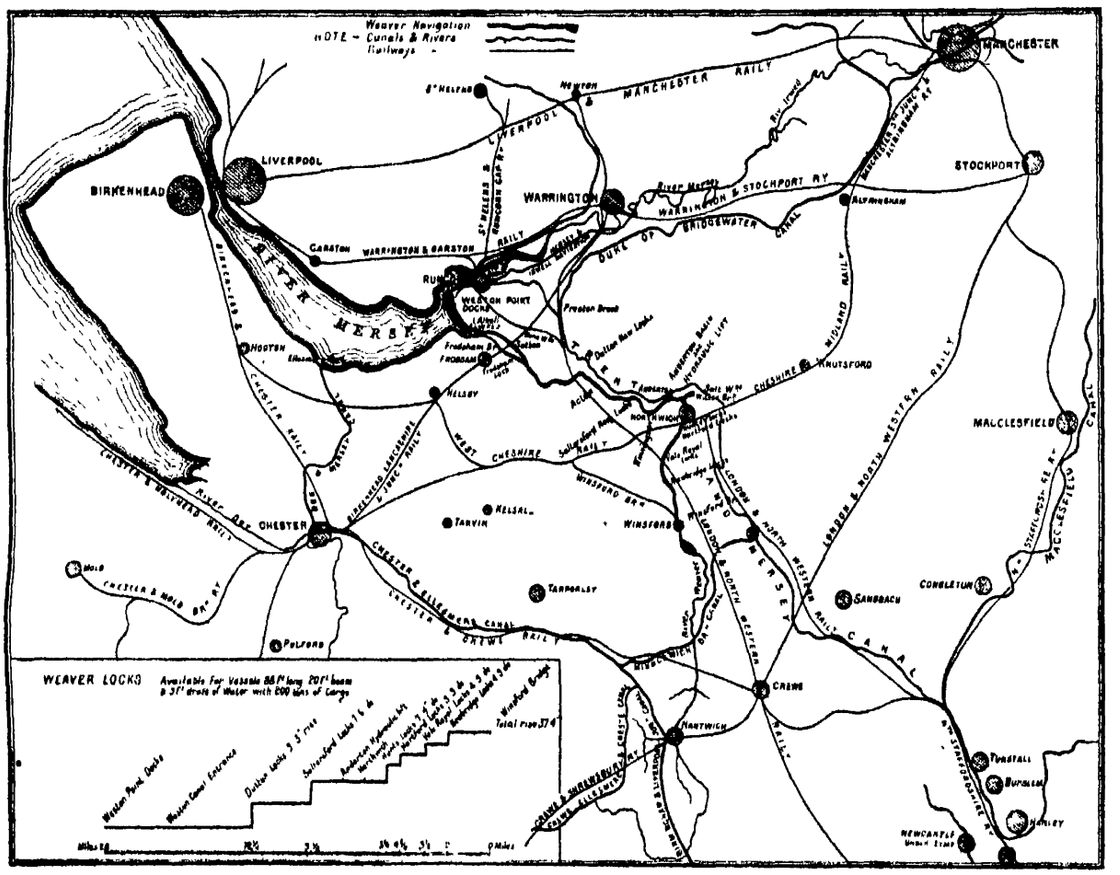
To insure a water-tight connection between the aqueduct and the basin, the cast-iron bedplate on which it rests is built into the masonry of the basin. The top of this bedplate was covered with red lead, and the bottom skin of the aqueduct was bolted to it. The inner edge of the bedplate was chamfered off, and the space between this chamfer and the skin of the aqueduct was caulked with wooden wedges. The sides are made water-tight with the masonry, by running in Portland cement at the backs of wooden fenders which protect the ends of the aqueduct girders.

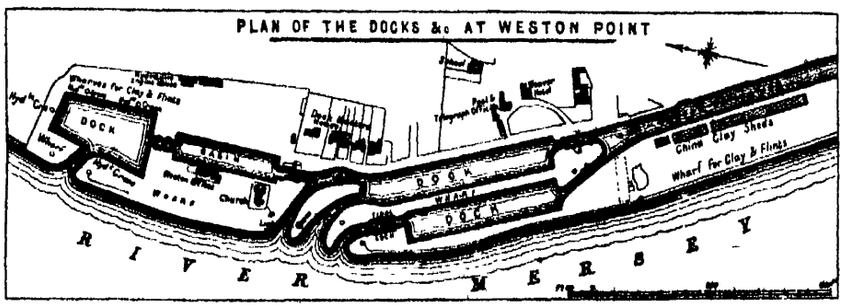
The columns A B bear on Portland cement concrete, contained in cast-iron cylinders, which rest upon a foundation of masonry supported on piles. The columns C, and all other columns round the lift pit, are carried down to below the bottom of the pit, and stand on foundations of brickwork and concrete. Each end of the aqueduct is fitted with wrought-iron lifting gates for controlling the ingress and egress of barges. As the aqueduct is divided into two separate channels, it follows that two such gates are required at each end. The weight of each gate is about 27 cwt. This is principally counterbalanced by weights D working over pulleys. The gates are lifted perpendicularly by a small crab and pulleys attached to cast-iron frames, which also serve as guides while the gates are being lifted or lowered. There is one crab to each gate, and one man can lift the gate 7 ft. 6 in. clear of the water in about a minute and a half. This is quite high enough to allow the largest barges to pass under. The gates have a strip of india-rubber fastened to the back of the flange, round their sides and bottom, and the internal pressure of the water forces it against a corresponding angle-iron flange fixed to the aqueduct, so that a water-tight joint is made.

The lift is double, and the barges are raised or lowered while floating in a box or trough, full of water, so arranged that one trough containing barges, in coming down to the river, assists in lifting barges in the other trough up to the canal. Each trough is 75 ft. long, and 15 ft. 6 in. wide, and is long enough to hold the largest barges that can be used on the canal, and wide enough to hold one of the largest or two of the small ordinary barges. The small barges each carry from 30 to 40 tons, the larger barges from 80 to 100 tons of goods. The troughs are constructed entirely of wrought-iron, their sides forming girders 9 ft. 6 in. deep in the centre, and 7 ft. 6 in. deep at the ends. These girders support the entire weight of the trough, with its load of barges and a depth of water of 5 ft. The sides of the trough are stiffened to resist the outward pressure of the water, by external gussets like those of the aqueduct, but there are no overhead arches. The pressure on the bottom is transmitted to the side girders by transverse floor girders 1 ft. 9 in. deep, and by longitudinal floor girders 9 in. deep

At each end of a trough there is a lifting gate, similar in construction and mode of operation to those described for the aqueduct. At the sides there are a number of cast-iron syphons for securing whatever depth of water the circumstances of lifting may require. Each of the troughs is attached to the head of a cast-iron ram by a central wrought-iron socket 3 ft. 6 in. deep, bored to fit the turned head of the ram. From this socket wrought-iron cantilevers radiate to the side girders of the trough to transmit the weight from the side girders to the ram. Each trough is thus entirely supported and moved up and down by one central vertical ram 3 ft. in diameter.

This ram passes through a stuffing-box in the bottom of the lift pit, and through the tunnel into the press. The wrought-iron tunnel under the lift pit, 4 ft. 4 in. in diameter, is to afford easy access to the valve box E, and to the glands of the presses and stuffing-boxes, for the adjustment of the packing, and for lubricating the rams. The weight of each trough, with the water and barges contained in it, is 240 tons, which is equal to a pressure of about 4¾ cwt. per square inch of area of the ram. The rams and presses are of cast iron, in three lengths, joined together by flanges and bolts. The flanges of the rams were covered with red lead before being bolted together. The flanges of the presses, besides red lead, have a ring of lead wire between them, which, being squeezed flat by the pressure of the bolts, makes a water-tight joint up to the required pressure The presses, pipes, and all other parts of the apparatus were tested to a pressure of 6 cwt. per square inch before being used. The presses are below the bottom of the lift pit, within cast-iron cylinders 5 ft. 6 in. in diameter, sunk to the required depth by the pneumatic process. They fit into cast-iron bedplates, laid on two layers of wood, each 4 in. thick, resting on the Portland cement concrete at the bottom of the cylinders. These bedplates are fixed in their places laterally by Portland cement concrete between them and the inside of the cylinders. Besides resting on the bottom bedplates, the presses can also rest on the





THE DUTTON SLUICES: RIVER WEAVER NAVIGATION.

MR. LIONEL B. WELLS, ENGINEER.

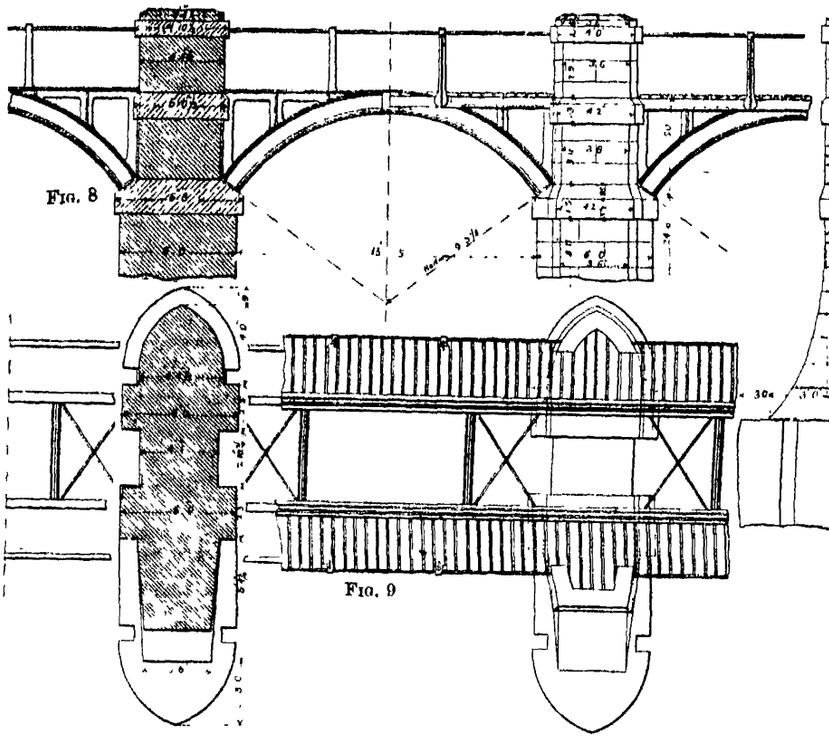


FIG. 8

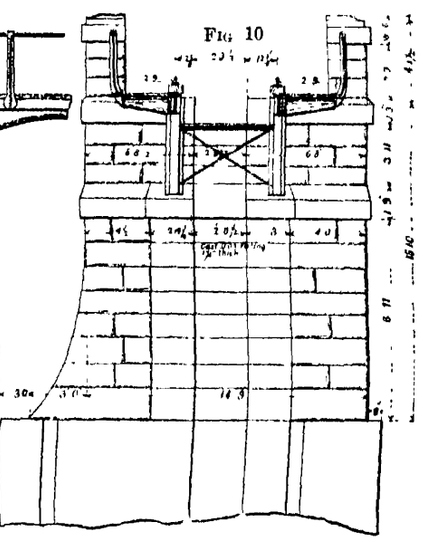


FIG. 10

FIG. 9

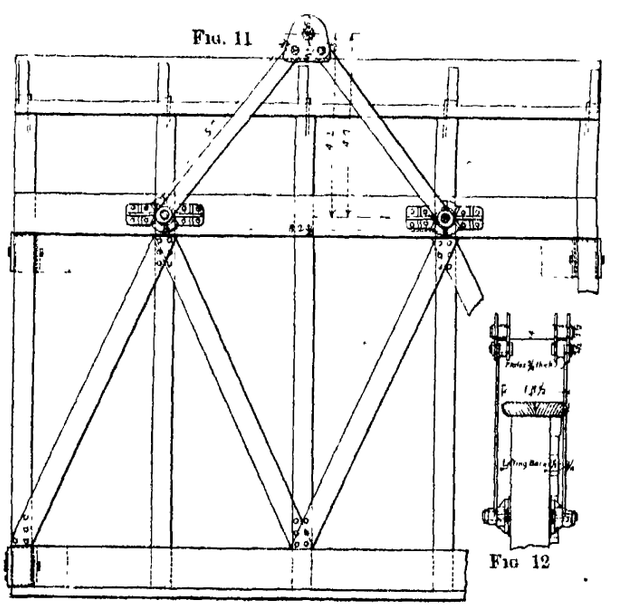


FIG. 11

FIG 12

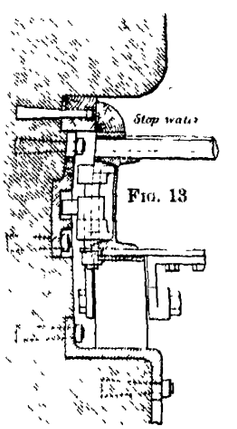


FIG. 13

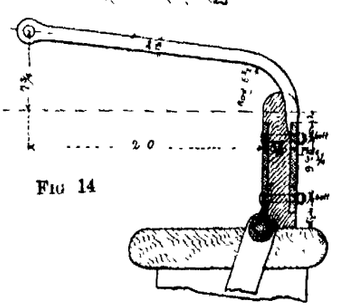


FIG 14

tops of the cylinders containing them, which have large external flanges, so as to give a great area of foundation. At the corners of each of the troughs there are cast-iron guide blocks, which work against guides on the columns round the lift pit, so as to keep the troughs steady while they are in motion. The guides and guide blocks are accurately planed and carefully fitted.

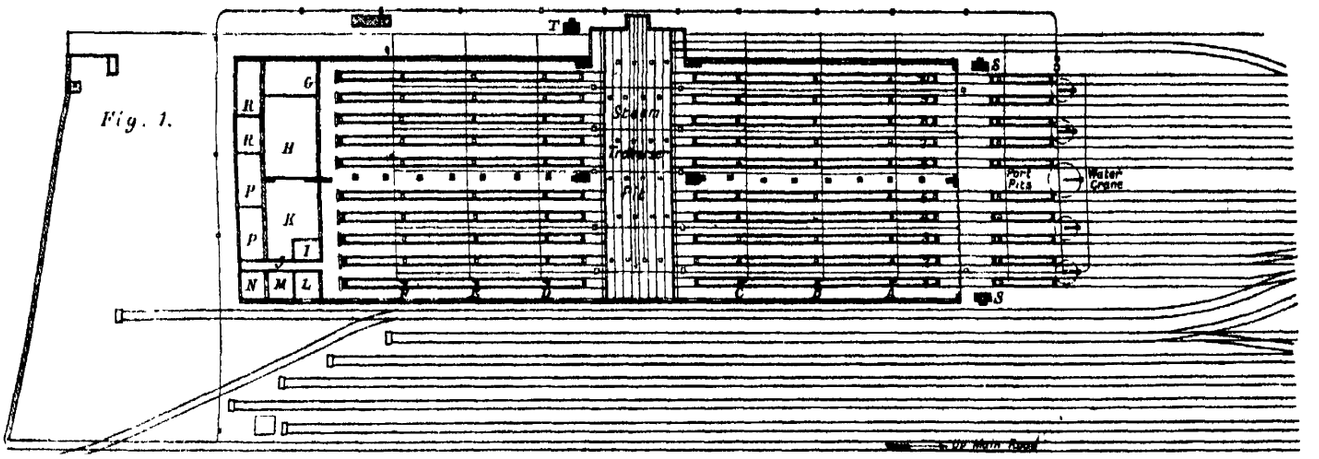
The guide columns are supported, below the bottom of the lift pit, on foundations of brickwork and concrete. They are filled with ballast, and built into the masonry round the lift pit to increase their weight and stability. At the aqueduct end of the lift pit they are braced to the columns supporting the aqueduct, and are tied to the aqueduct itself. At the river end they are braced together, and to a central column 10 ft. 6 in. distant from the centre guide column, so as to form a large triangular buttress of great strength. This is tied at the top to the guide columns at the aqueduct end of the lift pit by the lattice girders, which also carry a platform; and half-way between the ground and this lattice girder this buttress is again tied to the same columns by other small lattice girders, placed horizontally to resist wind, and slung from the platform girders so as not to sag. These girders are thus kept straight, and form efficient tie-rods.

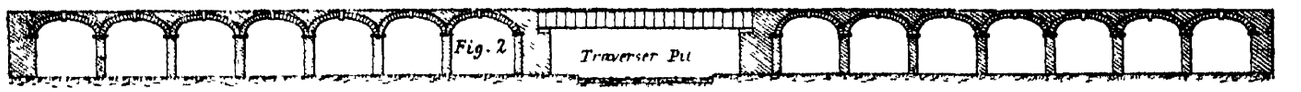
The distance between the guide columns is sufficient to allow a trough, when disconnected from the top of the ram, to be floated between them out of the lift pit; and as wooden gates can be fitted to close the river end of the lift pit, the water can be pumped out, and all parts of the apparatus easily got at for repairs. A platform round the aqueduct and lift pit, at the height of the water in the aqueduct, for the manipulation of the gates, and for moving barges in and out, &c., allows all parts of the apparatus to be easily seen from it. There is an accumulator, to assist in working the lift, having a ram 1 ft. 9 in. in diameter, with a stroke of 13 ft. 6 in.; it has a capacity equal to that of one of the main rams for a stroke of 4 ft. 6 in. The two main presses are connected by a pipe 5 in. in diameter (Fig. 7), fitted with an equilibrium valve E, for opening or closing communication between them.

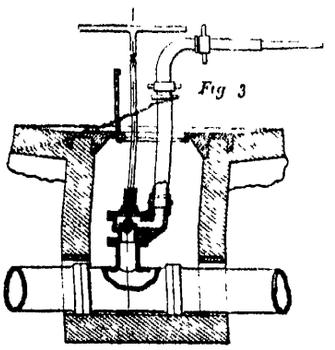
There is also a pipe, 4 in. in diameter, for each of the presses, passing from the accumulator

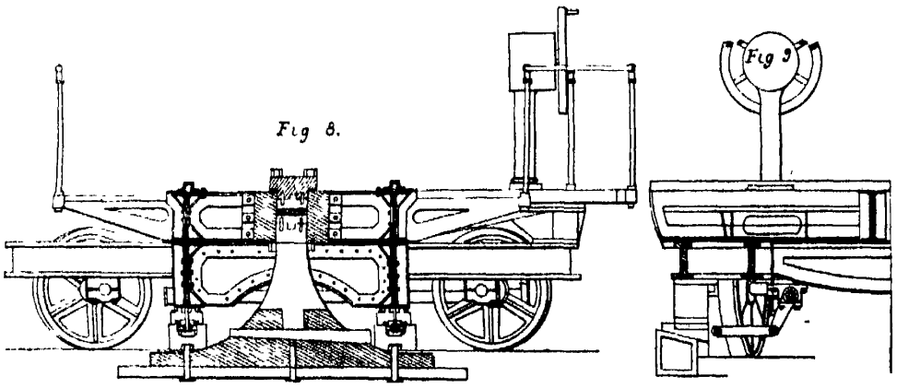
LOCOMOTIVE RUNNING SHED AT CARDIFF; TAFF VALE RAILWAY.

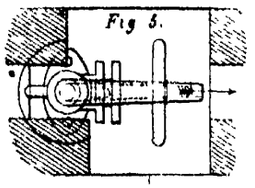
MR. CHARLES HURRY RICHES, ENGINEER, CARDIFF.

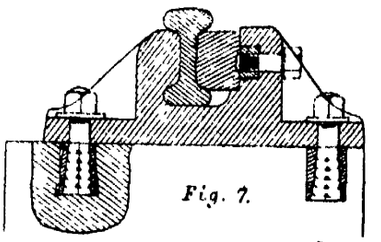


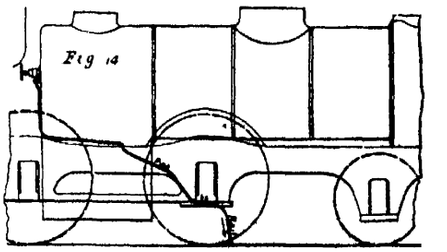


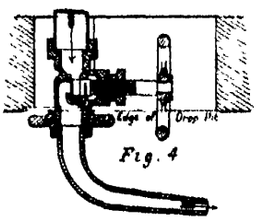


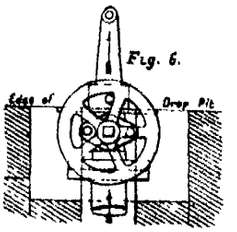


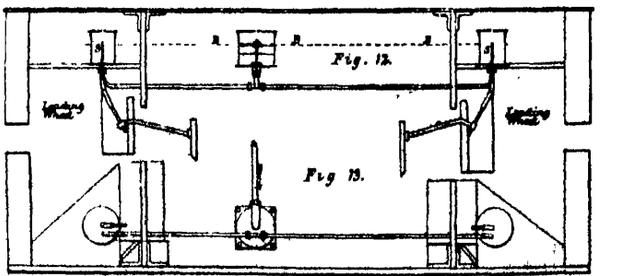












RUNNING SHED ON THE TAFF VALE RAILWAY.

New Locomotive Running Shed of the Taff Vale Railway at Cathays, Cardiff.[a]

By Mr. CHARLES HURRY RICHES, of Cardiff.

OWING to the large increase during the past few years in the traffic of the Taff Vale Railway, it became necessary to remove the Cardiff engine shed from the old site at the Cardiff terminus to a new and more eligible one at Cathays. The arrangements of the new shed, with its adjacent yard and appurtenances, are shown in the accompanying drawings, Figs. 1 and 2.

Main Shed.—The main shed is built to accommodate sixty large tender engines, and is 383 ft. long inside the walls, Fig. 1. It comprises two spans of 67 ft. each, divided by a centre wall, which is supported by elliptic arches, resting upon brick pillars, Fig. 2. There are five roads under each span, making ten in all. Midway in the length of the shed is placed a steam traverser, 40 ft. long, which works at the floor level right across both spans of the shed, so as to remove engines from any one of the ten roads. The pits are numbered from No. 1 on the eastern side of the shed, up to No. 10 on the western side. The same numbers hold good for the corresponding lines of road throughout the entire length of the shed, that is to say, both north and south of the traverser; and the length of the shed is divided into six divisions or tiers of berths. Commencing from the ten pairs of outlet doors at the north end the first berth is lettered A; consequently the

[a] Paper read at the Cardiff meeting of the Institution of Mechanical Engineers.

LOCOMOTIVE RUNNING SHED AT CARDIFF.

MR. CHARLES HURRY RICHES, ENGINEER, CARDIFF.

Fig. 10

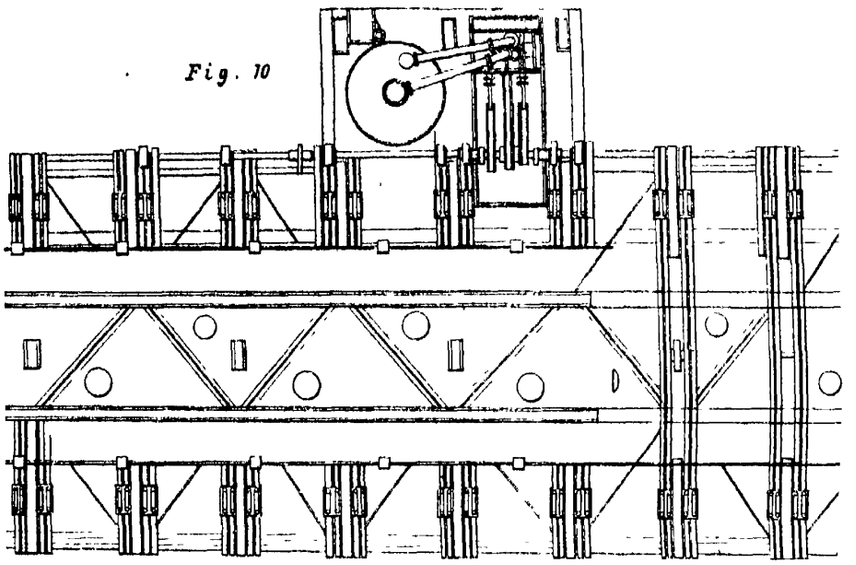


Fig 11

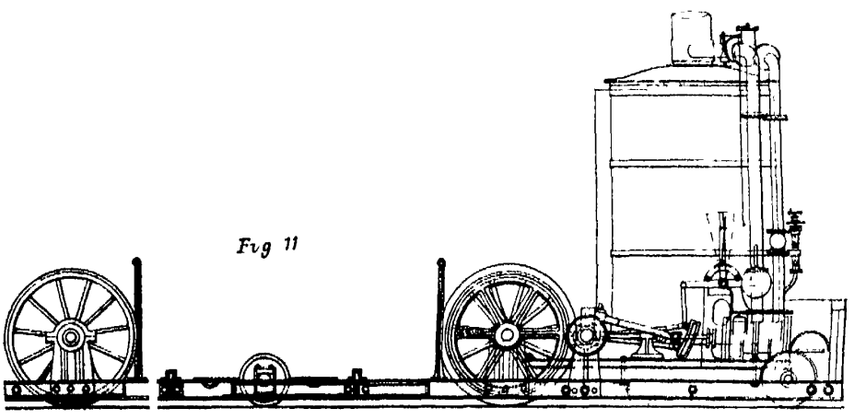


Fig 16

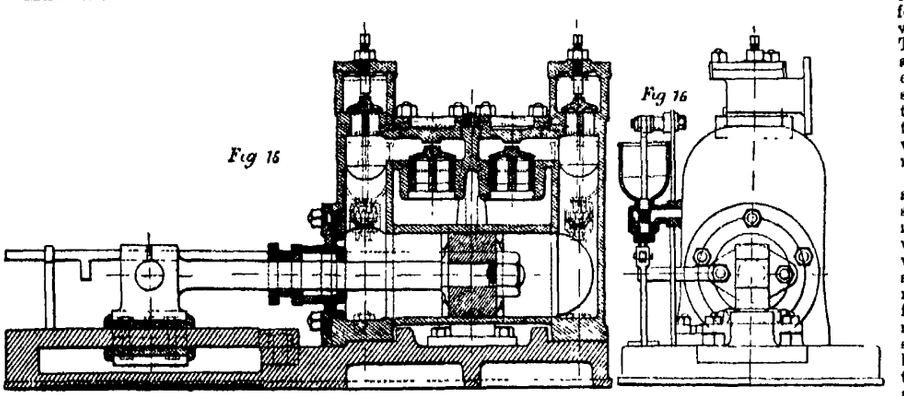


Fig 16

ten engines against the doors will be in berths 1 A to 10 A. The next tier of berths is lettered B; and so on to F, the last at the south end, which is invariably used for "day-in" engines. This plan of berthing the engines each "booked train" enables the men to find their engines at once when they come on duty, and obviates delay, which otherwise would inevitably arise in so large a shed.

Engine Pits.—The main pits are 3 ft. in. deep, and extend throughout the entire length of the shed, excepting traverser. In all the pits there are drains at intervals of 46 ft. 10 in., each of which is trapped syphon box; underneath the box is a sump, 2 ft. and 3 ft. deep, for the purpose of catching any refus the drain pipes lead away at a height of 2 ft. from the bottom of the sump. In every alternate space between the pits there is a water main, with hydrants at every 37 ft. 6 in. These are covered with cast-iron frames, having a small lifting flap for the insertion of the stand-pipe, which keeps the hose clear of the floor; and when not in use, the whole falls flush with the floor. All the hydrants have screwed plugs, and are of course duplicates of one another, as shown in Fig. 3. Between all the roads the floor of the shed is pitched with firebrick set on edge. At the berths F at the south end, called the "day-in" tier, pieces of hard wood are let into the pitching alongside each road, for placing lifting-jacks upon; and south end of the shed, adjoining these berths, are the fitters' benches.

Workshops and Offices.—Across the south end, and covered by continuations of the same roofs, are placed the workshops and offices, Fig. 1. The coppersmiths' shop, entered through the end wall at the south-west corner, is 19 ft. 6 in. wide and 19 ft. 3 in. high to the eaves. Adjoining this come the boiler shop and smiths' shop, also entered from the main shed, near the longitudinal centre wall; these two shops together occupy the end of the western span. In the eastern span, and entrance from the shed, comes the in the corner of which is placed the chief foreman's office; then the passage for the workmen's entrance, and finally a tier of timekeepers' offices. The southern extension of the main roof is 30 ft., and consequently all these shops have an equal width, as shown in the plan, Fig. 1. The offices on the eastern side of the entrance passage are two in number: the one nearest the shed being the train booking timekeeper, and the other for those taking enginemen's "trips" and shedmen's tickets. Adjoining the latter, by a lean-to roof, is a trainmen's waiting-room, where the men remain to give their "trips" off, and await orders for trains. The lean-to roof extends across the whole south end of the shed, and under it are placed two long mess rooms of 30 ft. length and 14 ft in width, and also the stationary engine and boiler houses, Fig. 1.

The lighting of the shed is by gas; but it is intended to light the yard and approaches by electricity.

Drop Pits.—Outside the shed at the northern or outlet end the ten roads lead to separate drop pits, each of which has a large syphon drain, fitted with similar sumps to those in the shed; and with water jets so arranged as into the ash-pan without the use of flexible hose. Adjoining the drop pits are erected two double fire furnaces for lighting the engines; and there is also a third by the doors of the traverser. On the further side of the drop pits are five water cranes, placed between alternate pits, and each capable of supplying two roads

Yard.—Passing out into the yard, there are cross over ads with compound shunts, so arranged as to lead the engines out from any of the ten shed roads to the six main running lines that lead from the yard, or to the main coal stage roads. There are three junctions to get from the yard to the main line.

The coal stage has a double platform, with a road for the wagons in the centre, and a road on the outside of either platform for the engines. The platforms are 133 ft 3 in. long, and each is fitted with three coal cranes and nine tumbler buckets for working

Sand Drying.—Between the coal cranes are placed nks for containing dried sand; and in close proximity to the coal stage there is a sand-drying kiln. This has three furnaces, and the flues are so arranged as to heat 106 square feet of drying platform, which is made of firebrick. The sand is first thrown in through doors in the front of the kiln, ranged above the stoke plates, and is there received inclined iron slide, the bottom end of which d into steam. The sand from the slide is cast and spread out upon the kilns, and in process of drying is gradually worked by hand across to the delivery side, where when dried it is cast upon a sloping screen, and the fine sand passing through is taken to the tanks upon the coal stage, the rough refuse being thrown out

Water Supply.—The water used at this shed is pumped up from a well by means of a Tangye "special" pump, which delivers it into a cast iron tank, supported by wrought iron girders that rest upon a stone building. The bottom of the tank is 25 ft. above the ground The well is 53 ft in depth, of which 7 ft. is subsoil, 9 ft gravel, and 37 ft marl From this depth about 7000 gallons per hour are obtained. The water cranes are of the ordinary type, and require no special notice.

Turntable.—The main girders of the turntable are semi-elliptic inverted, of rivetted plate, and of treble T section. The centre piece is supported by two short wrought-iron beams. The centre pivot is composed of a round pin, as shown in Fig. 8, supported by a cast-iron cone in two parts, which rests upon the centre foundation stone. Between the top of the cast-iron cone and the point of the pin is inserted a case-hardened washer of double convex section, to reduce the friction The ends of the table are carried round the race upon four cast-iron wheels, two at either end, which are shod with crucible steel tyres of 2 ft 11⅛ in. diameter The short axles of the wheels run in plummer blocks attached to cast-iron frames, which support the extreme ends of the table. The race is of ordinary double-headed steel rails, fixed in special chairs with adjustable keys; the chairs are carried upon stone, Fig. 7. Although this table is of the ordinary construction, it works so well without any cog gea mention of it might be

Traverser.—The main frames of the traversor, Figs. 10 and 11, are composed of eighteen pairs of double-headed steel rails, laid transversely, and joined together by angle iron and wrought-iron plate both diagonally and transversely, with cast-iron distance pieces intervening, the whole rivetted together both top and bottom, thus forming a broad shallow box girder, upon which are laid the bridge rails that carry the locomotive This box girder is formed for a width of 9 ft. 9 in.; but the double-headed rails are made to extend a distance of 3 ft. 10 in. beyond on either side; and to these are attached the cast-iron bearing blocks, which carry the axles of the traverser wheels. On the western side these rails are still further extended, so as to form a platform, upon which are carried the boiler and engines that work the machine Upon the same side the axles of the bearing wheels are prolonged, so as to attach to them cog wheels, into which gear the main pinions of the driving engines, Fig. 10

The driving engines are a pair of 8 in. cylinders, with 12 in. stroke; they have a suitable vertical boiler.

In working across the shed, the traverser runs into the 1, which enables engines to be ng without passing through the northern half of the main shed. This arrangement also obviates the necessity of having large doors of the whole width of the traverser pit.

Roof.—The main roof framing is a compound of iron, both wrought and cast, with ties of mild steel. The covering is two-fifths of slates, laid upon wood planking, and three-fifths of rough ribbed glass in cast-iron frames. The whole of the engine roads are covered with smoke trunking, made of galvanised sheet iron, 2 ft. 11 in. wide by 3 ft. 5 in. deep, and with outlet chimneys carried up through the roof at intervals of 35 ft. 8 in. All of these chimneys have holes cut in them just before they reach the roof, so as to draw off any smoke or steam which may have escaped into the roof.

In addition to the foregoing description of the running sheds, advantage may be taken of this opportunity for

mentioning one or two smaller matters which may be worthy of attention in the working of locomotives.

Flange Lubricator.—A simple contrivance for lubricating the flanges of the leading wheels of an engine when running round curves is shown in Figs. 12 and 13. It is composed of three small vessels, one placed upon either side, and the third in the centre of the leading end of the engine, under the footplate. The middle vessel is a closed tank, which is connected with both the others by means of a ⅜ in. copper pipe. It is also connected with the tender or feed water tank by another pipe, on which is arranged a small inlet valve I, worked by a float F in the vessel; and this float admits water up to a certain level B only. In each of the two side vessels is fixed a small syphon S, the top of which stands at a certain height above the ordinary water level B, so that no water will flow out through the syphon unless the water level is raised above its top. From the syphon a pipe passes down to deliver the overflowing water on the flange of the leading wheel.

To put the apparatus into working order, water is poured into all three vessels until it rises to a height B, at which the float F closes the inlet valve I. When the engine is running round a curve, the centrifugal force causes the water to flow towards the outside of the curve, where it rises in the vessel at that side, and flows over the top of the syphon, and down to the flange. This continues till the engine leaves the curve, when the water will resume a uniform level in all three vessels, and the float F will drop and admit a supply to bring the level up to its normal height.

Jet for Washing Rails.—For washing the road clean during dirty weather, a simple device, shown in Fig 14, consists in supplying a very small jet of water from the boiler, directed upon the rail in front of the driving wheels. This arrangement has been found most efficient during the past winter, and also saves a considerable quantity of sand.

High-Speed Air Compressor.—Although not connected specially with locomotive engines, a small high-speed air compressor, shown in Figs. 15 and 16, may be of some little interest, and will be shown to the members visiting the locomotive shops. It was designed some five or six years back for testing the effect of air mixed with steam, and was used for a few weeks. It has worked up to 120 revolutions per minute, and compressed air up to 250 lb. per square inch, delivering at each stroke its whole volume of air, 75 cubic inches, without any loss through clearances, the cylinder being 4 in. in diameter and 6 in. stroke. It is constructed on the principle of a water piston, sucking in and discharging again at each stroke a very small quantity of water. Curiously enough a very similar air compressor has recently been brought out in Belgium, as something good and at the same time uncommon.

TECHNICAL TRAINING.*

At the opening of the Science and Art Classes in Naval Architecture, Machine Construction, &c., for the ensuing winter season at Govan, on the 11th instant, Professor F. Elgar, of Glasgow University, delivered an address to the students upon scientific training. In the course of a long address, which was listened to attentively through out, Professor Elgar said:

All of the students who attend the classes in naval architecture and engineering here are probably much better acquainted with the practical and experimental aspects of the work they are engaged in than they are with the science which underlies it; and their present object is the very vital and praiseworthy one of acquiring such scientific and technical knowledge as will enable them to apply sound principles to the performance of their work, and will assist them in dealing intelligently and successfully with the many difficult and novel questions which are constantly obstructing and puzzling them. There are no branches of mechanical art in which sound scientific knowledge is more essential and useful, or in which it is more necessary for theory and practice to go hand in hand together, than in those of shipbuilding and engineering. A modern steamer is so complex a machine that no attempts to construct one without calling in the aid of science in some form—either directly or by copying what others have learned by it to do—could possibly end in any thing but disastrous failure. Try to imagine a man who had never heard or read of any of the teachings of science attempting to construct a modern steamship—a man who did not know even of the proposition said to have been demonstrated by Archimedes, that a floating body displaces a volume of water whose weight is equal to its own weight; and who was ignorant of the wonderful discoveries that have been made of the laws by which heat generated by the combination of coal is converted into mechanical work through the agencies of the boiler and steam engine. It only requires to state the matter in this bald form in order to show how hopelessly impossible and absurd such an attempt would be, and how vitally dependent shipbuilding and engineering are upon the past achievements and present teachings of science. On the other hand, the highest scientific talent the world has yet produced would be equally unable to arrive at a successful result simply by means of pure theory, however advanced, and by strictly *à priori* methods. The course you are pursuing, and which I trust you will not depart from, is the one best calculated to insure for you the greatest success in your work and advancement in your various positions in life; and as in the daily practice of your profession, you are perforce kept well abreast of the practical and experimental sides of your work, I would now urge you, in the strongest manner possible, to cultivate most diligently and thoroughly a knowledge of the science and of those natural laws upon which the efficiency and success of your efforts mainly depend. Do not be content with merely learning methods of setting off work and performing calculations, or with copying processes you may have seen others employ. The man who merely does as he sees others do, without very well comprehending why they do it, and who works strictly by rule and line, looking to custom as his supreme authority, will never improve or advance himself, nor be of much real use in such times as these, nor will he find much interest in his work.

"Custom, which all mankind to slavery brings,
That dull excuse for doing silly things."

Never look to custom as being a sufficient authority for anything, however respectable its antiquity may have made it; but be determined to understand for yourselves whether or not it is based upon sound and intelligible principles. Do not be too eager to believe that anything you are told is correct until you are able to prove it for yourselves, and till you no longer feel any ignorance or doubt in the matter. The necessity for combining wide scientific knowledge and sound theory with practical experience in the carrying on of shipbuilding and engineering operations, is daily becoming more and more pressing. If you tried to avoid it you could not. In this age of keen competition and rapid development, increasing demands are made upon all who are engaged in these important industries. Every success that is achieved by the most advanced and sensational productions creates a demand for still further progress; and in meeting these demands in the future the race will be to the swift and the battle to the strong. The speed and the strength that you require in order to enable you to hold your own in this contest are speed and strength of intellect. In other words, you require your intelligence to be cultivated and well informed and to be made prompt and active by means of scientific culture, and it is necessary for you to acquire such a firm and comprehensive grasp of sound theoretical principles as will enable you to rely safely upon your own powers of judgment, and to act in difficult cases with certainty and precision. Not only does modern competition ever demand more from you in the way of technical knowledge, skill, and resource, but it also shortens the time at your disposal for supplying it. The huge and complicated engineering structures of the present day, which are constructed in this district, have to be completed in as short a time as the much simpler and smaller ones of a generation ago. You have thus not only much more to think about in building a ship, and problems of greater number and difficulty to solve than used to be the case, but you have only the same time for doing it all in. You cannot afford to delay the progress of construction for the purpose of trying experiments or brooding over any difficulties you may meet with. It is necessary to decide promptly each question as it arises, and you have to qualify yourselves for doing that. The naval architect and engineer of the present day requires to supplement his practical knowledge by a close and systematic study of various branches of science. An enumeration of some of the chief of them would be sufficient to show how great are the demands thus made upon him. No man has ever yet succeeded in completely mastering the difficult and complicated problems connected with shipbuilding; and it is perhaps not possible for many of you to advance very far towards their solution. Still it must be borne in mind that it is only by studying the sciences which bear upon them that any real or substantial progress can be effected, and although finality may be unattainable, great advances are possible, and are constantly being made. Hardly a year passes without something considerable being done to improve our knowledge of those natural laws upon which the safety and efficiency of ships at sea depend. There is probably no district in this country which has benefitted in the past more than Govan by scientific progress and great mechanical skill in shipbuilding and engineering, or whose prosperity in the future is more dependent upon it. Govan has been placed among the foremost of shipbuilding communities by means of great scientific and practical talent, industry, and enterprise; and it rests with many whom I now see before me, to maintain it in the honourable and distinguished position to which it has been raised. The names of Napier and Elder, not to mention others, are alone sufficient to give prestige to any engineering locality; and they insure for Govan a high place in all future records of scientific, mechanical, and industrial progress. Upon you rests the responsibility of worthily walking in the footsteps of those and others among your distinguished men, and of striving to keep erect in this district the noble edifice they have reared. I am very pleased to find that students have such opportunities afforded them here for intellectual and social improvement, and still more pleased that so many have the good sense and the energy to avail themselves of them. I trust that the opportunities which exist will be added to and not diminished, and that the future generation of naval architects and engineers in Govan may thus be enabled to excel their fathers in all those qualities which will attract scientific and intellectual distinction to themselves and industrial prosperity to this neighbourhood.

Professor Elgar afterwards distributed the Science and Art Department certificates, and the local prizes gained by the students during the last session.

* Abstract of address by Professor Elgar, of the Glasgow University, to the Govan students.

RAILWAY BRAKES.

We reprint above a letter on Railway Brakes, which appeared in the *Times* on Wednesday last, and which served as a text for a leading article in the same issue. It will be read with universal interest, and with almost universal approval, and is a valuable contribution to the agitation now actively on foot to enforce the use of efficient brake appliances.

"*To the Editor of the 'Times.'*

"Sir,—I am an express engine driver on one of the important railways, and a few days ago when I arrived at the end of my journey, one of the passengers as he passed my engine handed me the *Times* of Monday, September 1, with the remark, 'Here, driver, read the letter on brakes.' Well, Sir, I have read it, and I can tell you it is a good letter; it does lay down the truth as straight as possible. We have heard very much about brakes lately at half-yearly meetings, but somehow, I can't just say how it is, the chairmen don't seem to go into the matter properly; they don't at any rate express the opinion of the drivers.

"We are their servants, but still we know which brakes are best, which we dare trust our lives to, and which we dare not trust. Chairmen don't know this from experience; it is seldom they come on a journey with us on the foot-plate of the engine, and when they do they seem uneasy, as if they wished they were in a first-class carriage instead. Only to-day I had a director riding with me, and he said, 'No more riding on engines for me.' Now, Sir, I say it is a pity chairmen and directors don't come often and ride with us and just see for themselves how we require a good brake; they would then tell some different accounts to the shareholders at the meetings.

"I have been a driver now 21 years. My lot has been no worse than that of my mates. I am as fond of my engine as they say a sailor is of his ship; so I will be obliged if you will give me just a little of your space just to give my experience.

"Well, Sir, during my 21 years I have twice had my engine run off the rails and down the embankment, one collision, the result of bad signalling, eight crank axles have broken under me, in all cases the engine came off the rails, and plenty of smaller things which I won't trouble you with. There are about ten sorts of brakes, and there are four of these used a good deal, and I have worked all the four. I have said above I know which brake to trust and which not. Now I may just explain that when I get a bad system of brake I cannot be sure of, I work in this way—I don't work with that safety and comfort which is such a thing for us; I know this bad brake may fail me any moment, so I don't feel easy. I always say to my fireman, 'Mate, get to that hand-brake; I dare'nt trust this thing, it may work and it may not.' Now, give me a good automatic self-acting brake that I know is safe, I run as free as can be with my hand on the driver's brake valve handle; in fact, Sir, I often sing as I go along, knowing that in an instant one turn of my wrist and the wheels of every coach in my train will have got two brake blocks clutching them tight with about 80 lb. air pressure to the square inch.

"You will see, Sir, we drivers see danger first, and if any are to be killed we stand in the first place; so it is to our interest—in fact, it is a matter of life and death to us, if the companies adopt good brakes or if they don't.

"Perhaps, Sir, you will say, 'Well, driver, you seem to feel strongly that we ought to have brakes; now tell us, after your experience, if you had the power which brake would you have in general use.'

"I don't know that you will ask this question, but if you do I will give you my answer and my reason.

"I have worked four brakes. Three of them failed more than once or did not prevent accidents. The fourth is the Westinghouse; it never fails, it has saved my life or limbs five times, and I say that it is the best. Have that system on all trains, that is what we drivers want; and it stands to sense what we know to be best for our safety is best for the safety of passengers, no matter what chairmen may tell gentlemen at meetings.

"I should like to sign my name in full, but as one of my mates got discharged for writing to a paper I beg to call myself

An Express Driver."

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Glasgow Pig-Iron Market.—Last Thursday's market was somewhat irregular, but a fairly good business was done. Transactions were reported on forenoon 'Change at 41s. 7d. up to 41s. 8d. and down to 41s. 6d cash, also at 41s. 9d. up to 41s. 10d. and down to 41s. 8d. one month, buyers at the close offering the lower quotations and sellers wanting ½d. per ton higher. In the afternoon business was transacted at 41s. 6½d., 41s. 5½d., and 41s. 6d. cash, also at 41s 8d. and 41s. 7½d. one month, the close being sellers at 41s. 6d and 41s. 8d. cash and one month respectively, and buyers offering ½d. per ton lower. There were transactions on Friday forenoon at 41s. 6d. and 41s 6½d. cash, also at 41s. 8d. and 41s. 8½d. one month, with sellers at the close wanting the top prices and buyers offering ½d. less per ton. A decline took place in the afternoon to 41s. 5½d. cash and 41s. 7½d. one month, and sellers remained at those prices at the close with buyers near. The market was firm on Monday forenoon, but dulness subsequently set in, and the closing quotations were ½d. per ton under those of last Friday. In the forenoon 41s. 5½d. and 41s. 6d. cash were paid, also 41s. 7½d. and 41s. 8d. one month, the close being sellers at the top quotations, and buyers at ½d. less per ton. Business was done in the afternoon at 41s. 5½d. and 41s. 5d. cash, also 41s. 7½d. and 41s. 7d. one month, and buyers at the close were offering 41s. 4½d. cash and 41s. 6½d. one month, with sellers wanting ½d. higher per ton. Yesterday's market was a little firmer, and there was a recovery of ½d. per ton. Down to 41s. 4½d. cash and 41s. 6½d. one month were again accepted, but in the afternoon the prices were 41s. 5d. cash and 41s. 7d. one month, with sellers at the close asking ½d. per ton higher. Higher rates ruled in to-day's market. During the forenoon 41s. 6d. and 41s. 6½d. cash were paid, also 41s. 8d. and 41s. 8½d. one month, the market closing

nominally at the top prices, which were also paid in the afternoon, the close being sellers at those quotations, with buyers near. Two causes were at work to advance prices up to the point reached on Thursday. One of them was the fact of bears covering their oversales, and the other was a report that several of the ironmasters were intending to blow out some of their furnaces, but as that report appeared not to be based on reliable grounds, the market again gave way, and at least 2d. of the advance was lost before the business of the week came to a close. A large amount of business was done towards the close of the week, but it was practically all the result of the operations of the trade. Outside speculation is quite dormant, and the present condition of trade does not offer much encouragement to it. Alike as regards home and foreign consumption, the demand continues to be unimproved, and yet this week's report state that there is rather more inquiry from the United States. Legitimate business is unchanged, and the pressure on some of the special brands, which is owing to the shipping season drawing near a close, still continues. There are again ninety-five blast furnace in actual operation, an additional one having been blown at Carnbroe Iron Works At this time twelvemonth there were 114 furnaces blowing. Flatness is still the rule with the hematite pig iron trade, the price for the usual proportions of Nos. 1, 2, and 3 brands being only 43s 6d. per ton f.o b. at Cumberland ports. Last week's shipments of pig iron from Scottish ports amounted to 12,978 tons, as against 9539 tons in the preceding week, and 12,894 tons in the corresponding week of last year. They included 1410 tons to the United States, 670 tons to Canada, 365 tons to India, 125 tons to Australia, &c., 860 tons to France, 700 tons to Italy, 2185 tons to Germany, 1850 tons to Holland, and lesser quantities to other countries. The stock of pig iron in Messrs Connal and Co.'s public warrant stores stood at 584,922 tons yesterday afternoon, as compared with 585,677 tons yesterday week, showing an increase of 755 tons for the week.

Exports of Locomotives from the Clyde —Amongst the foreign and colonial shipments from the Clyde reported last week, there were locomotive engines for Calcutta of the value of 14,328*l*., and for Bombay of the value of 10,060*l*., or a total of 24,388*l*.

The Forth Bridge at Alloa.—During the past few months considerable progress has been made with the new Caledonian Railway Bridge over the Forth at Alloa. The swing span in the middle of the river has now been completed, but the engine and working gear has still to be fitted up. The embankment leading to the junction with the North British line near the Grange crossing has been finished, and the workmen are engaged in laying the rails. It is not expected that the work will be finally completed until the end of the present year or the beginning of next spring.

Tay Bridge Works.—The large bowstring girder bridge which crosses over the west end of the Esplanade, at the north end of the Tay Bridge, was tested last Thursday in the presence of Mr. Barlow, the engineer, and other gentlemen. Four locomotive engines of the heaviest class were employed in the work, two being placed on each set of rails, and the experiments, which were continued for a considerable time, proved very satisfactory. The girder on the adjoining span has now been placed in position, and workmen are engaged in completing it and carrying on the work of rail laying.

Cross River Communication at Glasgow.—An adjourned meeting of the sub-committee of the Glasgow Statute Labour Authorities charged with the holding of an inquiry on cross-river communication, was held to-day for the purpose of taking additional evidence upon the subject. The first person examined was Mr. D Cunningham, harbour engineer, Dundee. He submitted a statement urging the propriety of constructing what he calls a double swing bridge at an estimated cost of 50,000*l*. His proposed bridge was on a new principle of construction which had not yet been put to a practical test by actual use. Councellor Smith made a long statement, the purport of which was to show that there was no congestion of traffic on Broomielaw Bridge, and that a new bridge was not required. Mr. G. W. Muir, who also contended that no new bridge was needed down the harbour, advocated an extension of the ferry system for passengers and the construction of a new bridge close to and immediately west of the Caledonian Railway viaduct for heavy traffic. Mr. Nicol M'Nicol, naval architect, Glasgow, submitted a plan for a tidal ferry boat 70 ft. by 48 ft., to be used at Finnistone Quay. A solid low-level iron or stone bridge opposite York-street was recommended by Mr. David M'Call, of Messrs. Formans and McCall, civil engineers, Glasgow. A somewhat complicated scheme was proposed by Mr. James Ritchie, architect; and Mr. E. C. Boothby, C.E., Kirkcaldy, submitted additional particulars regarding a steel bridge having a central span to lift by hydraulic power to a height of 120 ft. or so in order to allow vessels to pass through at all states of the tide. After a statement had been made by the chairman of the Twelfth Ward Committee, urging the absolute necessity of erecting a bridge west of Broomielaw Bridge, and suggesting a swing bridge between Clyde-street and Finnieston-street, the inquiry was brought to a close.

The Scotch Railway Companies.—The directors of the Caledonian Railway Company have resolved to recommend a dividend at the rate of 4 per cent. for the past half-year, and at the meeting of the shareholders of the Glasgow and South-Western Railway Company it is intended by the directors to propose a dividend of 4½ per cent. on last half-year's profits.

NOTES FROM THE SOUTH-WEST

The Barry Dock.—A meeting of the Barry Dock promoters was held on Thursday, at Cardiff, under the presidency of Lord Windsor. As this was the first meeting of the new company, Lord Windsor was appointed chairman of the directors, and Mr. D Davies, M P, vice-chairman. The engineers, Messrs. Barry and Co, London, and Mr. T. Foster Brown, Cardiff, were present, and received instructions to take all necessary measures, so that the work might be commenced as early as possible. The day for cutting the first sod was, however, not fixed.

Newport —The steam coal trade has been rather inactive, but there has been no change in prices The Alexandra Dock has been fairly well supplied with tonnage, but at the river wharves the shipments have been comparatively small. The shipments of manufactured iron have again been limited, and orders still come slowly to hand The tin plate works are in a more healthy state. Last week's coal clearances were 59,791 tons. The quantity of iron exported was 1860 tons, viz, Alexandra, 340 tons; Montreal, 1231 tons; and Rouen, 280 tons. From Bilbao there arrived 3520 tons of iron ore, and 3300 tons came to hand from other sources.

Llancaiach —A level, which Messrs. W and E Beddoe some time since purchased on the Gelligaer side at Llancaiach for the purpose of developing and working the Mynyddislwyn rider vein of house coal, has passed into the hands of a fresh firm, having been purchased by Messrs. T. J. Evans and Co., who are about to open up the workings so as to work the seam during the coming winter. The house coal level on the Heal Fawr, near Gellihir, has been purchased by Messrs. Mitchell, Freeman, and Harris, and they have secured a large taking of land on towards the mountain under the Tonterlwr, Twyn, Gellihir, and Castle Llwyd farms, where they expect to find the Mynyddislwyn seam of house coal.

Milford Docks Company.—The half yearly meeting of this company was held at Palmerston-buildings, London, on Wednesday, Mr S. G Sheppard presiding The chairman, in moving the adoption of the report, which was taken as read, congratulated the shareholders upon the improved position of the company Through the decision of an arbitrator no less than 470,000*l*. worth of liabilities had been disposed of. More than this the claims of the company against a certain estate in bankruptcy for about 46,000*l* had been confirmed, and at the same time the proceedings of the company in Parliament had resulted satisfactorily. He thought it would be agreed that the time had now arrived when the undertaking of the company should be completed. A contract had been signed and sealed with Messrs Pearson and Sons for the completion of the dock, and there was every reason to believe that the works would be completed within the time named in the contract, that was within 21 months from the date of commencement The question of raising the funds necessary for carrying out the works had occupied the attention of the directors; but he thought it would be easily disposed of when he considered the important body of shareholders and debenture holders now existing.

Cardiff.—The steam coal market has presented little change, prices being practically without any alteration. Small steam coal continues in easy demand. For house coal there has been a fair inquiry The iron ore market does not show much change. Last week's clearances comprised 122,495 tons of coal, 2867 tons of iron, and 4242 tons of patent fuel. From Bilbao there were received 5149 tons of iron ore, and 1454 tons came to hand from other sources.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a good attendance on 'Change, but the tone was as unsatisfactory as ever There is no improvement in the general condition of trade, but rather the reverse. At this season of the year, and especially as a good harvest is assured, the tone is as a rule cheerful, and the fact of so much depression is the constant theme of comment. The Board of Trade returns for August show the position of our exports to be declining heavily, and this, together with the curtailed demand at home, accounts for the low prices ruling for all classes of iron and steel. The shipments of pig iron from the Tees, however, are good this month, having reached 26,500 tons to date, compared with 18,600 tons last month, and 26,700 tons for the corresponding time last year. Prices are steady at 36s. 3d. to 36s. 6d. per ton for No. 3 g.m.b., but special brands are maintained at 37s. The lower qualities are in poor request, and quotations are easier. Prospects in the steel rail trade are no better, and other districts as well as Cleveland feel this. The manufactured iron trade is dull, but steady. Ship-plates are still quoted 5*l*. per ton, and angles 4*l*. 15s., less 2½ per cent. at works. There is no change in hematite pig iron, 44s. per ton being the price of Nos. 1, 2, and 3 f.o.b. west coast ports.

The Eston Steel Works.—At last, after being closed for several weeks owing to the lack of orders, the Eston Steel Works of Messrs. Bolckhow, Vaughan, and Co., Middlesbrough, are to be restarted on Monday. The company have secured an order for steel rails which will afford employment partially to the works and about a thousand hands will be in their old places on Monday. It is hoped that other orders will come to hand and that the works will be kept permanently going. The company are now in a position to produce Siemens steel as well as basic steel in quality equal for almost any purpose for which that material is used Tin-plates are also to be made by the company.

The Wages Question —A meeting of the Board of Arbitration for the North of England Manufactured Iron Trade was held at Darlington on Monday and the wages question was thoroughly discussed It was suggested that both employers and operatives should withdraw their notes for reduction and advance respectively, but this was rejected, and ultimately, after the desirability of establishing a sliding scale upon a proper basis had been talked over, the Board adjourned till the 19th inst. on the understanding that if no settlement is then agreed to the question must be referred to an arbitrator.

Shipbuilding and Engineering.—On the northern rivers these industries continue in a depressed condition Many of the shipyards are entirely closed, and the engineering establishments have little to do; the marine builders, as may readily be supposed, being almost without an order.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

The Staveley Coal and Iron Company.—Mr Charles Markham presided at the annual meeting of the Staveley Coal and Iron Company, Limited He said the condition of trade was somewhat discouraging, and he did not anticipate any immediate improvement The report of the company showed a net profit on the year's working of 39,939*l*. 13s. 10d, but the total available profit was 64,307*l*. 7s 6d, of this sum 25,201*l* 7s 6d. was carried to the next account

Dear Improvements.—The Finance Committee of the Sheffield Corporation has prepared a report upon the sinking and loan funds of the corporation and the investments of the same, and has also considered the financial requirements of the corporation under the various statutory authorities during the next twelve months The following are the estimated requirements up to December, 1885. Mortgage debt, 61,760*l* 1s 8d, sewage works 50,000*l*; Crookes Valley road, 12,000*l*, tramways, 70,500*l*; total, 194,260*l* 1s 8d And with 39,610*l* in respect of the School Board, the gross total is 233,870*l* 1s 8d The sub-committee attach several resolutions recommending methods of dealing with these requirements

Important Miners' Meeting —A meeting in connection with the Wath Main Yorkshire Miners' Association has been held at Bolton-on Dearne Mr Hoyland (Wath) moved a resolution pledging all persons present to join the Yorkshire Miners' Association —Mr Edward Cowey, President of the Association, said that every man who received benefits from the influence of a society, and was not paying towards its support, was doing an unjustice and a wrong to those who did support it. He concluded by expressing a hope that the miners would have their minds fully made up on political questions in view of the present crisis.

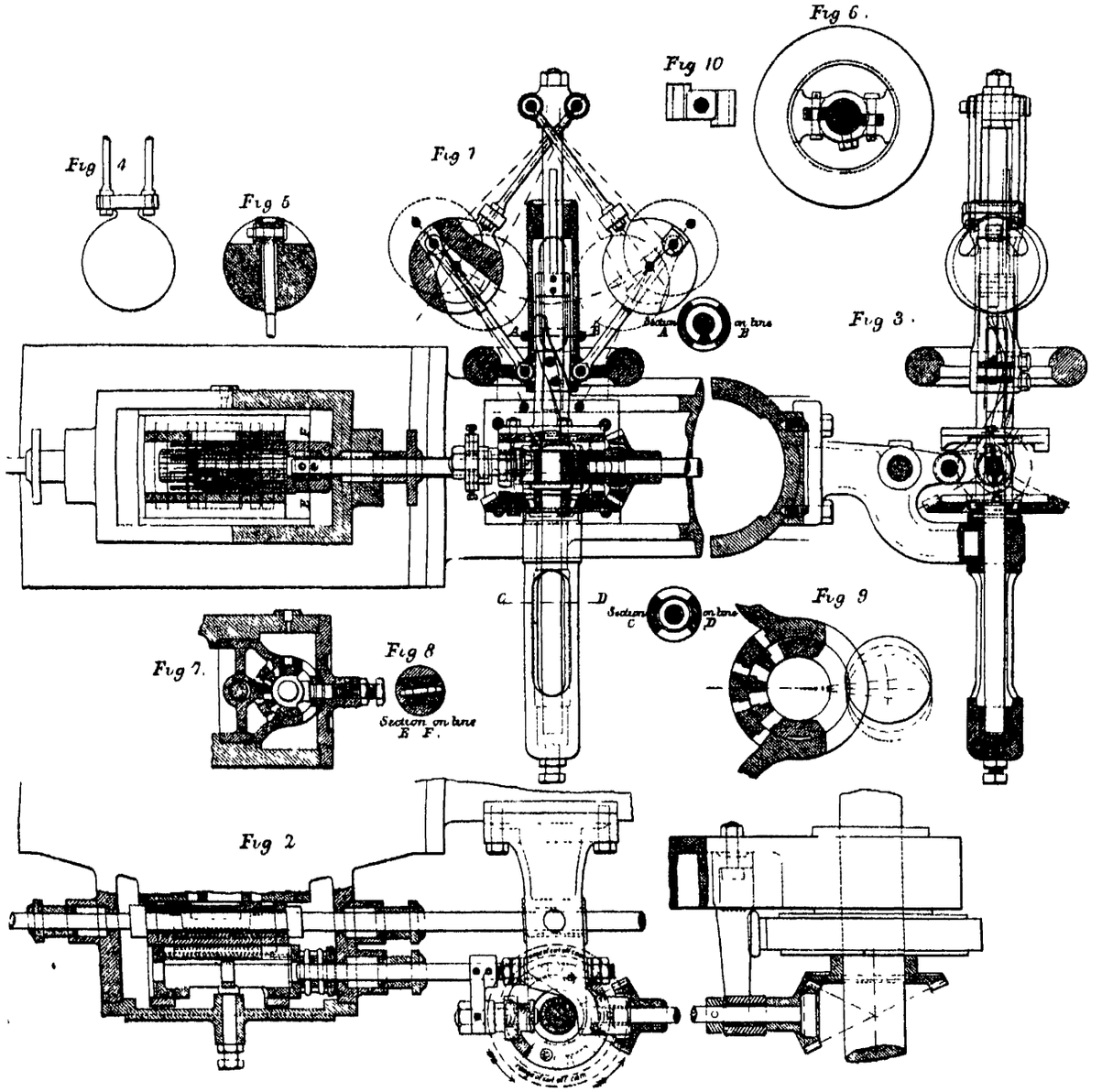
SILVERTON.—*Silverton is the excitement of the hour in Australian mining circles. Many of the claims are held by South Australians, and the ore from some of them—if the assays are to be relied upon—is as rich as the best silver of Nevada.*

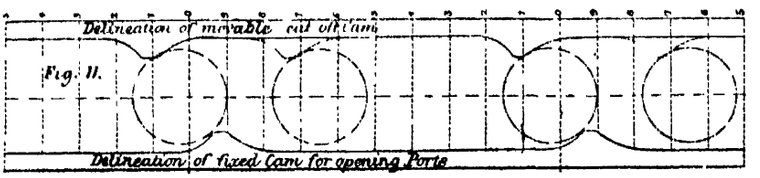
MESSRS. RANSOMES, SIMS, AND JEFFERIES —At the late International Agricultural Exhibition at Amsterdam, Messrs. Ransomes, Sims, and Jefferies were awarded a prize of honour, value 40*l*, as the first prize for the best steam thrashing machine. The competition extended over three days and included machines by Messrs. A. Albaret, R Hornsby and Sons, Limited, Merlin and Co., Nalder and Nalder, Limited, and Robey and Co. They also obtained the gold medal for the best horse rake, the gold medal for the best haymaker, four gold medals for the best ploughs, and two silver medals. These prizes put them in the position of having achieved the highest honours at the Exhibition, both among English and foreign makers

THE KHARTOUM EXPEDITION.—In addition to the flotilla of river craft which is being constructed for the Khartoum expedition by various builders, the Government have entered into a contract with Messrs. Yarrow and Co., of Poplar, for the immediate supply of a steel stern-wheel steamer for service on the Nile, and we understand that it will be shipped in the course of the next few days from Woolwich. In design it is very similar to Le Stanley, built by the same firm for the Association Internationale for the navigation of the upper waters of the Congo, and which, it may be remembered, was tested on the Thames in the early part of this year with great success The steamer just purchased by the Government was built for Central America. It is 80 ft. in length by 18 ft. beam, and will have a draught of 16 in only It is being shipped in pieces, all of a size suitable for hand porterage, so that it can be sent on to any section of the Upper Nile that may ultimately be decided upon, and there put together and launched. The military authorities, after much consideration, have come to the conclusion that the steamer is the one best suited for overcoming the difficulties incidental to the navigation of the shallow portions of the Nile, and especially for ascending the rapids. In order that there shall be the greatest possible despatch in rivetting up and starting the vessel, a large staff of engineers and shipbuilders from the works of the firm are to accompany the expedition. The steamer will be furnished with an upper and lower deck, and it is estimated that it will be capable of conveying from 400 to 500 soldiers. It will be fitted with several machine guns, mounted at a considerable elevation so as to command an extensive range over the river banks, and it is hoped it will be found to be a valuable addition to the expedition.

LOW'S AUTOMATIC CUT-OFF GEAR.

CONSTRUCTED BY MESSRS. WHITMORE AND BINYON, ENGINEERS, WICKHAM MARKET, SUFFOLK.

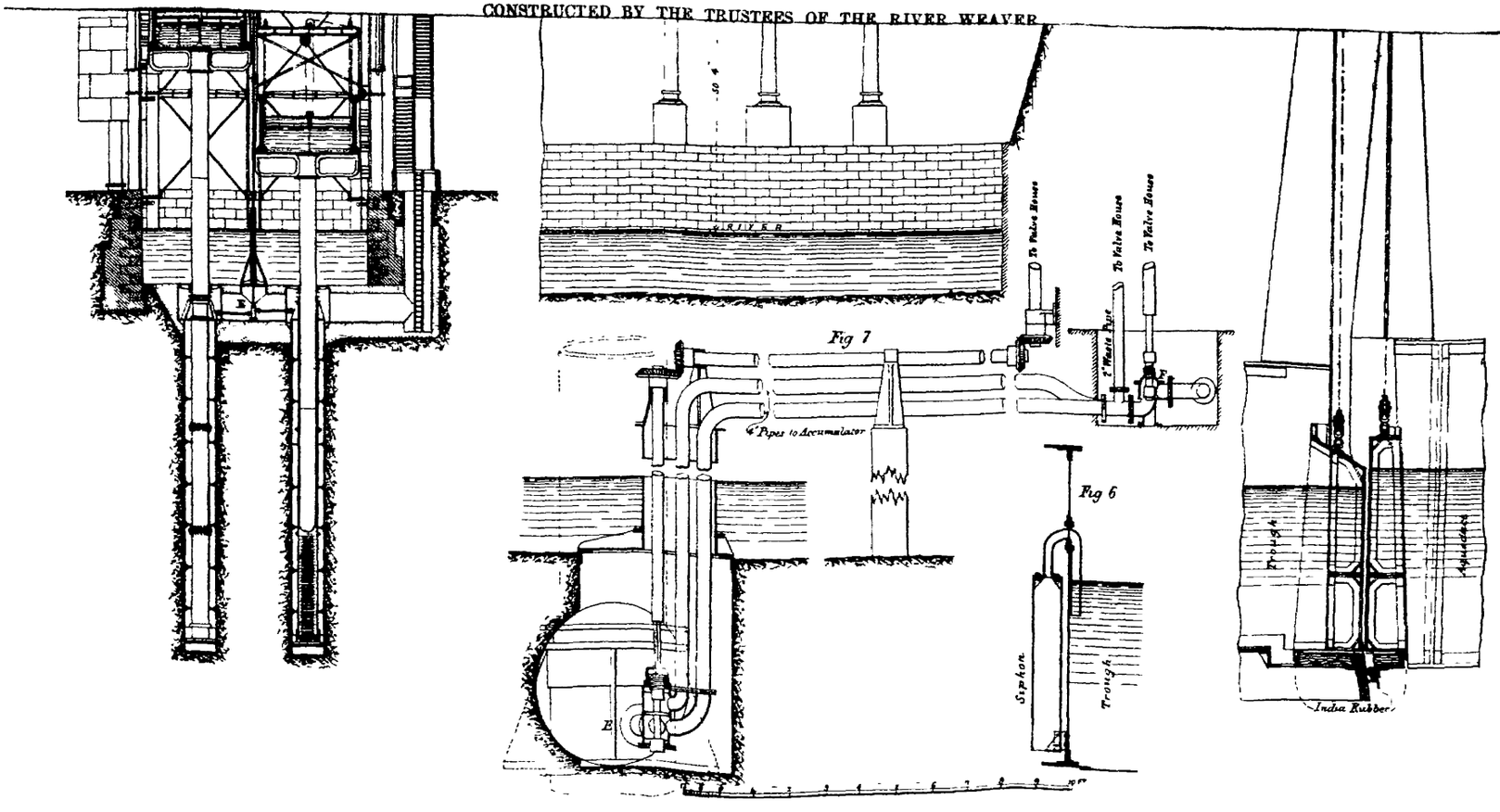




WE illustrate above an ingenious form of cut-off gear invented by Mr. George Low, of Ipswich, and manufactured by Messrs. Whitmore and Binyon, of Wickham Market. The steam is admitted to each end of the cylinder through an ordinary slide valve with closed steam and exhaust ports in its front face, access to these ports being through other ports at right angles to them in the back of the valve, which is bored to receive a cylindrical valve, lying with its axis parallel to that of the steam cylinder (Figs. 1, 2, and 7). This cylindrical valve is provided with a double set of ports; part of them correspond with ports in the cavity in which it works, opening into the steam chest, and part with the ports communicating with the face of the slide valve. The slide valve has a to-and-fro reciprocating motion in the usual way, and the cylindrical valve has an oscillating motion about its axis; it has no endwise motion. The oscillating motion of the cylindrical valve always admits steam to the slide valve before the commencement of the stroke, and then cuts it off again at some point between zero and .625, according to the load on the engine. The admission point is constant, but the cut-off is varied by the governor which acts on a rotating cam that operates the valve, setting it backwards and forwards with relation to the crank-shaft according to the requirements of the work. The motion of the valve is effected as follows: On the end of its spindle is an arm carrying a roller at its extremity. This roller (Figs 1, 2, and 3) runs between two circular rotating cam plates on the governor spindle (Fig. 3), one of which effects the opening of the valve, and the other the closure. Fig. 11 is a development of these cams. The former, which is the lower of the two is fixed to the spindle, as its position does not need to be varied, but the latter, although obliged to rotate with the spindle, can be set backwards or forwards in relation to it within certain limits. These limits depend partly upon the speed of the governor. If it make the same number of revolutions as the crank-shaft, the cam must have two projections in it, one for each stroke, and its range of motion with relation to the spindle will be about five-eighths of half a revolution. If the governor runs twice the speed of the engine the cam has one projection only, and must be capable of moving twice the above amount. To operate this cam there is cast upon its upper side a sleeve (Fig. 1) having in it a spiral groove of a length equal to the lift of the governor ring, and a pitch corresponding to the desired motion of the cam. A sliding die in the inside of the ring or sleeve of the governor works in this spiral groove, and as the arms rise and fall rotates the cam one way or the other, giving more or less steam to the engine. The cam plates are plain for the greater part of their circumferences, but each has a projection which comes in contact with the roller on the arm. The fixed cam pushes it up to open the valve and leaves it there, held by the friction of the stuffing-box on the spindle, and by the pressure of the steam on the valve. The movable cam then comes round and forces it down. If the governor arms be extended to their widest range this occurs at the commencement of the stroke, while if they be closed it does not happen until five-eighths of the stroke have been accomplished. If the governor be constructed so that the balls move in an approximately parabolic path, and be made very sensitive, the speed of the engine can be kept constant within an extremely small range. An engine fitted with this gear was exhibited by Messrs. Whitmore and Binyon at the Shrewsbury Show, and was a capital specimen of workmanship.

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FRIDAY, SEPTEMBER 12, 1884.

PRIMARY BATTERIES AND ELECTRI LIGHTING.

IN a recent lecture delivered in the hall of t Society of Arts, Mr. J. Probert entered into th relative cost of dynamo and battery lighting. H took as the basis of his calculation a house lighte by 100 incandescence lamps each requiring ½ ampère and an electromotive force of 100 volts. Each lamp would therefore require 75 watts, and the whole 7500 watts, or 10.05 horse-power. Sup posing the dynamo to have a commercial efficienc of 80 per cent, then the actual horse-power r quired would be 10.05+1.25=12.55 horse-pow A horse-power requires in the steam engin a consumption of, say, 4½ lb. of coal per hour. Therefore 56½ lb. of coal would be required to enerate the 12.55 horse-power, and this would st 6*d* Assuming that the lamps were required burn 1800 hours a year, or five hours a day, the nual cost of coal would be 45*l.* The prime cost a suitable dynamo and engine with boiler would , say, 300*l*, the interest on which at 4 per cent., ould be 12*l.*, and the annual depreciation would 10 per cent., or 30*l.* The cost of attendance ould be 60*l.*, so that the prime cost would be 0*l.*, and the total annual cost 147*l.*, or 1*l.* 9*s.* 5*d.* r lamp.

On the other hand, with a voltaic battery the energy would require to be produced at a rate between 10 05 and 20.1 horse-power, since its efficiency depends on the ratio between the internal d external resistance of the circuit. Supposing e ratio to be such that the efficiency is 80 per nt. To liberate a horse-power of energy a y of zinc must be oxidised equal to 2.(ided by the electromotive force of a single cell. e highest electromotive force obtainable in a ic sulphuric acid battery is 2.248 volts, but from his must be taken the energy absorbed in depolari

The amount of reduction depends on the of the depolariser, with nitrate of soda and ulphuric acid it is .708 volt, with bichromate of otash it is .343 volt, with fuming nitric acid it is volt. Assuming that the latter is the depola the net electromotive force would be 1.964 olts, and this corresponds, by the above rule, to a umption of 1.03 lb of zinc per horse-power-hour nergy. To liberate 12.55 horse-power-hours, .93 lb. (say 13 lb) of zinc must be used. If the price of zinc be taken at 2½d per pound, the zinc used per hour costs 2*s* 8½*d.*; but the expense does n end here Sulphuric acid, the usual oxidant zinc, costs ¾*d.* per pound To oxidise a pound of zi ½ lb of sulphuric acid is required ($Zn+H_2SO_4=ZnSO_4+H_2$). To oxidise 13 lb. of zinc requires 9½ lb. of acid, and this costs 1*s.* 2⅝*d.* This added o the cost of zinc makes 3*s.* 11*d* To give the best sturn the electromotive force must be high, and if e suppose the nitric acid produces N_2O_2, the mount of acid required is shown by the equation HNO_3+3H_2 (equivalent to $3Zn)=N_2O_2+H_2O$ It follows that the solution of every pound of zinc is accompanied by the deoxidation of ⅔ lb. of nitric acid. In the production of 12.55 horse ower-hours of energy, 8⅔ lb of nitric acid will b deoxidised, the cost of which at 6*d* per pound 4*s.* 4*d.* This added to the cost of zinc and sulphuri acid gives 8*s* 3*d* as the total cost of materials. Neglecting the waste due to scrap zinc and partially spent solutions, this rate for 1800 hours per year amounts to 742*l.* 10*s* for cost of materials only The prime cost of the battery would be 120*l.*, th interest on which at 4 per cent is 5*l.*, and th annual depreciation at 10 per cent is 12*l* Neglect ing cost for attendance, we get a total of 759*l* 10*s* or at the rate of 7*l.* 11*s* 8*d.* per lamp, as against 1*l.* 9*s.* 5*d* for dynamos.

Mr. Probert concludes rightly enough from the figures that for a large installation batteries are ou of the question as compared with dynamos, a least until they are greatly improved, but for small installations, where dynamos are unsuitable (an there are many openings for such) the battery has future before it. The use of lead or iron in plac of zinc, or some cheaper oxidant than sulphur acid, may considerably reduce their cost; and th utilising of waste projects, a subject which Mr Probert passed over as of little moment, may a still further economy. "It may be interesting to notice," said Mr Probert, "that in the Tel graph Department of the Post Office, no residue are thought worth preserving, except the 'blac mud' (technically so-called) from the Daniells, which contains a very large percentage of pur copper in the metallic state. Last year there wer 69,323 Daniell cells in use, and the sum realised b the sale of the year's 'black mud' was 167*l.* 14*s.* r rather more than ½*d.* per cell per year. An ide may be formed from these figures of the magnitude of the sum likely to result from the sale of the zin residues—which in the Post Office are thrown awa as worthless—in the case of an ordinary house holder using some ten or twenty cells."

Indeed, if we are to go by the results of the P Office in this matter, the return from waste batteries for electric lighting would be small, and probably the plan adopted of thro ing them away as worthless would be adopted. T German Imperial Telegraph Department acts on different system, and sells the waste material on far more favourable terms, for according to figures recently published by us (see ENGINEERING, vol. xxv, page 566) the department recovered no less han 22 per cent of the cost of materials consumed their batteries During the year 1881-2 Mr olb tells us that 12,350*l* were spent on the 27,166 cells in use in Germany, and 2727*l*, or bout 22 per cent.. was recovered by the sale of ttery residues consisting of lead, copper, and nc salts. As compared with the insignificant m realised by our own Post Office, the difference very striking. The *normal* cell in the German legraph service is also a form of Daniell, and we are therefore forced to conclude that it is by properly saving up, instead of throwing away, the ons and other materials, as well as the ud," and disposing of these in a proper market, that the striking difference exists English emists can utilise these waste products as well as erman ones, if the matter were brought before them It will then be seen that Mr. Probert has been unfortunate in his example of the return to be expected m waste products. Moreover he has apparently erlooked two very important factors in the pro m He has overlooked the fact that electric light batteries, working at a high pressure so to peak, and supplying powerful currents,

h more materials than telegraph batteries, send comparatively feeble currents through a high ternal resistance, and working *intermittently* is own figures may be brought forward to show ow much the waste of materials in a lighting battery is. Suppose for example that 22 per cent of the 759*l* 10*s* expended in his battery for 100 lights were obtained for waste products, the sum would be 167*l*, which is almost the exact figure realised by the "black mud" of the whole 69,323 cells of the Post Office And this estimate of 22 per cent is not too high for other batteries than 's if their solutions are properly utilised. some electric light batteries now in the ield it is much too low We are acquainted with one which, in a chemist's hands, returns much more han 22 per cent. of the original cost of materials This brings us to the other matter overlooked by Mr. Probert, namely the utilisation of the depolarising solution, as well as the oxidant solution, and also the gases liberated For example, in the Holmes-Burke battery, the nitrous gas can be utilised by rming nitrate of ammonia solution with it Indeed, e whole matter is in its *early stages*, and there is nple room for enterprise in the chemical utilisation waste battery products. When the matter has been properly studied, as it will be, if batteries are used for lighting, it is very possible that a considerable percentage of the cost of materials will be returned from the utilisation of the waste materials. At one time the residuals from gas manufacture presented a more hopeless problem.

THE NORTH WOOTTEN RAILWAY ACCIDENT.

AN accident which, because it was attended with no fatal results, has attracted but little public attention, occurred recently on the Lynn and Hunstanton Railway, a single line, which is worked by the Great Eastern Company. Apart from its initial cause, which appears to be obscure, it resembled very closely that at Penistone, but, fortunately for the passengers and the shareholders, the train was provided with means by which all disastrous consequences, except some damage to material, were avoided It was on the third of this month that the accident occurred, on the line above mentioned, and between the Wootten and Wolferton stations, about five miles from Lynn. The train consisted of a tank engine, a carriage truck, an empty horse-box, four carriages, and a brake van As it was a half-holiday, there were an unusual crowd of travellers, the number of passengers in the train being 150. At two miles beyond Wootten Station, where the train did not stop, and when it was running at a high speed, the engine suddenly left the rails, from what cause has not been ascertained. After ploughing through the ballast, to the destruction of the permanent way, for a distance of about 70 yards, it turned across the line, almost at right angles to it, and fell into the ditch at the side of the track. The behaviour of the train was as follows: The carriage truck next to the engine was partly dragged across the track and fell on its side; the horse-box broke away from the train, and fell over on the opposite side of the road; a composite carriage and a third-class carriage were both thrown over on their sides,

the latter vehicle being lifted off its wheels by becoming mixed up with the rails that had been torn up, and twisted in all directions. The two last carriages and the brake van also left the rails, but were not upset. Not one passenger was killed, nor seriously hurt, though of course all were severely shaken, and the driver and fireman who stuck to their engine, had an almost miraculous escape. There is only one reason why the train escaped being totally wrecked as at Penistone, and with consequences equally disastrous, for although in the latter case the fatality was *indefinitely* increased by the fact of the carriages falling over an embankment, while at Wootten there was no embankment, yet at Penistone the train ran over 200 yards before the fatal spot was reached, while at North Wootten the whole of the space comprised by the accident was 70 yards, and had the carriages still been running at any speed when they reached the carriage truck lying on the line, they would have inevitably been totally wrecked, with a loss of life that does not bear contemplation.

But the train, or rather a part of it, was fitted with an efficient continuous brake, which was able within so short a distance as 70 yards to reduce the speed so far as to render the final shock comparatively harmless. Nobody who is acquainted with the capacity of the Westinghouse brake, and—free from prejudice—is willing to do it justice, will feel surprised that in this case, as in so many others, it did its work promptly and efficiently. But there are some striking features in the Wootten accident that must not be overlooked. In the first place, the engine was not fitted with the brake, and had only its hand brake to rely upon, the carriage truck and horse-box were also unfitted, except for the connecting pipes. But the four carriages were equipped, and had, at Lynn, been taken from an engine also fitted, and at the time of the accident the reservoirs were partially charged, having about 50 lb of air pressure, but of course the driver had no control over this means of arresting the train. It fortunately happened (we would say providentially, but that the word has been rather spoiled by Sir Edward Watkin) that the guard was sitting in the van with a hand on the tap of the automatic brake, and as the engine left the rails, the shock to his hand threw on the brake, so that the maximum retarding power was available from the very instant that the engine became derailed, and short as the distance was, and imperfectly as the brake was prepared for such an emergency, the results were entirely different to those at Penistone, where the vacuum brake—according to its strongest champion—did all that was possible. Doubtless it did so, only there, as soon as the engine broke away, the train was left helpless, and doomed to destruction, while at Wootten the four carriages and passengers not only were saved, but the brake which did this good service also held back the engine, and undoubtedly saved the lives of driver and fireman by reducing its speed to moderate limits.

Unless emphasised by loss of life or great damage to material, railway accidents produce but little effect on the public mind, while of those numerous cases in which accidents are avoided by an efficient brake, of course nothing is known, except in rare instances. The Westinghouse brake cannot therefore share the publicity enjoyed by the various vacuum appliances, and this fact gives the accident at North Wootten a special interest, apart from the several remarkable attendant features. In relation to this subject of brake efficiency we have found space, upon another page, to reprint from the *Times* a letter from an "An Express Driver," the genuineness of which is guaranteed by the fact of its publication. The final paragraph of this letter is full of bluntly expressed truth and common sense, and will probably help to awaken public interest on this all-important matter He says, "I have worked four brakes. Three of them failed more than once, or did not prevent accidents, the fourth is the Westinghouse; it never fails, it has saved my life or limbs five times, and I say that it is the best Have that system on all trains, that is what we drivers want, and it stands to sense what we know to be best for our safety is best for the safety of passengers, no matter what chairmen may tell gentlemen at meetings"

THE MANUFACTURED IRON TRADE.

In the north-east of England the working of the Board of Arbitration has furnished a series of most valuable statistics showing the extent and the value of the production of manufactured iron over a period of years; and in junctures like the present these figures become of the greatest importance. The fluctuations of the trade are very fully marked by these statistics, and they show that in the period which they cover two distinct waves have flowed and ebbed, the last having probably reached the full extent of its movement. Between the time of these undulations there was that change in the trade which the collapse of the iron rail manufacture brought about, and thus, though the position of the trade now is somewhat similar to that of five years ago, as far as the volume and the value of the output are concerned, there is a very marked difference in the nature of the production. It is not very easy to show in a tabular form all those changes, but some of them may be displayed in that way, the figures being extracted from the official reports of the Board of Arbitration. First we may deal with the prices, and these are the prices realised for all the iron sold over the period reported on in whatever form it was made. Beginning at the year 1872, we trace first the increase, then the decrease, in the average price, and the following similar movement, as under:

Date.	Price. £	s.	d
February, 1872	7	16	6
February, 1874	11	18	3
February, 1876	6	19	6
December, 1878	5	18	7
August, 1879	5	3	3
November, 1879	5	5	6
June, 1880	6	10	8
March, 1881	6	3	7
March, 1882	6	2	11
February, 1884	5	13	7
June, 1884	5	8	11

Thus there is shown the upward movement in the price, and then a downward movement reaching the minimum towards the end of the year 1879, with a speedy but short revival and a more steady range of prices, until the fall began about a year ago. The present rates nearly approach the minimum of August, 1879 The quantity has fluctuated, though not so greatly or in such a regular manner. Taking the returns for similar periods, but dividing them into months, as the periods reported on vary, we have the following indication of the fluctuation in the extent of the production of manufactured iron by the associated ironmakers of the north-east:

Month.	Quantity (tons).
February, 1872	48,300
February, 1874	46,000
February, 1876	38,000
December, 1878	35,000
August, 1879	22,000
November, 1879	24,000
June, 1880	44,000
March, 1882	53,000
October, 1883	58,000
February, 1884	45,000
June, 1884	37,500

As we have said, the fluctuation is not so great as in the other Table, the reason being that one branch of the trade has almost died out. But still it is clear that between 1872 and 1879 the extent of the production fell off more than 50 per cent, that it continued to rise from the latter year up to 1883, when it was considerably in excess of that of 1872, and that during the present year it has continued to decline. The lessened fluctuation is owing to the decay of the iron rail trade and the growth of the production of iron plates, and a Table showing this will be of some interest just now It may be given shortly by the citation of figures showing the percentage of the two chief forms of iron at a few distinct dates, as follows, the percentage being that out of the total production of manufactured iron at the time named

	1872.	1875	1878.
Rails	48 50*	44.17	2.33
Plates	30 45*	28.29	59.07
	1879	1881.	1884.
Rails	3.03	1.39	.03
Plates	57.53	65.05	65.24

In these three sets of figures, then, the records of the value, and the volume of the total production of manufactured iron in the north-east, and the proportion that the two chief classes of iron bore to the total, we have an outline of the history of the trade in the north-eastern district during a dozen momentous years. In the earliest year dealt with we find that the price was high, 7*l.* 16*s.* 6*d.* per ton on the average of the first quarter, and that the production was very large—over half a million tons yearly—and nearly half of that was in the shape of iron rails. For two years the price rose, but the extent of the production was practically unchanged, and so was the proportion of rails to the total. After that, a rapid declension set in—in prices, in the extent of the iron made, and especially in the quantity of the rails made—whilst the decrease in the rail trade was in a slight degree counterbalanced by the increased activity for a time in the plate manufacture. It was about the middle of 1879 that the climax was reached, and at that time the rail production had fallen to not a tithe of what it had been. Prices were very low, and then a reaction set in in plates and shipbuilding iron, and an upward movement began which had its culmination about the middle of last year. The price of the manufactured iron had, however, by that time passed its highest point, but the volume of trade enlarged until then, the cause of the enlargement being the increased demand for shipbuilding iron. This year a rapid declension has been known in the extent of the production, and in price, whilst the proportion of the plates to the total is slightly less, and iron rails are not now one per cent. of that total. Except in the fact that the class of iron made is different to that made five years ago the situation is curiously alike to that of the year 1879. The production of manufactured iron is not much above what it then was, and the price is only fractionally over that of the period referred to; whilst the similarity is increased by the exact resemblance of the rates of wages then and now.

There is a similitude also in the position in regard to the advance of the use of steel. Five years ago the iron rail trade in the north-east was in a state of collapse, and there were then begun the large steel rail mills which have been perfected since. Now whilst the iron plate trade is not in a state of collapse, it must be admitted that there is a growth of the steel plate trade. The largest of the works in Durham for the production of plates—the Consett Works—has had for some time what were deemed "experimental" steel plate mills at work, which have been so satisfactory that it is about to quadruple its plant for the production of that class of plates, and whilst steel plates advance the output of the older form will be decreased there. Other makers are preparing to produce the newer form of plates, and though the present dulness in the trade is not likely to be so prolonged as that of five or six years ago, it is probable that it is one which will witness to a considerable extent the substitution of steel plate mills for those of iron. Hitherto the margin of difference between the price of steel plates and that of iron has been large enough to check the demand for the former in Durham; but as the production of the steel plates is increasing and that of iron plates is decreasing, there will be a reduction of that margin. This is apart from any influence that may be exerted by the production on a scale of magnitude of steel plates by the basic or allied processes. Hitherto, the production of steel plates has mainly been in the districts near the Clyde and Wales, and this has tended to minimise the use in the Durham shipbuilding trade. But now that they are produced largely at Consett and other centres, and that they may be produced even more largely near the Tees, it will be found that the use will grow, for the carriage will be simply the equivalent per ton of that of the iron plates, instead of the much larger sum which has had to be paid for those brought from Scotland or Wales. It would seem therefore, that another branch of the manufactured iron trade in the North will be superseded soon; but whether others will take its place and grow up as did the iron plate trade to maintain the quantity of the manufactured iron made in the North, remains to be seen.

* The remaining percentage is that of bars and angles.

THE AGRICULTURAL SHOW AT STOCKPORT.

THE annual Show of the Royal Manchester, Liverpool, and North Lancashire Agricultural Society was held on Thursday, Friday, and Saturday of last week at Stockport. The general exhibition was of fair average merit, but coming so soon after the more important gathering at Shrewsbury, it was not to be expected that any striking novelties would be offered, and had it not been for a competitive trial of traction engines, the affair would have ranked with other county meetings of the same kind. But it is so long that since the claims of agricultural engine makers have been put to a public experimental proof that the announcement of a special award in this class, founded upon per-

formances on the spot, was sufficient to give a peculiar interest to the Show. The last trial of the kind took place at Wolverhampton in 1871, and many changes have been wrought since then. Rubber tyres which were then on their trial have been abandoned, and the question of springs *versus* elastic wheels has been fiercely debated. Compounding has been tried with more or less success, and numerous improvement, small perhaps when considered individually, have so altered the traction engine that a record thirteen years old had become a piece of ancient history. The prospect of a fresh test and a gold medal was therefore calculated to arouse a good deal of excitement, both among makers and buyers, and lent an interest to the Show which it would otherwise have been far from possessing.

It was not to be expected that a local society could conduct trials of this kind with the thoroughness that prevailed at Wolverhampton. They have not the funds or the staff necessary for a really exhaustive test, and therefore the judges, Mr. J. T. King, of Liverpool, Mr. W. Scotson, of Aigburth, and Mr. J. Whalley, of Warrington, were wise in not attempting to do more than the means at their disposal warranted. Dynamometer tests and trials of evaporative efficiency were clearly out of the question, as unless they are carried out in a manner that does not admit of dispute they have no scientific value, while in any case their meaning is but little understood by the class who buy engines. Mr. King, therefore, decided upon a trial which, whatever might be its defects, had the merit of being intelligible to the farmer, and reproduced pretty accurately the conditions of every day practice. Perhaps the best defence of the conditions he adopted may be found in the remarkable uniformity of the results obtained in the second series of trials, when the least efficient of the engines had been weeded out, and the men had grown accustomed to their work. In the first instance each engine had a quantity of coal weighed out to it, and upon this had to get up steam and make a journey, partly empty and partly with a load behind it. The length of the trip determined the order of merit, and five engines that ranked high in the first test were submitted to a further trial in which they were loaded during the whole journey, and were allowed to get steam up to 100 lb. pressure before they received their set allowance of fuel.

The firms who entered the competition were Messrs. Marshall, Sons, and Co, of Gainsborough, Messrs. C. Burrell and Sons, Thetford; Messrs. J. and H. McLaren, Leeds; Mr. Edwin Foden, Sandbach; Messrs Aveling and Porter, Rochester; Messrs. John Fowler and Co., Leeds, and the Durham and North Yorkshire Steam Cultivation Company, Ripon. Some of these offered one engine, and some two. In the first series of tests there was weighed out to each engine 20 lb. of coal for each nominal horse-power at which it was rated by the makers, and 20 lb. of wood to start the fire. With this supply of fuel steam was to be raised to 125 lb. on the square inch, and then the engine went on a preliminary canter across the Show ground and an adjoining field, and through one or two of the neighbouring streets, the course being about half a mile in length, and involving several sharp turns. When it returned to the field again it was hooked to a wagon or lurry loaded with cotton bales, the whole weighing between four and five tons, and dragged the load round and round the course as many times as it could. The track was 410 yards in circuit, and involved two very sharp depressions, one or other of which always terminated the trial. The ground was in splendid condition; the heavy rain which fell in some parts of the country on Wednesday night and Thursday did not reach Stockport, and the soil was in a very firm state, and even at the end of the second day the ruts were not deep.

The trials commenced on Thursday. Messrs. Burrell and Sons entered two engines, both of eight horse-power, and provided with spring wheels. The first, which is described as specially adapted for heavy haulage work, made three circuits of the course before it stopped, and the second, which is a lighter engine, got round eight times. Messrs. McLaren's eight-horse engine made 6⅜ laps before it stopped. In the second series of trials this same engine gave a much better result, the poor performance of the first day being attributable to the fact that holes had been hurriedly drilled in the cylinder for the insertion of indicator cocks, and the borings had not been swept out. When the covers were removed it was found that a considerable quantity of them had lodged in the piston. Mr. Foden only showed one engine, of six horse-power. This was fitted with springs which could be screwed down to render them inoperative when desired. It ran 10⅜ times round the course. Messrs. Aveling and Porter's engine, which was nominally shown by their agents, Messrs. J. S. Warburton and Co., of Preston, was an eight horse-power agricultural locomotive with spring wheels and a feed-water heater. It made 9½ laps. Messrs. Fowler got through the trials of both their engines the first day. The first was an ordinary engine, and made 9⅜ laps, and the second a compound engine. This made the highest score on the first day, taking its load 12⅛ times round the course before it gave in. The list of Thursday's trials is concluded with the Durham and North Yorkshire Steam Cultivation Company's seven-horse agricultural locomotive, which made 3⅜ laps.

On Friday morning there remained three engines to be tried. The first to enter the course was an eight horse-power traction engine by Messrs. Marshall, Sons, and Co. This went round seven times before it stopped. It was followed by an eight horse-power traction engine exhibited by Messrs. Aveling and Porter, and of their ordinary manufacture. This also made seven circuits of the field. The last of the three was a six horse-power traction engine of Messrs. McLaren's, and this beat all the previous records by traversing the course thirteen times before it stopped. At this point the score stood as follows:

Name.	Horse-Power	Laps.	Weights.		
			tons	ct	qr
McLaren	6	13	10	11	1
Fowler	compound	12½	12	12	2
Foden	6	10⅜	10	2	2
Aveling and Porter	8	9½	—		
Fowler	6	9½	11	5	0
Burrell	8	8	10	10	3
Aveling	8	7	12	16	1
Marshall	8	7	11	1	0
McLaren	8	6⅜	12	18	2
Durham Company	7	3⅜	9	17	0
Burrell	8	3	13	18	0

The weights are with the water half way up the gauge and the tank half full

There was a good deal of dissatisfaction among the competitors when the trial was over. Some of them had been kept waiting a considerable time after steam was up before they could receive their loads, and others were warning in the special experience which counts for so much in contests of this kind. The judges therefore ordered a second test, for which five engines were entered, under somewhat altered conditions. Each was to come upon the ground with steam up, and then rake out the fire. When the pressure had fallen to 100 lb there was delivered to the driver 12 lb. of wood to start his fire, and 10 lb of coal for each nominal horse-power of the engine, and on this he was to take his former load round the field as long as he could. It was further arranged that a stop from any cause should end the course, and thus it was no longer possible to change from the fast to the slow gear at the different parts of the track, as had been the custom of many of the competitors on the previous day, a practice that had the additional advantage of allowing the firedoor to be opened when there was no blast to draw in the cold air.

Mr. Foden was the first to take the field. He went 8⅜ times round it before he came to a standstill on one of the hills. He was followed by Messrs. Aveling and Porter's eight horse-power engine which succeeded in making one lap more, or 9⅜ Messrs. McLaren followed with their eight horse-power engine which had suffered from the accident the day before. It was expected they would keep to the engine which had done so well in the morning, but they were anxious to demonstrate that their previous poor performance was the result of a misadventure, and not due to defective construction, and they therefore brought out the heavier engine and took it round eight times before they were obliged to stop. No doubt this was good policy from a business point of view, but it may be doubted whether it did not impair their position in the race. Messrs. Fowler followed with their compound engine which made 8½ circuits, and the trial was finished by Messrs. Burrell who stopped at the end of the sixth round.

At the conclusion of the Show the judges reported that dealing with performance the results were very close, but considering design, steadiness, fitness, workmanship, and performance conjointly, the gold medal was awarded to Messrs Aveling and Porter, and silver medals to Messrs. J. and H. McLaren, Mr Edwin Foden, and Messrs. Fowler and Co

It is impossible not to be struck with the great similarity of the results obtained by four out of the five competitors in the last trial The worst made eight laps and the best only nine and a half. At the same time it must be remembered that the conditions were easy, and bore no resemblance to those at the Wolverhampton Show, when the loads were heavier and the ground a perfect quagmire in places. At that place Messrs Aveling and Porter drew a load which was 105 per cent of the weight of the engine, and other makers took heavy trucks behind them under the most unfavourable conditions of ground and weather. But at Stockport the loaded lurries were less than 40 per cent. of the weight of the engines, and the ground was in excellent condition, so that the test was more directed to the efficiency of the boiler and the economy of the engine than to its power to cope with heavy loads in a difficult country. We do not wish to disparage either the scheme of the competition or the results; it reproduced the conditions of every-day practice, and there is no reason to think that, if circumstances of exceptional severity had been chosen instead, that the information gained would have been more valuable to the general public, or that the result would have been greatly different.

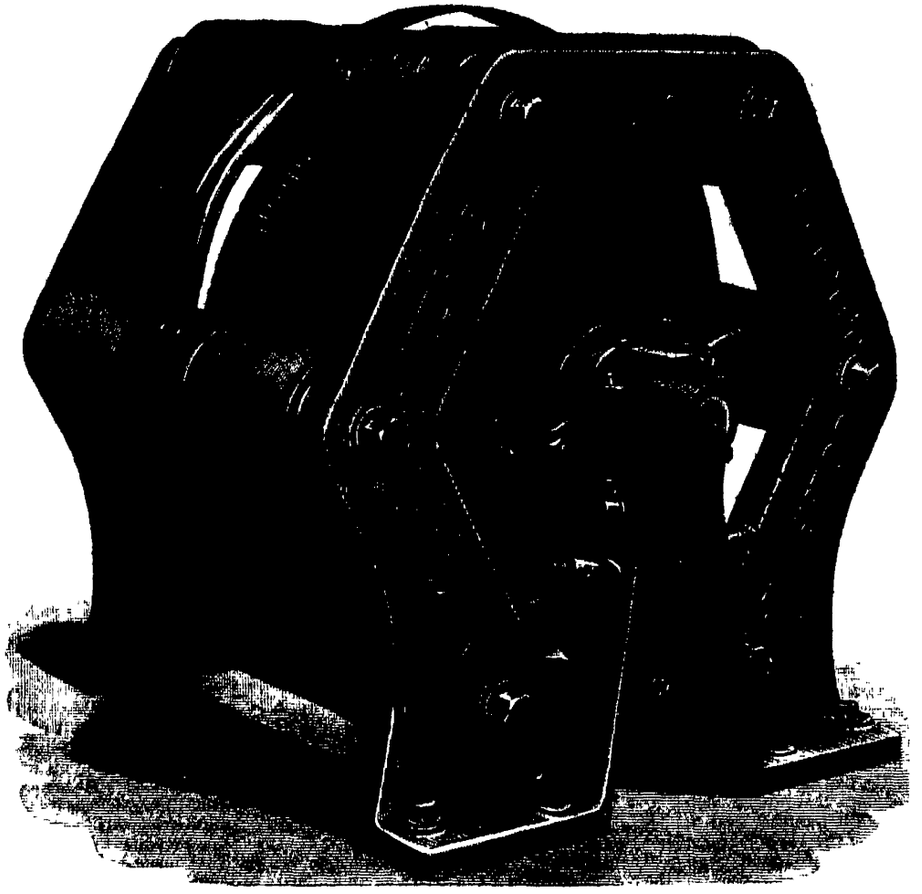
Of the remainder of the Show there is but little to say. Messrs Ransomes, Sims, and Jefferies had an eight horse-power agricultural engine on the ground, but did not enter the competition, and Messrs. Ruston, Proctor, and Co, and Messrs. Robey and Co., showed portable engines of their usual make. Among the machinery in motion were Johnson's brickmaking and pressing machines, which we lately described. (ENGINEERING, vol. xxxvii, p. 548) The subject of ensilage was but poorly represented. Messrs Richmond and Chandler showed two cutters and elevators with travelling wheels of the same description as those which appeared at Shrewsbury. Messrs Moore and Co., of Auburnside, Crewe, offered a novel apparatus for compressing the vegetable matter in a silo, and maintaining the pressure during the time that it is sinking. The press consists of a pair of beams connected at each end by toggle arms The joint of each pair of arms carries a nut, and through these two nuts there works a right and left-handed screw, parallel to and equidistant between the two beams. When the screw is turned in the appropriate direction the toggle arms are forced outwards, and the beams moved away from each other In using the apparatus a pair of chains or wrought-iron bars are secured to the floor beams of the silo, and led up to the top of it, where they are made fast to the upper of the two beams. Boards are laid crosswise upon the ensilage, and over these two strong timbers running lengthwise of the building Upon these latter the lower beam of the press rests, and when the screw is turned the covering boards are pressed down with a force varying from 70 to 120 per square foot of surface. To maintain this pressure as the ensilage sinks a cord is wound on a drum or fusee on the screw, and led over pulleys to a weight hanging outside the silo As the pressure relaxes the weight falls, and rotates the screw to expand the press, and causes the covering boards to be squeezed down When the screw has come to the end of its travel it is wound back again, and a fresh hold taken off the chains lower down, after which the apparatus may be left to its automatic action for a week. The other exhibits scarcely demand any notice.

ELECTRIC LIGHTING AT THE INTERNATIONAL HEALTH EXHIBITION.

No. V.

No collection of electric lighting plant would be complete unless it included specimens of the Brush manufacture. This company was one of the first in the field, and has attracted more public notice than any other, perhaps more that all others put together. In the early days of electric lighting, its success was most rapid, and the reason was not difficult to find. Its plant could be safely put into the hands of unskilled men, and could be relied upon to give satisfactory results with a very meagre amount of attention. The lamps contained neither springs nor clockwork, and could be placed in exposed and dirty situations without fear that a little dust would upset their action. The system of one

THE ELECTRIC LIGHT AT THE HEALTH EXHIBITION.



VICTORIA DYNAMO MACHINE, CONSTRUCTED BY THE ANGLO-AMERICAN ELECTRIC LIGHTING CORPORATION.

circuit was also a great recommendation, as users could easily comprehend it, and could move their lamps to suit their requirements without fear of damaging their apparatus by improper arrangements. A comparison of a Brush installation with any of the others which existed at the time the system was introduced into this country, showed at once the reason of the hearty appreciation it met with. It was seen at once that the inventor was perfectly free from any professional traditions, and throughout his design he had kept in mind the conditions under which his apparatus was to work and the class of people in whose hands it would be placed. Nearly all the early electric lamps were constructed by makers of telegraph and philosophical instruments and bore ample evidence of their origin in their complexity and delicacy. The ordinary mechanic was quite unable to undertake their supervision, because he had no tools suitable for their repair, and their tiny parts dropped out of his rude grasp, and were lost in the litter at his feet. But the Brush lamp was constructed in a manner that was familiar to him, and hence it seldom wanted attention, and if by chance it did, there was no difficulty in putting it to rights. There is ample proof of the great superiority of its design in the fact that it has been steadily adhered to up to the present, with the single exception that the original ugly mounting has been exchanged for a more ornamental case. During the same time other makers have been engaged in perpetual modifications and improvements.

The Brush dynamo was early distinguished by its good workmanship and the high potential at which it could be safely worked, thanks to its perfect insulation and the form of its commutator. Indeed, the employment of a current of high electromotive force formed the keynote of the system, allowing of great simplicity of arrangement and an important economy in the cost of leads. In a system of town lighting in which four machines of the newest type are used, each feeding 60 lamps in series, spaced 80 yards apart, it is possible to light twelve miles of streets from a single centre. Now if the potential of the current were reduced to a point at which it would only maintain twelve lights in series, there would be five times the length of lead required, and the first cost, at 70*l.* per mile, would be increased from 770*l.* to 2940*l.*, while the expense of laying and jointing would go up in the same proportion. Mr. Brush was always ready to defend his plan against those who decried it on the score of danger, and he has recently made an improvement in the armature of his dynamo by which he is enabled to increase the number of lamps in series by 40 per cent., while at the same time the efficiency of the generator is augmented 10 per cent. One of the new machines is shown at the Health Exhibition. It is of the size originally known as a 16-light dynamo, but it is feeding 23 lamps arranged in a circuit which commences by Lockhart's cocoa rooms, passes through the Western Annexe, round the grounds as far as the east band stand, and back through the East Annexe.

The construction of the new armature core is shown in Figs. 1, 2, and 3 on the opposite page, where it will be seen that it bears a general resemblance to the original core, but that instead of being cast in one piece it is built up of thin wrought-iron plates. It is formed of a long strip or band of iron, and a large number of H-shaped plates (Fig. 3); the band is wound in a spiral round a foundation ring A^1, and the H pieces are placed between its convolutions to inclose spaces B in which the coils of insulated wire are wound. The parts are bound together by rivets *r* (Fig. 2) which pass from the outer to the inner circumference. The ring is mounted upon a gun-metal boss with three arms which are secured to the inner periphery of the core, and hold it in position with regard to the axis. It is found that with the new construction, the heating effect is greatly decreased, while the enormous surface exposed to the air allows a rapid ventilation, which keeps the temperature very low. The practical effect of the invention is that for the same outlay a machine can be manufactured to run 55 to 60 lights instead of 40 as formerly.

In addition to the arc lights, the Brush Company exhibit 200 incandescence lamps driven by a pair of Victoria dynamos, one actuated by a Tower spherical engine, and the other by a Parsons engine. This generator, a very fine example of which is illustrated above, has already been described by us,* but since the date of our notice it has received considerable improvement. It is made in two patterns, one with four magnetic fields, and the other with six. There are, of course, as many neutral points in the commutator as there are magnet poles, and originally there was a brush at each neutral point, but, by a method invented by Mr. Mordey, one of the company's engineers, all the brushes, except one pair, are dispensed with, and the difficulty and complication which formerly existed are avoided. The invention consists in connecting to one another, all the coils, or all the commutator segments, which are of equal potential. Supposing there are six poles, as in the figure, it is evident that the coils of the armature may be divided into three groups, all of which are under similar conditions. The first coil of No. 1 group will always be traversed by a current of equal potential to the current of the first coil of No. 2 or No. 3 group, whether the coil be advancing towards or receding from a pole, as all the others will be similarly situated, and consequently these coils may be joined by cross connections between the wires which couple them to the commutator segment. The same thing is true of the second, third, and fourth coils, and of all of them. Now let us return to the first coil, and imagine it to be approaching a neutral point between two poles. The corresponding commutator segment should be in contact with a brush (say the positive brush), and so would the segments corresponding to the first coils of No. 2 and No. 3 group. But since all these three coils are connected together, the current from each can either flow

* See ENGINEERING, vol. xxxv., page 462.

THE ELECTRIC LIGHT AT THE HEALTH EXHIBITION.

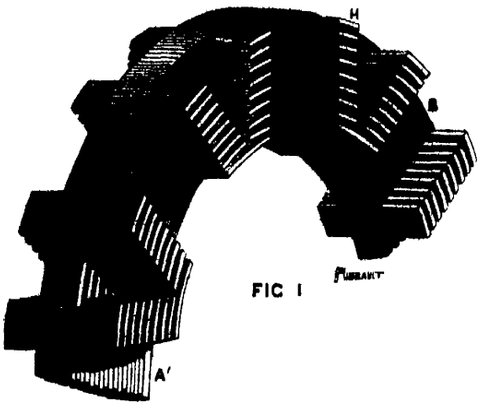


FIG 1

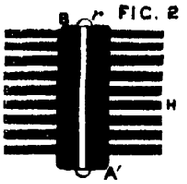


FIG. 2

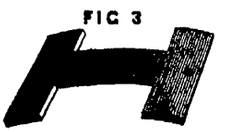


FIG 3

ARMATURE CORE FOR BRUSH DYNAMO MACHINE.

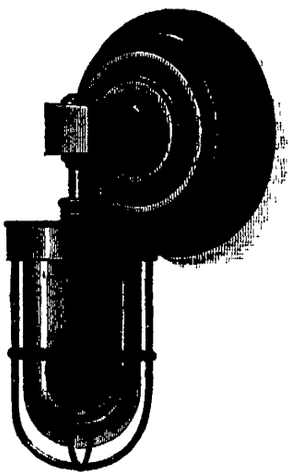


FIG. 4.

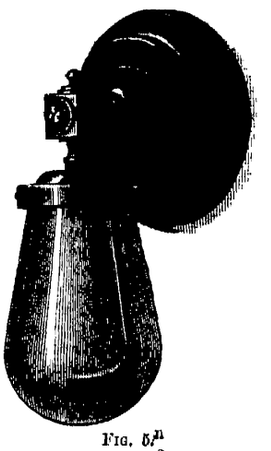


FIG. 5.

BRUSH ELECTRIC LIGHT FITTINGS.

directly to the respective commutator segments, or the currents from groups 2 and 3 can traverse the cross connections and flow to the commutator segment of the first group. If there is only one positive brush this is what happens, and all the current escapes at one segment. When the first coils approach the next neutral point, the brush will be over the segment corresponding to the second group of coils, and this will now serve also for No. 1 and No. 3 groups, and so on, each segment in turn receiving the current from three coils and performing the office which two other segments filled, when three pairs of brushes were used. In addition to its simplicity, the Mordey method of connecting up multipolar machines has the advantage of allowing the brushes to be placed in an accessible position, for out of the original six brushes any pair of positive and negative terminals can be retained, that is, they can be separated by either 60 deg. or 180 deg. as found most convenient.

The armature is of the ring type, and is wound Gramme fashion with coarse wire. The pole-pieces are in the form of jaws, which embrace the disc, and are mounted on wrought-iron bars, which constitute the magnet cores, and serve to bind the two sides of the machines together. These bars have large collars where they abut against the frames, and when they are screwed up the structure is perfectly solid, and does not require a bedplate. The width of the pole-pieces is not great, as experience has shown that if the space between them is large, the neutral point is very accurately defined, and does not extend beyond one segment of the commutator. The result is that sparking is almost obviated, and a current of several hundred ampères can be taken off nearly imperceptibly, while the brushes can be set radially, instead of tangentially as usual. From a practical point of view this latter is a great advantage, as the wear takes place on the end of the wires instead of their sides, and consequently they do not become uneven or ragged. The brushes are arranged in pairs, so that they can be renewed, if need be, without stopping the machine, and the details of the holders have been very carefully designed.

The two brush holders are carried upon a double bracket capable of being rotated round the commutator to find the best position, and the commutator segments are made very thick, so that they can be turned up many times should they be cut. The current is led off by flexible conductors to insulated studs in the frame, and passing to the inner side it traverses the coarse coils of the field magnets and then returns to the main terminals of the machine. The fine coils of the compound winding have independent terminals not shown in the figure, so that the current may be sent through them or not as desired. The machine we illustrate is of the size designated by the makers H_3; it produces a current having an electromotive force of 110 volts, and will feed 550 lamps requiring 72 ampère each.

The annexed Table gives the sizes of Victoria dynamos which are manufactured at present. It is divided into two sections, the second of which includes only slow-speed machines, specially designed for use on board ship where straps and countershafts are inadmissible.

List of "Victoria" Dynamo Electric Machines.

Type	Number of 20 Candle Power Lamps.	Watts in External Circuit.	Revolutions per Minute.	Price.
				£
A_2	12	750	1800	35
B_2	30	3,500	1000	75
B_2L	75	5,000	1400	90
D_2	125	9,000	850	150
D_2L	175	12,000	1000	175
F_2	275	18,000	550	275
F_2L	400	27,000	750	325
H_2	550	36,000	850	500

Slow-Speed "Victoria" Dynamos for Ship Lighting.

Type	Number of 20 Candle-Power Lamps.	Watts in External Circuit	Revolutions per Minute	Price
				£
B_2 slow	50	3,000	900	90
D_2 ,,	110	7,200	600	200
F_2 ,,	220	14,500	400	350
F_2' ,,	300	20,000	400	400
H_2 ,,	550	36,000	350	500

The Brush Company early acquired the Lane-Fox patents for the manufacture of electric lamps, and have since greatly improved the process, increasing the brilliancy of the illumination and the duration of the filament, as well as their economy, their consumption of energy being now only 3 watts per candle-power. The lamps are made in four sizes of 10, 20, 40, and 50 candle-power, and in two series intended to work with 60 and 100 volts. In addition to these, 80 volt lamps of 10 and 20 candle-power are made for the Admiralty, in order that they may be supplied by the same dynamo which feeds the search light, it having been found that for a hand-regulated lamp giving 25,000 actual candle-power, a difference of potential of 80 volts gives the most satisfactory results, as small irregularities of feeding do not interrupt the current or greatly vary the resistance of the long arc which can be maintained.

The method of mounting the lamp is exceedingly neat, and has the advantage of not leaving any delicate platinum loops exposed to rough usage. The conductors which pass through the glass are soldered on the outside to copper wires; the neck of the globe is surrounded with a brass ferrule cemented in its place, and having its outer end stopped with a plug of non-conducting material through which these copper wires pass. In the end of the plug there are two brass cheese-headed screws, and around these the copper wires are wound, so that the screw heads are in contact with them, and thus form the terminals of the lamp The holder is a convolvulus-shaped cup with the edge divided into a number of petal-like fingers, which embrace the lamp globe, and exert an elastic pressure upon it The ferrule on the lamp neck is provided with two pins which enter slots in the holder, and are locked there after the manner of a bayonet joint, and thus the globe is secured in the holder. The electrical connection is effected at the same time by two insulated segmental springs in the base of the cup. These are secured at one end to the base, and are raised at their free ends, so that they form parts of spiral inclines. When the lamp is turned in the bayonet joint the two cheese-headed screws rise over these springs, pressing them down and making good contact with them.

This holder is employed in all installations except those on board Her Majesty's ships, where it has been found that a special arrangement is required to prevent the filament suffering from the concussion caused by the firing of the heavy guns. To this end the conductors, which pass through the globe, end in loops which are hooked on to spiral springs in the bottom of the convolvulus-shaped cup. The cup is divided into two parts lengthwise, and these can be separated to allow the engagement of the loops by the springs to be easily effected. When this is done the cup is closed with its spring fingers around the neck of the globe, and is held there by an elastic ring which is slipped over the outside and lies in a circular groove or depression formed for its reception. By this arrangement the hold on the lamp is rendered most elastic, and it is free to move in every direction, while the rapid vibrations of the decks and bulkheads cannot be transmitted to it

Many of the Brush incandescence installations have been made on the ships of the Royal Navy, and their fittings for ships' use are therefore of an especially solid and handsome type. Two of them are illustrated by Figs. 4 and 5, one being of a more ornamental type than the other. The lantern inclosed in the grating is designed for use in passages, between decks, and other situations where it is liable to come in contact with passing objects. The other is intended to be fixed in cabins and state rooms. In addition to these, a complete set of brackets have been manufactured suitable for use in the engine-room, stokehole, bunkers, and other parts of the ship, some of them being permanently fixed, and some supplied with flexible conductors by which they can be connected to any of the numerous contact sockets fixed about the engine-room. Each bracket is usually provided with a

fusible cut-out, while larger cut-outs are arranged in each of the sectional circuits. The switches by which the lamps and circuits are turned on and off always make contact at two points in succession, so that the sparking and consequent oxidation are confined to a portion which is out of circuit when the nominal current is passing. A spring is always provided to keep the two contacts either in close connection, or wide apart to prevent all danger of an arc forming, and the bases are of slate to maintain the insulation.

Among the ships lighted by the Brush Company are the Dolphin, Bacchante, Raleigh, Conqueror, and Colossus. All of them have both search lights and internal incandescence lights, and the dynamos can be applied to one or other of these purposes as required. The Bacchante, Raleigh, and Conqueror have each two F, dynamos, which will feed search lights of 25,000 candle-power, or 200 incandescence lamps of 20 candle-power. The Colossus has three such generators, and 600 incandescence lamps. It is somewhat remarkable that a firm which made its reputation in arc lighting, and that two years ago appeared hopelessly out of the race in incandescence work, should have attained so rapidly such a high position as to be entrusted with nearly the whole of the Admiralty contracts, and it reflects the highest credit on the staff. In addition to this the company has secured a fair share of the orders for merchant steamers and land installations, and is in the position of being able to carry out contracts of nearly every kind from stock designs, without the delay which is always involved when experiments have to be made and new patterns to be produced.

THE UNCHAGAH, THE GREAT RIVER OF CANADA.

(*Continued from page 232.*)

ABOUT 120 miles below Vermillion, the river now flowing generally east, the only serious obstruction to navigation for nearly 1000 miles from the mountains, occurs in a transverse bed of limestone rocks which crosses the channel, and over which the river falls in a series of small cascades, or "chutes," breaking all the way across from bank to bank, and lowering its bed probably from 15 ft. to 20 ft. The cliffs rise 20 ft. or 30 ft. above the water level on either side, a full mile apart, and the channel, obstructed by isolated rocks and wooded islands, connected by limestone ledges, forms a beautiful panorama of rushing and falling water in every variety of shape, succeeded below the rapids by the deep placid river. About three miles below the chutes, Little Red River comes in from the south, presenting a new series of rocks and a singular formation of fossil corals of a number of different species, the finer descriptions in the bottom beds, and the larger and coarser varieties higher up in the series. A second obstruction to navigation, but not of such a serious character as the chutes, occurs 60 miles below them, where the Rapids Bouillé cause a strong current, which, though navigated by the company's boats in descending the river, would be beyond the power of an ascending steamer. At this point the stream has cut its way through a thick bed of gypsum as white as snow, and which for the next 20 miles, in the section exhibited on the river bank, appears as the lowest rock in the series. At the foot of the rapids a rocky island in the middle of the stream divides the channel for some distance into nearly equal parts. The gypsum bed, in many places contorted, but never broken, shows itself on the banks all the way to Peace Point, where this series of rocks terminates, and the character of the river and the surrounding country undergoes another and an important change. Below Peace Point, and from this to the Quatre Fourches River, 700 miles below Fort St. John, the Unchagah runs through low alluvial banks, but little above the water level, and muddy islands, in a number of ever-changing channels, exhibiting in their soft plastic sides, the varying heights of the water and the action of the ice In some localities the low shallow mud banks are covered with young willows, in others these have succeeded in establishing themselves, and are attracting and matting together the silt and mud as it comes down the river, whilst in others again this process has been some time in operation, and the new ground has attained a sufficient density and elevation above the water, and is now covered with immense poplars. The whole district appears to have been thus made from the river silt, and where secure from the action of the ice, the rapid growth of the young forest shows the surpassing richness and wonderful fecundity of these alluvial deposits.

The Quatre Fourches, the main arm of which is 25 miles long, running east and west between the Unchagah and Arthabasca Lake, is as its name implies the meeting of four waters, and is in itself a singular phenomenon. To the south of it is a large body of water called Lac Claire, 30 miles long by 30 miles wide, the discharge of which is by a third branch of the Quatre Fourches, the fourth is the Stony River at its eastern end, and which is also the outlet, or one of the outlets of Arthabasca Lake, and the business of this complicated water connection appears to be to equalise the height and outfall of each. In the spring of the year, the Peace River sends part of its impetuous flood down the Quatre Fourches into Arthabasca Lake; later on in the season Lac Claire is enabled to contribute to the supply of both the Peace and Stony Rivers; in autumn a strong stream runs from Arthabasca into the Unchagah both by the Quatre Fourches, and the Stony; whilst in winter the probability is that the Quatre Fourches is stationary, and the Stony River delivers the Arthabasca's waters alone to the main stream. When Professor Macoun was there, Lake Arthabasca was fully 20 ft higher than the Unchagah, and a strong current was running from it both by the Quatre Fourches and the Stony, one running west into what is locally called the Peace River, and the other north into what is called by the hunters the Slave River, though both are really the Unchagah, whose main waters run by a channel which forms the base of a triangle of which the other two are the sides, and Lake Arthabasca the apex.

Lake Arthabasca is an immense sheet of water, over 200 miles long, 40 in width, and covering 7000 square miles. Its proper name is the Arabascon, which means the meeting place of waters, and in its bosom many different waters do mingle their common streams. At its south side, its main affluent, the Elk or Arthabasca, which has been before referred to, sends its huge flood, after its long course of 1000 miles from the Rocky Mountains, through a delta of muddy islands, which are yearly encroaching on the lake with the enormous deposit annually brought down by the river. At the east a number of streams disgorge the waters of unknown lakes which cover two-thirds of the area of the broad belt of Laurentian rocks, which sweeps along from Labrador to the Arctic, and holds in its granitic embrace one-half of the Arthabasca waters. To the west the Quatre Fourches and the Stony form its two connections with the Unchagah, and at the point where the latter discharges its waters is situated Fort Chipweyan, which has played so important a part in all the stories of Arctic adventures. From this place, in 1792 and 1795, Mackenzie started to discover a road to the Arctic on one journey, and to the Pacific on the other. From this rendezvous Hearne and Back set out to trace their adventurous journeys, to the Arctic Ocean, and to map out the one the Coppermine, the other the Great Fish River, and at this hospitable station, Simpson, Franklin, Richardson, Rae, and almost every Arctic explorer, who has made the passage by land, has looked his last on friendly faces before piercing further the unknown wilds beyond. The fort consists of two large wooden stores on the lakeside landing, and six or eight whitewashed houses in the rear, where the company's permanent officers reside, surrounded by the usual stockade, and including besides all the necessary offices and outbuildings for the large business which was formerly transacted at this "Capital of the North," as the employés like to call it. The lake in front abounds with all the necessary supplies of food. On the Quatre Fourches the company have a permanent fishery which yields sufficient for the sustenance of the men and dogs employed at the post, or supplied from it for half the year; wild geese and ducks of a score varieties swarm round the lake, and contribute no small portion of the sustenance of its dependents, whilst the larger ruminants, the bison, moose, elk, and deer, frequent its waters, and die by hundreds to feed the army of hunters, who radiate from this as a centre. Formerly enormous herds of buffalo roamed over the Arthabasca plains, but these are scarce now, and the pemmican which was then largely manufactured here, has now to be procured elsewhere, for its diminished requirements. But Fort Chipweyan still opens its hospitable portals to the northern wanderer, who is apt to forget, whilst partaking of its friendly cheer, that 1200 miles intervene between himself and civilisation, and that in latitude 59 deg. the nights are long and the winter severe. The North American Indian, as a rule, subsists entirely upon meat or fish, which they eat without salt, and care nothing for vegetables or bread. The voyageurs and trappers have learned to imitate them, and hence at the Hudson's Bay forts, and at the permanent Indian settlements, few vegetables have hitherto been grown, and hence perhaps the reason that, at these establishments, so little has been done to test the agricultural wealth of the magnificent country in which most of them have been located. The few travellers, on the other hand, that have heretofore explored this north-west have, as a rule, selected the winter time for their journey, when the facilities for travelling, but not for seeing the country, are better, when the lakes, swamps, and rivers are frozen, and their dog-sleds can cut straight across the country in any direction to the desired goal. The excessive cold that occasionally breaks upon the winter's monotony, has become in the accounts of their travels, half the relish of the story, the point of interest and danger that is essential to romance, and the result has been a general impression unfavourable to a country known only in connection with the hardships that have been endured, and privations that have been often rather provoked than necessarily inherent, either to the journey or to the country. It seems, therefore, strange when an examination, made under other circumstances and with another object than the production of a book, discloses facts that prove this same district to be the very reverse to our preconceived opinions, and to be in fact one of the most highly favoured regions on the continent, a promising field for agricultural enterprise, and naturally the abode of everything to make home happy and life enjoyable. Instead of the vigorous climate of an Arctic solitude we find it actually milder than 6 deg. or 8 deg. further south, that the productions are positively superior to those grown in the most favoured localities, and that, as soon as opened up to emigration and settlement, this north-western district offers exceptional inducements to the persevering farmer. At the French mission, only two miles from Fort Chipweyan, the very place heretofore associated with Arctic suffering, the wheat and barley were as healthy as, and in fact heavier than, that grown 5 deg. or 6 deg. further south. At Fort Liaird, in latitude 61 deg., the climate is actually warmer than on the Peace River at Fort Simpson; barley always ripens between the 12th and 20th of August, whilst wheat succeeds four times out of five, and even under the Arctic Circle, at Fort Yukon, barley hardly ever fails. Professor Macoun collected between Hudson's Hope and Fort Chipweyan, 591 species of flowering plants and ferns, of which 434 are found in the western prairies, 411 are found in Ontario, and 402 may be seen in the province of Quebec. Another injury to the character of this north-western country has been perpetrated, probably in ignorance, in the description given of it in the deed, by which the Hudson's Bay Company surrendered to Canada the territory of the north-west. In this the fertile belt is defined to be bounded to the north by the northern branch of the Saskatchewan, and inferentially all above that is relegated to Alpine forests and Arctic barrenness. But between the Saskatchewan and any of the affluents of the Unchagah, is another great river 1100 miles long, the Missinippi, "river of much water" in the Cree language The usual route from Lake Superior to Fort Chipweyan crosses this valley at right angles, and from Frog Portage, the summit between it and the Saskatchewan to Methley portage, between its affluents and one of the Arthabasca branches, is 300 miles. The whole of this is south and east of any of the Unchagah's branches, and may probably prove to be even more deserving of the character of fertile than either of the Saskatchewan valleys.

The Unchagah properly, and in ordinary states does not interfere with the Lake Arthabasca, which is really in the course of the great tributary, the Arthabasca River; but winding northwards from the willowy archipelago, where the Quatre Fourches joins it, for 25 miles it flows through a placid channel fully 20 miles north-east of the lake, to its confluence with the Stony River, again 20 miles below Arthabasca. At the height of water in the springs of the year, the Unchagah, or Peace River, overcomes the usual strong current of the Stony, and in addition to its discharge by the

Quatre Fourches, sends another portion of its waters back into Lake Arthabasca by the Stony, rendering the usually clear water of the lake muddy and discoloured. As a rule, however, the Stony has a strong current of its own, amounting at one point to a rapid, in which some years since an officer of the company had his canoe upset and lost his life. After the confluence of the Peace and Stony Rivers the united stream has always borne the name locally of the Slave River, and 30 miles below this junction is the most serious obstruction to navigation on the whole length of the Unchagah. It seems that the river here marks the division geologically between the pyrogenous rocks of the great primitive belt, that runs through the east of Canada from Labrador to the Arctic, here 300 miles across, and the limestone formation of the prairie to the west of it. Huge masses of granite show themselves in the river and crossing it at intervals form rapids, whilst limestone cliffs occur in other places, and the water-worn exposures along the river singularly illustrate the combination of the two classes of minerals at different points along its banks. A large island, where both rocks are seen intermingled, divides the river into two main branches, and at the foot of this, amongst a maze of rocky islands and confusion of channels, a series of rapids and cascades lower the bed of the great river probably as much as 50 ft. The highest individual fall may not be over 10 ft. or 12 ft., and of no great breadth or magnitude, and many of the channels are so obstructed or blocked up with accumulations of logs and drift timber that much of the water cannot be seen, whilst other channels are so concealed by the impending wooded islands, that only a small portion of this labyrinth of passages, rapids, and falls can really be taken in by the eye at any one point. The descent is made by boats with a series of portages or carrying places, which extend probably over a mile of its length, and the last of these bears the ominous name of Portage des Noyes, or Portage of the Drowned. Here granite is the prevailing rock, and here for some hundreds of miles down the river it is last seen. Large flocks of pelicans make this their home, choosing the most inaccessible cliffs amongst these rocky isles for their nests, which are built on the brow overhanging the roaring cascades. Exceeding a swan in size—in fact, the largest of the feathered tribe in the country—these voracious birds destroy an immense quantity of fish. They generally choose a rapid for their excursions, where floating down with the current they soon fill their pouches, which are frequently so crammed with fish that they cannot rise in the air until they have relieved themselves of a portion of their load. This they do by landing, and drawing the bill between their legs to turn out the fish. They fly in small flocks of a dozen to a score in number, in a line abreast, when their size and snow-white plumage gives them an imposing appearance.

Fifteen miles below the Portage of the Drowned is the outlet of Salt River, so named from a series of seven or eight salt springs, which flow from a ridge 300 ft. or 400 ft. high, some 20 miles up the tortuous stream, the brine from which, after depositing on the sloping plain a pure common salt, flows into the river, giving a bitter brackish taste to it, until lost in the great waters of the Slave, which is from a mile and a half to two miles across. These salt springs supply the Hudson's Bay fort, and one of their old hunters has built a house or cabin at the mouth of the river, to supply the company with the salt, and to assist in the victualling of their annual brigade of boats, on its passage up and down the river to their distant forts on the great lakes north of this and on the Mackenzie.

(To be continued.)

NOTES.

Purifying Zinc.

M. Hérôte, the well-known French chemist, has recently been occupied with the question of purifying zinc from the arsenic and antimony which it usually contains. The process which he finds most effectual is to melt the zinc with chloride of magnesium. All the arsenic then takes the form of chloride of arsenic, and the antimony, when it is present, is also disengaged with it.

An Optical Telegraph at Mauritius.

In default of a submarine cable the heliograph service between the islands of Réunion and Mauritius is in a fair way of being carried out. In Réunion M. Adam has connected the hill of Lacroix by heliograph with a station situated at St. Benoit, from which a telegraph runs to St. Denis. Recent experiments between Lacroix and the Pic Vert in Mauritius, have shown that a heliographic communication is quite feasible between them. At Mauritius the Pic Vert station will heliograph its messages to the Pouce Mountain, celebrated in "Paul and Virginia" and from thence the message will go by wire to Port Louis.

Melted Lead in the Eye.

A curious case of accident from a fragment of melted lead solidifying on the surface of the eye without injuring it, was recently brought before the Bordeaux Society of Anatomy and Physiology by Dr. Perrier, who showed that the immunity of the eye from burning was really due to the "spheroidal state." The melted jet of lead was at a higher temperature than 171 deg. Cent., the temperature necessary to produce the spheroidal state, hence when it arrived at the surface of the eye it vaporised the moisture of the latter. When it had cooled below 171 deg. Cent. the lachrymal secretion prevented the metal from scorching the ball.

Thermal Coloured Rings.

M. Decharme, whose experiments on the flow of currents in pipes and their hydro-dynamic analogy to electric currents have attracted much attention, has also recently drawn attention to the fact that thermal coloured rings bear a striking resemblance to electro-chemical coloured rings. When a copper plate is exposed to the flame of a spirit lamp or a Bunsen burner, an irisated or rainbow-coloured corona is produced about the heated point. Under good conditions these colours are fixed and unalterable in the air. These rings are, according to M. Decharme, quite similar to Nobili's electro-chemical rings; like the latter they succeed each other in waves, the colours being in the same order, namely, that of Newton's rings viewed by transmission.

A Red Solar Halo.

M. Forel, a French *savant*, observed a remarkable reddish halo round the sun from a position in the Bernese Alps on August 26. At an altitude of 1000 metres the phenomenon was visible, at 1500 metres it was quite distinct, and at 3000 metres it appeared of striking splendour. The effect was repeatedly seen by M. Forel about this time and at different places in Switzerland, such as Grimsel, Innert-kirchet, and the Glacier du Rhône. The phenomenon was also observed in July by M. Forel at Saas-Fée at an altitude of 1800 metres; and he does not hesitate to affirm that during the months of July and August last a red halo or corona surrounded the sun, which, though difficult to see at low altitudes, became quite brilliant at 2000 metres above the sea. It would be well if aëronauts would keep a look-out for this phenomenon.

An Electrical Actinometer.

At the last interesting and very successful conversazione of the Society of Telegraph Engineers and Electricians, held under the presidency of Professor W. Grylls Adams, at King's College, one of the novelties, in fact, the leading novelty, was a new actinometer, based on photo-electric action, which was exhibited by its discoverer, Professor Minchin. The cell sensitive to blue light, consisted of a glass test tube filled with alcohol and having a small quantity of nitrate of ammonia at the bottom. Two electrodes or strips of tinfoil, held in position by the cork, were immersed in the alcohol, and when one of these was exposed to a ray from an ignited magnesium wire, a current was set up in the cell sufficient to cause a considerable deflection of the needle of a sensitive reflecting galvanometer in circuit with the two tinfoil strips. In fact the spot of light went quickly off the scale. That this effect was solely due to the blue or actinic rays of the light was demonstrated by Professor Minchin interposing a plate of orange glass between the cell and the magnesium light. The spot of light was then just seen to move; and if the glass had cut off all the blue rays it is presumed the spot would have been stationary altogether. The strength of current is proportional to the actinic energy of the light. For measuring the effect of sunlight (or another source of illumination) during a fixed time, Professor Minchin stores the current in a condenser, and measures the discharges at the end of that time. To this end he has devised a clockwork arrangement to close a shutter automatically at the end of the specified time, and thus cut off the light from the cell.

The Cost of the Electric Light in France.

A paper has recently been read by M. Ph. Delahaye before the Société Technique de l'Industrie du Gaz en France, giving an account of the progress made by the electric light during 1883. He commenced by a brief account of the inventions of the year, and then turned to the question of expense, as compared with that of gas, founding his conclusions upon figures derived from typical installations. He stated that among manufacturing establishments the installation at the Cail workshops was among the most interesting, as it comprised both arc and incandescence lamps. The total superficial area illuminated is 251,880 square feet, and the number of lights 177, of which 94 are arc lamps and 83 incandescence lamps. The cost, without land and buildings, was 4900*l.*, and the maintenance per hour is 1.07*d.* for the arcs and .10*d.* for the incandescence lamps, the power required being 1.38 horse-power for the former, and 10 kilogrammetres for the second. The total working expense is 19*s.* 2*d.*, or .003*d.* per carcel hour (one carcel = 9·5 standard candles). The amortisation and interest on capital, and the maintenance, taken together at 15 per cent., represent 736*l.* Assuming a mean of 500 hours lighting per annum there must be added on this account .0046*d.* per carcel hour, which will bring the total cost to .0076*d.* The total expense is 2·44*l.* per hour, or equal to the cost of 7167 cubic feet of gas at 6*s.* 9*d.* per 1000 ft., a quantity of gas which M. Delahaye does not think will even be brought to yield the same amount of light as is furnished by the electricity. He next takes the case of the Grand Magasins du Printemps, the lighting of which has been described in these columns *. The lights burn five hours per day for 300 days in the year, with the exception of thirty Jablochkoff candles in the basement, which are in use nine hours per day. The annual cost for candles, carbons, and electric lamps is 60,900 francs (2436*l.*), the cost of the motive power (490,065 horse-power hours) is 39,200 francs (1568*l.*); the expenses of the staff are 33,000 francs (1320*l.*), the amortisation and interest, at 10 per cent., 68,400 francs (2736*l.*); and the maintenance, at 5 per cent., 29,200 francs (1168*l.*). The total expense is thus 230,700 francs (9228*l.*). M. Delahaye institutes two comparisons between this and gas lighting. *First, he estimates what would be the price of a gas installation, and what it would cost per year*; and second, what consumption of gas corresponds to the light furnished by the electricity. In the former case, assuming that there would be 3000 gas burners, giving 9·5 candles each, and taking the price of gas at 6*s.* 9*d.* per thousand, and adding thereto 33 per cent. for amortisation interest, supervision, &c., the yearly expense is 221,625 francs (8865*l.*), or almost the same as electricity. According to the latter mode of investigation, the consumption would be 69,509,760 cubic feet. At the price given above, the cost would be 31,015*l.*, or three and a half times as much as electricity. Of course such an amount of gas could not be burnt, as it would render the place uninhabitable. M. Delahaye did not adduce any precise instance of incandescence lighting, but he gave a detailed estimate of its cost, and came to the conclusion that in an important installation it need not be dearer than gas at Paris rates, a result that will meet with very general acceptance in this country, where some have been bold enough to argue that it might compete with gas at half the price at which it is supplied in Paris. The paper is chiefly interesting in showing how favourably situated the electric light is in France, and how slow its progress is there even with the odds in its favour.

ELECTRIC LIGHTING NOTES.

The electric light formed a prominent feature in the city illuminations on the occasion of the visit of the Prince and Princess of Wales to Newcastle-on-Tyne on August 20 and 21. Three powerful arc lights, each of 8000 candle-power, were erected in different parts of the city; one of these was placed in the beautiful lantern tower of St. Nicholas' Cathedral, and was visible for many miles around. The light shining through the stone tracery threw dark shadows across the sky in the shape of a gigantic cross. The other two lights were placed in the principal streets, one of them being just opposite to the gas offices, where an extensive gas illumination was exhibited. All these instal-

* See Engineering, vol. xxxvi., page 361.

lations were carried out by Messrs. J. H. Holmes and Co., electric light engineers, Newcastle-on-Tyne. The same firm has also lighted a Polytechnic Exhibition at Hetton, County Durham, for four weeks, by means of forty-five Swan lamps and one arc lamp worked in parallel circuit from the same dynamo with perfect

The managers of the Covent Garden Theatre have again adopted the electric light for this season's promenade concerts. The Maxim-Weston Company have supplied the installation, the work being carried out on their behalf under the superintendence of Mr. Hugh Watt, the managing director of the company. The systems of this company are complete in themselves, that is to say, they comprise special generators and arc and incandescance lamps, and all requisite appliances In the installation we are now noticing, the generating plant is situated on the ground floor just outside the Floral Hall, and comprises three Maxim and three Weston generators. The current from the three Maxims could supply 600 Maxim incandescence lamps, those in use being arranged in the auditorium and over the stage. The Weston machines could supply current to forty-two Weston arc lamps; these lamps each give out a light equal to 1500 candles, actual. The positions of the lamps have been carefully selected, and give a very fine effect, more especially in the auditorium and over the stage, while the Floral Hall is entirely lit by arc lamps. The Maxim generator in outward appearance resembles the Siemens. It differs, however, from this machine in the construction of its armature, and the method of coupling up the coils differs from that employed in the Gramme. The principal feature of the new Maxim incandescence lamp lies in the preparation of its filament by a new process just patented, which the company claim, gives 20 per cent. more light, for the same power, than any other. The Weston arc lamp has long been known as remarkably steady in its action, and the simplicity of its construction renders it especially suitable for outdoor illumination. Covent Garden is one of the largest theatres in Europe, and

length.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, August 29, 1884.

IT WAS confidently believed two weeks ago that 27 dols. was the inside price for steel rails, at mill, but large transactions have just been closed at 50 cents below, and it is believed, in some cases, at 1 dol. less, though, owing to the reticence of railmakers, it is impossible to get at the bottom facts at this hour. Upwards of 40,000 tons have been sold at the low figures named, and there are a good many negotiations in hand, which will make the aggregate not less than 100,000 tons. Railroad builders are willing to accept the risks of purchasing at 26 dols. to 27 dols., and even the requirements at this limit are not sufficient to provide employment for the companies that are willing and able to run. There are elements at work which may possibly make 26 dols. the general price. Wages have been reduced 10 per cent. at the Pennsylvania Works, 15 per cent. and 20 per cent. at Scranton and Bethlehem, and a reduction has gone into effect at the Cambria Works, where wages are determined with reference to the selling prices of rails. Makers are therefore realising as wide a margin as before. A great deal of attention is being given given in our rail mills to the devising of minor economies, by which cost can be reduced. A great deal of railway building is projected. The first attempt to restrict the production of pig iron has failed because the plan was not practicable, and besides, the proprietors of 39 anthracite blast furnaces refused to co-operate. Correspondence is now in progress, looking to a restriction upon some other bases. It is a surprising thing to see such a movement gain force, when there is no more than enough iron in the country for two weeks' consumption. There is actually no necessity for restriction, as it is not the supply of iron on hand that creates the depression. The objective point is an improvement in price, but, unfortunately, any decided improvement will let in a number of furnaces, and thereby increase the supply. The miners in Western Pennsylvania are still agitating, and over 100 of them have been imprisoned, while their wives and children are seeking bread from the authorities. The operators are determined to break up the union if possible. During the past week 1500 tons of Scotch pig iron were imported; Gartsherrie, 21 dols. to arrive; Shotts, 20.50 dols.; Langloan, 21.50 dols.; Glengarnock, 20.50 dols.; Coltness, 22 dols.; Sumerlee, 21 dols.; Eglinton, 19.25 dols.; Clyde, 20 dols. A good deal of inquiry has sprung up for old rails, and about 3000 tons have just been sold. Tees are worth 17.50 dols. to 18 dols. Spot lots have sold at 19 dols. to 19.50 dols., according to quality. Crop ends are worth 20 dols. for American, 19 dols. to 19.50 dols. for Welsh, 20 dols. to 21 dols. for English. American foundry iron ranges from 18.50 dols. to 21 dols. for No. 1; No. 2 is dull at 18 dols.; mill irons can be had at 16 dols. to 18 dols., but very little standard iron sells outside of 17 dols. to 17.50 dols. The week has been quiet in plate, tank, and structural shapes. There is an improved demand for all kinds of glass. The Knights of Labour are holding their annual session in this city. The organisation is perhaps the largest in the world, and is growing rapidly.

TRIAL TRIPS AND LAUNCHES.

MR. W. B. THOMPSON, Whiteinch, Glasgow, on the 21st ultimo, launched an iron screw steamer named the Berry, built to the order of the Société Générale des Transports Maritimes à Vapeur, of Marseilles. She is a vessel measuring 255 ft. by 34 ft. by 24½ ft., and is being fitted by the builder with engines of 250 horse-power nominal.

On August 22nd, Messrs. Ramage and Ferguson, Leith, launched the Bordeaux, an iron screw steamer built to the order of the Loire and Thames Transit Company (Limited), and measuring 170 ft. by 26 ft. 9 in. by 13 ft. The builders are supplying the vessel with compound engines having cylinders 22 in. and 41 in. in diameter respectively, with stroke of 30 in., and working with steam at a pressure of 80 lb. per square inch. She is intended for the trade between London and France, and has been built under the superintendence of Mr. Adam Miller, London.

The Drumpellier, a handsomely-modelled iron spar-deck screw steamer, of 4000 tons gross register, was launched on the 22nd ultimo by Messrs. William Hamilton and Co., Port-Glasgow. She measures 350 ft. by 41 ft. 3 in. by 32 ft. 6 in., and has been built under Admiralty inspection, so that she may be entered on the list of vessels suitable for carrying troops. She is being fitted with compound surface-condensing engines of 3000 indicated horse-power by Messrs. Duncan, Stewart, and Co., Glasgow. Messrs. Henry Ellis and Son, London, are the o

With the same tide Messrs. Blackwood and Gordon, also of Port-Glasgow, lafinched the Gairloch, a steel twin-screw steamer of 350 tons gross, and measuring 147 ft. by 23 ft. by 9 ft., the owners being the Northern Steamship Company, of Auckland, New Zealand. She is being fitted by her builders with two pairs of surface-condensing compound engines of 85 horse-power combined, the cylinders being respectively 17 in. and 31 in. in diameter, with a stroke of 21 in., and the boilers working up to a pressure of 90 lb. per square inch. She is intended for the development of the cattle, passenger, and cargo trades at the northern ports of New Zealand, and will be furnished with all the latest improvements. There will be accommodation for forty first-class and twelve second-class passengers.

W. Allsup and
Crocus, a
uble twin-screw steamer for the passenger s... ice of the Wallasey ferries. The vessel, which is constructed entirely of Siemens-Landore steel, is divided into eighteen watertight compartments, and is built to the requirements of ... highest class at Lloyd's. The dimensions are: Length, 130 ft.; breadth, 35 ft.; and depth moulded, 11 ft. 6 in. The saloon on deck is 110 ft. long, and both the main and saloon decks are of teak. The machinery consists of two complete pairs of compound surface-condensing engines, having cylinders 18 in. and 37 in. in diameter and 24 in.
... steering gear are fitted. Messrs. Allsup have a sister vessel to the Crocus in course of construction for the Wallasey Local Board; both steamers are from the designs, and under the superintendence of Messrs. Flannery and Wawcus, of Liverpool.

On Thursday, the 31st ultimo, the Earnest, a new steam fishing vessel, built by Messrs. A. G. Gifford and Co., Leith, to the order of Mr. Alexander Cook, fish ... Edinburgh, and intended for the net and line fi... her official trial trip in the Forth. She measures 62 ft. by ... 6 in. by 7 ft., and is fitted with engines of 54 horse-power ... hour.

Messrs. Russell and Co., Greenock, launched on the ... a finely-modelled iron sailing ship named ... Main, a vessel of 1690 tons register, and measuring 251 ft. by 38 ft. by 23 ft. She is sister ship to the Shannon, launched by the same firm at Port-Glasgow last S... tember, and is classed 100 A 1 at Lloyd's. The Main has been built to the order of Mr. James Nourse, Liverpool, who is the owner of a very magnificent fleet of sailing vessels aggregating 19,567 tons.

With the same tide, Messrs. ... Co., Port-Glasgow, launched the Palgrave, a handsomely modelled iron four-masted full-rigged sailing ship, which is stated to be the largest sailing vessel in the world, her measurements being 340 ft. by 49 ft. by 25 ft. 8 in. She is a vessel of 3173 tons register, and is said to have a carrying capacity of 4900 tons of dead weight. This really magnificent vessel has been built to the highest class at Lloyd's under special survey, and is in many respects in access of Lloyd's requirements, having main and 'tween decks iron fully laid fore and aft. Her principal yards and masts are made of steel. One of the novelties of this ship is that instead of the usual poop and top-gallant forecastle, she has a long bridge or deckhouse amidships, under which all the accommodation for the captain, officers, and crew is placed, and this very large deckhouse has an iron bulkhead at each end, so that she will be a very much safer vessel in heavy weather than the usual type. All her other structural arrangements and fittings are in with ... tons of goods for her first voyage f... to Calcutta.

A twin-screw hopper dredger of 900 tons ... compound engines of 500 horse-power, and has been designed for dredging to a depth of 35 ft. She will raise 400 tons of ... España are intended to take the place of a ... barges, tugs, and stationary dredgers on the old system, which has been in use for many years.

On the 28th ultimo, Messrs. Russell and Co., Greenock, launched the Kirkcudbrightshire, a splendid iron sailing ship for the "Shire" Line, owned by Messrs. Thomas Law and Co., Glasgow. She is a vessel of 1500 tons, and measures 240 ft. by 38 ft. by 23 ft.

...ay, 30th of August, the screw steamer Wellington, built by Messrs. Burrell and Son, Dumbarton, to the order of Messrs. John Terry and Co., London, for general coasting traffic in Tasmania, went down the C... on her official trial trip, and attained on the measured mile speed of 10½ knots per hour. The machinery was supplied by Messrs. Ross and Duncan, Govan.

On Tuesday, the 2nd of September, the screw steamer ..., built and engined by Messrs. Pearce Brothers, Dundee, went down the Tay on her trial trip. She is capable of carrying 600 tons of cargo, and measures 172 ft. by 28 ft. by 13 ft. Her engines are 450 horse-power indicated, and when loaded with a full cargo she steamed at the rate of 10 knots per hour.

...s been built to the order of Mes... Adolphs Enke, of Copenhagen, and is intended for their trade between Denmark and Norway. It will be fitted with the builders' compound surface-condensing engines of 400 horse power indicated.

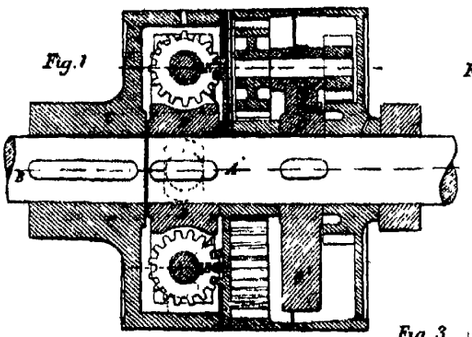
On Saturday, September 6, Her Majesty's ship Acorn was successfully launched from the yard of the Pennar Shipbuilding and Engineering Company. The Acorn is a composite twin-screw gun-vessel of iron frames, with two thicknesses of teak planking, and her top sides lined with steel. Her principal dimensions are as follows: Length, 176 ft.; breadth, 31 ft.; draught of water, 14 ft. She has a displacement of 950 tons, and will be propelled with engines of 850 horse-power. Her armament will be eight 5-in. breechloading guns. She is a handsome serviceable vessel, designed by the constructors of the Admiralty.

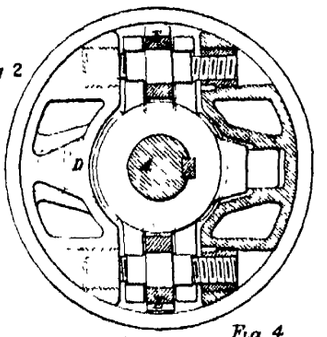
On Saturday last the Barrow Shipbuilding Company unched from their yard the iron paddle-wheel tug eamer Gannet, built to the order of the Melbourne Harbour Commissioners. Her dimensions are 134 ft. by 22 ft. by 11.7 ft. moulded depth and 11 ft. depth of hold, and she will be classed 100 A 1 in Lloyd's register. The vessel was first contracted for as a powerful tugboat, but it was subsequently determined to put in a large fire engine made by Messrs. Shand, Mason, and Co., and a 6 in. Armstrong breechloading gun in the bow, capable of commanding a clear range from 115 deg. on either side. She ... cylinders of 20 in. and 35 in. diameter with a 4 ft. stroke. The two boilers are 9 ft. 6 in. in diameter and 9 ft. long, fitted with four furnaces 3 ft. in diameter, with a total heating surface of 1742 square feet; the cooling surface in condenser is 1000 square feet, and the vessel will be capable of steaming from 11 knots to 12 knots per hour.

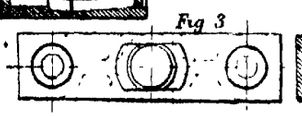
MESSRS. H. POOLEY AND SON.—At the International Agricultural Exhibition at Amsterdam ... to Messrs. H. Pooley and Son, of 80, ... a gold medal in Class 304, silver medals in Classes 303 and 308, and a bronze medal in Class 302. They also received a special silver medal for their collection of weighing machines.

THE LATE MR. WIMSHURST.—Mr. Henry Wimshurst was born in 1804, and, owing to his energy and ability, had in 1838 a substantial business as shipbuilder, &c., at Millwall, London. It was at this time that he first ... the small experimental boat owned by the late Sir F. Smith, and propelled by a screw; Mr. ... the ex... t, and its great promise ... fitted in a properly ... h of ol... it this idea in spite of much d...fficulty, and, b... Archimedes, the first ship ... is screw. He afterwards ... cost the Novelty, a larger vessel, and the first steamer which made a commercial voyage. The Government and the shipowning world were slow to accept the success, and Mr. Wimshurst's means became exhausted. A few years later he obtained a lease of Ratcliffe Dry Dock, where, with the financial and practical aid of his sons, he carried on a pretty successful business till 1862, when it was considered desirable that he should retire. He died on the 21st of August at 69, Warrior-square, St. Leonards-on-Sea.

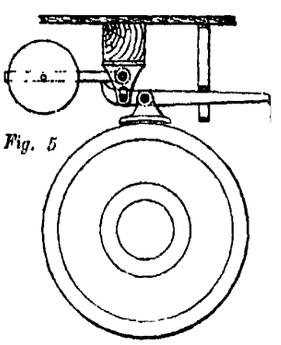
HERMANNI'S FRICTION COUPLING.











FOR some time past a new friction coupling, designed by Mr. G. Hermanni, of Hamburg, for shafting and other purposes, has been successfully introduced into a number of works in Germany and given great satisfaction, and we now place before our readers illustrations of this arrangement. The feature which at first sight would most recommend this coupling is, that it has no externally sliding collar or other parts, and is entirely inclosed and certainly not liable to catch anything in its rotation, a point which no doubt would recommend it to the factory inspectors if it becomes introduced into this country. In the illustration A is the driving shaft, the balanced lever G and the cross arm piece D are firmly keyed to this, while the driven shaft B only carries the casing C on a long sleeve. In the forked end of the cross I are secured on short axles the gear wheels E E; the two ends of these short shafts have right and left handed threads, screwing into two friction or brake blocks, which are in addition pivotted on the stud extensions of the cross D. It will be now understood that if the pinions E E are turned, the brake blocks will be forced against the inside face of the brake box C [illegible] will be drawn away from it, in one case causing the shaft B to rotate, in the other to stop. To effect this one end of the lever G carries a short shaft, to each [illegible] id of which a pinion is firmly attached; each of these [illegible] in the illustration, one with [illegible] wheel cast on the outer disc, the other with the toothed annular ring cast on the inner disc, both these discs being loose on the shaft; and the inner disc having on its outer face a worm which gears with the two pinions E E. A collar on the shaft holds all the parts together and prevents lateral movement.

If now by internal friction blocks (see Fig. 5) one or the other of the loose discs, which will ordinarily run with the shaft in consequence of the friction between the wheel teeth, is stopped, say the outside one, then the two pinions will revolve, and the inner disc will be driven in the opposite direction, carrying with it the worm and small wheels E E, that in consequence of their screwed ends expand the circular brake blocks, and the brake is gradually put on. To throw it off all that is necessary is to stop by means of the external brake the middle disc. This coupling seems very ingenious, and though it may lack one very desirable feature, that of simplicity, there is nothing in it likely to cause undue wear, and in its action and appearance it certainly is all that could be desired.

way opened in France during the twelve months ending [illegible]

'ENGINEERING" ILLUSTRATED PATENT RECORD.

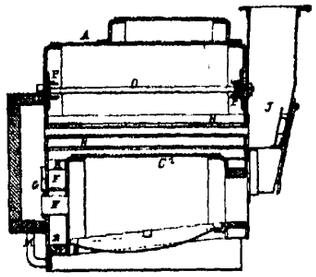
COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF RECENT SPECIFICATIONS PUBLISHED UNDER THE ACT OF 1883.

The number of views given in the Specification Drawings is stated in each case after the price, where none are mentioned, the [illegible] Inventions [illegible] &c., of the Communicators are given in italics
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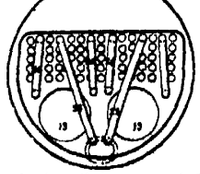
BOILERS.

1572. F. J. Burrell, Thetford, Norfolk. Boilers for Launches, &c. [6d. 2 *Figs.*] January 16, 1884.—The shell A of the boiler is rivetted to the solid foundation ring B by which it is tied together. The crown and side plates C2 of the firebox are also rivetted to the ring which is carried up at the front end[illegible] as a ring for the firedoor, the space left open below [illegible] ng filled by a dead plate carrying the centre fi[illegible] se F convey the products of combustion from t[illegible]



[illegible] combustion chamber G fitted [illegible] boiler, and conducting the gases to the tubes H, from which pass to the smokebox J. The tube-plate K is stayed to the shell-plate by the large tubes F. Small tubes M connect the ashpit with the combustion chamber. The back and front steel plates are stayed by the stays O and angle irons P. By this construction of boiler it will be seen that the tubes are immediately [illegible] al May 13

2513. A. [illegible] Steam Boilers. [6d. 9 *Figs.*] February 1, 1884.—In order to obtain a thorough and efficient circulation of the water in the boiler, bent tubes communicate with the upper and lower parts [illegible]



the boiler. These tubes have their upper ends fixed in the tub[illegible] plate and their lower ends fixed in a lower part of the boiler. T[illegible] illustration is a transverse section of a marine boiler showing t[illegible] bent tubes 20 and 23, the tubes 23 having their lower ends fixed a part below the furnaces 13. (*Sealed April* 29, 1884).

2976. G. Grimer, Paris. Steam Boilers. [4d. 6 *Figs.*] February 8, 1884.—In order to obtain a more perfect mixture of



the gases resulting in a higher temperature and better combustion [illegible] pillars of refractory material, arranged in zig zag fashion, [illegible] in the flue. The illustrations show the invention applied to an elephant boiler. The pillars A are carried upon supports or arches V, and the groups are separated by air spaces [illegible] which permit the cinders to fall into the pits T. (*Sealed May* [illegible], 1884).

3738. W. Workman, Belfast. Steam Boilers. [8d. 3 *Figs.*] February 21, 1884.—The boiler is formed with an internal flue or flues terminating in an enlarged combustion chamber carried up to within a short distance below the water level of the boiler. A vertical tube at the side or back of the combustion chamber having its ends open, extends down nearly to the bottom of the boiler and upwards to about the level of the crown of the combustion chambers. The tubes, it is stated, ca[illegible] circulation of the water. (*Sealed May* 27, 1884).

3962. A. W. L. Reddie, London. (*W. Craig, Brooklyn, U.S.A.*) **Producing the Circulation of Water in Steam Boilers.** [6d. 3 *Figs.*] February 26, 1884.—A suction or supply pipe leads from one part of the boiler to the water inlet of an in[illegible] discharge of which leads to another portion of the boiler. (*Sealed July* 1, 1884).

March [illegible] [illegible]nis consists of a mixture of six parts caustic soda, four parts charcoal, one part Irish moss, and forty parts of malt combs or dust and water. (*Sealed July* 4, 1884).

[illegible]ndon. (*G. Stolle*[illegible] [6d. 10 *Figs.*]
This invention, as applied to a boiler of the Cor[illegible] [illegible] a boiler, ha[illegible] heating tub[illegible] municating with each other in such a manner as to form a second boiler as it were within the boiler. (*Sealed July* 22, 1884).

1563. A. J. Boult, London. (*E. W. Vanduzen, Newport, Kentucky, U.S.A.*) **Water Purifiers for Steam Boilers.** [6d. 6 *Figs.*] January 16, 1884.—In order to purify the feed water, it is forced through a pipe and through an ejector, where it meets and mixes with water from the boiler, the water from the pump, before meeting the water from the boiler, entering a vessel containing soda, which it dissolves, when the pulsation of the pump exhausts a portion of the solution and mingles it with the feed water. The water then enters a purifier provided with a series of [illegible]

[illegible] uary 18, [illegible] steam or [illegible] [illegible] temperature further raised by live steam, the impurities held in solution being thus eliminated. The apparatus comprises a heater, a superheater, and a filter. The heater comprises a series of vertical tubes, mounted on a tube plate divided by central longitudinal partitions, and opening at the lower ends into a chamber provided with a peculiar arranged diaphragm meeting the diaphragm of the tubes. The exhaust steam enters one part of the chamber, passes up one side of the tubes down the other side to the other part of the chamber. The superheater comprises a series of straight tubes and a vessel containing a second series of tubes inclosed within an inner chamber or drum connected with the steam generator. The filters are provided [illegible] [illegible] annular rims w[illegible] [illegible] the water t[illegible] [illegible] e centre of the filter. (*Sealed April* 29, 1884).

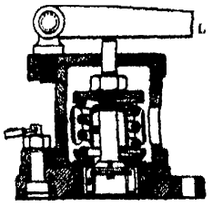
with one or more tubular boilers containing the feed water under a higher pressure than that prevailing in the steam boiler. The feed water enters a purifying chamber, and is met by a circulating mixture of steam and hot water from the tubular boiler and is forced through filtering media to the steam boiler. (*Sealed April* 29, 1884)

BOILER FURNACES.

1886. G. G. M. Hardingham, London. (*J. C. Jones, Chicago, Ill., U.S.A.*) **Self-Cleaning Furnace Grates.** [4d. 3 *Figs.*] January 22, 1884.—The bars are pivotted or journalled in different planes, so that when rocked they have a differential movement, and thus vary the spaces between them. (*Sealed April* 29, 1884)

5562. W. Vogel, Chicago, U.S.A. Extracting Carbon from Furnace Fumes. [4d. 4 *Figs.*] April 4, 1884.—The smoke is passed from the furnace into a cooling cylinder and is acted upon by a blower and forced in succession through a series of vertical cylinders surrounded by a large sheet metal cylinder. The vertical cylinders are partially filled with water and contain beaters rotating between arms projecting internally from the cylinders. The inventor states that by means of his invention he [illegible] [illegible] [illegible]

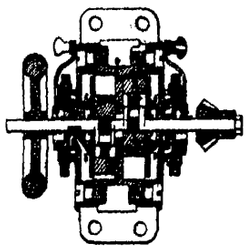
the spiral spring S to the annular valve A, and so long as it does not exceed that of the spring S, the compound valve will act as an ordinary safety valve Should this pressure exceed that of the



spring S, the annular valve A will be held c central valve B opened inwards, allowing valve is shown formed with a whistle H o give the necessary valve to be rotated on its seat, one or more stops N a engage with corresponding stops on the annular valve. (*June* 6, 1884)

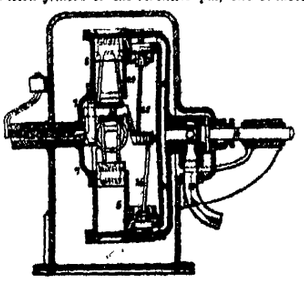
P. G. Jacomy, Turbes, **as Pumps, &c.** [6d.

forming a distinct engine; the parts are symmetrically placed and act on the crankshaft, the cranks of which are diametrically opposite to one another. Referring to the illustration, a horizontal section, a piston *b* is connected by suitable bearings to each crank and reciprocates horizontally in movable frames



capable of a vertical motion in guides formed by the stays *s*. The steam from the boiler passes round the outer casing to the top and by a valve into a chamber where a lubricator supplies a lubricant thereto From this chamber it passes by suitable passages through the distributing valves *p* and ports 5 to the pistons *b*, the exhaust taking place through similar ports and passing off by a pipe at the bottom of the motor. The valves *p* are movable so that the cut-off can be varied. (*Sealed July* 16, 1884).

4012. A. B. Brown, Edinburgh. High Speed Motors. [6d. 2 *Figs.*] March 15, 1884.—In this engine, two or more single-acting cylinders are arranged upon a rotating disc; the motive fluid acts only on the outer sides of the pistons which are jointed upon a stationary eccentric pin. Referring to the illustration, the cylinders *b*, of which there are four, are cast in one piece with a disc 6, and are bolted at one side near their inner ends to a disc 7 fitted with a sleeve and bearings to rotate on a short stationary shaft 8 clamped in bearings formed on a casing surrounding the motor A valve casing 10, fitted with a piston valve, is formed at one side of each cylinder, and passages 12 be steam from the inlet 13 to the casings 10. The stationary 8 is formed with a crank and pin 23, which are stationary subjected to an abnormal strain sufficient to make the shaft 8 turn in its gripping bearing The piston 24 of each cylinder has jointed to it by means of a hollow pin, a connecting rod which is itself jointed to the eccentric pin, one connecting rod



having a single bearing on the pin and the others two bearings each at equal distances on the opposite sides of the middle of the pin. If steam be admitted to the cylinders, the disc 6 and with it the shaft 15 will be caused to rotate, the cylinders rotating about the shaft 15 and the pistons about the pin 23. The exhaust is partly through the holes 30 and partly through valve ports into the casing. When the motor is rotating at its proper speed, the centrifugal forces acting on each piston and connecting rod is somewhat more than the aggregate effective pressure of the steam acting in the opposite direction on the piston, and there is thus always a force tending to move each connecting rod bearing towards its cylinder, and there will be no concussion even if the bearing is slack. The piston valves are worked by the rods 26 and are also acted on by the centrifugal force. The oiling arrangements are indicated by the interrupted lines. If the motor is worked in connection with compound engines it is worked by high pressure, and exhausts into the intermediate casing, or it is worked from the intermediate casing and exhausts into the condenser. (*Sealed June* 20, 1884).

4093. L. Mogy, Paris. Motors. [6d. 7 *Figs.*] March 18, 1884.—This relates to high-speed engines with single-acting cylinders, and with single-acting cylinders transformed into the Otto type. The introduction, expansion, and exhaust of steam is effected by a single distributing apparatus consisting of a cylindrical cut-off valve capable of turning with an angular movement, and situated in the centre of a cylindrical distributor in-

The governor c series of weights arranged together with adjustable springs in cavities in a wheel, and connected to a collar transmitting its motion by levers to the cut-off valve. The frame of the engine formed with a central closed box traversed by the inclosing the wheels operating the distributor, the reservoir of oil. (*Sealed June* 24, 1884).

GAS ENGINES.

1272. L. Sterne, London. Gas Engines. [4d. 1 *Fig.*] January 19, 1884.—In order to insure the silent exhaust of gas engines the inventor connects the exhaust pipe with a vessel partially filled with water. The pipe extends down to or nearly to the water level. (*Sealed April* 29, 1884.)

3878. P. Mugnier, Paris. Gas Motors. [6d. 6 *Figs.*] April 22, 1884.—The oscillating motion of the cylinder is caused to introduce to the centre of ignition the quantity of gas necessary to produce the explosion at the exact moment, only a small gas flame being required at other times Referring to the illustrations, the cylinder A is water jacketted and oscillates in the bearings *b* The distributing apparatus consists of a cylindrical box bolted to the cylinder, and in which driven from the main shaft by the p from the valve T cam. The stroke the valve can be varied by means of the nuts,

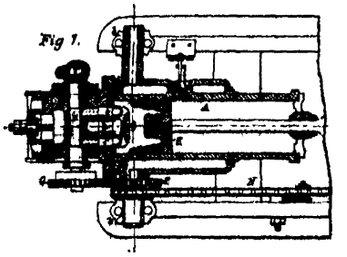


Fig 1.

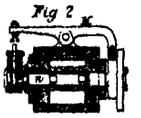


Fig 2

b being closed by the spring . Air is introduced through orifices into the cylinder C and mixes with the gas, the mixture passing through the perforated tube *g* to the cylinder The products of combustion escape by the orifices *e*, *f*, and A. In order to prevent rarefaction in the cylinder resulting from the irregular supply of gas, a box provided with a valve opening inwards is placed at the lower part of the cylinder, and as far away as possible from the centre of ignition. The piston E in its stroke uncovers an orifice and draws in the flame through the valve *m* from a gas burner which is relighted by a second burner. The oscillation of the cylinder then releases a lever from a tappet, and the gas tap is partially closed by the action of a spring. (*Sealed August* 1, 1884).

PISTONS.

2155. W. Lockwood, Sheffield. Construction of Spring Packing for Pistons, &c. [6d. 4 *Figs.*] January 26, 1884.—The packing is formed of alternating sections in such a manner that one series of sections will impart a longitudinal and lateral action to the spring for effecting a radial or outwards

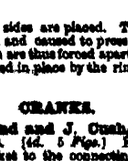


Fig 1

Fig 2

expansion of the piston rings, and the other series will impart an action to the spring tending to keep the piston rings apart. Referring to the illustration, the segments 1 effect the radial expansion of the rings, and the segments 2 tend to keep the rings apart. (*Sealed April* 29, 1884).

3495. T. H. Taylor, Southampton. Packings for Pistons. [4d. 3 *Figs.*] January 31, 1884.—The illustration clearly shows the construction of this packing. The packing rings P are provided with bevelled flanges, and between them two



rings R having inclined sides are placed. The rings R are forced apart by coiled springs, and caused to press upon the flanges of the packing rings which are thus forced apart and expanded. The packing rings are retained in place by the ring J. (*Sealed May* 9, 1884).

CRANKS.

3613. S. Marchand and J. Cush, Bolton. Lubricating Crank-Pins. [4d. 5 *Figs.*] February 6, 1884.—A pump is fixed by a bracket to the connecting rod, and is worked by an eccentric fixed to the crank-pin. A suitable case containing wire gauze covered with flannel collects the lubricant as it works out of the neck. A pipe carries the lubricant from the pump to the receiver. (*Sealed May* 13, 1884).

LINK MOTION.

P. Bryce-Douglas, Sheffield, Ardrossan, Motion for the Slide Valves of Engines. March 15, 1884.—A beam mounted on a stationary ected at one end by a link to the crosshead of the pin on the beam is mounted a curved link fitted block linked by a rod to the slide valve rod. A pin on the main connecting rod is connected by a link to the middle joint of a pair of toggle levers, one pivotted on the beam and the other to a radius rod having a pin on it connected by a link to arm of the curved link. The link working the valve rod is link at a portion of its length to a radius rod. (*Sealed June* 20, 188

REVERSING VALVES.

3576. T. E. Owen and S. W. Allen, Cardiff. Steam Engine Reversing Valves. [4d. 7 *Figs.*] March 21, 1884.—The ordinary slide valve is replaced by a slide or piston valve which communicates with a regulating valve by two steam pipes, one acting as the exhaust when the engine is running in one direction, and as the admission when running in the opposite. Referring to

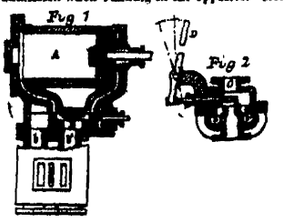


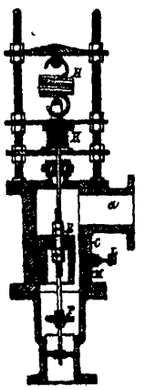
Fig 1

Fig 2

the illustrations, the steam cylinder A is provided with a slide valve B having a flat face and a ring at the back. The pipes *b b'* communicate with the valve chamber, and the supply to one or other of these pipes is determined by the reversing valve C and hand lever D The valve B may be replaced by a piston valve (*Sealed June* 27, 1884).

GOVERNORS.

2480. H. J. Haddan, London. (*A Zalm, Rotterdam*) **Governor for Steam, &c., Engines.** [4d. 8 *Figs.*] February 16, 1884.—This invention, it is stated, is based on the fact that the rapidity of a streaming fluid is in inverse proport resistance it encounters on its way. Referring to the ill the steam enters at *a* and acts upon the regulator piston controls the position of the valve F. A spring H compr the diminishing pressure under the valve P as it comes



seat, or two balanced valves, may be employed. The spring K balances the weights of the parts. The steam passages around the seating of the valve E are adjustable by means of blocks M and screws L. (*Sealed May* 23, 1884).

DYNAMOMETER.

4230. R. H. Brandon, London. Dynamometer. [6d. 11 *Figs.*] March 4, 1884.—The dynamometer is mounted upon the shaft, from which the power is taken, and around which a pulley mounted on another shaft revolves Two levers are pivotted upon the arms of the dynamometer casing, and their short ends are forced outwards against stops by flat springs bearing upon the hub of the casing, so that when the pulley is rotated in the required direction, lugs on it will bear against the short arms of the levers, and will thereby carry the dynamometer shaft round, and the more resistance this shaft offers to its revolution the further will the arms be forced away from the stops. The motion of one of the levers is utilised for recording by means of a pencil, the resistance of the shaft to revolution, the other lever being merely a balancing lever. An arrangement for advancing the tape at every change in the resistance consists of a spring pawl attached to the lever, and working a ratchet, on the shaft of which is mounted a bobbin taking the tape from a second bobbin. If it is desired to advance the tape once during every revolution of the shaft, one end of a lever lies between an annular flange in the dynamometer and a loose surrounding ring, and adjacent to a notch in the flange. It is drawn out of the notch by a spring except when vertically above the axis of the shaft, when the weight of the loose rings causes it into the notch, and causes a spring pawl to rotate a ratchet wheel working by worm gearing the tape reel. When relieved from this weight by further revolution of the wheel, it is drawn out of the notch, and advances the pawl over the teeth of the ratchet. (*Sealed June* 10, 1884).

PACKING.

10,076. W. J. Adams, London. Packing for Joints. [2d.] July 11, 1884.—The packings are composed of sheets or layers of asbestos and caoutchouc compound alternating with and uniting from opposite sides of a sheet or sheets of coarsely woven or loosely felted cotton. (*Accepted August* 12, 1884).

UNITED STATES PATENTS AND PATENT BUSINESS.

Descriptions with illustrations of inventions protected in the United States of America from 1867 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of Specifications, 25 and 26, Bedford street, Strand.

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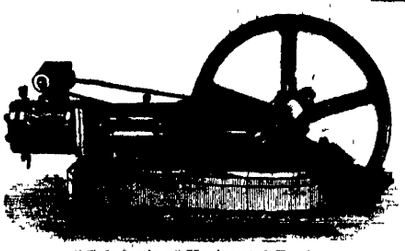
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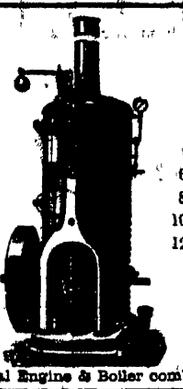
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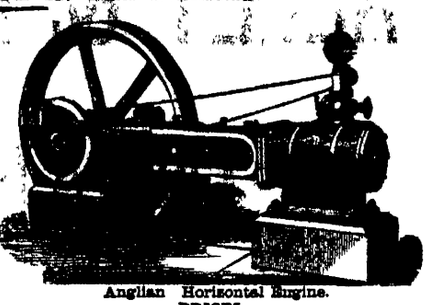
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10 HP.	70	30 HP.	250
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Vertical Engine & Boiler combined.

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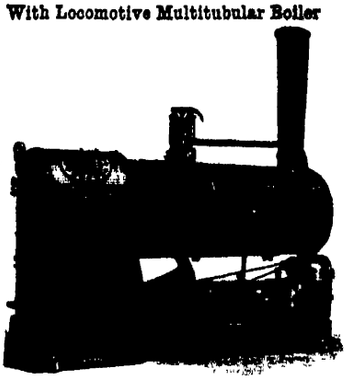
PRICES.			
6 HP.	£37 10s.	16 HP.	£145
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10 HP.	95	25 HP.	210
12 HP.	110	30 HP.	240

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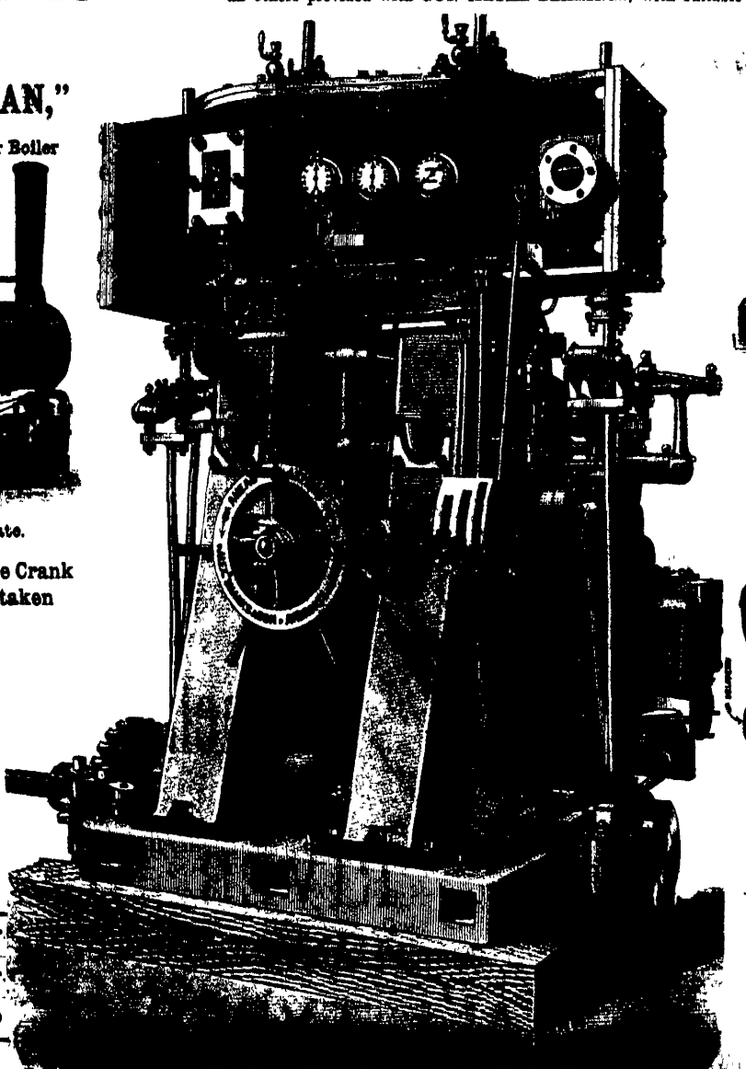
With Locomotive Multitubular Boiler



Combined on one Sole Plate.

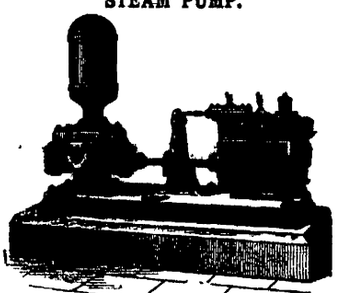
The Engine having a Double Crank enables the power to be taken from either side.

The above is the cheapest and most convenient form of Engine with Locomotive Boiler in the market.



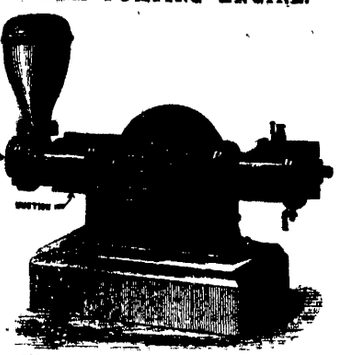
Size of Engine	4 HP.	6 HP.	8 HP.	10 HP.	12 HP.
Size of Boiler	6 HP.	8 HP	10 HP.	12 HP.	14 HP.
Engine & Boiler as above	£130	£155	£210	£260	£300

SHANKS'S IMPROVED DIRECT-ACTING STEAM PUMP.



The utmost regularity in reversing and steadiness in working secured.

SHANKS'S IMPROVED EXPANSIVE STEAM PUMPING ENGINE.



THE SIMPLEST MADE.
ACTION CERTAIN.

Prices, Illustrations & Particulars on application.

ALEX. SHANKS & SON will be glad to furnish, on application, detailed Specifications for Engines up to 1000 I. HP., with suitable Boilers, [illegible] board complete, or securely packed for shipment.

STEAM CRANES AND HOISTING ENGINES OF ALL SIZES.

SHANKS'S PATENT COMPOUND STEAM ENGINES in the Horizontal or Vertical form, with or without Boilers.

SHANKS'S PATENT COMPOUND LAUNCH ENGINES.

ILLUSTRATIONS, WITH FULL PARTICULARS AND PRICES, ON APPLICATION.

ALEXANDER SHANKS & SON, DENS IRON WORKS, ARBROATH.

And 27, LEADENHALL STREET, LONDON, E.C.

JAMES FARMER & SONS,

ADELPHI STREET IRONWORKS, SALFORD, MANCHESTER,

MAKERS OF

STEAM ENGINES, BLEACHING, FINISHING, DYEING & CALICO PRINTING MACHINERY,

WIRE MACHINERY

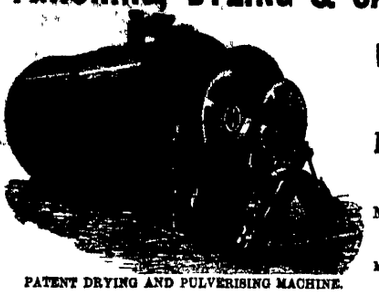
Consisting of Continuous and other Rolling Mills, Wire Pointing Machines, Wire Looms, Wire Testing Machines, Wire Blocks, &c.



COPPER TUBE ROUGHING LATHE.

BRASS & COPPER TUBE MILLS.

Wrought Iron TUBE MACHINERY.



PATENT DRYING AND PULVERISING MACHINE.

COMPLETE PLANT FOR

LINOLEUM MACHINERY

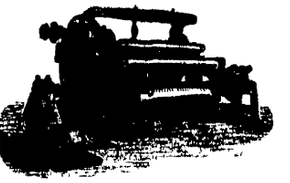
Two and Four Yards wide.

"PATENT"

Drying & Pulverising MACHINE

For Excrementitious Matter & other Materials and Compounds.

MACHINERY IN GENERAL.



POWER WIRE LOOM. 4889

FOR BRICK, TILE, & PIPE MACHINES,

JOHN WHITEHEAD & CO.,

ALBERT WORKS, PRESTON, LANCASHIRE,

HAVE BEEN AWARDED

FOURTEEN PRIZES by the Royal Agricultural Society of England,

INCLUDING THE SOCIETY'S SPECIAL SILVER MEDAL FOR SUPERIOR EXCELLENCE.

Also Awarded the PRIZE MEDALS of the INTERNATIONAL EXHIBITIONS of LONDON, 1851, 1862, and 1874; PARIS, 1855, 1856, 1867, and 1878.

ILLUSTRATED CATALOGUES FREE ON APPLICATION. 4007

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

S.S. "Rangatira," Royal Albert Dock, 10th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure 110 lbs. Vacuum .... 26 inches.

My experience does not show an equal result from any other packing

The voyage from New Zealand to Plymouth was accomplished in 27 days 22 hours, being the fastest run from New Zealand on record

Yours obediently,

D HENDERSON, Chief Engineer, S.S "Rangatira"

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department,

Grimsby, April 10th, 1884

Dear Sirs,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing It is especially valuable where high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory

Yours truly,

Mr J. BELL G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts,

Admiralty, Whitehall, 20th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos packing to sample submitted.

Elastic core. . . square. | Elastic core .....round.

To Mr JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plate burned is thereby obviated

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; $\frac{1}{8}$ in., 60 per cent., $\frac{1}{4}$ in., 120 per cent.

Thus the Preservative avoids the great risks which are inseparable from sealed plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

Being in pot into the feed tank or boiler, as may be most convenient.

In 1lb. packets and tins bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To Messrs Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality

I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



TRADE MARK

BELL'S ASBESTOS.

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "house" orders should be sent direct to the undermentioned depôts and not through agents or factors.

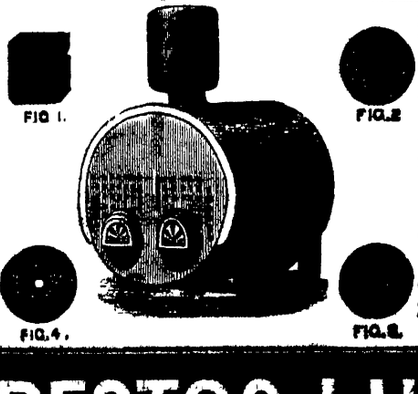


FIG 1. FIG.2 FIG.4. FIG.3.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 85 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off at any many years' use, mixed up with 20 per cent of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates . . . . . 256 deg.

Covering. . . . . 52 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov 26th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 50 per cent. in fuel through using your covering.—Yours truly,

"W SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

Gunnislake, Tavistock, 5th April, 1884.

Mr. JOHN BELL, Southwark, S.E.

Sir,—I have much pleasure in stating that the Asbestos Covering supplied by you to the boiler of our travelling crane at Kit Hill has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us I should add that the crane runs on high gantries, and is fully exposed to all weather I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W J CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without packering, and is especially useful in making joints of manhole and mudhole doors It is kept in stock in rolls of 100 ft., from $\frac{1}{2}$ in. to 2 in wide, and any thickness from 1 16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and 1 millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts,

Admiralty, Whitehall, S.W., 17th May, 1884.

Sir,—I have to inform you that your tender for Asbestos Millboard has been accepted JOHN COLLETT,

Mr JOHN BELL. Director of Navy Contracts.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT"

REGD.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

OR THE DEPOTS—

Mr. SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

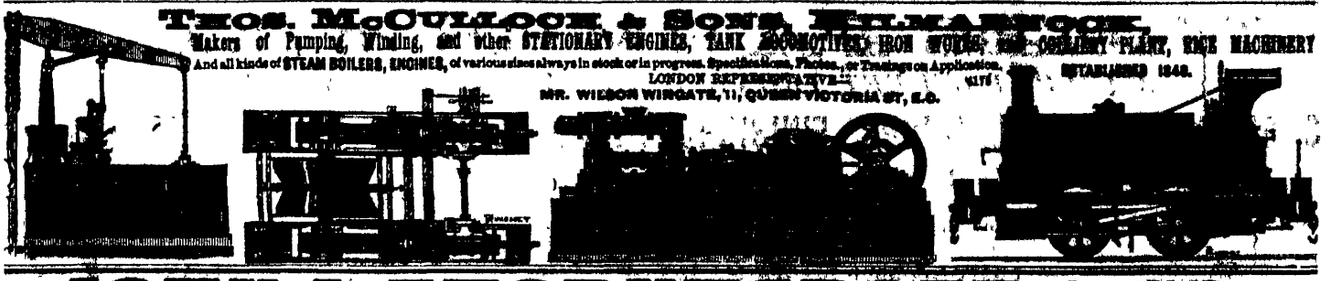
4943

THOS. McCULLOCK & SONS, KILMARNOCK.

Makers of Pumping, Winding, and other STATIONARY ENGINES, TANK LOCOMOTIVES, IRON WORKS FOR COLLIERY PLANT, PACK MACHINERY

And all kinds of STEAM BOILERS, ENGINES, of various sizes always in stock or in progress. Specifications, Plans, or Tenders on Application. ESTABLISHED 1848.

LONDON REPRESENTATIVE:
MR. WILSON WINGATE, 11, QUEEN VICTORIA ST, E.C.



JOHN I. THORNYCROFT & CO.,

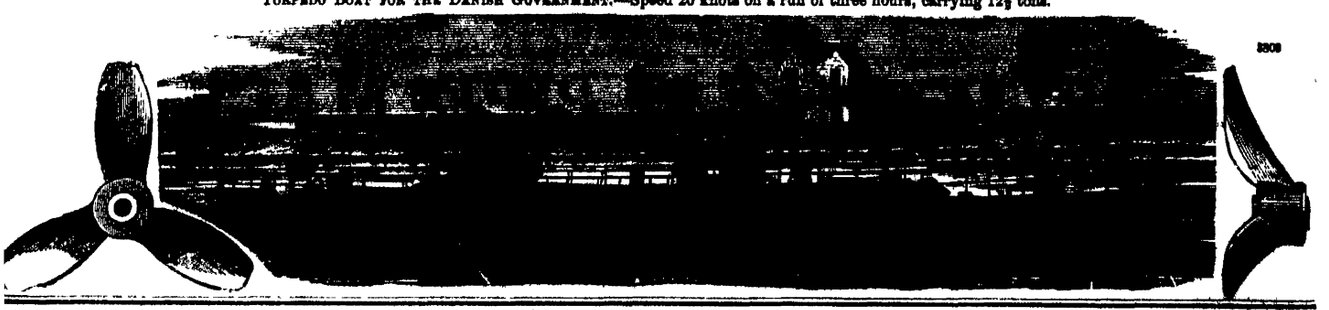
STEAM YACHT AND LAUNCH BUILDERS,

CHURCH WHARF, CHISWICK, LONDON, W.

YACHTS AND LAUNCHES FOR SEA OR RIVER SERVICE, from 25 to 100 feet in length, and Speeds from 10 to 25 Miles per Hour

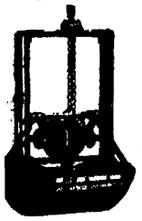
Thornycroft's Patent Screw Propellers made for all sizes of Vessels. Efficiency superior to any hitherto brought out.

TORPEDO BOAT FOR THE DANISH GOVERNMENT.—Speed 20 knots on a run of three hours, carrying 12½ tons.



2809

SINGLE CHAIN GRABS.



SUPPLIED TO ORDER WHEN PREFERRED.

WORKS: Holderness Foundry, HULL.

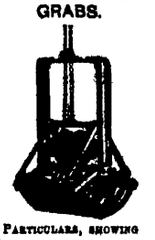
PRIESTMAN BROTHERS.

CONTRACTORS FOR BARGES TO H.M. GOVERNMENT & THE INDIAN BOARD.

GOLD MEDAL, CALCUTTA, 1884.

LONDON OFFICE: 52, QUEEN VICTORIA STREET.

DOUBLE CHAIN GRABS.



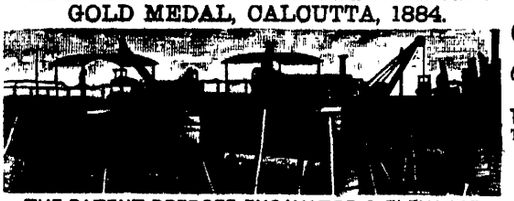
PARTICULARS, SHOWING GREAT ADVANTAGES, ON APPLICATION. 3057

AWARDS

DIPLOMA of HONOUR AMSTERDAM, Paris, Melbourne, Adelaide.

Contractors for Dredgers to

THE ENGLISH GOVERNMENT
THE CROWN AGENTS FOR THE COLONIES
The German Government
" French Government
" Italian Government
" Cape Government
" Danish Government
" Chinese Government
" Chilian Government



THE PATENT DREDGER EXCAVATOR & ELEVATOR.

AWARDS

GOLD MEDAL FISHERIES LONDON, Sydney, New Zealand, Tynemouth.

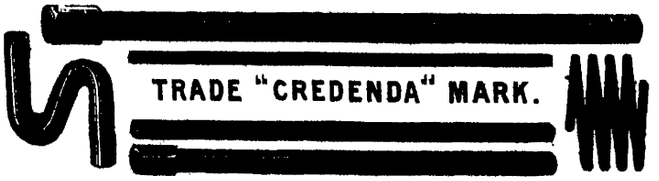
Contractors for Dredgers to

THE INDIAN BOARD
THE MERSEY DOCK & HARBOUR BOARD
The South Australian Government
" New Zealand Government
" Spanish Government
" Victorian Government
" New South Wales Government
" Dutch Government
" Queensland Government

—:PATENT:—

COLD-DRAWN SEAMLESS

THE CREDENDA COLD-DRAWN SEAMLESS STEEL TUBE COMPANY, BIRMINGHAM.



TRADE "CREDENDA" MARK.

BIRMINGHAM WORKS & OFFICES: LEDSAM STREET, MONUMENT LANE STATION.

LONDON OFFICE: 4, WATER LANE, GT. TOWER STREET, E.C.

4990

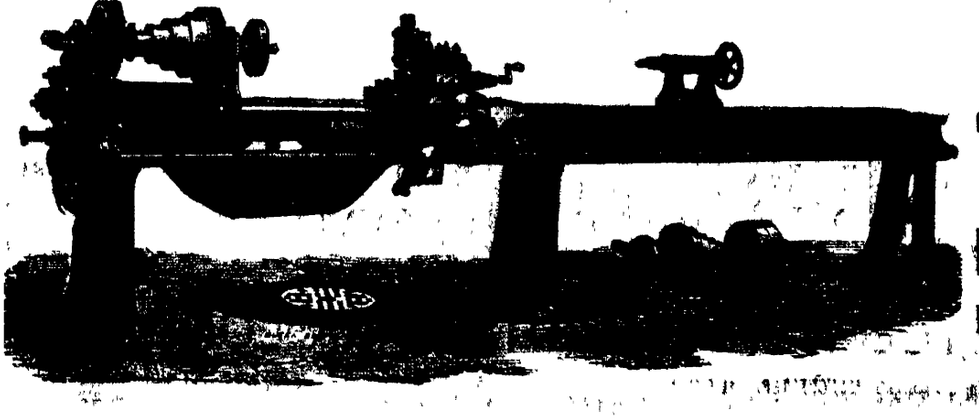
FOR BOILERS AND STAYS, HYDRAULIC PRESSES, AIR RESERVOIRS,

STEEL TUBES.

BORING RODS, COUPLINGS, BUSHES, SPINDLES, COLLARS, BICYCLES & OTHER USES.

SCREW-CUTTING LATHES,

6 in. to 24 in. Centres.



PRICED CATALOGUES ON APPLICATION.

LOUDON BROTHERS,

Bothwell St., GLASGOW. AND U. Thames St., LONDON.

CLASS A.



LOCO. PATTERN, SINGLE LEVER.



THE HANCOCK

INSPIRATOR

ONLY GOLD MEDAL Paris, 1878.

FIRST AWARD, Sydney, 1879.

60,000 IN USE.

THE DONKEY PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND RELIABLY.

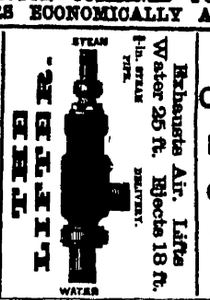
No Adjustment.

Draws Water at 140°.

All Sizes lift water 25 ft.

Delivers to Boiler up to 212°.

ESTIMATES FOR FIXING COMPLETE with Guarantee to start in good working order, and all information on application to—



Feeds through Heaters.

Can be used as a Pump only.

No Valves or Wearing Parts.

Can be examined instantly.

THE HANCOCK INSPIRATOR CO., 108, Upper Thames St., London, E.C.

CLASS C.



Cheap Class of Machine.

STATIONARY PATTERN. 5116

Henry Bessemer and Co., Limited,

Manufacturers of Cast Steel,

SHEFFIELD.

FORGINGS

In Steel of any size.—Quotations given either for uses or finished complete.

STEEL CASTINGS

Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0.30 per cent. carbon, and to bear a tensile strain of 34 tons to the square inch.

TYRES AND AXLES.



SOFT CAST STEEL

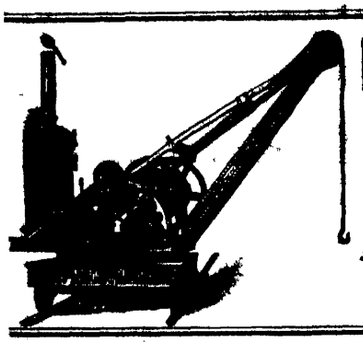
In bars and rods, for general use in Engineering Works.

BLOOMS, BILLETS, & SLABS

Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,

Of superior quality. 5116



EXORS. OF WM. BALMFORTH,

RODLEY, NEAR LEEDS,

MANUFACTURERS OF

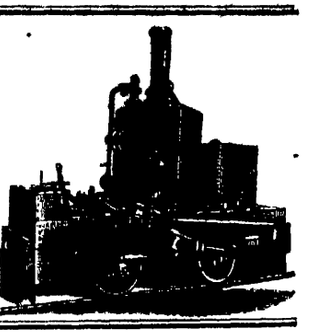
LOCO. STEAM CRANES, CONTRACTORS' LOCOS.,

TRAVELLERS, HOISTS,

AND ALL KINDS OF LIFTING MACHINERY.

4007

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes.





THE COALBROOKDALE COMPANY, LIMITED

MAKERS OF

STEAM ENGINES,

HORIZONTAL AND VERTICAL,

AND

OTHER MACHINERY.

MAKERS OF

STEAM PUMPS.

PARKER & WESTON'S PATENT

PUMPING ENGINES for Mines, Sewage and Water Works.

BOILER FEEDERS and SLIP PUMPS.

AGENCIES { LIVERPOOL - 19, SWEETING STREET.
MANCHESTER, 29, PRINCESS STREET.

WORKS & OFFICES, COALBROOKDALE, SHROPSHIRE.

DICK, KERR & CO., Engineers and Contractors,

(Five Medals awarded, Calcutta International Exhibition, 1883-4.)



SOLE MANUFACTURERS OF

KERR'S PATENT

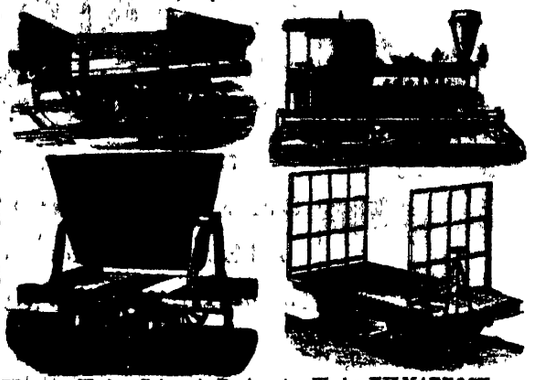
PORTABLE RAILWAY

SUITABLE FOR MINES AND PLANTATIONS.

WAGONS & LOCOMOTIVES

FOR ALL CLASSES OF WORK.

Catalogues and Prices on application. 5024



101, LEADENHALL ST., LONDON, E.C. Works: Britannia Engineering Works, KILMARNOCK.

JESSOP'S CRANES

For Particulars see last Week's "ENGINEERING," or WRITE FOR HANDBOOK.

J. JESSOP & SON, LEICESTER. 5118

Or 112, CANNON STREET, LONDON.

BRICKMAKING MACHINERY.

THOMAS C. FAWCETT, OLD VICTORIA FOUNDRY, MANOR ROAD, & BURMANTOFTS FOUNDRY, CROMWELL ST., LEEDS,



Maker of Patent Semi-dry & Plastic Brickmaking Machines,

Steam Presses, Pugmills, Solid and Perforated Bottomed Clay Pans, Clay Rollers, Clay Mixers, and Sieves,

BOILERS, ENGINES, MARINE AND STATIONARY

SHAFTING AND MILLWRIGHT WORK,

DRUMS AND PULLEYS OF ALL SIZES,

SPUR, BEVIL, MITRE,

And other Wheels by Patent Moulding Machine.

ILLUSTRATED CATALOGUES FREE. 4088



POINTS & CROSSINGS

FROM EVERY SECTION OF RAIL.

Portable Railways and General Railway Plant.

HARTLEY & ARNOUX BROS.

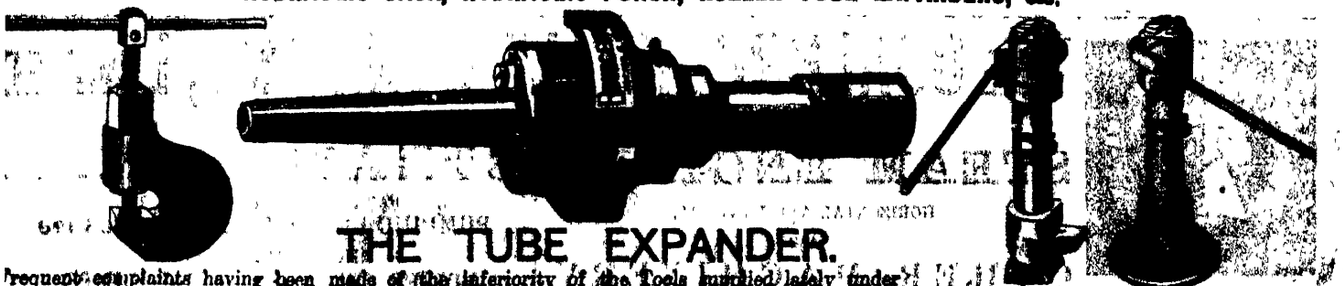
STOKE ON TRENT

RICHARD DUDGEON,

114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF HIS

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, &c.



THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "DUDGEON'S ROLLER TUBE EXPANDERS," R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only are stamped as under:—

R. DUDGEON, N.Y., Patd. Feb. 5th, 1867, on the Guide-ring of each Tool, WITHOUT WHICH NONE ARE GENUINE.

[illegible]

15 PRIZE MEDALS.] **THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED,** [15 PRIZE MEDALS.

4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1883, 1.



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 4794

100 to 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

Crossley's Patent TWIN-ENGINES. Impulse every revolution. The steadiest running Gas Engine yet made.

THE "OTTO." GOLD MEDAL at Crystal Palace, & HIGHEST AWARD at Paris Electrical Exhibitions.



New Patent SELF-STARTER. Best, Safest, and Simplest made, may now be applied.

CROSSLEY'S NEW VERTICAL ENGINE. Requiring little floor space

½ TO 100 HP. IND. MANY IMPROVEMENTS. OVER 15,000 IN USE.

LONDON: 24, POULTRY, E.C. GAS ENGINE GLASGOW: 58, UNION STREET

4775

CHEAP GAS FOR MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·3 lb. per ind. H.P. per hour.

THE DOWSON ECONOMIC GAS COMPANY, Ltd., 7, Great Queen St., Westminster, S.W.

4838

PULLEYS FOR TRANSMISSION OF POWER BY BELTS, CAST OF SELECTED IRON, FROM CAREFULLY DESIGNED PATTERNS, EITHER WHOLE OR SPLIT, PLAIN OR TURNED, BALANCED.

TURNED SHAFTING, SHAFT-FITTINGS, PATENT ADJUSTABLE, SELF-ADJUSTING, SELF-LUBRICATING, & OTHER BEARINGS, PEDESTALS, HANGERS, WALL-BOXES,

TAYLOR & CHALLEN

ENGINEERS * MACHINISTS * FOUNDERS * SMITHS

DERWENT FOUNDRY * BIRMINGHAM * CONSTITUTION HILL



SOLE MAKERS OF WITHINSHAW'S NEW PATENT FEED-WATER HEATER AND Purifier.



Great Saving in BOILERS AND COAL.

MAKERS OF Winding, Forge Mill & Pumping Engines.

Price Lists on application.

This Advertisement appears next month.

PATERSON & COOPER,

ELECTRIC LIGHT ENGINEERS AND CONTRACTORS,

76, LITTLE BRITAIN, LONDON. Steam Factory: POWNALL ROAD, DALSTON.

Complete Sets of Electric Lighting Machinery and Fittings for Lighting Hotels, Public Buildings, Factories, Mills, Ships, &c., &c.

ESTIMATES FOR INSTALLATIONS FREE OF CHARGE. EXPERIENCED MEN SENT TO ALL PARTS OF THE COUNTRY.

Licensees of the "Clarke and Bowman" Arc Lamp, and of Joel's Storage Batteries.

PATERSON & COOPER'S DIRECT CURRENT "PHŒNIX DYNAMOS.

No. 1.—For	16	20 candle-power Lamps, or	2	Small Arcs, or	1	Large Arc			£36
No. 2.— „	30	„	„	„	3	„	„	2	„	„	54
No. 3.— „	75	„	„	„	7	„	„	4	„	„	80
No. 4.— „	120	„	„	„	12	„	„	7	„	„	120
No. 5.— „	200	„	„	„	24	„	„	14	„	„	180
No. 6.— „	300	„	„	„	...	...	...	...	...		250
No. 7.— „	500	„	„	„	...	...	...	...	...		400

4606

Awarded a First-Class CERTIFICATE OF MERIT at Manchester, and a First-Class DIPLOMA OF MERIT at Tynemouth.

PATENT DIAGONAL ROCKING FIRE-BARS

—(*Can be Fixed in a Few Hours.*)— ARE ECONOMICAL, DURABLE, SMOKE-CONSUMING. —(*No Attachment to Boiler necessary.*)—

Numerous Official Tests show an average economy of over 10 per cent. These Patent Bars last Years where ordinary Bars last only Months.

Recently supplied to the order of the eminent builders of the engines and boilers of the most powerful Ironclad afloat for use in the whole of the furnaces, to work with "Forced Draught," MAKING THE THIRD Ironclad fitted. Used by the most eminent Engine and Boilermakers (Marine and Land), Railways, Home and Foreign Governments, &c. 5119

Agents having connections among Steam Users Required in Principal Towns. — Particulars of the Manager at the Offices, 250, Gresham House, E.C.

REGISTERED TRADE MARK

PHOSPHOR BRONZE

The Best and Most Durable Metal for Bearings and Bushes of every Description; Hydraulic Pumps, Pinions, Valves, &c. &c. Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c.

SOLE MANUFACTURERS UNDER SEVERAL PATENTS. 1475

The PHOSPHOR BRONZE COMPANY, Limited, Sumner & Emerson Streets, Southwark, London, S.E.

Calcutta, 1884.—HIGHEST AWARD.



THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

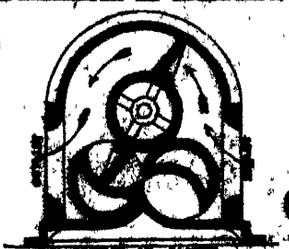
(LIMITED), SHEFFIELD,

Baker's Patent Rotary Pressure Blower and Gas Exhauster

BAKER'S PATENT ROTARY PUMP.

HALL'S PATENT STONE BREAKER.

CRUCIBLE STEEL CASTINGS.



General Machinery of Every Description.

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Cannon Street).

CHARLES CHURCHILL & CO.,

AMERICAN MACHINERY AND TOOL IMPORTERS,

21, CROSS STREET, FINSBURY, LONDON, E.C.

ESTABLISHED IN 1862.



C. C. & Co. have just removed to much larger premises with ample show rooms and warehouse, and will carry a greatly increased stock of all the best American tools.

SOLE AGENTS FOR

THE ONLY GENUINE AMERICAN MORSE TWIST DRILL,

WITH CENTRE GRINDING LINE, STOCKS AND DIES, REAMERS AND MILLING CUTTERS,

Stephens' Patent Vices, Horton Chucks, Cushman Chucks, Westcott Chucks, Sweetland Chucks, Stanley Rule & Level Co.'s Planes, &c., &c., Gould's Manufacturing Co.'s Pumps, and a great variety of New American Tools.

New Catalogue for 1883 just issued, 215 pages Quarto, sent on receipt of One Shilling in Stamps.

(THE LARGEST CATALOGUE OF AMERICAN TOOLS EVER PUBLISHED IN GREAT BRITAIN.) 4124

W. NEILL & SON,

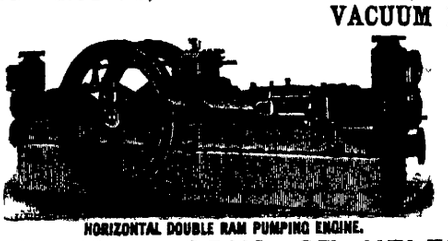
ENGINEERS, IRON & BRASS FOUNDERS, BOILER MAKERS, &c.

MANUFACTURERS OF

PUMPING ENGINES, BLOWING ENGINES, STEAM ENGINES, AIR COMPRESSORS, and VACUUM PUMPS.



DOUBLE RAM PILLAR PUMPING ENGINE.



HORIZONTAL DOUBLE RAM PUMPING ENGINE.



BLOWING ENGINE AND AIR COMPRESSOR. 4258

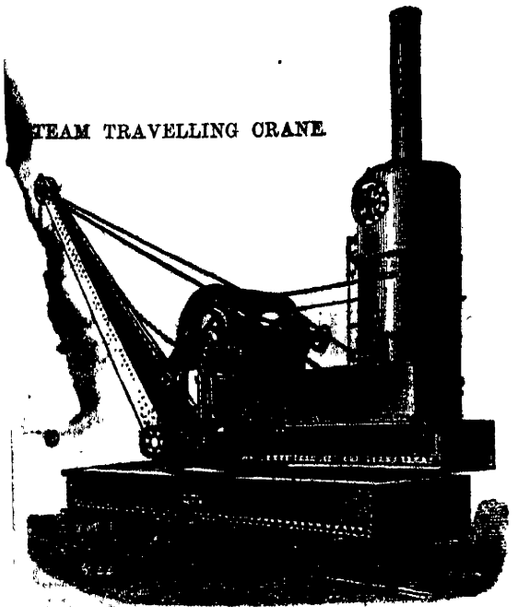
BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.

COWANS, SHELDON & CO., LTD.,

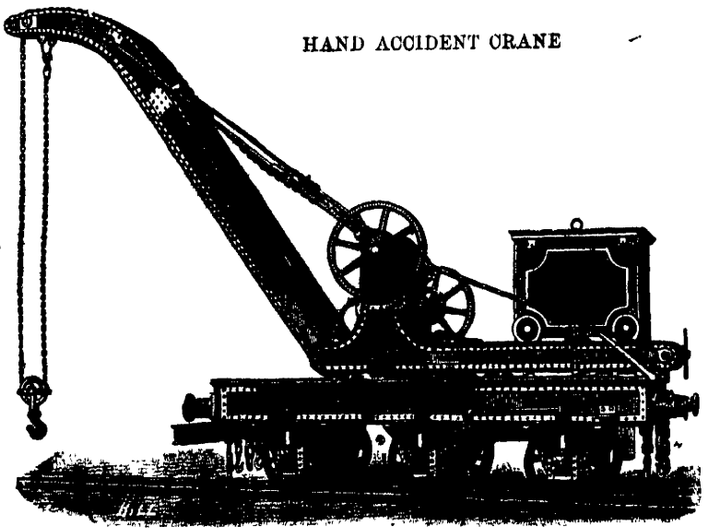
ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.

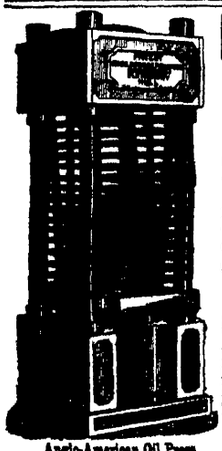
STEAM TRAVELLING CRANE.



HAND ACCIDENT CRANE



TURNTABLES, CRANES, MASTING SHEERS, AND TRAVERSERS OF EVERY DESCRIPTION BY STEAM, HAND, OR HYDRAULIC POWER.



Anglo-American Oil Press for 16 12 lb. Cakes.

ROSE, DOWNS & THOMPSON,

Established 1777.

OLD FOUNDRY, HULL.

Makers of the ANGLO AMERICAN

OIL-MILL MACHINERY,

For crushing Linseed, Cotton Seed, Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent. in labour and power, and 2 to 4 per cent. in Oil. (See *Engineer*, May 6, 1881, and Nov 23, 1883)

PRESSES FOR ALL KINDS of OIL SEEDS

Elevators and Creepers for Grain Warehouses, Accumulators and Hydraulic Dock Machinery, Stationary Engines, Boilers, Trawling Engines, and Capstans for Fishing Boats.

SOLE MAKERS OF

HODGE'S & THOMPSON'S PATENT

KINGSTON EXCAVATOR.

Grabs and Buckets for Mud, Sand, Shingle, Silt, Clay, Rock, Débris, Boulders, Coke, Ore, &c., supplied on Pontoons for Harbour and Dock Dredging

NO HEAVY BALANCE WEIGHTS

NO SPECIAL CHAINS.

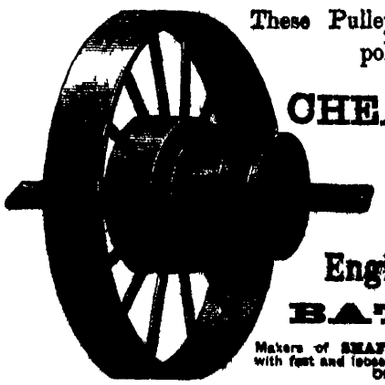
PERFECT AND RAPID WORK



Kingston Dredger with Mud Bucket. 5197

London Office (Dredging Machinery) 36, KING WILLIAM STREET, E.C.

TURNED WROUGHT IRON PULLEYS.



These Pulleys are **TURNED IN A LATHE,** and not polished on a Grindstone like those generally sold.

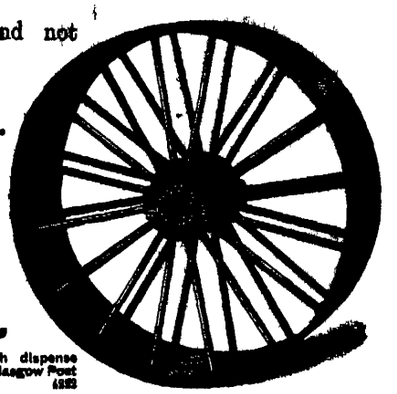
CHEAP, STRONG, AND TRUE.

Illustrated Circular Post Free

J. BAGSHAW & SONS,

Engineers, Ironfounders & Millwrights,

BATLEY, YORKSHIRE,



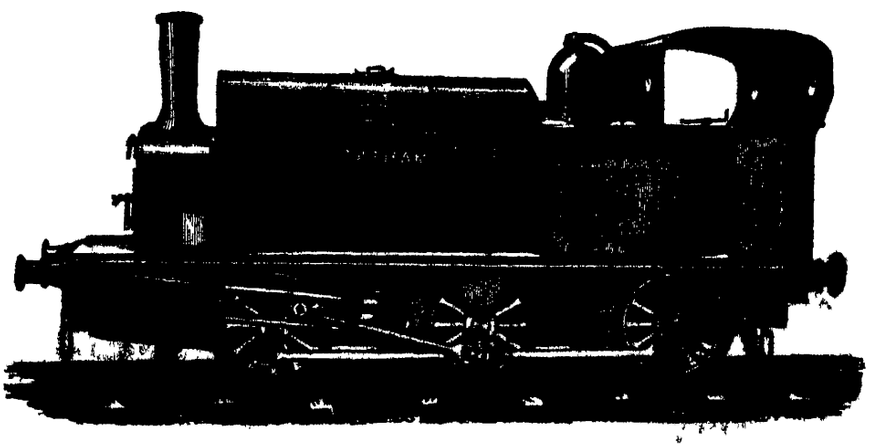
Makers of SHAFTING and FRICTION PULLEYS for Electric Lighting Machinery which dispense with feet and loose Pulleys one Pulley answers for both. In use at L.&N.W. Railway, Nine Elms, Glasgow Post Office King's Cross Station and all principal Factories home and abroad 1883

ESTABLISHED 1860.

HUDSWELL, CLARKE & Co.,

RAILWAY FOUNDRY, LEEDS.

PRICES and SPECIFICATIONS on Application.



FOR CASH or DEFERRED PAYMENTS.

LOCOMOTIVE TANK ENGINES

OF ALL SIZES AND TO SUIT ANY GAUGE OF RAILWAY,

For Main Line or Branch Railways, Contractors, Ironworks, Collieries, &c.

CRANES! CRANES!



SEE HALF-PAGE ADVERTISEMENT AUGUST 29th. Page 38.

RAILWAY PLANT!!

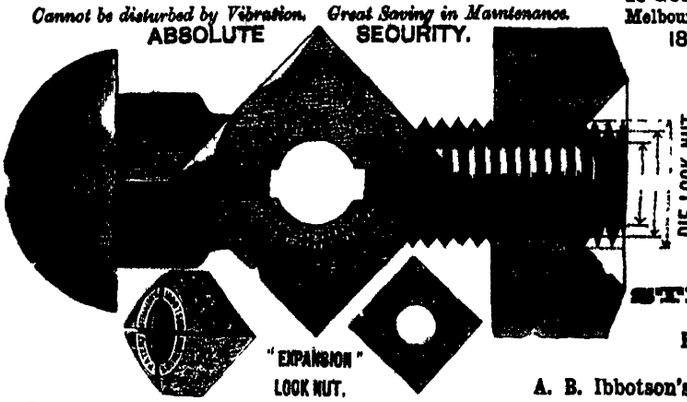


SEE HALF-PAGE ADVERTISEMENT SEPT. 5th. Page 33.

RANSOMES & RAPIER, 6, Westminster Chambers, LONDON, S.W., and Waterside Ironworks, IPSWICH. 5088

Patent Steel Lock Nuts and Steel Fish Bolts.

Cannot be disturbed by Vibration. ABSOLUTE *Great Saving in Maintenance.* SECURITY.



FIRST-CLASS MEDALS, LONDON, PARIS, SYDNEY, ADELAIDE, &c

18 GOLD MEDALS Melbourne Exhibition, 1880–81. } ONLY FIRM awarded GOLD MEDALS for Nuts and Bolts, Buffers, Couplings, Cradles, Springs, Steel Sleepers, Rail Joints, &c. GOLD MEDALS for Steel, Files, Saws, Steel Forgings, Railway Appliances, &c.

IBBOTSON BROTHERS

AND COMPANY, LIMITED,

GLOBE IRON AND STEEL WORKS

SHEFFIELD.

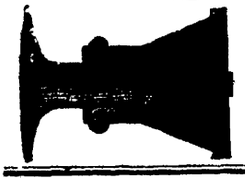
Manufacturers of

STEEL OF EVERY DESCRIPTION

STEEL FORGINGS, AXLES, &c., RAILWAY SPRINGS OF ALL KINDS.

Files (Hand Cut only), Saws, Edge Tools, and Patent Automatic Central Coupling Buffers.

A. B. Ibbotson's Patent Steel Die and Expansion Lock Nuts, and Steel Bolts, Railway Fastenings, &c., &c.



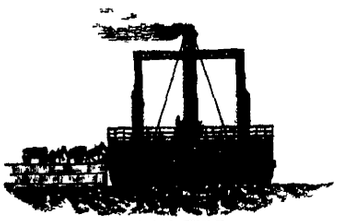
GEORGE TURTON'S PATENT WROUGHT IRON BUFFERS,

AND PATENT COMPOUND CAST STEEL SPRINGS. {4120 3013

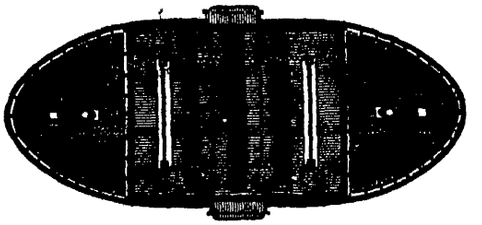
LONDON OFFICE: 4, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W



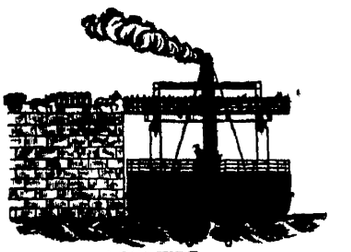
PATENT ELEVATING STEAMER,



HIGH TIDE.

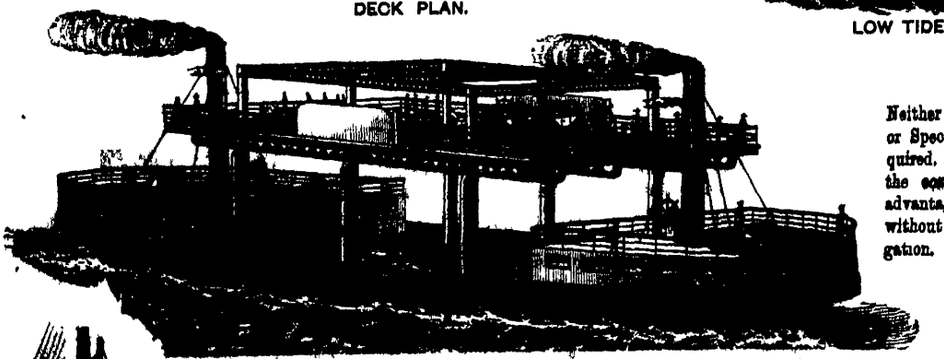


DECK PLAN.



LOW TIDE.

For Ferry Traffic, to Land and Embark Passengers, Carriages, Wagons, and Cattle on same level as Pier or Quay, irrespective of the rise and fall of tide. Also for Landing and Embarking Troops, Horses, and Artillery.



Neither Slips or Pontoons, or Special Berths are required. At a fraction of the cost it has all the advantages of a Bridge, without obstructing Navigation.



W. SIMONS & CO.,

SHIPBUILDERS & ENGINEERS,

RENFREW,

SCOTLAND,

CONSTRUCTORS.



END ON PLATFORM.

ESTABLISHED 1839. ESTABLISHED 1839.

JOHN MUSGRAVE & SONS, Ltd.,

GLOBE IRON WORKS, BOLTON,

Manufacturers of the only Patent Safety Starting, Turning, or Barring Engine.

Makers of STEAM ENGINES up to 3,000 HP.

With Patent Automatic Cut-off Motion Adaptable to Stamper Valves, Slide Valves, and Corliss Valves, which can also be applied to existing Engines.

STEAM HAMMERS,

On Condie's principle, with Patent Valve Motions, from 3½ cwt. to 25 tons.

Wrought-Iron and Steel STEAM BOILERS with drilled rivet holes only.

MILL-GEARING IN ALL ITS BRANCHES.

LARGE ROPE OR BELT DRUMS UP TO 35 FEET DIAMETER.

BLEACHING MACHINERY.

ALSO THE ONLY MODERN PLATE-GLASS MACHINE MAKERS. 4730

GOODFELLOW & MATTHEWS,

(LATE B. GOODFELLOW ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

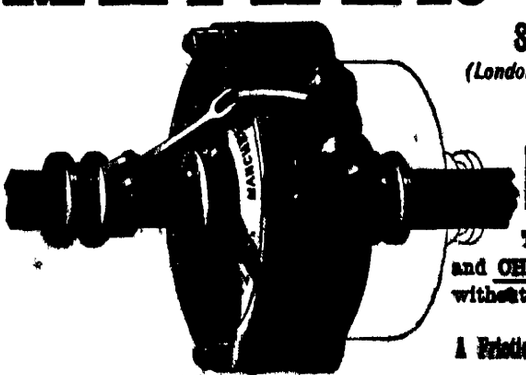
HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS.

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION 6088

MATHER & PLATT,



CLUTCH COUPLING.

LIBERAL TERMS TO THE TRADE.

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.

— PATENT —

FRICTION CLUTCH.



These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.

PRICES ON APPLICATION.

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1 Simplicity of Construction. 2. Saving of Fuel.
3 Greater Heating Surface. 4 Decidedly cheaper
5. Can be Easily Cleaned. 6. Most Durable.
7 Accessible for Repairs without Disturbing the other Parts
8 Great Economy in Boiler Space.
9 Will Burn either Tan, Breese, Small Coal, or Sawdust
10 Is Superseding all Others.

Testimonials and Prices on Application.



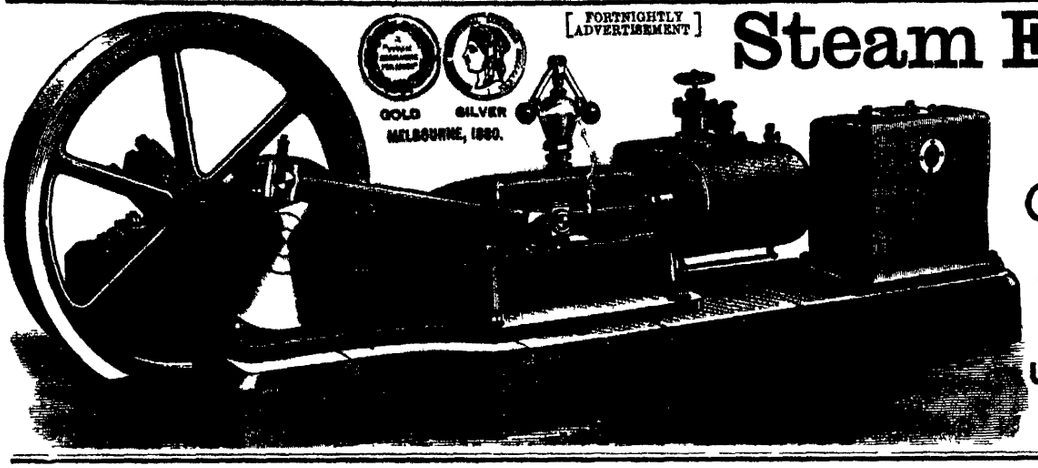
We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft	long,	5ft. 0in	diameter,	20	horse power
10ft	,,	5ft 6in	,,	30	,,
12ft	,,	6ft 0in	,,	40	,,
13ft	,,	6ft 6in	,,	50	,,
14ft	,,	7ft 0in	,,	60	,,
15ft.	,,	7ft 6in.	,	70	,,
16ft	,,	8ft 0in	,,	80	,,
17ft	,,	8ft 0in	,,	90	,,
18ft.	,,	8ft 0in	,,	100	,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS 5140

[FORTNIGHTLY ADVERTISEMENT]



Steam Engines

Fitted with

Expansion Valves

VARIED BY

GOVERNOR.

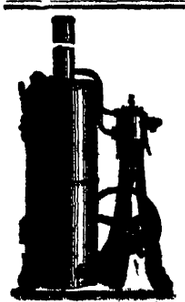
ALSO

STEAM HAMMERS.

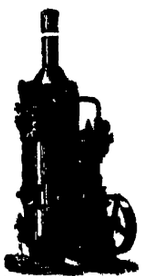
JOHN COCHRANE,

Engineer

BARRHEAD, NB



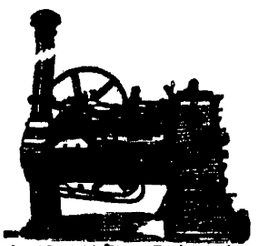
Vertical Engine Type No. 1 with Vertical Cross Tube Boiler 2½ to 12 HP



Vertical Engine, Type No. 2, with Vertical Multitubular Boiler 1 to 8 Horse Power



Traction Engine with Finishing Thrashing Machine and Straw Elevator on the Road



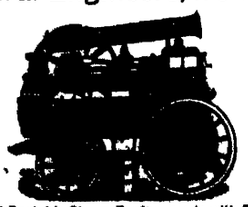
Semi-Portable Steam Engine made with Single or Double Cylinders, 2½ to 35 Horse Power

R. HORNSBY & SONS, Limited,

General and Agricultural Engineers, Ironfounders, Boilermakers,&c.



Improved Narrow Gauge Traction Engine, or Agricultural Locomotive



Patent Portable Steam Engine, made with Single or Double Cylinders, and from 2½ to 35 HP



Patent Thrashing, Shaking, and Finishing Dressing Machine.



Patent Undertype Compound Engine, 6 to 50 Horse Power with Boiler above (as shown) or separate from the Engine, as desired



Fixed Horizontal Steam Engine, 10 to 60 Horse Power, with New Patent Automatic Expansion Gear



Highland Society's £100 First Prize String Sheaf Binding Harvester

ALL PREVIOUS AWARDS ECLIPSED!!!

Hornsby's New 1884

TWINE BINDER

HAS BEEN AWARDED THE

First Prize of £100

BY THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND



R.A.S.E First Prize Mowers and Reapers

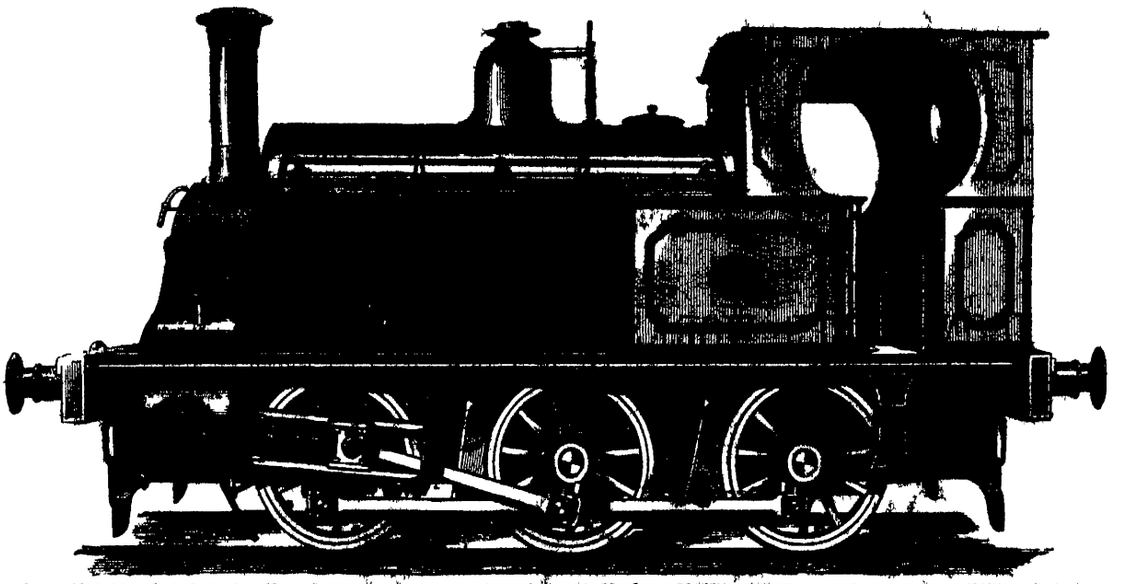
For particulars of the most modern improved and successful Agricultural Machinery, Ploughs, Dressing Machines Corn Screens, Turnip Cutters Root Pulpers &c SEE ILLUSTRATED CATALOGUES in English, French, German Spanish Russian &c, sent GRATIS and POST FREE on application

GOLDEN SHARES OF CAST IRON, CHILLED, WROUGHT IRON, MALLEABLE IRON AND STEEL, OF PATTERNS TO SUIT EVERY VARIETY OF WORK

At the [illegible] 1874, R. HORNSBY & SONS [illegible] gained 867 PRIZES, including 66 Gold Medals, 212 Silver Medals, and 309 FIRST PRIZES

GRANTHAM IRON WORKS, GRANTHAM. 4005

[illegible] STREET. Telephone No. 1234. South African Depôt: EDINBURGH BUILDINGS, DOCK ROAD, CAPE TOWN.

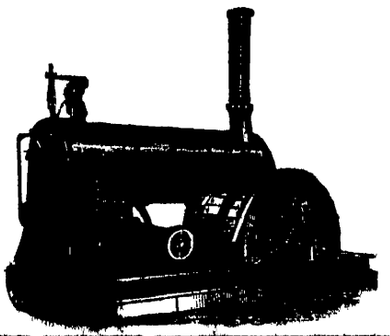


LOCOMOTIVES of VARIOUS SIZES in STOCK or in PROGRESS. 4972

THOMAS PECKETT (LATE FOX, WALKER & CO.) ATLAS ENGINE WORKS, BRISTOL.

JOHN FOWLER & CO., LEEDS, ENGLAND,

MANUFACTURERS OF



Steam Cultivating Machinery — Traction Engines — Patent Compound Yorkshire Semi-Portable and Fixed Engines — Semi-Portable Engines — Horizontal High-Speed Stationary Engines — Hauling, Winding, and Pumping Engines — Patent Automatic Expansion Valve Gear and Governor, for ensuring Economy, Regularity, and Safety—**Boilers of all types,** adapted for every kind of fuel and country—**Steel Portable Railway,** for Sugar, Cotton, and Indigo Plantations, Contractors' Works, Military Depots, Workshops, Mines, Timber Yards, Agricultural Holdings, &c —

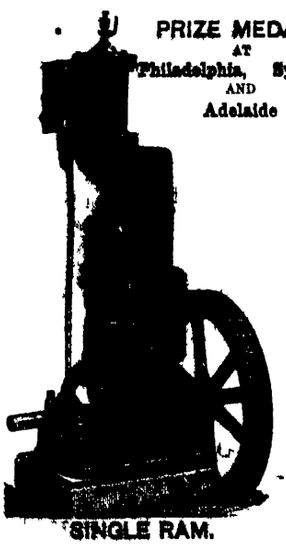
Locomotives of various gauges. 3061

CALCUTTA EXHIBITION, 1884, FIVE FIRST PRIZES.

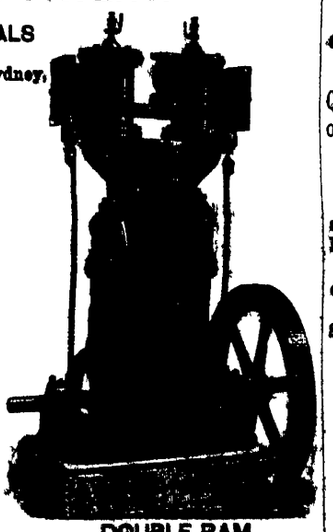
Budapest Agricultural Meeting, 1882—Two Gold Medals and other Awards.
Vienna Agricultural Meeting, 1882 — Special Diploma for excellency of work.
Sydney Exhibition, 1880—Three First Prizes
Hanover Agricultural Meeting 1881—Gold Meda and Diploma of Merit [and other Prizes
Paris Exhibition, 1878—Grand Prix, Gold Medal

The Manchester Pumping Engine
PEARN'S PATENT.

PRIZE MEDALS AT Philadelphia, Sydney, AND Adelaide



SINGLE RAM.

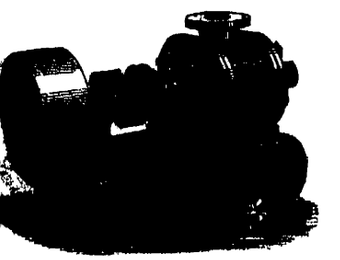


DOUBLE RAM.

Fast superseding all others in Iron and Steel Works, Collieries, Mills, Breweries, Chemical Works, and for fire and general purposes References can be given all over the world.

GOLDSCHMIDT, HAHLO & Co.'s
PATENT
"PORTLAND" ROTARY PUMP

Can be Driven by Hand, Belt or Steam Engine attached



No Valves.
Positive Action.
Will draw 25 ft. on suction, and force to a considerable height.
Can be run fast or slow, NOT depending on Centrifugal Force.
Direct passage of Fluid from Suction to Delivery Pipe.



The "Portland Pump"
IS THE
Simplest and most Effective
[illegible]

Will Pump all Kinds of Fluids, Hot or Cold, Dyes, Acids, Tars, Oils, &c.

Can be completely emptied in a second.

FOR PRICES AND PARTICULARS APPLY TO
THE SOLE LICENSEES AND MAKERS

FRANK PEARN & Co., West Gorton, MANCHESTER.

Sole Agents for London and District, Messrs. A. MANGE & Co., [illegible]



THE

Patent Steam Boiler Co.

HENEAGE STREET, BIRMINGHAM.

London Office: 11, Queen Victoria St. Mr. CONRAD KNAP, Representative.

Telegraphic Address:—"ROOT." (SOLE PROPRIETORS OF THE EUROPEAN PATENTS.)

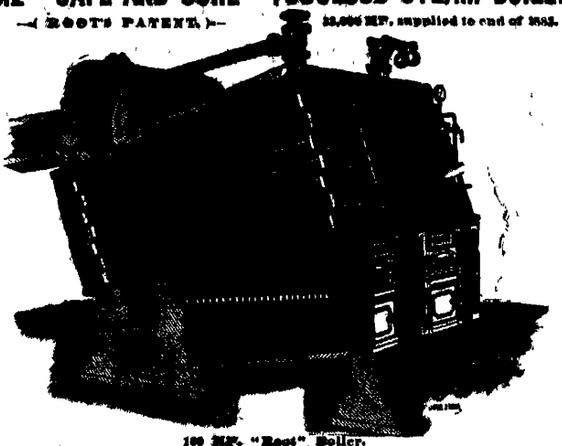
Agents: Ross & WALKER, for Dublin; A. TAPPER & Co., Invercargill, N.Z., for New Zealand; A. SHAW and Co., London, for Queensland: RABONE BROS., Birmingham, for New South Wales and Victoria.



THE "SAFE AND SURE" TUBULOUS STEAM BOILER

—(ROOT'S PATENT.)—

25,000 HP. supplied to end of 1883.

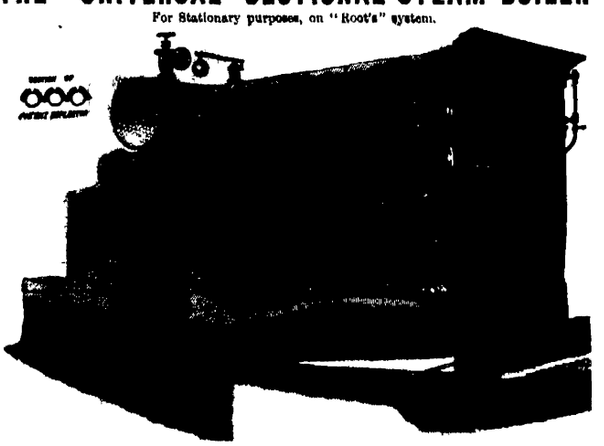


100 HP. "Root" Boiler.

Sizes from 10 to 300 HP., and of modified construction (but of equal strength) 1 to 3 HP. Nom. For Mountain Transport, made in pieces of 250 lbs., at special prices. An ordinary Mechanic can put together. Now working in a variety of situations all over the world, and in confined positions underground, &c. All parts made to gauge and kept in stock. Boilers of any power at a few days' notice. The Prices of our ROOT Boilers have been reduced; Lists on application. No accident to life or limb has ever been recorded against this Boiler. Tested to 500 lbs. per square inch with cold water. Large Steam Drums to 300 lbs. Suitable working pressure 150 lb

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For Stationary purposes, on "Root's" system.



"Universal" Boiler.

This powerful Steam Generator has been recently introduced to meet the views and requirements of many steam users. It is suitable for general application. Made in sizes from 5 to 300 HP. Nom. Attention is solicited to the advantages of this Boiler, viz.: Cheapness, Economy, Ample Steam and Water Space; Rapid Circulation, Prevention of Incrustation, Safety, High Power, Impossibility of Priming, Easily Cleaned, Durability, &c. This Boiler may be placed in space vacated by cylindrical boilers of far less power 5152

References to the Birmingham Corporation (1,365 horse-power); Messrs. Cochrane and Co., Middlesboro' (1,200 horse-power).

T. W. LAPWORTH, Manager and Secretary | For Estimates, Drawings, and full particulars, address— THE PATENT STEAM BOILER CO., Head Office, 28, Heneage Street, Birmingham.

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Turned true and bright to Whitworth's Gauges, any length, from 2 in. to 8 in. diameter, 14s. per cwt. at Nottingham. Also Couplings, Pulleys, Plummer Blocks, Hangers, Machine-made Spur, Bevel, and Mitre Wheels, Friction Gearing, &c.

H. HIND & SON, NOTTINGHAM, AND 82, BLACKFRIARS ROAD, LONDON, S.E. 4157

THE CLAY CROSS COMPANY,

COAL, LIME, & IRON WORKS, CLAY CROSS, near CHESTERFIELD,

SUPPLY HOUSE, GAS, AND STEAM COAL,

AND ARE MAKERS OF

PIG IRON, GAS and WATER PIPES, and ALL CASTINGS

in connection with Gas and Waterworks, Collieries, Engines, Pumps, &c. 5126

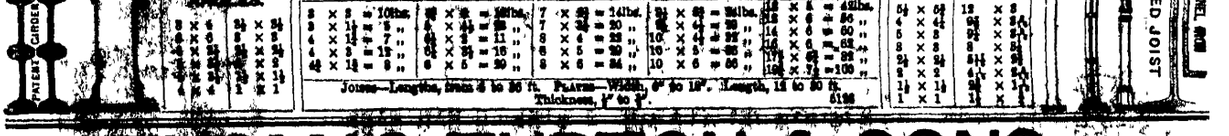
London Office and Exhibition Rooms: 33, QUEEN VICTORIA STREET, E.C. (opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents.

H. MEASURES BROS. & CO., SOUTHWARK STREET, LONDON,

Manufacturers of Patent Girders, Rolled Joists in Iron or Steel, Rivetted Girders, Fitch Plates, Bulb and Channel Iron, Contractors' Rails, Tee, Angle, and Bulb Iron, Bending Rolls, Joists, Girders, Washers, Chequered Flooring Plates, Patent Fire-proof Floors, Cast or Wrought Iron Columns, Stanchions, Tanks, and every description of Builders' Iron Work.

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MANUFACTURERS OF RAILWAY SPRINGS AND BUFFERS,

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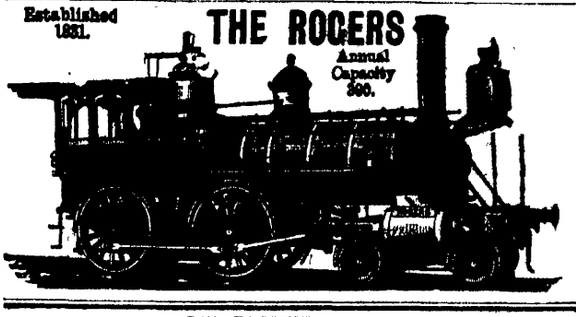
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Established 1851.

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Annual Capacity 300.

BUILDERS OF LOCOMOTIVE ENGINES OF ALL GAUGES
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ANNUAL CAPACITY 600.

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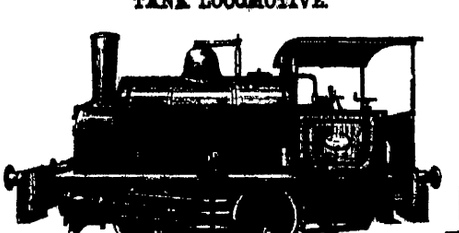
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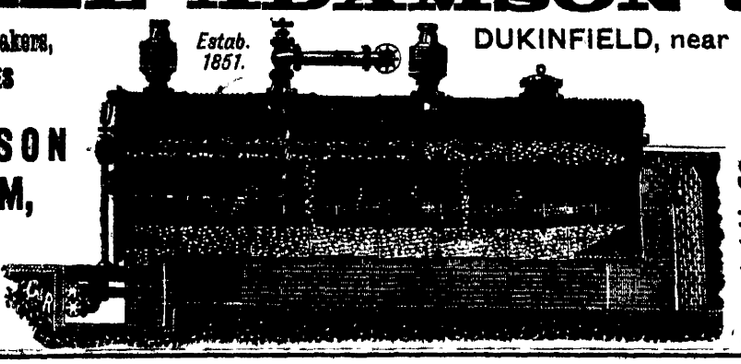
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And from over 20 Years old.

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For PREVENTING and REMOVING Incrustation and Corrosion in Steam Boilers.

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Borough Laboratory, 8, St. James's Square, John Dalton Street, Manchester, 15th September, 1876.

An analysis of a sample of this shows it to contain neither Free Alkali nor Acid. It is purely Vegetable matter, and has *no injurious action upon Iron.*

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London Office: 9, Victoria Chambers, Victoria Street, Westminster, S.W.

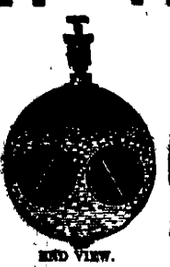


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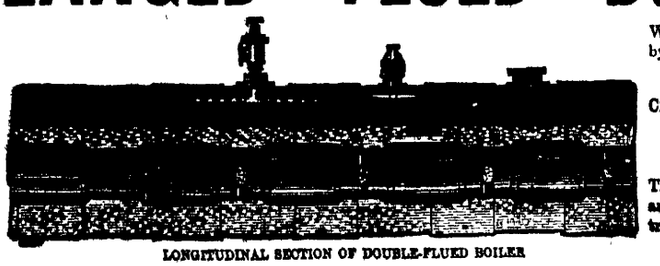
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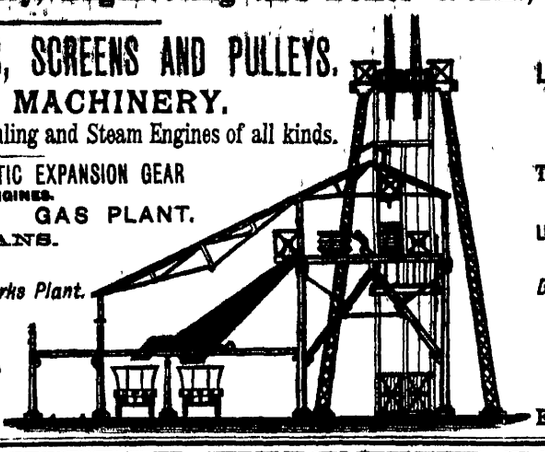
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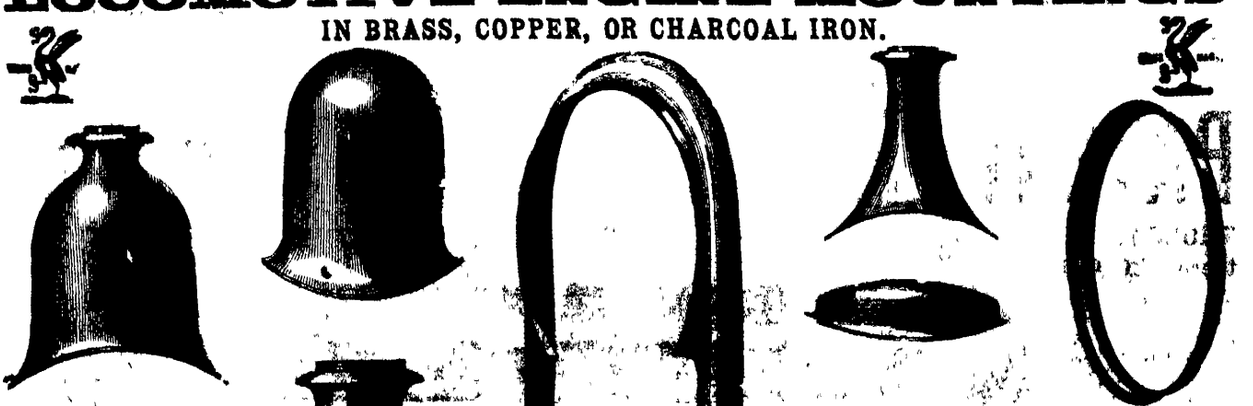
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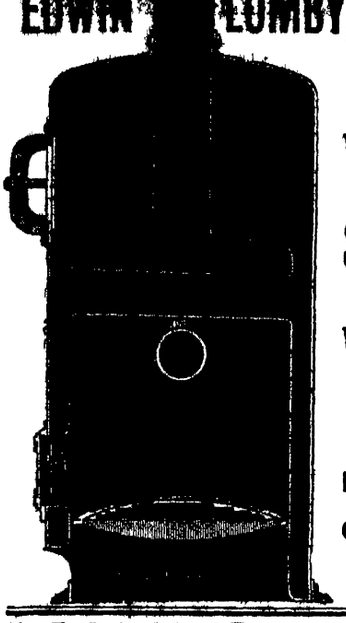
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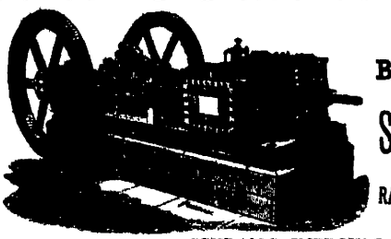
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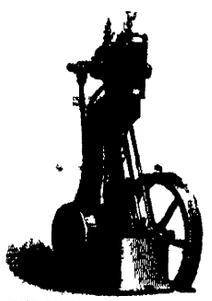
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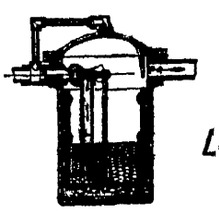
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VERTICAL STEAM ENGINE



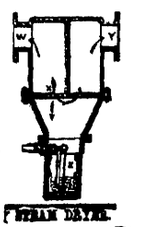
STEAM TRAP

QUEBEC WORKS,

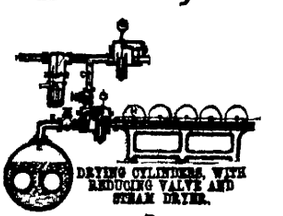
BRADFORD.

LONDON OFFICE: 37, WALBROOK.

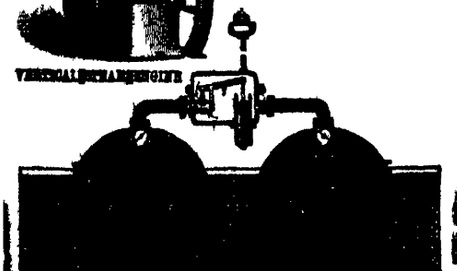
CATALOGUES ON APPLICATION



STEAM DRYER.



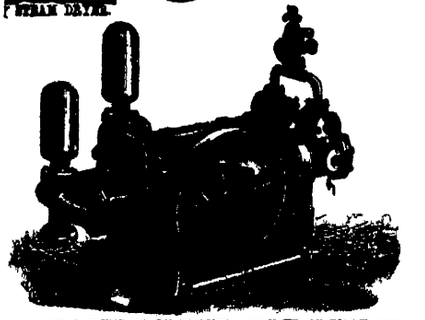
DRYING CYLINDERS, WITH REDUCING VALVE AND STEAM DRYER.



STEAM REDUCING VALVE.



STEAM WINCH, FOR HOISTING PURPOSES ON LAND OR SEA.



STEAM PUMP MADE TO SUIT ANY KIND OF WORK. 4079

WATER PURIFICATION

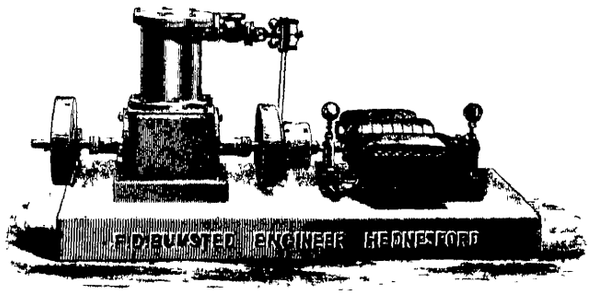
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The PORTER-CLARK PROCESS

Removes Lime, Magnesia, and Iron from **Hard Waters**, and thus, the **causes of Incrustation in Boilers and Pipes** This Process is in use in Paper Mills, Breweries, Sugar Works, India rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c One Railway Company employs it for feed water to the extent of **1,000,000 gallons** daily, and one of the London Water Companies at two of its Pumping Stations It is also in use in County Asylums, Public and other Schools, and Private Mansions The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich, are rendered soft and clear 5226

DESCRIPTIVE CIRCULAR ON APPLICATION.

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SPECIAL TOOLS having been made for these ENGINES they are MODERATE in PRICE.

1200 REVOLUTIONS per Minute Perfect System of Lubrication—no lubricators, no attention Half pint of Oil is sufficient for Two Days' Supply. Forged Steel Crank and Phosphor Bronze Working Parts throughout MADE IN FOUR SIZES

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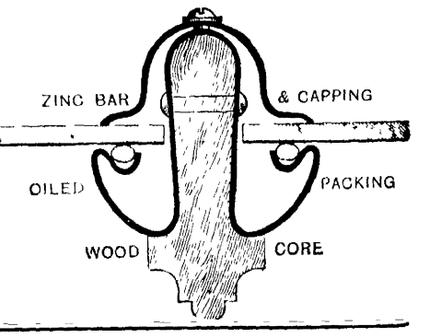
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MODELS AND SECTIONS ON VIEW. 5112



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FIRST PRIZE AT PARIS, VIENNA & PHILADELPHIA.

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The following is a List of those Boilers which are now completed, and which may be despatched at once with all their fittings.—

	Length		Diameter	Material	Working Pressure
Three Galloway Boilers	30 ft.	by	7 ft 0 in.	Iron	70 lbs
Four " "	28 ft	by	7 ft. 0 in.	"	70 lbs
Two " "	28 ft.	by	7 ft. 0 in.	"	80 lbs
One " "	26 ft.	by	7 ft. 0 in.	Steel	90 lbs.
One " "	24 ft	by	7 ft. 0 in	Iron	80 lbs.
One " "	24 ft	by	7 ft 0 in	"	70 lbs
One " "	24 ft	by	6 ft 6 in.	"	65 lbs

	Length		Diameter	Material	Working Pressure.
One Galloway Boiler	18 ft.	by	6 ft. 0 in	Iron	70 lbs.
Three Two-flued "	30 ft.	by	8 ft. 0 in.	Steel	80 lbs.
One " "	30 ft.	by	7 ft. 6 in.	Iron	70 lbs.
Five " "	30 ft.	by	7 ft. 0 in	Steel	90 lbs
One " "	22 ft.	by	6 ft 0 in.	Iron	70 lbs.
Two One-flued "	30 ft.	by	7 ft 0 in	Steel	80 lbs.

Total, 26 Boilers completely finished, besides many others in progress of construction 4336

Address, W. & J. GALLOWAY & SONS, Manchester, who will furnish detailed Specification and Prices of any of the above Boilers.

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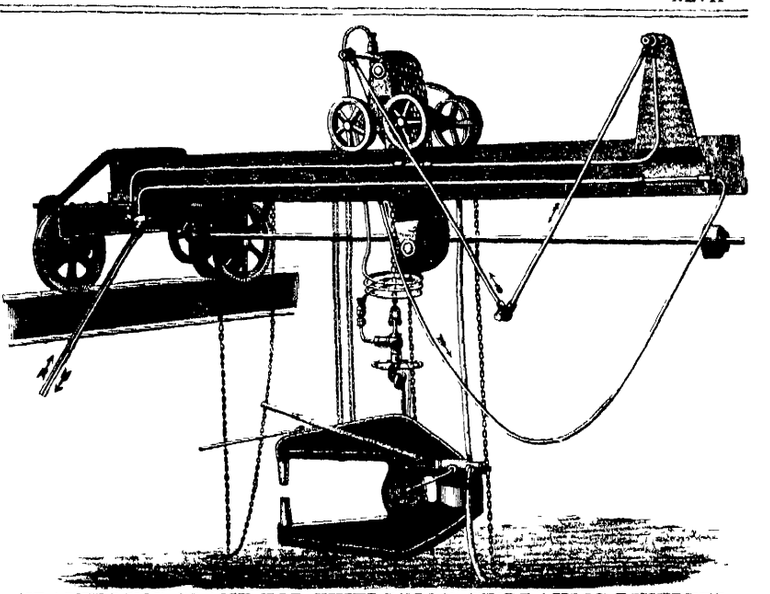
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SOLE MAKERS AND CO-PATENTEES,

FIELDING & PLATT,

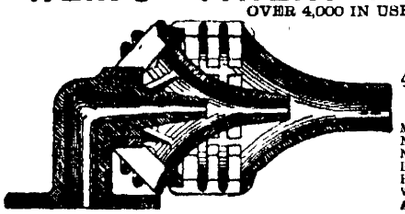
GLOUCESTER.

France, Belgium and Holland—
Mr. H. CHAPMAN, 10, Rue Laffitte, Paris,
Germany and Austria—
Mr. G. DIECHMANN, 41, Bahnhofstr, Essen, a/d Ruhr,
United States—
MORGAN ENGINEERING CO., Alliance, O.;
OR TO 4886
MR. RALPH HART TWEDDELL,
14, DELAHAY STREET, WESTMINSTER, LONDON, S.W.



TRAVELLING CRANE FOR TWEDDELL'S HYDRAULIC RIVETTER.

HIGH PRESSURE MARINE BOILERS.
Best and Cheapest Means of Preventing Unequal Expansion.
"WEIR'S" PATENT HYDROKINETER.
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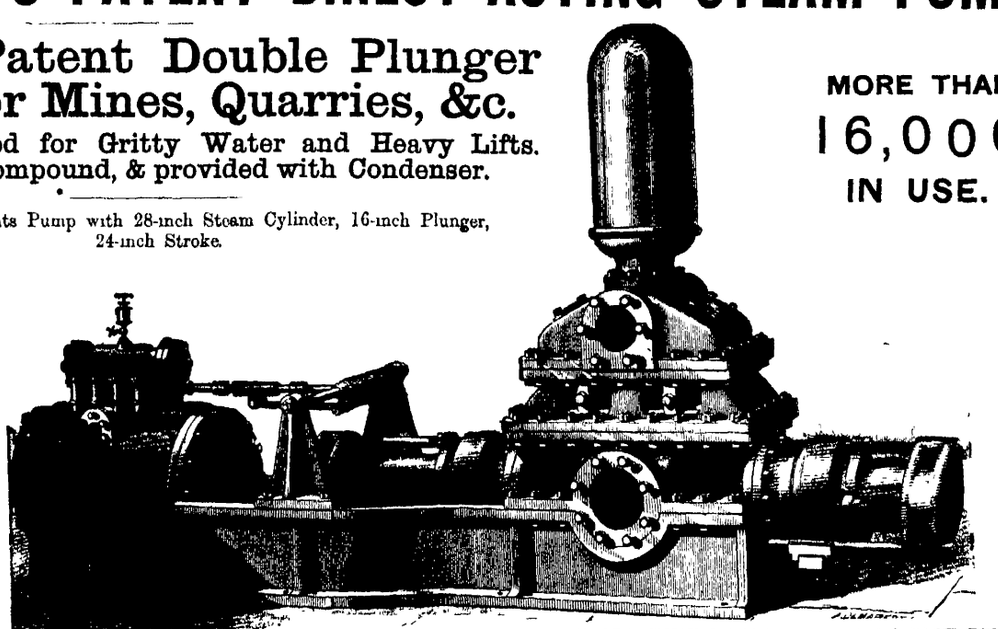
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Blake's Patent Double Plunger Pump, for Mines, Quarries, &c.

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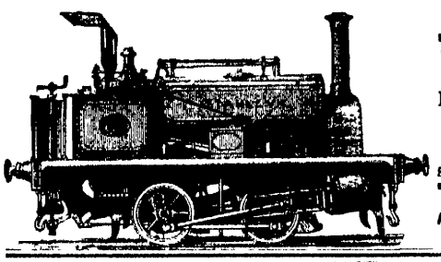
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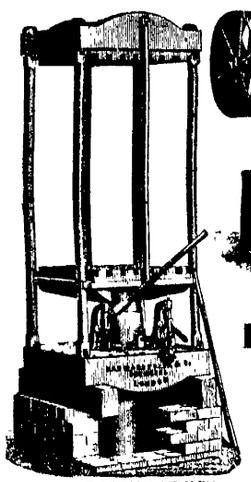
ROBT. von GLEHN & SONS, 7, Idol Lane, LONDON, E.C.

HAYWARD TYLER & CO.,

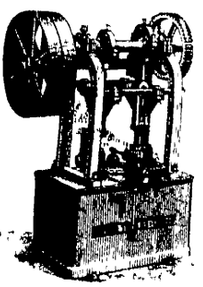
ENGINEERS

AND

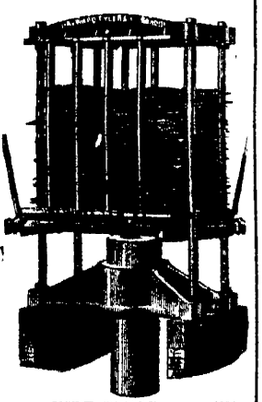
CONTRACTORS TO H.M. GOVERNMENT.



BALING PRESS



HYDRAULIC PUMPS AND PRESSES.

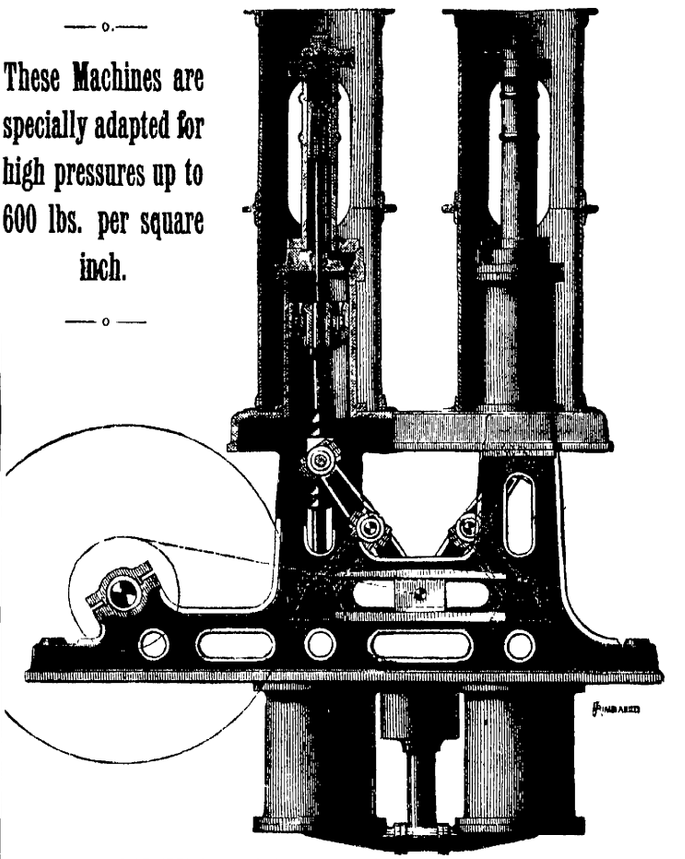


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OWEN'S PATENT AIR COMPRESSOR.

These Machines are specially adapted for high pressures up to 600 lbs. per square inch.



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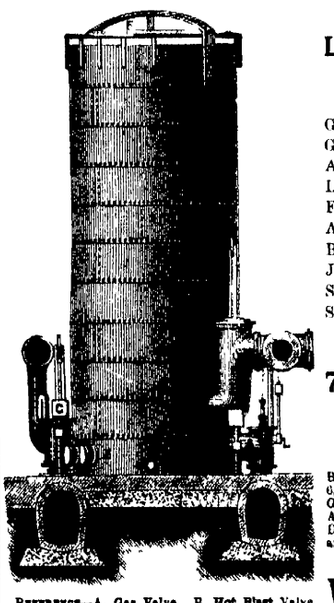
OLIVER & CO., Limited,

Broad Oaks Ironworks, Chesterfield. 4878

London Office: 9, NORTHUMBERLAND ST., CHARING CROSS, W.C.

FIRE BRICK HOT BLAST STOVES

(WHITWELL'S PATENT).



REFERENCE.—A, Gas Valve B, Hot Blast Valve C, Chimney Valve D, Cold Blast Valve E, Lower Cleaning Doors F, Upper Cleaning Doors G, Air Inlets for Combustion of Gas. NOTE.—Dimensions vary according to size required

LIST OF STOVES IN WORK OR CONSTRUCTION.

	Stoves	Blast Furnaces.
Great Britain	241	74
Germany	99	26
Austria	40	14
Luxembourg	16	3
France	110	36
America	228	73
Belgium	43	11
Japan	3	1
Spain	12	4
Saxony	3	1
Total	795	243

795 STOVES IN WORK OR CONSTRUCTION.

AGENTS.—Germany, Herr MACCO, Siegen, France, Belgium, and Luxemburg, M MAURICE, SAUTTER, 6, Rue de L'Oratoire, St Honore, Paris, and M. C GUYENET, Engineer, 88, Boulevard Magenta, Paris, Austria, M P KUPELWIESER, Witkowitzer Eisenwerks Direction, Witkowitz, America, Messrs WITHEROW and GORDON, Pittsburgh

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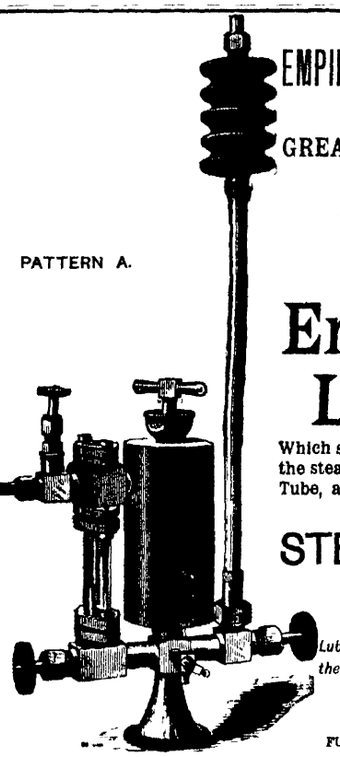
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GRANDISON'S
Empire Lubricator

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Which shows each drop of oil passing into the steam through the medium of a Glass Tube, and is the BEST APPARATUS now known for Lubrication of
STEAM ENGINES,
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Lubricators sent on approval to any part of the kingdom, and references given to users in all parts of the inhabited world.

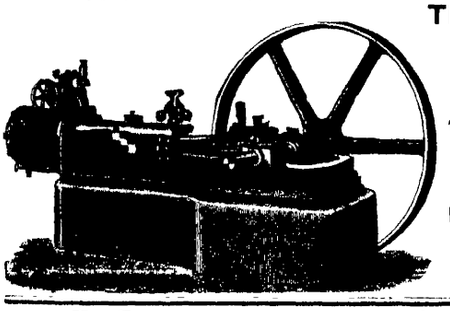
4708
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[TELEPHONE No. 6648.

BRITANNIA IRONWORKS, GAINSBOROUGH, AND MARSHALLS' BUILDINGS, 79, FARRINGDON ROAD, LONDON, E.C.

MANUFACTURERS OF PORTABLE, SEMI-PORTABLE, HORIZONTAL, FIXED, VERTICAL, AND TRACTION ENGINES, THRASHING, CORN GRINDING, SAWING AND TEA PREPARING MACHINERY.



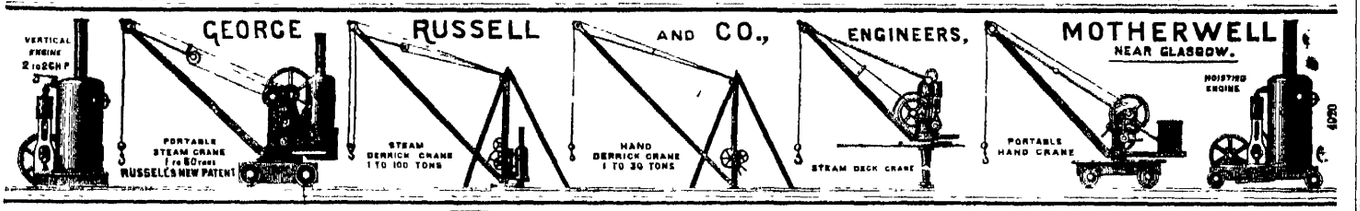
HORIZONTAL ENGINES WITH INSIDE CRANKS

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and

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4886

B. & S. MASSEY, MANCHESTER.

PATENTEES AND MAKERS OF

DOUBLE & SINGLE-ACTING STEAM HAMMERS.

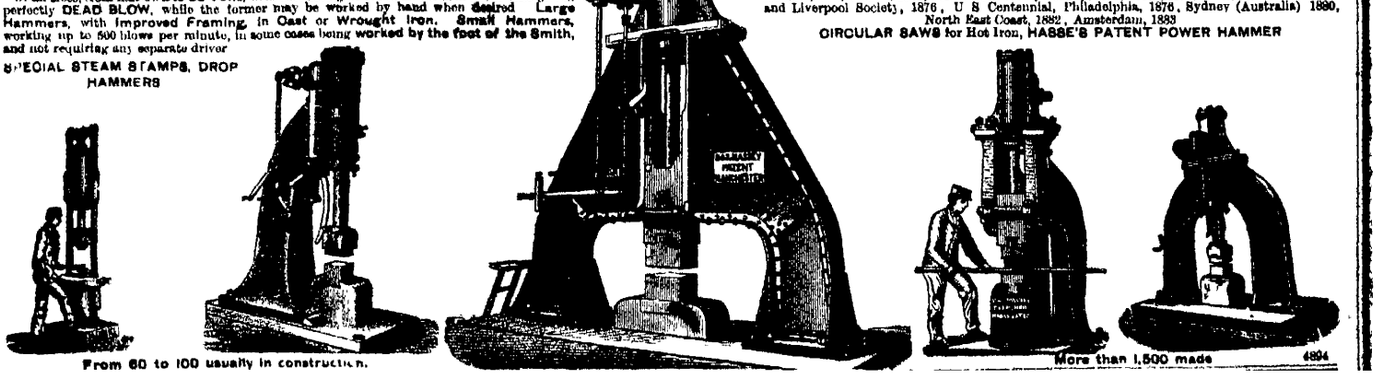
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VOL. XXXVIII.—No. 977.] *LONDON: FRIDAY, SEPTEMBER 19, 1884* [PRICE 6d BY POST 6½d

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Portland Cement,

manufactured by

Francis and Co.,

4714

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Portland Cement,

genuine and of the best quality, is supplied by the WOULDHAM CEMENT COMPANY for home consumption and export —For prices, &c, address, 39, Lime Street, London, E C 1780

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MANUFACTURERS OF

Portland Cement

Of the Greatest Strength and best Quality Roman and Lias Cement, Blue Lias Hydraulic Lime, Ground and Unground

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WORKS NEW BILTON AND NEWBOLD 4867

Oldham Brothers,

Civil & Mechanical Engineers,

5-8, Clive Street, Calcutta,

AND

110, Cannon Street, London, E C 3924

Over 15,000 "Otto" Engines

AT WORK,

Using 25 to 75 % less Gas per Brake HP. than Any other Engine.

Crossley's Patent Self-Starter,

Safest, Best, and Simplest made, may now be applied 4776

Crossley's Patent Twin-Engine

Impulse every Revolution. Very Steady in Running

HIGHEST AWARD AT PARIS ELECTRICAL EXHIBITION.

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Steam Launches. — Messrs. YARROW and COMPANY, Poplar, London, are prepared to contract for—

Screw Steamers having speeds up to twenty-six miles an hour Paddle Steamers having draughts down to 6 inches of water Machinery constructed for boats built abroad 4778

Steam Launches, fitted with really efficient and accessible tubular boilers For small steamers, steam lighters, salt flats, &c, these boilers will be found unrivalled — Apply, COCHRAN and CO, Birkenhead See page 4 4749

Steam Launches in Stock.— VOSPER & CO, Broad Street, Portsmouth, Build in Steel, Iron, or Wood, Sea-going Launches, fitted either with their Patent Silent Engines or ordinary ones 3551

V & CO'S Steel Boilers work well in salt water

Forrestt & Son, London, SHIP AND LAUNCH BUILDERS ENGINEERS 4457

G. F.G. Des Vignes, Chertsey, Surrey, Builder of First class High-speed Steel Yachts, Launches, & Torpedo Boats Estab 1869 3794

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Steam and Hand Cranes, OVERHEAD TRAVELLING CRANES (Hand and Power for Driving by Cotton Rope or Tumbler Shaft), DIRECT ACTING STEAM HOISTS, AIR COMPRESSORS, HYDRAULIC PRESSES, HYDRAULIC CRANES AND LIFTS, DONKEY PUMPS HENRY J COLES, 89, SUMNER STREET, SOUTHWARK, LONDON 4827

John Spencer and Sons, NEWBURN STEEL WORKS, NEWCASTLE-ON TYNE SPRINGS, BUFFERS, STEEL CASTINGS, FORGINGS, TOOL STEEL, FILES SPRING STEEL, &c SIEMENS STEEL BLOOMS AND BARS 3703 PARLIAMENT MANSIONS, VICTORIA ST, LONDON, S W

Johnson & Phillips, Telegraph ENGINEERS, ELECTRICIANS, and CONTRACTORS, 10, Union Court, Old Broad Street, E C Works and Wharf at Charlton, S E Makers of all Machinery, &c, for the complete equipment of Telegraph Cable Factories and Steamers, Electric Leads, Cables, and Carbons, &c 4762

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Thomas Kell and Son, Lithographers, &c, execute every description of Lithography, Chromo lithography, Engraving, and Printing, Engineering, Architectural, and Pictorial Drawing in best manner Paper Drawing, photo lithography, &c —40, King St, Covent Garden, W C 3462

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R. E. Crompton and Co., ELECTRIC LIGHT ENGINEERS, MANSION HOUSE BUILDINGS, E C 4812 See Advertisement, page 29

Isca Foundry and ENGINEERING COMPANY Railway Plant & General Engineers,

Switches, Crossings, Turntables, Water Cranes, Girders, Bridges, Roofs, Pipes, Pumps, Wagons, Tanks, Engines, Boilers, Cranes, Works NEWPORT, MON London Office 4187 10, BUSH LANE, CANNON STREET, E.C

Steam Boilers, Ready for Delivery.

W. & J GALLOWAY & SONS, Manchester, always keep a large stock of "GALLOWAY" and "TWO-FLUED" Boilers ready for dispatch 5060

Willans' Patent Compound ENGINES, for marine and general purposes Stock sizes from 6 to 150 I HP Special patterns for Electric Lighting —WILLANS & ROBINSON, Thames Ditton, Surrey 5283

Iron Roofs, Sheds, Buildings, HOUSES. Best work, reduced prices. Dixon's special CURVED IRON ROOFS are the most economical for spans up to 45ft. Catalogues, Designs, Estimates, on application

Hunter and English, ENGINEERS AND MILLWRIGHTS, IRON AND BRASS FOUNDERS, BOW, LONDON, E. DREDGING MACHINERY HYDRAULIC MACHINERY "WILLIAMS'" PATENT CAPSTANS LAND AND MARINE STEAM ENGINES DISTILLERY AND BREWERY PLANT FLOUR AND RICE MILLS WATER AND GAS VALVES, CRANES, LOCK GATES, &c PUMPING MACHINERY HUNTER'S PATENT FLOATING CRANE FOR DOCKS, &c STEAM LAUNCH MACHINERY 4955

Boiler Tubes, Iron, Steel, and HOMOGENEOUS EDWIN LEWIS AND SONS, Wolverhampton 4963

Tubes, MARINE, LOCO', STEAM, BORING, COLLIERY LARGE TUBES LAP WELDED TO 12in DIAM

Joseph Aird, TUBE WORKS, GREAT BRIDGE, STAFFORDSHIRE LONDON OFFICES 46, QUEEN VICTORIA STREET MANCHESTER QUEEN'S CHAMBERS, 5, MARKET ST Mr L W SUTCLIFFE, M E, AGENT 5189

James Russell and Sons, LIMITED, CROWN TUBE WORKS, WEDNESBURY London Warehouse 108, Southwark Street, S E Leeds Warehouse 6, Mark Lane, Briggate Price Lists on application 5001

Wrought Iron Tubes and FITTINGS LLOYD AND LLOYD, ALBION TUBE WORKS BIRMINGHAM WAREHOUSES— 90, Cannon Street, E C Liverpool 6, Paradise Street Manchester 7, Blackfriars Street 5051

STEEL CASTINGS STEEL CASTINGS

Hallfield's Steel Foundry Co, SHEFFIELD GOLD Medals, Paris and Melbourne, 1878&80 For Engineers, Railways, Tramways, Mines, Hydraulic Work, Dredgers, &c, &c Specially sound, dense, and of unequalled strength, toughness and durability Our Unhammered Steel Castings, as recently tested by H M Govt, stand 40 to 45 tons per sq inch (varying according to the hardness and purpose required) and up to 20 per cent elongation Can be thoroughly relied upon for regularity and uniformity of temper See Advertisement page 29 4593

The Only First Award for WOOD WORKING MACHINERY granted to European Exhibitors at the SYDNEY INTERNATIONAL EXHIBITION, 1879-80, was awarded to

John M'Dowall & Sons, Saw Mill Engineers and Wood Working Machinists, Walkinshaw Foundry, Johnstone, near Glasgow LONDON AGENT— J R GUTHRIE, 70, Bishopsgate Street Within

Okes, LONDON AGENT FOR **Atkinson's Patent Gas Engines.** 5054

89, QUEEN VICTORIA STREET, LONDON, E.C

Field's Patent Boilers and TUBES LEWIS OLRICK & CO, London 5046 See Illustrated Advertisement, page 24

George Russell & Co., ENGINEERS and BOILERMAKERS, ALPHA STEAM CRANE and ENGINE WORKS, MOTHERWELL, near GLASGOW SILVER MEDAL, PARIS 1867 4921

Steam Hammers.— Massey's Patent Hammers RECEIVED THE *ONLY* PRIZE MEDAL PARIS 1878 More than 1500 made Drop Hammers Hasse's Patent Power Hammer B. & S MASSEY, MANCHESTER

The "Differential" Pumping ENGINE —DAVEY'S PATENT for Draining Mines, Water Supply of Towns, Irrigation, Supplying Docks, Pumping Sewage, and General Pumping Purposes HATHORN, DAVEY, & CO, LEEDS H, D, & Co have Patterns of "Differential" Engines of all sizes from 5 to 500 horse power, and have facilities for supplying very powerful Engines and Pumps at a short notice 4750

Locomotive Tank Engines designed and constructed by MANNING, WARDLE, AND COMPANY, Boyne Engine Works, Leeds. 2487 See their Illustrated Advertisement, page 4

Locomotive Tank Engines, TRAMWAY ENGINES AND CARS. Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough 5206 See Illustrated Advertisement, page 10

The Patent Corliss Engine And PATENT CORLISS GEAR ENGINE, with special Improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N B These engines are made Horizontal or Beam, Condensing, Non Condensing, and Compound Also makers of Rice Mills, and Paper Mills, and General Engineers Machinery shipped or tracked direct from the premises 3599

Gunpowder Machinery IS A speciality of JOHN HASTIE and CO, Kilbirnie Engine Works, GREENOCK Also Patentees and Makers of the most economical Water Pressure Engines ever constructed 2475

Steel Hydraulic Cylinders.— HENRY BESSEMER & CO, Limited, SHEFFIELD See Advertisement last week, page 31 3627

Tweddell's Hydraulic Rivetting Machines

14, DELAHAY STREET, WESTMINSTER, LONDON, S W 4897

See Illustrated Advertisement last week, page 47

L. Sterne & Co., Limited. ENGINEERS, Sole Makers of **Clerk's Patent Self-Starting Gas Engine.**

HIGHEST AWARD, BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881

GOLD MEDAL, CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifiers, WITH STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels, Emery Machines, Spiral Springs.

The Crown Iron Works, GLASGOW

The Crown Iron Works (Hollinwood), MANCHESTER

10, Victoria Chambers, WESTMINSTER.

City Office and Show Rooms, 40, CANNON STREET, E C.

10, Rue Lafitte, PARIS

International Inventions

EXHIBITION, London, 1885

DIVISION I, INVENTIONS DIVISION II, MUSIC

Patron

HER MAJESTY THE QUEEN

President

H R H THE PRINCE OF WALES, K G

Applications to Exhibit must be made on Printed Forms, which will be supplied on application to the SECRETARY, International Inventions Exhibition, South Kensington, S W, or to Mr E J PAYNE, 1, Bonnett's Hill, Birmingham These must be filled up and returned on or before the 1st November, 1884 G 835

FINAL NOTICE

Applications for Space in the

SIXTH ANNUAL

NATIONAL EXHIBITION

AND

MARKET

OF

TRADE APPLIANCES, MACHINERY,

NATURAL PRODUCE, &c &c.

USED BY

BREWERS, MALTSTERS,

AERATED WATER MANUFACTURERS,

WINE & SPIRIT MERCHANTS,

LICENSED VICTUALLER AND HOTEL PROPRIETORS,

CIGAR AND TOBACCO MANUFACTURERS,

AND KINDRED TRADERS,

To be held at the

AGRICULTURAL HALL, LONDON,

On October 20th to 25th inst,

Must be made to the undersigned on or before SATURDAY, the 27th instant G 836

A DALE,
Secretary and Manager

Offices, 24, Wellington Street, Strand, London, W C

University College, Bristol

ENGINEERING DEPARTMENT

PROFESSOR H S HELE SHAW

The SESSION 1884-85, BEGINS on OCTOBER 7th The Department of Engineering includes separate courses for those intending to become Civil, Mechanical or Electric Engineers, or Surveyors or Architects

Students in Mechanical Engineering who study during the six winter months at the College, can spend the rest of the year in the workshops and offices of various firms in and near Bristol

Surveying and Fieldwork occupy a prominent place in the Civil Engineering Course during the Summer Term and arrangements have been made with leading Civil Engineers and Architects for the entry into their offices of Students who have passed through the respective courses

Information with regard to the lodging of Students can be obtained on application

Calendar, containing full information, price 1s, by post 1s 3d For Prospectus and further information apply to

ALFRED E STOCK, G 726
Registrar and Secretary

Bristol Mining School—

BOARD OF GOVERNORS—THE COLSTON TRUSTEES

The NEXT SESSION BEGINS on the 1st OCTOBER, 1884

The full course of Instruction extends over two years, but Students are received who wish to finish their studies at the end of their first session

The work of the School affords an effective preparation for the Mine Managers Certificate One day per week is spent in the field or mine, and considerable time is devoted to the plotting of surveys, and the drawing and study of Mine Machinery

There is a Chemical Laboratory, which is open daily for the general public as well as for Mining Students

There is also in the same Institution, but distinct from it, a School of Applied Science for Boys, intended as a preparation for the Mining School or Laboratory

Exhibitions to the value of £100 a year are given from this School to Pupils proceeding to a higher School, and can be held in the Mining School or Laboratory

For Prospectuses and further information, apply to GEORGE B POPE, Merchants' Hall, Bristol, who will enter Pupils and receive fees

Scholars of the Applied Science School can board in the house of one of the Masters, and other Boarding Houses may be heard of at the Hall. G 842

Owen's College, Manchester

(VICTORIA UNIVERSITY) ENGINEERING COURSE A detailed Syllabus of the COMPLETE COURSE in ENGINEERING will be forwarded on application The next Session COMMENCES on the 7th OCTOBER G 727

J HOLME NICHOLSON, Registrar

Mr. N. J. Spooner's Engi-

NEERING and DRAWING CLASSES, at the Polytechnic Institute, Regent Street, W, and at Enfield, Re commence the second week in October G 869

TENDERS

BOROUGH OF GATESHEAD

The Quay Committee invite

Tenders for the Supply and

ERECTION of a CRANE on the Gateshead Quay, capable of lifting 40 Tons, and also Tenders for one (if preferred by the Committee) capable of lifting 50 Tons The work is to include the necessary foundations in both cases

A section of the Quay Wall and other particulars will be supplied on application to the Borough Engineer, Town Hall

Tenders, addressed to the Quay Committee, should be sent to the Town Clerk not later than the 23rd September

The Committee do not bind themselves to accept the lowest or any Tender

J W SWINBURNE,
Gateshead Town Hall Town Clerk
8th September, 1884 G 812

PERTH GENERAL STATION

CONTRACT FOR WORKS

The Perth General Station Committee are prepared to receive

Tenders for the Enlargement

of the GENERAL STATION, PERTH

The Drawings and Specification may be seen at the Office of Messrs BLYTH & CUNNINGHAM, C E 135, George Street, Edinburgh, from Monday, the 8th of September, till Saturday, the 13th of September, and from Thursday, the 18th of September, till Friday, the 26th of September, and at the Office of the Secretary to the Perth General Station Committee, Perth, on Monday, Tuesday and Wednesday, the 15th, 16th and 17th of September when an Engineer will attend to point out the Site of the Works to Contractors

Forms of Tender, with copy of the Specification and duplicate copies of the Schedule may be obtained from the Engineers, on payment of Four Guineas

The successful contractor shall pay the cost of the measurements

Sealed Tenders, addressed to the undersigned, and marked "Tender for Works," must be lodged with him on or before Friday, the 26th day of September next

The Committee do not bind themselves to accept the lowest or any of the Tenders

ROBERT MORISON,
Perth General Station, Secretary
25th August, 1884 G 771

TO CONTRACTORS

GREENOCK HARBOUR TRUST

HYDRAULIC RAMS AND SLUICE PADDLES for Entrance Works of the "James Watt" Dock

The Trustees are prepared to receive

Tenders for the Supply of

NINE SETS OF HYDRAULIC RAMS AND SLUICE PADDLES for above Entrance Works

Specifications and Form of Tender, with Drawing attached, may be obtained at the Engineer's Office, on deposit of £1, which will be returned to all Contractors whose Tenders are lodged and properly filled in

Sealed Tenders, marked "Tender for the Supply of Hydraulic Rams, &c," must be lodged with the undersigned, on or before Saturday, the 27th day of September

None other than the printed Form of Tender will be received by the Trustees The Trustees do not bind themselves to accept the lowest or any Tender

Any further information may be obtained from WALTER ROBERT KINIPLE Engineer to the Trustees, 17, West Blackhall Street, Greenock, and 2, West minster Chambers, London, S W

Greenock, THO WILSON, Clerk
8th September, 1884 G 801

GREAT WESTERN RAILWAY

The Directors of this Company are prepared to receive

Tenders for the Supply of the

undermentioned STORES, from the 1st of November next to the 31st October, 1885

1 Fire Bricks, Fire Clay, Cement, Grindstones, Drain Pipes and Slates
2 Glass and Lamps
3 Dry Salteries
4 Oils, Paints, and Varnishes
5 Carpenters Work, Office Furniture, and Fencing
6 Cotton Waste and Lamp Cotton
7 Tin Ware, Block, Bar and Sheet Tin, Solder, Zinc and Lead
8, 9, 10 Telegraph Wire, Instruments and Materials
11 Brooms, Brushes, Painters' Tools, Baskets, Hampers, Bungs, Corks and Sponge
12 Rope, Twine, Canvas, Sacking, Flannel, Coir Mats, Coir Matting and Floor Cloth
13 Chain, Iron and Copper Rivets, Coach Screws, Carriage Bolts, Brass, Iron and Copper Tubes Steel and Files
14, 15, 16 Ironmongery and Hardware
17 Leather and Leather and India Rubber Goods
18 19 Carriage Furniture and Trimmings
20 Gas Fittings
21 Permanent Way Fittings

Samples and Patterns may be seen on and after Friday, the 12th instant, at the Office of the Storekeeper, Paddington Station

Specifications and Forms of Tender (upon which alone Tenders can be received), may be obtained at the Office of the Storekeeper at the Swindon or Paddington Stations

Tenders, addressed to the undersigned, sealed, and marked outside "Tender for Stores," will be received on or before Monday, the 6th proximo

The Directors do not bind themselves to accept the lowest or any Tender

FRED G SAUNDERS,
Paddington Station, Secretary
10th September, 1884. G 841

TO SHIPBUILDERS AND ENGINEERS

Tenders are required for Build-

ING a STERN PADDLE WHEEL STEEL STEAMER of light draught, in accordance with Specifications, which may be obtained after the 22nd inst at the undermentioned address, where the general design of the Vessel can be seen, and where Tenders are to be sent not later than noon of the 30th Sept, stating the price and the time in which Contractors will engage to deliver the vessel The advertisers do not bind themselves to accept the lowest or any Tender

JOHN THOMPSON & SON, Engineers,
12, London Street, E C G 802

The HARBOUR AUTHORITIES OF COPENHAGEN are prepared to receive

Tenders for the Dredging of

Copenhagen Inner Roads, to a depth of water of 24 ft The work comprises the dredging of about 60,000 tons yearly during one, three, or six years, and unloading of the punts, and the depositing of the dredged material in a depth of water of 5 ft or less, to a height of 8 ft above daily water

The conditions of contract may be obtained by application to the Harbour Administration of Copenhagen, on payment of 40 Kroner (50 Reichsmark or 2 Guineas), which will be returned on receipt of Tender The Tenders will be opened on the 27th October prox, at Eleven a m

THE HARBOUR ADMINISTRATION OF COPENHAGEN
16th September, 1884 G 813

STEAM TUGS, RAFTS, AND FIRE ENGINES

The Metropolitan Board of Works is prepared to receive

Tenders for the Supply of

Two IRON STEAM TUGS, Two IRON RAFTS, and Two STEAM FIRE ENGINES, for the Metropolitan Fire Brigade

Specifications, Forms of Tender, and other particulars may be obtained on application at the Office of the Board in Spring Gardens, between the hours of Nine a m and Four p m

Tenders, which must be on the forms supplied from the Office, must be under cover, sealed and addressed "The Clerk of the Metropolitan Board of Works, Spring Gardens" No Tender will be received after Four o'clock on Monday, the 13th of October

The Board does not bind itself to accept the lowest or any Tender

J E WAKEFIELD,
Spring Gardens, S W, Clerk of the Board
17th September, 1884 G 806

THE DOCK COMPANY OF KINGSTON UPON HULL

PATENT SLIP No 1, Adjoining the Works of Earle's Shipbuilding and Engineering Co, Limited

The Dock Company are prepared to receive

Tenders from Persons desirous

of LEASING and WORKING this Slip

The conditions upon which this Slip could be let, and the regulations under which it will have to be worked, may be ascertained on application to the undersigned in the meantime it will be worked by the Company, and all application for terms should be made to the Slip Dock Master at his Office

The Company are also prepared to receive APPLICATIONS for leasing an extensive Shipbuilding Yard, in which several large steamers have recently been built, situate on the Company's Citadel Estate, Victoria Dock Full particulars can be ascertained on application to EDWARD H GARBETT,
Dock Office, Hull, General Manager and Secretary,
13th September, 1884 G 844

TO CONTRACTORS AND OTHERS

THE TOWN COMMISSIONERS OF DUNDALK, being the Sanitary Authority, invite

Tenders for the Construction

of WATER WORKS for the Supply of the Borough

Plans, Specifications, and Form of Tender may be seen at the Town Hall, Dundalk, or at the Offices of the Engineers, Messrs R HASSARD and A W W TARPLIT, M M Inst C E, Westminster Chambers, on and after 1st October, and all Tenders must be sent in on the printed forms in sealed envelopes, endorsed "Tender for Water Works," and addressed to F FERRAR, Esq, Town Clerk, Dundalk, on or before the 25th of October

One Guinea will be charged for Copies of the Specification and Form of Tender, which will be returned on receipt of a bond fide Tender

The Commissioners do not bind themselves to accept the lowest or any Tender

By order,
Town Hall, Dundalk, EDWARD FERRAR,
11th September, 1884 Town Clerk

BOMBAY PORT TRUST DOCK EXTENSION.

TO CONTRACTORS

Tenders are invited for the

MASONRY and EXCAVATION of a Wet Dock of about 25 acres area, to be constructed on a site to the southward of the Prince's Dock, Bombay The works include about 7750 lineal feet of wharf walls, a sea entrance, and a passage communicating with the Prince's Dock

Plans, Conditions of Contract, Specification, and Form of Tender may be seen on application to Mr JAMES A MCCONNOCHIE, C E, Engineer's Office, Surrey Commercial Docks, Rotherhithe, London, agent for the Trustees of the Port of Bombay on and after Monday, the 29th September, 1884, and copies of the same, if available, may be obtained on payment of the sum of Ten Pounds

Sealed Tenders, endorsed "Tender for Contract No 1, Masonry and Excavation, Dock Extension," are to be lodged with the Secretary to the Bombay Port Trust, at Bombay, at or before noon of the 14th day of November 1884

Fifteen days' extension of the time for lodging Tenders (till 29th November, 1884) may be obtained under certain circumstances, particulars of which can be learned on application to the Trustees' agent No pledge is given that the lowest or any Tender will be accepted

G MANSON
Bombay, 25th August, 1884. Secretary

APPOINTMENTS OPEN.

To Electricians.—The Man-

chester and District Edison Electric Light Company (Limited), SEEK the SERVICES of an experienced Electrician A gentleman who is also an Engineer would be preferred —Applications, stating age, qualifications, salary required, &c, to be addressed to the SECRETARY, 19, Victoria Buildings, Manchester

Wanted, a Managing Foreman

by an old established Agricultural Engineering Firm in Australia Must be a good mechanic, accustomed to general construction, fair draughtsman, used to handling men, and sober and steady —Apply in first instance, stating experience, age, and salary expected, to G 845, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 845

Draughtsman Wanted in a

General Engineer's Office, accustomed to taking out quantities, estimating, &c (more especially for brewing), sugar machinery, and distilling apparatus, age about 30 to 35 —Apply, stating full particulars, salary, &c, to A B, care of Messrs R F WHITE & SON, 33, Fleet Street G 863

Wanted Immediately, a Good

DRAUGHTSMAN, accustomed to large hydraulic cotton presses —Address, HYDRAULIC, care of W H SMITH & SON, Advertising Agents, Manchester G 830

Wanted, a Draughtsman; one

with some experience in portable engines and thrashing machines preferred —Apply, stating salary expected, BOX 11, Post Office, Lincoln G 858

Wanted, Mechanical En-

GINEER, quick Draughtsman, with practical experience, accustomed to design steam engines and general engineering —Apply, by letter, stating age, salary, and experience, to A B, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C

Agents Wanted, to push First-

class MACHINERY OILS commanding a large and successful sale Liberal commission —Address BOX 201, Post Office, Liverpool. 5238

Lists of Berths Vacant or

WANTED See "ENGINEERING REVIEW," weekly 1d —E & F N SPON, 16, Charing Cross, London, or of all News Agents. 5262

SITUATIONS WANTED.

A M I.C.E (26), educated at

King's College, London, six years with leading firm of marine engineers, and some sea going experience, desires ENGAGEMENT as Under Manager or otherwise, first class references —Address, C E, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London W C G 870

A Young Chemist, diplomé in

Germany, speaking French, German, and English, and having been employed in blast furnaces and steel works on the Continent and in England for some length of time, wants a SITUATION in a laboratory, blast furnace, steel works, or chemical manufactory Address B 9,267, care of Messrs HASSENSTEIN & VOGLER, Advertising Agents, Cologne G 840

Basic Steel Works.—Wanted,

a SITUATION as Manager, by a competent engineer, holding a very responsible position in a Basic Steel Works Has designed and erected a Basic Works on the most modern principles Apply GRIT, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 846

To Civil Engineers and Con-

TRACTORS —A Young Gentleman who has just completed his articles, seeks EMPLOYMENT, either in an office or out of doors, has had experience in railways, sea walls, &c, factories (ironwork), surveying, and levelling, a fair draughtsman terms moderate —Address, A J B, Melrose House, Westonsuper Mare G 854

Scotchman wishes Situation as

Resident or Contractor's Engineer, thoroughly experienced, good references —Address, G 853, Offices of ENGINEERING, Bedford St, Strand London G 853

An Assoc. M. Inst C.E seeks

an ENGAGEMENT, specialities, sanitary engineering, water supply, drainage, municipal work, surveying, levelling, and drawing office work Fifteen years' experience Testimonials and references on application - Address, ENGINEER, 146, Lough borough Road, Brixton G 865

Swiss Engineer (26), Trained

in one of the best Continental Schools; special knowledge of Electricity, as DRAUGHTSMAN or ASSISTANT Fluent French and translate German —H B, Offices of ENGINEERING G 840

To Inventors.—An Ex-

perienced Engineer, proceeding to France and Austria, in order to dispose of some new patents, is prepared to NEGOCIATE for a few more —Address, M I M E, Offices of ENGINEERING G 848

Agency Wanted for Manches-

ter and Manufacturing Districts, by a gentleman, well known to buyers, and a member of the Royal Exchange Oils or Lubricants not required —Address, X Y Z, Offices of ENGINEERING G 847

PARTNERSHIPS.

To Mechanical Draughtsmen.

—PARTNER WANTED, with £300 to £800, in Established Business for something new —B J, Mrs MAIDEN, Stationer, Park Street, Islington G 867

To Civil Engineers in practice.

—The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright.

WHEATLEY KIRK, PRICE and GOULTY, 52, Queen Victoria Street, London, E C. 5292

WANTED, &c.

Wanted, One or Two Sets of Second hand PORTABLE RIVETTING MACHINES, equal to new, either Arroll's, Tweddell's or New's system State price and particulars —Apply, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 801

Wanted Immediately (New or Second hand), in first class order, One, Two, or Three pairs of Vertical COMPOUND ENGINES, tandem or otherwise capable of indicating together about 120 HP, must be of good and economical design —Apply, stating particulars and lowest price, to BOX 79, Post Office, West Hartlepool G 861

Wanted, New or Second-hand LOCOMOTIVE, 6 in or 12 in cylinders, gauge 8 ft or metre —Apply to KERR, STUART & CO, 20, Bucklersbury, London, E C

"Engineering."—Wanted, Copies of Jan 11th, 1884 – Address, stating price, C R, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W C G 780

"Engineering."—Wanted, Feb 13th, March 14th, and April 2nd, 1880 —State price to J E G, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W C G 804

Specialty Wanted to Manufacture, by Firm having extensive Works and Foundry, near London Exceptional facilities offered —Address Y J, at C H MAY & Co's General Advertising Offices, 7s, Gracechurch Street, London G 889

Lists of Machinery Wanted or on SALE See "ENGINEERING REVIEW," weekly 1d E & F N SPON, 16, Charing Cross, London, or of all News Agents 5262

FOR SALE.

For Sale, One Pair of Compound Surface Condensing MARINE ENGINES AND BOILER, 130 HP Nominal 5290
F GILMOUR & CO, Engineers, Glasgow

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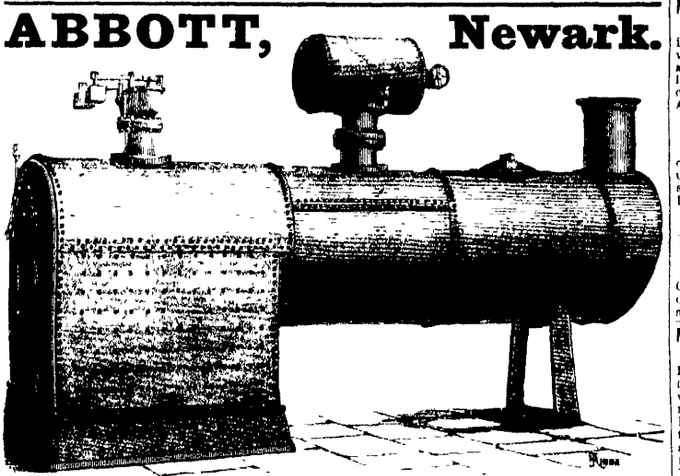
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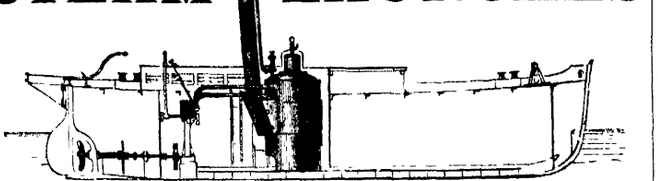


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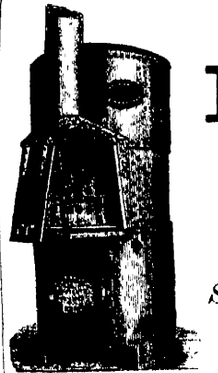
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PATENTS THE INVENTOR'S GUIDE TO THE NEW PATENT LAW GREAT INFORMATION BY RECENT AMENDMENTS HORN & SON PATENT AGENTS 172 STRAND LONDON

The Burham Brick, Lime, and CEMENT COMPANY, LIMITED NICHOLAS LANE, LOMBARD STREET, E.C. LONDON DEPOTS BURHAM WHARF, BELVEDERE ROAD, LAMBETH, S E, VICTORIA WHARF, AND DRAW DOCK, NINE ELMS, S W

GALT BRICKS, Cornice Tiles and Tubes, Quoins, Chimney Pots, Drain Pipes, &c Grey Stone Medway Lime, fresh from the Company's Kilns, delivered in large loads alongside or by the van load, &c, from the Company's Depôt Plaster of Paris, PORTLAND, SHEPPY, and ROMAN CEMENTS, as manufactured at the Company's Works, Burham, on the banks of the River Medway, and at Murston, near Sittingbourne, Kent.

Bricks, Tiles, &c, of any design made to order
GREAT CULAND CLIFF HYDRAULIC LIME.
This Lime is perfectly hydraulic, of great strength and tenacity, it sets readily under water, and becomes very hard in a short time
PARR AND STRONG'S PATENT COMBINATION (See *Builder*, May 10th, 1868)
The Burham Brick, Lime, and Cement Company, having been appointed sole manufacturers, are prepared to Supply Tubes for the Cellular Walls, &c,
Prices and particulars forwarded on application
PETHER'S PATENT DIAPER BRICKS, manufactured only by the Burham Brick, Lime and Cement Company
A great variety of designs are prepared for diapered surfaces, string courses, circular columns, window heads, &c., to be seen at their London Depôt. 539

With this week's Number is issued a Special Supplement, containing a Classified Index of the current Advertisers in ENGINEERING

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SHELLS, ANGLES, TEES, GIRDER BEAMS, "SS" BRAND SPECIAL QUALITY FOR BOILER FURNACE PLATES, WHICH ARE SUITABLE FLANGED

AXLES, FORGINGS TO 10 TONS, CASTINGS TO 15 TONS INGOTS, BLOOMS, BILLETS, BARS, WIRE RODS, RIVETS &c

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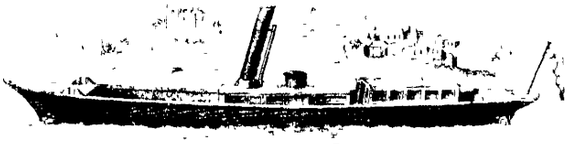
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Superseding Link Motion

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Best for Launches. Reverses in Valve. Rich Expansion

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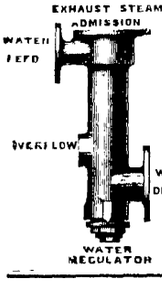
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FOR FEEDING BOILERS IN CONNECTION WITH NON-CONDENSING ENGINES

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Works with the Exhaust Steam from the Engine only.

NO STEAM IS TAKEN FROM THE BOILER



ECONOMY OBVIOUS.

SIMPLE TO MANIPULATE, CERTAIN IN ACTION

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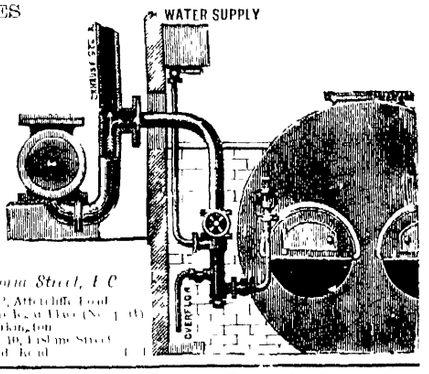
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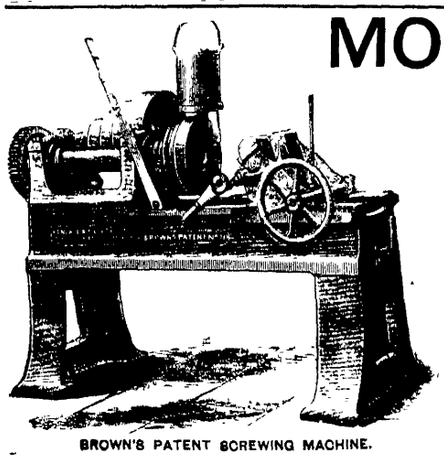
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BROWN'S PATENT SCREWING MACHINE.

BROWN'S PATENT SCREWING MACHINES

POWERFUL DUPLEX LATHES, for Heavy Cutting in Wrought Iron and Steel

MILLING AND PROFILING MACHINES, for Locomotive and Heavy Engineering Work

SPECIAL BRASS FINISHING MACHINERY

IMPROVED PLANING MACHINES, up to 10 ft. square

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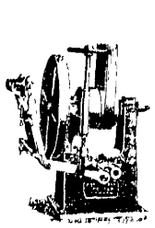
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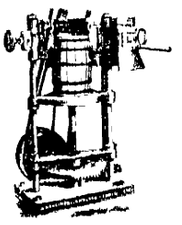
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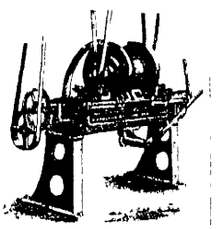
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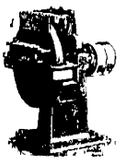
The Best Machinery for making CASKS and BARRELS of every kind can be obtained only of the

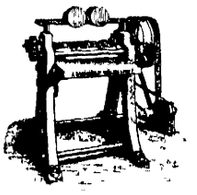
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Stave Jointer.


Trussing Machine


Chiming & Crozing Machine


Head Jointer


Head Planing Machine


Head Rounding Machine

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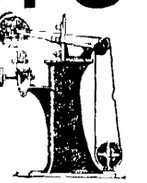

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Dimension Sawing Machine


Pattern Makers' Bench


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Planing and Jointing Machine


Saw Sharpener

5107

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LIGHT FORGINGS. | BRAKE WORK. WAGON IRONWORK.

GLASGOW HYDRAULIC FORGE CO., LIMITED, Sentinel Works, Polmadie, Glasgow, and Canal Road, King's Cross, London. 5136

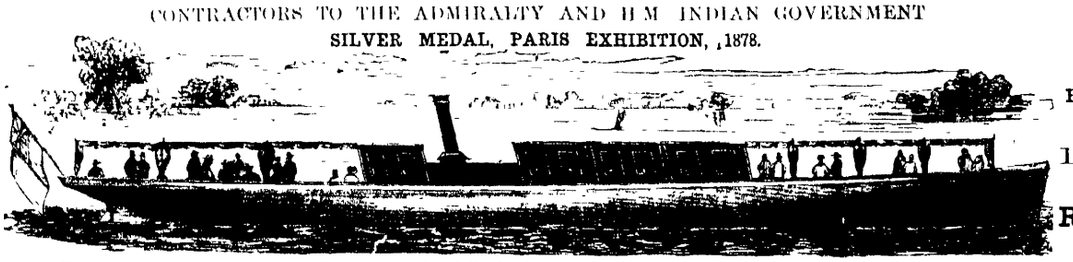
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Shipbuilders and Engineers, Wharf Road, Cubitt Town, London, E.,

CONTRACTORS TO THE ADMIRALTY AND H.M. INDIAN GOVERNMENT

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BUILDERS Of all classes of STEAM and SAILING VESSELS TORPEDO LAUNCHES, YACHTS, TUGS, LAUNCHES.



DREDGERS, Hopper Barges FLOATING DOCKS GIRDERS, ROOFS, &c.

YACHTS and LAUNCHES for Sea or River service up to 160 feet in length, built of Steel, Wood or Iron. Speeds up to 22 miles an hour. Draught of water down to 6 inches for shallow Rivers. 695

HARDINGHAM's Patent Sectional STEAM BOILER

ANNULAR WATER-TUBE SYSTEM.

FOR

FULL PARTICULARS,

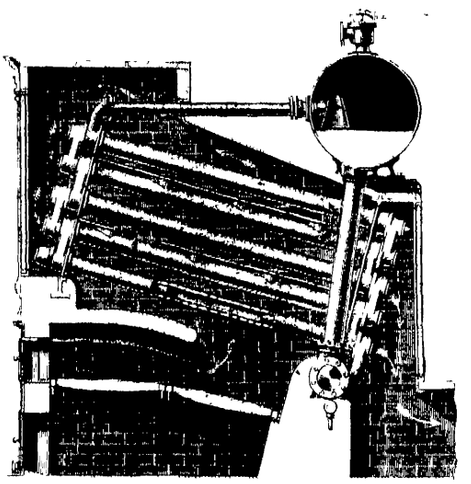
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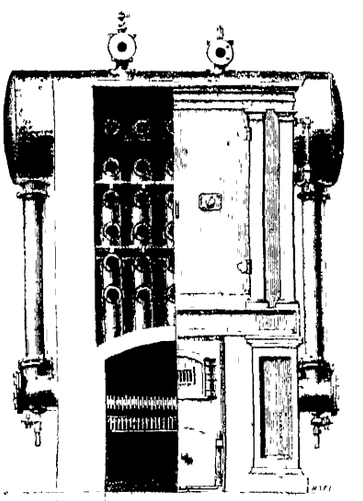
G.G.M.Hardingham

Engineer,

191, Fleet Street,

LONDON, E.C.

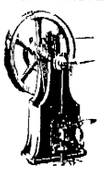




In the improved construction of Water-tube Boiler considerable economy in first cost and in working is effected.

Although the water-ways are exceptionally free from liability to fouling the construction affords peculiar facilities for thorough inspection.

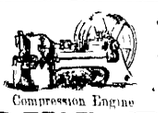
The system further allows of extreme compactness being attained.



Non-Compression Engine

GAS ENGINES

FROM 1 MAN TO 100 HP.



Compression Engine

ALL SIZES ABOVE 2 HP. SELF STARTING.

ATKINSON'S PATENTS.

FEED-WATER HEATERS.



Feed Water Heater

JOHN HASTIE & CO, GREENOCK, SOLE MAKERS OF THESE HEATERS FOR SCOTLAND

Sole Makers: BRITISH GAS ENGINE & ENGINEERING COMPANY, Limited, 11, Queen Victoria St., London, E.C

Ships' Engine and Steering Telegraphs.

Over 3000 Vessels have been fitted with CHADBURN & SON'S Patent Telegraphs including all the noted Steamers in the World, also 200 Vessels for English and Foreign Navies

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CHADBURN & SON'S NEW PATENT 'DUPLEX GONG' 1883.

ENGINE AND STEERING REPLY TELEGRAPHS.



ORDERS INDICATED BY SOUND & SIGHT.

A DEEP GONG from Astern to Ahead

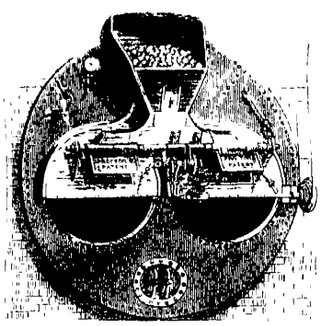
A SHRILL GONG from Ahead to Astern.

TELEGRAPH WORKS - WATERLOO ROAD,

GLASGOW 69, ANDERSTON QUAY LIVERPOOL. LONDON - 96, FENCHURCH ST

Received PRIZE MEDAL at the Smoke Abatement Exhibition, South Kensington, London

PROCTOR'S Patent Mechanical Stoker



BUFFER SPRINGS & BUFFERS ENTIRELY DISPENSED WITH.

WORKS NOISELESSLY

Will apply the Stoker for Two Months upon approval

Over 1000 Boilers or 2000 Furnaces have been supplied with these Stokers,

Over 200 Machines now working on the Continent

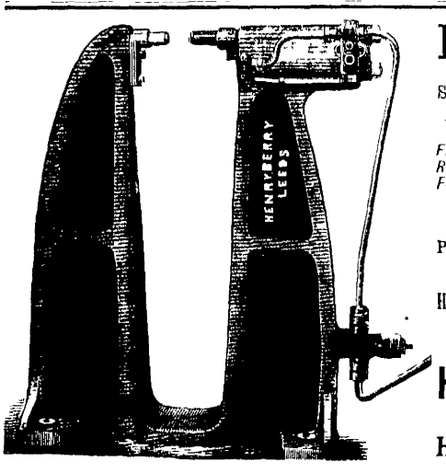
The simplest, Cheapest, and most Efficient in the Market.

Will evaporate 10 pounds more Steam with less Coal than can be done by hand-firing.

No drilling of the Boiler to fix it, the holes that used the ordinary fronts are used to fix the Stoker.

J. PROCTOR, PATENTEE & MAKER,

HAMMERTON IRON WORKS, BURNLEY, LANCASHIRE.



RIVETTERS

FOR

Ship, Locomotive, Carriage Builders, and Boilermakers.

VIZ.

Fixed and Portable Hydraulic Rivetting, Flanging, Bending, Forging, and Punching and Shearing Machines,

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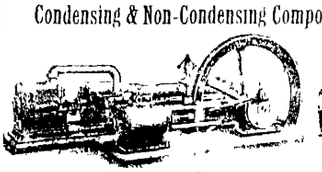
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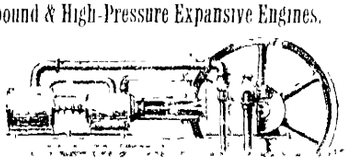
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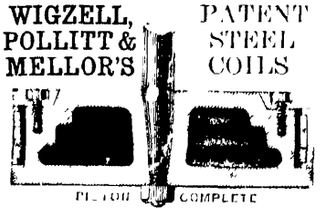
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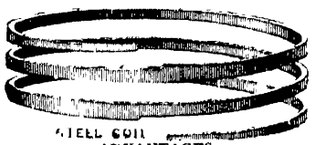
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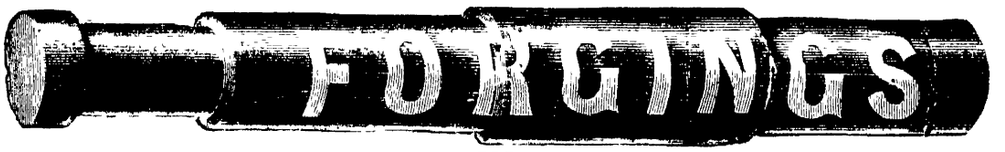
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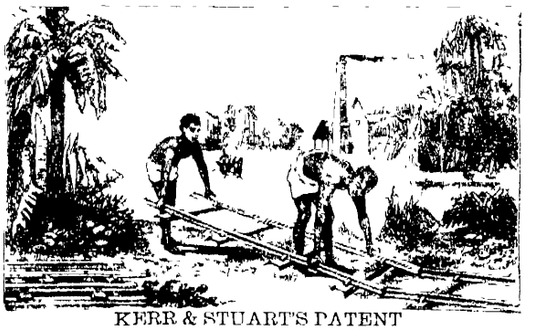
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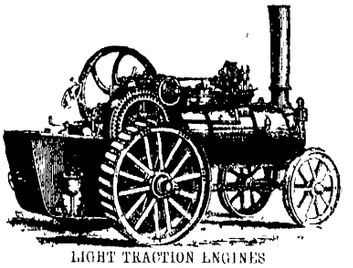
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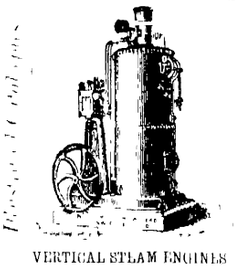
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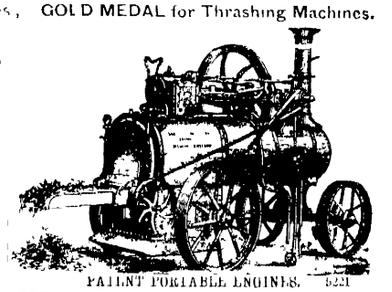
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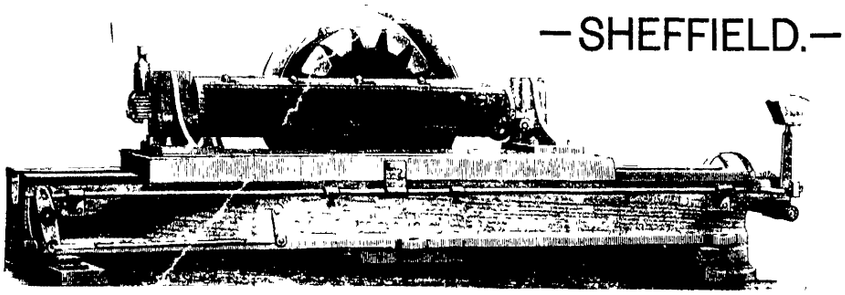


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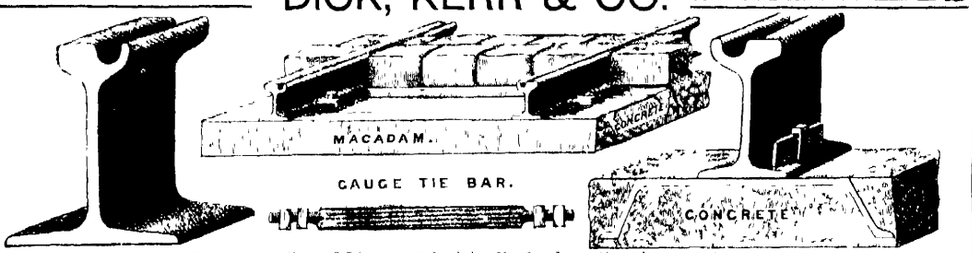
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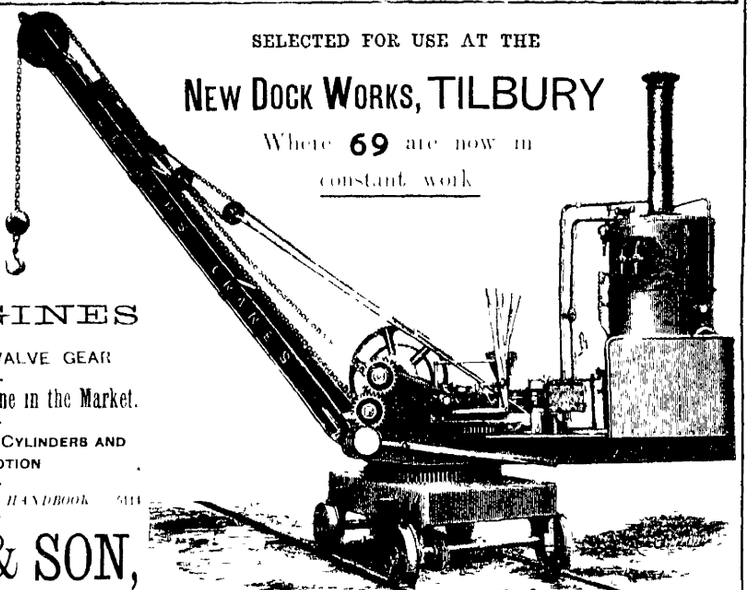
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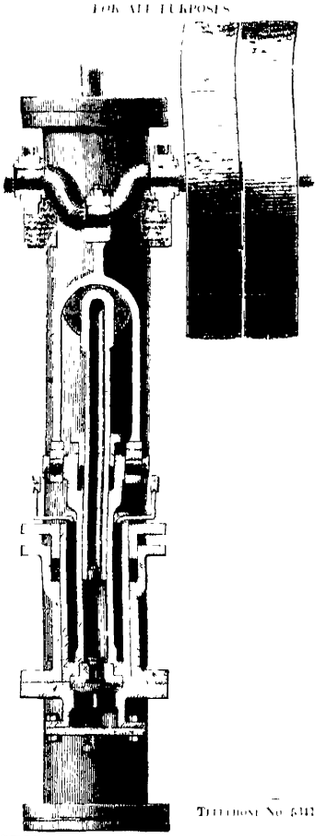
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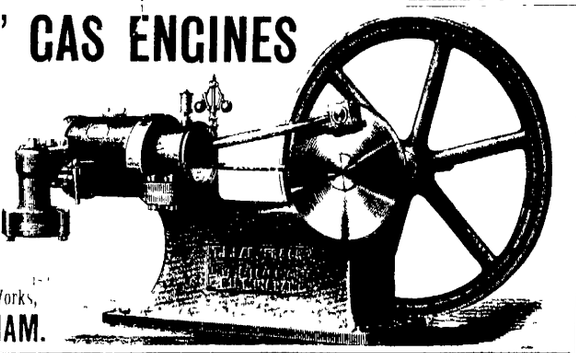
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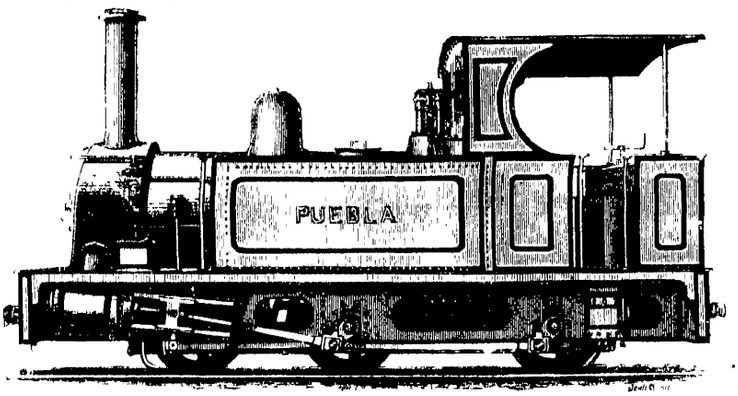


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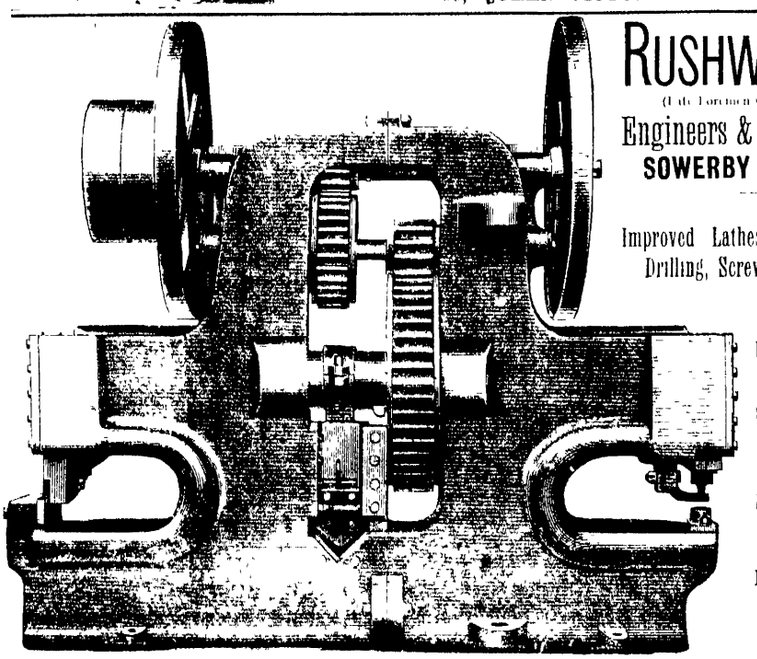
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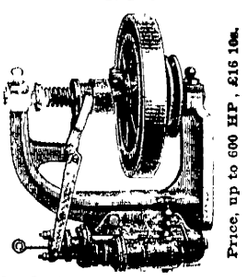
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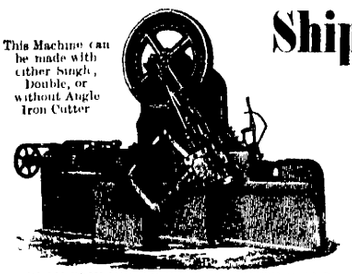
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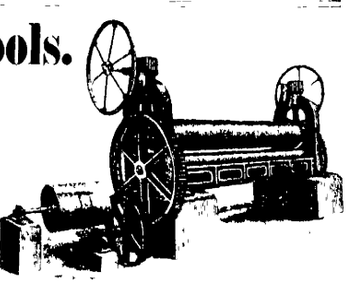
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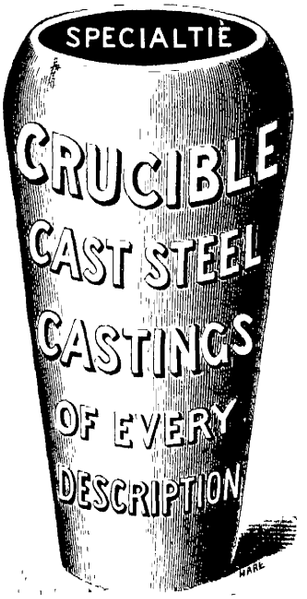
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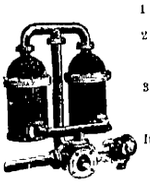
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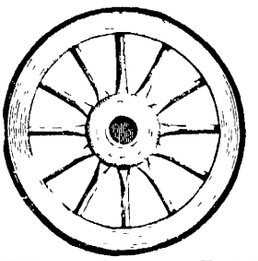
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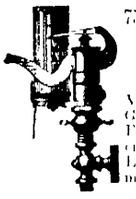
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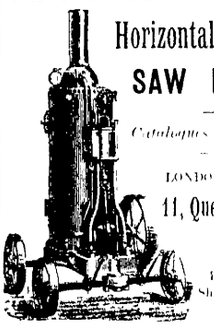
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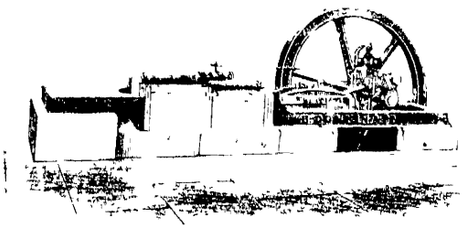
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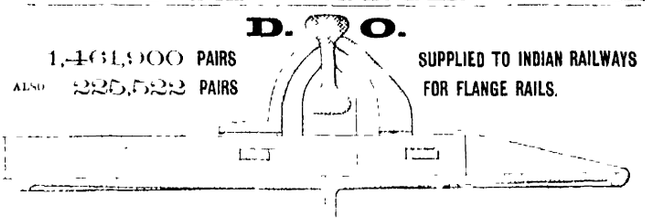
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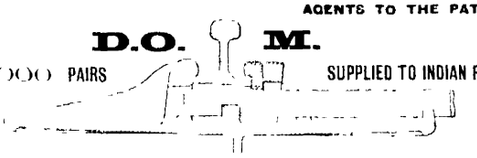
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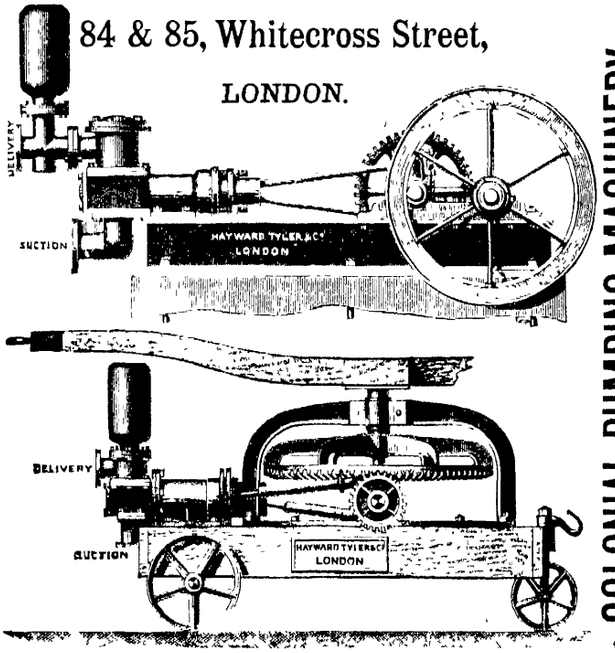
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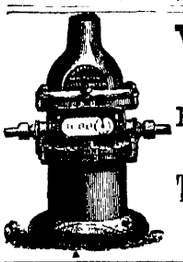
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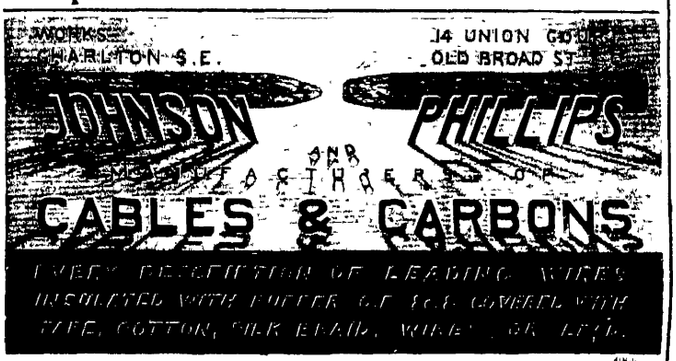
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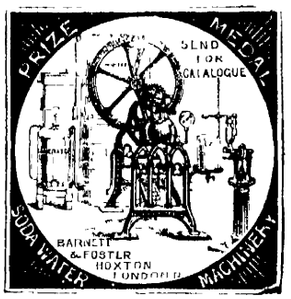


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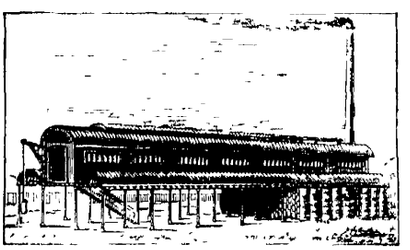
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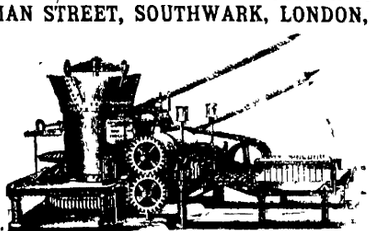
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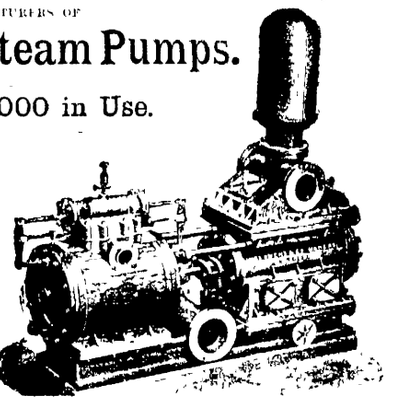
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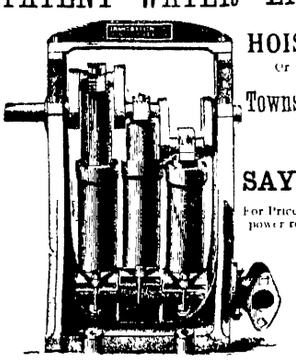
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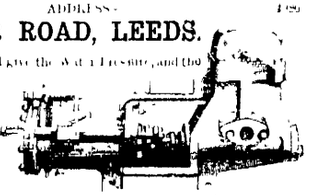
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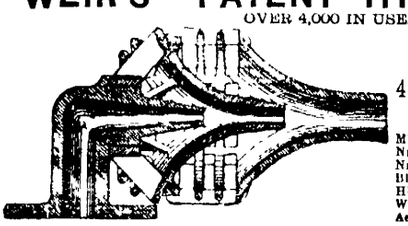


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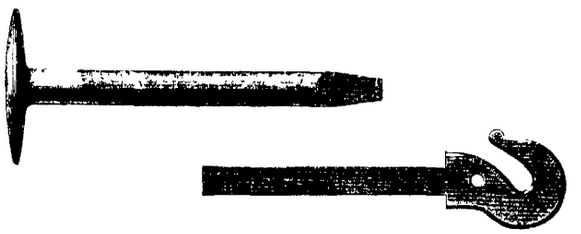
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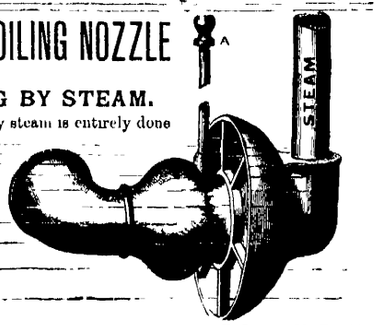
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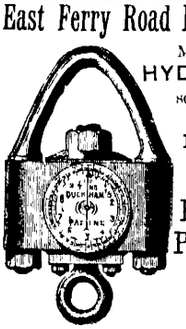
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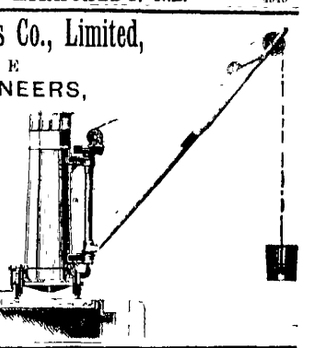
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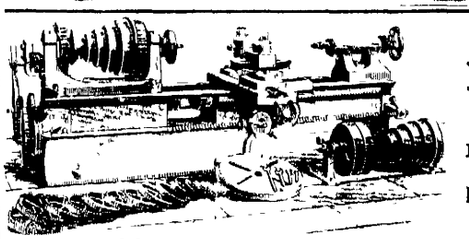
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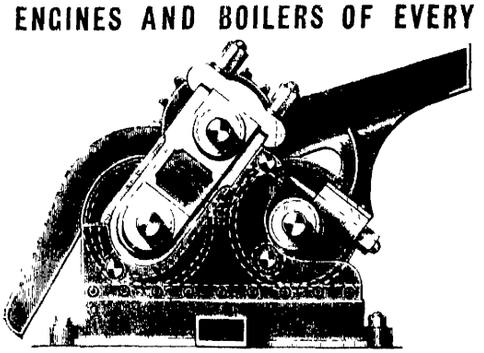
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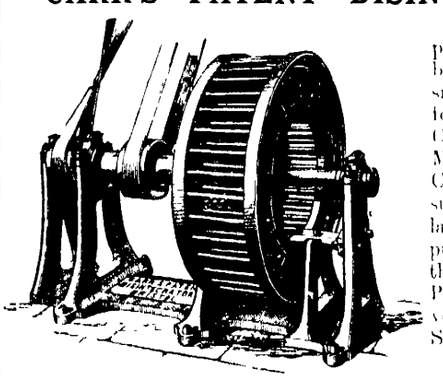
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A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee, 2523

PHILIP TRIGGS, Albion Chambers, BRISTOL.

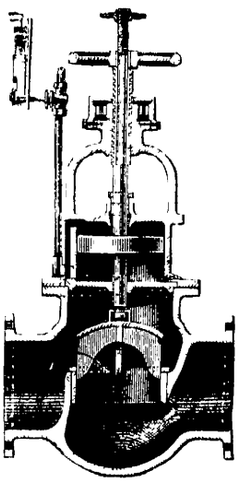
TATE'S PATENT

Electric Valve-Closing Apparatus

FOR STEAM ENGINES.

Medals Awarded AT THE INDUSTRIAL EXHIBITION, BRADFORD, 1882.

INTERNATIONAL FISHERIES EXHIBITION, LONDON, 1883.



THIS *APPARATUS* IS LARGELY USED ON STATIONARY ENGINES WITH THE GREATEST SUCCESS.

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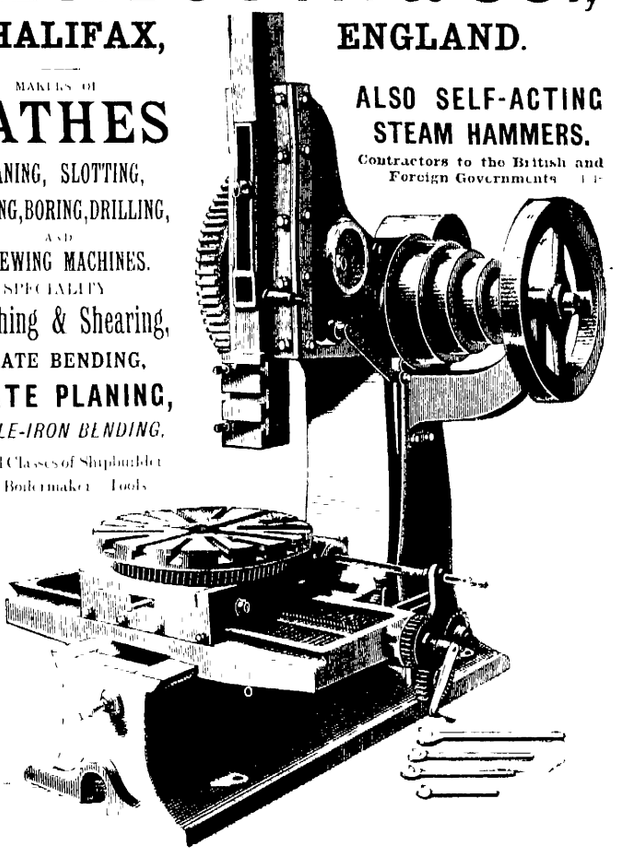
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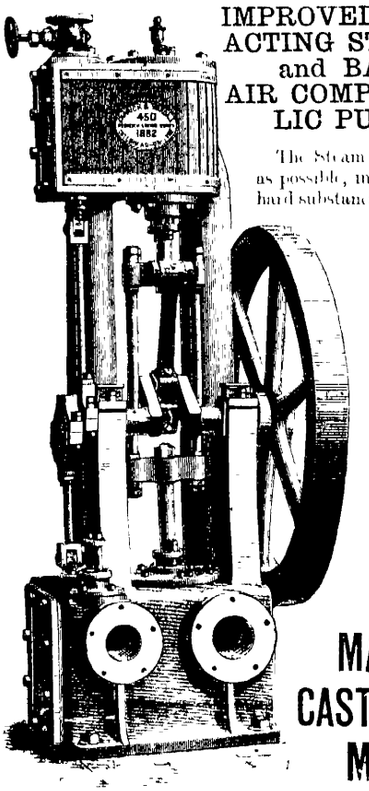
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(See Illustrated Advertisement September 17th, page 7.)

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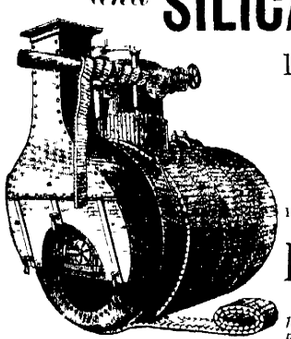


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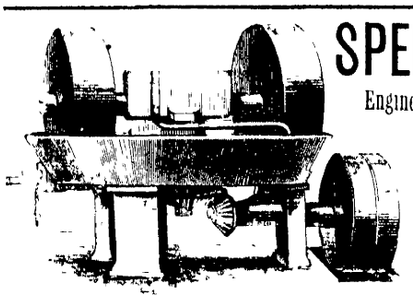
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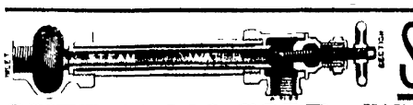
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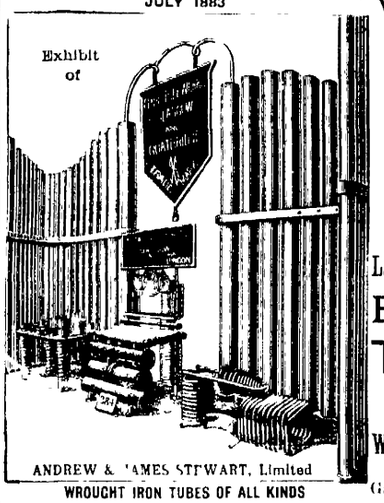
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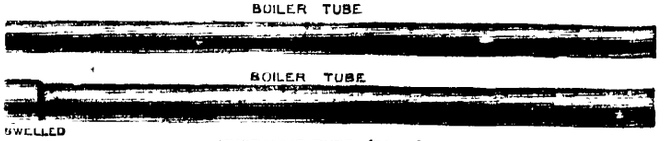
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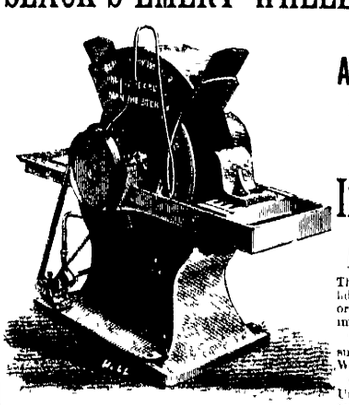
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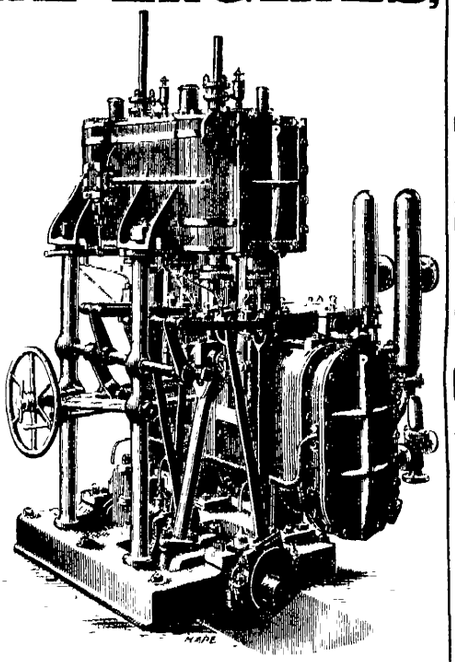
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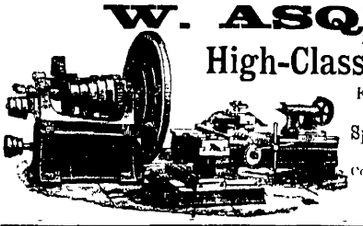
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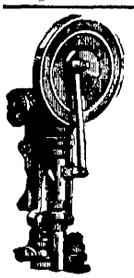


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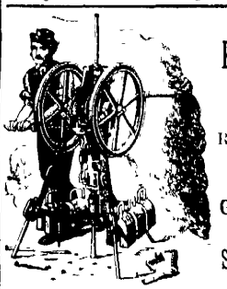
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4212

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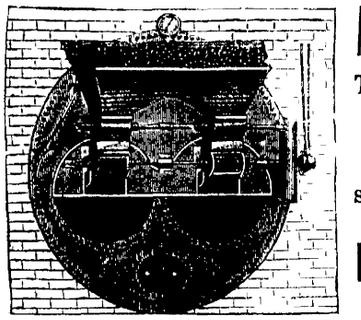
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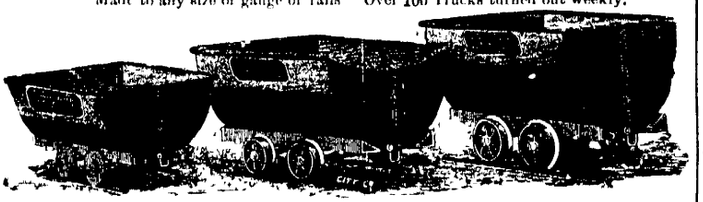
R. B. LINDSAY & Co., Plantation Quay (West), GLASGOW.

JOHN OAKEY & SONS,

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EMERY CLOTH, Philadelphia, 1876.
Wellington Mills, GLASS PAPER, 5206
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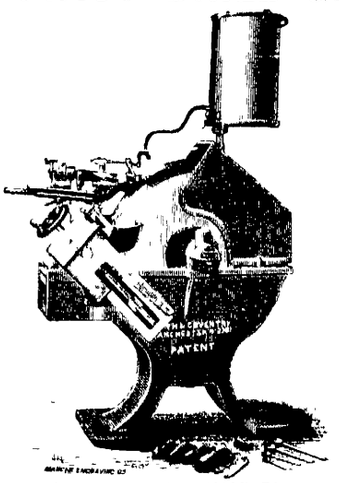
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PATENT TWIST DRILL GRINDER.

THE ONLY PERFECT MACHINE FOR GRINDING TWIST DRILLS

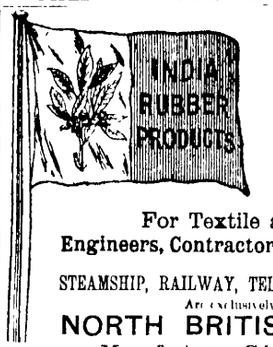


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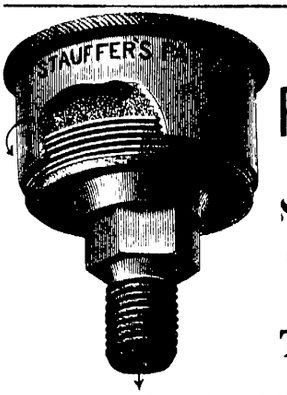
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PRICE LISTS ON APPLICATION

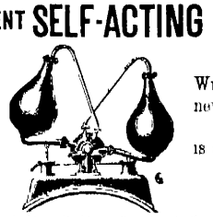


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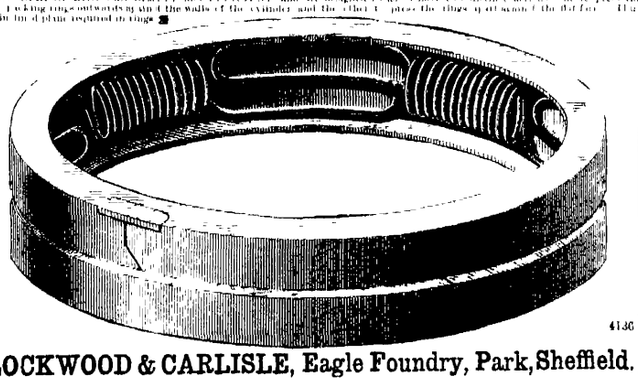
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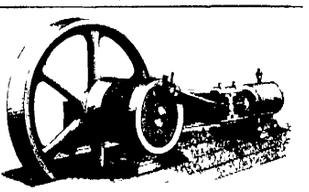
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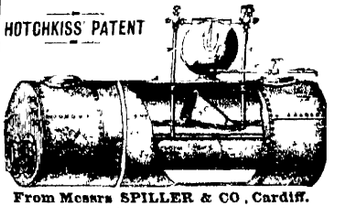
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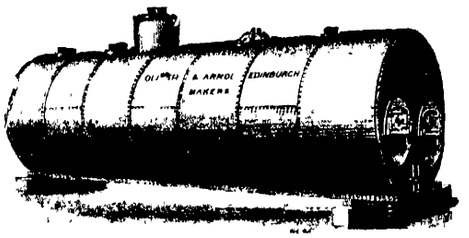
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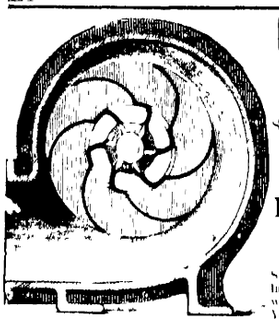


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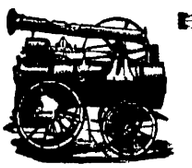
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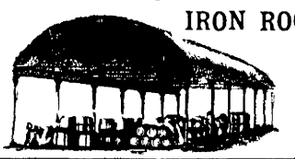
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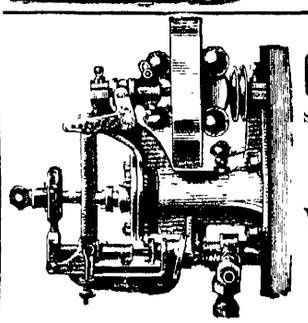
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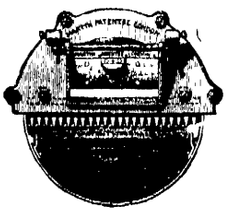
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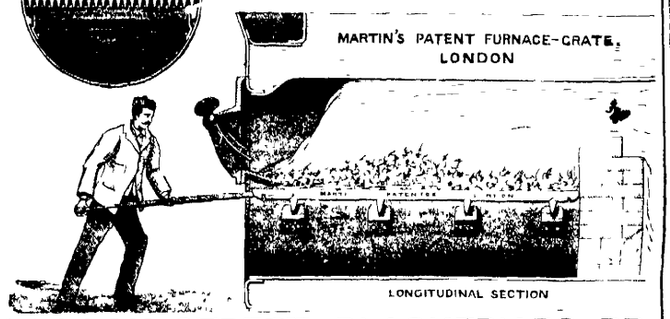
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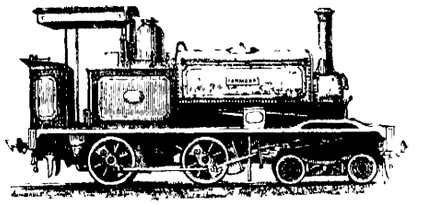


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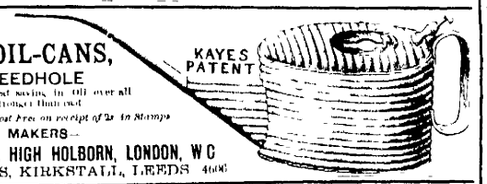
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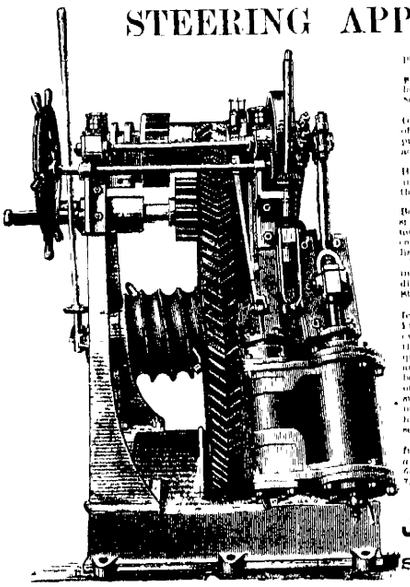
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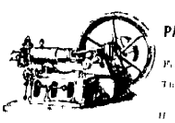
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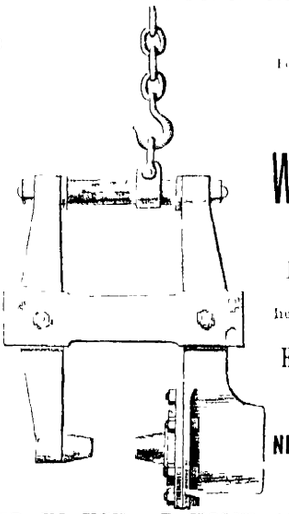
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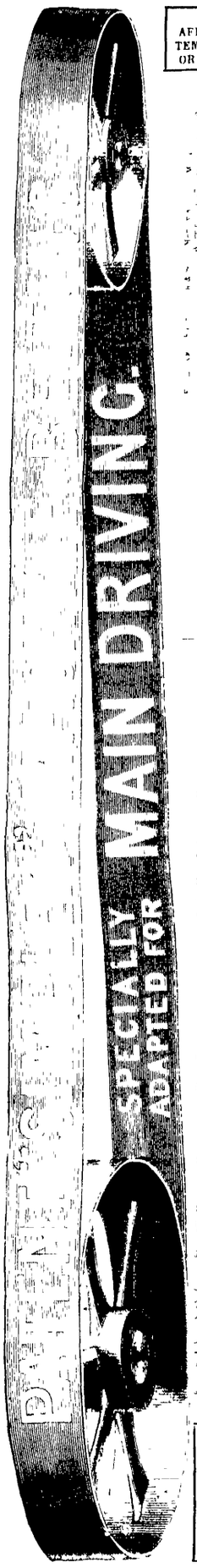
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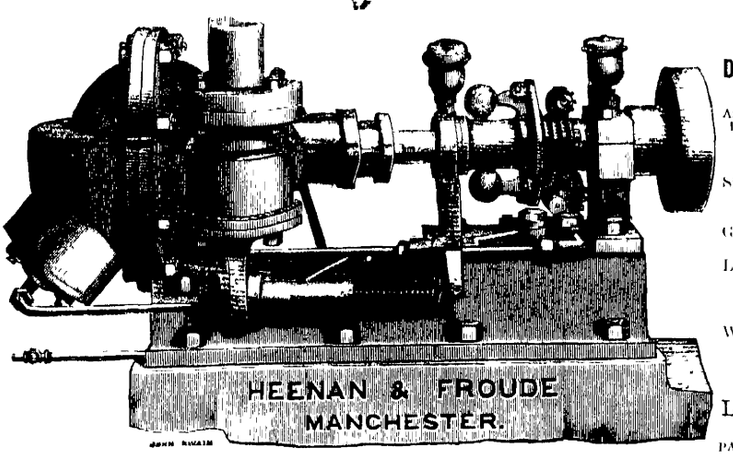
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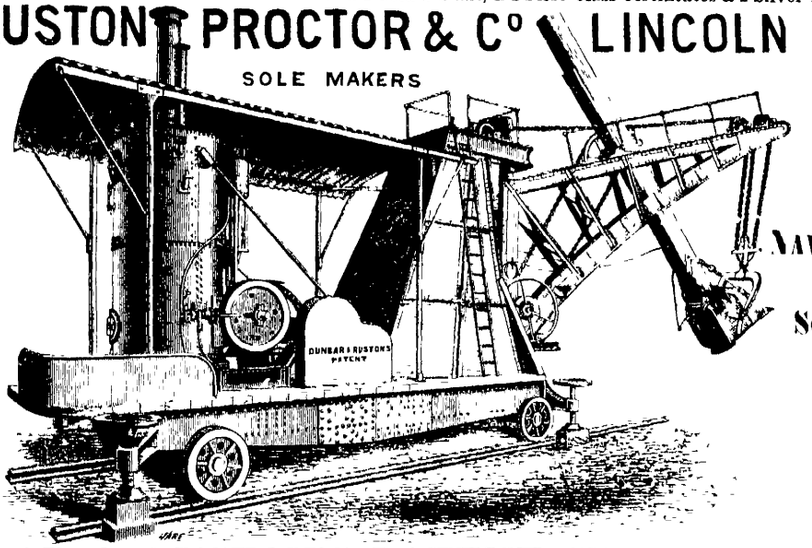
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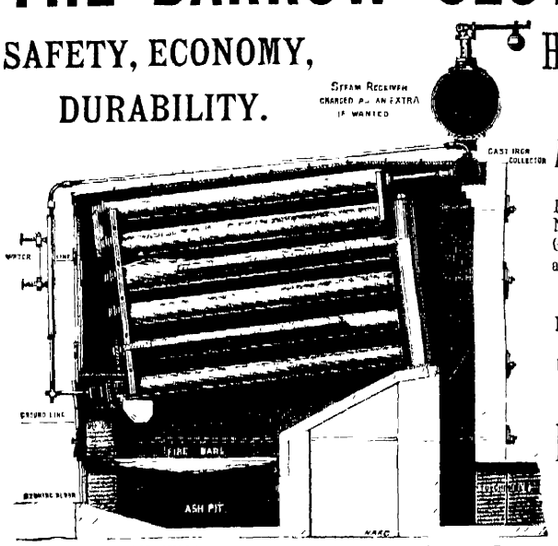
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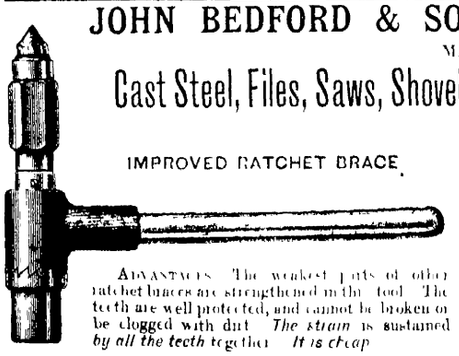
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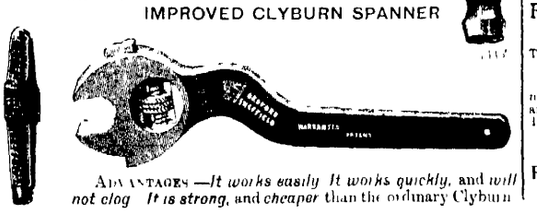
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ADVANTAGES.—*It works easily. It works quickly,* and *will not clog. It is strong,* and *cheaper* than the ordinary Clyburn.

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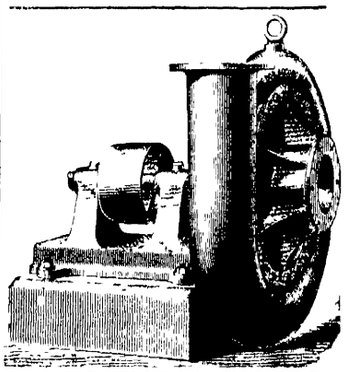
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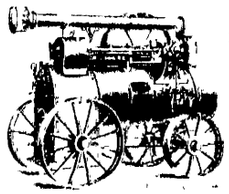
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Simple Cylinder, 4 to 12 HP nominal
Double 8 to 30 HP

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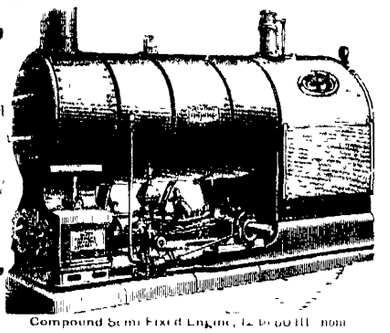
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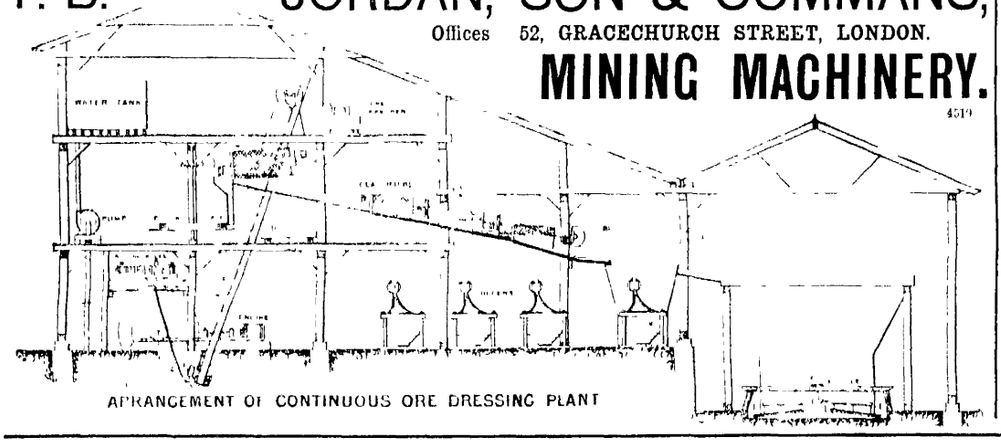
Compound Semi Fixed Engine, 12 to 60 HP nom

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AN Advertisement having been inserted in sundry papers by Messrs. F. REDDAWAY & Co., setting forth that Mr. GANDY has been ordered to pay their costs, about £5,000, in reference to the action brought by him against them, Mr. GANDY Gives Notice that as yet no costs have been paid to Messrs. F. REDDAWAY & Co. by him, that the decision referred to is now under Appeal, and that the amount of costs named is grossly exaggerated, and it is premature to say by whom the costs will ultimately have to be paid

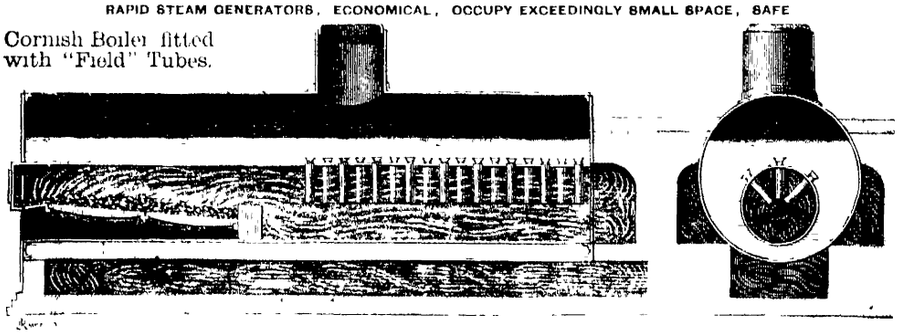
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Cornish Boiler fitted with "Field" Tubes.



TESTIMONIALS.

INFANT ORPHAN ASYLUM, WANSTEAD, March 3rd, 1884

GENTLEMEN,—I have pleasure in reporting that the "Field" Patent Tubes which you inserted in our Cornish Boilers give every satisfaction. Our coal consumption in each of these boilers was 6½ tons per week, and we had difficulty in keeping steam before the Tubes were inserted. We now have plenty of steam and our coal consumption is 4 tons per week, and the results have been altogether so satisfactory that we are preparing a third boiler to be fitted.—I am, Gentlemen, yours truly, (Signed) R. J. HAMMOND, Engineer

We have just received the following testimonial from a customer in Cirencester:

GENTLEMEN,—I have fixed the 2½ in. Field Tubes I received from you in my boiler, and they are acting splendidly. I reckon they save me at least 15 per cent. of fuel.—Yours faithfully,

(Signed) J. McLEOD,
Caledonian Iron Foundry

FIELD'S PATENT TUBES.

Easily fitted in Cornish, Locomotive, Cross Tube and other Boilers.

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PORTABLE SECTIONAL BOILER

CONSTRUCTED BY THE SANDYCROFT FOUNDRY AND ENGINEERING COMPANY, SANDYCROFT

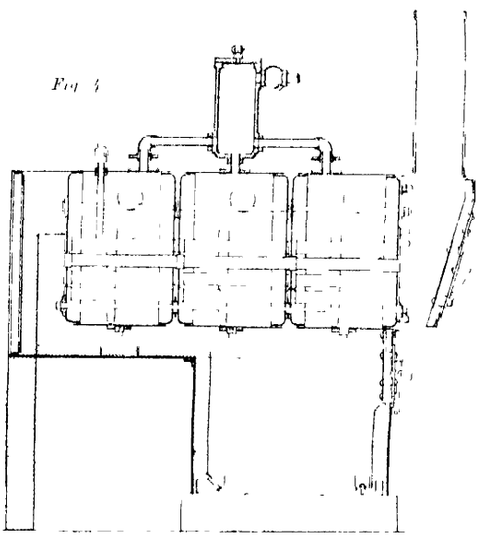
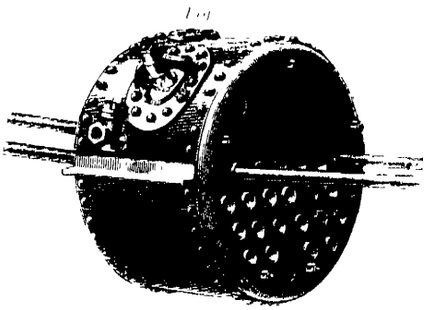


Fig 1



Fig

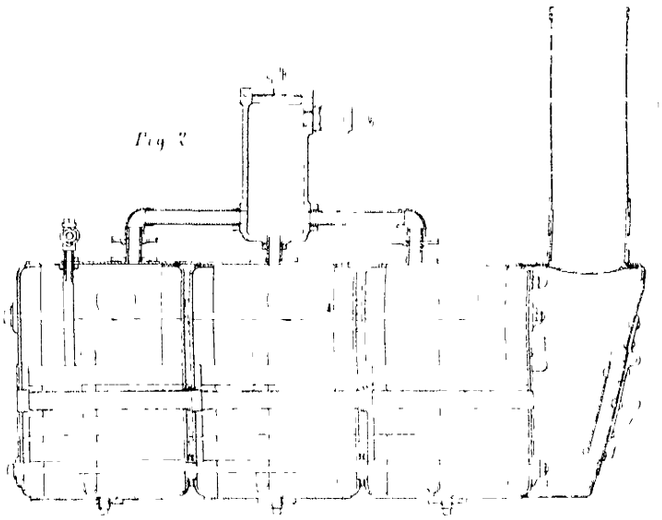
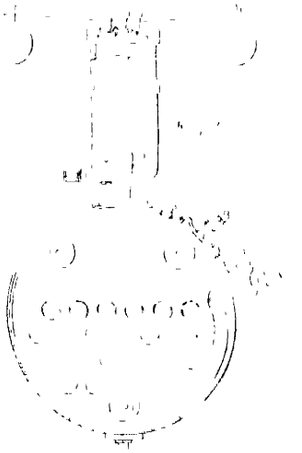


Fig 2



Fig

THE works of the Sandycroft Foundry and Engineering Company, established in the year 1837, are situated on the River Dee, about five miles from Chester, and close to the Sandycroft Station of the Chester and Holyhead Railway. In the ordinary course of events, an inspection of the shops, which will be thrown open next week to the members of the Iron and Steel Institute, should prove of considerable interest as the special branch of engineering here followed is the production of mining machinery. Perhaps, however, this statement requires modification, to some small extent, as the company turns its attention more particularly to the machinery used in the mining of the more precious metals rather than of iron. Unfortunately for the visitors, however, there is very little going on in the shops at present, the company having recently completed one or two large contracts, and others they have in hand are not fairly under way yet.

Starting at the erecting shop, near the offices, we notice two pairs of winding engines, which have been made specially to order for shipment to Venezuela, as they will have to go up country, where transport is very difficult. The cylinders are 20 in. in diameter and 3 ft. 6 in. stroke, and are fitted with automatic expansion valves. The bed frames are of wrought iron, in order to save weight. In this shop there are also the parts of a 100 in. cylinder beam engine, which the company has contracted to remove from the Talargoch Mine near Rhyl, to the Westminster Colliery near Wrexham. This shop is served by an overhead traveller and a pillar crane. From here we pass to the foundry, where the castings for a compound surface condensing marine engine for Belfast are in progress; the cylinders are 19 in. and 36 in. in diameter. Here also are castings in progress for a pair of pumping engines, having 36 in. cylinders, for the Madrid Water Works, and a Cornish pumping engine with 70 in. cylinders. There are also barrels for gold amalgamating machinery and special castings for other gold amalgamating machinery for Brazil. Five jib cranes command the whole floor, and there are four cupolæ. In the smithy there are two small steam hammers and one of Patterson's patent power hammers, which is a specialty of this firm, and to which we make more special reference later on. In the forge outside is a 2 ton Rigby hammer. The boiler shop has the usual tools, including a steam rivetting machine. This firm makes a special portable boiler, which we shall describe presently.

In the heavy machine shop are several large tools, amongst them a horizontal boring mill which will take work up to 100 in. in diameter, a face plate lathe that will turn 18 ft. in diameter, a planing machine that will take 40 ft. between the frames and has a bed 30 ft. long, and a screw cutting lathe with a 40 ft. bed and 12 in. centres, which has a duplex tool holder. In a second shop there are a number of somewhat lighter machine tools, including lathes, planing, slotting, and drilling machines &c. In the small machine shop on the floor above there are also several good tools. Amongst these we noticed two of Cooper's patent brass finishers, lathes by Smith and Coventry, a capstan headed hollow spindle lathe by the same makers, and a vertical milling machine. A second milling machine by Messrs. Smith and Coventry is also about to be erected.

In the fitting and erecting shop there are a 20 in. horizontal pumping engine in progress, an air compressing engine for an iron and steel company, and another to be used in connection with Shone's sewerage system. There are also in progress here some underground hauling engines for an ore stope with double drums of which we give an illustration on page 260. This type of machinery is also a special feature with the firm. The cylinders, it will be seen, are placed diagonally on each side of the crankshaft and work on to one crank pin. There are two clutch connecting clutches and two brakes, so

that either drum can be made to hoist or lower, independently of the other A single drum hauling engine of somewhat similar design, excepting that the cylinders are placed beside each other and the drum between, has also been recently brought out It is arranged so as to occupy as little space as possible, and can be used with compressed air or steam The drum can be thrown out of gear, and the load lowered under control of the brake without working the engine The starting and reversing handles and brake levers can be controlled by one man without moving from his position

There are also here an underground pumping engine and three or four of the new type of Patterson's patent dead blow forging hammer, of which we also give an illustration on page 265 The principal novelty in the arrangement consists in placing the semicircular cast steel bow, shown in the illustration, between the crank-pin and the tup, and at each end of this are trunnions for carrying strong spiral springs In working the hammer the tup is snatched upward on the rising stroke, by the motion of the crank pin and in this way the springs are compressed, so that the additional force due to their reaction is given off during the downward stroke. In this way we are informed that a hammer with a 100 lb tup is equal in working power to a 1½ cwt. double-acting steam hammer The blow can be adjusted to any required force.

In this shop there were also several pairs of Patterson's patent Elephant stamps used principally in gold mining and intended to replace the lifter or gravitation stamps and grinding mills, in any situation where it is required, to pulverise hard materials In this the same principle is applied as that which we have just described with regard to the hammer the cast steel bow and springs being used in the same manner For special situations, in which means of transport are limited, they are arranged so that no piece weighs above 6 cwt, or in extreme cases, if needed, they can be made with a weight of 350 lb for the heaviest piece There are also several rock drills of the company's special make in this part of the works

In the same shop we also noticed one of Thorne's patent portable drills by Messrs. Smith and Coventry This drill has a balanced slide valve, the travel of which is reduced to the smallest amount in order to avoid momentum of the port as much as possible At the same time the valve is cushioned so as to prevent injury The ports also are short and direct, which tends towards the greatest efficiency of the amount of air used and gives but little back pressure

On page 264 we give an illustration of a Californian ten stamp mill for gold or silver ores They are fitted with an automatic feed arrangement, and reversible lifter shafts They have steel cams, tappets, and heads, and the shoes are constructed of specially hardened forged steel They are made as required in pieces of a size that can be carried by a mule On page 265 we also give an illustration of a small ten-stamp mill for hand power which is designed especially for prospecting work

It will be seen that the Sandycroft Company makes a special feature of "portability, and, considering the out-of the way places where mining machinery is required, this is a highly necessary feature to study We will give one more illustration of this company's manufacture On page 261 will be found illustrations of a patent sectional tubular boiler, Fig 1 being a perspective view of a complete section, and Figs 2 and 3 longitudinal and transverse sections of the boiler It will be seen that this boiler can be made in two three, or more sections, each one being to a certain extent a boiler in itself The sections are fastened together by tie-rods, and the tubes telescope into each other, making a tight fit, or at any rate one tight enough for all practical purposes, as where the tubes join there is of course no pressure When the sections are placed together, a suitable furnace is built under neath, as shown in Fig 4 The total weight of each section is 2½ cwt.

The company have a good dock on the River Dee, which will take vessels of considerable tonnage and which is served by a 20-ton crane

CANADIAN PACIFIC RAILWAY
No. XX
Concluding Article

The main line of the Canadian Pacific Railway by the figures given in the preceding papers, is 2906 miles, from Montreal to Port Moody, the principal places and divisions being as under

—	Miles from Montreal	Miles between	Miles from Winnipeg	Miles between
Montreal				
Ottawa	120			
Chalk River	196	246		
North Bay	118	364		
Sudbury Junction	80	444		
River Pic	268	726		
Nepigon	181	907		
Port Arthur	67	974		
Rat Portage	207	1201	207	
Winnipeg	198	1428	428	
Brandon	133	1556	633	133
Broadview	181	1687	699	264
Regina	92	1779	791	356
Moosejaw	43	1822	837	399
Swift Current	113	1935	950	511
Medicine Hat	149	2084	1099	660
Gleichen	125	2209	1214	785
Calgary	84	2293	1298	869
Stephens	131	2424	1429	960
Columbia River first crossing	75	2499	1504	1035
" second	64	2563	1568	1099
Savona's Ferry	131	2694	1699	1230
Ayston	71	2765	1770	1301
Yale	53	2777	1782	1334
Port Moody	91	2906	1874	1445

The lengths differ from the official distances given in the annual report of the Minister of Railways for 1883 by 25 miles, of which five are in the distance between Port Arthur and Winnepeg, corrected subsequently as an error, and twenty are in the estimated distance in the incomplete portion between Stephens and Savona's Ferry, the above figures being taken from Major Rodgers last report to the general manager of the railway, and probably correct The distance between Pic and Sudbury is an estimate, and changes may still be made before its completion. Besides the main line the company have acquired or constructed the following branches

			Miles
Brought forward			2906
Miles from Montreal			
From Ste. Therese	19 to	St. Eustache	8
	19	St. Jerome	14
St. Lin Junction	21	St. Lin	13
Hull	118	Aylmer	7
Carleton Place	149	Brockville	46
Smith Falls	167	Perth	12
Sudbury	444	Algoma Mills	98
Selkirk	1402	Colville Landing	2
St Boniface	1422	Emerson	66
Winnepeg	1423	Gretna	70
Pembina Junction	1479	Manitou	46
	1479	Emerson	15
Winnepeg	1423	West Selkirk	22
Junction	1425	Stonewall	20
			486

The company has acquired by lease or purchase

The Ontario and Quebec Railway, Perth to Toronto	199
The Credit Valley and branches, Toronto to St. Thomas	183
The Toronto Grey and Bruce Toronto to Owen Sound	192
The whole system at the beginning of 1884 comprising	3675

The Ontario and Quebec, Credit Valley, and the Perth branch from Smith's Falls, forming a through line from Smith's Falls through Toronto to St. Thomas, are now amalgamated as the Ontario and Quebec, and authority has been obtained to extend this at both ends so as to form a new railway from Montreal to Detroit (which is 564 miles by the Grand Trunk) somewhat shorter than the existing line This system, with the Toronto, Grey, and Bruce, which runs into it at Toronto, will be over 1000 miles in length apart from the Pacific line proper, described in the previous pages. The company control and have authority to construct at least the same mileage to the east of Montreal, giving them access through the province of New Brunswick to the ports of St Andrews, St. John, Halifax, and Louisbourg, the last the nearest American port to Europe, and only 2200 miles from Liverpool. The Canadian Pacific will thus have, when complete, a main trunk line 3632 miles long from Louisbourg on the Atlantic in longitude 59 deg 57 min, to Port Moody on the Pacific in longitude 122 deg, covering altogether 62 deg of longitude.

The control of the trade of the East has been coveted by all commercial nations from the earliest antiquity, and the grandest cities of both ancient and modern times have derived their riches and importance principally from their connection with this eastern traffic They rose and became wealthy and prosperous when the Oriental trade passed through their marts, and they declined when this was diverted into another channel. The history of Tyre and Sidon, of the Greeks and Romans, of Genoa and Venice, of the Portuguese, Dutch, and English, all proves this. When the trade of the Orient was attracted to the Persian Gulf, the Euphrates Valley, and the Syrian Desert, Tadmor in the wilderness arose and flourished like a hopeful flower, and, surrounded by powerful opponents, maintained its prosperity as long as it maintained its trade When this was subsequently diverted from the Persian to the Arabian Gulf, Bozrah and Palmyra went down and Petra arose as the medium of supplying Europe with eastern merchandise. Alexander the Great had no sooner obtained a footing in India and crushed the Tyrians, the then eastern merchants and carriers, than he opened a communication between his new conquest and his western possessions, and brought the commerce of India through the Red Sea and the Nile Valley to the great city which he built at the western outlet of the river, and which perpetuates the name of the sagacious author of a new route for commerce more than the military commander, but only on the destruction of the former avenues of trade The success of Alexandria, quite as much as the arms of its founder, was the cause of the ultimate decay of Tyre, Palmyra, and Petra. Antiochus the Great, Tamerlane, and even Mahomet, all sought to enrich their kingdoms by securing the Oriental commerce The transactions of the fairs of Mecca were at one time the largest in the world, and the Arabians, from being barbarian hordes, became the carriers between China and Europe. Trade then flowed from the East to Constantinople, and new life was infused into the capital of Western Europe. Venice, Genoa, Florence, and Bruges followed, then Antwerp and Lisbon, and last, London, have all in turn risen to various degrees of wealth and importance whilst they led the eastern business, and have declined in the same proportion when they lost it Should the time ever come when England ceases to be the merchant and banker and carrier for the Oriental commerce, the entrepôt for the receipt, storage, and distribution of its productions, she, too, will suffer in her turn an important, perhaps irrevocable, loss in her prestige, her wealth, and her position

The discovery of a path to India by the Cape of Good Hope led to a revolution in the course of trade, and the golden tide swept for a time the shores of Portugal Then came the discovery of America, and the hope that across or around the extremities of this, the shortest and best way to Cathay and the Indies might be found, started a new career of exploration and adventure. This was the impulse that fitted out almost every expedition in the earlier periods of American exploration, and the futile attempts that have been continued almost to the present time to find the north west passage through the Arctic Ocean have had the eastern abuses of India for their ultimate aim and hope In 1851, when Maclure passed through the portals of the icy sea, it has been well said he closed the gates for ever behind him For a century before this the English acquisitions in India, her political and commercial supremacy in the East, and the gradual absorption of this business into English channels, were bringing the trade of the East extensively under British control, whilst the rapid extension and development of steam navigation were more firmly rivetting together the connections between England and the East. For a moment the construction of the Suez Canal served to bring the French interests into competition, but France failed to profit by the advantages, and the Suez Canal became another lever in the hands of England to help forward the development of the Oriental carrying trade The Union and Central Pacific Railways in America next put in a feeble claim for this eastern business, but their position for want of an efficient steam marine in connection has never been taken advantage of, and beyond the local consumption of the States themselves there has been no real diversion of the Indian carrying trade from the Mediterranean and the Suez Canal With the accumulated experience of all this before her, Canada now puts forward her claims, and by virtue of this new route and possible improvements still to be made, proposes to enter into competition as the best, shortest, cheapest, and most effective route yet opened from England to the teeming millions of Asia. However mistaken may have been the means employed by previous competitors to secure the shortest and best route, they were not wrong in the importance of the prize they sought to possess, and whoever can secure the most satisfactory route between the East and West must become master of a trade that has ever enriched all who have embarked in it, and been able to control its avenues,

The distance between Southampton, England, and Yokohama, Japan, by vessel round the Cape of Good Hope is 17,396 miles, and occupies 36 days. By Panama it is 12,710 miles, and occupies 56 days. By the overland route, Malta, Suez Canal, and Madras, it is 11,396 miles, and takes 65 days. By New York, San Francisco, and the Central Pacific Railway the distance is 11,159 miles, but the time is only half, 29 days, whilst by the Canadian Pacific it is 10,054 miles, and this trip will occupy 28 days. The two railway routes are made up as under:

	Miles.	Days.
Yokohama to San Francisco	4,731	15
San Francisco to New York ..	3,328	7
New York to Liverpool	3,053	10
	11,159	32
Yokohama to Burrard's Inlet .	4,396	14
Burrard's Inlet to Montreal ..	2,828	4½
Montreal to Liverpool	2,830	9½
	10,054	28

When, in addition to the saving of distance across the continent of nearly 500 miles, the remarkable engineering advantages on the Canadian Pacific, its lower summits, better gradients and easier curves, are contrasted with the inferior characteristics of the central route, it must be evident that the economical advantages of the northern route must confer on this line the essential elements of successful competition. Then, as regards the Pacific Ocean, the difference in mileage as taken from the charts, something under 400 miles, gives a very imperfect notion of the real saving in time and work, which is practically more than double the apparent gain in distance. In reference to this point, Professor Maury, of the United States, says, "The trade winds and the ocean currents place Vancouver Island on the wayside from China and Japan to San Francisco so completely that a vessel under canvas to the latter place would take the same route as if she were bound to the island, so that all return cargoes would naturally come there in order to save two or three weeks' time beside risk and expenses." This makes the advantage equal to the distance from Vancouver to San Francisco over 730 miles, and in addition to this the ocean currents sweep round from Japan to Vancouver in such a way that even a steamer could make a quicker trip by hugging Vancouver's Island than if she were to steer to San Francisco direct.

The Hon. W. H. Seward, late Secretary of State at Washington, one of the ablest politicians of his day, and by no means inclined to depreciate the position of the United States, endorses these views: "The route," said he, in a speech made in Washington, "through British America, is in some respects preferable to that through our own territory. By the former the distance from Europe to Asia is some thousand miles shorter than by the latter. Passing close to Lake Superior, traversing the watershed which divides the streams flowing towards the Arctic from those which have their exit to the south, crossing the Rocky Mountains at an elevation of over 3000 ft. less than at the South Pass, the road can be here constructed with comparative cheapness, and would open up a region abounding in timber and minerals, and admirably suited for grain growing and grazing. Having its Atlantic seaboard close to the coal mines of Nova Scotia, and its Pacific terminus in close proximity to the mineral deposits of Vancouver's Island, it would undoubtedly draw to it the commerce of Europe and Asia. Thus British America, from being a mere colonial dependency, would assume a controlling rank amongst the nations of the world; to her, other countries would be tributary, and in vain would the United States attempt to be her rival, for she never could compete for the Asiatic commerce nor the power which that commerce must confer." One of the most important considerations in the direction of the commerce of the future, in these days of steam, is the possession of economical deposits of coal. Sir Charles Dilke, in his "Greater Britain," puts this in a forcible way. "The position of the various stores of coal on the Pacific is of extreme importance as an index to the future distribution of power in that portion of the world, but it is not enough to know where coal is to be found, without looking also to the quantity, quality, cheapness of labour, and facility of transport. In China and Borneo there are extensive coalfields, but they lie the wrong way for the trade; on the other hand California and Oregon have plenty of coal, but it is of a very poor quality. Tasmania has good coal, but it is in no great quantity. The three countries of the Pacific which must rise to manufacturing greatness, are Japan, Vancouver's Island, and New South Wales. The future of the Pacific shores is inevitably brilliant, and Japan and Vancouver, jutting out from Asia and America as England juts out from Europe, will occupy the position that England has taken upon the Atlantic." The coalfields at either end of the Canadian Pacific are a distinctive feature, and peculiarly important as establishing this as the future highway between England and her distant dependencies in the Pacific and Indian Oceans. Where time and the passenger business is the main object, experience points out that railway termini in connection with ocean steamers want to be as nearly as possible where the first land is seen after crossing the ocean. For freight, perhaps, it is something different, and ocean steamers may profitably thread their way along the coast and through narrow channels to deposit their cargoes far inland. Montreal, nearly 1000 miles from the mouth of the St. Lawrence, is admirably adapted for a freight depôt, and there is an important economy in a vessel delivering her cargo and reloading at this point, but few passengers care to remain on board to Montreal, and the mails she has brought across the Atlantic have passed through Montreal two or three days before the vessel could get there. The Canadian route, even in midsummer, wants a good port 400 or 500 miles east of Montreal, as the point where the passengers should disembark (the mails are now taken off at Father Point, 350 miles east of Montreal). The port of Halifax in winter involves again too long a run along a dangerous coast which the vessel approaches very obliquely, and consequently where any error in reckoning is most likely to lead to disaster. The old French capital Louisbourg is now being reorganised as the proper ocean terminus for both winter and summer work, where the transference from the steamer to the railway can most easily be made. Louisbourg is 750 miles due east from Montreal, and about the same in geographic miles to New York, it is 180 miles east of Halifax, and about 2250 sea miles from Liverpool. It is not over 50 miles out of the direct course of a vessel from that port bound either to New York or Montreal, and is the natural shipping port of nearly all of the Cape Breton collieries that are now working, and where the coal could be put on board a vessel at 2 dols. per ton less than the same or any coal of equal quality could be bunkered either at New York or Montreal. On this economical point alone, it would pay for a vessel to coal at Louisbourg even if bound further west, and with no cargo to take or leave there. The average ocean steamers now making with passengers an average of ten trips per week in each direction across the Atlantic, could run regularly from Louisbourg to Liverpool within seven days. The substitution of the railway for even the best of these steamers would save a full day in the time of any passenger reaching his home at New York or any point west of it; nor is the first-class fare on the railway per mile for through tickets any more than the fare per mile on a first-class steamer, so that the saving in time has no drawback on the score of expense.

From Louisbourg and Pictou no more really good steam coal suitable for ocean steaming is found, on either route across the continent, until the Pacific is reached, and then only in proximity to the western terminus of the Canadian route. No other route across the wide space that separates England from her eastern possessions is so favourably situated. A kind Providence seems to have placed these vast stores just where they are most required, as if to furnish the means of each of the ocean termini to abridge that distance and economise its operating expenses as far as possible. The Cape Breton coalfield is at the nearest available seaport to "home," and the only coal on the Atlantic washed by its waters. In broad bands like black ribbons along its wave-washed shores, aggregating 150 ft. in thickness, it lays in lavish profusion, ready to be taken away at the minimum of expense. In almost similarly favourable position, equally good, and perhaps in still greater abundance, the Vancouver mines face the western terminus of the railway where the steamers in loading at the colliery wharves would pass over the heads of the miners safely working below the waters of the bay.

On the other side of the Pacific, the only other great maritime deposit is the Newcastle coal of New South Wales. Like the other two it is practically inexhaustible, and crops out upon the sea shore. Excepting the Japan coal in all the wide extent of the Pacific Ocean, there is only one small spot that seems likely to come into competition with the Vancouver or New South Wales coal for steam purposes, and this is the island of Labuan. It is only a speck upon the waters, but it contains a vast store of combustibles, and singularly enough it is on the route of our steamers forward from Japan, and belongs to Great Britain.

Now go from England to the East the other way. All down the coast to Gibraltar, along the Mediterranean by Malta, Alexandria, and the Red Sea to Aden, and along the shores of Asia, you will see no coal but English brought to the coaling stations at great expense, and as far as you go there will be no coal put upon your steamer till the Australian coal meets the English and carries you forward on your route. This coal question, and the favourable way in which it is disposed for the requirements of our commerce, is one of those immense factors in the future commercial and naval supremacy of the power of Great Britain that has not yet received the attention that it merits.

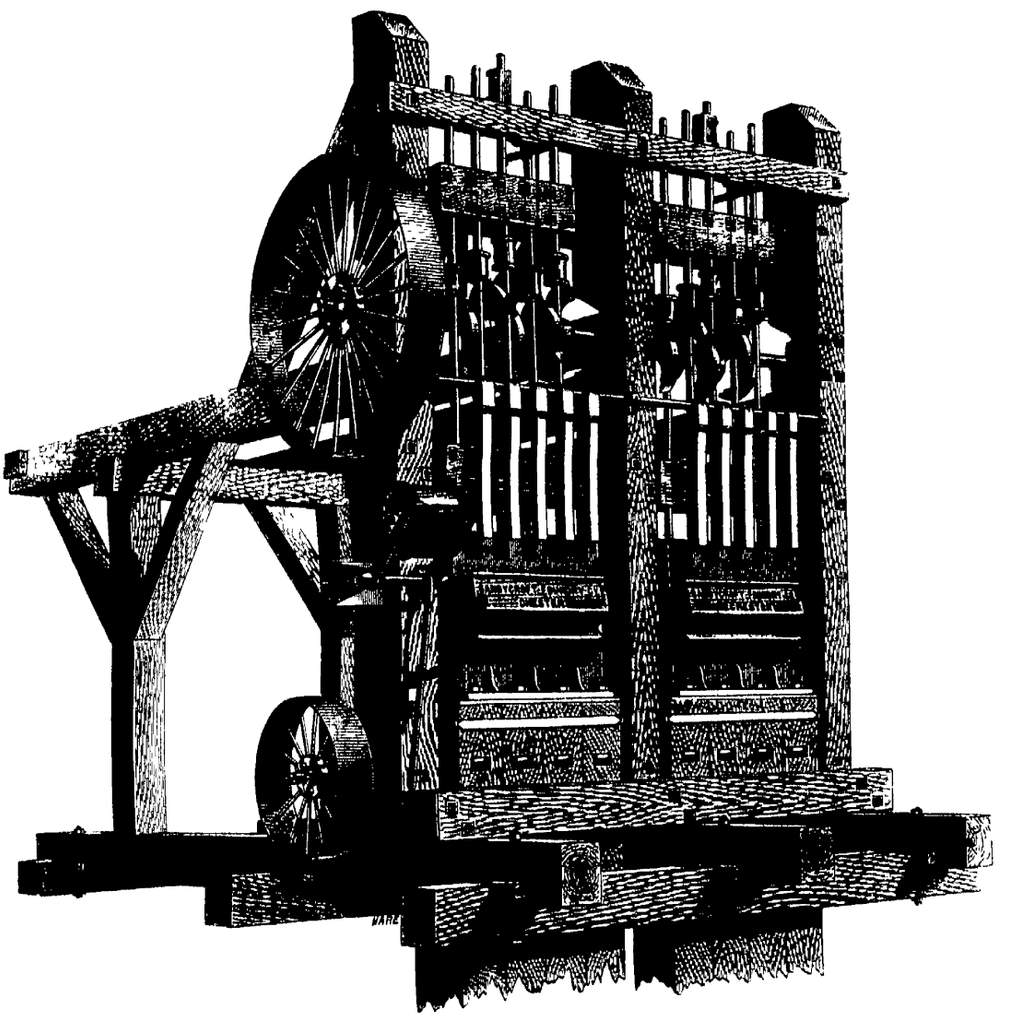
Away off in the South Pacific, almost at the antipodes, England has another dependency that next to Canada has the greatest claim upon her sympathies. Nearly as large in area as Canada or the United States, and as large as Europe, exclusive of the part north of the Arctic Circle, Australia and the allied islands have already a population, wealth, and resources of which they may well feel proud. From Southampton to Melbourne by the Cape of Good Hope is 11,720 miles, occupying sixty days; by Cape Horn it is 13,200 miles, and takes sixty-six days. By the Suez Canal and the Peninsular and Oriental steamers the distance is only 11,315, but it occupies fifty-four days. By New York and San Francisco the distance is over 13,000 miles, but the time is only forty-one days, whilst through Canada the distance will be less, and the time, taking the same speeds as now required on the land and water, will be under thirty-eight days. The ocean distance from Port Moody and San Francisco is about the same, and from either point less than from Panama, so that, when the Panama Canal is completed, either of the Pacific routes will be able successfully to compete in time, whilst the difference in distance is not much in favour of the tropical route across the isthmus.

There is another view to take of this new transcontinental railway, and that is its political position in case of such a war as England is not unlikely some day to be involved in. One other great European power has a territory bordering on the Pacific, and may some day wish to dispute with England the supremacy of that ocean. In 1851 Russia reached the Amoor River, and established an armed fortress on its waters, the St. Lawrence of Asia, and 2300 miles from its mouth built gunboats at this establishment, and with their assistance gradually, except down the long river, secured the military possession of the lands on either side, and ultimately established a dockyard at its mouth on the Pacific Ocean. Finding this to be blocked with ice in the winter, she subsequently acquired the island of Saghalien in the same latitude as Vancouver Island, and the open sea only between them, and to this point she has removed her naval establishment and strengthened her capacity for carrying on offensive warfare. She has got there also a large deposit of coal, perhaps not so good, but quite as easily worked, as our Vancouver mines. She has connected this distant establishment by telegraph with the St. Petersburg War Office, and her railway system is by degrees being pushed forward to the same destination. She is already in a better position than she was during the last war for carrying on a Pacific campaign and keeping upon the ocean a strong naval force, and whenever the two nations are again embroiled, this Pacific Railway will be one of the most important factors in preserving the communication between England and her fleet on the Pacific. One of the most important elements of security for a country in time of war is the capacity and capabilities of her harbours. On the whole extent of the Pacific coast north of the equator there is a singular dearth of good harbours until British Columbia is reached. Excepting San Francisco, nearly all of them are too shallow for a large man-of-war, and most of them are so encumbered with reefs and shoals as to be excessively dangerous to approach, and to offer a very poor protection excepting to vessels of small size and little draught of water. Even to the

CALIFORNIAN TEN-STAMP MILL.

CONSTRUCTED BY THE SANDYCROFT FOUNDRY AND ENGINEERING COMPANY, SANDYCROFT

(*For Description, see Page* 261.)



north of San Francisco there is no good harbour of refuge or available roadstead for a fleet till the international boundary is reached British Columbia, on the contrary, presents a marvellous feature in this respect, and as a distinguished naval officer expressed it, seems to revel in the possession of excellent ports and harbours, and all of them available for vessels of any size, and accessible at all times and nearly in all weathers In a speech delivered by Lord Dufferin in Victoria in 1876, he felicitously pointed out the peculiarity of the sea shore "Such a spectacle as this coast line presents is not to be paralleled by any country in the world Day after day for a whole week in a vessel of 2000 tons we threaded an interminable labyrinth of watery lanes and reaches that wound endlessly in and out of a network of islands, promontories, and peninsulas for thousands of miles, unruffled by the slightest swell from the adjoining ocean, and presenting at every turn an ever-shifting combination of rock, forest, and snowclad mountain of unrivalled beauty and grandeur When it is remembered that this wonderful system of navigation, equally available for the largest line-of battle ship and the frailest canoe, fringes the entire seaboard of your province, and communicates at points sometimes more than a hundred miles from the coast, with a multitude of valleys stretching eastward into the interior, whilst at the same time it is furnished with innumerable harbours, one is lost in admiration at the facilities for intercommunication which are thus provided for the future inhabitants of this wonderful region."

Such is a brief and imperfect description of the new route across the American continent now in the possession of Canada, which will shortly be opened to the traffic of the world In two respects it differs from and aims higher than any enterprise of similar character that has yet been organised, and carried to completion In the first place, it opens up to the population, development, and national existence a vast region of productive land utterly isolated and useless without it, a great farm so hidden away behind huge mountain ranges that nothing less than this great enterprise could open up a district where 100,000,000 people may find profitable employment, happy homes, and material prosperity On the other hand, it completes and fulfils the prophecy of ages, links together the old world from which the people of the new hemisphere have nearly all sprung, to that still older world the cradle of the race, places the keystone of civilisation and commerce in the great arch of the bridge that links Europe with Asia, and carries out the old idea of a north-west passage to the Pacific, whilst it wonderfully improves its value by substituting the pleasant wheatfields of Manitoba, and the grazing lands of Alberta for the frozen solitudes of the northern ocean and the dangerous discomforts of an Arctic voyage

THE FLOW OF WATER THROUGH TURBINES

On the Flow of Water through Turbines *

By ARTHUR RIGG, President of the Society of Engineers, London.

LITERATURE relating to turbines probably stands unrivalled among all that concerns questions of hydraulic engineering, not so much in its voluminous character as in the extent to which purely theoretical writers have ignored facts, or practical writers have relied upon empirical rules rather than upon any sound theory

In relation to this view, it may suffice to note that theoretical deductions have frequently been based upon a generalisation that "Streams of water must enter the buckets of a turbine without shock, and leave them without velocity." Both these assumed conditions are misleading, and it is now well known that in every good turbine both are carefully disobeyed. So called practical writers, as a rule, fail to give much useful information, and their task seems rather in praise of one description above another.

But, generally, it is of no consequence whatever how a stream of water may be led through the buckets of any form of turbine, so long as its velocity gradually becomes reduced to the smallest amount that will carry it freely clear of the machine The character of theoretical information imparted by some of these writers may be illustrated by a quotation from *The Chicago Journal of Commerce*, dated the 20th of February, 1884. There we are informed that "The height of the fall is one of the most important considerations, as the same stream of water will furnish five times the power at 10 ft. that it will at 5 ft. fall." By general consent, twice two are four, but it has been reserved for this imaginative writer to make the useful discovery that sometimes twice two are ten

Not until after the translation of Captain Morris's work on "Turbines," by Mr. E Morris, in 1844, was attention in America directed to the advantages which these motors possessed over the gravity wheels then in general use A duty of 75 per cent. was then obtained, and a further study of the subject by a most acute and practical engineer, Mr. Boyden, led to various improvements upon Mr. Fauneyron's model, by which his experiments indicated the high duty of 88 per cent. The most conspicuous addition made by Mr. Boyden was the "Diffuser." This ingenious contrivance had the effect of transforming part of whatever velocity remained in the stream after passing out of a turbine, into an atmospheric pressure by which the corresponding lost head became effective, and added about 3 per cent to the duty obtained.

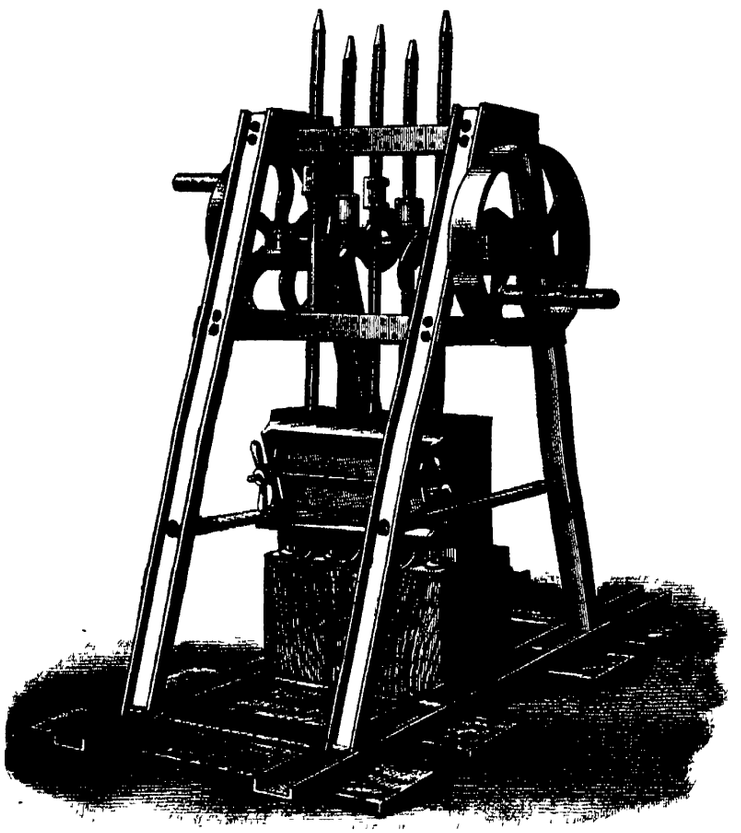
It may be worth noticing that by an accidental application of these principles to some inward flow turbines there

* Paper read before the British Association at Mon

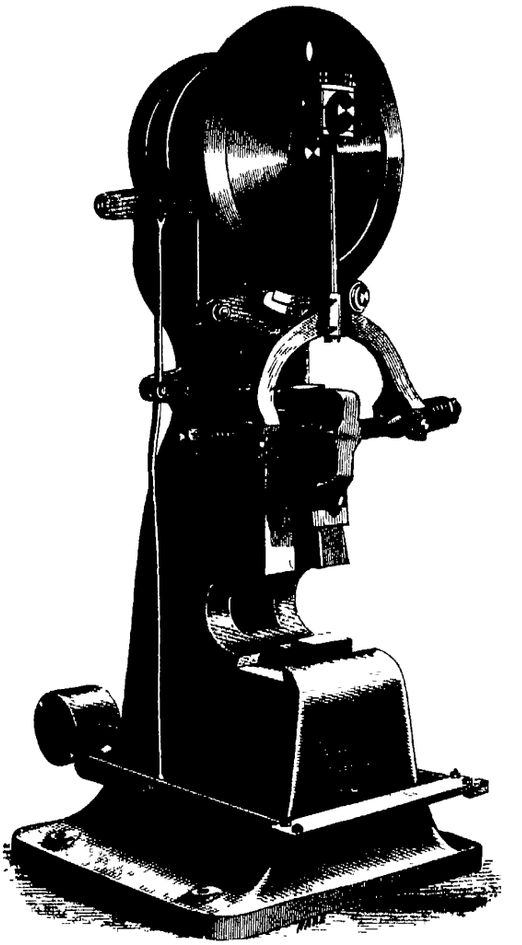
FORGING HAMMER AND MINING MACHINERY.

CONSTRUCTED BY THE SANDYCROFT FOUNDRY AND ENGINEERING COMPANY, SANDYCROFT.

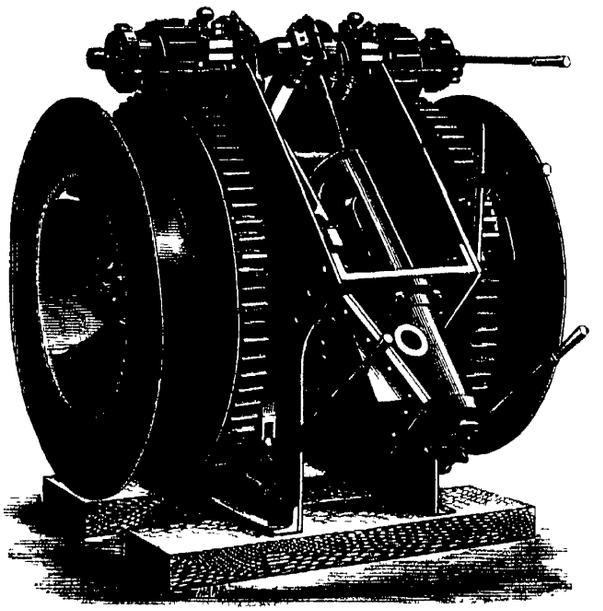
(*For Description, see Page* 261).



CALIFORNIAN TEN-STAMP MILL FOR HAND POWER.



PATTERSON'S DEAD-BLOW FORGING HAMMER.



UNDERGROUND HAULING ENGINE WITH DOUBLE DRUMS.

obtained most, if not all, of whatever advantage they are supposed to possess, but, oddly enough, this genuine advantage is never mentioned by any of the writers who are interested in their introduction or sale

The well-known experiments of Mr James B. Francis, in 1857, and his elaborate report, gave to hydraulic engineers a vast store of useful data, and since that period much progress has been made in the construction of turbines, and literature on the subject has become very complete.

In the limits of a short paper, it is impossible to do justice to more than one aspect of considerations relating to turbines, and it is now proposed to bring before the Mechanical Section of the British Association some conclusions drawn from the behaviour of jets of water discharged under pressure, more particularly in the hope that as water power is extremely abundant in Canada, any remarks relating to the subject may not fail to prove interesting to the present meeting.

Between the action of turbines and that of screw propellers exists an exact parallelism, although in one case water imparts motion to the buckets of a turbine, while in the other case blades of a screw give spiral movement to a column of water given aft from the vessel it propels ward Turbines have been driven sometimes by impulse alone, sometimes by reaction alone, though generally a combination of impact and reaction, and it is by the named system that the best results are now known to obtained

he ordinary paddles of a steamer impel a mass of r horizontally backwards by impact alone, but screw propellers use reaction somewhat disguised and only to a limited extent

The full use and advantages of reaction for screw propellers were not generally known until after the publication of papers by the present writer in the Proceedings of the Institution of Naval Architects for 1867 and 1868, and more fully in the Transactions of the Society of Engineers for 1868

Since that time, by the author of the investigations then described by the English Admiralty and by private firms, further experiments have been carried out, some on a considerable scale, and all corroborative of the results published in 1868 But nothing further has been done in utilising these discoveries until the recent exigencies of modern naval warfare have led foreign nations to place a high value upon speed Some makers of torpedo boats have thus been induced to slacken the trammels of an older theory, and to apply a somewhat incomplete form of the author's reaction propeller for gaining some portion of the notable performance of these hornets of the deep, just as in turbines, a combination of impact and reaction produces the maximum practical results, so in screw propellers does a corresponding gain accompany the same construction

Turbines.—While studying those effects produced by jets of water impinging upon plain or concave surfaces corresponding to buckets of turbines, it simplifies matters to separate these results due to impact from others due to reaction And it will be as well at the outset to draw a distinction between the nature of these two pressures and to remind ourselves of the laws which lie at the root and govern the whole question under present consideration

Water obeys the laws of gravity, exactly like every other body, and the velocity with which any quantity may be falling is an expression of the full amount of work it contains. By a sufficiently accurate practical rule, this

velocity is eight times the square root of the head or vertical column measured in feet

Velocity per second = 8 $\sqrt{}$ head in feet Therefore for a head of 100 ft as an example, V = 8 $\sqrt{100}$ = 80 ft per second The graphic method of showing velocities or pressures has many advantages, and is used in all the diagrams with which this paper is illustrated

Beginning with purely theoretical considerations we must first recollect that there is no such thing as absolute motion All movements are relative to something else, and what we have to do with a stream of water in a turbine is to reduce its velocity relatively to the earth, quite a different thing to its velocity in relation to the turbine, for while the one may be zero the other may be anything we please

In the first diagram, A B C D represents a parallelogram of velocities, wherein A C gives the direction of a jet of water starting at A and arriving at C at the end of one second or any other division of time At a scale of $\frac{1}{10}$ in to 1 ft, A C represents 80 ft, the fall due to 100 ft head, or at a scale of 1 in. to 1 ft, A C gives 2 ft, or the distance travelled by the same stream in $\frac{1}{10}$ of a second The velocity A C may be resolved into two others, namely, A B and A D or B C, which are found to be 69 28 ft and 40 ft respectively, when the angle B A C is 30 deg

If, however, A C is taken as 2 ft, then A B will be found 20 78 in, and B C = 12 in. for a time of $\frac{1}{10}$th or .025 of a second Supposing now a flat plate B C = 12 in wide move from D A to C B during 025 second, it will be readily seen that a drop of water starting from A will have arrived at C in 025 second, having been flowing along the surface B C from B to C without either friction or loss of velocity

If now instead of a straight plate B C we substitute one having a concave surface, it will be found necessary to move it from A to L in 025 second in order to allow a stream to arrive at C, that is K without, in transit friction or loss of velocity This concave surface may represent one bucket of a turbine

Supposing now a resistance to be applied so that it can only move from A to B instead of to L Then, as we have already resolved the velocity A C into A B and B C so far as the former (A B) is concerned, no alteration occurs whether B K be straight or curved But the other portion B C, pressing vertically against the concave surface, becomes gradually diminished in its velocity in relation to the earth and produces an effect known as "reaction" A combined operation of "impact" and reaction occurs by further diminishing the distance which the bucket is allowed to travel Thus the jet may be impelled against the lower edge of the bucket, and give a pressure by its impact, then following the curve with a diminishing velocity it is finally discharged, retaining only sufficient movement to carry the water clean out of the machine

Thus far we have considered the movement of jets and buckets along straight lines, but this can only occur, so far as buckets are concerned, when their radius is infinite In practice these latter movements are always curves of more or less complicated form, which effect a considerable modification in the forms of buckets, &c, but not in the general principles, and it is the duty of the designer of any form of turbine to give this consideration its due importance Having thus cleared away any ambiguity from the terms "impact" and "reaction," and shown how they can act independently or together, we shall be able to follow the course and behaviour of streams in a turbine, and by treating their effects as arising from two separated causes, we shall be able to regard the problem without that inevitable confusion which arises when they are considered as acting conjointly

Turbines, though driven by vast volumes of water, are in reality impelled by countless isolated jets or streams, all acting together, and a clear understanding of the behaviour of any one of these facilitates and concludes a solution of the whole problem

Experimental Researches.—All experiments referred to in this paper were made by jets of water under an actual vertical head of 45 ft, but as the supply came through a considerable length of $\frac{1}{2}$ in bore lead piping and many bends, a large and constant loss occurred through friction and bends, so that the actual working head was only known by measuring the velocity of discharge This was easily done by allowing all the water to flow into a tank of known capacity

The stop cock had a clean circular passage through it, and two different jets were used One, oblong, measured .5 in by .15 in, giving an area of .075 square inches The other jet was circular, and just so much larger than a $\frac{1}{4}$ in to be .05 of a square inch area, and the stream flowed with a velocity of 40 ft per second, corresponding to a head of 25 ft Either nozzle could be attached to the same universal joint, and directed at any desired inclination upon the horizontal surface of a special well adjusted compound weighing machine, or into various bent tubes and other attachments, so that all pressures, whether vertical or horizontal, could be accurately ascertained and reduced to the unit, which was the quarter on an ounce

The vertical component p of any pressure P may be ascertained by the formula

$$p = P \sin \alpha,$$

where α is the angle made by the jet against a surface, and in order to test the accuracy of the simple machinery employed for these researches the oblong jet which gave 71 units when impinging vertically upon a circular plate, was directed at 60 deg and at 45 deg thereon, with results shown in Table I, and these, it will be observed, are sufficiently close to theory to warrant reliance being placed on data obtained from the simple weighing machinery used in the experiments.

TABLE I.—*Impact on a Level Plate.*

Distance	Inclination of Jet to the Horizontal	90 deg	60 deg	45 deg
		Pressure	Pressure	Pressure
1¼ in	Experiment	71 00	61 00	49,00
	Theory		61 48	50 10
1 in	Experiment	63 00	55 00	45 00
	Theory		54 00	46 00

In each case the unit of pressure is one quarter of an ounce

In the first trial there was a distance of 1¼ in. between the jet and point of its contact with the plate, while in the second trial this space was diminished to ¼ in. It will be noticed that as this distance increases we have augmented pressures, and these are not due, as might be supposed, to increase of head which is practically nothing, but they are due to the recoil of a portion of the stream which occurs increasingly as it becomes more and more broken up These alterations in pressure can only be eliminated when care is taken to measure that only due to impact without at the same time adding the effect of an imperfect reaction

Any stream that can run off at all points from a smooth surface, gives the minimum of pressure thereon, for then the least resistance is offered to the destruction of the vertical element of its velocity, but this freedom becomes lost when a stream is diverted into a confined channel As pressure is an indication and measure of lost velocity, we may then reasonably look for greater pressure on the scale when a stream is confined after impact than when it discharges freely in every direction Experimentally this is shown to be the case, for when the same oblong jet, discharged under the same conditions, impinged vertically upon a smooth plate, and gave a pressure of 71 units, it gave 87 units when discharged into a confined right angled channel This result emphasises the necessity for confining streams of water whenever it is desired to receive the greatest pressure by arresting their velocity Such streams will always endeavour to escape in the directions of least resistance, and therefore in a turbine means should be provided to prevent any lateral deviation of the streams while passing through their buckets. So with screw propellers the great mass of surrounding water may be regarded as acting like a channel with elastic sides, which permits the area enlarging as the velocity of a current passing diminishes

The experiments thus far described have been made with jets of an oblong shape and they give results differing in some degree from those obtained with circular jets Yet as the general conclusions from both are found the same it will avoid unnecessary prolixity by using the data from experiments made with a circular jet of .07 square inch area discharging a stream at the rate of 40 ft per second This amounts to 5.2 lb of water per minute, with an available head of 25 ft or 1300 foot pounds per minute

The tubes which received and directed the course of this jet, were generally of lead, having a perfectly smooth internal surface, for it was found that with a rougher surface the flow of water is retarded and changes occur in the data obtained Any stream having its course changed, presses against the body causing such change, this pressure increasing in proportion to the angle through which the change is made, and also according to the radius of a curve around which it flows This fact has long been known to hydraulic engineers, and formulæ exist by which such pressures can be determined nevertheless it will be useful to study these relations from a somewhat different point of view than has been hitherto adopted, more particularly as they bear upon the construction of screw propellers and turbines, and by directing the stream vertically into a tube ⅝ in in internal diameter and bent so as to turn the jet horizontally, and placing the whole arrangement upon a compound weighing machine, it is easy to ascertain the downward pressure due to impact, and the horizontal pressure due to reaction In theoretical investigations it may be convenient to assume both these pressures exactly equal, and this has been done in the paper on screw propellers already referred to, but this brings in an error of no importance so far as general principles are involved, but one which entirely destroys much of the value, such researches might otherwise possess for those who are engaged in the practical construction of screw propellers or turbines The downward impact pressure is always somewhat greater than the horizontal reaction, and any proportions between these two can only be accurately ascertained by trials In these particular experiments the jet of water flowed 40 ft per second through an orifice of .05 square inch area, and in every case its course was bent to a right angle The pressures for impact and reaction were weighed coincidentally with results given by columns 1 and 2, Table II.

TABLE II.—*Impact and Reaction in Confined Channels.*

Number of columns	1	2	3	4
Description of Experiments	Impact	Reaction	Resultant	Angles A B S
				deg
Smooth leaden tube 1¾ in mean radius	71	62	94 27	49
Rough wrought iron tube 1¾ in	78	52	93 75	56 5
Smooth leaden tube bent to a sharp right angle	71	40	81 5	60

The third column is obtained by constructing a parallelogram of forces, where impact and reaction form the measures of opposing sides, and it furnishes the resultant due to both forces The fourth column gives the inclination at which the line of impact must incline towards a plane surface, so as to produce this maximum resultant perpendicularly upon it; as the resultant given in column 3 indicates the full practical effect of impact and reaction

When a stream has its direction changed to one at right angles to its original course, and as such a changed direction is all that can be hoped for by ordinary screw propellers, the figures in column 3 should bear some relationship to such cases Therefore it becomes an inquiry of some interest as to what angle of impact has been found best in those screw propellers which have given the best results in practical work Taking one of of the most improved propellers made by the late Mr Robert Griffiths, its blades do not conform to the lines of a true screw, but it is an oblique paddle, where the acting portion of its blades were set at 48 deg. to the keel of the ship, or 42 deg. to the plane of rotation

Again, taking a screw tugboat on the River Thames, with blades of a totally different form to those used by Mr Griffiths, we still find them set at the same angle, namely, 48 deg. to the keel, or 42 deg. to the plane of rotation. An examination of other screws tends only to confirm these figures, and they justify the conclusion that the inclinations of blades found out by practice, ought to be arrived at, or at any rate approached by any sound and reliable theory, and that blades of whatever form must not transgress far from this inclination if they are to develop any considerable efficiency Indeed, many favourable results obtained by propellers, are not due to their peculiarities, but only to the fact that they have been made with an inclination of blade not far from 42 deg to the plane of rotation.

Referring to column 4, and accepting the case of water flowing through a smooth tube, as analogous to that of a current flowing within a large body of water, it appears that the inclination necessary to give the highest resultant pressure is an angle of 49 deg, and this corresponds closely enough with the angle which practical constructions of screw propellers have found to give the best results.

Until, therefore, we can deal with currents after they have been discharged from the blades of a propeller, it seems unlikely that anything can be done by alterations in the pitch of a propeller So far as concerns theory, the older turbines were restricted to such imperfect results of impact and reaction as might be obtained by turning a stream at right angles to its original course; and the more scientific of modern turbine constructors may fairly claim credit for an innovation by which practice gave better results than theory seemed to warrant, and the consideration of this aspect of the question will form the concluding subject of the present paper.

When a current passes round such a curve as the quadrant of a circle, its horizontal reaction appears as a pressure, which is the result of the natural integration of all the horizontal components of pressures, all of which act perpendicularly to each element of the concave surface along which the current flows. If now we add another quadrant of a circle to the curve, and so turn the stream through two right angles, or 180 deg, such a complete reversal of the original direction represents the carrying of it back again to the highest point, it means the entire destruction of its velocity, and it gives the maximum pressure obtainable from a jet of water impinging upon a surface of any form whatsoever

The horizontal reaction already noticed is now confronted by an impact of the now horizontal stream as it is turned round the second 90 deg of curvature, and reacts also vertically downwards It would almost seem as if the first reaction should be exactly neutralised by the second impact from F to D, but such is not the case, as experiment shows an excess of the second impact over the first reaction, amounting to 6 units, and shows also that the behaviour of the stream through its second quadrant is precisely similar in kind to the first, only less in degree, also the impact takes place vertically in one case and horizontally in the other

The total downward pressure given by the stream when turned 180 deg is found by experiment thus:

$$\left.\begin{array}{l}\text{Total impact and reaction from}\\ \text{180 deg. change in direction of}\\ \text{current}\end{array}\right\} = 132 \text{ units},$$

and by deducting the impact (71 units), as previously measured, the new reaction corresponds with an increase of 61 units above the first impact. It also shows an increase of 37.75 units above the greatest resultant obtained by the same stream turned through 90 deg only Therefore, in designing a screw propeller or turbine, it would seem from these experiments desirable to aim at changing the direction of the stream, so far as possible, into one at 180 deg. to its original course, and it is by carrying out this view so far the necessities of construction will permit that the scientifically-designed modern turbine has attained to that pre-eminence which it holds at present over all hydraulic motors.

Much more might be written to extend and amplify the conclusions that can be drawn from the experiments described in the present paper, and from many others made by the writer, but the exigencies of time and your patience alike preclude further consideration of this interesting and important subject

CONTINUOUS BRAKES.

TO THE EDITOR OF ENGINEERING.

SIR,—We engine drivers are pleased to see that the letter of one of us has found a place in the *Times*, and that you, Sir, have copied it, and say it is valuable "Express Driver" has just put in words just what we all

think and feel. He has now got a brake on his train which he can trust his life to, and he is able to say how nice and comfortable he does his work—one turn of his wrist, and he has a brake block on every wheel. Now, Sir, I only wish I was in his fortunate position; for some time I worked the Westinghouse brake and felt just as happy as he does, but now after re-arrangement of traffic working, I am on trains without it. I am working the vacuum, and there is no feeling of safety or comfort with it. You see, Sir, there is no depending on it. Now on one occasion I was approaching a station, I tested the brake a mile off, it was all right then, when I put it on to stop at a platform the brake would not act, and the train ran the full length past the platform; well, Sir, I was soon off the engine and found a "sack" cracked under the second coach. The inspector came to me two days after to inquire into it, and said Mr ——— (the superintendent) was determined to put a stop to these frequent failures, so I would have to be fined a day's pay. Now, Sir, don't you think it hard on us drivers that our directors give us a brake to work with which we know is not safe, and then when it fails we get fined? I do. I felt an interest in this failure, so I got a look at the Board of Trade return expecting to find it, but the company have not put it down, and when I look over the list I see lots of other failures, the same as mine are not put in the Blue book.

I wish with your correspondent "Express Driver" that directors would come and ride on the footplate with us and just see how things are, and how much we do want a good automatic brake for our safety as well as for the passengers. I see by your paper that Mr. Moon and Sir E. Watkin have been lately telling their shareholders *which is the best brake*. Now, Sir, I ask with all respect what do they know about it? You see it is our trade, and when we have worked first one brake and then the other, don't you think we drivers ought to know which we can trust and which we can't? and if I am told correctly neither Mr. Moon nor Sir E. Watkin have a Westinghouse train on their lines, so I don't just see how they can tell us much about it. I note in a paper that the Manchester, Sheffield, and Lincolnshire Company call the Westinghouse brake the "Board of Trade" brake, but I say, Sir, it is the *engine driver's brake*, because it is the only one drivers dare trust their lives to. I, like "Express Driver," don't wish to be discharged, so will not give you my name, but call myself,

ANOTHER EXPRESS DRIVER.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read with very great interest the valuable details relating to continuous brakes which have been given by "An Express Driver;" the results of his twenty-one years' experience cannot fail to be highly instructive. The good sound common sense written by this practical man, forms a striking contrast to the absurd statements recently made by Sir Edward Watkin and Mr. Moon upon the brake question. Details have lately been given in your columns of several failures of vacuum brakes, and the cry is still they come. For instance on Tuesday last (9 inst.), the up express from Liverpool, Manchester, and Leeds due at St. Pancras at 5.15 a.m., overran the platform at Leicester, past the signal at danger, and ran foul of the London Road Junction. The train was fitted with the "two minute leak off brake." Passengers felt the brake applied and the speed seemed fast reducing, when gradually the brake took no effect and the train ran forward through the station. The train was not delayed, the driver will be fined as usual, and there the matter ends. Such cases as these very frequently occur, but as "leaking off" is part of the design and construction of the brake, it is not *considered or returned as a failure*. Now, I am of opinion that "leaking off" is a very great failure and a fatal defect. For an express train to overrun a station and foul of a junction is a very serious matter, and if, as frequently happens, a down goods train had been crossing from the down main to the goods line in front of the express (as I have constantly seen them do), a severe collision must have been the result of this failure.

The advocates of vacuum brakes have often contended that the adoption of what they choose to call the "universal coupling" would render various forms of vacuum brakes interchangeable; facts have, however, often proved the incorrectness of this theory. Several instances have occurred of Great Western and Midland vehicles causing trouble on the North-Western and North Staffordshire Railways, the officials being seriously perplexed, as when one brake was applied the other came off, and *vice versâ*. The two automatic vacuum brakes are said to work together perfectly, but in practice even they do not do so. On Monday (8th inst.) the 12.20 p.m. express from Leicester to St. Pancras was as usual fitted with the "two minute leak off brake," but in addition, a South Western Company's saloon carriage was attached near the tail of the train, the brake of which is not constructed to leak off. The vacuum brake was used to slacken speed near Luton, its power soon died away upon the Midland vehicles, but remained "on" upon the South-Western saloon, consequently this important train had to be stopped, the brake released by hand, and a delay of three or four minutes was thus caused.

Cases have occurred of trains having to run without the use of the continuous brake, as no vacuum could be maintained; for instance, on Thursday (4th) the 11.55 a.m. express from Manchester to St. Pancras was delayed and had to be worked over part of the journey with hand brakes only. These are but a fair specimen of ordinary working on the Midland. During the past half-year I have seen failures, and been a passenger in trains when others have occurred, yet not one of these instances is reported or appears in the brake return lately issued. For purposes of comparison therefore the returns have been rendered practically useless, and the Act of 1878 is fast becoming a dead letter.

I am, &c.,
CLEMENT E. STRETTON.
40, Saxe Coburg street, Leicester, September 15, 1884.

THE ELECTRIC LIGHT AT THE HEALTH EXHIBITION

TO THE EDITOR OF ENGINEERING.

SIR,—Allow me to correct a slight mistake you have made in your issue of ENGINEERING of the 12th inst. in describing the Victoria dynamo machine constructed by the Anglo American Brush Electric Light Corporation, and exhibited at the Health Exhibition.

On page 254 you say "There are, of course, as many neutral points in the commutator as there are magnet poles, and originally there was a brush at each neutral point, but, by a method invented by Mr. Mordey, one of the company's engineers, all the brushes, except one pair, are dispensed with, and the difficulty and complication which formerly existed are avoided," and again on page 255 "In addition to its simplicity, the Mordey method of connecting up multipolar machines has the advantage of allowing the brushes to be placed in an accessible position, for out of the original six brushes any pair of positive and negative terminals can be retained, that is, they can be separated by either 60 deg. or 180 deg., as found most convenient."

In the early part of last year, being then engaged with Messrs. Paterson and Cooper, who made hectopolar dynamos, I suggested the adoption of cross connecting the coils on the armatures distant by an angle of 60 deg. This proving successful, I further suggested the adoption of two brushes instead of six, putting these, for the sake of convenience, distant by 60 deg. This second alteration also proved successful, increasing the output of the machine from 1½ to 2 per cent., besides simplifying the working and reducing the cost of maintenance by an economy of brushes.

One machine made by Messrs. Paterson and Cooper was worked successfully under my own direction at the Electrical Exhibition at the Royal Aquarium, Westminster, last year. A machine at that time working the lights at the Reform Club, Pall Mall, was altered by myself to this plan, causing a suspension of the lights for one evening in so doing. Another machine on this plan (a compound wound machine) was sent by Messrs. Paterson to the works of the Anglo American Brush Electric Light Corporation, and exhibited there in action, driving some 400 Lane Fox lamps. The result of this experiment was not as successful as could be desired, in consequence of the resistance of the lamps not being exactly suited to the dynamo. Mr. Mordey was present at the time, taking great interest in the experiments, and I drew his attention to my improvement of using two instead of six brushes. You are therefore in error in describing the doing away with the four superfluous brushes as an invention of Mr. Mordey's, and as a novelty exhibited for the first time at the Health Exhibition. It would be interesting to know whether the Gulcher Electric Light Company have yet tried this plan of reducing the number of the brushes. I think it will be found to work with great economy with their machines.

Trusting you will spare me space in your columns for this correction,

I am, Sir, your obedient servant,
H. JUSTUS ECK.

11 and 10, Dean street, Holborn, W.C.,
September 15, 1884.

[The date of Mr. Mordey's patent is January 24, 1883, from which it would appear that his application had been filed some time before Mr. Eck's idea was publicly shown.—ED. E.]

INFLUX INJECTORS

TO THE EDITOR OF ENGINEERING.

SIR,—I have read the article in your issue of September 5th describing the novel action of the influx injector, and now see a letter stating that an automatic injector has for some years been made by Messrs. Fairburn and Hall.

Without entering into the merits of the "influx," with which I am quite unacquainted, except from your description, it nevertheless seems to me that if it can do what is claimed for it, it is an entirely different instrument from the injector of Messrs. Fairburn and Hall, which in practice I have found to be a fair ordinary injector, but without any automaticity in its action, indeed, the arrangement of its nozzles would seem to preclude any such action, but on this point I shall be glad to be enlightened by those who understand the subject better.

Yours truly,
CHARLES DIXON.

Park Row, Leeds, September 16, 1884.

TRIAL TRIPS AND LAUNCHES

ON Friday, 5th of September, Messrs. Napier, Shanks, and Bell, Yoker, near Glasgow, launched the Nagato Maru, a spar decked, steel screw steamer of about 1810 tons, built to the order of the Union Steamship Company, of Japan. She measures 265 ft. by 35½ ft., and has a cellular double bottom. Her engines, which are being supplied by Messrs. James Howden and Co., Glasgow, are of the direct acting compound type, the cylinders being 36 in. and 68 in. in diameter, respectively, with stroke of 44 in. They are of 250 horse power nominal. For the same owners there have been built within the past year and a half, and nearly all on the Clyde, no fewer than seventeen steamers of a total of 21,500 tons, and representing 520,300!

On the same day, the magnificent steel screw steamer Chusan, the last of four vessels which Messrs. Caird and Co., Greenock, contracted in the early part of last year to build for the Peninsular and Oriental Steam Navigation Company, went down the Clyde on her official trial trip. She is a vessel of nearly 5000 tons gross register, and measures 400 ft. by 45 ft. by 31 ft. 6 in., her displacement on a draught of 25 ft. is 8800 tons, while on a mean draught of 23 ft. she will carry 4060 tons of dead weight. Her measured capacity is 19,000 cubic feet. Accommodation is provided on the main deck for 109 first class passengers, and on the lower deck for 44 second class. The lighting, ventilation, and mechanical appliances with which the vessel is fitted are practically perfect. The engines, supplied by the builders, are of the inverted direct acting compound type, indicating 3750 horse power, the cylinders being 52 in. and 96 in. in diameter respectively, with stroke of 56 in. There are three double ended steel boilers, fitted with eighteen Fox's corrugated furnaces, and all designed to carry a working pressure of 90 lb. of steam. The vessel is fitted throughout with incandescence electric lamps by Messrs. Siemens Brothers, London. On the measured mile a mean speed of 15 knots was attained, or one knot above the guaranteed speed.

By a somewhat strange coincidence two splendid steamers for rival New Zealand lines were launched on the Clyde on Monday, the 8th inst. One was the Kaikoura, the fourth vessel of the same kind built by *Messrs. John Elder and Co. for the New Zealand Shipping Company*. She measures 420 ft. (between perpendiculars) by 46 ft. by 33 ft. 4 in., and is a vessel of 4650 tons gross register. On the spar and main decks together she will have accommodation for 87 first class passengers, and there will also be excellent accommodation for 32 second class and 250 third class passengers. The engines, which will indicate 4000 horse power, will be supplied by three cylindrical double ended multitubular boilers, made of steel and fitted with eighteen of Fox's corrugated furnaces, the working pressure being 110 lb. per square inch. The other vessel was the Tainui, of about 5000 tons gross, built of steel and measuring 420 ft. by 46 ft. by 32 ft. She is sister ship to the Arawa, and was built by Messrs. William Denny and Brothers, Dumbarton, for the Shaw, Saville, and Albion Company, of London, having been expressly designed for their London and New Zealand line. She has a cellular double bottom capable of containing 840 tons of water ballast. Her accommodation is designed for 95 first class, 52 second class, and 670 adult steerage passengers. The guaranteed speed is 12½ knots at sea on the voyage. The engines are of the tandem triple expansion four-cylinder type, working with steam at an initial pressure of 160 lb. per square inch, and the cylinders being two of 71 in. diameter, one of 91 in., and one of 37 in., with a stroke of 5 ft.

On Monday, September 8, the screw steamer Bordeaux, lately launched by Messrs. *Ramage and Ferguson, Leith*, went on her trial trip on the Forth, and attained a mean speed of 11 knots per hour, which was considered satisfactory. She is owned by the Lorie and Thames Transit, and is intended for their trade between St. Nazaire and London. Her engines are of 410 effective horse power, and the working pressure of steam is 90 lb. per square inch.

The screw steamer Bermuda, which was launched some weeks since by Messrs. Burrell and Son, Dumbarton, ran her official trial trip on the Clyde on Tuesday, the 9th inst. She is owned by the Societa Italiana di Trasporti Marittimi Raggio, of Genoa, and is a vessel of about 3000 tons gross, she measures 320 ft. by 37 ft. by 27 ft. 6 in., and is fitted with engines (by Messrs. Duncan, Stewart, and Co., Glasgow) of 1400 horse power indicated. On the measured mile a speed of fully 12¼ knots was attained on the very moderate coal consumption of 18 tons per twenty four hours, the vessel's carrying capacity being 3400 tons.

Messrs. Scott and Co., Bowling, on the 11th inst., launched the James Mutter, a finely modelled iron screw steamer measuring 100 ft. by 19 ft. by 9 ft., which has been built to the order of Messrs. W. and J. Mutter, Glasgow, for their Islay trade. She is being supplied with engines by Messrs. William King and Co., Dock Engine Works, Glasgow.

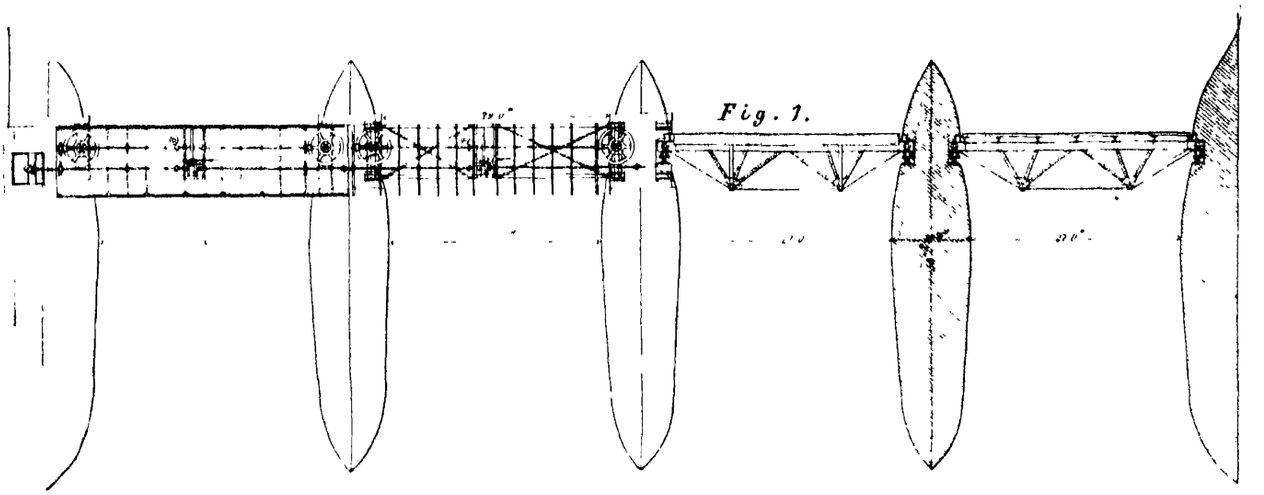
The new Allan Line steamer Siberian, lately launched from the yard of the Govan Shipbuilding Company, made her official trial on Saturday, the 13th inst. An average speed of 13 knots per hour was attained on the measured mile.

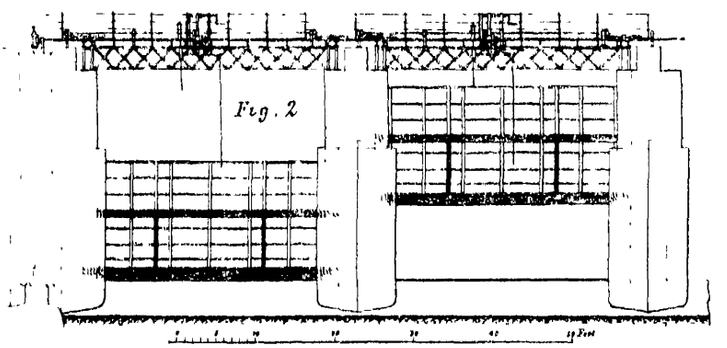
On the same day, the steel screw steamer Rivas, a vessel of 2800 tons gross, and measuring 300 ft. by 42 ft. by 28 ft. 3 in., had her official trial trip on the Clyde. She was built and engined by Messrs. Alexander Stephen and Sons, Glasgow, and owned by Senor Martinez de las Rivas, of Bilbao, and has been specially designed for the Bilbao ore trade—carrying ore and pig iron to the United Kingdom and other countries and coke back to Spain. On the measured mile she attained a speed of 11.36 knots. Her engines have cylinders of 38 in. and 68 in. in diameter respectively, with 48 in. stroke, and working at a steam pressure of 90 lb. per square inch.

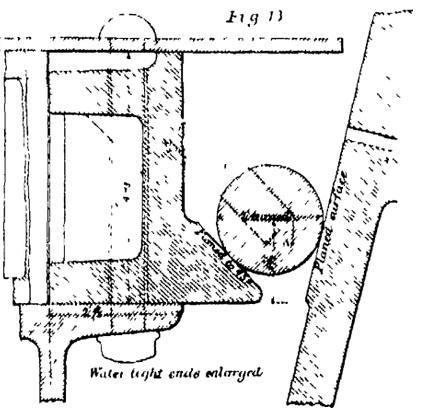
INTERNATIONAL INVENTIONS EXHIBITION, 1885.—The latest date for sending in applications for space has been extended from October 1 to November 1.

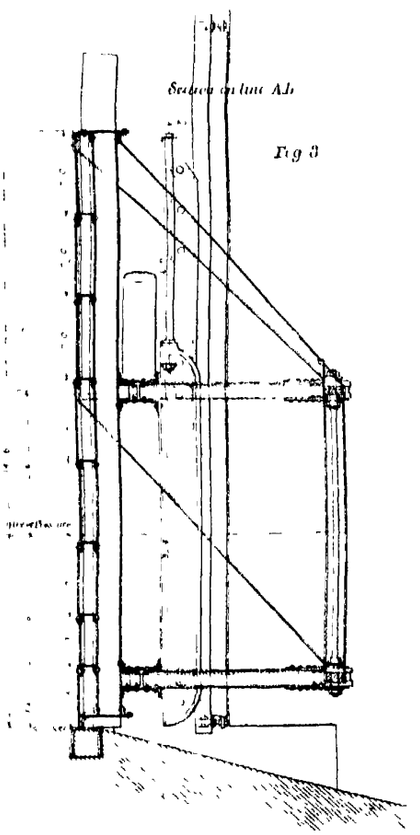
SLUICES AT THE LOUGH ERNE DRAINAGE WORKS.

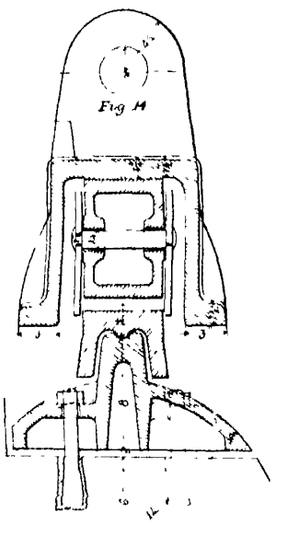
CONSTRUCTED FROM THE DESIGNS OF MR. F. G. M. STONEY, LONDON.

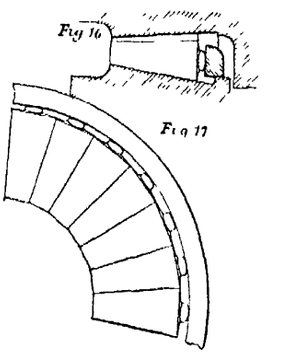


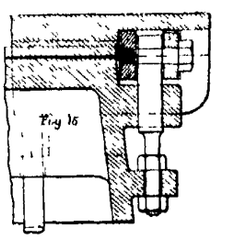










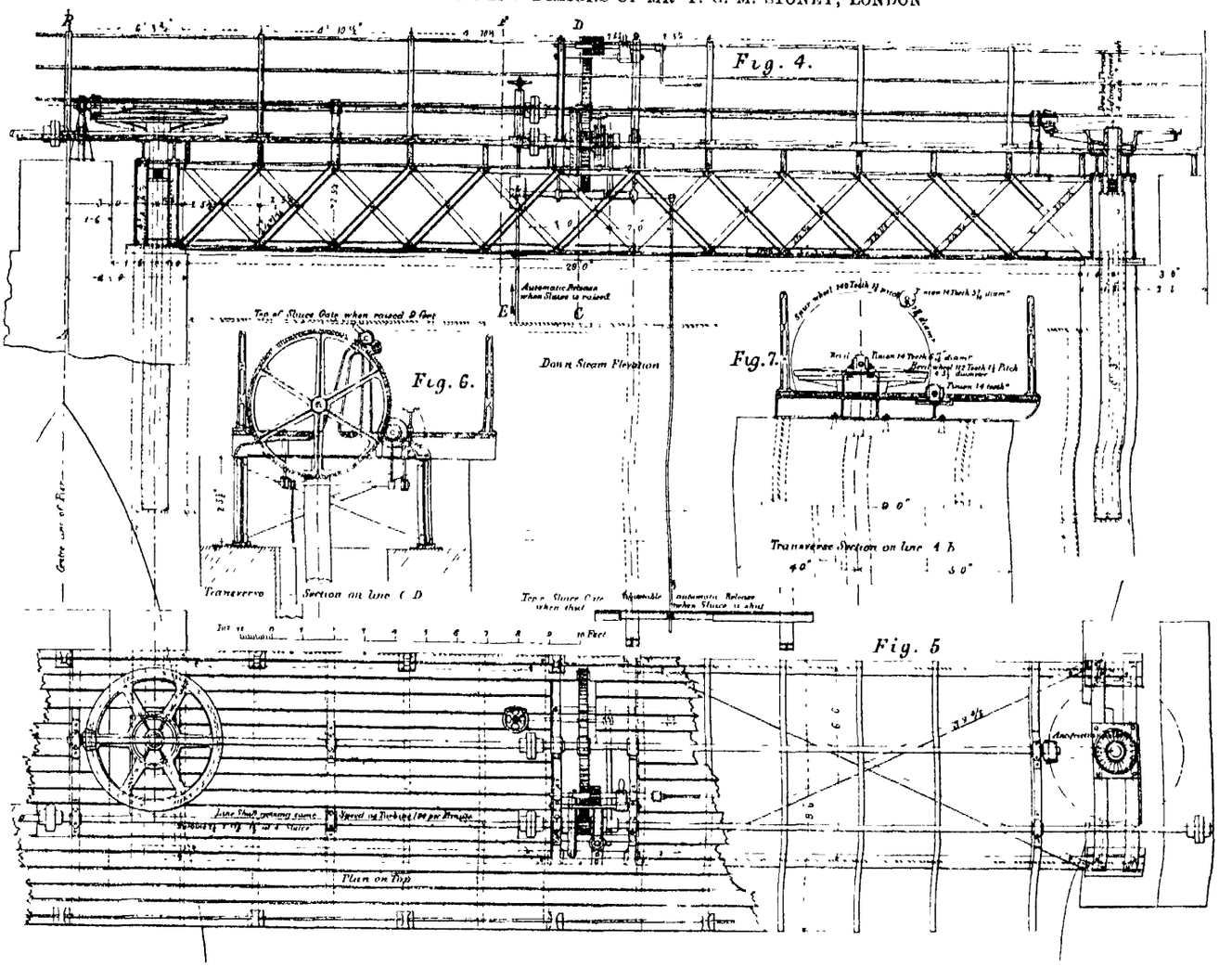


ON the present and opposite pages, and on page 272, we illustrate a novel and very noteworthy set of sluices lately erected at the Lough Erne Drainage Works from the designs of Mr. F. G. M. Stoney, of 4, Westminster Chambers, London. These works are designed to maintain and improve the navigation of the chain of lakes which have their outfall at Belleek, and at the same time to prevent the flooding of the up-country. For the first object the permanent dry weather level of the whole system is being raised some feet, and as this would naturally raise the flood level if taken alone, special arrangements have been made to facilitate the escape of flood waters. From Belleek to the Atlantic there is a short river of only a few miles in length, but with an exceedingly steep fall, 150 ft., so great that it is entirely useless for purposes of navigation, as it is broken into rapids and cascades, so that the waters from the lake system enter it they may flow away with the greatest possible rapidity. At the head of the first or Belleek falls, Mr. Stoney's sluices are situated about two miles down the river from the foot of the lake at Roscoe. They perform the function of a weir, that is, they back up the inland waters, but unlike a weir they form no obstruction to floods, and do not give rise to any deposit of silt requiring to be periodically removed. When the gates are raised the water flows beneath them, producing a scour, cleaning the bed, and escaping with a velocity due to the head behind it, instead of falling lazily over a weir to waste its energy in foam and eddies.

The river is commanded by four gates (Fig. 1), each with a span of 31 ft. between the roller bearings and a height of 14 ft. 6 in. The clear span of each gate is 29 ft. 2 in., and its weight, which is uncounterbalanced, 13 tons. A clear lift opening of

SLUICES AT THE LOUGH ERNE DRAINAGE WORKS.

CONSTRUCTED FROM THE DESIGNS OF MR F. G. M. STONEY, LONDON



9 ft can be obtained at each The distinctive feature of Mr Stoney's system is the use of free roller bearings The water pressure, which is from 80 to 100 tons, is transmitted to the buttresses through free rollers on which the gate runs in rising and falling, and so perfect is the arrangement that each sluice can be raised by one man without difficulty. The rollers, which are shown in Figs. 3, 9, and 10, and to a larger scale in Fig 14, page 268, are independent both of the gate and the pier, and as they roll between the two they rise and fall at half the speed of the sluice They are mounted in a frame which is suspended from the bight of a chain passing round a pulley at its top One end of this chain is fixed to the abutment, and the other is made fast by an elastic connection to the gate, and thus as the door rises and falls the rolling frame is sustained by the chain, and prevented from falling down when the gates are free from water pressure The rollers run between vertical rails carried on the ends of the sluices and fixed in grooves in the stone work of the pier (Fig 10, page 272) Both rails are capable of being adjusted (Fig 14) to allow the rollers to obtain a fair bearing upon them. That on the sluice, which is in the form of a box girder, is pivotted at the top and bottom, while that on the masonry (Fig. 14) is provided with a compound face likewise secured (Fig. 15) at its two extremities, and can rock in a V groove in a fixed casting behind it By this arrangement both rails can be fixed accurately parallel with each other, even if the mason should have failed to work exactly to the drawings.

The sluices themselves are wrought-iron framed and plated structures (Figs 8 and 9) supported by two heavy trussed beams on the rear side (Figs 1, 2, and 3) A diagram of the strains in the truss is given in Fig 11, with the load on each part marked in tons. Between the beams and the door are seven H irons which transmit the strain to the trusses These latter are tied together by vertical rods (Fig 3) at their outer angles, and are steadied by suspenders which, as shown in the second span of Fig 1 and in Fig 10, may be easily mistaken for part of the truss

Each sluice is suspended by two screws (Fig 4, page 269), situated in a vertical plane passing through its centre of gravity These engage with nuts, each of which is mounted on the top of a tube rising from the compression member of the truss (Figs 3 and 9), and secured to it by six tie-bolts (Fig 8) The upper part of the screw is defended from dirt by a tube which telescopes with the one bearing the nut, and carries a bevel-wheel which is rotated by means to be described later. To render the junction of the door and the masonry water tight, each is provided with a planed cast iron face (Figs 10 and 13), set out at an angle to each other, and to the centre line of the stream. Between these two faces there stands a turned wrought iron rod suspended from the top of the gate, in such a way that it can accommodate itself to the best position in the angle into which it is forced by the water pressure This forms a most satisfactory joint without leakage, and is one which while exceedingly simple allows for the variations arising from expansion and contraction, and from the maladjustment of masonry, &c The sill consists of a planed cast iron beam fixed in concrete (Fig 3), and the edge of the front plate of the door descends hard on to it

The lifting appliances are shown in Figs. 4 to 7, and can be operated either by hand or power, the motor in the latter case being a turbine in the left-hand pier (Fig 1) The whole of the piers are carried up to a sufficient height to allow the gates to be lifted 9 ft., and a light lattice girder bridge is thrown across them. Along the whole length of this bridge a line shaft is carried from the turbine, being connected to the vertical shaft by bevel wheels so arranged that it can be rotated in either direction Motion from this shaft can be communicated to the screws of any or all of the gates These screws are of such a pitch that when they are free the sluices will just run down under the impulse of their weight at a speed which does not require the application of the brake At the top of each screw is a bevel wheel which carries the whole weight of the sluice upon its boss. To render the friction as light as possible, this boss rests upon an antifriction bearing (Figs 16 and 17, page 268) consisting of a number of conical rollers running between two conical surfaces, one on the wheel and the other on the bearing These rollers are enclosed by a steel ring, against which they bear endwise, and are alternately larger and smaller in diameter The large ones carry the load, the intermediate small ones serving as distance pieces only The reason of this arrangement is that if all the rollers were the same size, their contiguous surfaces, which run in opposite directions, might grind together, the small rollers being free, will roll in unison with the bearing rollers on each side of them These two large bevel wheels are geared together by pinions and a cross shaft, which carries a large spur wheel near its centre This wheel can be driven either by a pinion and crank handle, or by a similar pinion on the line shaft The former can be slidden in and out of gear, while the latter is provided with a friction clutch which is automatically released when the gate reaches the top of its travel, or just before it arrives at the sill The clutch is normally held in gear by a weighted lever (Fig 4) which can be raised and lowered by a hand screw From each end of the lever there depends a rod, one descending to the level of the top of the sluices in its highest position, and the other carrying a stop at a point corresponding to lowest position of the sluice When the limit of the travel has been gained in either direction the weight is lifted and the gear stopped In lowering, this is set to take place a few inches above the sill, and the remaining distance is closed by hand, to prevent the chance of over winding

All the details are so clearly shown in the engravings that very little description is needed to make them intelligible. The sluices have already been at work for over a year most successfully, giving perfect

satisfaction. Each gate can be lifted by one man, and when allowed to run down by itself, falls at a moderate velocity, which can be instantly arrested The joint at the sides and sill is practically perfect, while the immense power for discharging floods which is placed in the hands of the engineer of the works by this arrangement, is shown by the fact that if the waters be dammed back until they reach the top of the sluices, and the channel below is dry, the level of the river is raised 6 ft two miles away within twenty minutes of the time the gates are lifted *Sluices have an immense advantage over fixed weirs* as they allow the navigational authorities and the mill owners to raise the minimum level several feet, with the advantage to the latter of greatly increased head and power, and the ability of letting storm waters past with increased facility In fact in most cases the miller might, without flooding the country, raise the summer level to a height corresponding with the surface level of flood waters passing over his weir, because he has the power, in this form of movable weir, of raising the *sluices, and allowing the floods to escape at greatest* advantage, and because of the initial velocity due to the head being preserved, there will be a minimum of back water In this manner the water power of the country might be increased, with a decided advantage to the drainage capacity of the rivers

These sluices can easily be counterbalanced and rendered automatic, while, at the same time, they are under perfect control The pressure of 80 or 100 tons is practically not perceptible in the working of these sluices, as it seems to take no more force on the handle to start the gates when there is 14 ft 6 in head on one side and no water on the other, than when the gate is raised in air

The Lough Erne Drainage Works have been under consideration some eighteen years, and the project has been revised and kept alive, and finally brought to a practical issue by the persistent energy of Mr J G V Porter, of Belfast, and under the guidance of Mr James Price, Dublin, chief engineer to the Lough Erne Drainage Board The sluices were erected at Belleek in the summer of 1883, under the personal superintendence of Mr F G M. Stoney

BLOCK SETTING MACHINE.

THE recent visit of the Prince of Wales to Newcastle, and the successful opening of the Albert Edward Dock at Cable Dene, has attracted a great deal of attention to the extensive improvements which the Tyne Commissioners have effected on their river, and to the large works which are still in progress there Of primary importance amongst these works are the two great piers which run far out to sea on the north and south sides of the river mouth These piers are mainly composed of concrete blocks placed and bonded with concrete hearting, and when it is understood that a large proportion of these blocks weigh about 40 tons, the block-setting plant used to put them in position becomes of considerable interest, for long after the commencement of the work the blocks were set by overhead travellers running on staging supported by piles, and this method of construction is for the present still in use on the south pier

On the north pier, the staging and traveller method of setting has been superseded for some time by the more modern plan of using a "block setting machine," and Mr Messent, the engineer to the commissioners, must be congratulated on having designed and set to work the largest "block-setter" in existence, a machine that has rightly earned its title of "Mammoth," and we think that our readers will be much interested in the engraving and description of this machine that we give on page 276

The main structure of the Mammoth, including the under carriage, girders, jib, bracing, and truss work, were made in the Tyne Commissioners' own yard and workshops The whole of the machinery, engines, boiler, gearing, and travelling carriage, and also the great revolving turntable, were constructed under Mr Messent's superintendence by Messrs Stothert and Pitt, of Bath, who for many years have made block setting and harbour making plant a specialty The radius of the Mammoth is 92 ft and the load 40 tons to 45 tons, we believe that this is by far the longest radius that has been used with a travelling crane intended to lift such heavy loads The engraving is taken from a photograph of the machine in actual work and shows clearly the general design.

The machine travels on two rails, one laid on the inside edge of the pier, and the other on the outside parapet, on the under carriage a system of heavy girders is placed to carry the large circular roller path, on which the whole of the superstructure revolves This roller path is 34 ft in diameter, and on it runs a ring of fifty two live rollers The circular movement is produced by a pinion gearing into the large spur ring seen in the engraving

The whole of the motions are worked by steam, viz, the lifting, slewing, and racking in and out from the maximum radius of 92 ft to the minimum radius of 20 ft.

For block setting, great accuracy and steadiness of motions are essential, especially in lowering the blocks into place; the Mammoth was therefore fitted with the patent hydraulic brakes of Mr W Matthews, these brakes act by compressing water in cylinders in front of pistons, an arrangement being provided by which the escape can be adjusted with extreme nicety, and the descent of the heaviest loads regulated with the greatest accuracy, the hydraulic brakes have been exclusively applied for block-setting machines, and have worked exceedingly well in practice

The Mammoth, when in complete working trim, weighs with load about 300 tons, but the weights are so well balanced that, when the machine is being slewed at a good speed, the motion is almost imperceptible, and the Mammoth can be handled as quickly or easily, and much more quietly, than an ordinary steam crane

The large brackets shown on the jib, carry an ingenious arrangement of chain porters which are opened by the frame seen on the travelling carriage The large side timbers used for stiffening the jib beams are of interest, from the splendid pieces of Vancouver pine used in their construction, we believe that timbers were procured of the unusual scantlings of 2 8 ft by 2 8 ft by 98 ft long It will give some notion of the force of the sea at Tynemouth when we say that one of the large brackets previously mentioned was broken during a storm, and that sometimes the whole machine disappears in a cloud of spray.

We understand that the Mammoth has been so successful in actual work that a duplicate machine is in course of construction by the commissioners for the south pier, the machinery for which is again entrusted to Messrs. Stothert and Pitt

GLASS ROLLING TABLE.

WE publish on page 277 an illustration of a machine constructed by Messrs Robert Daglish and Co, St Helens' Engine Works and Foundry, for rolling out cast glass into sheets As will be seen the table is portable, being mounted on four wheels so that it can be moved with ease to any part of the glass works The moulding tables are of cast iron, and of widths varying from 2 ft 9 in to 4 ft 2 in The surface is either plain, ribbed, checkered, or formed with any device which it is desired to impress on the glass On each side of the table a rack is mounted on the frame of the carriage, and gearing into each rack is a toothed wheel *mounted on a shaft, which also carries* a plain iron drum the width of the table The melted glass is poured on the table in front of the roller, which is then passed to and fro by means of the handwheels shown, and the glass is thus spread out into a sheet An adjustable guide is placed at the back of the roller to regulate its travel, and means are provided of varying the thickness of the sheet rolled

THE ALBERT BRIDGE FLOUR MILLS

WE publish on our two-page plate two vertical sections of the Albert Bridge Flour Mills, Battersea In our next issue we shall give the remaining views and a detailed description of the whole For the present it will be sufficient to say that these mills are the property of Messrs Marriage, Neave, and Co, corn millers, and that they were built to the designs of Mr Fred Bath, of London and Salisbury, while the machinery was supplied by Messrs Thompson and Williamson, Wakefield

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig Iron Market.—Last Thursday's warrant market was rather firmer, with transactions reported on forenoon 'Change at 41s 5½d. and 41s 6d cash, also at 41s. 7¾d and 41s. 8d one month, the close being buyers at the lower quotations and sellers wanting ½d per ton higher Slightly better prices prevailed in the after noon, the market closing nominally at 41s 6¾d cash, and 41s 8¾d one month Up to 41s 7d. cash was paid on Friday forenoon and 41s 9d. one month, which were the prices asked by sellers at the close, with buyers offering ½d per ton lower In the afternoon a little further advance was made, sellers at the close wanting 41s. 7¾d. cash and 41s 9¾d. one month and buyers at ½d. lower per ton The market was again strong on Monday, and the closing prices showed a gain of another 1d. per ton from last week's closing quotations A fair amount of business was done Transactions were reported in the forenoon at 41s 7d, 41s 6¾d., and up to 41s 7½d cash, also at 41s 8¾d up to 41s 9¾d one month, the close being sellers at the top prices and buyers offering ½d per ton less. In the afternoon the prices ran up to 41s 8d cash and 41s. 10d. one month for sellers, with buyers offering ¾d. per ton lower at the close. Yesterday's warrant market was very strong, and at one time prices showed a gain of 2½d per ton, but a pressure of holders to realise led to 2d. of that gain being lost by the close. Business was done in the morning at from 41s. 8d up to 41s 10d cash, and from 41s. 10d. up to 41s 11½d one month, the closing quotations being 41s 10d. cash and 42s one month for sellers, with buyers offering ½d lower per ton The quotations in the afternoon ranged from 41s 10d. and 41s. 10½d down to 41s. 8½d. cash, and from 42s. and 42s. 0½d. down to 41s. 10d. one month, the market closing with sellers at 41s. 8½d. cash and 41s 10½d one month, and buyers at ½d less Very little change took place to-day, the prices ruling both forenoon and afternoon being 41s 8d to 41s 8½d. cash and 41s 10d to 41s 10½d one month, with sellers at the close in the afternoon asking the top quotations, and buyers near No doubt the speculative department of the market has become somewhat more decided latterly, but much of the buying reported from day to day is to cover over sales, as the public still continue to hold quite aloof from the market, which is almost entirely in the hands of the regular members of the trade The leading feature of the past week has been an increased demand for special brands, the makers of several of which have sold fair parcels for delivery over the next month Some of the "specials" have advanced in price from 2s to 4s per ton in consequence of the improved demand for them, and a feeling is now arising that founders and other users of Scotch brands may turn their attention to the use of hematite pig iron, the price of which is decidedly lower than the "specials" referred to, while the quality is quite suitable for many purposes The state of trade generally is practically unchanged, for though the German requirements have been on a somewhat larger scale — more especially as regards special brands — the demand for the United States shows no signs of improvement. There are now again 94 blast furnaces in actual operation, one having been damped down at Summerlee Iron Works At this time last year there were 115 furnaces blowing Last week's shipments from all Scottish ports amounted to 13,167 tons, as compared with 12,978 tons in the preceding week, and 10,311 tons in the corresponding week of 1883. They included the following United States, 1210 tons; Canada, 2142 tons, Australia, &c, 420 tons; France, 120 tons; Italy, 1153 tons, Germany, 2931 tons, Russia, 183 tons, Holland, 457 tons, Belgium, 210 tons, and other countries, lesser quantities The stock of pig iron in Messrs Connal and Co's public warrant stores yesterday afternoon stood at 584,527 tons, as compared with 584,922 tons yesterday week, showing a decrease of 395 tons over the week

Casting a Large Anvil Block —At the new basic steel works of Messrs Merry and Cunninghame, Glengarnock, there has just been cast, under the superintendence of Mr Finlay Finlayson, engineer for the works, the anvil block for the 10 ton steam hammer The block contains 215 tons of metal, and is the heaviest that has been cast in Scotland by about 30 tons Messrs Miller and Co, Coatbridge, sent two of their men to make the mould, and the whole operation was completed without a hitch

New Shipbuilding Contracts —Messrs. Caird and Co, Greenock, have just concluded a contract with the Peninsular and Oriental Steam Navigation Company to build another large steamer for that company, much the same as the Tasmanian and the Chusan, which have lately been handed over to the same owners The announcement of that contract has been good news to many of Messrs Caird's workmen, who were nearly all going idle for want of work Messrs A M'Millan and Son, Dumbarton, have secured a contract to build a sailing vessel of 1000 tons net register for Messrs Thomson, Dickie, and Co, Glasgow She is to be fitted out for the East Indian and Australian trades. A few days ago Messrs Russell and Co, Greenock and Port Glasgow, who have for a long time back been exceedingly busy, laid down the keel for an 1800-ton iron ship, for Messrs. P Denniston and Co., Glasgow

Large Exportation of Flooring.—Last week the barque Berwickshire, of Glasgow, 900 tons, left the port of Montrose for Melbourne, with upwards of 1000 tons of flooring boards, shipped by Messrs Robert Millar and Sons, timber merchants

Aberdeen Water Works.—It is proposed by the Water Committee of the Town Council of Aberdeen to apply in the ensuing session of Parliament for a Bill authorising them to provide an additional supply of water at a total estimated cost of 80,000*l*. The intention is to construct two new reservoirs at Mannofield, two new middle service reservoirs at Hill of Pitfodels, and to lay down a pumping station at Cults. When these proposed works are carried into execution the supply of water taken from the River Dee at the intake will be increased from six to eight million gallons per day.

Opening of New Coal Seams —On Saturday last, Messrs. Gardner and Sons, of Meiklehill Colliery, near Kirkintilloch, reached the Kilsyth coking coal seam in the new pit, which they have been sinking during the last two years The coal was found to be 3½ ft. in thickness, and of the usual first class quality of steam or coking coal. The area owned and leased by Messrs. Gardner extends to 500 acres, and it is estimated that it will yield 2½ millions of tons of this famous coal This quantity will allow of a large output for many years, and will contribute largely to the prosperity of the district. The depth of the new pit is nearly 150 fathoms, and it is noteworthy that during the whole time it has been sinking not a single accident has occurred.

Monkland Iron and Coal Company —In the report just issued by the directors of the Monkland Iron and Coal Company, it is stated that the accounts show that the loss for the past year has been 26,170*l* 4s. 6d., making with the preceding year's loss a total of 46,861*l*. 16s. 11d.

A very despondng view is taken of the present position and future prospects of the company

The Steel Company of Scotland —The annual meeting of the shareholders of this company was held to day, when a fairly satisfactory report was submitted by the directors, its leading feature being a recommendation to declare a dividend of 7½ per cent In moving the adoption of the report, the chairman (Mr Charles Tennant, M P) made a satisfactory statement regarding the condition of the works, and the prospects of the steel trade

NOTES FROM THE SOUTH-WEST.

Llwydarth Tin-Plate Company — This company, of which Mr D Gray is managing director, has purchased the tin plate works at Caerleon, which have been idle for some years.

Newport —The best qualities of steam coal are those which have been in most demand , for secondary qualities the inquiry has continued weak The improved tone in house coal has been confirmed Iron ore has continued quiet Last week's exports of manufactured iron were 220 tons to Rio Grande, 1805 tons to Buenos Ayres, and 20 tons to Smyrna. There is not much change to report in iron The tin plate trade has become somewhat quieter Last week's coal clearances 60,591 tons From Bilbao, there arrived 4000 tons of iron ore, and 6075 tons came to hand from other sources

Exeter and the Great Western Railway —At a meeting on Thursday of the Exeter Chamber of Commerce it was resolved to join with other bodies in preparing statistics to lay before the Railway Commissioners with reference to the fares and accommodation on the Great Western Railway below Bristol The rates and fares are alleged to be higher and the accommodation worse than those beyond Bristol

Cardiff - During the past week the steam coal clearances again reached a satisfactory total Steam coal continues to be quoted at from 10s. to 11s per ton The small coal market continues somewhat quiet House coal is in fairly good request The patent fuel market maintains a satisfactory tone , the foreign shipments have been heavy, and the works continue to be well supplied with orders The iron ore market is without alteration Last week's clearances comprised 151,781 tons of coal, 1201 tons of iron, 4550 tons of patent fuel, and 800 tons of coke From Bilbao, there arrived 6739 tons of iron ore, and 375 tons came to hand from other sources

Working Stock on the Great Western Railway —In the course of the half year ending June 30, 1884, the Great Western Railway Company expended 86,164*l* for additional working stock This expenditure carried the aggregate outlay made by the company for working stock to the close of June, 1884, to 8,324,915*l* At the close of June, 1884, the company owned 1577 locomotives, 785 tenders, 4588 vehicles used in the coaching department, and 37,425 vehicles used for the conveyance of merchandise and minerals In the course of the current half year, it is proposed to expend a further sum of 110,000*l* for additional engines, carriages, wagons, &c

The Tin-Plate Trade —Steel plates are better Wasters of charcoal, coke, steel, and ternes are sold cheaply and bought largely.

Permanent Way on the London and South Western Railway —In the course of the half-year ending June 30, 1884, the London and South Western Railway Company expended 152,262*l* in the maintenance and renewal of way and works, as compared with 146,746*l* expended under the same head in the first half of 1883 The length of line maintained in the first half of this year was 708 miles 39½ chains, as compared with 707 miles 50½ chains in the first half of 1883 It should be observed, however, that 505 miles 69 chains of double line were maintained in the first half of this year, as compared with 498 miles 29 chains in the first half of 1883 The cost of the materials used in the first half of this year was 51,559*l*., as compared with 49,134*l* in the corresponding period of 1883.

NOTES FROM SOUTH YORKSHIRE

SHEFFIELD, Wednesday.

Messrs William Jessop and Co's Dividend.—The directors of Messrs. William Jessop and Co , Limited, have declared an interim dividend for the half year of 15s. per share, payable on the 1st of October.

Tennant Brothers, Limited —The annual report of the directors of this company states that there is a balance of 7568*l* 3s 1d , which, after payment of interest on mortgages, leaves 5044*l* 0s 9d , making, with 137*l* 7s 3d brought forward from the previous year, the sum of 5181*l* 8s available for dividend The directors recommend the payment of a dividend of 5*l* per cent per annum, free of income tax, on the paid up capital This dividend will absorb 4998*l* 17s. 5d , leaving 182*l*. 10s 7d to be carried forward to next year.

Belper Gas and Coke Company —The directors of this company at their monthly meeting resolved to reduce the price of gas, on and after the 1st of October, 6d per 1000 ft. This reduction, which is to come into operation on the 1st proximo, will bring the price down to 3s 3d per 1000 ft., subject to very liberal discounts This makes the third reduction within three years. The company also contemplate supplying to their customers either on hire or purchase, the most improved cooking stoves and appliances The directors are of opinion that no company of a similar status to this are supplying gas at so cheap a rate as proposed.

Threatened Strike at the Barrow Collieries, Barnsley — The whole of the colliers employed at the Barrow Hematite Collieries in the Silkstone and Parkgate seams have given in their notices to leave their work in fourteen days, and the company on their part gave fourteen days' notice to all the day men and lads in their employment The men have given notice because of a dispute which has arisen as to the mode of working the Thorncliffe seam at the colliery, the company desiring to work only the south side of that seam with two colliers in each working place, formerly worked in by one collier and his trammer Altogether about 1000 men and lads are affected by this affair

The Masborough Chemical Company —On Thursday about forty men ceased work in the alum department of the Masborough Chemical Works, but the sulphuric acid branch will be continued for a short time longer The proposed closing of the works is in consequence of an order of the Court of Chancery to close the liquidation proceedings Steps are being taken to find a purchaser, and, if successful, the works will not long remain idle

Leeds Corporation Stock —A special meeting of the Leeds Town Council has been held for the purpose of authorising a further conversion of the floating debt of the Corporation into funded stock The mayor (Alderman Woodhouse) presided In replying to a letter from the town clerk of Leeds, conveying the decision of the Council in regard to supplying water outside the borough, the town clerk of Bradford wrote "The result is no more than was expected at the hands of so honourable a body of gentlemen as your Corporation " Alderman Boothroyd, chairman of the Finance Committee, moved resolutions authorising the conversion of any perpetual annuities issued by the Corporation, or any portion of their debt now subsisting on security of outstanding mortgages or bonds of the Corporation, not exceeding altogether the sum of 250,000*l* , into debenture stock of the Corporation of the like amount, to be called "The Leeds Corporation Consolidated Debenture Stock," the whole of such stock to be redeemed at par on the first day of July, 1927, unless it has previously been redeemed by agreement with the holders of such stock, or any part thereof respectively, the stock in the mean time to bear interest at the rate of 3*l* 10s per annum In doing so Mr Boothroyd said the market was in a very favourable condition just now, and as they never knew what might happen, they thought it advisable to call a special meeting of the Council instead of waiting until the next meeting The Committee would issue the stock on the best terms they could get The quotations in London of Leeds stock was 102½ to 102¼, as against 101 in Leeds , but the difference was accounted for by the fact that in the former case the price included accumulated interest and the latter did not The motion was seconded by Alderman Bower, and after a few remarks from Alderman Scurr, who said the action of the Committee was a perfect justification of the course he had pursued from the first in regard to this stock, was carried

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES

MIDDLESBROUGH, Wednesday

The Cleveland Iron Market —Yesterday the market at Middlesbrough was fairly well attended, but there was no change in prices No 3 was again quoted 30s 3d to 30s 6d per ton g m b f o b , special brands being still 37s Telegrams stated the Glasgow market to be a little stiffer owing to a belief that the production of pig iron in Scotland is to be lessened by the blowing out of several furnaces connected with a works which has not been paying lately Shipments at Middlesbrough continue good, being 44,800 tons up to date this month, against 39,800 tons to same time in August, and 49,800 tons to corresponding time last year The manufactured iron trade remains in a depressed condition on the basis of 5*l* per ton for ship plates, and 4*l* 17s for angles, less 2½ per cent on trucks at makers' works.

Closing of Messrs Jones Brothers' Works —Owing to the low prices now ruling and the difficulty there is in getting orders sufficient to keep plant in full operation, Messrs Jones Brothers, of the Ayrton Rolling Mills, Middlesbrough, have closed their works entirely, and do not intend to reopen them until they can see their way to carry on business at a profit It is highly probable that other manufacturers will shortly follow the example of Messrs Jones.

Engineering and Shipbuilding —The Tyne is more active than either the Wear or the Tees, but at the best there is comparatively little doing Bridge builders and general engineers are fairly well occupied, but marine engine makers are badly employed The foundries are busy, more especially the big pipe makers like Messrs Cochrane, Grove, and Co , of North Ormesby, Middlesbrough, who are executing some large contracts to London merchants' orders.

The Teesside Iron and Engine Works Company, Limited —The directors' half yearly report to this company has just been issued, and will be submitted at the shareholders' meeting to be held at the extensive works, Middlesbrough, at the end of this week The report states that two of the four furnaces were blown out at the end of February in accordance with arrangements with other ironmasters The reduction in make consequent upon the blowing out of eighteen furnaces of the district at that time, and subsequently three more, has no doubt prevented the increase of stocks, but has not as yet had the desired effect of raising prices to a paying point, and it is to be regretted that this department has been worked so far without profit Owing to the continued unsatisfactory prices of finished iron, the rolling mills still remain closed The shipyard has now been so far completed as to be capable of executing orders for ships of large tonnage, but the shipbuilding trade is at present so depressed that the directors have not thought it a favourable time either to commence shipbuilding themselves or to put the yard in the market The capital expended has been comparatively small

The Wages Question —The Board of Arbitration will again consider the question of wages in the manufactured iron trade on Friday afternoon, and will do one of three things, viz , adjourn for a fixed time the claim of reduction and counter claim of advance, agree to a sliding scale, or refer the whole subject to an arbitrator. The latter course is the most probable

FOREIGN AND COLONIAL NOTES

An Oyster Fleet - Work on two new iron steamers for Maryland's oyster fleet has been started at Neafie and Levy's shipyard, Philadelphia The vessels will be screw steamers designed as revenue cutters, and schooner rigged They will be 115 ft long over all, 21 ft beam, and 9 ft 6 in deep, with a draught of 7 ft 6 in They are to have a guaranteed speed of 14 miles per hour The vessels will cost 29,995 dols each One will be delivered this month, and the other on October 1 They are intended to guard from the depredations of outside dredgers, the oyster fields of that part of Chesapeake Bay over which Maryland has jurisdiction

An American Gun —The construction of a 6 in wire wound gun has been begun at the Navy Yard at Washington This is said to be the first attempt in the United States to make a gun entirely from American steel

Denver and Rio Grande Railroad -It is now said to be settled that a third rail will be laid on the Denver and Rio Grande Railroad between Ogden and Salt Lake without delay, so that Central Pacific trains may run into Salt Lake city

New Brunswick Work on the Caraquet Railway has been commenced, and arrangements for pushing forward the work without further delay have been satisfactorily made

Dry Dock for Port Adelaide Preliminary operations are being pushed on by Mr H C Fletcher at the site of his new dock at Port Adelaide, and in a short time the main excavation will be commenced

Water Supply of Adelaide Some time since the late South Australian Government being desirous of developing and encouraging local manufactures, determined that the water pipes for the existence and maintenance of the Adelaide city and suburban water supply system should be of colonial make In conformity with this intention, special facilities were given to local founders, and tenders were invited for 12,000 tons of cast iron pipes, the tender to extend over a period of four years Only two offers have been received, the lower one being that of Messrs Fulton and Co The value of the work proposed to be contracted for is about 100,000*l*

American Locomotive Building The Baldwin Locomotive Works, Philadelphia, have taken a contract to build ten *Mogul freight engines for the Central Railroad of Georgia, to be delivered in time for autumn business*

Earthquakes and Steam Engines A 300 horse power pumping engine at the Flatbush (Long Island) Water Works was stopped by a recent earthquake, and did not fully resume work for three days, owing to necessary repairs The injury was caused by the oscillation of the water tower at the city line, which contains 1,500,000 gallons, and created a back pressure sufficient to break the pump

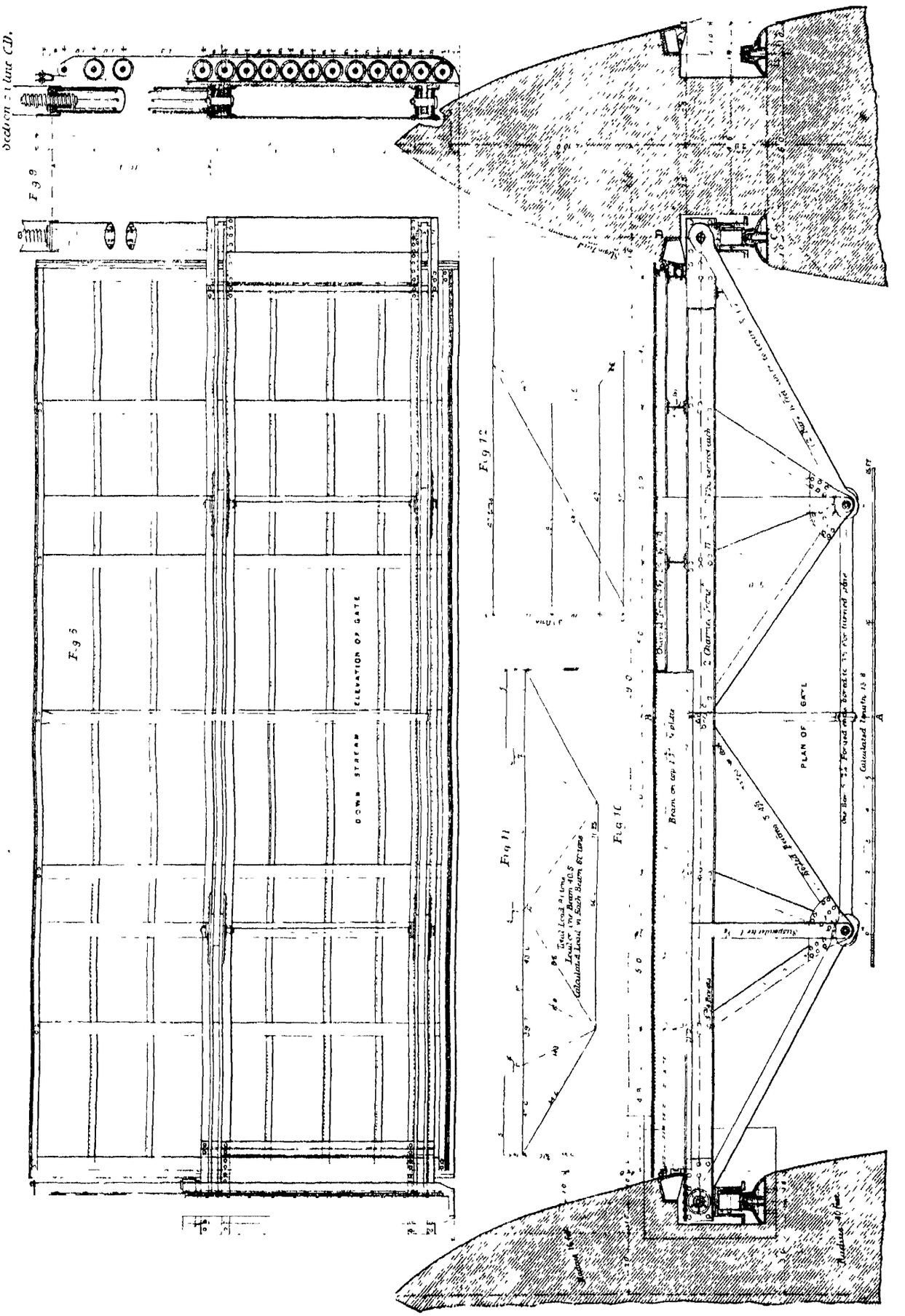
STOCKPORT AGRICULTURAL SHOW ERRATUM — In our account of the Stockport Agricultural Show last week, we inadvertently stated that Messrs J and H McLaren's six horse-power engine made 13 laps, and the eight horse engine 6¼ laps It was the eight horse engine which made the best record, and the six horse engine which was partly disabled by the bornings in the cylinder

THE SPANISH NAVY — A Commission appointed to consider the reorganisation of the Spanish Navy has matured its general plan, and has submitted it to the Spanish Government The Commission has endeavoured to bear in mind all the conditions associated with the defence of the Peninsula, the West Indies, and the Philippine Isles The Commission is of opinion that there are grounds for separating the general naval service of Spain from the coast guard service, and that the latter service must have vessels of its own stationed at various points The results of such a measure would, in respect of economy and efficiency, be, in the opinion of the Commissioners, much superior to those now obtained The number of ironclads now owned by Spain is twelve, of which six are first-class and six second class vessels The Commissioners propose that some second class ironclads and two cruisers should be stationed in the West Indies, and at the Philippines, with the view of protecting the colonies of Spain in those quarters The remaining ironclads should, in the opinion of the Commissioners, be employed in the ports and waters surrounding Spain itself By this means it is urged that the budget of the Spanish colonies would be considerably relieved The Commissioners propose that a flotilla of fourteen torpedo boats should be provided, as they consider that torpedoes will sustain a considerable rôle in future naval wars As regards cruisers, the Commissioners recommend the prompt completion of some which are now in course of construction, and also that an additional cruiser of large size should be built The Commissioners also urge that all modern improvements should be introduced in this class of vessels

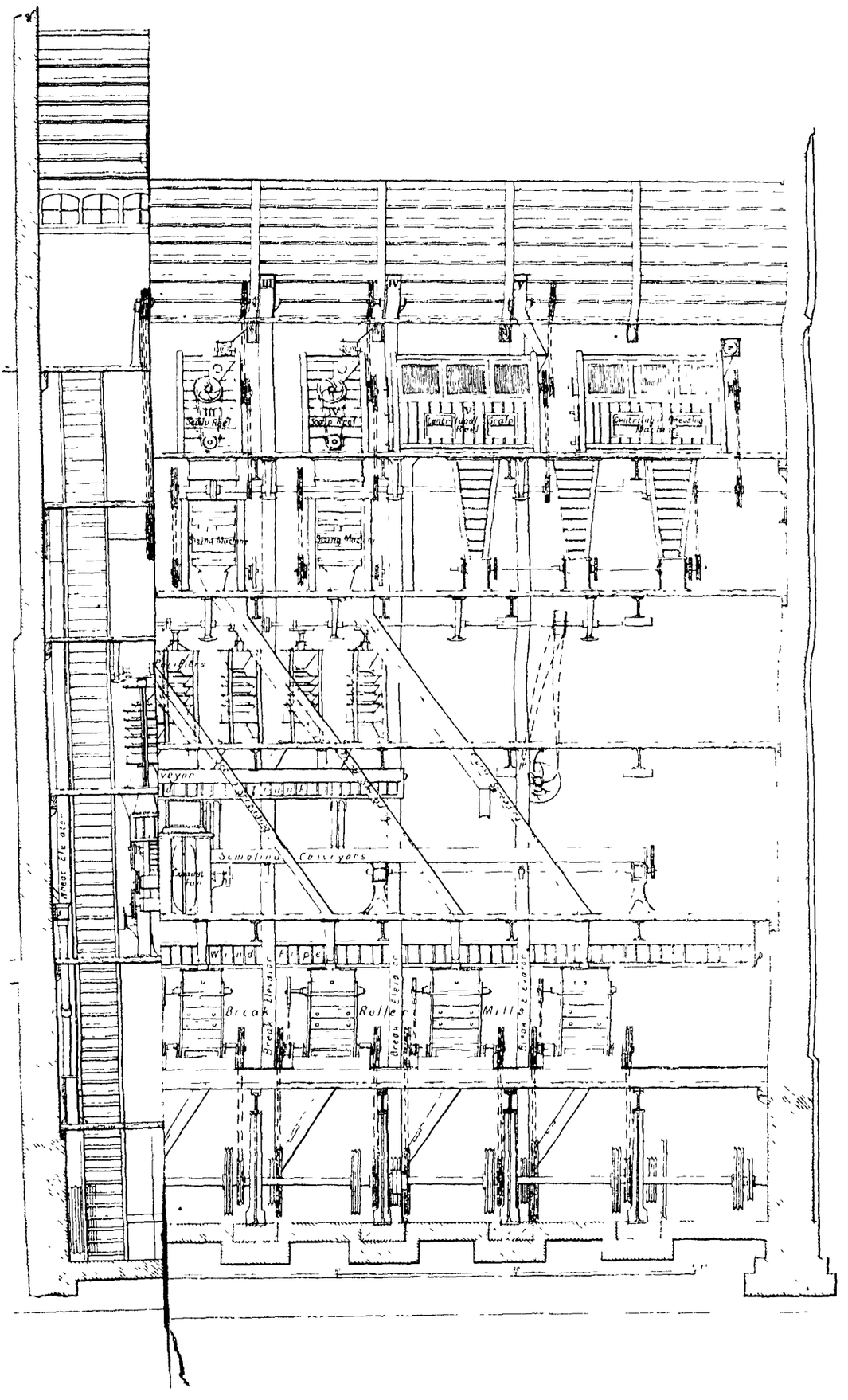
SLUICES AT THE LOUGH ERNE DRAINAGE WORKS.

CONSTRUCTED FROM THE DESIGNS OF MR F. G. M. STONEY, LONDON.

(*For Description, see Page 268.*)



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The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

NOTICE OF MEETING

THE IRON AND STEEL INSTITUTE.—The autumn meeting of this Institute will take place in the City of Chester, on September 23rd and three following days The following is a list of papers and subjects for discussion —"On the Geology of Cheshire," by Mr Aubrey Strahan, of H M 's Geological Survey, London; "On Improvements in the Siemens Regenerative Gas Furnace," by Mr Frederick Siemens, C E, London, "On Recent Improvements in the Method of the Manufacture of Open Hearth Steel," by Mr James Riley, Glasgow, Member of Council, "On a New Form of Regenerative Furnace," by Mr F W Dick, Glasgow, "On the Manufacture of Crucible Steel," by Mr Henry Seebohm, Sheffield, "On the Recovery of By Products from Coal, more especially in connection with the Coking and Iron Industries," by Mr Watson Smith, Owen's College, Manchester, "On the Most Recent Results obtained in Germany in Utilising the By Products from Otto and other Coke Ovens," by Dr C Otto, Dalhausen, "On the North Eastern Steel Company's Works at Middlesbrough, and their Products," by Mr Arthur Cooper, Middlesbrough, "On the Spectroscopic Examination of the Vapours Evolved on Heating Iron, &c, at Atmospheric Pressure," by Mr John Parry, Ebbw Vale The following programme of arrangements may be subject to slight modification —Tuesday, September 23rd, 10 30 a m General Meeting of Members in the Town Hall Reception by the Mayor (Chairman of the Local Reception Committee), the Right Rev the Lord Bishop, the Dean of Chester, and other Members of the Local Committee 1 0 p m Luncheon at the Grosvenor Hotel 2 30 p m Depart from the Grosvenor Hotel, in special conveyances, to Eaton Hall, Park, and Gardens, and Hawarden Castle and Grounds, 7 0 p m Annual dinner (Grange-Institute, in the Grosvenor Hotel Wednesday, September ... 10 0 a m General meeting of Members in the Town Hall ... p m Depart from Chester by special train, to visit the C ... Locomotive and Steel Works Luncheon will be provided, on ... invitation of the London and North Western Railway Comp... 6 0 p m Leave Crewe by special train for Chester Thurs... September 25th, 10 30 a.m General meeting of Members in the ... Town Hall 1 30 p m Luncheon at the Grosvenor Hotel Alternative excursions —No 1, 3 0 p m Depart by special trains for the Salt Mines and Works at Northwich (16 miles) The return train will leave Northwich about 5 30 o'clock It is expected that arrangements may be made for illuminating some of the mines No 2, 2 45 p m Depart by special train for the Alkali Works at Flint (11 miles) The return train will leave Flint about 5 o'clock At 3 o'clock the Very Rev Dr Howson, Dean of Chester, will receive such Members as are interested in local antiquities, in the cathedral, which he will describe, as well as the ancient church of St John the Baptist and the adjoining ruins of the Priory 8 0 p m A conversazione, to which the Members of the Institute and lady friends are invited, will be given by the Chester Society of Natural Science, in the Town Hall The following works in Chester and its neighbourhood will be open for the inspection of Members any day during the week, upon production of cards of membership

The Lead Works The Gas Works The Hydraulic Engineering Works The Water Works The Dee Iron Works	Chester
Lloyd's Cambrian Chain and Anchor Public Testing Company's Works The Dee Oil Works The Patent Candle Works	Saltney
Sandycroft Foundry and Engine Works (5 miles by Holyhead Railway)	
Mostyn Iron Works (21 miles by Holyhead Railway)	

The following collieries will also be open for inspection during the week, viz —

Plas Power Gatewen Westminster Wynnstay Colliery, Ruabon	Wrexham

Friday, September 26th This day will be entirely devoted to an excursion into North Wales The programme is intended to embrace Ruabon, the Vale of Llangollen, the Festiniog Slate Quarries, Portmadoc, Carnarvon, and Bangor visiting *en route*, if time should permit, Carnarvon Castle and the Menai and Tubular Bridges

ENGINEERING.

FRIDAY, SEPTEMBER 19, 1884.

A DEFENCE FOR PENISTONE

SIR EDWARD WATKIN and his colleagues have at length been goaded into making a reply, if so it can be called, to the remarks on the inefficient character of the brake in use on the Manchester train which was wrecked at Penistone, and we think most people will agree with us that the advocates of automatic brakes have no reason to be otherwise than grateful to the directors of the Manchester, Sheffield, and Lincolnshire Railway for penning such an effusion as that which their secretary has sent to the Railway Department of the Board of Trade This defence (!) consists briefly of an abusive attack on the Board of Trade and their inspecting officers, as well as on the Westinghouse brake, and a protest against that legislation which Sir Edward Watkin and the various companies he controls are doing so much to bring about There is absolutely no real defence attempted, and the letter reminds us irresistibly of the well-known instructions to a learned counsel, "No case, abuse plaintiff's attorney" First, Major Marindin is censured for casting blame upon the company for the "non-adoption of a particular form of automatic brake—presumably the Westinghouse brake, which appears to be considered as 'the Board of Trade brake'" We need hardly say that the inspector never alluded to any particular brake, but was content to do his duty by simply showing that whereas the vacuum brake had failed to be of the slightest use, one having superior qualifications would have been of the greatest service, and he says "the value of a brake having rapid action, and above all, automatic action, in such a case as this, can hardly be contested" It is quite true that the Westinghouse brake is distinguished by, and has frequently proved itself in emergencies to be possessed of, the qualities which Major Marindin finds so essential, and it is so far gratifying that the Manchester and Sheffield directors are so quick to recognise this fact from Major Marindin's description of what is required The secretary, however, following the example of the North-Western chairman, goes on to quote Colonel Yolland's remarks on the Westinghouse brake, from the report on the Blackburn collision Sir Edward Watkin has not always been so ready to adopt the views of "so experienced an officer as Colonel Yolland," and he can hardly have forgotten the estimate he formed of that gallant officer's powers when reporting on the Channel Tunnel That there was considerable animus displayed against the Westinghouse-copper, copper-liquid, and liquid-zinc, Volta considered the first the most important, but he himself thought it the least important Whenever we measure electrostatically we have together air metal, the metals M and M¹ Which of these three-ssed himself in favour[illegible] of s conclusions on the Blackburn collision, as we showed at the time, were based upon theories which had no foundation in fact, and which there was neither argument nor evidence to support, whereas several witnesses who were passengers in the tram, swore positively that they distinctly felt the brake in action up to the time of the collision, and the verdict of the jury was to the effect that the accident was solely due to the loose system of working the signals and to the recklessness of the driver We may add, too, though not perhaps palatable information, that the Lancashire and Yorkshire Company contested no claim, and paid, it is said, some 50,000*l.* in compensation Major Marindin is further accused of going out of his way to create a prejudice unfavourable to the Manchester, Sheffield, and Lincolnshire Company, by "using arguments which, however ingenious, may from their purely hypothetical character, be altogether fallacious." Most people will think that the bare possibility of saving life is sufficient *reason to justify the use of any well-tried appliance*, but experience of numerous cases of a similar character to that at Penistone, where trains have been thrown off the line, renders it, humanly speaking, certain that a quick acting automatic brake would have had most beneficial results, and that in all probability not a life would have been lost Under any circumstances, no brake could possibly have behaved worse than did the vacuum contrivance with which the tram was actually equipped, and the defence on this point is as weak and absurd as that of other portions of the letter in question. The Penistone disaster, with its shocking list of killed and injured, is a fact, and there is, at all events, nothing hypothetical or fallacious in the reasoning that, however little use an automatic brake might have been, the vacuum brake employed was as powerless to prevent this calamity as though no brake had been fitted at all

The feelings of Sir Edward Watkin and his directors would also appear to be seriously hurt by the allusion in Major Marindin's report to the recent accident at Dinting on the same railway, and this is quoted by these gentlemen as a further *proof that undue prejudice is sought to be created* against the Sheffield Company The inspector reminds the directors that they had a few months before received an "emphatic warning as to the need for automatic action, when after a carriage had left the rails when running at high speed near Dinting Station, the vacuum brake pipe was severed, the brake became useless, and the carriage was dragged along off the rails for over 350 yards further than it would have been if the brakes had remained on, at the imminent risk of falling, and taking with it the carriages behind it, over a viaduct of 100 ft in height' Is this incident a fact [illegible] by is it another illustration of hypothetical or fallac[illegible] Pro- reasoning! It cannot be supposed that Sir Ed[illegible]eries," and his colleagues really refuse to be convi[illegible]plate until sufficient lives have actually been sacrifi[illegible] space yet this is the logical effect of their reason[illegible]re of though Penistone would appear to have left th[illegible] dis- still in doubt The public are greatly indebted[illegible]icity, the Board of Trade inspector for his pointed [illegible]ore, apposite allusion, and they will disregard th[illegible] of wounded feelings of the Manchester and Sheffield[illegible] directors, who, had they been wise, would have taken the reproof in silence, and have resolved to amend their ways for the future

The concluding paragraph of this epistle is not the least remarkable, and is as follows "The general tenor of the reports of the officers of the Board of Trade would seem to justify a suspicion that they are written under instructions with a view to form a groundwork of legislation inimical to railway property and to the interests of railway shareholders, and for this reason my directors feel they would be wanting in their duty to their constituents if they did not enter their protest against such manifest injustice" It would be interesting to know if Colonel Yolland is included in this sweeping charge of writing to order, but in any case such a piece of impertinence is not calculated to further the interests of Sir Edward and his party The Board of Trade and its inspecting officers know how to take care of themselves as Sir Edward has good reason to be aware, and as their views have been

to
tain
One w[illegible] Company had already forgotten the fact that twenty-four people were killed, and sixty-two seriously injured at Penistone on the 16th of July last, and yet for proposing to put a stop to this wholesale slaughter, the Board of Trade and their officers are accused of "manifest injustice," and this when reason, argument, and evidence are entirely in their favour. But it will naturally be asked, if the Manchester and Sheffield, and other companies are to suffer manifest injustice by the compulsory adoption of automatic brakes, what is to be said of the several hundred companies in America, upon the Continent, and other parts of the world who have voluntarily adopted these appliances to the extent of some 80,000 sets of the Westinghouse brake alone? Have they betrayed their trust, and acted in a manner "inimical to railway property, and to the interests of railway shareholders"? We have ourselves good reason for desiring that these interests should be protected, but we fail to see that any company can have them much at heart which provides an appliance that admits of a train being wrecked into matchwood, and the killing of twenty-four people in a way which we can hardly believe was to their "interests." In face of the simple facts, is it not incongruous to find the Sheffield Company posing as the champion of railway property and the interests of railway shareholders? As we have already said, the letter from the secretary contains no word of argument or allusion to evidence to controvert the opinion of Major Marindin. The case indeed is one which does not admit of it. Should the Manchester and Sheffield and other companies persist in their course of obstruction, there can be no doubt that the public will demand legislation. But if this prospect has such terrors, surely the simplest course is to follow the example of other companies, who with a view of protecting their property and the interests of their shareholders, have already taken the step Sir Edward Watkin professes to consider so dangerous, and whose action would only be confirmed, and not hampered, by legislation. The letter says: "If the Board of Trade or Parliament will say that a particular kind of brake is to be adopted by all railway companies, no one would have ground of complaint." In face of the remarks which follow, as to the "manifest injustice" of such a course, this sounds somewhat contradictory, and the letter would appear to have been written with a view of protesting against intended legislation. The Board of Trade are clearly justified in urging their views when the lives of travellers are at stake, and should Parliament give them the powers, there will be no hardship in their insisting upon their conditions being complied with, not because they are only attainable [illegible] a particular form of brake, as is suggested, but, [illegible]use no brake which comes short of their standard, [illegible]give that security to the public in those emergen[illegible]and contingencies of railway working which the [illegible]erience of over fifty years has taught us have to [illegible]rovided against. That the Westinghouse should [illegible]present be the only brake which can thoroughly [illegible]fil their conditions, can surely not be urged as a [illegible]son why the Board of Trade should hesitate to [illegible]xpress its opinions, or become an argument that they should frame another set of conditions to suit less efficient appliances. We would ask these opponents of the Board of Trade whether they can suggest [illegible] other qualifications which are more likely to be [illegible]ce than those required by the Board of [illegible] of ser[illegible]hen such emergencies arise as those of Trade, [illegible]and Downton. This has never been Penistone [illegible]The causes which lead to such calami[illegible] attempted. [illegible]occurring since trains were set in [illegible]ties have been [illegible]continue to recur so long as rail[illegible]motion, and wil[illegible] remedy has, however, been [illegible]ways exist. [illegible]that of a powerful automatic suggested beside[illegible]us in action on trains of any brake, instantaneo[illegible]e by guards or driver under length, applicable a[illegible]ing traffic, and which, when all conditions of work[illegible]ain on until purposely re[illegible]once applied, will rel[illegible] released.

It must be remembered [illegible]hat there is nothing exceptional in the idea that the [illegible] Board of Trade conditions should be granted powers to make their [illegible]ent has compulsory. For many years this departm[illegible] which exercised control over all new works, none o[illegible]ened for traffic until passed by a Board of [illegible] inspector who has certified that it is in a [illegible] and proper condition, and complies with the [illegible]rd of Trade regulations for railways. The latter [illegible]ady comprise matter relating to the strains on [illegible]ders, to platforms, permanent way, signals, sidings, bridges, level crossings, the block system, the interlocking of points and signals, and other subjects; and this being the case, we contend that there is nothing illogical or inconsistent in the Board of Trade being granted powers to insist upon the conditions which experience has so often proved to be just as essential to public safety, if not more so, than the other matters over which they already have control. Sir Edward Watkin, Mr. Moon, and other opponents of the Board of Trade, would appear to forget that the disturbing forces inseparable from railway traffic, as now carried on, are constant; whereas the powers of resistance to these forces are varying from day to day without warning, and therefore require the assistance of another power to prevent or mitigate the consequences of this unequal struggle. To suggest, as is virtually maintained by advocates of non-automatic brakes, that when engines and trains are connected, intact, and complete, continuous brakes are a valuable adjunct to safety, but that, when they are separated, or the brakework injured, it is right and proper that the carriages should be uncontrolled and unprotected, will, we venture to say, be a greater puzzle to future generations even than it is to our own. Those who continue to support such a contention must not be surprised if their motives are questioned, and their professions of tender care for the shareholders' interests, considered subservient to their personal prejudices.

THE CONSTRUCTION OF ORDNANCE.

In our issue of July 25, we reviewed a book on "The Application of Wire to the Construction of Ordnance," by Mr. James A. Longridge, with which those of our readers who take an interest in the subject are by this time doubtless familiar. In this book we have the somewhat novel sight of one eminent man holding views apparently diametrically in opposition to those generally received and acted on by the great gunmakers and artillerists of the world. We say apparently, because upon investigation we find that these views are not so very much opposed as might appear at first sight, and that really the great points at issue are, whether guns can be made a certain strength, and if so, how to do it. We propose discussing the different points raised by Mr. Longridge, and endeavour to give an impartial opinion on the questions at issue. These questions are of vital importance to us as a nation, and we feel sure that even if we fall short in our endeavours to do justice to both sides, yet that by ventilating the subject and causing it to be discussed, we shall be doing good. Mr. Longridge in his book has confined himself more particularly to the doings of Woolwich and Elswick, and since what we propose to do now is simply to see if our gun manufacture can be improved in the particular direction pointed out by Mr. Longridge, we also will confine ourselves to the two great representatives of English gunmaking.

It will be remembered that the points raised by Mr Longridge were as follows:

1. That slow-burning powder is a retrogade step, and is introduced, not because it gives the best results, but because we cannot build guns strong enough to burn the quick powder, and further that weight for weight, the quick powder gives the best results.

2 That the principle of building guns with a thick homogeneous A tube is a mistake.

3. That the Elswick guns are in advance of those of Woolwich manufacture, but that neither are constructed on proper scientific principles.

4. That he (Mr. Longridge) made, twenty years ago, a perfectly successful wire gun.

5. That accuracy in shrinking on hoops in a hooped gun, or laying on wire in a wire gun is essential.

6. That the practice of chambering is to be condemned.

7. That distinct portions for giving circumferential and longitudinal strength should be used.

We will proceed in the present article to discuss in some detail the four first points.

1. On the position taken by Mr. Longridge on the question of slow-burning powder there can scarcely be two opinions, and though the author has taken a great deal of trouble to show that the last part of his statement, namely, that "weight for weight quick-burning powder gives the best results," we do not see that any one attempts to dispute the truth of the bare statement. There is not the slightest doubt that it would be a material advantage could we use quicker explosives; for example, gun-cotton. What a tremendous gain it would be, could we use this as a propelling agent instead of gunpowder. Fouling and smoke would be abolished and four times the power generated. But, can a gun be constructed to stand a strain such as this? Even were the principles advocated by Mr. Longridge shown to be practically correct, we could not hope that any large gun, however constructed, could stand a strain of more than 40 tons (say) on the square inch. We speak subject to correction here, and it would be interesting to know what Mr. Longridge considers as the maximum strain that a gun of certain calibre (13 in., for example) could stand. In the 13 in. gun described by him on page 116 of his book, the strain which it is calculated to bear is, we see, about 35 tons, or that which would be produced in a closed vessel by gunpowder with a gravimetric density of .9.

In the paper read by Colonel Brackenbury, of the Royal Powder Factories, at the United Service Institute, and quoted by the author, we have a distinct statement that the necessity of taming down the spirit of artillery (as Colonel Brackenbury calls the powder) is greatly deplored by our authorities, and the weakness of the guns thoroughly appreciated. Hence, as we have said, artillerists and Mr. Longridge are really at one on this point, and the only question at issue here is whether a gun can be made strong enough to permit the spirit to have its full vent. Mr. Longridge thinks that (at all events, as far as powder is concerned) this can be done, and as far as we can see, nobody attempts to deny the accuracy of his statements. We will, however, deal with this part of the question later on.

With reference also to the question of quick and slow burning powder, we shall show hereafter, when dealing with chambering, that the ignition of a large mass of powder before the projectile starts, is by no means an easy matter, and the larger the charge and the denser the powder, the harder the operation becomes. This shows that if we succeed in building guns capable of standing heavy pressures, we will have to look elsewhere for our propelling agent, or else improve the igniting arrangements.

2. Mr. Longridge maintains that the principle of building guns with a thick homogeneous A tube is a mistake.

Here we have a case where there is a decided difference of opinion, and according to our views the author is quite right. For independently of the reasons given by him, and supported by investigations and formulæ, if we assume that the pressures on a thick homogeneous tube vary inversely as the squares of the radii, then the pressure on firing, transmitted to the outside of this thick cylinder will be in this ratio, supposing the metal to be incompressible. This, however, is not the case, and therefore we have a smaller strain than this transmitted to the outside. Now suppose wire to be wound on at a tension equal to this strain, then the actual tension that will be passed on to the interior will not be this tension into the square of the thickness, but this amount, less that lost by the compressibility of the material. Hence the wire would have to be wound on at a higher tension than is actually required, and we could not get that desideratum in a well-constructed gun—an equal strain on all parts. We see both Elswick and Woolwich departing from this principle, though both acknowledge it to be theoretically correct. We can understand this being done at Woolwich, since they boldly say that it is impossible to carry the theory into practice, but Elswick has always stuck to the thin coils, and we fail to see why they have now departed from these principles. Colonel Maitland's theory about the outer portion being able to bring up its strength to reinforce the inner with slow-burning powder, though there is not time for it to do so with the quick powder, we hold to be quite untenable, and Mr. Longridge's reasoning against it appears unanswerable. The principle of using cast-iron as a core we are hardly prepared to agree with, inasmuch that there is one point that the author does not deal with, when urging its advantages for this purpose; this is the uncertainty and liability to flaws in that material. Yet, from the description

given of the performances of Captain Blakely's gun (page 159) we pause before we condemn the principle, though even these performances fail entirely to show that cast-iron can be treated entirely as a trustworthy material. The particular cast-iron used there happened to be good, but it does not follow that it can always be obtained so.

3. Elswick guns, according to Mr. Longridge, are in advance of those of Woolwich manufacture, but neither are constructed on scientific principles.

The latter part of this statement is doubtless true, if we accept the theoretical proofs adduced by the author, but the former part, we think, requires verification. The actual proof of the value of a gun, must be demonstrated by (*a*) its power of doing mischief, (*b*) its safety, (*c*) and its endurance.

With regard to the first point, there can be little doubt that Elswick has as a rule led the way in the introduction of new and improved ordnance, and were this the only point on which the matter hinged we would at once agree with the author. While on this subject it might be as well to pause for a moment and see what reasons exist for this leadership on the part of Elswick. One reason at once suggests itself. The private firm has for its leaders men who have more or less devoted their lives to the subject and whose own individual interests are immediately concerned in the well-doing of the business. The Government factory, on the contrary, has at its head men who though they may be very good of themselves, yet are only there for the time and have other professional duties to make themselves familiar with. Nor have they the same interest in devoting themselves body and soul to the work as the members of a private firm. On the other hand, the Government have wider means of acquiring information, and if they only possessed the power of using the brains which are so lavishly placed at their disposal, this should be more than sufficient to counteract the other effect. This, however, is a digression and we have no wish to try and reform either establishment.

With reference to the safety and endurance of the guns manufactured at the two yards, we certainly do hear of the Woolwich guns coming to grief, but it appears to us that the Elswick company can as little boast of their ordnance being free from failure. We hear of guns coming in through their trunnion hoops, and though very little has been said about the matter, it is no secret that several of the 80 pounders (6 in. B.L.R.) guns failed during trial. We should very much like to see a return of the failures of the ordnance from the two firms which have occurred during the last ten years.

We now come to the fourth point, which refers to Mr. Longridge's claim that he made twenty years ago a perfectly successful wire gun.

It appears from the statement made in the book that the gun in question, which was sent to the Ordnance Select Committee for trial, was in an incomplete state in so far that it had no trunnions Now it must be remembered that the great difficulty with respect to wire guns has always been that of getting sufficient longitudinal strength, and it does seem rather rash of Mr. Longridge to trust his child into strangers' hands so insufficiently clothed. In those days (here we are open to correction), the system of placing guns in carriages without trunnions, and so getting the strain transmitted direct to the breech, was not dreamt of, and we can quite understand the Committee having doubts on the matter.

Still we cannot but be surprised at the very peculiar way in which they endeavoured to test the longitudinal strength, by securing the muzzle, and so bringing all the strain on the tube round which the wire was coiled. We cannot help thinking that Mr. Longridge could not have been sufficiently clear in pointing out that the gun was not intended to take recoil in this way. Very few persons realise the additional strain brought on a gun by the trunnions taking the recoil. Roughly speaking, if P be the powder pressure, then P into the area of the bore is the force tending to split the gun transversely. This force also acts in sending out the shot and in making the gun recoil. Therefore, if the checking of the recoil is to be done by the trunnions, we must have about as much additional strength between the trunnions and breech as is necessary to counteract the original longitudinal strain. Of course since the recoil must be checked we must have this additional strength somewhere, but as far as the gun itself is concerned, the arrangements for longitudinal strengthening can be materially reduced by transmitting the recoil direct from the breech.

The remainder of the points raised by Mr. Longridge we must leave for discussion in another article.

THE BRITISH ASSOCIATION.

On Wednesday, August 27, the British Association met for the first time beyond the limits of the United Kingdom, and commenced its deliberations in the City of Montreal. No less than 765 members had crossed the Atlantic to aid in the proceedings, while crowds of Canadians and Americans assembled to welcome the visitors and to do all in their power to render their stay both agreeable and memorable. Lord Lansdowne received the Association to the country, welcoming them in the name of the Canadian people, who he said, were not excelled in their desire for the diffusion of knowledge and culture. As Professor Cayley was not present, Sir W. Thomson introduced Lord Rayleigh, the new President, who entered the chair, and delivered a long address dealing with the advance which had been made in those branches of science with which his own work had been principally connected. The next day the work of the sections commenced, and was of unusual interest, as will be seen from the papers we have already published, and the subjoined summary of the discussions in the Physical and Mathematical Section.

Physical and Chemical Sections.

The work in Sections A and B was so heavy that no adjournment could be made before four or even a later hour in the afternoons, and Section A had finally to divide itself into two sub-sections, mathematics and physics. Notwithstanding this unusual arrangement, the final adjournment was again only reached after four o'clock, although the unfortunate authors of the last papers on the list had yielded to appeals from the chair to be as concise as possible. The main cause of the protraction of business consisted in the animated and most instructive discussions, to which both the Canadian and American members, amongst whom we may mention Messrs. Barker, Wolcott Gibbs and Willard Gibbs, Rowland, Carpmeal, MacGregor, Woolsey Johnson and Newcomb, liberally contributed. It cannot, however, be denied that the Council ought to insist upon papers, which from their character, are not adapted for immediate discussion, being communicated in the form of abstracts.

Sir William Thomson's address to Section A would of course form an exception to this rule, even if the presidential address were not exempt from the regulation about the time allotted to each speaker. It would, however, be quite useless to try to deal with Sir William's "Steps towards a Kinetic Theory of Matter" in a few words; and we must reserve his weighty address for a future occasion when we hope to print it *in extenso*. The list of papers is altogether so comprehensive that we shall have to confine ourselves to a few remarks on the most important ones. Professor Osborne Reynolds spoke upon the action of lubricants and kinetic elasticity; and Professors Ramsay and Young on the vapour pressures of a substance in the liquid and solid state at the same temperature.

On Friday morning Professor Dewar, in Section B, opened a discussion on the "Constitution of Elements," which mainly turned on dissociation, and the remarkable complex inorganic acids containing thousands of atoms to the molecule, which Professor Wolcott Gibbs had exhibited the day before. Professor Oliver Lodge introduced, by a very able paper, a discussion upon "The Seat of Electromotive Forces in the Voltaic Cell." Dr. Lodge has fully studied the literature bearing upon the real seat of electromotive force, and has discovered that very widely differing views exist, which may be a consolation to those who are not clear about this problem. The publications of Dr. Exner, of Vienna, on thermo-chemistry, he characterised as an extraordinary series of papers, whilst he spoke with great appreciation of the researches of Schulze-Berger and Von Zahn. Professor Lodge summarised his views thus: There is an electromotive force at the junction of two substances, and the total electromotive force is the sum of all those contact forces at any junction; it is wrong to regard the metallic junctions only, instead of every junction. Of the three main junctions, zinc-copper, copper-liquid, and liquid-zinc, Volta considered the first the most important, but he himself thought it the least important. Whenever we measure electrostatically we have together: $\frac{\text{air}}{\text{metal M}}$, metals $\frac{M}{M^1}$ and $\frac{M^1}{\text{air}}$. Which of these three plays the most important part is by no means clear; Dr. Lodge holds the two air junctions far more effective than is usually believed. Similarly we have in any series of metal plates instead of one electromotive force, always a three-fold sum. Electrostatic tests cannot teach us the real electromotive force.

The discussion opened rather disappointingly in so far as both Professors Rowland and Forbes, on being called upon, declared that they knew nothing about the matter. But it soon became lively and occupied the section for over two hours, when pressure of time brought it to a close. Sir William Thomson declared that to move a body through air to a zinc plate, and again to a copper plate soldered to it, would require amounts of work differing by the difference of potential of those plates. The electricity goes up hill from zinc to copper and downhill from copper to zinc as in a pipe system. If two plates are dipped into water they assume at once the same potential. This latter statement Sir William afterwards modified, stating that it refers, and approximately only, to water alone Professor Silvanus Thompson remarked that the Volta condenser measures the difference of potential between points outside the zinc and copper in the air. A zinc-copper plate is an air battery. If we immerse two joined plates, then the electromotive force will increase as the external resistance decreases until upon soldering the two together with an external resistance equal to zero, the full potential difference is reached.

Professor Willard Gibbs stated that there was no more real uncertainty about these facts than about the facts of capillarity or the motion of water in a pipe system of which one leg only is heated. The cause of force and motion may be heat or gravitation, or it may be the ninth man in a tug of war against eight, as well as the first man. Dr MacAlister put the question to Sir William whether two pieces of zinc and copper brought together in a hypothetical perfect vacuum would be electrified. Sir William affirmed this by replying that there is an attraction and consequent electromotive force, limited by the heat of combination which anticipates that a real combination takes place. To this opinion Dr. Lodge took exception; he assumes an attraction, but not connected with the heat of combination of zinc and copper, both copper and zinc are attacked by oxygen zinc more so, and the difference calculated for the zinc-oxygen combustion, minus the copper oxygen combustion, constitutes the volt.

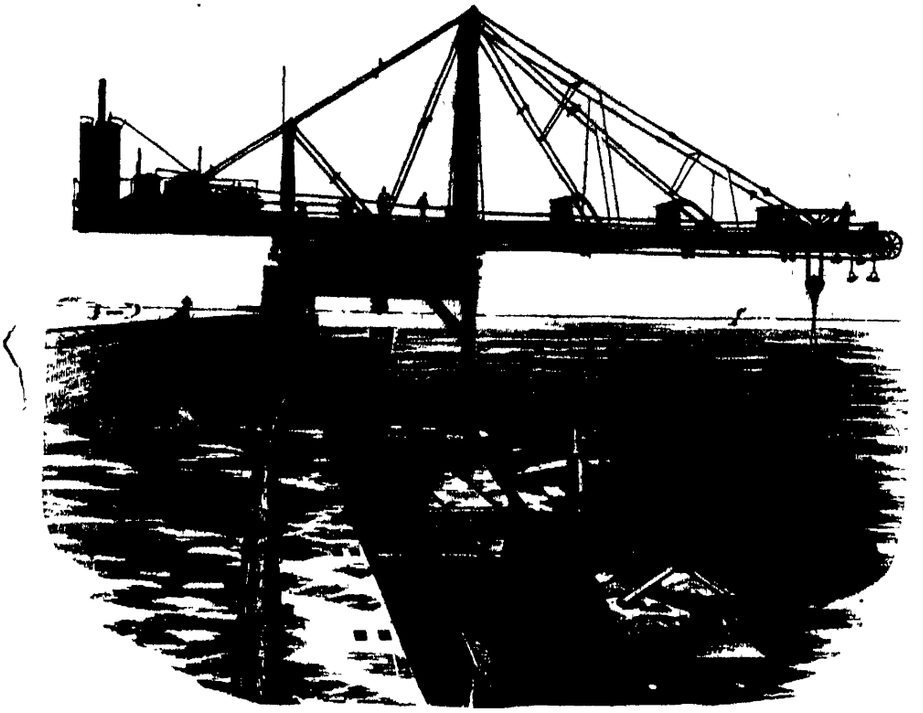
Sir Henry Roscoe's address in the chemical section summarised the chemical theories advanced since the death of Berzelius in 1848, and concluded with some words upon technical education in England, and the position that scientific England holds by the side of her Continental fellow-workers. Professor Frankland, in a paper on "Storage Batteries," referred to his storage cells, in which each plate resembles a slate with its frame, and the space between is filled with a solidifying mixture of minium and sulphuric acid. Dr. Frankland distinguishes between discharged useful electricity, with an electromotive force of two volts and more, and useless energy with an electromotive force of less than half a volt. The efficiency curves render this distinction clearly apparent by a sudden fall in the line which at first is almost horizontal.

Lord Rayleigh contributed three papers: "A Lecture Experiment on Induction," "On Telephoning through a Cable," and "A Galvanometer with Twenty Wires." Basing his researches upon a principle laid down more than thirty years ago, he has calculated a formula for the limit of length of a telephone line, which would, for the Atlantic cable, give a limit of twenty or twice twenty miles. Professor Graham Bell declared that then the practical limit exceeded the theoretical one, as he had talked through fifty miles of cable. His question as to any differences probably caused by the various rates of vibrations, Lord Rayleigh answered in the affirmative, so that the higher components being better transferred than the lower ones, a change in the sound must ensue. Mr. Preece related his experience of cable telephoning from Dartmouth to Guernsey, a line of fifty miles, where he could just speak, and on the Dublin-

BLOCK-SETTING MACHINE AT THE COBLE DENE DOCKS.

CONSTRUCTED BY MESSRS. STOTHERT AND PITT, ENGINEERS, BATH.

(*For Description, see Page 270.*)



Holyhead line, where larger magnets gave better results. With artificial cables, it is possible to speak through about a hundred miles, but an accurate conversation cannot be carried on over more than twenty-five miles. Magneto telephones, both as transmitters and receivers, give higher results on account of certain counter currents. Ordinary telephones with microphones are more troublesome. But the employment of two, or *generally four wires twisted*, will secure good results both for underground and overground wires, without leading to interference of the different wire groups. Resistance as such has nothing to do with the efficiency of a telephone; it is simply a question of static induction. If a 2000 ohms coil would not speak, it was because it was single wound instead of double wound. Lord Rayleigh then described his galvanometer with twenty wires, not at all a formidable instrument, as he assured his hearers. His silver voltameter answers exceedingly well for weaker currents, but for stronger currents the present device is better adapted. Twenty cotton-covered wires 8 ft. long are twisted in pairs to form a rope, which is bent to a circle of a foot in diameter, and with the two ends hanging down. One circuit comprises ten wires in parallel arrangement; the other has ten wires in series, so that a current flowing through both groups must give ten times the effect in the second group, provided that the resistances of the single wires are all equal.

Monday morning commenced with another most interesting discussion on "The Connection of Sun-Spots with Terrestrial Phenomena," introduced by Professor Schuster, who spoke with his usual marked conciseness. The connection between sun-spots and magnetic storms, as well as aurora borealis and telegraphic disturbances, is established beyond doubt. How we are to account for it remains an open question. If the sun was one enormous steel magnet, those strong influences upon the magnetic needle could not exist. The assumption of a direct electrical conduction through space from the sun has little foundation, yet space may contain sufficient matter for conduction, which would help us over Edlund's inconsistent view of the vacuum being a perfect conductor. Our vacua are so far from being perfect that all experimental data have to be accepted with greatest caution. The problem is closely connected with the question of constancy or variation of solar radiation. Most mountain observatories, Simla for instance, are in unfit places. The Lamas residing on the plateau of Thibet might undertake this work. From 1810 to 1860, there appears to have been a coincidence between temperature and sun-spots, since then not; but Professor Balfour Stewart's theory of two superposed sun-spot periods of 10½ and 12 years might help us over some difficulties which the generally assumed period of eleven years brings with it. Rhine wine years again, appear to go together with sun-spots minima; cyclones, with spots maxima. The data about rainfall and barometric pressure and the like are uncertain; the influence of certain comets aggregating to periodical swarms may be granted. The joint paper of Professors B. Stewart and Lant Carpenter "On certain Short Periods common to Solar and Terrestrial Phenomena," continued the same theme. Temperature and magnetic observations extending over thirty-six years, point to the existence of periods of about twenty-four days; similar temperature phases occur at Toronto, in Canada, eight days before they appear at Kew, and one day previous to Utrecht, and these temperature changes are predicted by magnetic weather declinations which travel from Toronto to Kew in 1.6 days.

The report of the committee on the "Harmonic Analysis of Tidal Observations," read by Dr. George Darwin expressed regret that the English Admiralty declined to co-operate upon the base suggested by the British Association Committee, the advantages of which had been acknowledged, and the suggestions followed up at the Cape, in Australia, by the German Government, and in other countries. The vigorous interest in tides which is taken everywhere, with the exception of Canada, furnishes abundant observations which in many cases are simply lost, as there are no competent persons to properly analyse the figures. Professor Johnson complained of the absence of tidal observations in the Gulf of St. Lawrence, where most wrecks occur in fine weather. The sun-spot question received a further able contribution from the Reverend Professor Perry, who is examining the spectrum from D to B, whilst others work on the other side of the D line. Professor Rowland, of Baltimore, exhibited his marvellous spectroscopic photographs on sheets of 3 ft. in length, taken with concave gratings 6 in. in length and 21 ft. radius, with 7500 lines. The advantages of the use of gratings over ordinary photography are generally acknowledged, yet no one was ready to undertake the work, so that Professor Rowland had to do it himself. The photographs surpass everything as yet accomplished, as Professors Schuster and Perry testified; Professor Lockyer declared that he would have to start his own work again. Yet Mr. Rowland rejects the greater number of his photographs, and intends to prepare during the winter, another stock of plates and papers, as that part of the work cannot be performed during the summer.

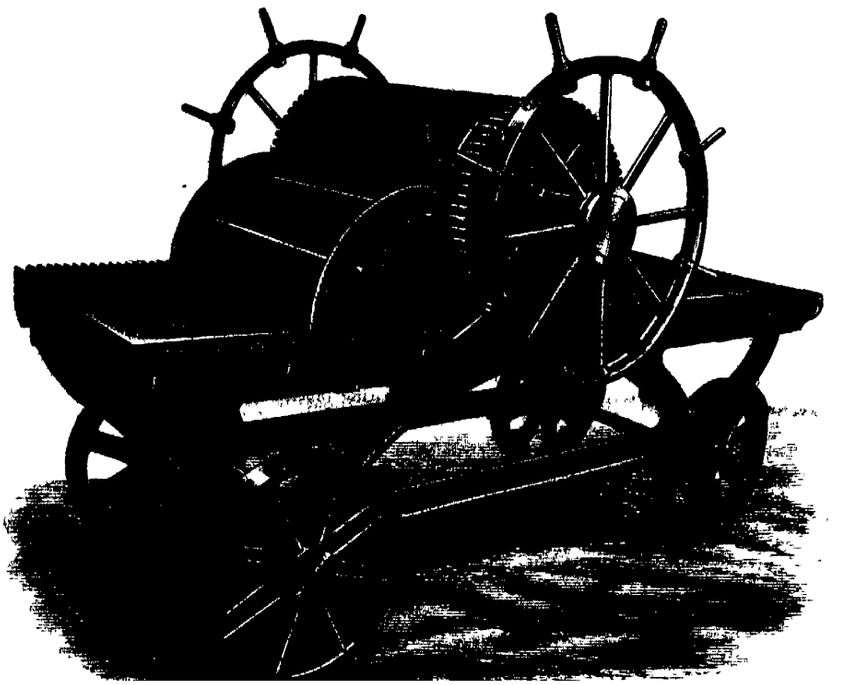
Mr. H. Preece, who also introduced the subject of domestic electric lighting and storage batteries to a most attentive audience in Section G, proposed, and was in this proposal supported by Sir William Thomson, to supplant the old horse-power, equal to 746 watts, by a new horse-power of 1000 watts, which would make the new horse-power the equivalent of 44,000 foot-pounds, and bring it into the category of the electrical measurements. He spoke very favourably of the application of storage batteries charged by a dynamo for telegraphic purposes and counts upon a saving of 75 per cent., if the 22,000 cells in use at the General Post Office could be replaced by one dynamo with storage batteries. Mr. Preece further contributed a paper on "The Law Regulating the Connection between Current and Intensity of Incandescence in Glow Lamps." His previous experiments pointing to an increase of light emitted with the sixth power of the current, have fully been confirmed by experiments of Captain Abney and Professor Kittler, of Darmstadt. This law holds good as long as resistance and current vary uniformly together, but as the state of incandescence is increased, a point is reached varying with each kind of lamp, when the resistance ceases to diminish at the same rate, and eventually begins to increase. Then the light intensity increases much faster than the sixth power of the current. This point indicates a change of state in the filament which leads to disintegration.

Professor Douglass Archibald has made a novel departure in trying to ascertain the velocity of wind at various heights by means of anemometers attached to the kite wires. Such measurements in the undisturbed atmosphere necessarily should yield much more reliable figures than when on the top of hills or high buildings. The data already arrived at prove that the velocities become more uniform at greater heights; for instance, at 98 ft. the velocity recorded was 864 ft. per minute, at 217 ft. height, 1207 ft. per minute; whilst for heights of 310 ft. and 646 ft., the respective velocities were 1648 ft. and 1769 ft. per minute. Atmospheric electricity render these original and most instructive experiments somewhat dangerous. Professor Archibald also gave a preliminary account of the vast amount of

GLASS ROLLING TABLE.

CONSTRUCTED BY MESSRS. R. DAGLISH AND CO., ENGINEERS, ST. HELENS.

(*For Description, see Page* 270.)



evidence which has been brought before the Committee that seeks to settle the question connecting the volcano Krakatoa, and the recent sun-glow. The evidence does not militate against the Krakatoa theory; the halos are still visible as clearly as last autumn, although the glows have gone. A paper sent in by Professor James Thomson and read by Sir William Thomson on "Whirlwinds and Waterspouts" does not lend itself to a short notice.

In the chemical section, Dr. Perkin, the discoverer of aniline colours, gave a sketch of the investigation and utilisation of the bye-products which have made the coal-tar industry so marked a success. Mr. Walter Weldon dwelt upon the facture of chlorine in connection with the ammonia-soda process. Magnesia is employed for the decomposition of ammonium chloride, and further added to form magnesium-oxychloride, which, on heating, yields the chlorine gas. The high importance of this process need not be emphasised. Sir Henry Roscoe described the diamondiferous deposits of South Africa and the ash of diamonds.

On Tuesday Dr. MacAlister read the report of the Committee for facilitating the Adoption of the Metric System in Great Britain. The answers from the Board of Trade and the Government, which the Committee intended to memorialise again, were not favourable. The Government did not wish to join the "Bureau International des Poids et Mesures." Since the report was drawn up, however, the Government have agreed to join this body. Lord Rayleigh then mentioned the results of his calculations on "the colours of thin plates." Adopting Newton's well-known colour triangle with red, green, and blue, at the three corners, and agreeing with Maxwell that these colours are practically, if not absolutely, primary, and sufficient to produce all shades known, he finds that the colour curve appears to pass a little to the right or left of the theoretical white centre of the triangle, then through yellow, red, violet, blue, blue-green, green (which is not very well defined), again through yellow and so on, forming a spiral round the white centre. Sir William Thomson remarked that he had never been able to produce a perfect match out of any two of the complimentary colours, and to him the three colour theory is only a physiological approximation. Lord Rayleigh has further investigated some minor anomalies of Clark's standard cell. A probably very instructive paper of Mr. Urquhart Mackenzie, of the Toronto School of Science, on "A Telemeter System," was drawn up too much in the fashion of a patent specification, so that the audience became somewhat impatient; the apparatus described had unfortunately arrived too late and in bad condition. Professor Hele Shaw's "New Mechanical Principle," adapted for continuous calculations, and permitting of a large application for the transmission of force, we hope soon to bring before our readers more fully than we should be able to do now. Professor Reinold, of Greenwich, described the thinning of liquid films by electric currents. The films were formed between a cylinder and a ring, and were thus barrel-shaped; they consisted of soap-water or a mixture of glycerine and soap. Under ordinary circumstances the film shows white, with coloured rings at the top, but the greater part of the film cylinder is colourless. A current, which owing to the high resistance of the film, is very weak, passing downward through the film, widens and diffuses the rings and partially turns their zone black; an upward current extinguishes all rings, and the black appears only after a long time. Mr. Michelson, of Cleveland, Ohio, who has made similar experiments, did not find the transition from black into white so abrupt as Mr. Reinold; he thought also the black is really dark blue. Mr. Michelson himself read a very warmly discussed paper on the "Velocities of Red and Violet Light in Carbon Bisulphide," a paper which induced Professor Forbes to say that he would certainly repeat his experiments which had yielded a velocity for the violet rays, 1.8 per cent. higher than that of the red rays. The only explanation of this anomaly which Professor Forbes had been able to consider as possible was that suggested by Professor Cornu. Professor Chandler-Roberts has continued his researches into the "Diffusion of Metals." It will be remembered that he heats lead or alloys in U-shaped tubes and places a piece of precious metal on the top of the lead in the one leg, and waits for its appearance at the surface of the other leg. To avoid direct convection currents, he has treated the top of the tube only, and thus found that the melting metal passes down pretty quickly, and more slowly up the other leg; platinum travels at the rate of about ten miles per hour, but only one-tenth of the platinum gets round in thirty-six hours. Dr. Stone showed his very light aluminium wire electro-dynamometer suspended by a gilt silver wire.

Mr. W. J. Millar, of Glasgow, has inquired into the "Cause of Flotation of Solid Metals on Molten Metals." Pieces of cast iron, if small, at once float on molten iron, if large they first sink but soon rise and continue to float until melting. If immediately taken out again, they appear of a dull red heat and exhibit an expansion of one-eighth of an inch per foot. Pieces of gun-metal and phosphor-bronze behave like iron; copper, lead, and [illegible] show less floating power. Mr. Millar [illegible] as one not agree, however, with Sir William Thomson, who wished to show from his experiments that [illegible]n expands in solidifying. Professor Barrett minded his hearers of Mr. Thomas Wrightson's experiments, who by repeated cooling and heating of a square iron block converted it into a sphere, the effect of expansion, at dull red heat.

The rest of the papers, including an able investigation by Professor Silvanus Thompson into "Equations of Dynamo Machines," had to be hurried through. The last paper was read by Dr. Borns, who wished to call attention to the inconvenience arising from the arbitrary mode of quoting periodicals, and also proposed a system of abbreviation of titles. His suggestion that each journal ought to bear on its title page, in a prominent position, the abridged title by which it is to be cited, and that all quotations should state volume, page, place if necessary, and year, appear worth considering, as the unnecessary trouble caused by inexact and incomplete quotations, and particularly by omission of the date, which often decides the value of a communication, will be generally acknowledged.

The section then adjourned until the Aberdeen meeting next year, after a very busy week.

THE DEE OIL COMPANY'S WORKS.

THE works of this company are situated on the banks of the navigable portion of the River Dee, at Saltney, about two miles from Chester. The chief products of the firm are mineral lubricating oils and candles, the latter being manufactured in a separate branch of the company's works close by.

The crude petroleum residuum which comes from America in barrels, is brought into the works by rail, both the London and North-Western, and the Great Western Companies, having lines into the works. The barrels are emptied in a warm room, known as the skipping house, and placed on racks over tanks, after which they are steamed, to remove any material that may be left. A couple of cylin-

drical receiving vessels of large capacity are placed outside the house, from these the air is exhausted, when these are put in communication with the receiving tanks mentioned, and the "residuum" is drawn into them for storage. When required to be used, the material is forced out, and into the stills, by air pressure.

There are three benches of stills, about 30 in all. They are of the ordinary form, being of iron cased with brickwork. There is a service by which a jet of steam is injected near the bottom; this keeps the material agitated whilst the heat is on, and prevents burning of the bottom. There is also a neat arrangement of man-lid, by which the cover is easily removed and fixed on again. Attached to each of these stills is a condenser, consisting of a cast-iron worm placed in a tank of water, by means of which the products of distillation are reduced to a liquid state The receiving-house is placed at the back of the still, there being a wide passage between the two, over which the condensers are placed. In this house there are a large number of receiving tanks, some square and some circular; the condensers discharge the "once-run oil" into these. A quantity of solid matter remains in the still, and has to be removed after each working; this takes the form of a fusible spongy mass, which is indeed almost pure coke; it is largely used for domestic fires, for which it is well suited.

The oil of various specific gravities is taken from the tanks, and pumped into an agitator. This is a large cylindrical vessel, composed of cast-iron plates bolted together; it is mounted on columns, so that the bottom may be accessible, and the tar which settles to the bottom may be drawn off through a valve. In this agitator, the oil, to the quantity of about 6000 gallons, is mechanically agitated, together with sulphuric acid. The acid combines with the impure matters, and the whole sinks to the bottom, to be drawn off by the valve referred to. The oil having been thus treated, is run into lead-lined tanks, and in order to neutralise any traces of acid that may be left, it is washed with caustic soda. The soda liquor falls readily to the bottom, and is removed by a tap, the oil remaining in the washing tanks. From the refinery the oil is taken into other stills, similar to those first used, and the process of distillation and condensation is then repeated, a very small quantity of coke being obtained.

After the last process the oil is pumped into shallow tanks 12 *ft.* square and 3 *ft.* deep, and there allowed to cool, after which it is "bagged." This is a process of straining in canvas bags by means of filter presses, of which there are a very large number. In this way the oil is strained through, and the hard paraffin remains to be subsequently used in the candle works. The oil is collected in tanks and is from them pumped into the refrigerating presses. As we have stated, the hard paraffin has been extracted from the oil by means of the presses, and it is now required to remove the soft paraffin, which has passed through the press cloths, when the operation was carried on at the normal temperature of the atmosphere. In order to effect this, the second pressing is carried on at an artifically reduced temperature, sufficiently low to solidify the soft paraffin, so that it will not pass through the cloths. The oil is pumped into cylindrical vessels placed in an insulated building, and these vessels are surrounded by a brine jacket, reduced to a very low temperature, about zero Fahr., circulating in the annular space thus formed. From the refrigerating cylinders, the pressure from the pumps (60 lb. to 80 lb. to square inch), forces the oil into the filter presses, and through the cloths which retain the solid "soft" paraffin. It should be stated that the oil is agitated whilst in the refrigerating cylinders by a mechanical stirrer.

For producing lubricating oils of the highest quality, it is necessary that both the hard and soft paraffin should be completely abstracted. The former is not difficult to deal with, as may be gathered from what we have said; but it will be easily seen that the soft paraffin is only completely eradicated by the application of somewhat costly and complicated appliances.

The brine-refrigerating machinery is composed, firstly, of a gas-holder, about 20 ft. in diameter, which is used for holding the ammoniacal gas, the refrigeration being on this principle. The motor is a pair of horizontal compound condensing engines, with steam cylinders 10 in. and 18 in. respectively. The gas-compressing cylinders, two in number, are placed tandemwise in the same bedplate, and are 6½ in. and 13 in., the stroke of all being 2 ft. 6 in. The low-pressure engine works the first gas cylinder, by means of which a compression of 40 lb. to 50 lb. is obtained. After passing through a cooler, the gas is further compressed by means of the high-pressure engine to a pressure of about 170 lb.; it is then cooled in the usual way, and refrigerates the brine by expansion in the ordinary coffee. In the same engine-house there is a horizontal air-compressing engine, which is for general works purposes.

After the soft paraffin has been extracted in the way described, the oil is again treated with acid and caustic soda as before, and, having been bleached by exposure to the light in shallow tanks, is pumped in the store tanks, to be kept until required, for packing and sending out. During the process of distillation a certain amount of light oils are obtained, the periods at which the light and heavy oils come over during distillation, being well marked. These light oils are treated in a manner somewhat similar in some respects to that of the heavy oils, and are sold mostly for burning. The heavy oils are, however, the staple production of the firm, and these are used for lubricating purposes, both as cylinder and bearing lubricants. A large quantity of the very finest mineral oil is used in the Lancashire district for cotton machinery, the spindles of which run at a very high number of revolutions. For this purpose a lubricant is required that will always flow, and not clog or gum, and which yet must have considerable viscosity. Heavier oils are made for cylinder purposes. The high steam pressures that are daily becoming more general, render this a point of considerable importance and increasing difficulty; so much so, that efforts are being made to run marine engines without cylinder lubrications at all. Even if this can be carried out successfully, to the extent of not scoring the cylinders, the additional friction must certainly involve an increased load on the engines, if the pistons are to be kept approximately steam-tight. We understand that the cylinder oils of this company have been used with good results, and that for the last three or four years they have been the sole contractors to the Admiralty.

On the works are smiths' and fitting shops, besides an extensive cooperage. The method of storing the oil and filling the packages is well arranged.

In the candle works referred to, the crude wax, or paraffin scale, as it comes over in the bags, is melted by steam, and is then pumped into tanks, the hard and soft scale being kept separate. The ordinary hard and soft wax have melting points respectively of 132 deg. and 105 deg. Fahr., although some wax is obtained which will not melt below 140 deg. Fahr. The higher melting point is, we believe, very unusual, and the middle one not often attained. This is attributed by the manufacturers to the superior mode they have of preparation, so far as comparison may be made with American manufacturers; whilst with regard to the Scotch manufactures, the advantage is due to material. The quality of the candle depends greatly on getting a high melting point, as it makes it not only stiffer, but affords a better illuminating power.

The wax having been melted as stated, is allowed to settle, in order to get rid of any accidental impurities, and is then drawn off in "jacks," and is poured into flat caking tins or trays, placed in racks to set. When hard, it takes the form of flat cakes of a light yellow colour, it being now the object of the manufacturer to remove this colouring matter, which consists of a small quantity of heavy oil, and other impurities. The cakes are wrapped in cloths, and are placed in presses of special construction, which are the subject of two patents held by the company. Pressure is applied to the cakes whilst under water, which is kept near melting point, and the oil is pressed out and floats to the surface. The cakes are taken out and removed from the cloths, and are again cooled. To casual observation they are now fairly white, but the practised eye can detect a certain greyness, which would detract from the purity of colour in the finished candle. In order to remove this the cakes are again melted by steam, together with a quantity of animal charcoal. The effect is absolutely the reverse to what might be imagined, for the wax, after being passed through a filter of cloth or wool, appears a pure white on being cooled, and is ready to be made into candles.

The department set apart for moulding the candles contains a large number of patent machines. These comprise a number of moulds (from 96 to 112), which are simply elongated cylinders exactly the shape of the candle. They are placed vertically in two rows on a suitable frame. The bottoms of the moulds are movable, and can be pushed up and down in the moulds as required by a rack and pinion gearing. The candles are cast upside down, and the movable bottom of the mould is in the form of an inverted hollow cone, which forms the top conical part of a moulded candle. The movable bottoms being in their lowest positions, wicks are passed through small holes left for the purpose in these bottoms, and are drawn up through the centre of the moulds. Melted wax is then poured in, and the first lot of candles is made. These are cooled by water being caused to circulate amongst the moulds, and, when set, the movable bottoms are forced up through the moulds, and so push the candles upwards, and out of the moulds, where they are held by two long wooden clamps arranged above to take them. The wick cottons, it should be said, are wound on spools, one being placed below each mould. When the wick is drawn up as explained, it is not cut off, but forms the upper end of the continuous length, passing through the hole in the movable bottom and round the spool. When the candles are pushed upwards out of the moulds, they draw another length of wick into place ready for the next casting, and when the movable bottom passes down the cylindrical mould again, it slides on the wick which remains in the axis of the mould, and goes to form the necessary part of the next lot of candles. When these are moulded, and have become hard, the first lot of candles are cut off through the wicks with a sharp knife, and the second batch is left to carry on the operation.

The packing room and other offices are placed in convenient positions, and call for no special comment.

In this branch of the works the sulphuric acid used in refining the oil is made There are the ordinary kilns for burning the copper pyrites, and the vast leaden chambers used in such cases. There is also the platinum rectifying plant generally seen in connection with such work.

ELECTRIC LIGHTING AT THE INTERNATIONAL HEALTH EXHIBITION.

No. VI.

The artistic aspect of electric lighting has, from the first been very unsatisfactory. Indeed, it was a long time before it could be said to have any existence at all. If an application was made to a firm of engineers to fit up a house, they could provide engines, dynamos, and lamps, but they were totally unprepared to supply any kind of fittings, and had to rely upon a few stock patterns which certain metal workers had hurriedly got out to meet the occasion. These were mostly of two classes; they were either modified forms of gas brackets, or they represented some form of vegetation, of which the lamp was to figure as the flower or the fruit. This latter idea was carried out to a great extent, and culminated in the barbaric splendour of the chandelier exhibited by the Edison Company at the Crystal Palace. But after the incandescence lamp had been made to represent every kind of fruit and flower that an elastic imagination could conceive it capable of, it was found that brass vegetation bearing glowing glass products did not satisfy the general taste. Then a fresh trial was made of gas bracket designs modified to suit the new use, and with somewhat better success, as all redundant ornament was avoided, and the lamps were covered with glass globes of various kinds, so that the general appearance approximated to gas fitting, and thus had a familiar aspect which did not challenge criticism. But to clothe electricity in the left-off garments of gas betrays a sad want of appreciation of its advantages. Gas must be placed high so that its fumes may not be felt; it must be rigidly fixed at one place, and it must be surrounded with a globe to defend it from draughts, and to obscure its flickering. None of these limitations refer to the incandescence electric light, which gives off no fumes and never flickers, at least is not supposed to do so. It therefore follows that in designing fittings all ideas and patterns connected with gas should be cast aside, and no chance should be lost of utilising to the full all the good qualities of the new illuminant.

That appropriate and chaste fittings can be devised for the electric light is shown in the four elegantly furnished rooms at the left-hand corner of

the south gallery in the Health Exhibition. These consist of a boudoir, a drawing-room, a dining-room, and a bedroom illuminated by a current from a dynamo and a set of Planté batteries manufactured by Messrs. Elwell and Parker, of Wolverhampton. The lamps and their mountings are supplied, and the whole installation managed, by Mr. Taylor Smith, of 101, London Wall. Mr. Smith is an architect, and beginning where the electricians stop, he has exercised great ingenuity in applying the electric light to domestic purposes, elaborating a complete system which may be introduced into existing houses without defacement of the decorations, and which can be made to harmonise with any style of ornamentation or of furniture. In wiring a house he runs an additional skirting board or wainscot along the lower edge of the existing one, and when this is painted to correspond with the original board, it is not noticeable, and forms a concealment for the conductors which lie behind it. At appropriate places doors are constructed in it, and behind these, boxes are inserted to receive switches, fusible cut-outs, and the like. At frequent intervals, lamp connections are inserted, and as these form a very important feature of the system we will describe them in detail. Two small holes are cut through the board, about 1½ *in. long* and ¼ in. wide, and at the back of each of these there is a spring contact, one connected to the positive and the other to the negative main, each of which is bared for a short length to bring the copper into contact with the brass of the spring. These springs are quite hidden from view, and the sole indication of the fact that the room is ready to be lighted electrically, is the presence of the small holes, which are only to be found on close inspection. Each table lamp is provided with a flexible wire connection ending with a disc of polished wood or ebonite, provided with two substantial hooks on its rear face. If these hooks be pushed through the holes in the skirting board, they enter the spring contact pieces, opening the jaws and sliding down between them for a considerable distance, so that each time they are applied or removed the surfaces are rubbed clean. The springs are so long and pliable that the most careless insertion of the hooks is sufficient to make good contact, while their hold is so elastic that a jerk at the flexible conductor withdraws the hooks.

The larger forms of table lamps are provided with means for coiling up the slack of the conductors. Within a hemispherical base or foot there is arranged a drum or winch, something like a fishing reel, with its axis vertical. This drum is fixed upon a tube which goes right through the shaft of the lamp and has the Swan or other globe mounted at the top. The twisted conductor passes through the body of the drum, and up the central tube, when its two wires are separated and led to the terminals in the usual way. By this arrangement there are no sliding contacts to oxidise or become displaced, but a continuous metallic circuit is maintained throughout. This is one of the essential characteristics of Mr. Smith's apparatus, and appears in every modification of it.

The smaller table lamps, which are more particularly designed for illuminating music on the piano, have no coiling arrangement. In them advantage is taken of the fact that an incandescence lamp, unlike any other, will act equally well in any position, and either way up, and accordingly the base of the bracket is made to stand either on its foot or its side. Over the lamp globe is a shade carried by a swinging frame mounted in trunnions, so that whatever the position of the bracket the shade stands over the globe. The lamp itself is at the end of an extended arm, and if the stand be placed on the top of a piano, the rays are cast downwards over the pages of the music and on to the keys, while the performer's eyes are completely protected from them. An eye in the foot of the stand enables it to be hung from a hook in the wall over a music stand, when other instruments than the piano are being used. These two forms of fittings are particularly adapted for the drawing-room where people disperse themselves in the corners, and there is no central gathering point. Another fitting, more adapted for general illumination than to supply the needs of an individual or small group, is the wall bracket. For this purpose spring contacts, such as described above, are arranged in the wall at a height of 6 ft. or 7 ft., and a bracket, carrying at one side a group of lamps, and at the other two hooks, can be fixed in any of these contacts. This apparatus appears to need a little modification, as there is some difficulty in inserting the hooks into the orifices, when the bracket is large, and obscures the view.

In rooms where people occupy more fixed positions, as in dining-rooms and libraries, hanging lamps suggest themselves. For these, ceiling contacts are provided covered with neat or ornamental caps. These are different in construction from the hooks and springs described above, as they have to carry the weight of the lamp, but they are quite as simple and as readily removed when the cap is unscrewed. From the cap there depends a double flexible conductor, to the lower end of which the lamp is attached. The great requirement of an overhead lamp is that it should be capable of being raised and lowered—even the ordinary gasalier is capable of this—and this point has been very ingeniously provided for by Mr. Smith, by the device of hiding a drum in the lamp-holder. Within the drum are two coiled springs, and on the edge of its flange there rests a brake lever. When this brake is released by pressing on a thumb-piece the lamp can be drawn down, coiling up the springs, or it can be allowed to wind itself up. The use of two springs is a very ingenious arrangement for carrying out the plan of positive connections. The body of the drum is of non-conducting material, and the two springs are fixed to it, one at each end. The other extremities of the springs are fastened to two stationary studs upon which the drum turns. The positive and negative conductors are connected respectively to the two springs, and consequently the current flows through one spring to the stud, and thence to the lamp, and back again through the other stud and the second spring, there being perfectly good connection all the way.

The bedroom lamp is on a telescopic stand so that it can be fixed at various heights. It can be hooked on to the top of the mirror in two positions, and can rest on the dressing-table. Besides this it can be fixed to a hook on the wall to aid in the often condemned practice of reading in bed, which has now lost its danger, and it can be carried about, within the length of the conductor, to aid a search in a drawer or a wardrobe.

We have dwelt at considerable length on this exhibit, because it is by far the most serious and successful attempt we have met with, to grapple with the application of electric lighting to domestic illumination on a moderate scale. Palaces and country seats have been fitted with incandescence lamps, but the methods adopted in large *salons, furnish no* example for the houses of persons of moderate means, and it is to those that manufacturers must look if ever their business is to be established on a sound commercial footing. The production of a system which combines reliable electrical arrangements with a thoroughly artistic appearance will prove of great advantage to both makers and users Middlemen, although the objects of great abuse, are a crying want in electric lighting, for firms which are interested in the production of dynamos and the manufacture of lamps are very ill fitted for the smaller, though no less important, work of house fitting, and cannot give to it the amount of attention it requires. Besides this, engineers are by no means celebrated for combining beauty with utility. We have said little of the appearance of these fittings, because it would be impossible to convey a definite idea regarding them without illustrations, but many of them are singularly beautiful and all are quite free from resemblance to the conventional gas bracket. Formerly architects designed our houses only; then they took our furniture in hand and worked a revolution in that, and now it appears they aspire to light our dwellings, leaving to the electrical engineer his proper work of designing and supplying the machinery.

We have not to go far to find the other or palatial aspect of electric lighting. It is to be seen in the Prince of Wales's Pavilion, where an exceedingly good result is obtained by lines and groups of lamps arranged just below the ceiling, shedding an even and brilliant illumination over every object, but at an expense which could not be borne in an ordinary dwelling. In the smoking temple there is a domed roof surmounted by a skylight, and here a very curious effect is gained by a double set of lamps. One set consists of ordinary clear glass globes arranged in sight, and the other of tinted lamps fixed around the base of the dome, and hidden by a projecting cornice. When the white lamps are in operation the overhead decoration is of delicate tint, approaching to white. When these are extinguished and the current is turned into the others, which are amber coloured, the interior is suffused with a warm golden glow which accords well with the style of the decorations, and is suggestive of the meditative quiet which should accompany the after-dinner enjoyment of tobacco. Other examples of these lamps, which are produced by Mr. A. H. Simpson, of Nottingham, are to be seen in a rockery at the entrance to the aquarium.

NOTES.

The Megametre.

Some time ago M d'Abbadie proposed in the French Academy of Sciences the adoption of the term *mégate* to represent the fourth part of the terrestrial meridian, or a length of 10,000 kilometres on the French metric system In order, however, to have a term more in accordance with the nomenclature of the multiples and sub-multiples employed to-day by electricians, M. Hospitallier has made an amended proposition to the effect that the word megametre should be used instead.

Race between Two Electric Launches.

A new electric launch, the Australia, has just been completed and launched from the works of the Electrical Power Storage Company at Millwall. The hull of this launch has been built by Messrs. Forrest and Sons to the order of Messrs. Stephens, Smith, and Co., engineers, for an Australian firm. She is of mahogany, length 25 ft., beam 5 ft. 7 in., and can carry sixteen persons comfortably. The motive power consists of a number of E.P.S accumulators placed as ballast at the bottom of the boat, and a Reckenzaun electro-motor driving a two-bladed gun-metal screw 18 in. in diameter and 11 in. pitch. The Reckenzaun motor weighs 390 lb., and is capable of working up to six horse-power mechanical, but ordinarily it will be worked at a lower rate; in this boat at the rate of five electrical horse-power Weather permitting, a competitive trial trip will take place on Saturday next, at two o'clock, from Millwall to Charing Cross Pier and back to Greenwich, the competing launch being the well-known boat Electricity, which caused some sensation when launched in September, 1882. This launch was designed at the time by Mr. Reckenzaun for the Storage Company. She is of iron, 25 ft. long, and only 5 ft. beam. A set of E P S. accumulators supply the current to a Siemens D, dynamo, weighing 658 lb.; the screw is of steel, made by Messrs Yarrow and Co., 18 in. in diameter and 11 in. pitch, and which screw formed a pattern for casting the one in the new launch. It will be arranged that during the trial both machines shall be supplied with the same amount of energy, viz., 3730 watts, or five electrical horse-power.

The Limed Coal Gas Process.

At the Tunbridge Wells Gas Works a modification of the ordinary process of gas making has been tried during the past year with marked success. It is due to Mr W. J Cooper, and was introduced at the works on the recommendation of Mr. R P. Spice, consulting engineer to the gas company. The process consists in mixing lime with the coal before it is put into the retorts, thus obviating the necessity of purifying the gas from sulphur after it is made. The nuisance and trouble of cleaning out the lime purifiers is thus avoided. At Tunbridge Wells the coal used is New Pelton, mixed with 2½ per cent of cannel, and this is mixed with 5 per cent of lime (which has been partially slaked with its own weight of water). The mixed coal and lime are ground and incorporated by passing through a mill with toothed rollers The limed coal is then lifted by elevators to fixed hoppers in the retort-house, and fed by West's apparatus to the retorts, thus saving manual labour. From the retorts the gas passes through a St. John carbufetting apparatus, which prevents the formation of naphthaline, and is drawn to the condensers by means of a steam jet exhauster. From the condensers the gas goes to the scrubbers, where it is cleaned from ammonia by falling water, and finally, after passage through the oxide of iron purifiers, it goes to the holders. The original extraction of the sulphur is favourable to the process of gasmaking; the oxide of iron purifiers are found to last much longer without being opened, the lime purifiers are dispensed with altogether, and there is an increased production both of tar and ammonia. Moreover, the coke is said to be entirely free from sulphur, because the compound of sulphur and lime which is attached to it

falls down as a solid in the ash, the sulphur not being burned in the fire.

A New Hand Anemometer.

A hand anemometer, consisting of Robinson's cups in connection with a dial, registering miles per hour while an attached sand-glass is running out, has lately been invented by Mr. F. Galton, F.R.S. Let d = distance from centre to centre of opposite cups = 8 in.; r = number of revolutions of cups to register one mile on dial = 20.5; c = instrumental constant, commonly taken as 3; t = minutes marked by sand-glass. Then the formula for the instrument is $\pi d r c \frac{60}{t}$ = one mile = 5280×12, from which if any three of the quantities $d r c t$ be given the fourth may be found. To find t, the sand-glass being the part most likely to be broken and therefore to be renewed,

$$t = \frac{\pi d r c 60}{5280 \times 12} = \frac{\pi d r c}{1056}$$

$$t = \frac{3.1416 \times 8 \times 20.5 \times 3}{1056} = 1.5 \text{ minutes}$$

nearly. If c be taken as 4,

$$t = \frac{3.1416 \times 8 \times 20.5 \times 4}{1056} = \text{two minutes}$$

nearly.

In Professor G. Stokes' paper *in* Proc. Roy. Soc., 1881, p. 187, the value of c is given as 2.826; if this be accepted,

$$t = \frac{3.1416 \times 8 \times 20.5 \times 2.826}{1056} = 1.4 \text{ minutes nearly.}$$

In this case the sand-glass should run out in 84 seconds, and its error should not exceed ± 2 seconds. To determine the number of revolutions, and hence to find the error of indication of an instrument, count the number to one mile on the dial; let it be R, then compute r; the difference is the error per mile; R was found to be 207, $d = 11$ in., $t = 2$, and c taken as 3. Then

$$r = \frac{1056 \times 2}{3.1416 \times 11 \times 3} = 20.372;$$

and $R - r = 207 - 20.372 = .328$. Error per cent.

$$\frac{100 \times .328}{20.7} = 1.6 \text{ nearly too much.}$$

The dial is graduated to show fifty miles per hour, each small division represents two miles, each large division ten miles. The handle fitted to the sand-glass is to be turned so as to throw the dial out of gear with the shaft of the cups, and all the sand is to be allowed to run into the lower vessel. The hand on the dial is to be brought to 0. The handle has to be turned and the instrument left to itself till the sand has all run out. The instant this has occurred the handle has to be turned so as to throw the dial out of gear, and the indication on the dial read and recorded. A piece of stout iron tubing should be fixed vertically on a firm support, where it will be exposed to the winds, and where access to it can readily be had. When an observation is to be made the anemometer is to be placed upon this tube which it should fit by a bayonet joint.

Measuring Electric Currents.

Lord Rayleigh has suggested the application of Faraday's discovery of the rotation of the plane of polarised light by an electric current as a means of measuring the current. Mr. J. E. H. Gordon found that the reversal of a current of four ampères circulating 1000 times round a column of bisulphide of carbon through which the polarised ray passed, produced a rotation of the plane of polarisation of the ray of about 7½ deg. With heavy glass, which is more suitable for measuring purposes, the rotation is somewhat greater. The method does not seem very promising, but in Lord Rayleigh's hands something may be made of it. It has the advantage of requiring no springs or gravity indicators, the ray of light serving this purpose. One drawback exists in the depolarising properties of heavy glass. A more useful, if less novel, method of measuring currents by means of the ordinary apparatus is also given by Lord Rayleigh. A standard cell is connected through a high resistance, such as a set of resistance slides, and two points in the slide are found which have the same difference of potential on two points of a strip of German silver through which the current to be measured is passed. The equality of potentials is found by a galvanometer in circuit which gives no deflection where the two points are found. Knowing the difference of potentials on the slides (it is equal to the electromotive force of the cell × the resistance between the two points on the slide ÷ the whole resistance of the slides), and the resistance between the two points on the German silver sheet, the strength of current is easily found by Ohm's law. It is equal to the above difference of potentials divided by the resistance between the two balancing points on the slide. This method is well known; but the use of a German silver strip with lugs or projections on it at a given resistance apart to serve for the points of connexion in the balance, is a new modification.

NOTES FROM THE UNITED STATES.

Philadelphia, September 5, 1884.

The month of September opens with very fair, though not at all brilliant prospects, for the leading American industries. Prices continue very low, production is, and must continue to be restricted, and demand is confined to the filling of requirements for immediate consumption only; but there is a feeling of greater confidence, and a general belief that the lowest point of the depression has been passed, and that from this time there will be a steady though slow improvement. The iron trade especially shows an improvement this week. There is greater firmness in many departments, and a tendency to place orders with more freedom. The project to bank up blast furnaces has been dropped, at least so far as eastern furnaces are concerned. The demand for pig iron is active, though consumers refuse to stock up largely; stocks are very light in first hands, and prices are beginning to recover, owing partly to the clearing out of a few heavy lots of inferior iron, which leaves the market in better shape. There is very little iron of extra quality on hand, and makers are holding prices up at 20 dols. for No. 1 foundry, 18.50 dols. for No. 2, and 17.50 dols. for grey forge, though good iron can be had at a little less. There is very little demand for foreign irons, which are quoted at 19 dols. for Bessemer, 27.50 dols. to 28 dols. for 20 per cent. spiegeleisen, and 23 dols. to 23.50 dols. for 10 to 12 per cent. Steel blooms can be had at 40 dols.; steel wire rods 46.50 dols. to 47 dols. Stocks of steel wire rods at the port of New York, September 1, were 2591 tons against 4073 tons for September 1 of last year. Stocks of tin plates, same date, 15,770 boxes, against 39,673 boxes last year; spiegeleisen, 465 tons, against 534 tons; iron wire rods, 500 tons, against 850 tons last year. The steel rail trade is beginning to feel the effects of the heavy business that has been done within the past few weeks, and prices show a greater firmness, and are quoted at 27 dols.; the lowest point evidently has been passed, and a gradual improvement is expected by makers, though there is every reason to believe that the strong competition, and the fact that cost of production has been so materially reduced, will keep rails below 28 dols. for some time to come, unless there should be a railroad building "boom," which does not appear at all probable at present. Pennsylvania mills are well fixed for the fall months, and are receiving a good many inquiries for supplies to be delivered in the winter and spring. The mills throughout the eastern part of the State are doing only a moderate amount of work. Bar iron is in dull request, though prices show a little improvement this week. Large orders are withheld, though no better terms are likely to be had than those now prevailing. Refined bars sell at 1.85 to 2 cents here, and common iron at 1.50 cents at Pittsburgh. The western mills are sending some of their cheap iron east, and this competition has seriously affected some of the interior mills. The bridge works continue busy, though there have been no important new orders placed recently. Builders have anticipated their requirements for three or four weeks to come, but later in the season some heavy requirements will be presented. The anthracite coal combination still holds together, though it is unable to keep prices at the desired limit, owing to the dull demand. The mines are idle this week, and will probably be idle another week this month, unless demand should suddenly improve.

Amateur Photography.—The pleasure of a holiday greatly depends upon the mind and body being both supplied with some light and agreeable occupation which is a change from the routine of daily life. One of the most interesting distractions for those who have a love of beauty, but lack the technical training of an artist, is to be found in the practice of photography, which, by the introduction of the dry plate process, has been transformed from the dirty operation it formerly was, to one which may be followed by a lady without soiling her fingers if she can command some little assistance in the developing stage. To the engineer, who, as a rule, never leaves the "shop" entirely behind him, a portable set of apparatus furnishes the means of carrying back with him from his summer tour a supply of graphic notes concerning bridges, culverts, aqueducts, and the like, which may prove useful in years to come, and always serves to recall the pleasant memory of the celebrated works he has seen on his journey. The apparatus is not expensive, and gratuitous instruction can be obtained by purchasers from the London Stereoscopic Company, Regent-street, W., so that intended photographers are saved from the disappointment which usually attends early efforts in a new art.

THE "STOCKPORT" GAS ENGINE.

A novel form of gas engine is now being exhibited for the first time at the Agricultural Hall by Messrs. J. E. H. Andrews and Co., of Stockport, the manufacturers of the well-known Bischop gas engine, which has figured so regularly at all exhibitions during several past years, and of which two thousand are doing satisfactory work in all parts of the kingdom. In a short time we hope to lay before our readers detailed engravings of the new engine, but in the mean time, as it possesses very many points of interest, and is attracting very considerable attention, we will give a cursory description, aided by the perspective view on the opposite page, so that the general arrangement and method of working may be understood.

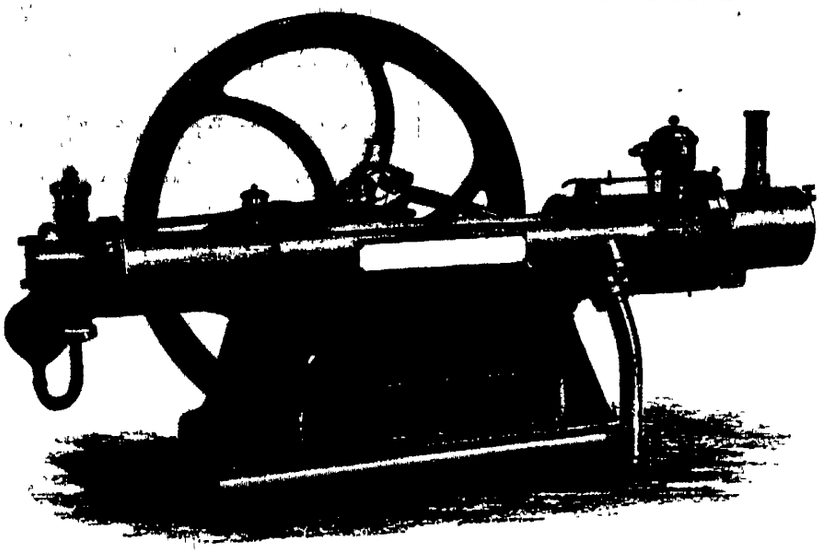
The Stockport gas engine is of the type of those which compress the charge, and it has an explosion at every revolution, whether the engine be lightly or heavily loaded. As will be seen from the illustration, there are two cylinders arranged on the same axial line, one serving to draw in the combustible mixture of gas and air, and the other acting as the working cylinder in which the charge is exploded to produce power. The pistons of these two cylinders are connected by a trunk, so that they are in rigid union, moving simultaneously in the same direction. The central part of this trunk, in the free space between the two cylinders, is partly cut away, so that for a portion of its length it is no longer cylindrical, but is rather less than half a cylinder. This is for the purpose of accommodating the connecting rod, which is pivotted at one end to a pin in the centre of the trunk, and at the other end to the crank-pin which works in the reduced portion of the trunk. The whole arrangement recalls some form of steam pumps, with the crankshaft midway between the steam and water cylinders.

The cycle of operations, to use a phase which became stereotyped in the trial of Otto *v.* Linford, comprises one revolution only, and is very easy to follow. Commencing with the explosion, the working piston is driven forward by the force of the expanding gases, which follow it almost to the termination of its stroke. Just before it reaches the end, however, it passes an open exhaust port, communicating through a pipe with the outer air. At this point the gases have, in the normal conditions of working, a pressure of about 30 lb. per square inch, and they instantly discharge themselves until the cylinder and combustion chamber are filled only with products of combustion at atmospheric pressure. At this moment the slide valve opens communication between the cylinder and a reservoir (to be described later), filled with combustible mixture under moderate pressure. This sweeps out whatever remains of the exploded charge, driving it before it, without sensibly mixing with it, and completely filling the cylinder, before the piston, which has now commenced its return stroke, covers the port. All this occupies but a very slight portion of the piston's stroke, but as it travels very slowly for a considerable angle of the crank on each side of the centre, there is ample time for the evacuation of the spent charge and the introduction of the new one. The piston now moves inwards, driven by the energy in the flywheel, and compresses the mixture into the combustion chamber at the end of the cylinder, until the crank again passes the centre, when the ignition port is opened, and the cycle is complete.

Turning now to the other or supply cylinder, and commencing at the same point, namely at the moment when the explosion occurs, we find the cylinder filled with an intimate mixture of gas and air. These two fluids are intentionally blended as completely as possible, stratification or the introduction of air cushions being purposely avoided, as the thorough ventilation of the working cylinder at each revolution keeps the temperature of the metal and the residual gases below the point at which they will ignite the incoming charge. As the piston moves backward it forces the mixture into a reservoir in the bedplate of the engine, when it is momentarily retained, and then on its outward stroke, it draws in a fresh supply. Thus it will be seen that when the working piston is propelled by an explosion, the supply piston forces a charge into the reservoir ready to sweep out the products of combustion, and to take its place ready for compression, and when the working piston is compressing this charge, the supply cylinder is being filled afresh.

As there is an explosion at every revolution, it follows that the strength of the charge must be varied to suit the load on the engine. This is done by a governor which controls a small equilibrium valve in the gas passage, raising and lowering it as the speed increases and decreases. There is, however, a limit beyond which this method of regulation cannot be carried, for if the mixture be made too poor it will not ignite. If an engine were running absolutely empty it might easily happen that the poorest ignitable mixture would provide too much power, and the result would be an excess of speed. To prevent this the governor, besides controlling the throttle valve, do

THE "STOCKPORT" GAS ENGINE.



termines the position of a stud on a lever connected with a valve on the cylinder. At a given speed the stud is moved into the path of a tappet, and opens the valve when the compression is taking place in the working cylinder. The result of this is that a part of the charge is driven out of the cylinder through a pipe which ends in the air inlet pipe to the supply cylinder from which the rejected charge is drawn at the next stroke, and delivered again to the reservoir.

Besides the above-mentioned tappet valve, which is usually out of action, there are only two valves in the engine, both of them slide valves, and both operated from the same eccentric. The working cylinder valve is driven direct, as in a steam engine. The supply cylinder valve is worked by an arm at the end of a small weighshaft, the other end of which carries a slotted lever gearing with a pin projecting from the strap of the eccentric. This pin follows a curved path, moving backwards and forwards in the slot, the result being that the angular velocity of the lever, and consequently the speed of travel of the valve, varies very greatly at different parts of the stroke. The valve of the supply cylinder is a flat plate working between the face on the cylinder and a back plate, in which there is a cavity in constant communication with the gaspipe, after it has passed the throttle valve. There are three ports in the cylinder face, one opening into the air, one to the cylinder, and one to the reservoir, and there is a cavity in the face of the valve, with a number of small passages leading from it to meet the cavity in the back plate. During the indrawing stroke the gas enters the valve in fine streams, and the air sweeps across it at right angles as it is drawn to the inlet port of the cylinder. At the end of the stroke the movement of the valve cuts off the gas and air, and puts the cylinder port in communication with the pipe leading to the reservoir. The whole arrangement is exceedingly simple and resembles the valve of a single-acting steam engine.

The valve of the working cylinder is likewise a flat plate valve. It slides on the side of the cylinder, not the end, just in the same way as the valve of a steam engine. Its function is to put the cylinder in communication with the reservoir when the piston passes the exhaust port, and to break the communication when the piston again closes the port. In addition to this very simple operation it has to effect the ignition of the charge. The master light burns in a recess or chimney formed in the end of the cylinder, or more correctly, in the combustion chamber. It has an opening through the valve face, and past this opening there travels a cavity in the valve. This is supplied by gas, which becomes ignited, and in this condition is carried to the main port of the cylinder, the whole width of the cavity being presented to the port at once, and thus insuring the certainty of an explosion. The valve is cored out for the circulation of water which enters and leaves through flexible connections, and by this means its temperature is kept at a point where there is little fear of seizing or cutting. It is held up to its place by a back plate with springs under the nuts which secure it, and is further retained by clamps on the studs. These give way as the valve expands, and allow it to obtain just the amount of room which it requires.

The gas consumption of these engines is 35 cubic feet per hour per actual horse-power, or 20 ft. per indicated horse-power when working at their full capacity. The average pressure in the cylinder is 73.69 lb. per square inch, the initial and terminal pressures being 210 lb and 30 lb. The motion is regular, since there is an explosion at each revolution, whether the load be light or heavy, and a sudden increase of work cannot stop the engine. The engine at the Exhibition is of two horse-power nominal, and will give 4½ brake horse-power; four, six, and eight horse-power engines are also made.

Although our account is necessarily brief, and in the absence of illustrations, cannot go into details, yet it will serve to convey a fair idea of the main features of the latest venture in gas engines, and will show that it enters the market with every prospect of success. Its regularity will commend it to electric light engineers who have incandescence lamps to drive, and to all who require steady turning, while its general simplicity and its compact design will attract users who do not understand complicated machinery, and fear to introduce it into their premises. The resemblance to the steam pump is so close that a man who can manage the one may understand the other, and may undertake its supervision without any special training.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

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Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

SHIPS

3507. A. S Hamand, London. Ships and Similar Floating Structures such as Piers, Quays, Breakwaters, and Bridges. (*4d* 3 *Figs*.) February 18, 1884.—The vessel is composed of a platform forming a deck or decks supported on columns carried by two or more vessels, more or less wholly submerged, with ends of such shape as to offer the least resistance to motion in the water, the whole structure being properly braced together. The deck has its bottom at such a height above the level of the water as to be above the tops of the highest waves, and is constructed so as to act as a raft in case of emergency The submarine portions contain the boilers, coal, and ordinary propelling machinery. (*Sealed May* 30, 1884).

PROPELLING SHIPS.

7336. A. J. Boult, London. (*S. Oram, Philadelphia, U.S.A.*) **Construction of Ships and Apparatus for Propelling the Same.** (*6d.* 20 *Figs.*) May 6, 1884.—Concavities forward of the mid-ship section and below the water line are provided with two or more screw propellers having an oblique downward and outward thrust and rotated separately and independently by motors. The concavities receive and guide the currents of water to and from the propellers. (*Sealed August* 1, 1884)

8533. (*E. S. Hawley, Buffalo, N.Y., U.S.A.*) Arrangement of Screw Propellers for Vessels. (*6d. 7 Figs*.) June 3, 1884.—Two screws are placed in the line of the keel, one at the bow and the other at the stern, both located in the dead wood. Twin screws are also placed at the ends of the vessel, and located along the tapering portions of the bow and stern. The shafts by which the twin screws are rotated are slightly inclined upwards, so that the twin screws at the bow have a lifting tendency, whilst those at the stern have a depressing tendency. The shafts also converge towards the bow and stern. (*Sealed September* 5, 1884).

SCREW PROPELLER.

8167. H. H. Lake, London. (*H. C. Pearsons, Ferrysburg, Mich., U.S.A.*) **Screw Propellers.** [*4d. 8 Figs*.] February 12, 1884.—The propeller blade is sharpened on the after side at the forward or leading edge and has its forward side constructed with a convex surface so as to make it tangential to the "line of motion" at the forward edge of the blade. (*Sealed May* 16 1884).

PADDLES.

894. A. M. Clark, London. (*C. L Petersen, Boston, U.S.A.*) **Feathering Paddle Wheels.** [*6d. 4 Figs*.] January 7, 1884.—The several blades of the wheel are pivotted at their inner edges in the frame of the wheel, and suitable stops are arranged in the frame radially beyond the pivots of the blades near their outer edges, which act to hold the blades to their work while passing through the water The frame of the wheel is composed of side plates which are preferably made in skeleton form, and are duplicates of each other, the blades being pivotted upon rods secured at their ends in the side plates (*Sealed May* 30 1884)

PROTECTIVE COMPOSITIONS.

257 W. Day, Blackheath, Kent Compositions for Ships and Method of Applying the Same. [*4d*.] January 4, 1884.—A coating of crude spirits of naphtha or other similar spirit is first applied and penetrates the pores of the surface, and a second coating, consisting of a mixture of india-rubber, naphtha, resin, tar, granulated pitch, and cement or oxide of iron, is applied to the first while it is yet sticky. A third coating of hot asphalte may be applied if desired. (*Sealed July* 18, 1884).

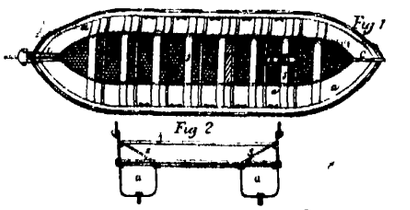
340 E. J. Pearce, Southsea. Preserving the Bottoms of Steel and Iron Ships and Preventing Rust and Internal Steam Accumulations. [*2d*.] January 12, 1884.—A composition, consisting of a mixture of orange shellac, white and red lead, vegetable pitch, marine driers, and linseed oil, is applied to the ship's bottom, turpentine being added to bring it to a suitable consistency. (*Sealed April* 29, 1884).

5966. G. J. Andrews and J E. Sutton, London Paints or Compositions for Coating Ships' Bottoms and other Submerged Surfaces to Prevent Fouling and for Preserving Iron and Wood, &c., from Exposure to Salt Water, &c. [2d.] April 5, 1884.—This consists of a mixture of linseed oil, litharge, corrosive sublimate, bitumen, pitch, and red lead. Spirit of turpentine or its equivalent is added in sufficient quantity to form a good working paint (*Sealed August* 1, 1884).

6490. A Eyrie, Hebburn-on-Tyne Protection from Fouling of Iron, Steel, and Wooden Ships' Bottoms [2d.] April 18, 1884.—This consists of a mixture of clear resin, 1 cwt.; Scotch naphtha, 4 galls.; purple or red oxide of iron, 1½ cwt.; creosote oil, 8 galls., and methylated spirit, 4 galls (*Accepted August* 1, 1884)

BOATS.

2315 J A. Timmis, London. Life and other Boats. [6*d*. 6 *Figs*.] January 29, 1884.—Two tubes, flat at the top, rounded at the bottom, and provided with keels, are placed parallel amidships at a suitable distance apart and are kept in position by stretchers These tubes are tapered fore and aft and are brought together and secured to the stem, thus forming a camber They are also provided with water-tight bulkheads at



suitable distances apart Upright or curved bulwarks are secured to the outer sides and tops of the tubes, and between them is a Manilla rope or hemp deck Fig 1 is a plan of the boat and Fig 2 a cross section The tubes *a* are secured to the metal stem O The deck *h* is open to allow any water shipped to run away; *j j* are the thwarts, *k* is the mast step, and *s s* are stays. (*Sealed July* 22, 1884)

RAFTS.

4093. T. A. F. Hall, Millbrook, and H. T. Clanchy, Shirley, Hants. Rafts Applicable for Use as Pontoons. [6*d*. 4 *Figs*.] February 28, 1884.—The raft or pontoon comprises a central framework or structure and side flaps serving as decks The side flaps are hinged to the central framework or structure, and are provided on their under surfaces with flexible air-tight vessels or chambers. The central framework is provided with reservoirs of compressed gas which can be admitted to the air-tight vessels by means of suitable valves The inflating of the vessels causes the flaps to turn on their hinges and form the deck (*Accepted August* 8, 1884).

DAVITS.

4225. D. Pattison, London. Raising, Lowering, and Stowing Ships' Boats. [*6d 2 Figs*] March 1, 1884.—The lower end of each davit is jointed to the main deck by a universal joint at a proper distance inboard from the ship's rail to allow space for the boat to rest in chocks outside of the davits. This joint allows the davit to be lowered into an oblique position so as to hang clear of the ship's side ready for lowering, or to be brought into a vertical position and then revolved so that the boat can be lifted out of chocks whether inboard or outside of the davits. A tackle attached to an upright is employed for raising or lowering the davit, which works in a slot or guide formed in the boat skids so as to steady it. (*Accepted July* 25, 1884).

3841. P P. Bonnafoy, Marseilles. Ships' Davits. [6*d* 12 *Figs*.] June 11, 1884.—The davit consists of a lever P M T pivotted at its lower end P to the deck, having the boat secured by suitable tackle to its free end T, and having suitable tackle R fastened to its middle M for steadying the boat in its descent As will readily be seen, the davit is so shaped that when released the weight of the boat will cause it to descend. The lever P M T is prevented from turning on its pivot by a lever L held in position by a lashing *a*, which is cut when it is desired to

lower the boat. The keel of the boat is supported when in position by the lever U (shown separately in *Fig.* 2) pivotted on the same centre as the davit, its free end being secured by a lashing to a ring bolt I. A flat lashing F fixed to the edge of the boat

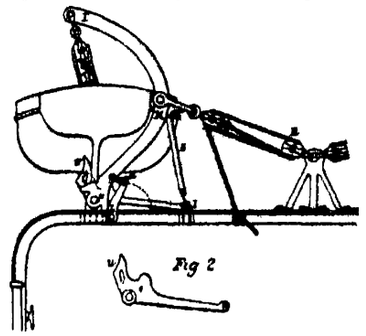


Fig 2

and to the ring bolt I prevents the boat rocking on its keel, when supported as shown, during the rolling of the vessel. (*Accepted July* 11, 1884).

BUOYS.

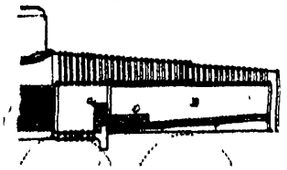
2126. R. Tindall, Fraserburgh, Aberdeen. Metallic and other Buoys. [6d. 11 *Figs.*] January 25, 1884.—The buoy is provided near its lower part with an india-rubber or other valve arranged to open automatically when or before the buoy is sunk to such a depth as would otherwise tend to cause it to collapse from external pressure. The water admitted through the valve tends to equalise the external and internal pressure whilst the air still confined maintains the buoyancy. (*Sealed July* 8, 1884).

TARPAULIN FASTENER.

1916. W. Rockliffe, Sunderland. Iron Battens and Fastenings for Securing Tarpaulins to Ships' Hatches. [6d. 6 *Figs.*] January 8, 1884.—Holes are punched or drilled in the sides of the hatches at suitable distances apart, and have studs secured therein. Each stud has an opening for receiving an iron wedge. In each batten corresponding holes are formed to fit over the studs, which may be screw-threaded to receive a nut. Holes in the edges of the tarpaulins are slipped over the studs, the battens are then placed over the tarpaulins, and the wedges knocked in to secure the whole. (*Sealed June* 20, 1884).

LOCOMOTIVES.

906. S. Pitt, Sutton, Surrey. (*J. E. Wootten, Philadelphia, U.S.A.*) **Locomotive Boilers.** [6d. 2 *Figs.*] January 1, 1884.—The object of this invention is to afford improved facilities for the effective and economical combustion of lignite and other fuels, permitting the separation of small particles from the larger when burned under a forced blast, and relates to that class of locomotives in which the firebox is located above, and extends laterally beyond the driving wheels, and is combined with a com-



bustion chamber and a firebridge. The illustration shows the firebox end of a locomotive. A table C extends across the firebox B immediately in rear of the bridge *a* above the surface of and supported upon the forward portion of the firegrate. This table serves to receive and sustain particles which may from time to time be lifted by the action of the exhaust from the mass of fuel in combustion. The rear end of the table is closed from its top to the surface of the grate, and its upper surface is located at about the ordinary level of the bed of fuel on the grate. (*Sealed April* 8, 1884).

2074. A. M. Clark, London. (*F. G. Wheeler, New York, U.S.A.*) **Steam Street Cars or Locomotives.** [6d. 6 *Figs.*] June 14, 1884.—The firebox is surrounded by a water chamber which is connected with a system of tubes from which the engine takes its steam. The chimney communicates with a water box and a steam jet therein cools and ejects the products of combustion and regulates the draught. A water tank is provided with a spraying device to condense the exhaust steam, and an ejector pipe returns the water of the water box to the tank. (*Accepted July* 15, 1884).

RAILWAY COUPLINGS.

4237. J. Hyde, London. Couplings for Railway Vehicles. [6d. 3 *Figs.*] March 13, 1884.—The coupling consists of two links, the one attached to the drawbar and hook in general use, and constructed to admit of the sliding of second link in slots at its outer end. The second link is weighted so as to rest in a slightly inclined position in the slots of the first link. The first link, actuated from levers on either side of the carriage, is raised, and carries the second link upward until it comes in contact with the hook of the adjoining vehicle, when it gives way until it clears the hook, when the weight again brings it into a horizontal position. The first link being then lowered, the second link will come in contact with the upper portion of the hook and slide to the ends of the slots, and the first link being again slightly raised, the coupling will be completed. (*Accepted July* 8, 1884).

AXLE-BOXES.

1962. T. R. Summerson, Houghton-le-Spring, Durham. Chilled Cast-Iron Pedestals or Axle Bearings for Railway Vehicles. [6d. 2 *Figs.*] January 9, 1884.—The complete pedestal is cast at two operations; the shell is cast from soft or non-chilling iron, and differs from an ordinary pedestal in that it possesses a cavity extending to nearly the full length of the wearing part. When the shell is nearly cold, it is placed upon an ordinary chill and the hard or chilling metal cast into the cavity and upon the chill through a hole left in the shell. (*Accepted August* 12, 1884).

4786. W. M. Smith, Newcastle-on-Tyne. Radial Axle-Boxes. [4d. 10 *Figs.*] March 12, 1884.—In order that radial axle-boxes and wheels of locomotives, &c., may be kept in proper positions relatively to the longitudinal centre line of the vehicle, and when moved out of such positions during passage round a curve, may be caused to resume their normal positions, when a straight portion of the line is reached, springs are provided between the axle-boxes and the vehicle frames, and the two axle boxes of each axle are connected by cross stays. Referring to



the illustrations, spiral springs A are arranged in opposite in the axle-box guide C, and act on plungers D that press against flanges on the axle-boxes F. Stays G prevent the springs A from unduly pressing the axle-boxes against the axle collars. Other slight modifications are described and illustrated. (*Sealed July* 8, 1884).

7946. W. R. Lake, London. (*G. W. Stewart, New York, U.S.A.*) **Journal or Axle-Boxes for Railway Vehicles.** [6d. 5 *Figs.*] May 6, 1884.—The inner end of the axle-box A is provided with a dust excluding plate B having a circular opening for the car axle and fitted to slide freely. A thrust plate D is fitted in the groove near the outer end of the box and a cover E is fitted in the ordinary manner. Below the cover E the journal box is made open down to the bottom plate, and this opening serves to receive an iron trough F serving to hold the lubricant, and a lower packing of cotton waste. The journal box A is also

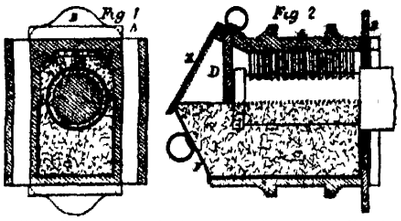


Fig 1

Fig 2

provided with a series of inclined corrugations *g* extending from each of the side walls, as clearly shown, and transversely to the length of the box. They serve to receive the packing material H formed of a mixture of old gummy waste, oil and black lead, and, if desirable, asbestos. To apply this waste, the axle-box is raised off the journal, and the waste rammed between the top of the journal and under surface of the box, and the box is then lowered. The top of the box is made with a rectangular depression which aids in holding the packing in position. The horizontal underside of the top of the box is made plain. (*Sealed September* 2, 1884).

8677. S. A. Flower and P. Ross, Jersey, N.J., U.S.A. [4d. 1 *Fig.*] June 6, 1884.—The axle-boxes are packed with fibrous material consisting of cocoa-nut or other resilient fibre and jute or other absorbent woody fibre chemically treated with caustic alkali for the removal of natural resinous and gummy matters. (*Accepted July* 8, 1884).

BRAKES.

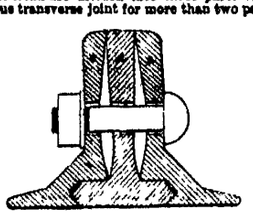
2059. J. J. Lappin, Toronto, Canada. Brake Shoes for Braking Railway Cars. [4d. 6 *Figs.*] January 24, 1884.—Certain parts of the face of the shoe are hardened by means of chills in the process of casting, the other parts being left soft and so proportioned as to produce an effective and durable brake shoe. The soft portions wear and bring the shoe to an exact bed on the rim of the wheel before the chilled portions come in contact therewith. (*Sealed May* 2, 1884).

PERMANENT WAY.

1227. D. Ellis, Aberystwith. Suspension Tramear and Rail. [4d. 6 *Figs.*] February 11, 1884.—The rail is tubular with corrugated sides to strengthen it and with the lower part of both sides bevelled. The rail is open on its lower edge to receive a cross tubular piece mounted over the supporting posts of the road. The tramcars are made so that the travellers sit back to back; the interior of the back contains the running wheels of the carriage. Two oblique wheels on each side of the carriage bear on the bevelled lower parts of the rail, and serve to keep the carriages perpendicular. (*Sealed May* 13, 1884).

2780. M. Stevens, Bath, and F. W. Stevens, Bombay Securing Railway Rails to Chairs and Connecting Railway Rails. [4d. 4 *Figs.*] February 6, 1884.—The rails are secured in the jaws of the chairs by means of a cast-iron box and a wrought-iron split wedged key. The box is divided into two parts with projections on one part, working between the projections on the other. The interior of the box is wedge-shaped to take the key, which is split up for about one-third its length and is wedge-shaped. (*Accepted July* 29, 1884).

2890. S. Pitt, Sutton, Surrey. (*F. B. Stevens, Hoboken, N.J., U.S.A.*) **Railway Rails.** [6d 6 *Figs.*] May 27, 1884.—The rail and its tread are divided into three parts so that there is no continuous transverse joint for more than two parts, and so



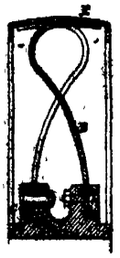
constructed that there is no vertical movement between the three narrow treads. The illustration clearly shows the construction of the rail. The joints of the centre part *d* break joint with the joints of the side parts *c*. (*Accepted July* 8, 1884).

POINTS AND SIGNALS.

660. C. Adams, Brussels. Railway Point and Signal Interlocking Apparatus. [4d. 3 *Figs.*] January 4, 1884.—A frame, through which two rods are fitted to slide parallel to the rails, is situated beside a set of points. One end of one of the rods is connected to the main line signal and one end of the other rod to the branch line signals, the other ends being linked to a sway beam, the middle of which is connected to the signal-lever. A bar connected to the points slides across the two rods and the bars and rods have notches in them so arranged that supposing the points are right for the main line then the crossbar presents a notch through which the rod connected to the main line signal can slide, but no notch for the other rod. On now pulling over the signal lever the sway beam moves on the pin of the latter rod as a fulcrum and moves the other rod giving the main line signal, and this rod passing into the notch of the crossbar prevents the points from being moved while the signal is displayed. In a similar manner when the points are shifted for the branch, the pulling over of the signal lever gives the branch line signal. (*Accepted July* 18, 1884).

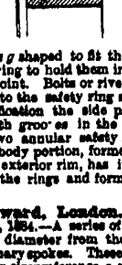
WHEELS.

2552. C. Bagnall and T. Bagnall, Thetford, Norfolk. Spoking Wheels. [6d. 4 *Figs.*] January 22, 1884.—The spokes of the wheels are made of double plates of metal set edgewise in a direction at right angles to the side of the wheel, so that the wheel shall be elastic in its action both vertically and sideways. The illustration shows a cross section of half of a wheel. The spokes F of tempered steel have their inner ends secured in



recesses in the side of the flanges A', and are held in place by rings C, one half being secured to one flange, and the other half to the other flange. The spokes are bent sideways from the flanges towards the opposite side of the wheel, and may then be bent backwards and rivetted to the interior of tyre K, or they are rivetted directly to flanges projecting from the interior of the tyre. (*Accepted March* 15, 1884).

4718. S. Pitt, Sutton, Surrey. (*J. A. Hagan, Three Rivers, Mich., U.S.A.*) **Railway Car Wheels.** [6d. 8 *Figs.*] March 11, 1884.—The illustration shows one method of forming the wheel. The tyre is made with an internal flange or ring made in sections, and dovetailed and keyed into an annular dovetail groove in the inner face of the tyre. The wrought-iron hub A has an annular projection B forming shoulders for the reception of the side plates C D, whose outwardly curved flanged rims support the tyre. The steel tyre E has an annular dovetail groove in its inner face, from which projects inwards a safety ring composed of



two sectional side pieces *g* shaped to fit the dovetail groove and a sectional centre key serving to hold them in place. These sections are arranged to break joint. Bolts or rivets H and I secure the side plates respectively to the safety ring and to the annular projection B. In a modification the side plates are formed with flanges interlocking with grooves in the sides of the tyre. In another modification two annular safety rings project inwardly from the tyre, and a body portion, formed of dish-shaped side plates connected by an exterior rim, has its periphery in contact with the tyre between the rings and forming a seat for the tyre. (*Sealed June* 20, 1884).

5285. H. S. Steward, London. Spring Wheels. [4d. 2 *Figs.*] March 28, 1884.—A series of concentric corrugated steel rings increasing in diameter from the nave to the tyre are used in lieu of the ordinary spokes. These rings being corrugated radially describe in their circumference a series of waves or flutes alternately inwards towards the centre and outwards from the centre, the outward flutes of each ring abutting upon and being rivetted to the inward flutes of the next larger diameter. In a modification, the corrugated rings are situated between a complete inner wheel and the tyre. (*Sealed June* 24, 1884).

ROPE TRAMWAYS.

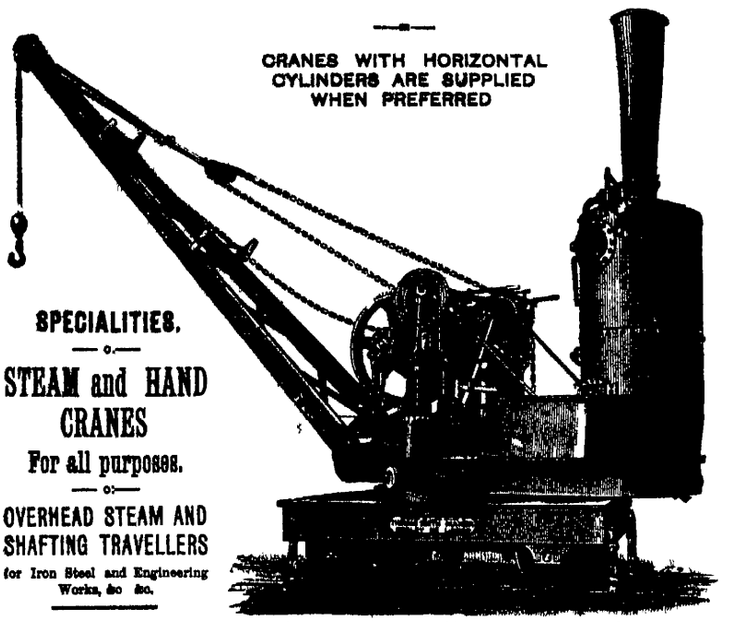
2854. W. R. Lake, London. (*H. R. Taylor, Oakland, Cal., U.S.A.*) **Rope Clamping Apparatus.** [6d. 8 *Figs.*] February 9, 1884.—Endless chains of clamping blocks shaped to fit the surface of the rope move upon elliptical shaped ways. Clamping blocks operated by screws press the endless chains against the side of the rope. The endless chains of clamping blocks move with the wire rope until the friction of the clamping surface is sufficient to overcome the inertia of the car. (*Sealed May* 16, 1884).

UNITED STATES PATENTS AND PATENT FRAUDS.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 *and* 36, Bedford-street, Strand.

VENTILATION OF PUBLIC BUILDINGS.—Messrs. Robert Boyle and Son, 64, Holborn Viaduct and Glasgow, have just applied their patent self-acting air pump ventilators and system of ventilation to the Inland Revenue Department, Somerset House; Gresham Hall, Brixton; University College, Bangor, North Wales; Council Room, Barnsley; Masonic Club, Landport; Alexandra Club House, Southend; Free Library, Northwich; New offices, Edmonton Local Board of Health; York Institute, York; Carr and Company's new stables, Carlisle; new factory for the Ekman Pulp and Paper Company, Northfleet; "Lillahurst," "Simonstown Hawes," Shrubland Park and Muncaster Castle, residences of the Duke of Sutherland, Lord Wharncliffe, Sir G. Brooke Middleton, Bart., and Lord Muncaster.

SMITH'S STEAM CRANES.



CRANES WITH HORIZONTAL CYLINDERS ARE SUPPLIED WHEN PREFERRED

SPECIALITIES.

STEAM and HAND CRANES
For all purposes.

OVERHEAD STEAM AND SHAFTING TRAVELLERS
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Of all descriptions on the Single and Double-Rope Systems, Self Acting and Driven by Steam, Water, or Horse Power.
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COCKSHOTT & JOWETT,

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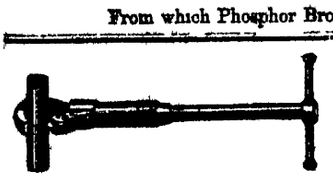
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PHOSPHOR TIN & PHOSPHOR LEAD,

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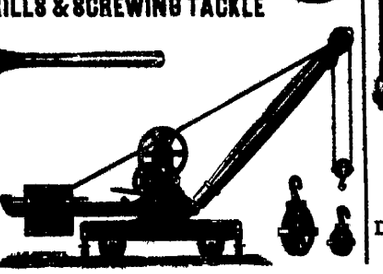






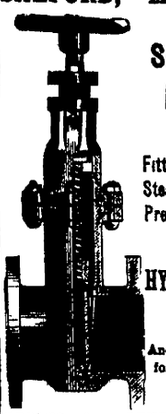


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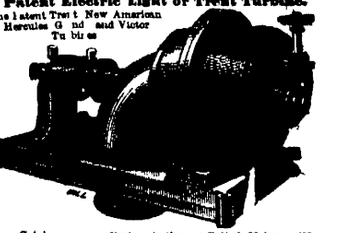
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Patent Electric Light or Trent Turbine.
The Latest Trent New American Hercules Gand Victor Turbines



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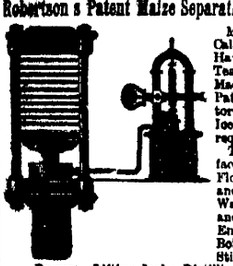


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LATHES 8 in do do 8 ft 10 ft and 12 ft beds
LATHES 9 in do do up to 20 ft beds.
LATHES 10 in and 12 in do do up to 28 ft beds
PLANES 2 ft by 2 ft by 4 ft. 5 ft. and 6 ft long
PLANES 2 ft 6 in by 2 ft 6 in, by 6 ft and 8 ft. long
Our Patent Square Centreing Facing and Chamfering Machines will square centre any length of shafts. Over 500 in use
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Bench Drills Pillar Drills, Radial Drills Milling Screwing, Screw and Stud Making Machines &c
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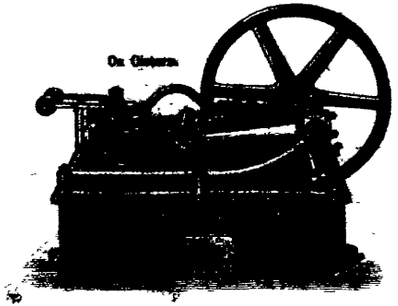
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TANGYES'

POWERFUL HYDRAULIC PRESSURE PUMP

On Cistern.



This arrangement consists of two or more best gun-metal Plunger Pumps, mounted on a strong cast-iron base [illegible] in one with the main cistern; Crank Shaft and Connecting Rods of hammered iron; all [illegible] best gun-metal; Safety Valve and Pulley.

The Cistern measures 36½ ins. long by 22½ ins. wide, and 15 ins. deep inside.

No. 1. Set of Quadruple Pumps similar to Illustration, but with Spur Wheel and Pinion and [illegible] Shaft, having two 12 in. and two 3 in. Plungers, 6 ins. stroke, capable of discharging 200 gallons per hour at a pressure of 2 tons per square inch, or 1200 gallons at 400 lbs. per square inch. } £180

No. 2. Set of Quadruple Pumps similar to Illustration, with two 2 in. and two 3 in. Plungers, 6 in. stroke, capable of throwing 100 gallons per hour at a pressure of 2 tons per square inch, or 1200 gallons at 400 lbs. per square inch. } £135

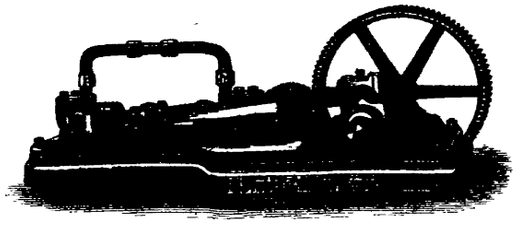
No. 3. Set of Double Pumps, having one each 1 in. and 3 in. Plungers, 6 in. stroke, capable of throwing 50 gallons per hour at a pressure of 2 tons per square inch, or 600 gallons at 400 lbs. per square inch. } £110

157

TANGYES'

POWERFUL HYDRAULIC PRESSURE PUMP

Without Cistern.



This arrangement consists of two best Gun-metal Plunger Pumps, Forged Crank Shaft and Connecting Rod, heavy Cast-iron Base Plate. All Bearings of best gun-metal. The Pump Crank Shaft is geared to Counter Shaft, and latter can either be coupled to Main Shaft of a Steam Engine, or provided with fast and loose Pulleys.

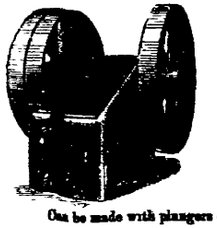
Pressure per square in.	Diam. Plungers	Revolutions per min.	Gallons per min.	Price
40 cwts.	1 in.	50	1·7	£22
20 ,,	1½ ,,	50	2·6	33
20 ,,	1½ ,,	45	3·4	35
10 ,,	2 ,,	40	5·4	35

The Gearing shown in illustration is not included in prices; quotations given on receipt of necessary particulars. 158

TANGYES'

DIAGONAL HYDRAULIC PRESSURE PUMP

For Steam Power.



Set of Double Pumps—viz., one each 1 in. and 2 in., to give a pressure of 2 tons per square in. for working Presses, &c. } £42

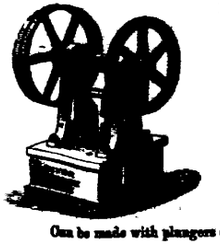
Set of Treble Pumps—viz., one each 1, 1½, and 2 in., to give a pressure of 2 tons per square inch. } £60

Can be made with plungers of equal sizes for uniform pressure at same prices.

TANGYES'

HYDRAULIC PRESSURE PUMP

For Steam Power.



Set of Double Pumps—viz., one each 1 in. and 2 in., to give a pressure of 2 tons per square inch for working Presses, &c. } £48

Set of Treble Pumps—viz., one each 1, 1½, and 2 in., to give a pressure of 2 tons per square inch. } £65

Can be made with plungers of equal sizes for uniform pressure at same prices. 159

TANGYES' HYDRAULIC PRESSURE PUMP

For Hand Power.



With one 1-inch Pump to give a pressure of 2 tons per square inch. } £22

With two Pumps as Illustration, viz., one each 1 in. and 2 in., to give a pressure of 2 tons per square inch. } £30

TANGYES' HYDRAULIC PRESSURE PUMP

For Hand Power.

Steel Gun-metal Pumps and Valves, enclosed in Cast-iron Cabinet, for pressure of [illegible] per square inch.



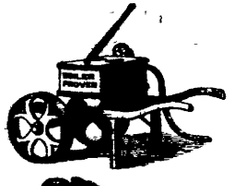
No. 1, with one 1-in. Pump £10 10

No. 2, with one 1-in. and one 2-in. Pump. } £16 0

Hydraulic Gauge, £3 3s. extra.
Safety Valve, instead of Gauge, £2 5s. extra. 160

TANGYES' BARROW BOILER PROVER,

TO TEST UP TO 200 LBS. PER SQUARE INCH.



Price	£14 10
If without Barrow	12 10

Can be made for greater pressures at an extra charge.

TANGYES'

TRIPOD BOILER PROVER.

TO TEST UP TO 200 LBS. PER SQUARE INCH.



Price ..	£3 0
Weight	56 lbs.

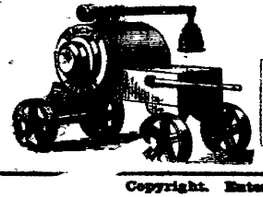
The price includes flexible suction and delivery pipe, and brass connections.

Bucket shown in engraving not included in price.

TANGYES'

HYDRAULIC GIRDER TESTER,

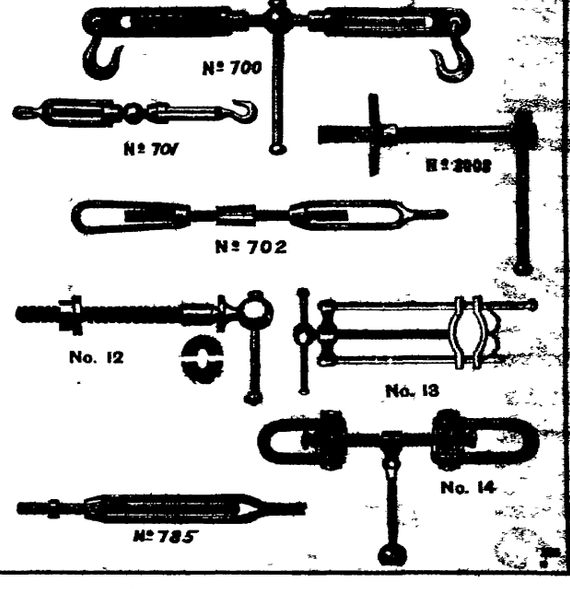
With Two Pumps



To	Diam. Ram.	Moment.	Weight.	Price
Tons.	ins.	ins.	cwts.	
50	8	10	8	£25
100	10	10	12	35
150	10	10	17	40
250	12	12	28	60

Hydraulic Pressure Gauge, £3 3s. extra. 161

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THE ENGINEERING. [Sept. 19, 1884.

Gold Medal Paris, 1881. **ELECTRIC LIGHT.** Gold Medal Crystal Palace, 1882

WORKSHOPS, MILLS, DWELLING HOUSES, OUT-DOOR CONTRACTS.

R. E. CROMPTON & CO., Electric Light Engineers,

MANSION HOUSE BUILDINGS, LONDON, and ARC WORKS, CHELMSFORD,

Contractors to H.M. Board of Works, General Post Office, Principal Railway Companies, &c,

ARE PREPARED TO SUPPLY SETS OF MACHINERY FOR

ELECTRIC LIGHTING EITHER BY ARC OR INCANDESCENT SYSTEM,

AS UNDER.

ARC LIGHTING.

		£	s	d
10-light set	(including Burgin Dynamo machine, Ten 16 hour, 2 000 candle power lamps cable, switch &c) packed and delivered free to any railway station in England	330	0	0
6-light set	do do do	195	0	0
3-light set	do do do	120	0	0

INCANDESCENT LIGHTING.

		£	s	d
30-light set	(including self regulating Burgin Dynamo machine Thirty Swan 20 candle power lamps 30 holders cable branch wire cut outs, plain wall brackets or pendants) packed and delivered free to any railway station in England	100	0	0
75-light set	do do do	195	0	0
150-light set	do do do	300	0	0

OTHER PRICES AND LIST ON APPLICATION

Extract from a Letter from the Manager of the South Wales Tin Plate Works (who have since increased their installation by the addition of both Arc and Incandescent Lamps) with reference to an Installation by R E CROMPTON & CO

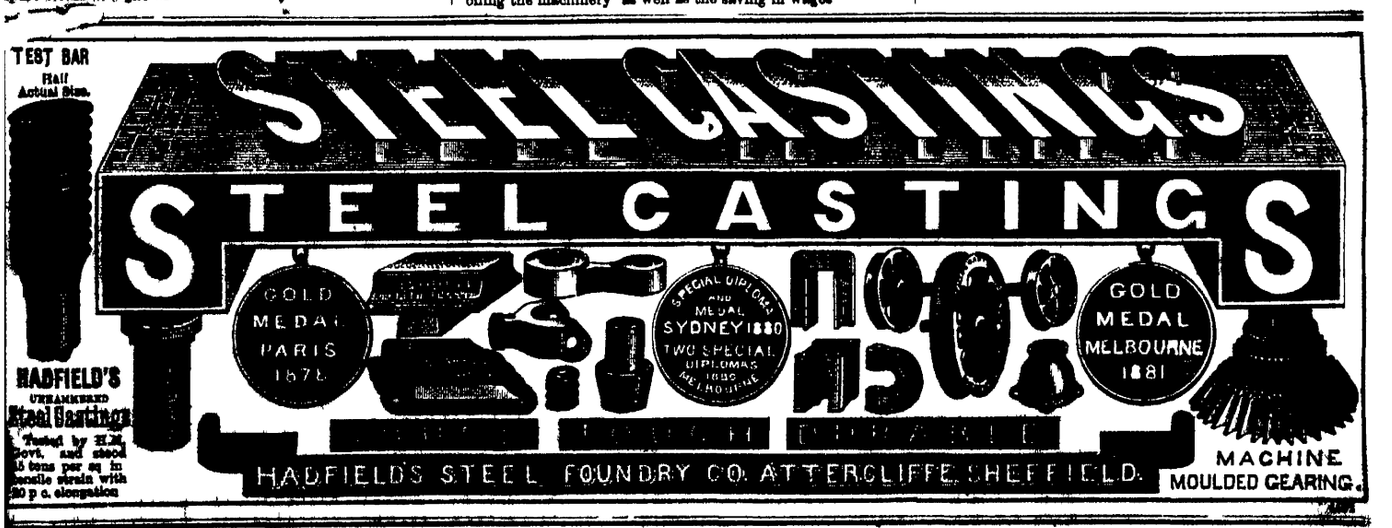
Six months experience is too short a time to enable me to give anything but an estimate of the cost of Electric Lighting as some parts of the machines only require renewing once in every two or three years. In fact as yet the cost of renewals has been almost nothing except in lamps I, however, estimate that over a series of years this item of expense will not exceed £80 per annum for 100 lights exclusive of lamps, and this is confirmed by the reports of others who say that 10 per cent upon the cost of the plant will quite cover repairs and £60 is a great deal in excess of 10 per cent upon the cost of our plant Taking this sum as the expenditure on repairs, the cost of the Electric Light will be as follows in cases similar to ours where there is spare steam at night —

Wages	£62	0	0
Lamps	90	0	0
Repairs &c.	60	0	0
Oil and Stores	13	0	0
	225	0	0
Less work done by Engineer	41	6	8
	£183	13	4

I deduct the above amount for the work done by the engineer He has nothing to do except to oil the bearings once or twice during the night, and can turn rolls screws for the mattle, &c., in a lathe driven by the same engine as the Dynamos; in fact it is an advantage in more ways than one to give him this work to do as it prevents him from going to sleep and so neglecting oiling the machinery as well as the saving in wages

This cost is for 100 lamps of 17 candle power for a year using them on an average five nights a week for 14 hours in the winter six months and nine hours in the summer six months, this gives a total of 2 990 hours during the whole of which we have 1 700 candle power of light for the sum of £183 13s 4d

What would an equal light cost in Gas at 3s. 9d a 1 000 cubic feet? We cannot calculate a burning less than one cubic foot of Gas per hour for every three candles power so that for 1 700 candles power for 2 990 hours we should burn 1 696 300 cubic feet of Gas costing [illegible] £183 13s 4d for the same light if supplied by the Incandescence Electric system 4813



New Patent Barring Engine.

AUTOMATIC MOTION FOR MOVING INTO GEAR, AND FALLS OUT OF GEAR AUTOMATICALLY WHEN MAIN ENGINE STARTS.

The SIMPLEST, SAFEST and BEST, and also the CHEAPEST Automatic Safety Apparatus for Turning Main Engines.

Sole Makers: HICK, HARGREAVES & CO., ENGINEERS, MILLWRIGHTS AND BOILER MAKERS,

SOHO IRONWORKS, BOLTON.

JOHN LYSAGHT, Limited,

TRADE MARK.

IRON ROOFS & BUILDINGS,

DESIGNS AND ESTIMATES UPON APPLICATION.

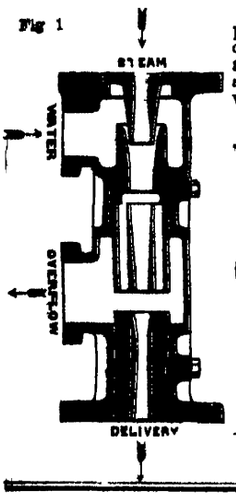
GALVANIZED CORRUGATED AND PLAIN SHEETS.
GALVANIZED STEEL SHEETS FOR WORKING UP.
GALVANIZED WIRE, WIRE NETTING, TANKS, &c.
WROUGHT AND CAST IRON GIRDERS, COLUMNS, &c.

BRISTOL: ST. VINCENT'S GALVANIZED IRON WORKS
WOLVERHAMPTON: SWAN GARDEN MILLS.
LONDON: 28, GRACECHURCH STREET, E.C. 4453

GRESHAM'S PATENT IMPROVED SELF-ACTING INJECTOR

For Supplying Stationary, Locomotive, Agricultural, or Marine Steam Boilers with Water.

Fig 1



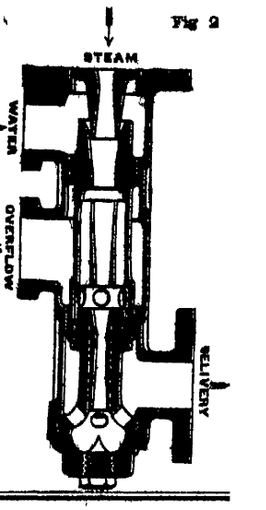
The Self acting Injector possesses the following **great advantages over all other** Injectors —It is **perfectly** Automatic and **cannot fail** to work It will lift its water supply **15 ft**, and can, when specially ordered be made for **greater lifts**. It will work with **more ease** and **certainty** with **hot water** than any other Injector If it ceases working from **any cause** (for instance, shortness of water, and consequent admission of air), it will **re-start Automatically** immediately the cause is removed It will work **equally well** at **any pressure** from 10 lb to 200 lb It may be fixed in **any position** above or below the water supply

The combining and receiving Cones of Fig 2 can be taken out and cleaned without breaking any pipe joints

The above and every other class of Injector Ejector, and Elevator in stock and in progress, also Brass Fittings for Locomotive and other Boilers

Upwards of **100,000** *of Gresham's Patent Injectors are now in use*

Fig 2



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ENGINEERS, PATENTEES, & MANUFACTURERS,

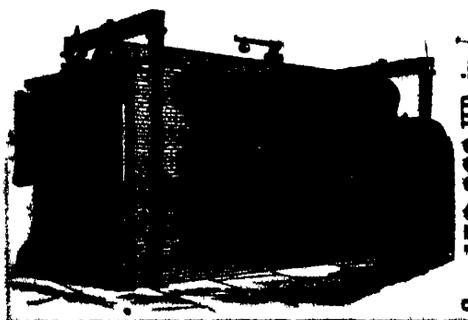
Craven Ironworks, South Hall Street, Ordsal Lane, Manchester.

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(NEW YORK & GLASGOW)



Over 150,000 HP. in use.

PATENT

WATER-TUBE STEAM BOILER

Safe, Economical (as to space and fuel), and Durable, Having Perfect Water Circulation, and Spare Steam room, Easy of Transportation, and perfectly Accessible for Cleaning external and internal

For Illustrated Circular and full particulars apply to our European Offices,

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3, VICTORIA BUILDINGS, DEANSGATE, MANCHESTER.

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THE MERSEY FORGE, LIMITED



CRANK SHAFT FOR No. 206.
Forged Weight 24 tons 11 cwt ; Finished Weight 18 tons 8 cwt 1 qr.

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Marine and other Crank Shafts

STERN AND RUDDER FRAMES,

FORGINGS OF ALL KIND IN IRON AND STEEL.

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ENGINEERS, LEEDS,

Makers of the heaviest class of Machinery used in the manufacture of **IRON** and of **STEEL** by the *Bessemer* and *Siemens* processes.

COGGING, RAIL & PLATE MILL ENGINES.

Armour Plate and Forging Presses.

STEAM HAMMERS.

Hydraulic Cranes and Capstans.

WORKS: EAST GREENWICH, LONDON, S.E.

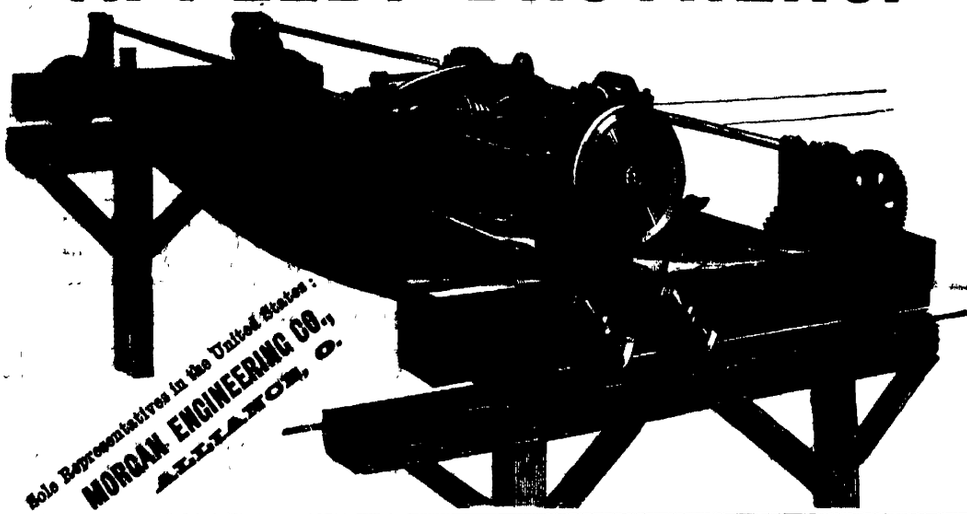
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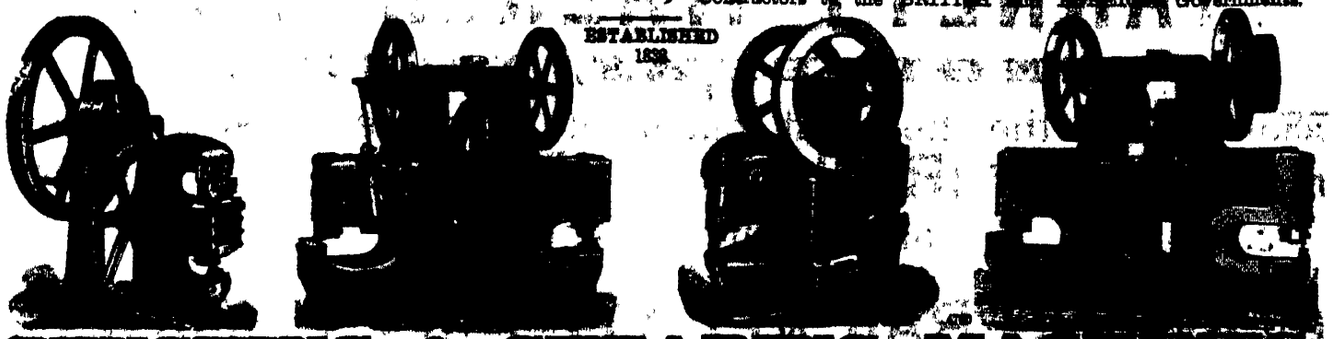
AGENCIES { LIVERPOOL - 19, SWEETING STREET. MANCHESTER, 29, PRINCESS STREET.

WORKS & OFFICES: COALBROOKDALE, SHROPSHIRE.

FRANCIS BERRY & SONS,

Ironfounders, Engineers, and Tool Makers,
SOWERBY BRIDGE, ENGLAND.
Contractors to the BRITISH and FOREIGN Governments.

ESTABLISHED 1838



PUNCHING & SHEARING MACHINES.

BORLAND'S PATENT INJECTORS

START PROMPTLY WHEN THEY ARE HOT.

No Moving Parts. No Joints to make. Continuous Action. Cheap and Economical. Small and Neat. Cleaned in a few seconds. Of best Gun-Metal only.



SPECIALITY IN INJECTORS FOR TRAMWAY, TRACTION, & LIGHT LOCOMOTIVE ENGINES.

SOLE LICENSEE :—

CHAS. S. MADAN,

21, MANSFIELD CHAMBERS, ST. ANN'S SQUARE, MANCHESTER,

WHO TESTS ALL INJECTORS PERSONALLY.

SPECIALITY IN INJECTOR AND GENERAL BOILER FITTINGS, GUARANTEED TO BE OF HIGHEST UTILITY AND EXCELLENCE.

ALL OF BEST GUN-METAL ONLY. A LARGE STOCK KEPT.



AGENTS—LONDON AND DISTRICT, HOPKINSON & PRINCE, 15, Walbrook, E.C.; LIVERPOOL AND DISTRICT, THOS. ROSKING, 18, Strand Street, Canning Dock; SWANSEA AND SOUTH WALES, PHILIP ROGERS, Coleridge House; ASHTON-UNDER-LYNE, JOHN FIELDHOUSE, Bayonet Brass Works; NUNEATON AND DISTRICT, TITUS ROBOTTOM; MANCHESTER, F. F. WELCH & CO., Station Street; CORK, D. MADILWRAITH & SONS; MIDLANDS, HUNT & MITTON, Oozells Street North, Birmingham.

PRICES, TESTIMONIALS, INSTRUCTIONS, &c., ON APPLICATION. LIBERAL TERMS TO THE TRADE.

WALKER BROTHERS,

ENGINEERS AND BOILER MAKERS,

PAGEFIELD IRON WORKS, WIGAN.

WALKERS' PATENT

AIR-COMPRESSING ENGINES

For COLLIERIES, STEEL WORKS, &c., and as supplied to HER MAJESTY'S GOVERNMENT for INDIA

WALKERS' PATENT GUIBAL VENTILATING FANS,

For Mines, Collieries, Tunnels, Sewers, &c. Diameters from the smallest size up to 90ft. With Simple or Compound Condensing Engines.
MAKERS OF THE GUIBAL, SCHIELE (the latest Patent), and WADDLE FANS.

LOCOMOTIVES. STEAM HAMMERS, Patterns up to 20 tons. FORGE and ROLLING MILL PLANT. WINDING, HAULING, and PUMPING ENGINES. IMPROVED FEED PUMPS for BOILERS.
STEAM CAPSTANS, Patterns for lifting up to 60 tons. OVERHEAD TRAVELLERS AND OTHER CRANES.
HORIZONTAL AND VERTICAL, STATIONARY, AND LOCOMOTIVE BOILERS.

Iron and Steel Forgings. Horizontal and Vertical Engines, Condensing and Non-Condensing. Roofs, Girders, Bridges, Pit Gears, &c., and all kinds of Iron and Steel Work.

WALKERS' Patent, as adapted to Bessemer Blowing Engines, is now in successful operation at the following Steel Works, and is about to be applied to other Engines for similar purposes :—

Messrs. BOLCKOW, VAUGHAN and CO., Eston, Middlesbro'.
" The DOWLAIS IRON CO., Dowlais.
" CHARLES CAMMELL and CO., Cyclops Works, Sheffield.
" The DARLINGTON IRON and STEEL CO., Darlington.
" The WEARDALE IRON and STEEL CO., near Durham.
" The NORTH-EASTERN STEEL CO., Middlesbro'.

And to nearly 200 other Engines for a variety of purposes throughout the country.

The advantages afforded by the application of the Patented Valves to Blowing Engines are greater endurance than has yet been attained by valves worked automatically (eccentrics, &c., for the valves not being required), and an almost perfect expulsion of the whole of the compressed air from the cylinders at each stroke.

RANSOMES AND RAPIER

5, WESTMINSTER CHAMBERS,

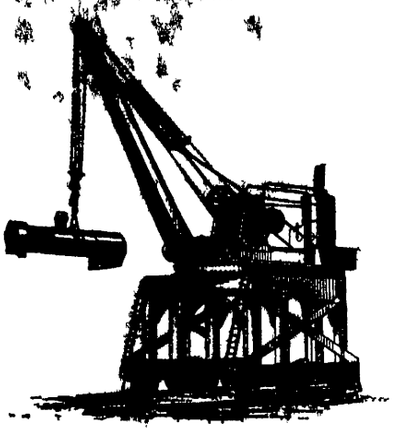
LONDON,

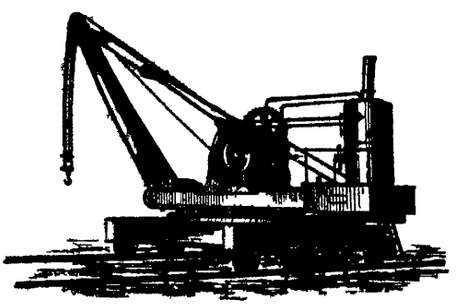
And WATERSIDE IRONWORKS, IPSWICH,

— MAKERS OF ALL KINDS OF —

STEAM & HAND CRANES

From 5 Cwt. to 50 Tons Load



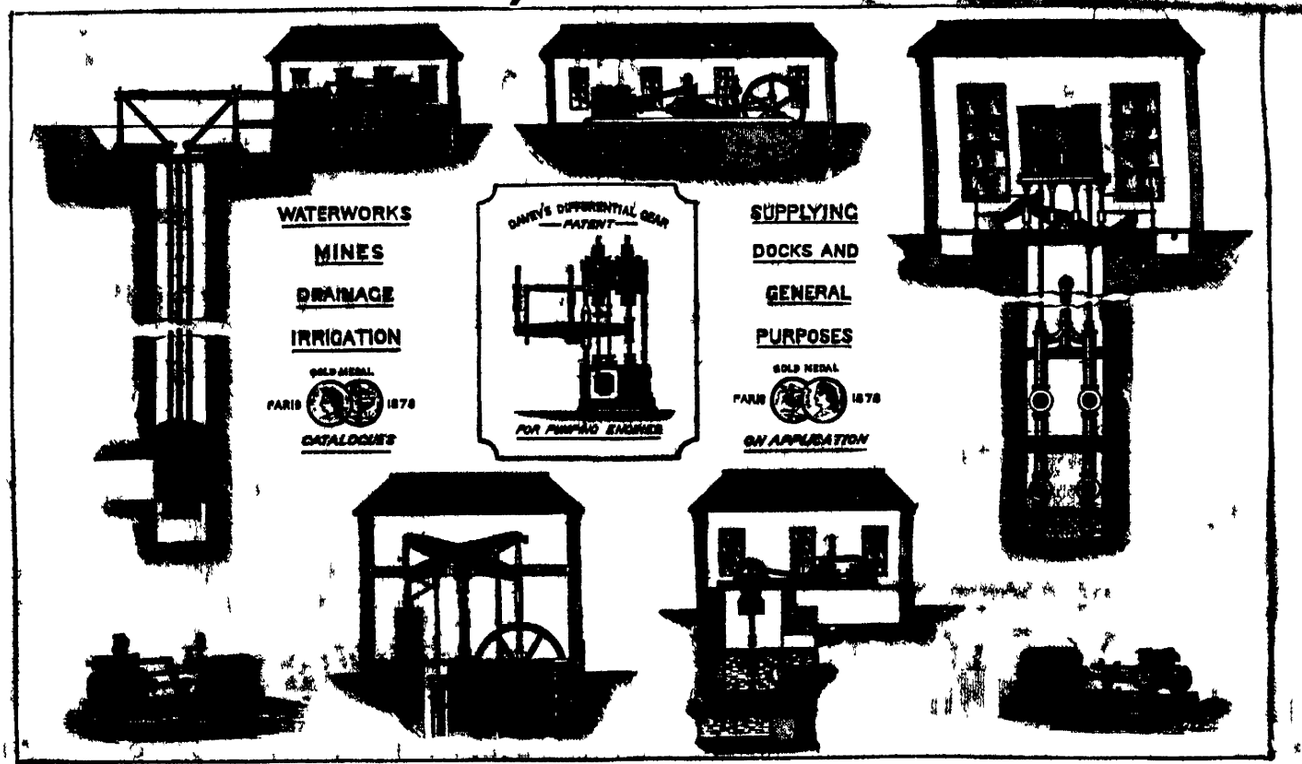




FOR PRICES AND ILLUSTRATIONS APPLY TO 5088

RANSOMES & RAPIER, 5, Westminster Chambers, LONDON, S.W.

HATHORN, DAVEY & CO.,



4978

SUN FOUNDRY, LEEDS.

T. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

The most important features connected with these Boilers are—
1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breese, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft.	long,	5ft. 0in.	diameter,	20-horse power.
10ft.	,,	5ft. 6in.	,,	30 ,,
12ft.	,,	6ft. 0in.	,,	40 ,,
13ft.	,,	6ft. 6in.	,,	50 ,,
14ft.	,,	7ft. 0in.	,,	60 ,,
15ft.	,,	7ft. 6in.	,,	70 ,,
16ft.	,,	8ft. 0in.	,,	80 ,,
17ft.	,,	8ft. 0in.	,,	90 ,,
18ft.	,,	8ft. 0in.	,,	100 ,,

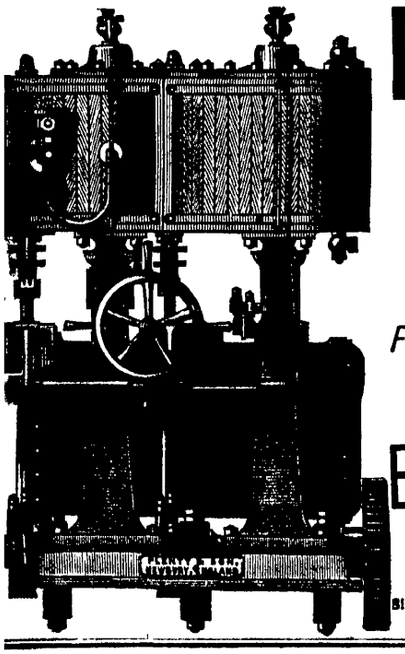
SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

BRASS & COPPER TUBES

SEAMLESS & BRAZED, FOR BOILERS, SURFACE CONDENSERS &c
BRASS & COPPER WIRE, SHEETS &c. 4857

BIRMINGHAM BATTERY & METAL CO. BIRMINGHAM.



PLENTY & SON,

EAGLE IRONWORKS,

NEWBURY, BERKS.

MANUFACTURERS TO THE ADMIRALTY.

First Prize, Royal Yacht Club, Cowes.

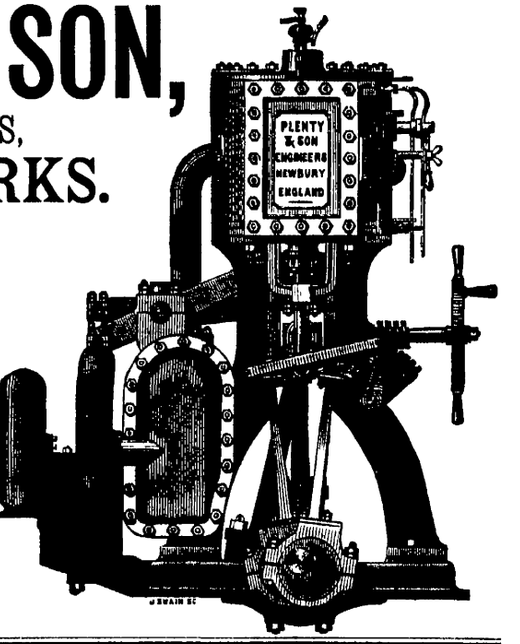
PATENT

ENGINES & BOILERS

FOR

SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &c.

Simple, High-Pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works. 4227

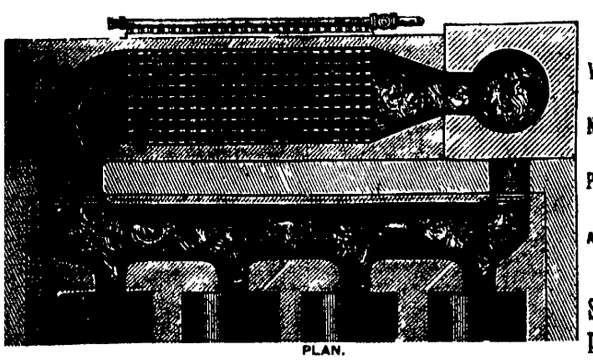


Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(FOR UTILISING THE WASTE HEAT FROM STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION



PLAN.

SPECIAL ADVANTAGES.

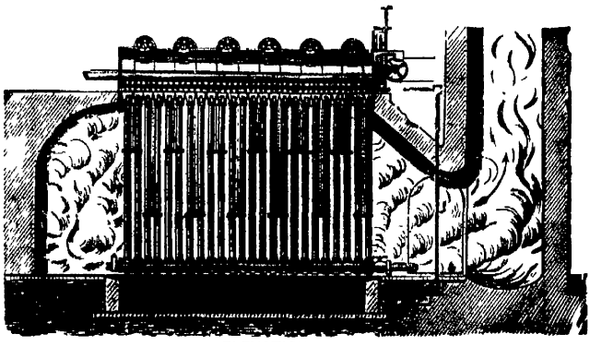
Vertical Pipe Castings. Guaranteed sound and perfectly true.

New Patent Spiral Scrapers The most effectual removers of *soot*.

Patent Reversing Gear. Never sticks or gets out of order

ALREADY IN OPERATION TO HUNDREDS OF STEAM BOILERS.

Saves from 20 to 25 per cent. of the fuel.



ELEVATION.

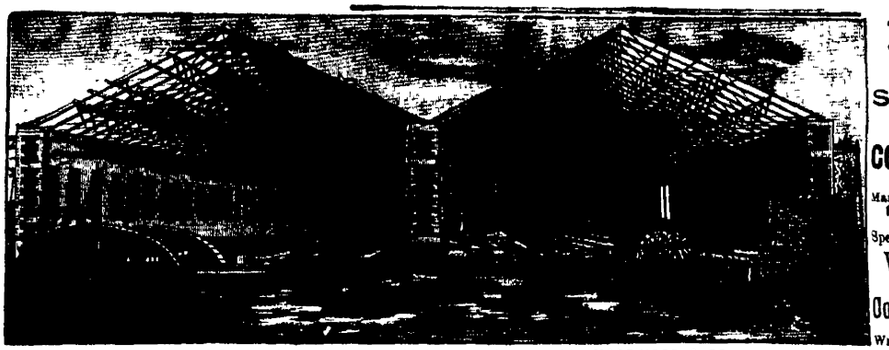
N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and abroad.

PRICES, TESTIMONIALS, AND FURTHER PARTICULARS ON APPLICATION TO 4420

ARTHUR LOWCOCK, (PATENTEE & SOLE MAKER) Coleham Foundry, Shrewsbury, England.

ROOFS and BUILDINGS in IRON and STEEL.



From Photo. of Engine Shed 600 ft. by 180 ft., recently erected by MOREWOOD & CO

MOREWOOD & CO.
WOODFORD IRONWORKS,
SOHO, BIRMINGHAM.
LONDON OFFICES—158, LEADENHALL STREET, E.C.
CORRUGATED AND GALVANISED SHEETS,
LION WORKS, BIRMINGHAM
Manufacturers of every description of Roofs and Buildings in Iron and STEEL for Forges, Rolling Mills, Railway Stations, Goods Sheds, Yards, Docks, Stores, and General Purposes.
Special Curved Corrugated Iron Roofs without Framing for moderate Spans.
WROUGHT IRON WATER TANKS, any size.
ANNEALING AND GALVANIZING POTS.
Corrugated Iron & STEEL Sheets & Fastenings, &c.
Ridges, Gutters, and Tanks, Galvanised or Painted
Wrought Iron Lattice and Plate Girders Railway, Road and Foot Bridges.
DESIGNS AND ESTIMATES ON APPLICATION. 4909

Paris, 1878.—GOLD MEDALS AWARDED.—Melbourne, 1881.

WM. JESSOP & SONS, LIMITED,

BRIGHTSIDE WORKS, SHEFFIELD,

MANUFACTURERS OF

EVERY DESCRIPTION OF TOOL STEEL & STEEL CASTINGS,

Cast, Shear, German, Spring, Blister & Sheet Steel for all purposes.

Files of First Quality —Steel Lagging Plates for Cylinders.—Steel Boiler & Ship Plates & Forgings of all kinds.

DEPOTS:—Manchester, Paris, Dusseldorf, St. Petersburg, New York, Boston, Philadelphia Cincinnati, St. Louis Chicago, San Francisco, Baltimore, Providence, Montreal.

LONDON OFFICE: MESSRS. CORNES, CALVERT & CO., 30, WALBROOK, E.C. 5137

DAVY BROTHERS, LIMITED,

SHEFFIELD,

MANUFACTURERS OF

STEAM HAMMERS

From 1 Cwt. to 50 Tons, for every kind of work,

Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.

BESSEMER STEEL WORKS PLANT,

FORGE AND ROLLING MILL MACHINERY,

Steam Engines for Mills, Ironworks, Collieries, &c.

SINGLE AND DOUBLE FLUED BOILERS. 5178

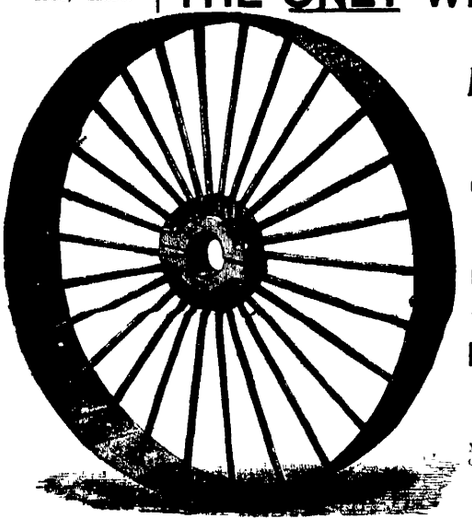
RODGERS' PATENT
WROUGHT IRON PULLEYS

Telegraphic Address, "LOCO," LEEDS.

WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.

THE ONLY WROUGHT IRON PULLEY MADE.

Telegraphic Address. "LOCO," LEEDS.



SPLIT OR SOLID.

All Sizes up to 24 feet Diameter.

40,000

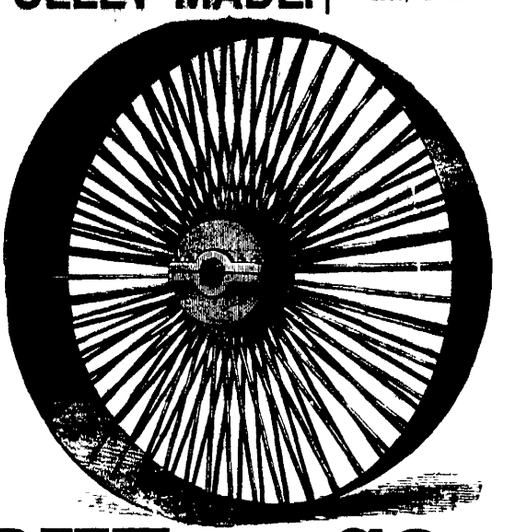
IN USE.

The Best Pulley in the World

USED SOLELY FOR

DRIVING THE ELECTRIC LIGHT AT THE HEALTH EXHIBITION, SOUTH KENSINGTON.

Messrs Marshall, Sons and Co, Limited, keep a Stock of our Pulleys at their Depôt, Marshalls' Buildings, 79, Farringdon Road, London, E C



SOLE MAKERS:

HUDSWELL, CLARKE & CO.,

RAILWAY FOUNDRY, LEEDS.

— SOLE AGENTS —

France—O BORISSOW, Rue a Fiens, Ster, Lille.
Russia—S G MARTIN, Galerny No. 12, Quartier 6, St. Petersburg
Austria—J EGLI, 1, Berz Freiung 7, Vienna
Saxony—W W DERHAM, Leipzig.
Belgium—D. GRANDY, Rue de l'Abattoir 30, Gand

Italy—A SINGTON & CO, Manchester and Milan
Holland—VAN RIETSCHOTEN EN HOUWENS, Rotterdam
Portugal—ALFD HARRISON, Rua Nova St Domingos 95, Oporto
Dominion of Canada—T J CHURCH, 672, Craig St. Montreal
Lancashire & District—F.B WELCH & CO, Market St, Manchester

Australia & Tasmania—John J. Horrocks & Co, Adelaide & Sydney.
North of England—Snowball & Co, Side, Newcastle-on-Tyne.
W. of England—Townsend & Young, Arch House, John St, Bristol
Glasgow & District—Robertson & Co., 9, Old Sneddon St., Paisley.
South of Ireland—Jas F. Roberts, 72, Francis Street, Dublin
New Zealand—Walter Brown, 1, College Green, Wellington. 4925

MATTHEW PAUL & CO.,

MAKERS OF

Steam and Hand Windlasses,

STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,

AND EVERY DESCRIPTION OF SHIP FITTINGS.

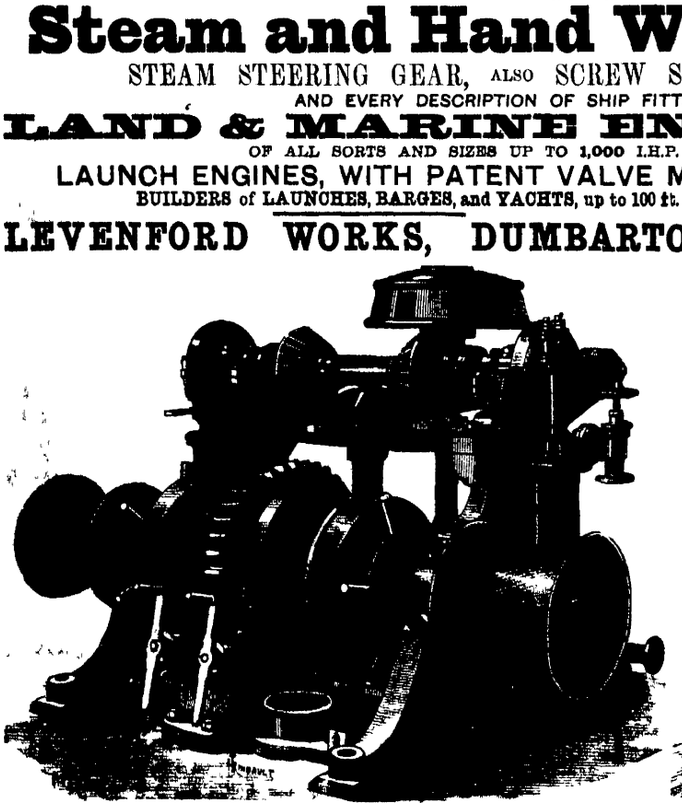
LAND & MARINE ENGINES,

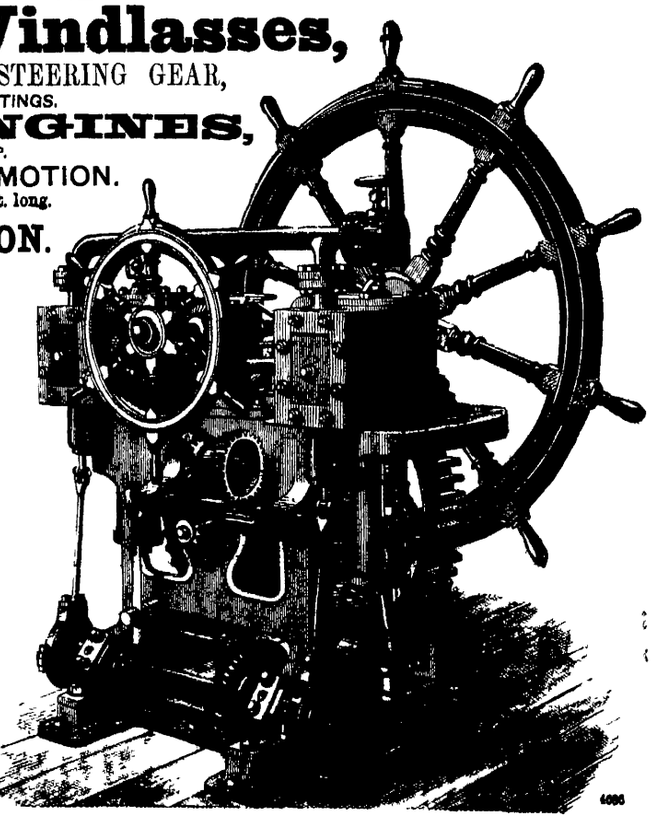
OF ALL SORTS AND SIZES UP TO 1,000 I.H.P.

LAUNCH ENGINES, WITH PATENT VALVE MOTION.

BUILDERS of LAUNCHES, BARGES, and YACHTS, up to 100 ft. long.

LEVENFORD WORKS, DUMBARTON.

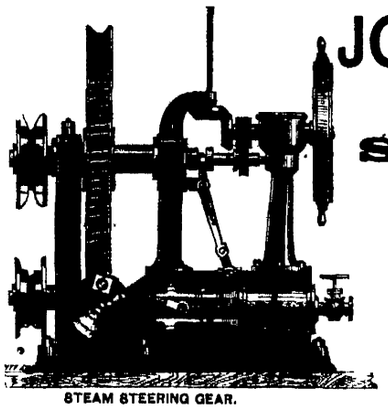
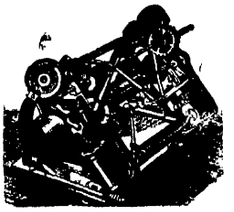
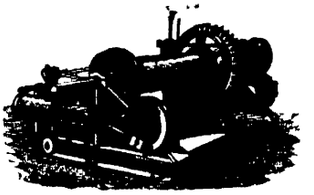




4086

FOR MINING, LEATHER
ENGINEERING, INDIA-RUBBER
AND GENERAL MECHANICAL PURPOSES GUTTA-PERCHA
GEO. ANGUS & Co. NEWCASTLE-ON-TYNE 18, BILLITER STREET, LONDON. LIVERPOOL. And BUTE DOCKS, CARDIFF.
5101

JOHN H. WILSON & CO.,
ENGINEERS AND BOILER MAKERS, &c.
SANDHILLS, LIVERPOOL.


STEAM STEERING GEAR.

VERTICAL STEAM WINCH

HORIZONTAL STEAM WINCH
4062

MANUFACTURERS OF STEAM CRANES, OVERHEAD TRAVELLERS, STEAM PUMPS, &c.

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing —

New Zealand Shipping Co., Limited.
R.M.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

BELL'S Asbestos Works, Southwark
Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high pressure pistons of this ship with the following remarkable results:—

16,000 miles continuous steaming without renewal.

Steam Pressure . 110 lbs. | Vacuum 26 inches.

My experience does not show an equal result from any other packing
The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record
Yours obediently,
D HENDERSON, Chief Engineer, R S "Ruapehu

Manchester, Sheffield and Lincolnshire Railway—Steamship Department,
Grimsby, April 10th, 1884

Dear Sir —I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing It is especially valuable when high pressures are employed, as in cases where other packings have perished owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory
Yours truly,
Mr J BELL
G H CLARKE, Sup Engineer

Department of the Director of Navy Contracts.
Admiralty, Whitehall, 20th June, 1884.

SIR,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Plastic core ....square. | Plastic core ....round

To Mr JOHN BELL. JOHN COLLETT, Director of Navy Contracts

The Patent Block Packing is square, as Fig 1, and Figs 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 10 per cent of coal, $\frac{1}{8}$ in., 20 per cent., $\frac{1}{4}$ in. 150 per cent

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred fold by economy of fuel

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotive and all Stationary Engines running at very high speed with intense friction.

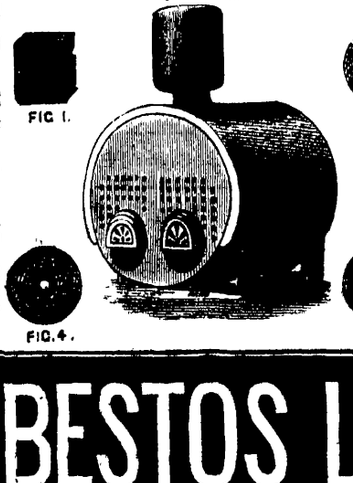
Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality

I am, dear Sirs, yours faithfully,
THOMAS WINTER, Colliery Engineer


TRADE MARK
— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices All Home orders should be sent direct to the undermentioned depots and not through agents or factors


FIG 1.
FIG. 4.
FIG. 2
FIG. 3.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up adheres to metal and preserves them from rust, prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 30 per cent of fresh and applied again The composition is supplied dry and is only to be mixed with water to the consistency required for use

A Horizontal Boiler, 27 ft. 6 in. long, 16 MP gave the following results:—
Temperature on plates 244 deg.
" Covering 94 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning

The following Testimonial refers to this Covering —

Offices of the Wimbledon Local Board, Wimbledon, Nov 28th, 1883

"Dear Sir —It may interest you to know that we save exactly 40 per cent in fuel through using your covering —Yours truly,
W SANTO CRIMP, C E, F G S."

The Tamar and Kit Hill Granite Company Limited,
Mr JOHN BELL, Southwark, S E Gunnislake Tavistock, 8th April, 1884.

SIR,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us I should add that the crane runs on high gantries, and is fully exposed to all weather I have formed the highest opinion of your Asbestos as used for this purpose and as you are aware, have had another boiler similarly covered though it has not since been used I can most strongly recommend the material —I am SIR yours faithfully
W J CHALK, Assoc M Inst. C E., Engineer and Manager

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be kept by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors It is kept in stock in rolls of 100 ft, from $\frac{1}{2}$ in. to 3 in wide, and any thickness from 1 16th in upwards. Manhole covers can be fitted many times before the renewal of the jointing material is necessary

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark without which none is genuine

It is very necessary to guard against imitations of this useful material and to secure themselves against being supplied with these inferior articles at any price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material Made in sheets measuring about 40 in. square, from 1-64th in to 1 in, and $\frac{1}{2}$ millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above —

Department of the Director of Navy Contracts.
Admiralty, Whitehall, S.W., 17th May, 1881.

SIR,—I have to inform you that your tender for Asbestos Millboard has been accepted.
JOHN COLLETT,
Mr JOHN BELL. Director of Navy Contracts

BELL'S ASBESTOS EXPANSION SHEETING, Patent

This Sheeting is another combination of Asbestos with India rubber giving to the steam user the special advantages of both materials

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable

This material is admirably suited to steam pipe joints and every class of valve

Valves made of this material are very durable, as they are not subject to injury by oil

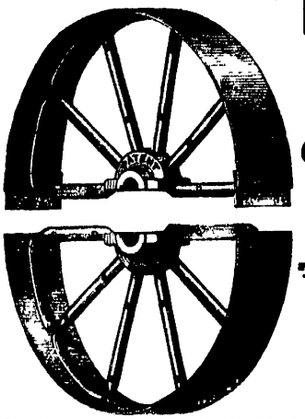
BELL'S "ASBESTOS LUBRICANT" REG'D.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

OR THE DEPOTS—
4942
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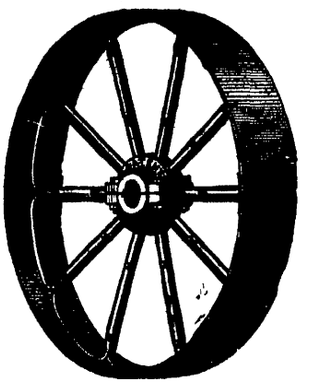
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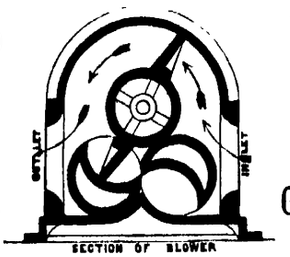
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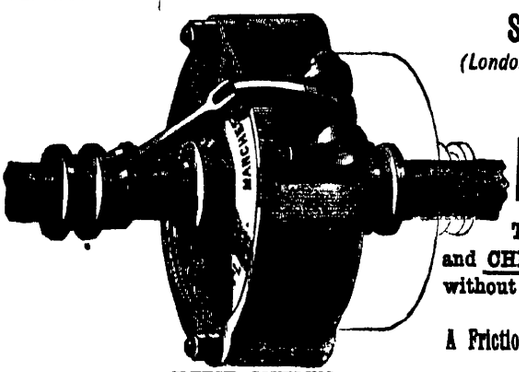
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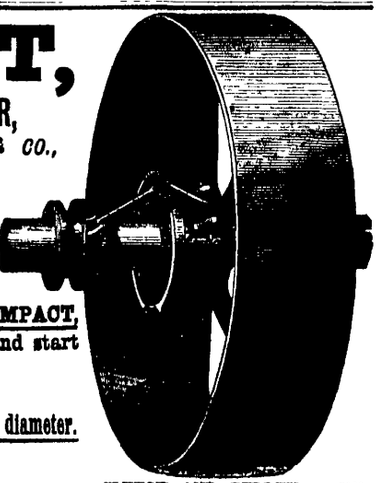
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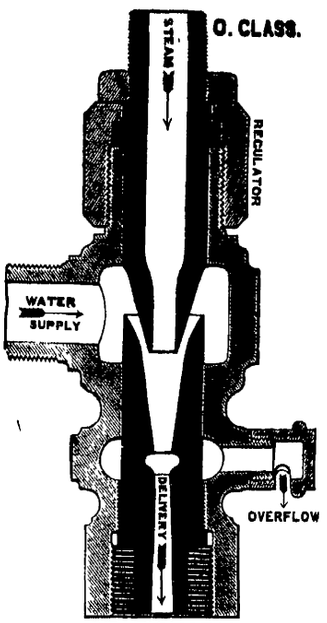
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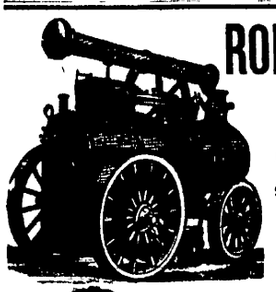
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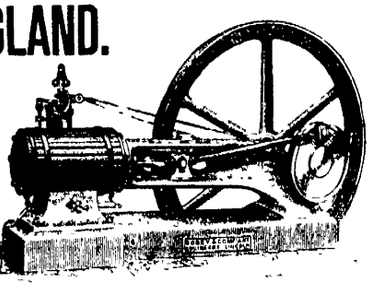
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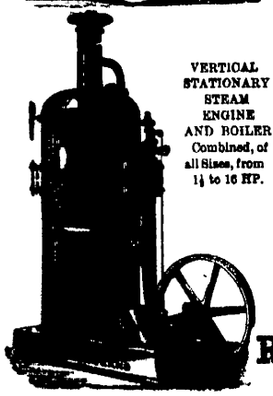

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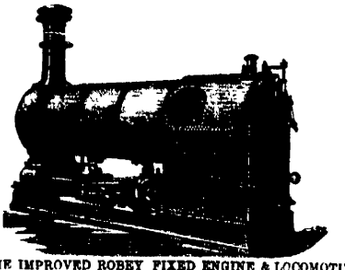
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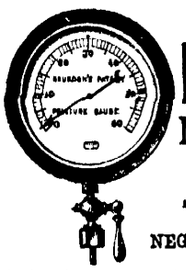
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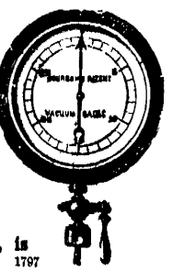
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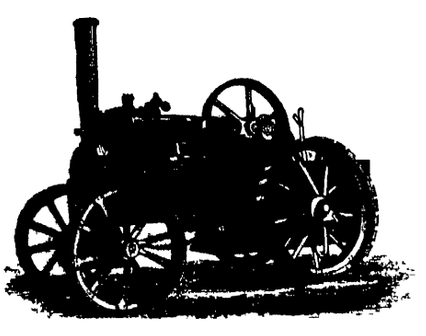


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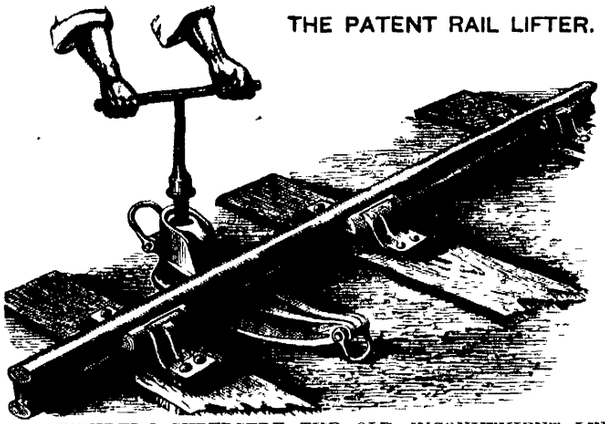
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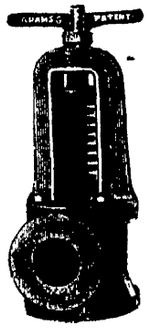
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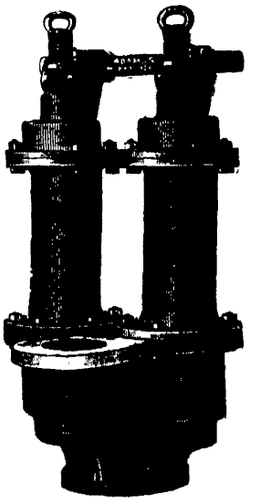
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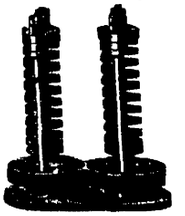


Pattern B—For Stationary Boilers. Pattern C—For Stationary Boilers



PATTERN A.—For Marine Boilers.





Pattern D—For Portable Engines. Pattern E—For Locomotives.

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The FASTEST SHIPS AFLOAT are Fitted with ADAMS' VALVE.

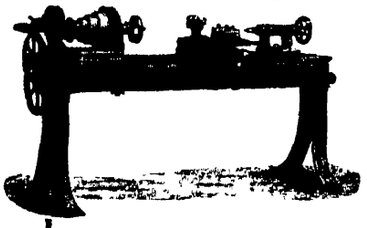
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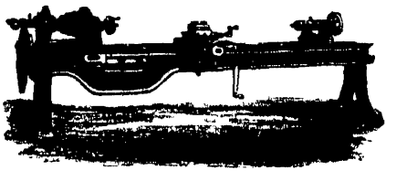
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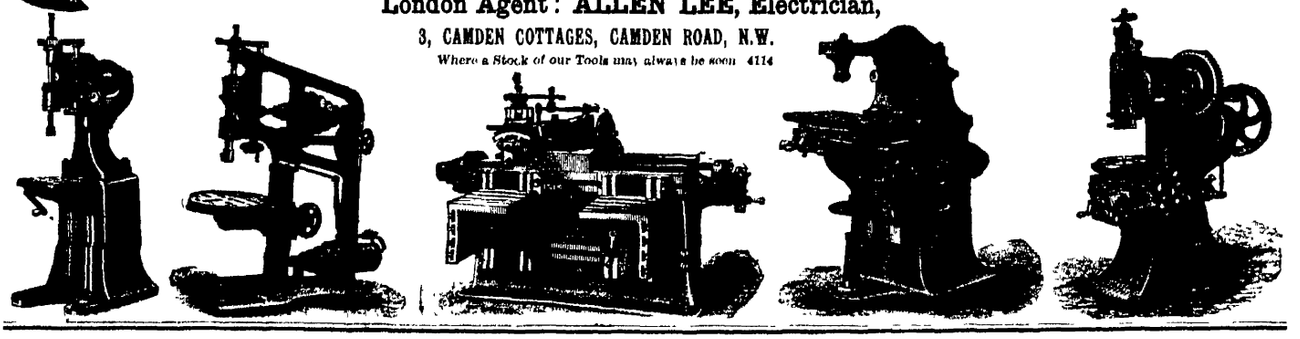


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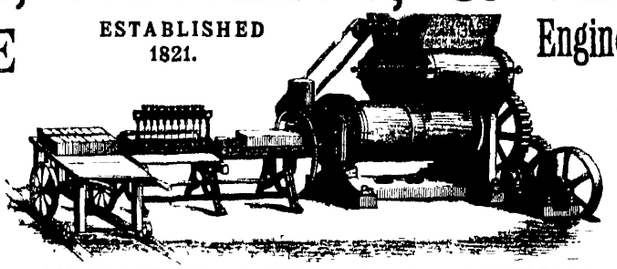
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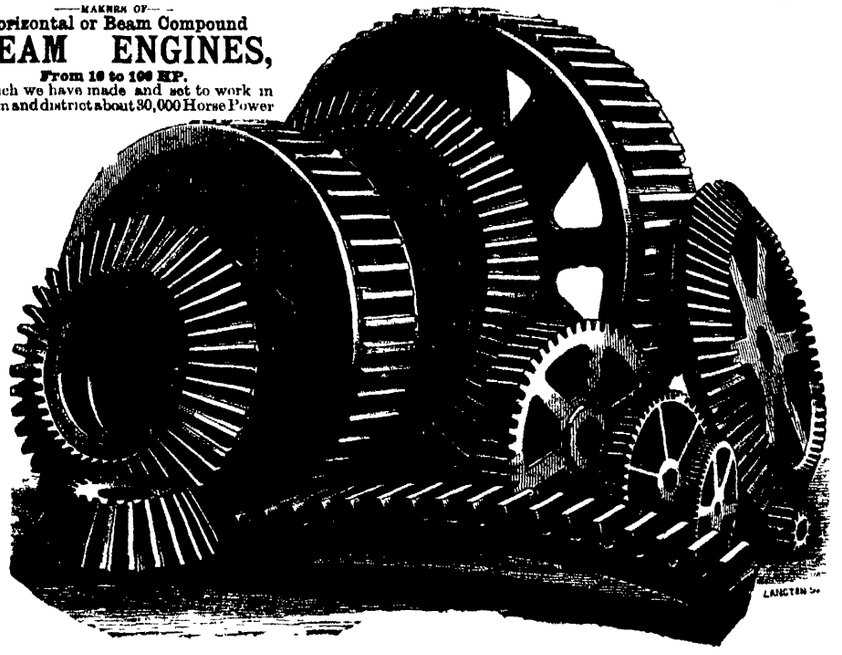
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Applied in cases where great strength is required.

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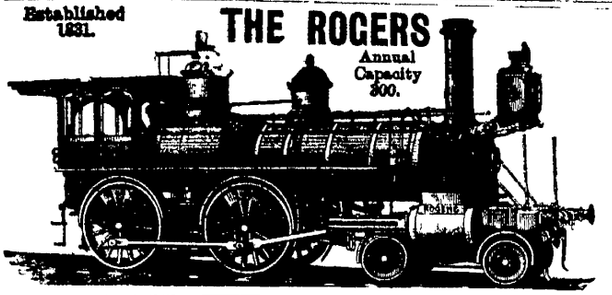
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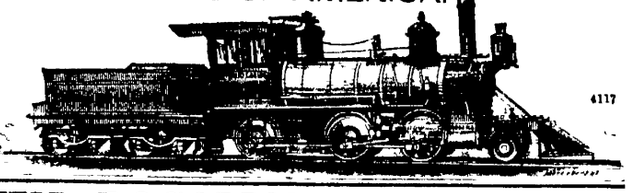
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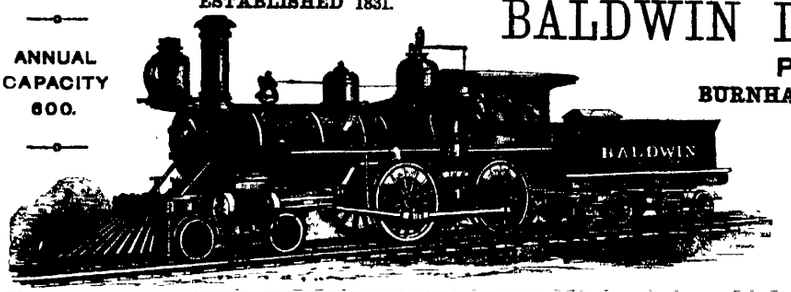
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4117

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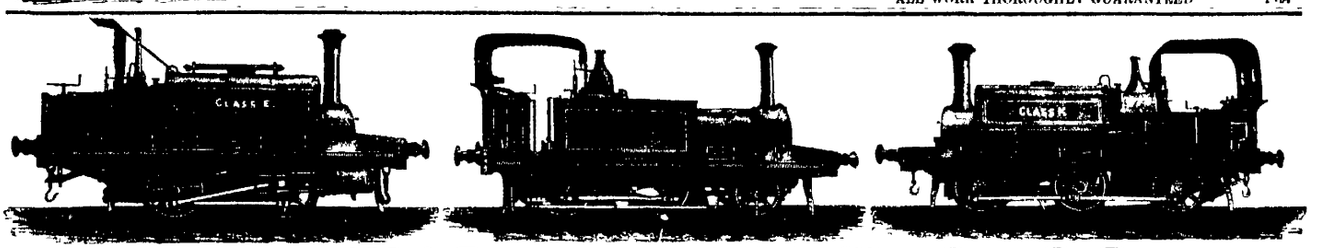
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MANNING, WARDLE & CO.,

BOYNE ENGINE WORKS, LEEDS,

Have designed and constructed one hundred various types of Tank and other Locomotive Engines for upwards of thirty different widths of gauge, adapted where necessary for passing round sharp curves and ascending steep gradients, suitable for any climate, and for burning coal or wood, &c. also for special duties required by Railway Companies, Contractors, Collieries, Iron Works, and Mines, Brick Works, Quarries, Gas Works, Ship Yards, Docks, Sugar Plantations, &c., &c. They are built accurately to standard gauges and templates in order that like parts of various classes of Engine will fit different Engines of the same type, and so that duplicates can be supplied on the shortest notice. The materials are the best of their respective kinds, and the workmanship cannot be excelled. MANNING, WARDLE & Co., having designs and models of such a great variety of Engines, are enabled to execute orders for Locomotive Engines adapted to most requirements in a very short time.

Locomotive Tank Engines from 8 inches to 15 inches Cylinders on Four or Six Wheels all coupled, always in Stock or in Progress. 2496

SPECIFICATIONS, PHOTOS, AND PRICES, ON APPLICATION.

EDWIN LEWIS & SONS,

WOLVERHAMPTON, STAFFORDSHIRE.

LAPWELDED IRON BOILER TUBES.

BUTTWELDED GAS, STEAM, and WATER TUBES.

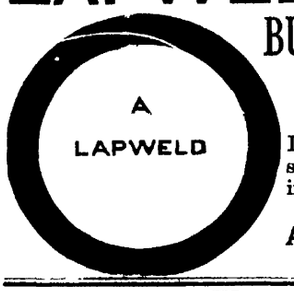
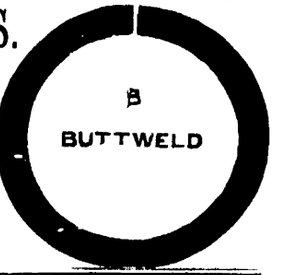
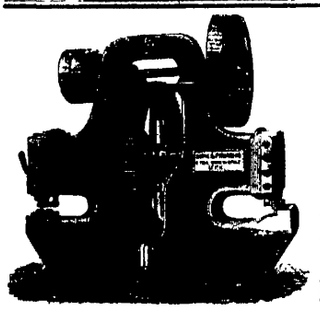


DIAGRAM SHOWING LAP AND BUTT WELDS.

These two Engravings, representing sections of Lapwelded Wrought Iron Tube (at A) and Buttwelded (at B) show conclusively the superior strength of Lapweld, which has nearly four times the surface in contact in the Weld over that given in Buttweld.



All Gas, Steam, or Water Tubes over Two-inch size are made Lapwelded by us. 4864



DAVIS AND PRIMROSE,

ETNA IRONWORKS, BANGOR ROAD, LEITH, N.B.

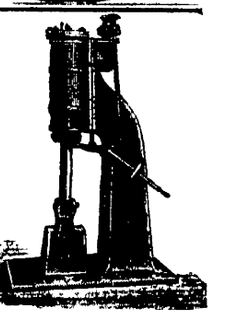
IMPROVED DOUBLE-ACTING STEAM HAMMERS

For Forges, Smithies, Stamping, &c.
AWARDED THE

FIRST PRIZE at SYDNEY EXHIBITION, 1880.

Sizes from 1½ cwt. to 12½ cwt. usually in Stock. 4377

Punching and Shearing Machines, Shipbuilders' and Boiler Makers' Tools, &c.



MEASURES BROS. & CO., SOUTHWARK STREET, LONDON,

Manufacturers of Patent Girders, Rolled Joists in Iron or Steel, Rivetted Girders, Pitch Plates, Bulb and Channel Iron, Contractors' Rails, Tee, Angle, and Sash Iron, Bonding Hoops, Bolts, Rivets, Washers, Chequered Flooring Plates, Patent Fire-proof Floors, Cast or Wrought Iron Columns, Stanchions, Tanks, and every description of Builders' Iron Work,

Have now in their TOWN STOCK 5,000 TONS, and can guarantee prompt delivery at lowest Market Prices.

ESTIMATES, SECTION SHEETS, AND BOOKS FREE ON APPLICATION.



ANGLES.

8 × 4	3½ × 3½
6 × 6	3 × 3
6 × 3½	2½ × 2½
5 × 3½	2 × 2
4 × 3½	1½ × 1½
4 × 4	1 × 1

SECTION OF JOISTS.

8 × 8 = 10lbs.	4½ × 8 = 18lbs.	7 × 2½ = 14lbs.	9½ × 3½ = 24lbs.
8 × 1½ = 6 ,,	5 × 4½ = 22 ,,	7 × 3½ = 20 ,,	9½ × 4½ = 32 ,,
4 × 1½ = 7 ,,	6½ × 2 = 11 ,,	8 × 4 = 22 ,,	10 × 4½ = 32 ,,
4 × 3 = 12 ,,	6½ × 3½ = 16 ,,	8 × 5 = 28 ,,	10 × 6 = 36 ,,
4½ × 1½ = 8 ,,	6 × 6 = 29 ,,	8 × 6 = 34 ,,	10 × 7½ = 56 ,,

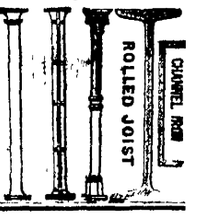
12 × 5 = 42lbs.	14 × 6 = 60 ,,	15 × 6 = 63 ,,	19½ × 7½ = 100 ,,
12 × 6 = 50 ,,	14 × 6 = 60 ,,	17½ × 6½ = 82 ,,	

Joists—Lengths, from 6 to 36 ft. PLATES—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to 2"

TEES.

5½ × 5½	12 × 3
4 × 4½	9½ × 3½
6 × 3	9½ × 3½
3½ × 3½	6½ × 3½
2 × 2	4½ × 2½
1½ × 1½	3½ × 1½
1 × 1	1½ × ¾

CHANNELS.



5126

DANIEL ADAMSON & CO.,

Established 1851.] ENGINEERS AND BOILER MAKERS, [Established 1851.

DUKINFIELD, NEAR MANCHESTER,

HIGH-PRESSURE, CONDENSING, & COMPOUND STEAM ENGINES.

SOLE MAKERS OF

THE WHEELOCK AUTOMATIC EXPANSION ENGINE,

(Grand Prize Paris, 1878, and First Prize Cincinnati, 1880, in competition with Corliss and other Automatic Expansion Engines).

THE BULKLEY PATENT INJECTOR CONDENSER, USED in the UNITED STATES at all the LARGE IRON and STEEL WORKS

ADAMSON'S PATENT TESTING MACHINES, to Test from 50 to 2,000 Tons.

BLOWING ENGINES, AIR COMPRESSORS, & BESSEMER PLANT.

PATENT HYDRAULIC JACKS.

GENERAL HYDRAULIC ENGINEERS. 4703

GEORGE SALTER & Co.

WEST BROMWICH,

MANUFACTURERS OF

Spring Balances, Roasting Jacks,

BOURDON'S, SCHAEFFER'S, & SILVESTER'S

PRESSURE GAUGES,

COLLIERY SIGNAL BELLS, RASTRICK'S TUBE SCRAPERS,

CONICAL, SPIRAL, and all kinds of COILED SPRINGS made to order.

DYNAMOMETERS

For Testing Strength of Wire, Rope, Cement, Cloth, &c.

GOODS SUPPLIED THROUGH ALL MERCHANTS AND FACTORS

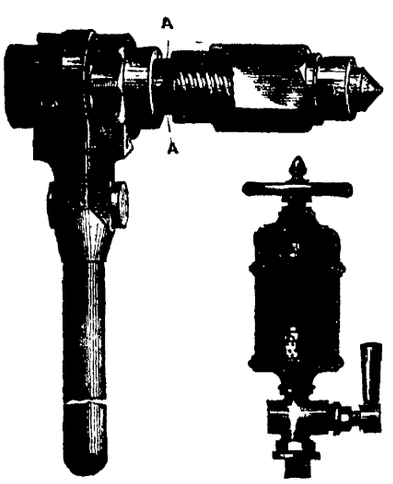


NETTLEFOLDS LIMITED, BIRMINGHAM,

SOLE MANUFACTURERS OF

WESTON'S STORER'S

PATENT DIFFERENTIAL RATCHET BRACE.—PATENT OPEN TOP SUET LUBRICATOR.



These BRACES, which have been several years before the public, and are MUCH APPRECIATED by them, NETTLEFOLDS have lately CONSIDERABLY IMPROVED by enclosing the SCREW in a SLEEVE (A) which always PROTECTS it from INJURY either from DIRT or BLOWS This SLEEVE also acts as a GUIDE for the NUT, thus keeping it steady throughout the whole of its traverse, and consequently enabling the drilling to be effected with PERFECT ACCURACY.

The SUET LUBRICATOR has effected a saving of 70 per cent. in the cost of lubricating material used for Nettlefolds' Engines, and has now been fully tested in their works on 15 Cylinders working to 750-horse power

Messrs. HICKS, HARGREAVES & Co. write:—"We find the saving in *excess* of that stated in Messrs. Nettlefold & Chamberlain's Report—viz, 70 per cent., and the cylinders to which these Lubricators have been applied are in beautiful condition. We shall adopt them for all our engines."

By this Invention the steam is lubricated before passing to the valves, while the supply of grease is uniform and constant.

SOLD BY THE UNDERMENTIONED AGENTS:—

BIRMINGHAM	Wakeman, C. H., Gt. Charles St.	NEWCASTLE-ON-TYNE	Galloway & Co.
LONDON	Nettlefold & Sons.	NOTTINGHAM	Manlove, Alliott, Fryer & Co.
LIVERPOOL	Sharp & Carline, 34, James Street.	BELFAST	Patterson, R., & Sons.
MANCHESTER	Edmundsons & Co.	DERBY	Handyside & Co.
GLASGOW	W McGeoch & Co., Schaffer & Budenberg	RUSSIA	Sumner, John M. & Co., Manchester.
EDINBURGH	Redpath, Brown & Co, Thos. Scott.	AUSTRIA	Simon Henry, Manchester.
BRISTOL	Weston, J D., & Son.	GERMANY	Schaffer & Budenberg Manchester. 736
SHEFFIELD	Wilkes Brothers & Co., Tasker Sons & Co.		

OF WHOM PRICED LISTS AND FULL PARTICULARS MAY BE OBTAINED.



4572

THE

Oldham Boiler Works Company,

LIMITED,

AND REDUCED,

(Late **JOSEPH PRITCHARD & SONS**).

ESTABLISHED 1816.

Attendance
MANCHESTER EXCHANGE,
Tuesdays and Fridays,
1 to 2 30 o'clock,
P Pillar.

MAKERS OF ALL TYPES OF

IRON AND STEEL

STEAM BOILERS,

ON THE MOST MODERN PRINCIPLE.

By Patent Machinery, specially adapted for Drilling, Rivetting, and Flanging.

ALSO SOLE MAKERS FOR LANCASHIRE, YORKSHIRE, AND CHESHIRE, OF

MIRFIN & NIELD'S PATENT

COMBUSTION CHAMBERED BOILERS,

WITH INCREASED FLUE-HEATING SURFACE.

Works: OLDHAM, ENGLAND.

LONDON AGENT: Mr. G. W. BLOW, 11, QUEEN VICTORIA STREET, E.C. 4885

WATER PURIFICATION

JOHN HENDERSON PORTER, PATENTEE,
1 & 2, TUDOR STREET, LONDON, E.C., furnishes the necessary Plant

The PORTER-CLARK PROCESS

Removes Lime, Magnesia, and Iron from **Hard Waters**, and thus, the **causes of Incrustation in Boilers and Pipes.** This Process is in use in Paper Mills, Breweries, Sugar Works, India rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c. One Railway Company employs it for feed water to the extent of **1,000,000 gallons** daily, and one of the London Water Companies at two of its Pumping Stations It is also in use in County Asylums, Public and other Schools, and Private Mansions. The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich, are rendered soft and clear 5226

DESCRIPTIVE CIRCULAR ON APPLICATION.

15 PRIZE MEDALS. THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED, 15 PRIZE MEDALS.
4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 3. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 3. GLASGOW, 1880, 2. LONDON, 1882, 1.



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD 4794

BRIDGE FOUNDATION CYLINDERS.

THE STOCKTON FORGE CO.,
STOCKTON-ON-TEES.
Make a Specialty of this work, turning out over 100 tons per week; also large quantities of Railway Chairs. 4809

The Metropolitan Railway CARRIAGE & WAGON COMPANY (Limited), Saltley Works, Birmingham, Successors to Messrs Joseph Wright and Sons, Manufacturers of Railway Carriages, Tramway Cars, Wagons, and Railway Ironwork of every description
RAILWAY CARRIAGES and WAGONS built for CASH, or UPON DEFERRED PAYMENTS EXTENDING over a SERIES of YEARS
A large number of COAL, IRONSTONE, BALLAST, and other WAGONS to be LET on HIRE
Manufactory and Chief Office—SALTLEY WORKS BIRMINGHAM
Branch Wagon Works EAST MOORS, CARDIFF and GREAT EASTERN RAILWAY, PETERBOROUGH
London Offices—No 85, GRACECHURCH STREET E C 500

TUBES AND FITTINGS.

LONDON STOCK.
LIBERAL DISCOUNTS AND TERMS
JAMES E. & SAMUEL SPENCER,
Warehouse 3, Three Cranes Lane, Upper Thames St, E.C
Offices 3, Queen Street Place, Cannon Street, London, E.C

MAIN LEATHER DRIVING BANDS.

JOHN WHITE & SONS,
Machine Belting, of all descriptions Hard and Soft Spinning and Drawing Roller Hides
Combing or Apron Leathers for Silk, Wool Jute, Flax &c
OAK TANNED AND GREEN PICKING BANDS
White Ox and Horse Hide, White Calf, Brown Leather and Flat Horny Laces Flap Leathers
Pump and Bucket Leathers of Extra Strength and Quality
AND ALL OTHER MECHANICAL LEATHER. 4905
PARK ROAD LEATHER WORKS, BINGLEY, YORKSHIRE.

R. HORNSBY & SONS, Limited,

[Established 1815.] General and Agricultural Engineers, Ironfounders, Boilermakers, &c. [Established 1815]

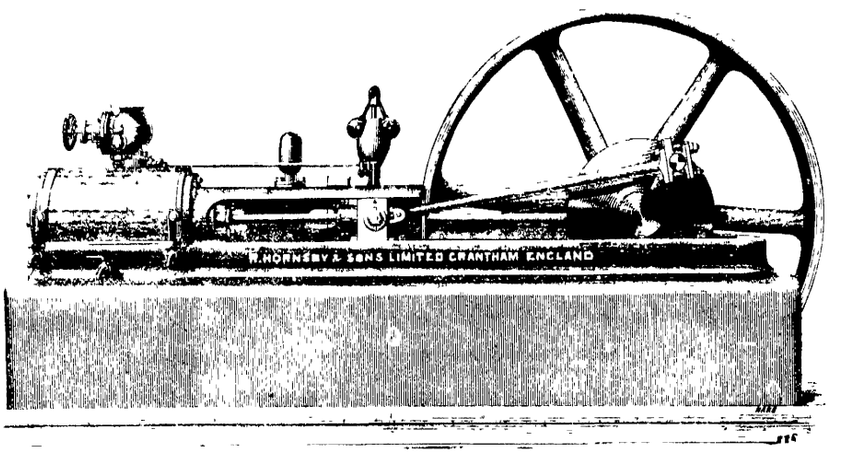
MAKERS OF IMPROVED STEAM ENGINES OF EVERY KIND, FROM 2½ TO 100 HP.

PORTABLE
With Inside or Outside Cylinders

SEMI-PORTABLE
With Inside or Outside Cylinders

VERTICAL
WITH
CROSS-TUBE BOILERS.

VERTICAL
WITH
Vertical Tubular Boilers.



FIXED HORIZONTAL STEAM ENGINE 10 TO 60 HORSE POWER, EITHER WITH NEW PATENT AUTOMATIC EXPANSION GEAR OR HIGH SPEED GOVERNOR WITH THROTTLE VALVE.

HORIZONTAL
STATIONARY
Both Simple & Compound, with or without Condensers

COMPOUND
Undertype Stationary
AND
With or without Condensers

HORIZONTAL
WINDING ENGINES
BOTH
Direct acting and with Gearing

TRACTION ENGINES

HORNSBY'S PATENT
Automatic Expansion Gear
CAN BE FITTED TO MOST OF THEIR ENGINES

BOILERS: Lancashire, Cornish, Vertical, Cross-Tube, Multitubular, Egg-Ended, etc., etc.

The New Hornsby 1884 Twine Binder, winner of the First Prize of £100 of the R.A.S.E., and the First Prize of £100 of the Highland and Agricultural Society of Scotland (being the two largest prizes ever offered), besides other high-class Awards.

For Particulars of the most modern improved and successful Agricultural Machinery, including the R A S E First Prize Mowers Reapers, Ploughs, Dressing Machines, Corn Screens, Turnip Cutters, Root Pulpers, &c, SEE ILLUSTRATED CATALOGUES in English, French German, Spanish, Russian, &c, sent GRATIS and POST FREE on application

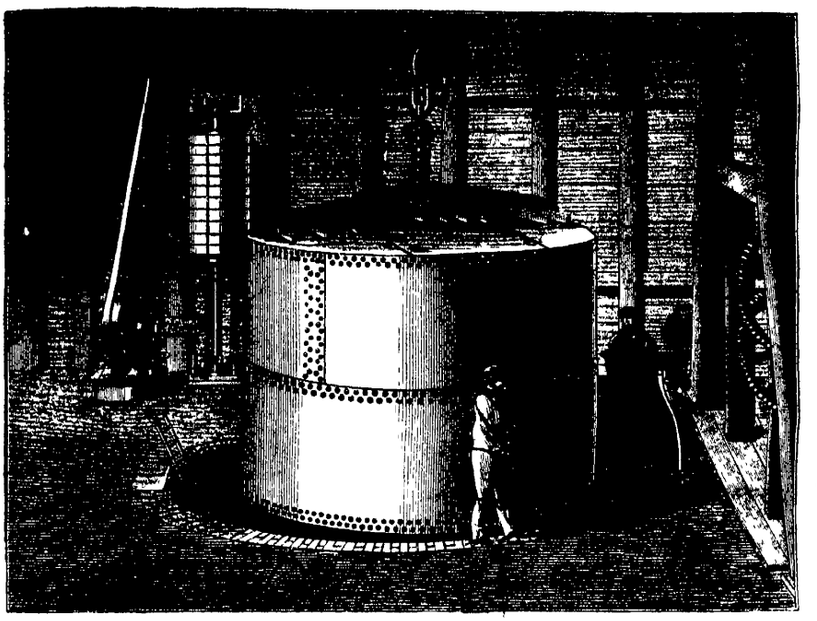
PLOUGH SHARES OF CHILLED CAST IRON, WROUGHT IRON, MALLEABLE IRON AND STEEL, OF PATTERNS TO SUIT EVERY VARIETY OF WORK, AND MADE TO LOCAL PATTERNS IF DESIRED.

At the most important Exhibitions and trials since 1874, R HORNSBY & SONS Specialities have gained 565 PRIZES, including 69 Gold Medals, 126 Silver Medals, and 323 FIRST PRIZES

SPITTLEGATE IRON WORKS, GRANTHAM. 4865

London Office: 84, LOMBARD STREET Telephone No 1294 South African Depot: EDINBURGH BUILDINGS, DOCK ROAD, CAPE TOWN

HYDRAULIC RIVETTERS



OF THE MOST RECENT TYPES.

Punching, Shearing, Bending, Forging, Hoisting,

AND OTHER HIGH-PRESSURE

HYDRAULIC MACHINERY

Please Note Change of Address:

ANDERSON & CALLWEY

Hydraulic Labour-Saving Machine Makers,

CREMORNE WORKS, 4985

CHELSEA, LONDON, S.W.

RAGOSINE OIL

THE RUSSIAN NATURAL LUBRICATING OIL. Gold Medal, Paris, 1878

Pure Hydro-carbon, free from acid. Body superior to Olive or Lard Oil | Never gums or clogs Never freezes or thickens.

No. V 2s. 6d. PER CAL.

RAGOSINE & CO.,

7, IDOL LANE, LONDON, E.C.,

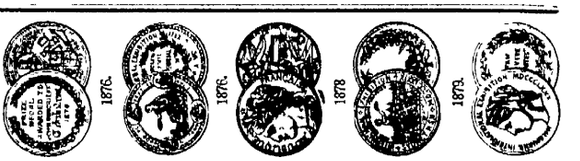
And Love Lane, Quayside, Newcastle-on-Tyne.

Works—BALACHNA and CONSTANTINOW, RUSSIA

Price Lists and full particulars on application 4779

No. VIII 2s. 0d. PER CAL.





THE PERTH GAUGE GLASS,

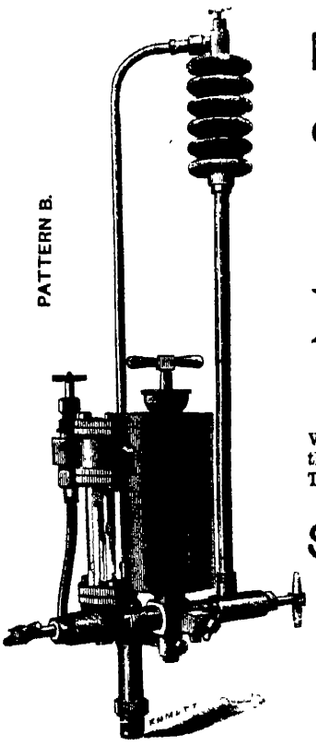
Warranted to stand upwards of **1500 lbs.** pressure to the square inch, and bear great variation of temperature

These Medals have been awarded for the above-mentioned qualities.



JOHN MONCRIEFF, CLIFFORD

North British Glass Works, PERTH. 1884



THE

EMPIRE LUBRICATOR COMPANY

EMPIRE WORKS,

GREAT BRIDGEWATER ST.,

MANCHESTER.

MANUFACTURERS OF

GRANDISON'S

Empire Lubricator

Which shows each drop of oil passing into the steam through the medium of a Glass Tube, and is the BEST APPARATUS now known for Lubrication of

STEAM ENGINES,

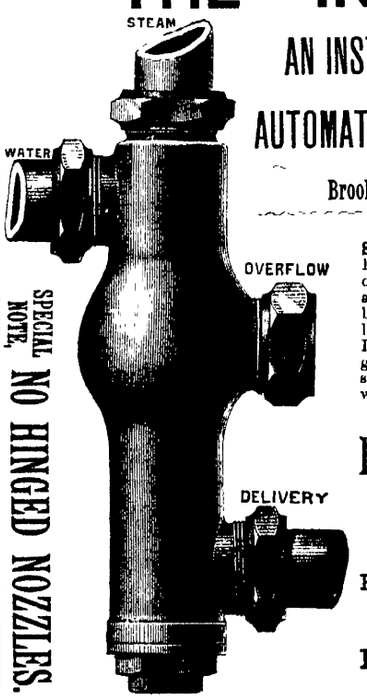
LAND OR MARINE.

Lubricators sent on approval to any part of the kingdom, and references given to users in all parts of the inhabited world.

4768

FURTHER PARTICULARS ON APPLICATION

THE "INFLUX"



SPECIAL NOTE, NO HINGED NOZZLES.

AN INSTANTANEOUS-STARTING AND AUTOMATIC RESTARTING INJECTOR

Brooke, Holden, & White's Patent.

The **only** Lifting Injector **devoid of Spindles**, Levers, Adjustable Internal Parts, or **hinged** Nozzles which lifts without manipulation and restarts automatically. **Instantaneous action** on Steam being turned full on Works equally well lifting up to 12 ft., or as a "non lifter." Invaluable for Locomotives, Traction Engines, Marine, and other Boilers Can be seen working on application, or reference will be given as to their perfect reliability

For Prices, &c., apply to

HOLDEN & BROOKE,

ST. SIMON WORKS,

SALFORD,

SOLE MANUFACTURERS.—Also Sole Makers of

BORLAND'S 5080

PATENT BOILER DRILL

For Drilling Boiler Shells

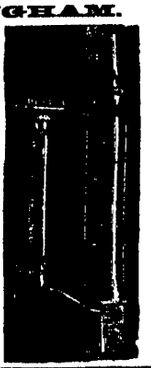
LICENSEES FOR THE SOUTH.

LEWIS OLRICK & CO.,

LEADENHALL ST., LONDON.

TAYLOR & CHALLEN,
ENGINEERS,
BIRMINGHAM.

SOLE MAKERS OF
WITHINSHAW'S PATENT
Feed Water
HEATER.
The most powerful invented
Great Saving in Boilers, Coals, and Labour.
LARGE HEATING SURFACE
Solid Drawn Brass Tubes
Free Expansion
No Scurf adheres to the Tubes
—o— 4887
List on application



BY ROYAL LETTERS PATENT.



MATHER'S
Fly-Wheel Portable Engines
ARE THE BEST FOR SMALL POWER.
They have large Fly Wheels on which they travel, they are light in draught and are handy
—o— 5101
G. R. MATHER,
WELLINGBOROUGH, ENGLAND.

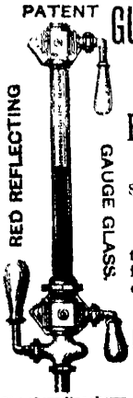
W. R. PALMER,
LIMITED,
BACOT STREET FOUNDRY,
BIRMINGHAM.
Manufacturers of
MALLEABLE IRON CASTINGS.
Guaranteed true to Pattern, of best Quality, and at Low Rates
Castings for the Bicycle and Tricycle Trades 4188



GOLD MEDAL, PARIS, 1878.

GAUGE GLASSES
AND
ENAMELS
For Iron, Cast-iron, Copper, &c.

PATENT
RED REFLECTING GAUGE GLASS.

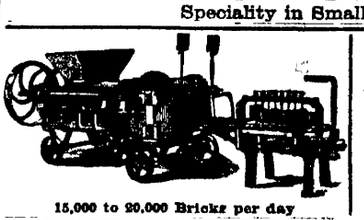


GUILBERT MARTIN
Patentee and Manufacturer of the
PATENT
RED REFLECTING GAUGE GLASS,
Showing through the water a Broad Red Line
N.B.—All Glasses are of the finest quality, and manufactured expressly to resist extreme pressure
DEPÔT
1 & 2, FALCON STREET,
Aldersgate Street,
LONDON, E.C.
The above line shown in black is of a rich Red. 5003
REPRESENTED BY
E. M. HAMBURGER.

EDWARD HAYES, Engineer, STONY STRATFORD
(LONDON OFFICE: 12, GREAT ST. HELENS, E.C.)
STEAM LAUNCHES
Speed from 10 to 25 miles per hour



MACHINERY constructed for Boa
Built Abroad.
—o—
Engines and Boile
kept in Stock.
BUILDER OF STEAM TUGS AND LAUNCHES
Speciality in Small STEAM TUGS for towing Barges and Lighters. 5103



15,000 to 20,000 Bricks per day

E. PAGE & CO.,
Victoria & Bedford Ironworks,
BEDFORD.
Illustrated and Priced Catalogues Free, in English, French, Spanish, or German, on application 4718

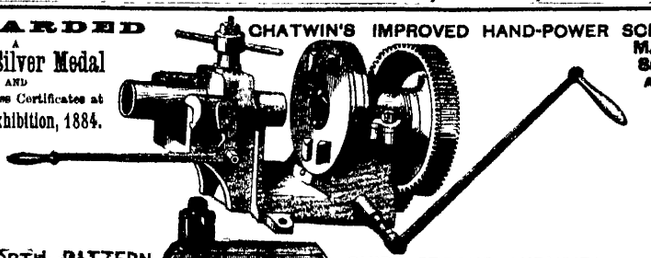


10,000 Bricks per day.

SPECIAL TOOL STEEL
FOR ALL PURPOSES.
BESSEMER AND SIEMENS STEEL FORGINGS AND SHAFTING.
SPECIAL TOUGH MINERS' DRILL STEEL
CRUCIBLE CAST STEEL TRAM CAR WHEELS AND AXLES. 52
ASKHAM BROS. & WILSON, Ltd., SHEFFIELD

AWARDED
A
Gold & Silver Medal
AND
Two 1st Class Certificates at
Calcutta Exhibition, 1884.

CHATWIN'S IMPROVED HAND-POWER SCREWING MACHINE, SCREWING AT ONCE OVER.

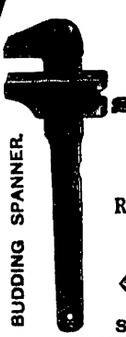


WHITWORTH PATTERN GUIDE STOCKS AND DIES.

PATTERN STOCKS AND DIES.



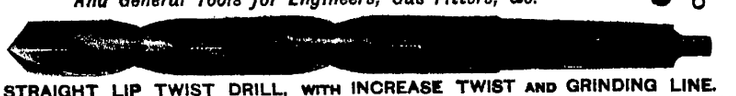
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PERCY CRANE AND ENGINE WORKS, LAMBHILL STREET, PAISLEY ROAD,

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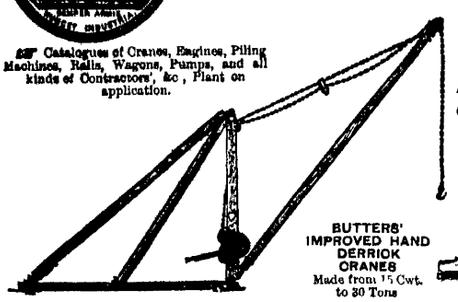
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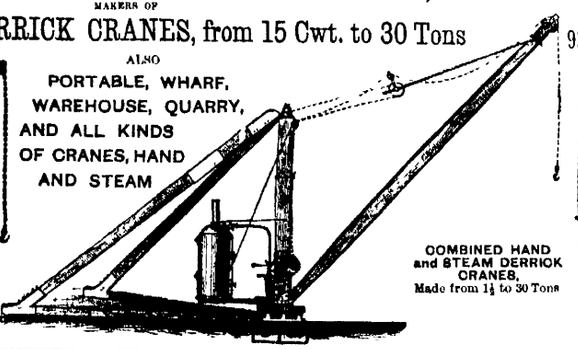
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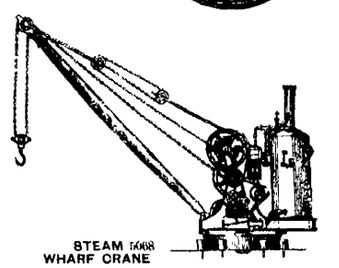
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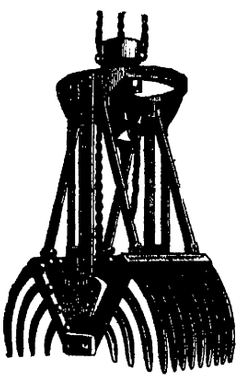


Fig. 534.—OPEN. WHOLE TINE DREDGER

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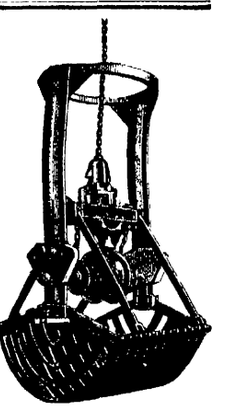


Fig. 534. CLOSED.

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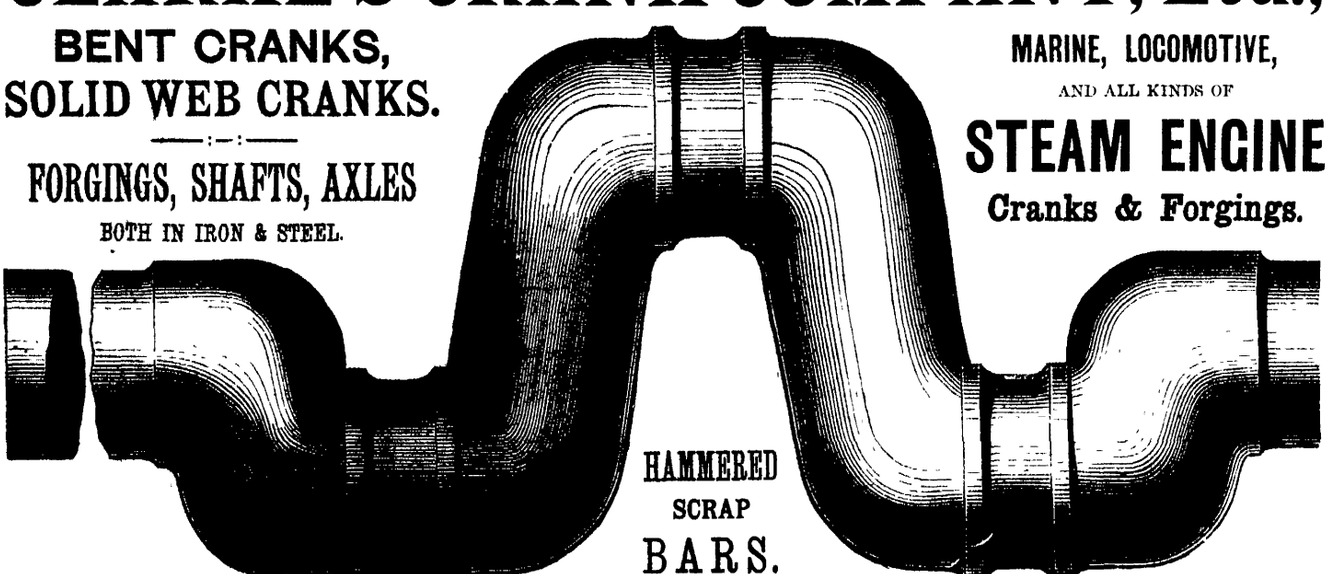
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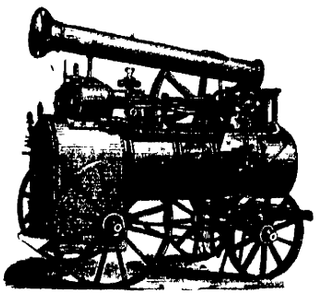
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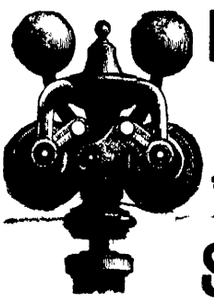
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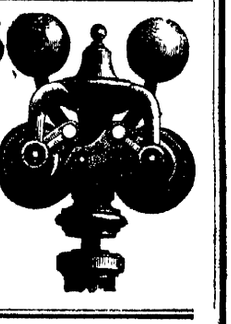


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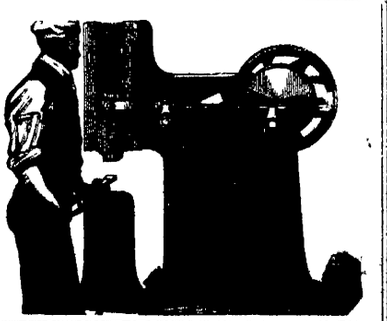
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[Registered at the General Post Office as a Newspaper

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An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

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VOL. XXXVIII.—No. 978.] *LONDON: FRIDAY, SEPTEMBER 26, 1884* [PRICE 6d. BY POST 6½d

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See Illustrated Advertisement last week, page 10.

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On Back Outside Page of Cover 4019

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WESTMINSTER, S W
See Illustrated Advertisement last week, page 25

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Self-Starting
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HIGHEST AWARD,
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President
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The NEXT SESSION BEGINS on the 1st OCTOBER, 1884

The full course of Instruction extends over two years, but Students are received who wish to finish their studies at the end of their first session

The work of the School affords an effective preparation for the Mine Manager's Certificate One day per week is spent in the field or mine, and considerable time is devoted to the plotting of surveys, and the drawing and study of Mine Machinery

There is a Chemical Laboratory, which is open daily for the general public as well as for Mining Students

There is also in the same Institution, but distinct from it, a School of Applied Science for Boys, intended as a preparation for the Mining School or Laboratory

Exhibitions to the value of £100 a year are given from this School to Pupils proceeding to a higher School, and can be held in the Mining School or Laboratory

For Prospectuses and further information, apply to GEORGE H POPE, Merchants' Hall, Bristol, who will enter Pupils and receive fees

Scholars of the Applied Science School can board in the house of one of the Masters, and other Boarding Houses may be heard of at the Hall G 842

The Mason Science College,

BIRMINGHAM

ENGINEERING DEPARTMENT
PROFESSOR
R H SMITH, M Inst M E, Assoc M I C E.
DEMONSTRATOR
Mr J HAMILTON, Whitworth Scholar

THE SESSION (1884-85) COMMENCES on FRIDAY, 3rd OCTOBER

Attached to the Engineering Department are Experimental Workshops, and a Mechanical Laboratory and Museum

A detailed syllabus of the complete three years' course in Engineering, entitling to a Junior Engineering Diploma at the end of two years, and a Senior Engineering Diploma at the end of three years, will be forwarded on application to the Secretary

COAL MINING DEPARTMENT
Professor J BROWN, M Inst C E, F G S

The Coal Mining Course includes a series of Special Lectures upon the Chemistry and Geology of Coal Mining, Mechanical Engineering as Applied to Coal Mining, and upon the Theory and Practice of Coal-Mining and Colliery Management, by the Professors of Chemistry, Geology, and Engineering, and by Professor Brown Syllabuses may be had on application to G 857

GEO H MORLEY, Secretary

Society of Engineers.—The

next ORDINARY MEETING of this Society will be held on MONDAY, the 6th day of OCTOBER next, at the WESTMINSTER TOWN HALL, Caxton Street, Westminster, S W

A Paper "on Modern Bronze Alloys for Engineering Purposes," by Mr PERRY F NURSEY, Vice President, will be read and discussed.

The Chair will be taken at half past Seven o'clock precisely

ALFRED WILLIAMS,
Hon Secretary and Treasurer
6, Westminster Chambers G 886

King's College Workshops.—

EVENING CLASSES will RE-OPEN on TUESDAY, 30th September, at 6 30 p m, for instruction and practice in Wood and Metal Work, as adapted for engineers, architects, amateurs, and gentlemen preparing for colonial life Skilled workmen as instructors in each branch of the work — For prospectus, apply to J W. CUNNINGHAM, Esq, King's College, London G 893

Mr Busbridge's Drawing

CLASSES will RE OPEN the SECOND WEEK in OCTOBER, for MACHINE DRAWING, Architectural Drawing, Building Construction, Practical Carpentry, and Geometry Fee 13s 6d for whole Course of seven months. A large number of valuable prizes are offered

Distribution of Prizes in the Guildhall by Lord Carlingford, 3rd November The Lord Mayor will preside, supported by the Sheriffs, Sir T Brassey, M P, and others — Prospectus free from Mr BUSBRIDGE, Grasmere, Herbert Road, Plumstead G 899

TENDERS.

INDIA OFFICE,
25th September, 1884

BY ORDER OF THE SECRETARY OF STATE FOR INDIA IN COUNCIL

INDIAN STATE RAILWAYS

The Director General of Stores for India is prepared to receive

Tenders from such Persons

as may be willing to SUPPLY—GIRDERS, Plate and Triangulated

The Conditions of Contract may be obtained on application to the Director General of Stores, India Office, Westminster, S W, and Tenders for Girders are to be left at his Office at any time before Two o'clock p m on Tuesday, the 14th October, 1884, after which no Tender will be received

A ABERCROMBIE JOPP, G 912
Director General of Stores

BOROUGH OF DEVONPORT NEW INTERCEPTING SEWERS

The Town Council of the Borough of Devonport require

Tenders for the Construction

of about 6,840 ft of INTERCEPTING SEWER in the neighbourhood of the Molesworth Road

The Plans and Specification, prepared by the Engineers, Messrs LAW & CHATTERTON, Westminster, may be inspected at the Municipal Offices, Ker Street, and Copies of the Bills of Quantities and Forms of Tender may be obtained on payment of One Guinea, which will be returned to all contractors sending a *bona fide* Tender

Sealed Tenders, with summary of cost duly filled up, and endorsed "Tender for Intercepting Sewers," must be delivered at the Town Clerk's Office by noon on the 7th day of October, 1884

The Town Council do not bind themselves to accept the lowest or any Tender

J J E VENNING,
Town Clerk

Dated 19th September, 1884 G 883

TO CONTRACTORS AND OTHERS

THE TOWN COMMISSIONERS OF DUNDALK, being the Sanitary Authority, invite

Tenders for the Construction

of WATER WORKS for the Supply of the Borough

Plans, Specifications, and Form of Tender may be seen at the Town Hall, Dundalk, or at the Offices of the Engineers, Messrs R HASSARD and A W W TYRRELL, M M Inst C E, Westminster Chambers, on and after 1st October, and all Tenders must be sent in on the printed forms in sealed envelopes, endorsed "Tender for Water Works," and addressed to E FERRAR, Esq, Town Clerk, Dundalk, on or before the 25th of October

One Guinea will be charged for Copies of the Specification and Form of Tender, which will be returned on receipt of a *bona fide* Tender

The Commissioners do not bind themselves to accept the lowest or any Tender

By order,
Town Hall, Dundalk, EDWARD FERRAR,
11th September, 1884 Town Clerk. G 850

BOMBAY PORT TRUST —DOCK EXTENSION

TO CONTRACTORS

Tenders are invited for the

MASONRY and EXCAVATION of a Wet Dock of about 25 acres area, to be constructed on a site to the southward of the Prince's Dock, Bombay The works include about 7750 lineal feet of wharf walls, a sea entrance, and a passage communicating with the Prince's Dock

Plans, Conditions of Contract, Specification, and Form of Tender may be seen on application to Mr JAMES A MCCONNOCHIE, C E, Engineer's Office, Surrey Commercial Docks, Rotherhithe, London, agent for the Trustees of the Port of Bombay, on and after Monday, the 29th September, 1884, and copies of the same, if available, may be obtained on payment of the sum of Ten Pounds.

Sealed Tenders, endorsed "Tender for Contract No 1, Masonry and Excavation, Dock Extension," are to be lodged with the Secretary to the Bombay Port Trust, at Bombay, at or before noon of the 14th day of November, 1884

Fifteen days' extension of the time for lodging Tenders (till 29th November, 1884) may be obtained under certain circumstances, particulars of which can be learned on application to the Trustees' agent No pledge is given that the lowest or any Tender will be accepted

G MANSON.
Bombay, 25th August, 1884 Secretary

TO CONTRACTORS

Tenders are requested for the

CONSTRUCTION of a GRAVING DOCK and other Works at the Bull Ring, North Shields, "for H S EDWARDS, Esq

Plans, Specifications, and Bills of Quantities for same can be seen at my Office up to 27th September

Tenders to be delivered at 77, Tyne Street, by noon on Monday, 29th September

The lowest or any Tender not necessarily accepted

F R N HASWELL
77, Tyne Street, North Shields G 880

BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY COMPANY

The Directors are prepared to receive up to noon on Thursday, the 2nd October,

Tenders for the Supply of

WAGON IRONWORK

Tenders must be made on Forms, copies of which with Specifications, can be obtained on application at the Company's Offices, 45, Finsbury Circus, E C, on payment of 21s each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender By order,

J PITT KENNEDY,
Offices 45, Finsbury Circus, Officiating Secretary
London, E C, 23rd September, 1884 G 911

The HARBOUR AUTHORITIES OF COPENHAGEN are prepared to receive

Tenders for the Dredging of

Copenhagen Inner Roads, to a depth of water of 24 ft The work comprises the dredging of about 60,000 tons yearly during one, three, or six years, and unloading of the punts, and the depositing of the dredged material in a depth of water of 5 ft or less, to a height of 8 ft above daily water

The conditions of contract may be obtained by application to the Harbour Administration of Copenhagen, on payment of 40 Kroner (50 Reichsmark or 2 Guineas), which will be returned on receipt of Tender The Tenders will be opened on the 27th October prox, at Eleven a m

THE HARBOUR ADMINISTRATION OF COPENHAGEN
16th September, 1884 G 843

BARRY DOCK AND RAILWAYS.

CONTRACT FOR WORKS —CONTRACT No 1

NOTICE IS HEREBY GIVEN, that the Directors of the Barry Dock and Railways Co are prepared to receive

Tenders for the Construction

of BARRY DOCK, situated at Barry Island, Glamorganshire, and of certain RAILWAYS (about seven miles in length) in connection therewith

The Drawings, Specification, Bill of Quantities, Form of Contract, and Form of Tender, may be seen on and after Wednesday, the 1st October, between the hours of Ten and Four, at the Office of Messrs J W BARRY and H M BRUNEL, 28, Delahay Street, Westminster, S W, and copies of the documents and of certain of the drawings may be obtained there on payment of Five Guineas

Tenders are to be delivered addressed to Mr G C DOWNING, Secretary of the Barry Dock and Railways Co, Vienna Chambers, Cardiff, and endorsed "Tender for Works, Contract No 1," at or before noon on Tuesday, the 14th October, 1884

The Directors do not bind themselves to accept the lowest or any Tender G 902

TO ENGINEERS

THE COMMISSIONERS OF IRISH LIGHTS, being desirous of obtaining

Tenders for the Supply, Delivery at the District Stores, Kingstown, and Erection on Fanad Point Lighthouse, Lough Swilly, County Donegal, of a NEW LIGHTHOUSE LANTERN AND OPTICAL APPARATUS for same, Notice is hereby given that the work will be let in the following sections, viz.

CONTRACT No 1—DIOPTRIC APPARATUS, &c
" No 2—SECOND ORDER LANTERN, with Girders, Floor, &c

Any person tendering will be allowed to tender for either or both sections

Drawings may be seen, and Specifications and Forms of Tender obtained on application at the Engineer's Office, between the hours of Ten a m and Four p m, on any day (Saturdays excepted)

Tenders must be made out on the prescribed Forms, sealed, marked on the outside with the name and number of the Contract, addressed to the Secretary, and delivered at this Office, on or before noon on Wednesday, the 15th day of October prox, after which no Tender will be received

The Commissioners do not bind themselves to accept the lowest or any Tender By order,

OWEN ARMSTRONG,
Irish Lights' Office, Dublin Secretary
19th September, 1884 G 888

APPOINTMENTS OPEN.

Wanted, by the — — Company, Limited, a Mechanical DRAUGHTSMAN who has passed through the workshop, and is capable of conducting correspondence on mechanical matters connected with water works. Salary £140 per annum —Full statement of career and references to be sent to G 905, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W C. G 905

Draughtsman Wanted in the

north of England, good salary and permanent situation may be secured by a thoroughly reliable man well up in steam and hydraulic work.—Address, X, Offices of ENGINEERING G 881

To Electricians.—The Manchester and District Edison Electric Light Company (Limited), SEEK the SERVICES of an experienced Electrician. A gentleman who is also an Engineer would be preferred —Applications, stating age, qualifications, salary required, &c, to be addressed to the SECRETARY, 19, Victoria Buildings, Manchester

Parliamentary.—Wanted, for

four or five weeks, in the north of England, thoroughly competent SURVEYOR and LEVELLER State age, salary, and recent references, to G 895, Offices of ENGINEERING G 895

Agents Wanted, to push First-class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool 5233

Lists of Berths Vacant or

WANTED See "ENGINEERING REVIEW," weekly 1d — E. & F N SPON, 16, Charing Cross, London, or of all News Agents. 5262

SITUATIONS WANTED.

Basic Steel Works.—Wanted,

a SITUATION as Manager, by a competent engineer, holding a very responsible position in a Basic Steel Works. Has designed and erected a Basic Works on the most modern principles —Apply GRIT, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 840

A Stud. Inst. C.E. (holding

a Diploma in Engineering, and first-class Certificates from H M Science and Art Department), is desirous of ENTERING the OFFICE of a Civil Engineer —Address, A K C, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W C G 884

Wanted, Situation as Assistant Draughtsman, ten years' workshop and office experience, good references, salary moderate for permanency —Address, A, 1, Adelaide Terrace, Nunhead Lane, Peckham Rye. G 889

A Gentleman, till recently

chief engineer to firm of Electric Light Contractors on the Continent, wishes for similar EMPLOYMENT, home or abroad —H B, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand G 890

Assistant Engineer (33) Disengaged, thorough draughtsman, leveller, and surveyor, accustomed to drainage, water, and municipal work at home and abroad —ASSOC M INST C E, 17, Lorn Road, Brixton G 908

Sugar Machinery.—Mechanical Draughtsman, accustomed to above, desires RE ENGAGEMENT —Address, G 914, Offices of ENGINEERING, 35 & 36, Bedford St., Strand, London, G 914

Whitworth Scholar, Seven

years' experience, three years in drawing office at general and marine engineering, DESIRES SITUATION, good references —C W, 2, Breakspear Road, St Johns, S E G 907

New Railway.—A London

SYNDICATE is desirous of communicating with Landowners and others, for the purpose of taking surveys and promoting, in the next Session of Parliament, a Railway Bill —Address letters, A M 237, care of RUDOLF MOSSE, 18, Queen Victoria Street, London, E C G 898

To Engineers, &c.—A Gentleman, with offices in the city, large experience, and established connection, with every facility for pushing business, is open to REPRESENT a FIRST-CLASS FIRM of ENGINEERS in London —Apply, with full particulars, to G 900, Offices of ENGINEERING 35 & 36, Bedford Street, Strand, London, W C. G 900

PARTNERSHIPS.

To Civil Engineers in practice.

—The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright

WHEATLEY KIRK, PRICE and GOULTY, 52, Queen Victoria Street, London, E C 5292

WANTED, &c.

Wanted, the following Second-hand MACHINE TOOLS, of first-class make and in good condition —

(1) One Planing Machine, to plane 6 ft, long by 3 ft. square.

(1) One 10 in Stroke Slotting Machine, to take in 42 in diameter by 16 in deep

(1) One 16 in Stroke Shaping Machine

Tenders for the above Tools should give full particulars Prices to include delivery at Liverpool docks —Address, PERU, Offices of ENGINEERING. G 876

Wanted, First-class Lathe,

8 in to 10 in centre, 15 ft. to 18 ft bed, also a First-class PLANING MACHINE, to plane 7 ft., and a Medium Size DRILLING MACHINE, all must be first-class.—Full particulars to WM S FREEMAN, The Mills, Otford, Kent. G 894

Wanted, Overhead Travelling

CRANE (Hand), working load 20 tons, single and double power cross and longitudinal motion; span 42 ft. centre of rails, height from rail to underside of roof its rod 5 ft — Address, 168, SHARP & Co, 14, Exchange Square, Glasgow G 901

Second-hand 10-ton Travellers

WANTED, one Overhead, 50 ft span, one Wellington, 25 ft span; complete, or ironwork only — Particulars by post to W. E FRENCH, 5, Westminster Chambers, Victoria Street, S W G 903

Cast Iron Tank.—Wanted, to

PURCHASE a Second-hand Cast Iron TANK, 3 ft to 4 ft deep, 5 ft. to 10 ft wide, and any length — Reply to X, care of Mr W TREMPEST, Dundarl. G 882

Specialty Wanted to Manufacture, by Firm having extensive Works and Foundry, near London Exceptional facilities offered —Address Y J, at C H MAY & Co's General Advertising Offices, 78, Gracechurch Street, London G 913

"Engineering."—Wanted,

Copies of Jan 11th, 1884 —Address, stating price, C R., Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W C G 786

Lists of Machinery Wanted or

ON SALE See "ENGINEERING REVIEW," weekly 1d — E. & F N. SPON, 16, Charing Cross, London; or of all News Agents. 5263

FOR SALE.

For Sale, One Pair of Compound Surface Condensing MARINE ENGINES AND BOILER, 180 HP. Nominal 5290
F GILMOUR & CO, Engineers, Glasgow

For Sale, the Invention of an Automatic Expansion Valve Gear for Steam Engines — Address, AUTOMATIC, Offices of ENGINEERING, 35 & 36, Bedford St, Strand, London G 900

For Sale, 9 in. Double Cylinder PORTABLE ENGINE, by Clayton and Shuttleworth, in good condition, being replaced by larger engine.—Apply to STRACHAN & CO, Frome Hall Mills, Stroud, Gloucestershire 5282

For Sale, being superseded by engines of higher power, a pair of High Pressure Condensing STEAM ENGINES Cylinders, 28 in diam, 3 ft 6 in stroke, with cold water pump for same.—Can be seen at work at the Manufactory of the LONDON PORTLAND CEMENT CO, Ltd, Northfleet, Kent, to whom enquiries may be addressed G 534

For Sale, by the Mortgagees, the NORTHFIELD IRON WORKS, Rotherham, Yorkshire (Freehold) 22 puddling furnaces, 18 in forge train, 14 in bar mill, guide and hoop mills, "Colliers" tyre mill Railway and canal to works — Apply to Messrs MACREDIE & EVANS, Chartered Accountants, Sheffield G 828

Dynamo Machines and Arc LAMPS (Siemens, Burgin and Gramme) FOR SALE Stock of Company in Liquidation Little used, and offered at half price —MACKEY & MESS, C A, Dundee G 811

Engineers' Plant for Sale — Lathes, 6 in to 20 in, Planing Machines, 2 ft to 6 ft, Shaping, Slotting, Boring, Drilling Machines, &c, all by first-class makers, and in good order — Send for List to ROWES, SCOTT & READ, Broadway Chambers, Westminster G 904

40-HP. Nom Semi-Portable ENGINE and BOILER combined, 14 in cylinders, 20 in stroke, with reversing motion, pump, and injector, working pressure 120 lbs, new, in stock, price £625 — THOMAS PECKETT, Atlas Engine Works, Bristol G 892

To Capitalists, or Persons Wanting Occupation —To be SOLD, by Private Contract, the Lease, Plant, Goodwill, and Book Debts of the MELDON LIME QUARRY, three miles from Okehampton — For particulars, apply to Mr G HIRTZEL, Solicitor, 12, Bedford Circus, Exeter G 877

To Merchants, Manufacturers, and OTHERS —BUILDING LAND in centre of Glasgow to be SOLD or LET on favourable terms, for permanent or temporary purposes, close to the Exchange and the central station of the Caledonian Railway — Apply to D MUNRO, Accountant, 39, Hope Street, Glasgow G 878

Engineering Business for Sale. The business is of long standing with an extensive and valuable connection, the works are held on lease, and are situated in the best locality in Glasgow for the purposes of the business, the Machinery and Plant are valued about £8,000, the business is in full operation, and satisfactory reasons can be given for disposing of it —Apply to MOORE & BROWN, C A, 128, Hope Street, Glasgow G 879

Engineering Business, near LONDON, FOR DISPOSAL, or a Partnership could be arranged, special trade, good government and railway connections, easily managed, owing to peculiar circumstances a low figure will be accepted, purchase probably from £5,000 to £8,000 —Apply to 755, WHEATLEY KIRK, PRICE, & GOULTY, 52, Queen Victoria Street, London, E C G 855

Modern Engineering Works to be LET or SOLD, situate in Midland County on canal bank, and within collecting area of two important railway stations, about 4½ acres of land (which can be increased if desired), excellent buildings with steam power, suitable for any engineering manufacturing purposes —Apply to WHEATLEY KIRK, PRICE & GOULTY, Albert Square, Manchester, or 52, Queen Victoria Street, London, E C G 897

Engines, Boilers, Steam and Electric Launches (Wood or Steel) supplied quickly, prices moderate —HENRY TIPPING & CO, Greenwich, London, Steam Ship Contractors, Surveyors, &c G 896

Engines and Boilers for Sale. 50 HP Beam Condensing, new, cylinder 24 by 48 in
25 HP ditto cylinder 18½ by 30, with Lancashire Boiler fitted complete, may be seen working
25 HP Inverted Condensing, cylinder 18½ by 30, nearly new
20 HP Horizontal, jacketted, cylinder 14 by 36
10 HP Table, non-condensing, cylinder 10 by 18 in
2 HP, Vertical Engine and Boiler combined, good condition Cornish Boiler, 18½ ft by 4½ ft, with fittings, tested to 90 lb Cornish Boiler, 12 ft by 4 ft, with fittings, tested to 100 lb 5167
The above offered very cheap, to clear out stock SPENCER & Co, Melksham Foundry, Melksham, Wilts

Locomotive Tank Engine for SALE or HIRE, second hand, cylinders 12 in in diameter, 18 in stroke, four wheels coupled, photo graph on application, new locomotives in progress — THOMAS PECKETT, late FOX, WALKER & CO, Atlas Engine Works, Bristol G 891

Tank Locomotives, 4 or 6 wheels coupled. Specification and workman ship equal to Main Line Engines — Apply to R & W HAWTHORN, Engineers, Newcastle-on-Tyne.
See Advertisement, page 45 4954

Locomotive Tank Engines always in stock or progress.—HUDSWELL, CLARKE and CO., Railway Foundry, Leeds, Sole Makers of RODGERS' PATENT WROUGHT IRON PULLEYS. See Illustrated Advertisement, page 40

For Immediate Sale, at low prices for cash.
SECOND HAND
LANCASHIRE BOILER, 18 ft 3 in by 7 ft diameter
VERTICAL CROSS TUBE BOILER, 7 ft 6 in by 3 ft 3 in diameter
TANK LOCOMOTIVE, 4 wheels coupled, cylinders 10 in. by 20 in
A New 9 HP CHAPLIN'S LOCOMOTIVE.
A Dozen HORIZONTAL ENGINES, with cylinders from 3 in to 10 in diameter (New)
5 ft 6 in FACE PLATE LATHE, by Whitworth
RAIL STRAIGHTENING MACHINE, with engine attached, by Collier
No 6 ROOT'S BLOWERS, by Thwaites
Two No 4½ PATENT BLOWERS, by Ellis
Two SCOTT WHEEL MOULDING MACHINES
10-ton RAILWAY WEIGHING MACHINE
STEAM WINCHES, from 5 in to 7 in cylinders.
For prices and full particulars of any of above apply to "PHILLIPS' MONTHLY MACHINERY REGISTER," Newport, Mon 4804

Compound Surface Condensing MARINE ENGINES FOR SALE, cylinders 10 in and 20 in diameter by 12 in stroke, fitted with Payton and Wilson's patent circular balanced and double-ported slide valves, and link motion reversing gear —Address ALEX WILSON & CO, Vauxhall Iron Works, Wandsworth Road, London, S W 4968

Cranes! Wagons! Rails!
Four 5 ton Steam Derrick Cranes, 50 and 60 ft. double jibs
Nine ¾ to 4 ton Hand Derrick Cranes
1½ and 3 ton Portable Steam Cranes
Three 6 ft 6 in pan, self-discharging Mortar Mills
Eighty five 4 yard End Tip Wagons
Malleable Wheels, Steel and Iron Tyres Cheap
Fifty tons 40 lbs Rails Cheap
—BUTTERS BROTHERS, Derby Crane and Engine Works, or Offices, 93, Hope Street, Glasgow G 740

Ready for Delivery.—
One Radial Drilling Machine, 6 ft arm
One 14 in stroke Shaping Machine, 6 ft bed
One 12 in ditto ditto ditto
One 14 in centre Sliding, Surfacing, and Screw-cutting Lathe, 14 ft gap bed
One 10 in ditto ditto ditto, 16 ft gap bed
One 8 in centre, risen to 10 in centre, Sliding, Surfacing, and Screw cutting Lathe, 12 ft gap bed
One 10 in stroke Slotting Machine
One ¾ in by ¾ in. Punching, Shearing, and Angle Iron Cutting Machine, 18 in gaps, to cut 4 in by 4 in by ¾ in angles
One 36 in Pillar Drilling Machine
GEORGE BOOTH & CO, Engineers' Tool Makers, Halifax 5225

Shipbuilding, Engineering, and BOILER PLANT for IMMEDIATE DELIVERY, including Cameron's 1¼ Punching and Shearing Machine, 30 in gaps, fitted with engine and cranes, by John Cameron, Manchester, 1¼ Double ended Punching Machine, 26 in gaps, fitted with angle iron cutter, engine, and cranes, by Davis and Primrose Angle and Beam Bending Machine, 40 Metal Angle Bending Blocks, square holes, Seller's 3 in Patent Screwing Machine, by Sharp, Stewart, & Co, 1¼ in ditto, ditto, Wheel Lathe, 26 in centres, with boring heads, by Berry Bros, Double-headed Horizontal Keyway Cutting and Grooving Machine, by Butterfield Bros, Double ended Wheel and Tire Tapping and Drilling Machine, by Fairbairn & Co, six Screw-cutting and Surfacing Lathes, from 6 in to 12 in centres, with 8 ft to 30 ft gap beds, 5, 6, 10, and 15 cwt Steam Hammers, 6 in Improved Tenoning Machine, 5 ton Steam Loco Bogie Crane, 43 w i jib, by Dunlop, Hislop, & Co, 8 ton ditto, Chaplins' patent, by Wilmhurst & Co, two 15 in cylinder Horizontal Engines, 10 in cylinder Portable Engine, 8 HP Traction Engine, by Fowler & Co, Vertical and Horizontal and Special Pumps, 4 in to 12 in cylinders, two new double 6 in cylinder Horizontal Steam Winches, 27 by 7 double flued Lancashire Boiler, Vertical Boiler, 22 ft high by 8 ft 6 in dia, six Galloway Tubes, several Cylindrical and Vertical Boilers, 5 and 6 ton Foundry Ladles, Pant Mill, by Priestman & Co, Hull, with two pairs of stones and one mixer, Hydraulic Jacks, Punching Bears, Anvils, Vices, Portable Forges, Bellows, Stocks, Taps, and Dies, and every variety of Screwing Tackle, Patent Differential and Ordinary Iron Blocks, Ratchet Braces, Tube Expanders, Steam Gauges, and Steam Fittings of every variety, India-rubber and Leather Goods, and every requisite for users of steam power — E BECKWITH & CO, Mechanical Valuers, Sunderland Machinery Stores, Sunderland 5325

AUCTION SALES.

Important Sale of Valuable Engineering and Ship building Plant, at Grove Engine Works, Hull

The following Tools and Ma- CHINERY will be SOLD BY AUCTION early in October, of which due notice will be given —
One 24 in stroke SLOTTING MACHINE, with quick return motion, elliptic gearing, self acting circular table and slides
One 9 ft treble gear FACE LATHE, with double rest
One Horizontal and Vertical PLANING MACHINE, to plane 14 ft by 14 ft
One 30 ft span TRAVELLING CRANE, iron beams, fitted with tailing, traversing, and lifting gear, complete
One patent fixed HYDRAULIC RIVETTER, with 5½ ft gap, wrought iron hob, one set 12 in to 4 in hydraulic pumps, one 10 in differential accumulator with weights
One set Vertical PLATE BENDING ROLLS, to bend plates 7 ft wide, fitted with engine
One Horizontal and Vertical PLANING MACHINE, to plane 14 ft vertically, and 12 ft horizontally
One Horizontal PLANING MACHINE, with table 7 ft by 16 ft, having two top and one side tool boxes
One CYLINDER BORING MACHINE, 11 ft 3 in wide with 11 ft 6 in travel of head, engine driven
One large Radial DRILLING MACHINE, 24 in column, height of lift, 11 ft 6 in, with arm capable of drilling a radius of 12 ft column
Also about 30 Slide and Screw cutting Lathes, various diameters, by first class makers, 2 Screw cutting Machines, to screw up to about 1¼ in, 5 Shaping Machines with double tables, 6 Vertical Drilling Machines, 9 Radial Drilling Machines, 1 Slotting Machine, 4 Planing Machines, 1 Plate Planing Machine, 1 Punching and Shearing Press, 2 Horizontal Boring Machines, 1 Tube Plate Drilling Machine for six drills, to drill six holes at one time, 1 Steam Hammer, 2 Root's Blowers, 1 pair of Emery Wheels, 1 Circular Saw Bench, 1 Band Saw, 1 Wood Turning Lathe, 5 Travelling Cranes
The whole of these Tools are nearly new, some scarcely having worked at all, and they are all by first-class makers, so that they cannot fail to give entire satisfaction to the purchasers. G 830

BANBURY & CHELTENHAM DIRECT RAILWAY

EXTENSIVE AND IMPORTANT SALE OF CONTRACTOR'S PLANT

Contractor's Yard, Chipping Norton (adjoining Great Western Railway)

Mr. Arthur T Crow, CONTRACTOR'S AUCTIONEER, SUNDERLAND,
Has been favoured with instructions from CHARLES ECKERSLEY DANIEL, Esq, Contractor, owing to approaching completion of the line, to

SELL BY AUCTION,
At the
CONTRACTOR'S YARD, CHIPPING NORTON
(Adjoining Great Western Railway),
The Valuable
CONTRACTOR'S PLANT
And
MATERIALS,
Consisting of
Eleven Splendid 6 and 4 Wheel Coupled Locomotive TANK ENGINES, 7 in, 8 in, 9 in, 10 in 12 in, and 13 in Cylinders,
By Manning, Wardle and Co, Hunslet Engine Co, Falcon Engine Co, and Fox, Walker and Co (All of recent dates and good working order)
Powerful STEAM NAVVY, by Ruston, Proctor & Co
Two 8 HP TRACTION ENGINES, by Barrows and Stewart
Three 10 Ton STEAM DERRICK CRANES, 45 ft, 70 ft, and 75 ft Jibs, by Balmforth & Co
Six 1½ Ton, 2 Ton, 3 Ton, and 5 Ton STEAM DERRICK CRANES, 24 ft to 45 ft Jibs Permanent way gauge
Five 6, 9, and 10 HP PORTABLE ENGINES (with and without link motion), by Barrows and Stewart.
Two 6 ft MORTAR MILLS
6 HP Vertical Boiler and Engine combined
TWO CIRCULAR SAW TABLES
CORNISH PUMPS TWO DONKEY PUMPS
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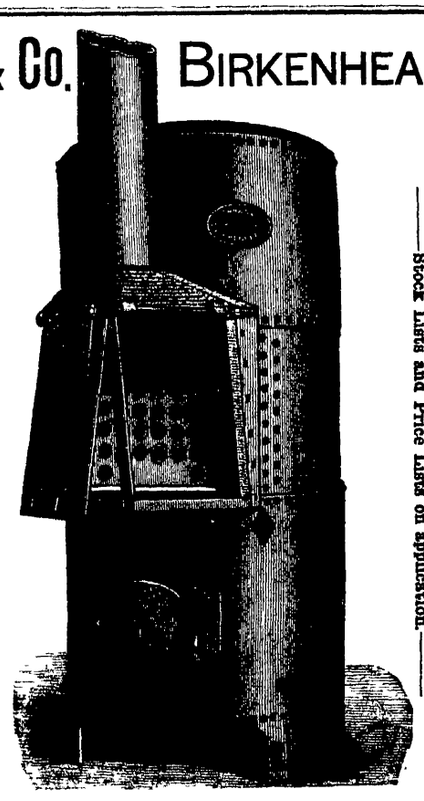
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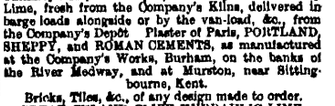
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Mirrlees Watson & Co Ltd	8
Morton Alex & Thomson	1
Mott W & Co	8
Munton & Metal Co	4
Murray J & Sons Ltd	4
Neill W & Son	3
Newton R R & Co	10
Nicholson's A	1
Nuttall E & Co	14
North British Rubber Co Ltd	1
Oakey J & Sons	1
Oates J C J	1
Oldham Ritter Works Co	1
Ltd	1
Oliver Ltd	1
Otis K Lifting Co	1
Ormerod Harrison & Co	1
Orton & Co	46
Owen & Co	1
Parkes & Co pel	1
Patent Asbestos Packing Co	1
Patent Deflecting Reflecting Co	18
Patent Tube Co	1
Patterson I	1
Pearn J & Sons	6
Petrie & Co	41
Phillips & Pott	1
Pickering Thos	18
Pilkington Bros & Co Ltd	1
Platt Bros & Co Ltd	1
Plenty & Son	1
Pontifex & Wood	1
Porter A & Son	1
Potter & Clarkson	1
Powell Duffryn Steam Coal Co	1
Price Bros	1
Priestman Bros	1
Pumps Co The	1
Pyle Iron Co	1
Ramsbottom J	1
Ramsden & Co	1
Ransomes & Rapier	11
Redfern & Sons	4
Reid Bros	1
Richardson & Boulton	1
Richardson J & Co	8
Richardsons Westgarth & Co	1
Ridley Portland Cement Co	1
Rigg Richard	1
Ritchie & Son	1
Robey & Co	1
Robinson & Co	1
Rodgers J & Co	1
Rogers Ellis & Machine Works	1
Rose Downs & Thompson	10
Ross W & Co	1
Rowley Portland Cement Co	1
Russell G & Co	1 & 4
Russell James, & Son	1
Rylands Bros for & Co	1
Sampson & Co	1
Sandie H	6
Sankey & Sons Limited Penn ant Hill Ironworks Ltd	1
Saville and Jackson	1
Scheffler and Jackson	1
Schultz Chas & Co	1
Schutz F A & Co	1
Scott Bridges and Bridges & Co	1
Scott Walter & Co	1
Seaton & Co	1
Shaw Henry	1
Shedden H H	1
Shipton Bros	1
Simon Henry	1
Smith & Johnston	1
Smith & Weldon	1
Spencer John & Co	1
Spencer Wm	1
Staff and Reyn Wheel & Axle Co	1
Stanley & Co	4
Stanley W F	11
Stanniah T	1
Stephenson Jones Steel Works	16
Stone Rubber Co	18
Steel Company of Scotland	16
Strain T and C Ltd	12
Stockton Forge Co	6
Stoney Isaac and Sons	48
Summers T and W	17
Tate & Sellers	52
Tangyes Ltd	11
Taylor and Challen	17
Thames Bank Iron Co	17
Thomas Thos & Sons	18
Thompson & Bull	1
Thorn & Co	1
Tinsley & Co John & Co	50
Tolhausen Patent Sand Blast Co	50
Tuke & Ltd	10
Turnbull Alex & Co	15
Tuthey Tom	41
Turton T & Sons	44
Twedell Ralph H	1
Tyler Hayward & Co	52
Ure & Engineering Co	29
Usmpson & Co	7
Vaughan & Son	4
Vipont and Co	1
Walker R	1
Warrington Wire Rope Co	54
Watt Jas & Co	44
Weir G & Co	1
Weir G & J	19
Weir G & J	41
Weldless Steel Tube Co	16
West Cumberland Iron and Steel Co	1
White J & Co	11
Whitehead E & Co	1
Whitehead & Co	14
Ditto	1
Whitfield Barker	20
Whitfield Wm & Co	18
Whitworth Wilson	1
Wolf Wm J H	19
Wood M	19
Wilkinson C R Limited	1
Williams Alex & Co	44 & 47
Wilson H M	24
Wilson J & Co	20
Wilson W	19
Wilson C & Co	17
Wimbledon Cement Co	1
Wright J & Co	19
Yates & Co	1
Yule & Co	47

J. & E. HALL'S COLD DRY AIR MACHINES

(PATENT)

FOR PRESERVING FOOD, &c., ON BOARD SHIP AND ON LAND.

MACHINES CAN BE SEEN IN OPERATION AT THE

INTERNATIONAL HEALTH EXHIBITION, STAND No. 1255, MACHINERY IN MOTION, WEST ANNEXE.

DARTFORD IRON WORKS, KENT, and 23, ST SWITHIN'S LANE, E C 4407

WIRE ROPE MAKERS TO THE ADMIRALTY.

BULLIVANT & COMPANY,

Patent Steel and Iron Wire Rope Makers,

Steel Ropes of Special Strength & Make for Tramways, Inclines, Collieries, Mines, Steam Ploughs & Bridge Work

MESSRS. BULLIVANT & CO. ARE PREPARED TO MAKE ROPES OF 1,200 TONS BREAKING STRAIN ON THE SINGLE PART.

BULLIVANT'S PATENT FLEXIBLE STEEL WIRE ROPE.

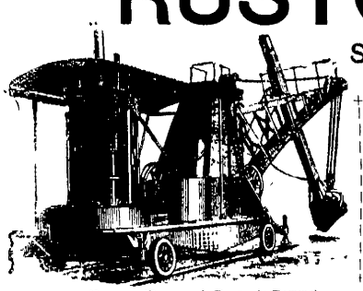
This Rope is exceedingly pliable, and can be worked round drums or pulleys (with perfect safety and without injury to the Rope) only six times in diameter the circumference of the Rope used 5075

CHIEF OFFICE **72, MARK LANE, LONDON, E.C.** WORKS **MILLWALL, LONDON, E.**

RUSTON, PROCTOR & CO.

SHEAF IRONWORKS, **LINCOLN,**

And 20, BUDGE ROW, LONDON, E.C.



STEAM NAVVIES (DUNBAR & RUSTON'S PATENT)

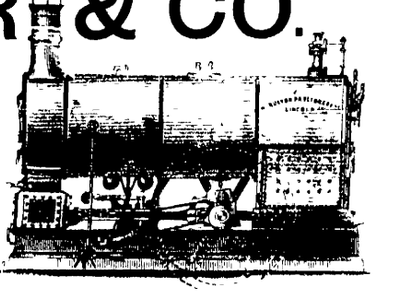
MANUFACTURERS OF

OVER 10,000 Steam Engines MANUFACTURED AND SOLD.



HORIZONTAL ENGINES, CONDENSING AND NON CONDENSING

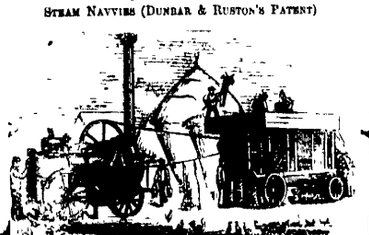
200 PRIZE MEDALS AWARDED



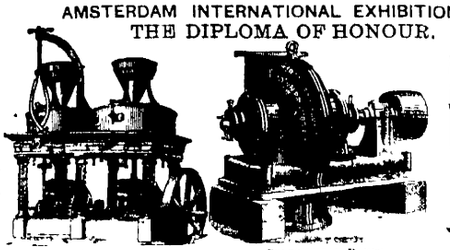
COMPOUND SEMI FIXED ENGINES

AMSTERDAM INTERNATIONAL EXHIBITION 883.
THE DIPLOMA OF HONOUR.

CALCUTTA EXHIBITION.
2 First Classe certificates and 2 Gold Medals
2 First Classe Certificates and 2 Silver Medals



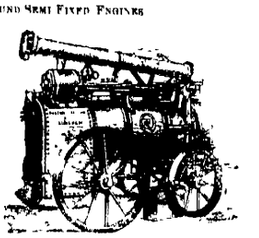
STEAM THRASHING MACHINERY



CORN GRINDING MILLS CENTRIFUGAL PUMPS



MINING MACHINERY



PORTABLE ENGINES.

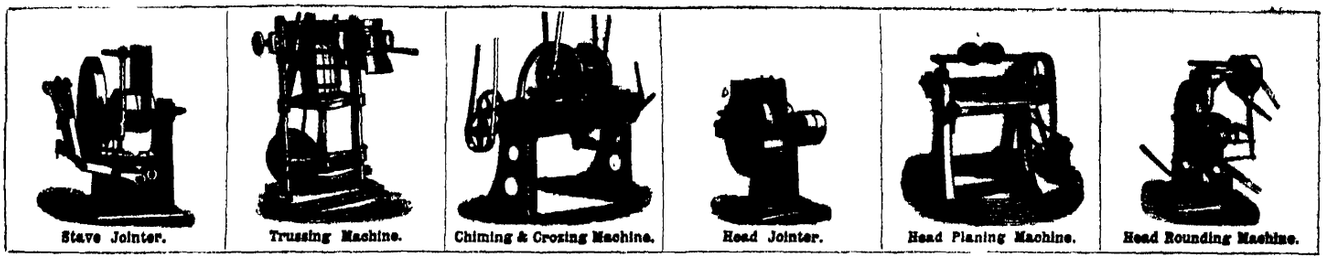
Catalogues, with full details of the above and other SPECIAL MANUFACTURES on application.

4891

CASK-MAKING MACHINERY

The Best Machinery for making CASKS and BARRELS of every kind can be obtained only of the

PATENTEES & SOLE MANUFACTURERS,



Stave Jointer. Trussing Machine. Chiming & Crozing Machine. Head Jointer. Head Planing Machine. Head Rounding Machine.

FOR WHICH A GOLD MEDAL HAS JUST BEEN AWARDED AT THE FISHERIES EXHIBITION.

A. RANSOME & CO., STANLEY WORKS, CHELSEA.

CAUTION.—The notorious success of A. RANSOME & Co.'s Cask and Barrel Machines having caused them to be copied by other Engineers, Purchasers are advised to ascertain that any Cooperage Machines they may be offered do not infringe any of A. R. & Co.'s Patents. 1662

GEO. RICHARDS & CO.



Note.—We have no connection with any Firm of Agents in Manchester trading under a somewhat similar name. All communications relating to Richards' Patent Wood cutting Machines should be addressed to us,

ATLANTIC WORKS, BROADHEATH, NEAR MANCHESTER

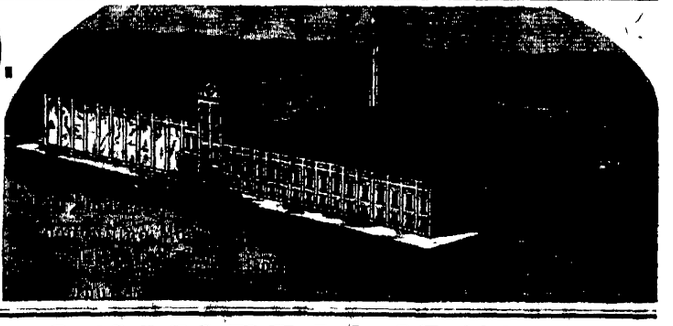
WOOD-CUTTING MACHINERY

OF HIGHEST CLASS AND OF ALL DESCRIPTIONS.

4977

London Show Rooms & Offices: 23 & 24, Whitecross St., E.C.

Continental Agents: SMITH & COVENTRY, 10, Rue Alibert, Paris.



WOOD-CUTTING MACHINERY OF ALL KINDS.

5148

PARTICULARS AND PRICES ON APPLICATION.

HAROLD SANDS, EAGLE WORKS, POPHAM ST., LEENSIDE, NOTTINGHAM.

JAMES GOODWIN & Co.,

Ironfounders, Bridge Builders, Engineers, & Boiler Makers

MOTHERWELL NEAR GLASGOW.

MAKERS OF *Cast Iron Chairs, Cast Iron Sleepers,* **COLUMNS, TANKS,** *Ingot Moulds, and General Castings.*

SOLE MAKERS OF HOPE'S PATENT **Stone Breakers.**

—:o:—

Foundries also at Ardrossan, Ayrshire, AND Johnstone, Renfrewshire.



VIADUCT AT HIGH BLANTYRE, CALEDONIAN RAILWAY. LENGTH, 790 FEET. ERECTED 1882.

5274

MAKERS OF IRON ROOFING AND GENERAL STRUCTURAL WORK.

BRIDGE FOUNDATION CYLINDERS.

THE STOCKTON FORGE CO., STOCKTON-ON-TEES.

Make a Speciality of this work, turning out over 300 tons per week; also large quantities of Railway Chairs. 4909





SCOTT BROS.,

WEST IRON WORKS, MOUNT HALIFAX.







Have the largest Stock in England of Self-Acting Slide and Screw Cutting Lathes, Radial Wall, Vertical, and Bench Drilling Machines, Shaping, Screwing, Slotting Punching and Shearing Machines, Plate Bending Machines, Steam Hammers, Horizontal and Vertical Engines and Wood-working Machinery.

ILLUSTRATED LISTS ON APPLICATION. QUOTATIONS FOR SPECIAL TOOLS. 4966

ITALIAN ASBESTOS.

ANALYSIS by Professor F. S. BARFF, M.A.

100, ABBEY ROAD, KILBURN,

July 14th, 1884.

A Sample of Italian Asbestos Fibre delivered to me by the United Asbestos Company for Analysis, contains:

	Per Cent.
Lime and Magnesia	37.84
Silica	41.69
Oxide of Iron	3.01
Potash	0.85
Soda	1.41
Alumina	2.57
Moisture evaporated at 100° C.	3.04
Loss on heating to white heat, water of hydration and organic matter	9.56
	99.97
Loss	.03
	100.00

This Asbestos contains nothing injurious to Metal with which it comes in contact when used in connection with Machinery, and the special character of ITALIAN Asbestos RENDERS IT VASTLY SUPERIOR TO THAT FOUND IN CANADA.

(Signed) **FREDK. S. BARFF, M.A.,**

Christ's College, Cambridge.

Fellow of the Institute of Chemists of Great Britain and Ireland; late Professor of Chemistry to the Royal Academy of Arts.

PURE ITALIAN ASBESTOS MILLBOARD, ASBESTOS and INDIA RUBBER SHEETING, TAPE; and WASHERS, ROLLED CLOTH, Woven, SQUARE BLOCK PACKING with India-Rubber Back, and ITALIAN ASBESTOS YARN and SOAPSTONE PACKING, FIBRE, CLOTH, POWDER, BOILER COVERING, PUTTY, CEMENT, and every description of Asbestos Goods.

"SALAMANDER"

THE UNITED ASBESTOS COMPANY LIMITED · LONDON · TRADE MARK

Special Terms to Merchants & Dealers.

"SALAMANDER"

THE UNITED ASBESTOS COMPANY LIMITED · LONDON · TRADE MARK

Please see that all Millboard, Sheeting, Tape, and every 15 ft. length of Packing bears our Trade Mark, without which none is genuine.

Specify United Asbestos Company's "SALAMANDER" BRAND.

NEW ILLUSTRATED CATALOGUE ON APPLICATION.

The UNITED ASBESTOS Company, Limited,

(Sole Makers of the Pure Italian Asbestos Goods,)

161, QUEEN VICTORIA STREET, LONDON, E.C. 6725

BRANCH DEPOTS:

MANCHESTER:	LIVERPOOL:	BIRMINGHAM:	GLASGOW:
85, CORPORATION STREET.	47, SOUTH JOHN STREET.	CLEMENT STREET.	52, ST. ENOCH SQUARE

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breese, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, shewing the small amount of space they occupy—

9ft. long,	5ft. 6in.	diameter,	20-horse	power.
10ft. ,,	5ft. 6in.	,,	30	,,
12ft. ,,	6ft. 0in.	,,	40	,,
13ft. ,,	6ft. 6in.	,,	50	,,
14ft. ,,	7ft. 0in.	,,	60	,,
15ft. ,,	7ft. 6in.	,,	70	,,
16ft. ,,	8ft. 0in.	,,	80	,,
17ft. ,,	8ft. 0in.	,,	90	,,
18ft. ,,	8ft. 0in.	,,	100	,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

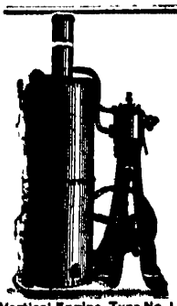
MANLOVE ALLIOTT FRYER & CO

MAKERS OF ALL KINDS OF

SUGAR MACHINERY

NOTTINGHAM, ROUEN, & LONDON.

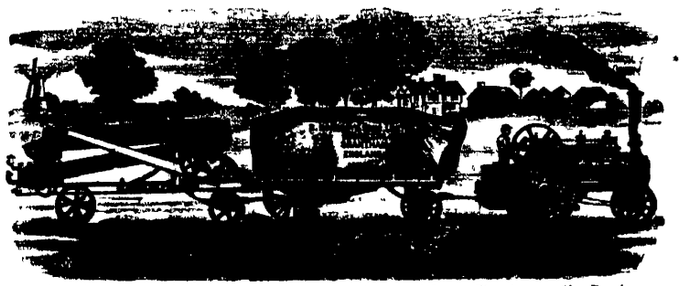
SEE FUTURE ADVERTISEMENTS. 5076



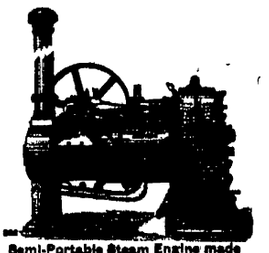
Vertical Engine, Type No. 1, with Vertical Cross Tube Boiler, 2½ to 12 HP.



Vertical Engine, Type No. 2, with Vertical Multitubular Boiler, 1 to 8 Horse Power.



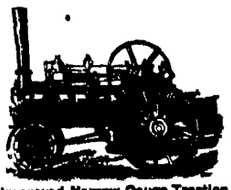
Traction Engine with Finishing Threshing Machine and Straw Elevator on the Road.



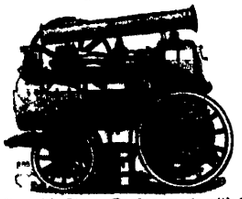
Semi-Portable Steam Engine made with Single or Double Cylinders, 2½ to 35 Horse Power.

R. HORNSBY & SONS, Limited,

General and Agricultural Engineers, Ironfounders, Boilermakers, &c.



Improved Narrow Gauge Traction Engine, or Agricultural Locomotive.



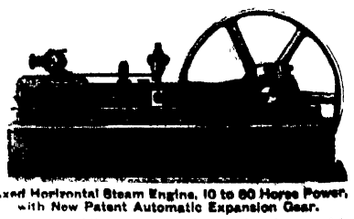
Patent Portable Steam Engine, made with Single or Double Cylinders, and from 2½ to 35-HP.



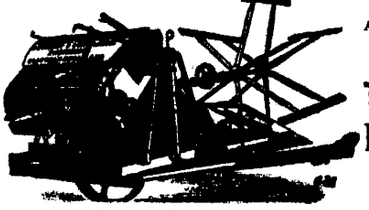
Patent Threshing, Shaking, and Finishing Dressing Machine.



Patent Undertype Compound Engine, 6 to 50 Horse Power, with Boiler above (as shown) or separate from the Engine, as desired



Fixed Horizontal Steam Engine, 10 to 60 Horse Power, with New Patent Automatic Expansion Gear.



Highland Society's £100 First Prize String Sheaf-Binding Harvester.

ALL PREVIOUS AWARDS ECLIPSED!!!

Hornsby's New 1884 TWINE BINDER

HAS BEEN AWARDED THE

First Prize of £100

BY THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND.



R.A.S.E. First Prize Mowers and Reapers.

For particulars of the most modern improved and successful Agricultural Machinery, Ploughs, Dressing Machines, Corn Screens, Turnip Cutters, Root Pulpers, &c., SEE ILLUSTRATED CATALOGUES in English, French, German, Spanish, Russian, &c., sent GRATIS and POST FREE on application.

PLOUGH SHARES OF CAST IRON, CHILLED, WROUGHT IRON, MALLEABLE IRON AND STEEL, OF PATTERNS TO SUIT EVERY VARIETY OF WORK.

At the most important Exhibitions and trials since 1874, R. HORNSBY & SONS' Specialities have gained 526 PRIZES, including 69 Gold Medals, 128 Silver Medals, and 263 FIRST PRIZES.

SPITTLEGATE IRON WORKS, GRANTHAM. 4365

London Office: 84, LOMBARD STREET. Telephone No. 1294. South African Depot: EDINBURGH BUILDINGS, DOCK ROAD, CAPE TOWN.

JOSEPH EVANS & SONS,
WOLVERHAMPTON.

TELEGRAMS, "EVANS" WOLVERHAMPTON.

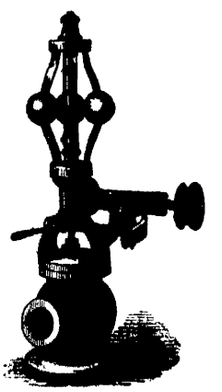
THE GREATEST VARIETY OF

STEAM PUMPS

(SIMPLE AND COMPOUND)

IN THE TRADE.

The only Perfect Governor for Electric Light Engines.



Will work Horizontally or Inclined.

THE "PICKERING" GOVERNOR.

50,000 SOLD.

Guaranteed the most Sensitive Governor made.

ESTABLISHED 1836.

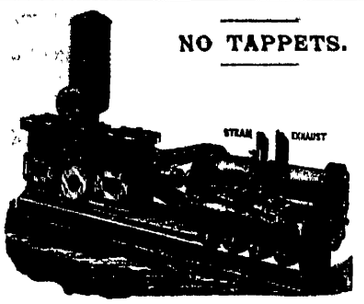
HAND PUMPS

IN EVERY DESIGN.

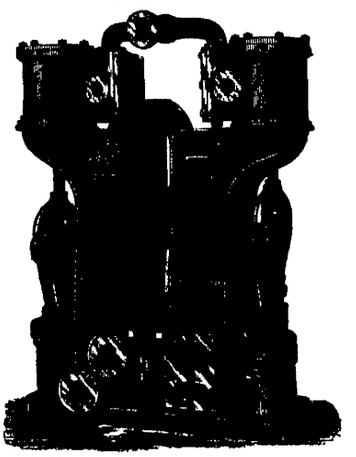
8,000 TO 10,000

ALWAYS IN STOCK.

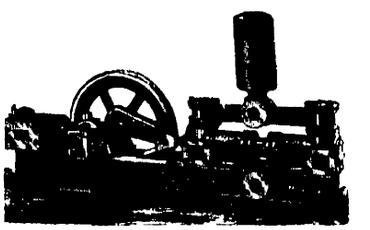
NO TAPPETS.



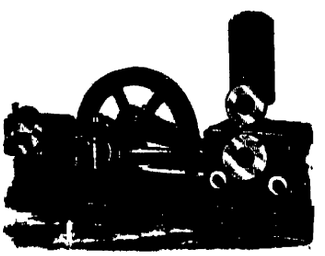
THE "CORNISH" STEAM PUMP.



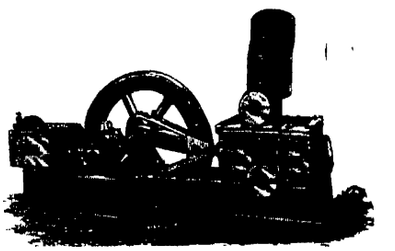
THE "RAM" STEAM PUMP.
(VERTICAL & HORIZONTAL.)



THE HORIZONTAL "RAM" PUMPING ENGINE.



THE "RELIABLE" STEAM PUMP.

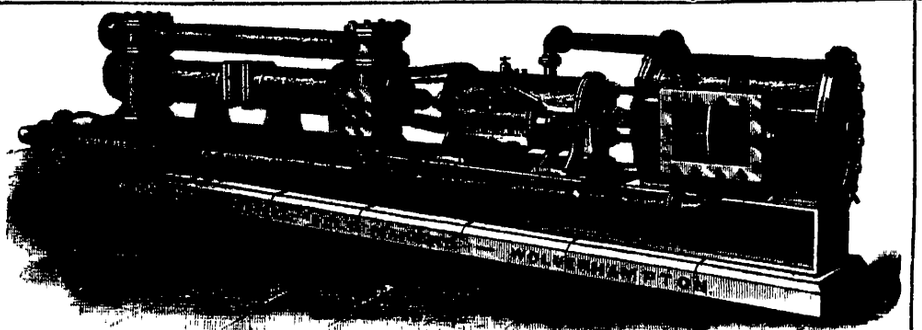


THE "RELIABLE" PUMPING ENGINE.

AMSTERDAM,



1883.



THE "CORNISH" COMPOUND PUMPING ENGINE.

AMSTERDAM,



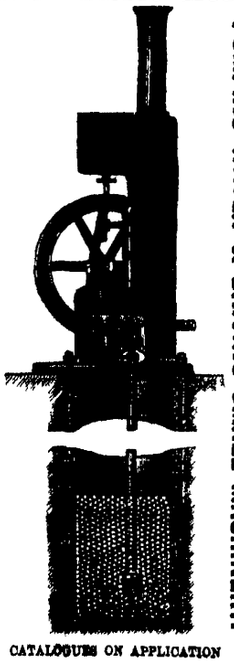
1884.

London Office: 52, Queen Victoria Street, E.C.

NEWCASTLE-ON-TYNE OFFICE and DEPOT:—1, ST. NICHOLAS BUILDINGS.
SHEFFIELD " " 36, NORFOLK STREET.
SOUTH WALES " " 118, COMMERCIAL ST., NEWPORT, MON.
LIVERPOOL " " 172, SCOTLAND ROAD.

THE DOMESTIC MOTOR.

HATHORN, DAVEY & CO., LEEDS.



THE MOST ECONOMICAL SMALL MOTOR FOR PUMPING WATER & DRIVING SMALL MACHINERY.

CATALOGUES ON APPLICATION 5923

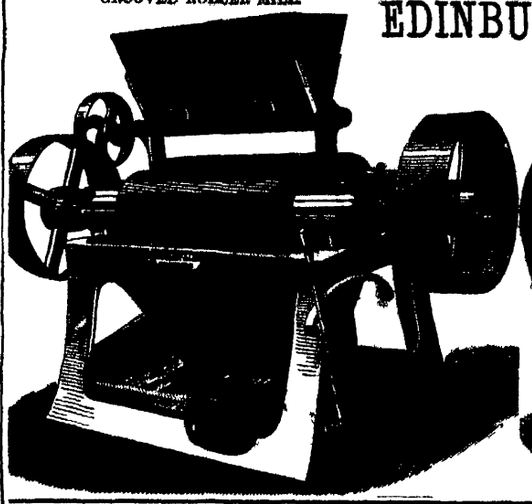
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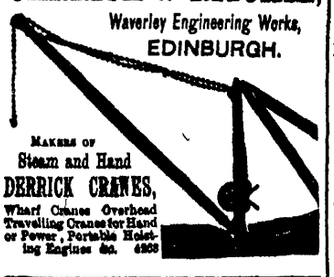
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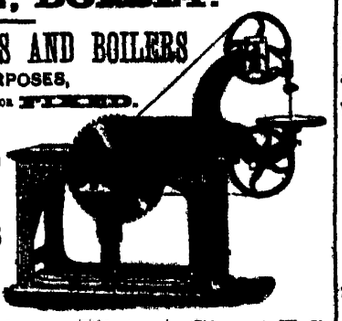
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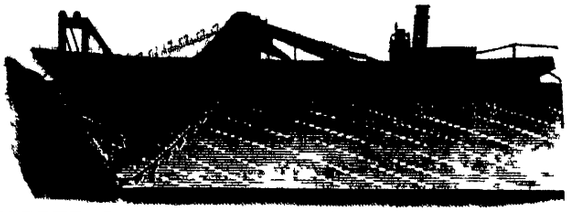
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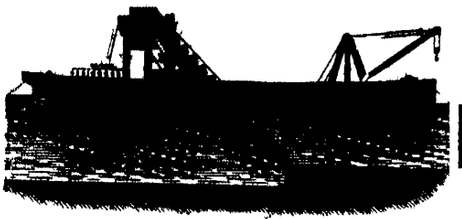
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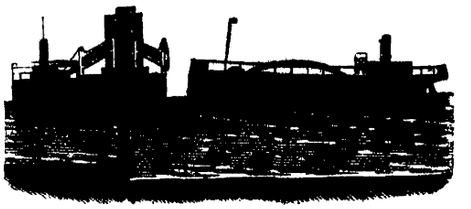
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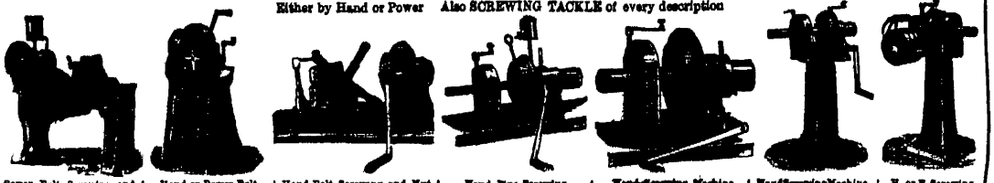
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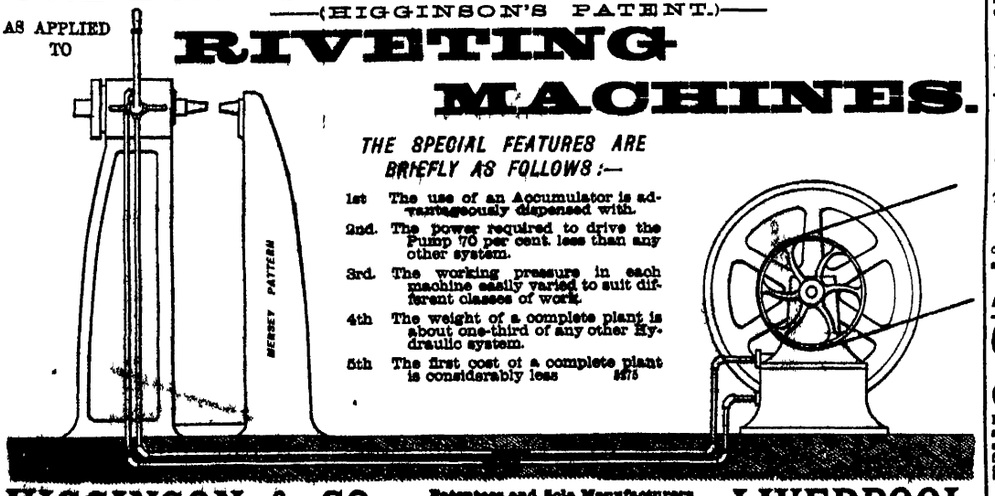
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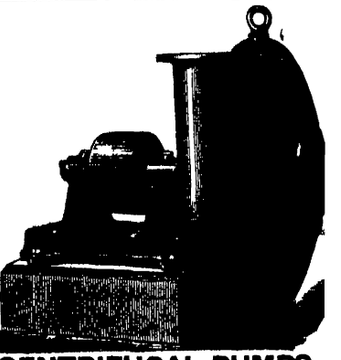
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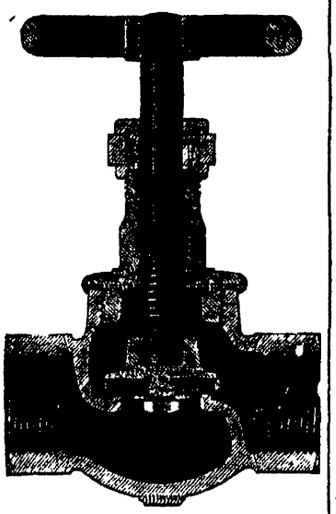
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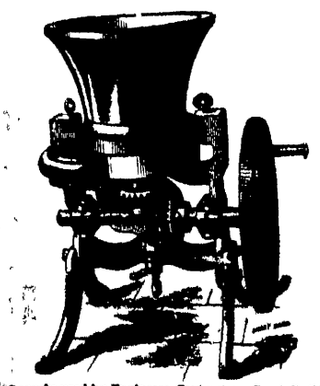
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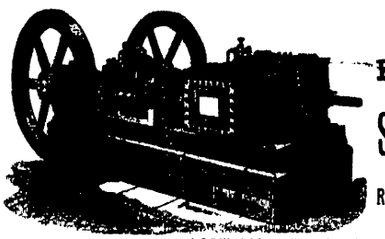
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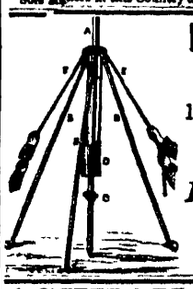
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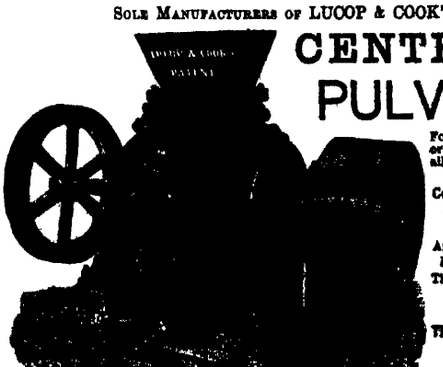
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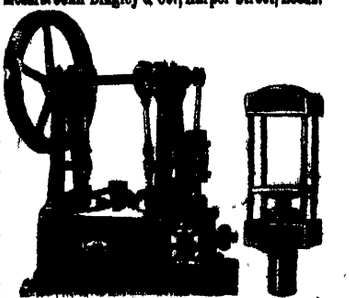
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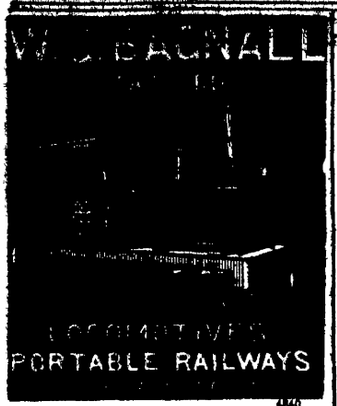


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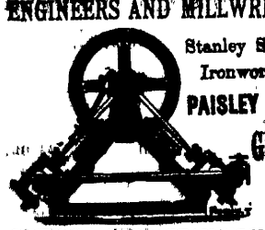


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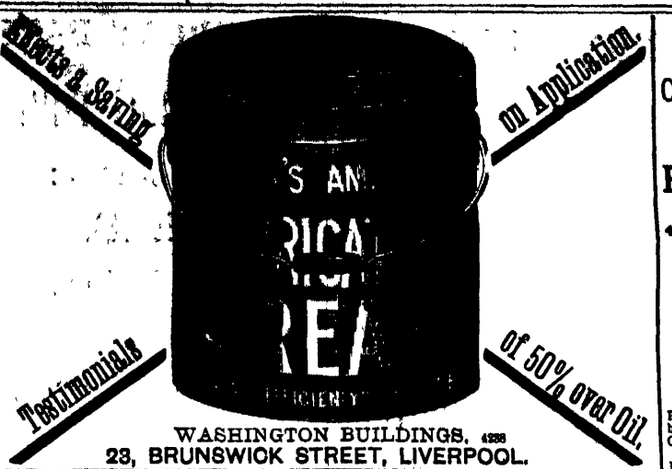
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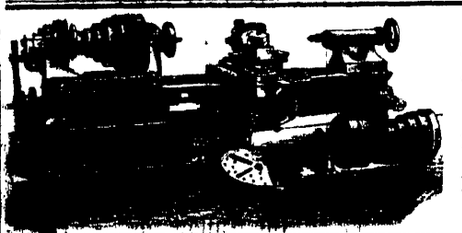
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AGENTS—GEO. E. PHILIP, 18, Renfield Street Glasgow; G. A. BUSHELL, Lombard Street, Quayside Newcastle-on-Tyne; R. BARTON, 78, Commercial Road Hull. 4904

N.B.—As parties are imitating P. Moir Crane & Co.'s Advertisements and Circulars, and offering Oil for Cylinders and Valves pretending to give the same results as Crane's Patent Oil, the Patentees distinctly state that their Patent Rights cover THE USE OF ALL THE CLASS OF OILS which give these results, and that for their own security they must proceed against those infringing

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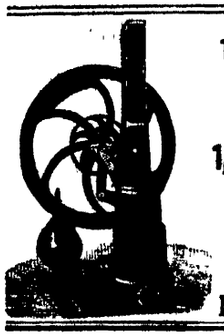
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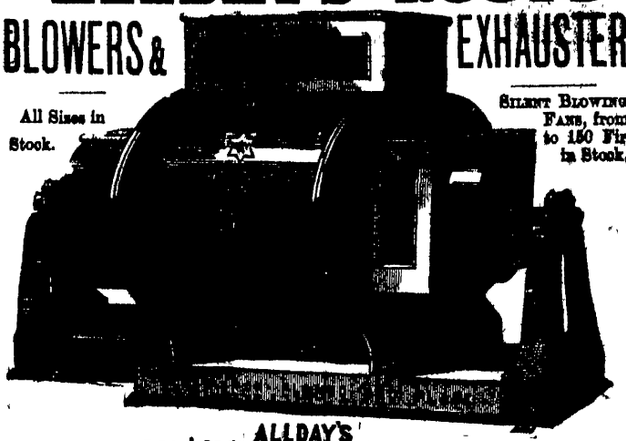
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RANKIN & BLACKMORE, Engineers,

GREENOCK,

MAKERS OF

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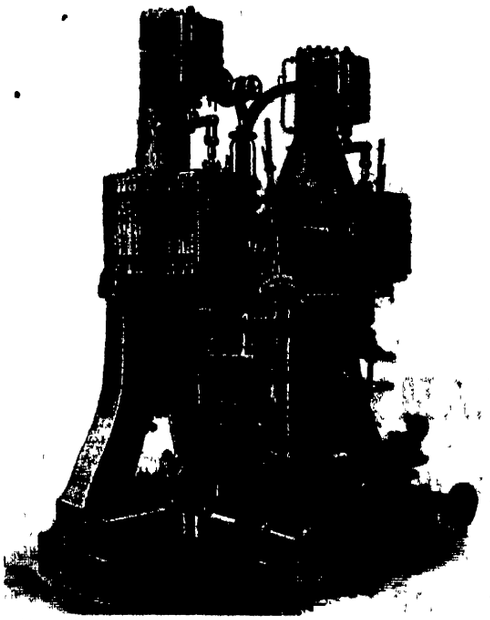
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4-CYLINDER DISCONNECTING TRIPLE-EXPANSION ENGINES,

FOR PADDLE AND TWIN-SCREW STEAMERS.

The principal advantages claimed for these Engines, as compared with the ordinary 4-Cylinder Compound and 6 or 8-Cylinder Triple-Expansion Engines, are

Simplicity of Construction, Economy of Fuel,



Accessibility of Working Parts, Superior Efficiency, and Less Tear and Wear.

FULL PARTICULARS AND PRICES ON APPLICATION. 3230

For Illustration of 2-Cylinder Paddle Engines, see ENGINEERING of this day Fortnight.

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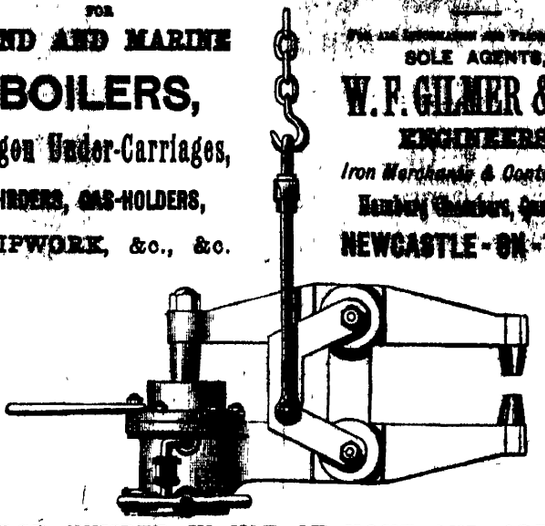
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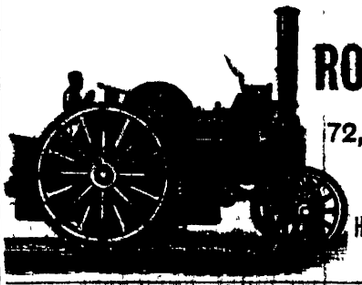
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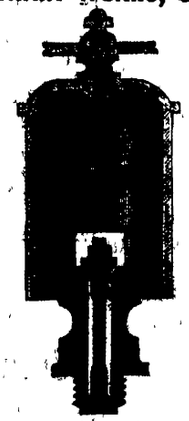
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Self-Acting Adjustable Lubricator,

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A Clear Saving of 50 per cent. in Oil, Tallow, or Grease.

Cannot get out of order.



Perfectly Clean in working.

One Month's free trial allowed.

Sizes.

2 in., 2½ in., 3 in., 3½ in., 4 in.

Prices on Application.

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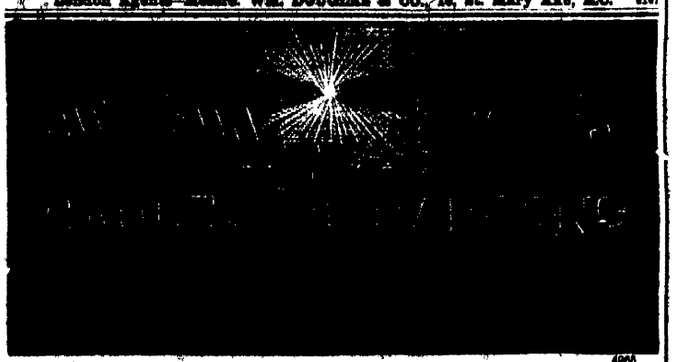
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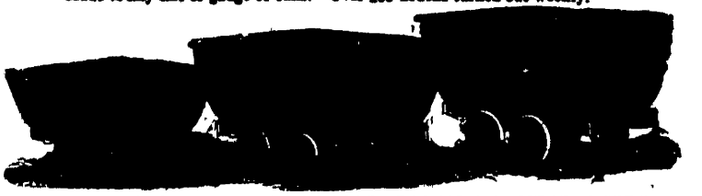
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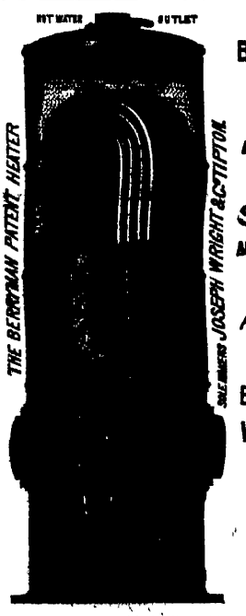
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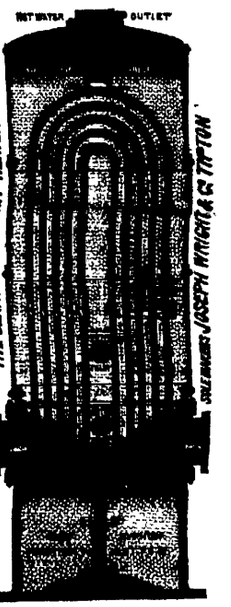
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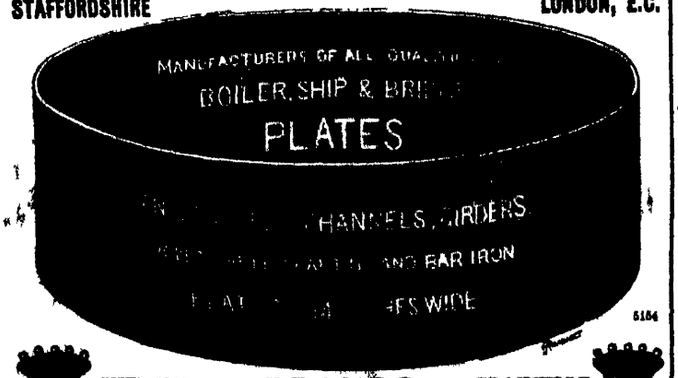
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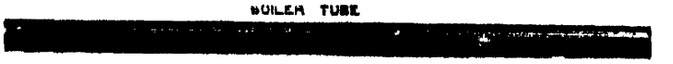
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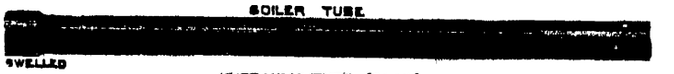
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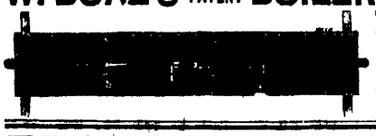
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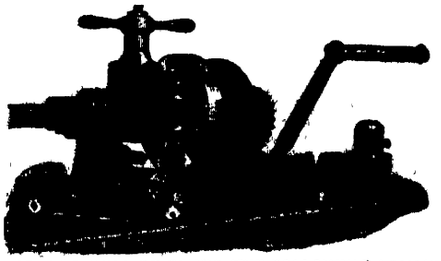
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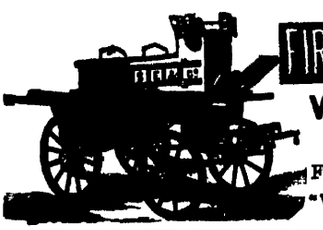
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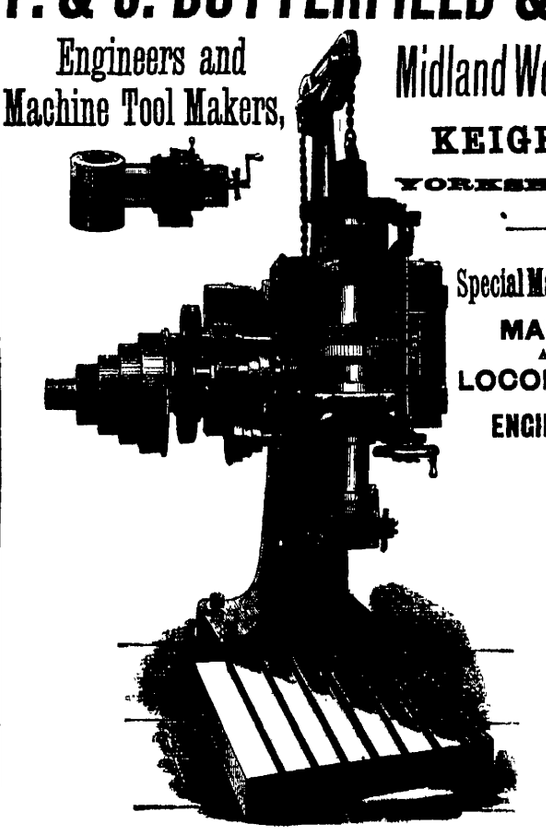


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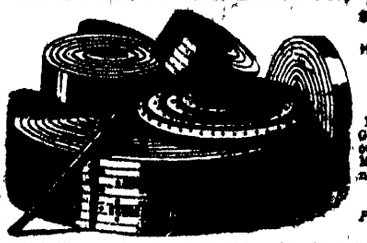
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WATERPROOF PUMP BUTTS, &c.

N.B.—All Waterproof Goods are stamped with our Registered Trade Mark, without which none are genuine.

ESTABLISHED 1850.

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ELECTRIC EXHIBITION.—This Belting was at work at the Royal Aquarium, transmitting up to 190 HP.

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THE STAR RUBBER COMPANY,

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MILLS: TRENTON, N.J., U.S.A.

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GLASGOW, 1884

Weldless Steel Expansion Hoops for Boiler Flues.

MANUFACTURED SOLELY BY

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BOLTON LANCASHIRE.

4446

JOHN & JOSEPH HUGHES,

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SINGLE and DOUBLE, for HAND, GAS, and STEAM power.

4179

THOS. THOMAS & SONS, "Acme" Hoist Works, CARDIFF.

DOUBLE CYLINDER



IMPROVED PORTABLE HOISTING ENGINES.

TESTIMONIAL.

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DEAR SIR,—I have much pleasure in certifying that the (C.P.) No. 7 Melville's Hoisting Engines which my Company bought from you some time ago are giving every satisfaction. They are easily worked, and do a large amount of work at a minimum cost. I can confidently recommend them for Wharf purposes.

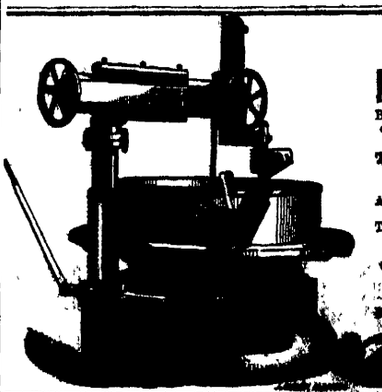
I am, yours faithfully, T. A. BROCK, Secretary.

To W. M. MELVILLE, Esq. Port Adelaide Dock Company, Limited

W. M. MELVILLE,

ENGINEER AND IRONFOUNDER, 4902

SINCLAIRTOWN FOUNDRY, KIRKCALDY.



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The most Complete and Efficient Machine hitherto introduced to Engineers.

All Machines warranted to mould with the greatest accuracy and precision.

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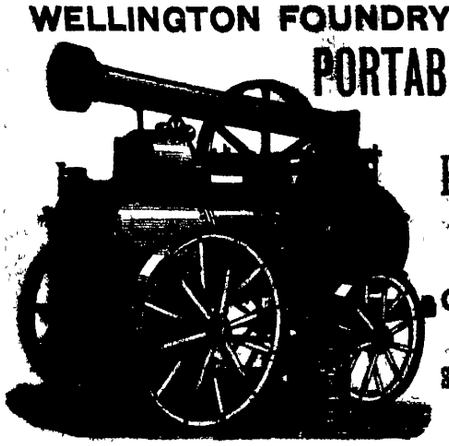
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PORTABLE ENGINES,

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FIXED ENGINES

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SAW BENCHES, &c.

SECOND-HAND ENGINES.

CATALOGUES & PARTICULARS ON APPLICATION. 4468

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These Tools contain many improvements and have a much greater range of expansion than any other.

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CURRIERS, 56, 57 & 61, HIGH STREET, AND St. Paul's Works, SHADWELL, LONDON

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IN UNSURPASSABLE 5089

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BOILER MAKER,

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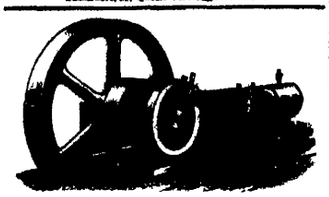
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FOR COVERING BOILERS & STEAM PIPES.

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ENAMELLED GAUGE GLASSES.

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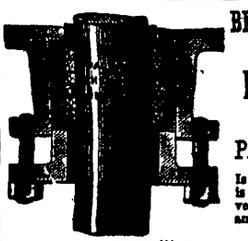
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Is the neatest, and is applicable for very high Steam and Hydraulic Pressures

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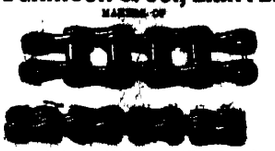
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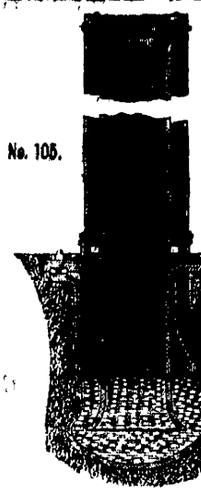
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AUTOMATIC FLUSHING SYPHONS

INVALUABLE FOR KEEPING DRAINS AND SEWERS FREE FROM OBSTRUCTION.

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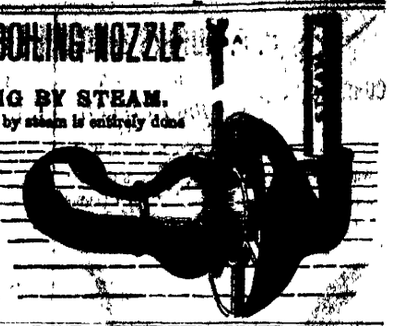
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The objectionable noise when boiling by steam is entirely done away with, and the liquor Heated or Boiled QUICKLY, ECONOMICALLY, and SILENTLY.

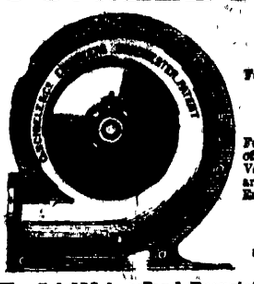
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BLOWING FANS.

For Smiths' Fires and Cupolas, Drying Yarn, Grain, and other substances: increasing draught in flues; Forcing Fresh Air, &c.

EXHAUSTING FANS.

For Ventilation of Mills, Grinding Rooms and Sewers; for Drawing off Dust, Stive and Foul Air. For Condensing Fumes and Noxious Vapours, and for Drying Substances by hot or cold air. A special arrangement for Ship Ventilation, with combined Engine. Suitable Engines to drive all sizes. All sizes kept in stock. Full particulars for any process on application.

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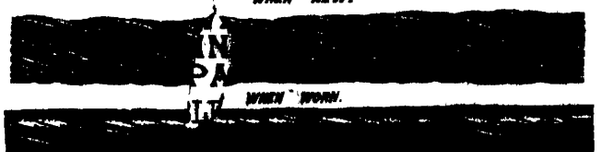
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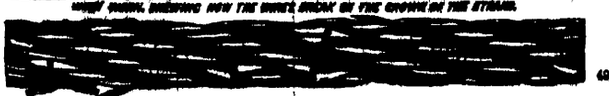
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Special Machinery for Naval Ordnance, Armour Plates and Small Arms.

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For Ships, Yachts, Torpedo Boats, and Land Stations.
Sizes 100 to 15,000 gallons (68,000 litres) per day.

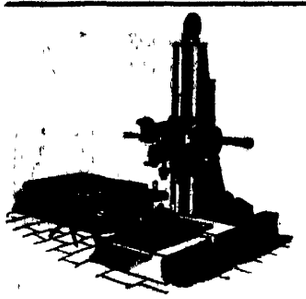
Normandy's Improved Patent Condensers, guaranteed to yield, *per 1 ton of coal, 28 tons, or 6100 gallons*, of Fresh Water, which as it flows from the apparatus, is clear, cold, bright-looking, agreeable, and equal in taste and appearance to the best river water.

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The Actual Production of Fresh Water is equal to, or 75, or 125, or 155 per cent. more than the Boiler Steam consumed by above Condensers, depending on kind of Condenser selected.

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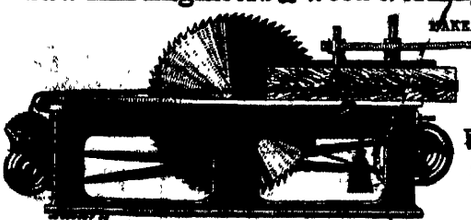
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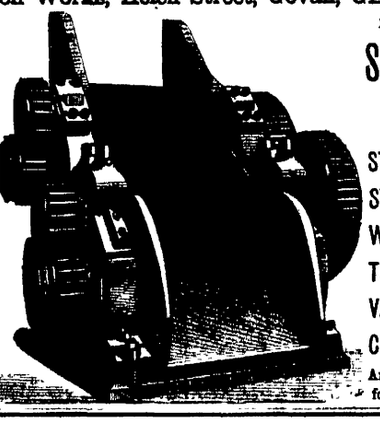
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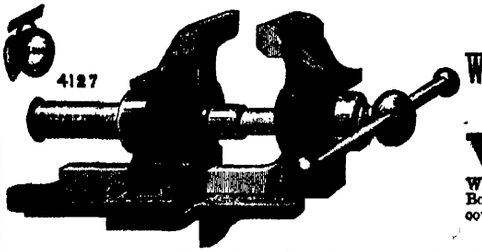
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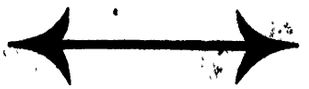
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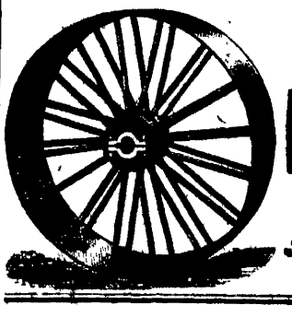
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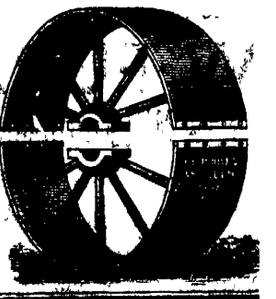
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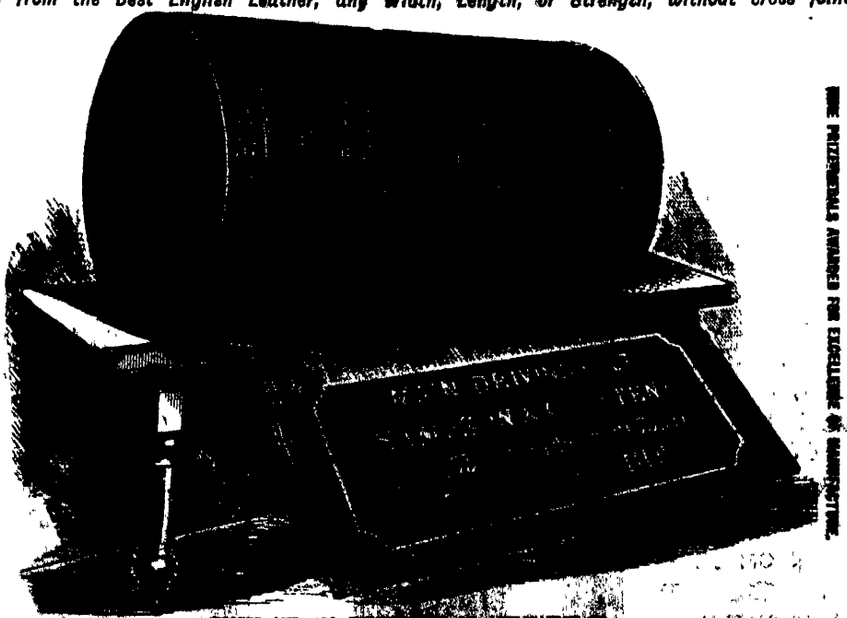


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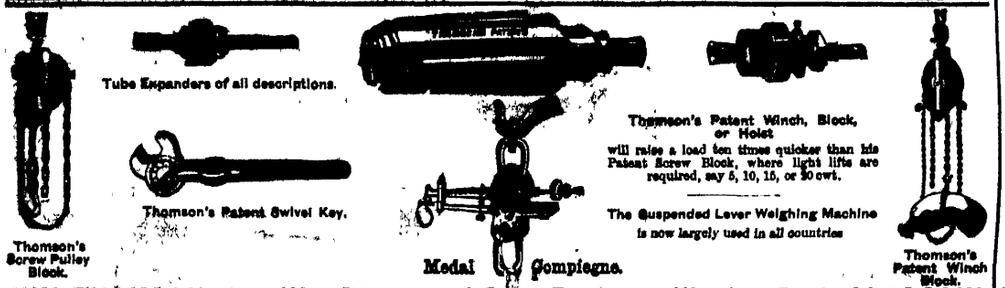
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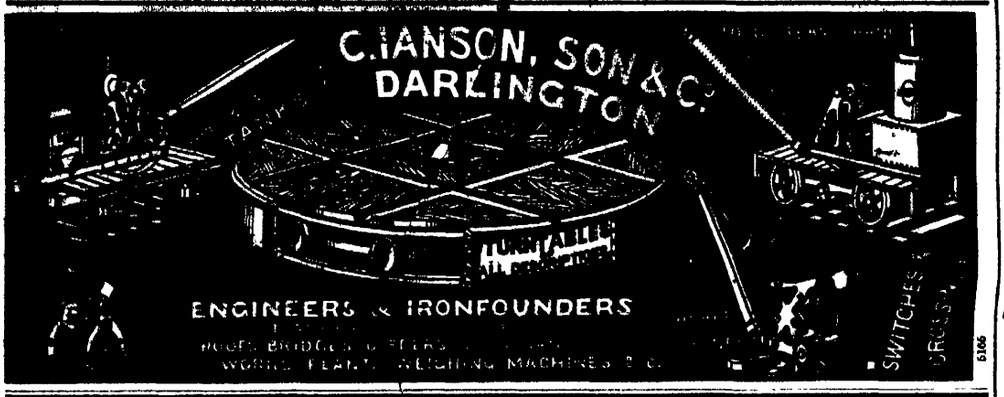
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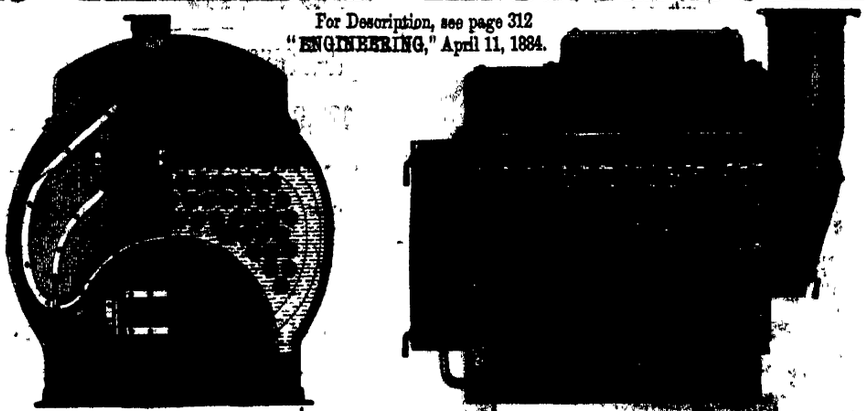
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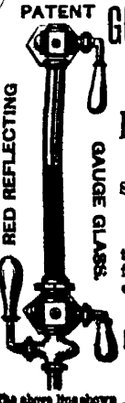
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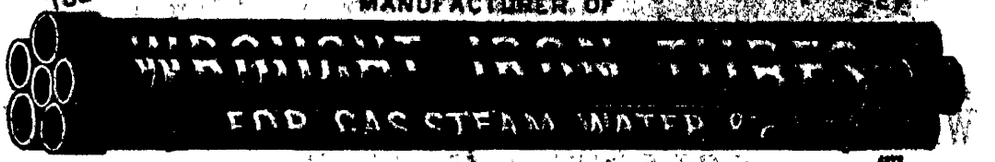
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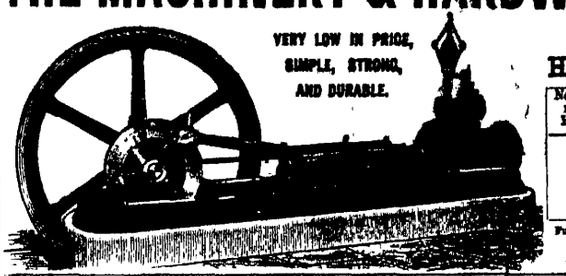
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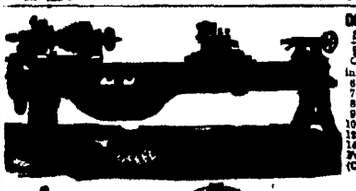
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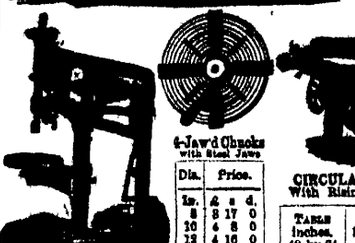




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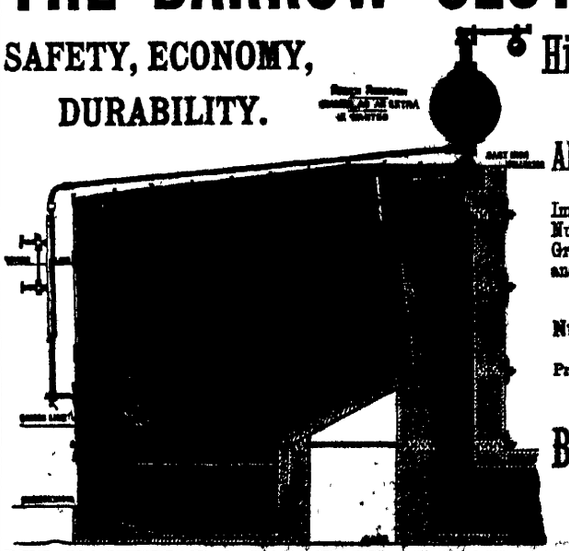
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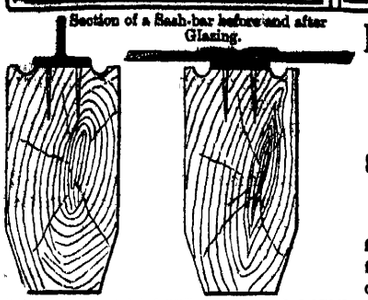
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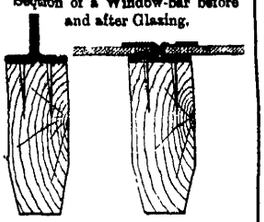


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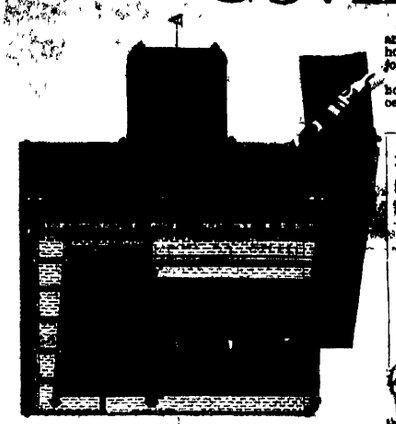
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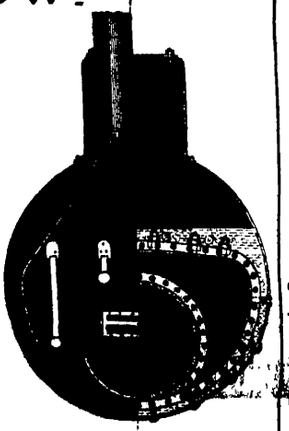
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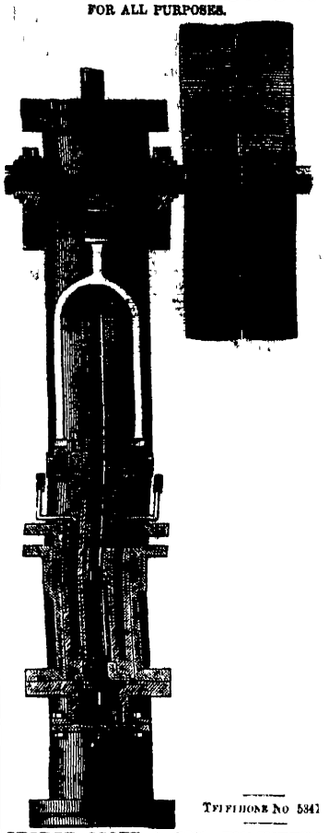
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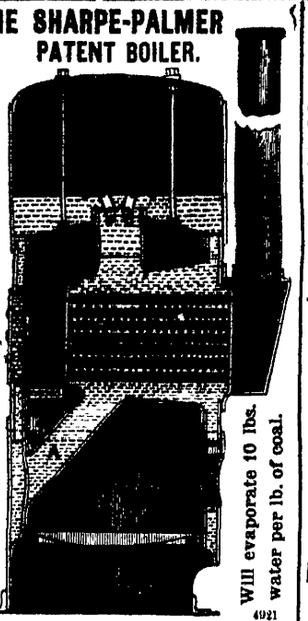
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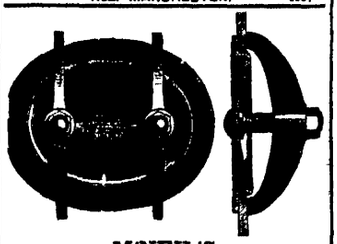
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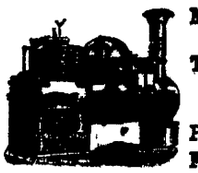
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THE FESTINIOG RAILWAY.

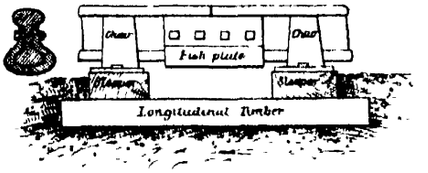
AMONGST all the excursions on the programme of the autumn meeting of the Iron and Steel Institute, probably none has proved more generally interesting to the members than that to the celebrated little railway running from Port Madoc to Festiniog, which Sir Henry Tyler has described as the most instructive line in the kingdom. So much has been written at different times on this mountain railway, that we feel some apology is necessary for opening up the subject at length again, especially as we intend repeating a good deal that has already appeared in our own columns. Whatever excuse, however, may be necessary, is supplied in the fact that the railway is included in the official programme, which we have no choice but to follow; and we are now endeavouring rather to make a record of what the members have seen, than to advance anything new.

The Festiniog Railway is amongst the oldest in the kingdom, having been constructed in 1832. It was at first used as a horse railway for the purpose of bringing down slates from the quarries of Dinas, near Festiniog, to Port Madoc for shipment. In the year 1863, Mr. C. E. Spooner, C.E., the present engineer and general manager of the line, introduced a couple of small locomotives for the purpose of working the traffic. Contrary to the expectations of many these proved highly successful, and were soon followed by two others, and at the end of the year 1869 there were six locomotive engines on the line.

Before dealing with the rolling stock, however, it is, perhaps, as well that we should give a few of the leading particulars of the line itself, of which a plan and a section are annexed. There is a single line of rails, and the length of main line from Port Madoc Station to Festiniog is 13¼ miles, exclusive of branches. The difference in elevation between the sea level and the upper terminus is 700 ft., the ascending gradient being continuous throughout. The maximum rise is 1 in 68.69, and the least is 1 in 186. On the Traethmawr embankment, however, where the line crosses the estuary, it is nearly level. For a distance of 12¼ miles the average gradient is 1 in 92. The greatest filling is 60 ft., and the deepest cutting is 27 ft. The width of the line between fences is 8 ft., and on the embankment 10 ft. at formation level. There are two tunnels, one of 730 yards through syenite, and one of 60 yards through the slate formation. Neither of these are lined. The maximum curves are 1¼ chains radius, in length from 80 ft. to 200 ft. There are others 3, 4, 5, and 6 chains, whilst the ruling curves are between 7 and 8 chains. The gauge of line is generally known as 2 ft., but is actually ½ in. less. In the curves, however, the rails are somewhat spread. As may be surmised from the above particulars, the line passes through a most irregular and picturesque country. For a great part of its length it is cut out from the side of the valley of that beautiful river which lower down swells into the broad estuary of the Traeth Bach.

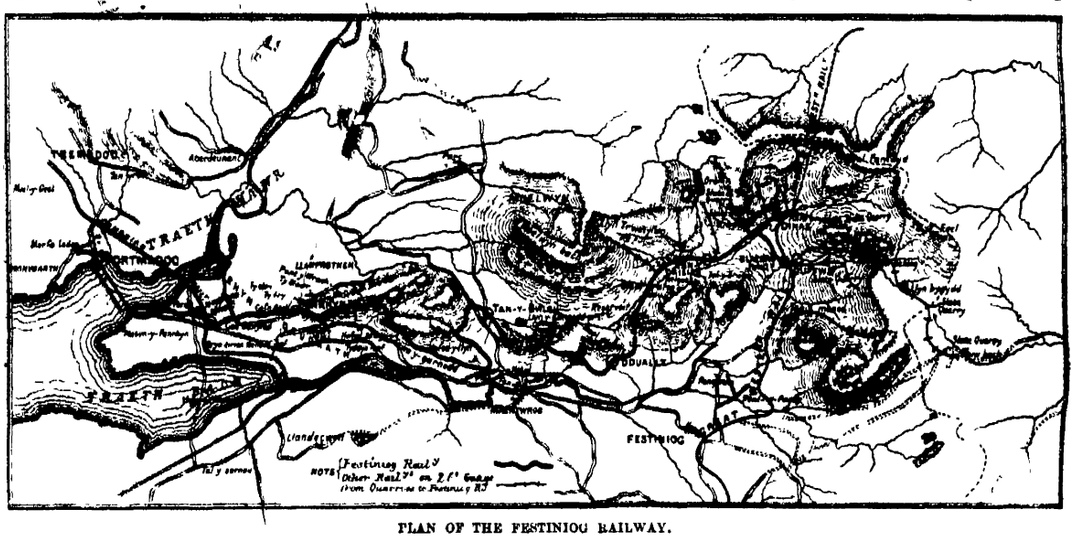
It would be useless attempting to give a description of the scenic beauties that are disclosed to the traveller on this romantic stretch of line, and indeed we are hardly in a position to do so. On the occasion of our two recent journeys the weather was so thick with mist and driving rain that for most of the time it was impossible to see much more than the length of the locomotive ahead. Indistinctness, however, added considerably to the startling effects obtained during this railway mountain climbing. Looking out from the footplate of the engine we appeared to be veritably flying through the clouds, for nothing could be seen below but the rolling volume of mist. Then for an instant, as the fog lifted, a glimpse into the valley would be disclosed, and one could see that the train was speeding along a narrow ledge scarped out of the face of the rock. But it does not require the fortuitous addition of indistinctness to supply startling effects during a run on this line. In parts there are, as we have said, curves of 1¼ chains radius, and some of the sharpest bends are cut out of the face of the solid rock. It needs actual experience on the footplate to appreciate the sensation of approaching one of these curves, especially when the base of the cliff is hidden in mist. One wants then all the assurance that reason supplies to avoid an instinctive conclusion that the whole train is about to leap bodily into space. Even as the engine sweeps round the curve it is difficult to realise how it is done, for the long boiler of the Fairlie engine still points at an angle of 20 deg. to 30 deg. to the line into the valley which we know underlies the mist below. Of course the narrow gauge, combined with the double bogie of the Fairlie engine, is sufficient explanation for all this, but one wants to travel on the Festiniog Railway in a fog to fully realise the utmost the bogie system is capable of in taking curves.

When the line was remodelled for steam traffic, the whole of the curves were laid out afresh by Mr. Spooner on the parabolic principle. They were set off with great care, the extremities being eased off into the reverse curves or straight lines. The result of this is that the train passes from one curve to another imperceptibly, unless one takes note of the cant. The super-elevation on the greatest curves is 3 in. The permanent way is admirably laid, and as a rule excellently kept up throughout. It is well ballasted and drained. Double-headed rails are used of 48½ lb. to the yard. A good part of the line is laid with steel rails. In the draughting office there are some interesting specimens of old permanent way. Amongst these is a part of the first rails used on the line in the year 1832.

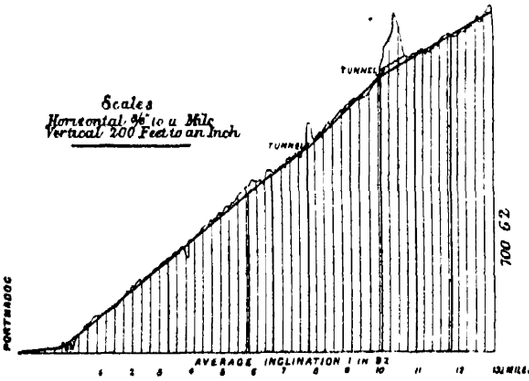


These were 16 lb. fish-bellied rails of oval section, 4 ft. long, and flattened at the ends to fasten in the chairs by means of an iron key. They were superseded by a heel rail which continued in use until the year 1868, when the present 48½ lb. rails were adopted. Mr. Spooner uses all his rails twice, planing the underside in the machine before relaying them, so as to take out the depression caused by the impact of rail on the chair. The rails are joined by a fishplate of Mr. Spooner's design. In this the section is such, that the web and lower flange of the rail are both supported, the two plates all but meeting under the centre of the rail. It has been found that the additional stiffness gained by this arrangement not only affords very much smoother running, but the nuts have no tendency to slack back, as the constant working of the plates against the rail is avoided. The points and crossings are of the ordinary construction. Whilst on the subject of rails it is perhaps as well to make reference to Mr. Spooner's patent rail bender, illustrations of which have already appeared in this journal (see ENGINEERING, vol. VIII., page 263). It consists of a cast-iron frame mounted on a couple of pairs of wheels, so that it can be run along the line to any point where it may be required, this frame carrying the three rollers by which the bending operation is performed. Two of these rollers are fixed on axles, each of which carries a spurwheel at one end, and these are geared together by means of an intermediate wheel. The axle of one roller also carries at its other end a wormwheel, and this wheel is driven by means of a worm and bevel gear. The axle of the bevel wheel passes right through from one side of the machine to the other, and it is provided at each end with a crank handle, these handles (not shown in the engraving) being turned by the men working the machine.

The degree of curvature given to the rail to be



PLAN OF THE FESTINIOG RAILWAY.



PROFILE OF LINE.

THE FESTINIOG RAILWAY: VIEW NEAR TAN-Y-GRISAU.



bent is regulated by the position of the third roller, which turns on bearings which move in guides, and can be raised or lowered. The rail to be bent is passed over the lower roller, and under the upper ones, it being drawn forward by the latter rollers as they are turned by means of the gearing we have described. The rollers are of cast iron hooped with steel, the hoops being grooved to suit the section of the rails to be bent. With this machine, rails can be bent with great accuracy from curves of the largest radius, to those suitable for an ordinary turntable. The makers are Messrs. Thomson, Sterne, and Co. With rails that are bent true to the required curve, friction between the rail and the wheel flange is reduced to the lowest point, a great point in the saving of wear and tear

The rails now laid on this line are fixed by strong chairs to 9 in. by 4½ in. larch sleepers, 4 ft. 6 in. long, and placed 3 ft. apart from centre to centre, except at the joints where the pitch is contracted to 2 ft. At each joint a frame is formed by placing two sleepers as longitudinals under the cross sleepers and spiking the latter to them. This arrangement, combined with the use of the stiff form of fishplate we have already described, enables the joints to be rendered very firm and even, an important matter in a narrow gauge line worked at relatively high speeds.

A prominent feature on the line are the dry stone walls or embankments which cross the ravines on the hillside. These are 8 ft. wide at top, with a batter of 1 in 6. Many of them are 50 ft. or more in height and are sharply curved.

The above illustration represents a part of the line near Tan-y-Grisau, where one of these "breast walls," as they are locally called, exists. The full depth of the ravine does not however appear; the photograph from which the engraving has been made not taking it in. Owing to the perspective, too, the embankment appears wider and lower that it actually is.

Besides the terminal stations there are five others. Taking them in order from Port Madoc upwards, they consist, firstly, of Minffordd Junction, where the line crosses that of the Cambrian Railway, and an interchange of traffic takes place. Next above is Penrhyn, then Tan-y-Bwlch, and higher still Tan-y-Grisau. Dinas is the highest station on the main line At Blannau Festiniog Junction, connection is made with the London and North-Western Railway, and at Duffws the Great Western Railway joins the line. The laying out of these junctions in a complete manner has been a source of considerable expense to the Festiniog Company, as everything has been done on the most approved principles in the matter of signalling, &c. At Port Madoc there are facilities which would enable 200,000 tons of slates being shipped per annum, although we believe 140,000 tons is the most that has ever been shipped in one year. The rise of tide is 18 ft. at ordinary springs, but at times there is as much difference as 21 ft. between high and low water springs.

The introduction by Mr. Spooner of the Fairlie double bogie engine opened up a new era for the Festiniog Railway, and has proved one of the most striking features in its history. The first two locomotives used on the line were built by Messrs. G. England and Co., of Hatcham, in 1863. They had four coupled wheels 2 ft. in diameter. The wheel base was 5ft. and the cylinders placed outside were 8 in. in diameter by 12 in. stroke. The weight of each in work was about 8 tons. The remaining engines of this class were also supplied by Messrs. England, but were about 2 tons heavier. The working pressure was usually 160 lb. In the year 1869, the double boiler Fairlie engine with double bogie, "Little Wonder," of which we give an engraving on page 286, was built by Mr. Fairlie, at the Hatcham works, and placed on the line. A double page illustration and full description of this locomotive was published in ENGINEERING at the time.*

The details of performance published on page 286 are taken from Mr. Spooner's book on narrow gauge railways, published by Messrs. Spon, of Charing Cross.

In 1872, the "James Spooner," also a double boiler double bogie Fairlie engine, was placed on the line.* The following are the chief particulars of this locomotive:

DETAILS OF THE LOCOMOTIVE "JAMES SPOONER."

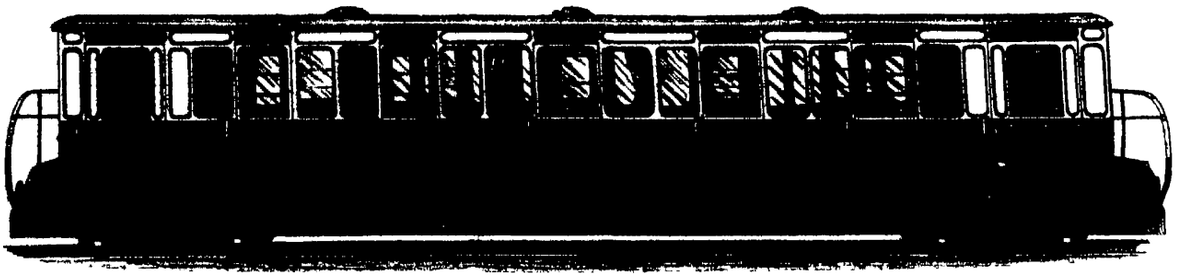
	ft.	in.
Cylinders.		
Diameter	0	8½
Stroke	1	2
Distance apart from centre to centre	3	1
Centres of valve spindles	0	9
Centre of cylinder to valve face	1	0
Length of steam ports	0	6⅝
Width " "	0	0⅞
" exhaust ports	0	1¾
" bars	0	0⅝
Thickness of piston	0	1⅝
Number of rings ... 2		
Diameter of piston rod	0	1½
Working Gear:		
Length of connecting rods between centres	4	6
Diameter of crank-pin bearing	0	2¾
Length " "	0	2⅜
Diameter of coupling-rod pins	0	2¾
Length " "	0	2
" of crosshead blocks	0	5
Width of motion bars	0	2½
Thickness of motion bars at centre	0	1¼
Length of eccentric rods	3	3⅝
Diameter of eccentric sheaves	0	9¾
Width " "	0	2
Throw " "	0	2½
Wheels and Axles:		
Diameter of wheels	2	4
Width of tyres	0	4
Distance between tyres	1	9
Wheel base of each bogie	4	6
Total wheel base	18	8
From leading axle to centre of bogie pin	2	5
" driving " "	2	1
Diameter of driving axles at centre	0	4½
" leading " "	0	4
" axle bearings	0	3⅜

* See ENGINEERING, page 316, vol. ix.

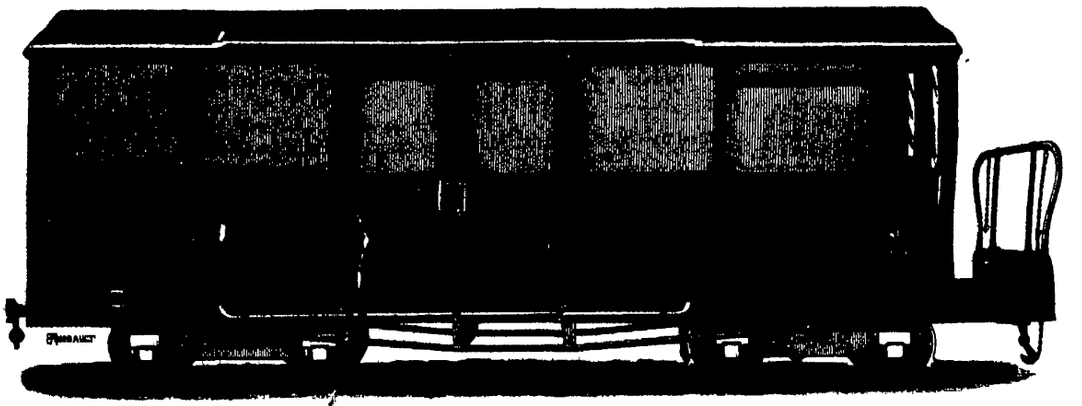
* For illustrations of this engine see ENGINEERING, vol. xv., page 179.

ROLLING STOCK ON THE FESTINIOG RAILWAY.

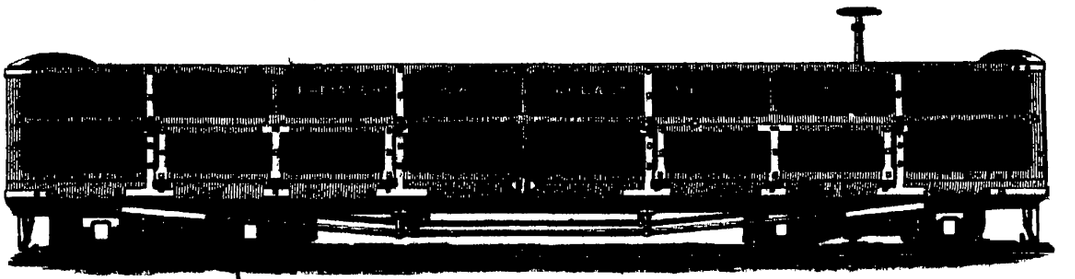
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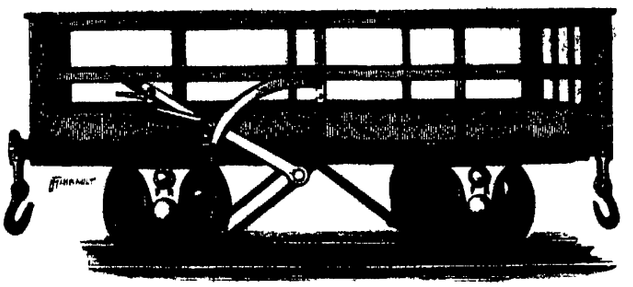
COMPOSITE CARRIAGE.



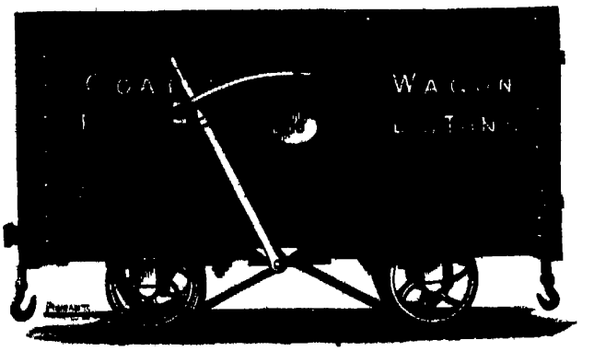
GUARD'S VAN.



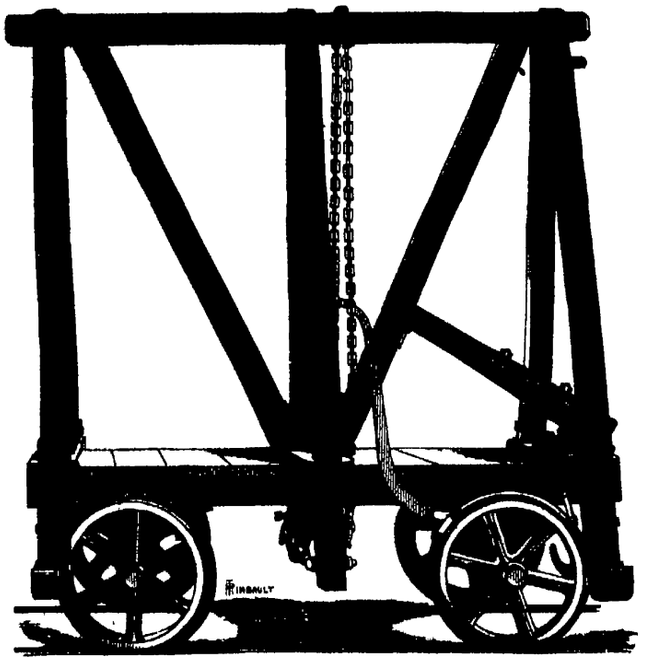
DOUBLE BOGIE COAL AND BALLAST TRUCK.



SLATE TRUCK.



COAL TRUCK.



TRUCK FOR SLATE SLABS.

TABLE SHOWING THE WEIGHT OF TRAIN GENERALLY TAKEN BY THE "FAIRLIE" ENGINE, TOGETHER WITH ITS CONSUMPTION OF FUEL.

DESCRIPTION	Weight of Locomotive Engine in Steam, and Tare Weight of Carriages, &c.	Number of Passenger Carriages, (same Up & Down).	Number of Passenger Carriages, Up (same Down).	Weight of Passengers and Goods, Up.	Weight of Carriages, and Load of Passengers, Up.	Entire Length of Train in Motion, including Engine.	Weight of Passengers and Slates, Down.	Weight of Carriages, Wagons, and Slate Trucks, Down.	Total Weight of Passengers, Goods, Slates, Carriages, Wagons, Trucks, and Engine, Up and Down.	Total Gross Weight of Train, Up and Down, exclusive of Engine.	Consumption of Fuel per Ton per Mile on Gross Weight of Train, exclusive of Engine.	Proportion of Paying to Unpaying Weight Hauled, taking the Up and Down Journey inclusive of Engine.
	t. c. q.			t. c. q.	t. c. q.	ft.	t. c. q.	t. c. q.	t. c. q.	t. c. q.	lb	
1 "Fairlie" engine in steam	19 10 0											
1 First-class carriage	1 3 2	..		..	..	..	..	1 3 2				
2 Second "	2 7 0	6	7½	4 17 2	11 18 2	..	4 17 2	2 7 0	11 18 2			
3 Third "	3 10 2							3 10 2				
				Passengers' Luggage.			Passengers' Luggage.					
1 Guard's brake van	1 13 3	1		0 13 0	2 11 3		0 13 0	1 13 3	2 11 3 Empty		*0.45	1 180 Paying to 1 Unpaying
6 Goods trucks	5 6 2	6		15 0 0	20 6 2 Empty			5 6 2	5 6 2		Which includes Standing at Stations, but does not include Shunting.	
112 Slate wagons	72 16 0	112		72 16 0	72 16 0		224 0 0	72 16 0	296 16 0			
2 Brakesmen and guard			3	0 4 2	0 4 2		0 4 2		0 4 2			
	86 17 1	125	75	21 0 0	107 17 1	1203	230 0 0	86 17 1	316 17 1	424 14 2		

* The consumption of fuel embraces an excess elevation to overcome on the up journey of 350 ft., supposing that the speed of down journey by gravity was at 20 miles an hour, *without application of brakes*, hence a saving of one-half in consumption of fuel would occur with the same loads by the reduced average inclination of 1 in 184, instead of the existing average inclination of 1 in 92.

	ft.	in.
Length of axle bearings	0	5½
Centres "	1	3½
Diameter of axles at wheel seats	0	4
Carrier Frames:		
Distance between frames	2	10½
Depth of frame at centre	0	9½
Centre of bogie pins	13	10
Width over footplates	6	6
Bogie Frames.		
Extreme length	9	7½
Depth	1	4½
Thickness	0	0½
Distance apart	1	6½
Buffers (Thomson's patent)		
Height of centre buffers from rails	1	7
Boiler Shell		
Total length between smokebox tubeplates	21	6
Length of each barrel	7	7
Diameter of each barrel inside smallest plate	2	6½
Thickness of barrel plates	0	0½
" smokebox tubeplate	0	0½
Height of centre of boiler from rail	4	0½
Length of firebox casing	6	4
Width " "	2	7½
centre of boiler to bottom of casing	3	0½
Thickness of side and crown plates	0	0½
" front plates	0	0½
Diameter of steam domes, outside	1	6½
Height " "	1	9½
Diameter of safety valves	0	3
Inside Fireboxes (Copper):		
Length at top	2	7
" bottom	2	8½
Width at top	2	0½
" bottom	2	1
Height of crown above centre of boiler	0	6
" " " grate at front	3	2½
" " " " back	2	7
Tubes (Brass):		
Number in each barrel 102		
Diameter outside	0	1½
Length between tubeplates	7	10½
Distance between centres, vertically	0	2
" " horizontally	0	3½

Heating Surface	sq. ft.
Fireboxes	84
Tubes (outside)	629
Total	713
Firegrate area	11.2

Smokeboxes and Chimneys		
Diameter of smokeboxes	3	2
Length " inside	2	8
Diameter of chimneys inside at top	0	10
" " " bottom	0	8½
Height of top of chimney from rail	7	9
Diameter of blast nozzles	0	1½
Tanks		
Length	8	0
Width	1	4½
Depth	2	3½
Capacity 720 gallons		
Weight of engine empty	14 tons 5 cwt.	
" " roadworthy	20 tons 1 cwt.	

A third-class of locomotive was tried in 1876. This consisted of the "Taliesin," a single boiler double bogie Fairlie engine of the following dimensions:

DETAILS OF THE LOCOMOTIVE "TALIESIN."

	ft.	in.
Diameter of cylinders	0	9
Stroke	0	14
Diameter of wheel	2	8
Wheel base of steam bogie	4	6
" trailing bogie	3	6
Diameter of wheels of trailing bogie	1	7
Centres of bogies	9	9
Total wheel base	13	11

Heating surface: Firebox 29.5 sq. ft., Tubes ... 313 ", Total 342.5 "

Firegrate area	6.25 sq. ft.
Capacity tanks	380 gals.
Weight empty	12 tons 5 cwt.
" roadworthy	15 tons

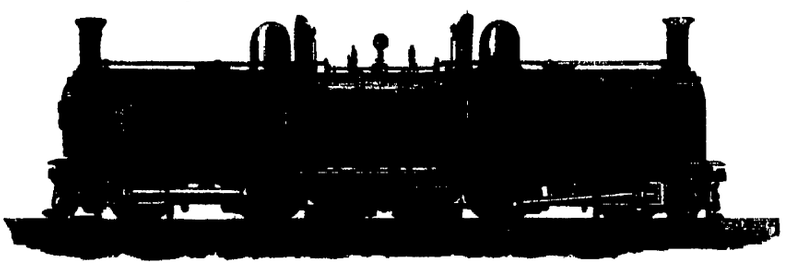
In the early part of the year 1870 were made the celebrated experiments as to the hauling power of the Fairlie locomotive "Little Wonder," at which the Duke of Sutherland, the members of a Russian Imperial Commission, representatives of the India Office, Board of Trade, France, Germany, and other countries were present. These experiments were fully described in this journal.*

We give on page 285 illustrations of some of the passenger and goods rolling stock used on the line. The bogie composite carriage shown accommodates first, second, and third-class passengers; it has seven compartments and will seat fifty persons, and has been in use since the year 1873. As will be seen, the weight is carried very low down, which is necessary with the narrow gauge; on this account, too, no platforms are required on the line. On the same page is an illustration of the type of guard's van at present in use. The double bogie truck is designed principally for carrying ballast, used in repairing the permanent way. The weight of this is 4½ tons, and it will take 12 tons of ballast, 7 tons of coal, or 8 tons of corn in sacks. By the addition of rising boards, however, over 10 tons of coal have been frequently taken in these trucks. The ordinary 5-ton coal wagon is also shown. The last illustration on the same page is that of a truck used for carrying large slabs of slate. These are placed against the framing as on an easel, and are supported by the curved ends shown.

The older stock of the company consists of first, second, and third-class passenger coaches. Some of the first-class carriages are open, having longitudinal seats placed back to back. Strong leather aprons are provided, and in fine weather these seats are in great demand. The first-class carriages are 10 ft. long and 6 ft. 3 in. wide; the others are 9 ft. 9 in. long and 4 ft. 10½ in. wide, with elliptical springs. The overhang of the passenger carriages with cross seats is 1 ft. 5 in. from centre of rail, and 10 in. from the end of the axle.

Passenger carriages with longitudinal seats which will carry twelve first, fourteen second, and fourteen third-class passengers, weigh 1 ton 6 cwt. With cross seats a twelve-passenger carriage weighs 1 ton 3 cwt. Coal trucks and slate wagons to carry 3 tons weigh 19 cwt., and goods trucks for 18 cwt., 2½ tons each. A 2-ton slate wagon weighs 13 cwt. The wheels on these are 1 ft. 6 in. in diameter, and are made of cast iron with Low-moor tyres, those on the slate trucks run from seven to nine years without requiring to be turned afresh. In the office we saw one veteran that had been twenty-six years in wear. The wheel base of some of the rolling stock is as follows, viz.: Passenger carriages, 5 ft. and 5 ft. 6 in.; goods and coal trucks, 5 ft 6 in. and 6 ft.; slate wagons, 2 ft. 11 in, 3 ft. 1 in., and 4 ft. 1 in.; slab trucks, 5 ft. The journals are 3½ in. to 4½ in.

A feature to which Mr. Spooner attaches great importance is the method adopted for coupling up the train. This is done by his patent combined buffer, drawbar, and coupling. By means of a hook which is held in its place by a falling weight and eccentric, the two combined buffers and drawbars are locked firmly together, so forming a central rigid connecting link between the two carriages. The connection is made to the carriage frame, some distance from the end, and considerable lateral play is given, in order to allow for the necessary motion in rounding curves. Figs. 1 and 2, page 288, show a modification of the arrangement which has been expressly designed for carriages with end communication. Fig. 3 shows the general design.



DOUBLE BOGIE FAIRLIE ENGINE "LITTLE WONDER."

About a mile from the Port Madoc Station are the carriage and locomotive shops of the company. Everything is naturally in miniature, the wheel lathe especially striking one as being very small. It is this feature that adds not a little to the economy with which this line has been run, and is one of the strong points of the narrow gauge system.

At the locomotive shops the company build their own engines—a double bogie Fairlie engine of the same general type as the "James Spooner" being now in hand. Slight alterations in detail have been made from time to time as experience suggested them, but in general principle the design remains the same. The cylinders of the new engine are a trifle larger, being 9 in. in diameter by 14 in. stroke, and the wheels are 2 ft. 9½ in. The boiler has been raised over the firebox to give

* See ENGINEERING, vol. ix., page 448

more steam room, and various parts have been strengthened or otherwise modified.

So far as the Festiniog gauge of 1-11½ is concerned, it was not a matter of choice, as the old horse tramroad had to be utilised. Mr. Spooner is not an advocate of a gauge quite so narrow as that he has under his charge, 2 ft. 6 in. being, we believe, his ideal dimensions.

MESSRS. J. WALKER, PARKER, AND CO.'S LEAD WORKS.

THE DEE BANK LEAD WORKS.

THESE works are one of Messrs. Walker, Parker, and Co.'s numerous establishments. They are situated at Bagillt, on the estuary of the Dee, and adjoining the Chester and Holyhead Railway. Here the operations of smelting the lead ore are carried on, and pig lead is desilverised. Sheet lead is also rolled, and red lead manufactured on the premises.

The lead ore is smelted in the manner generally known as the Flintshire process, which is by air reduction in reverberatory furnaces. These are of the usual type, being of rectangular construction, and built of firebrick bound with iron, and are 20 ft. long by 11 ft. wide. There are three doors on each side. The working bottom of the furnace is made up of slag from the process, and slopes on all sides towards the tap hole in front. The charge consists of about one ton of ore, to which is added about 2 cwt of "fume" collected from the flues, to which we shall make more special reference shortly. The ores at present worked are of a very pure and rich description obtained from the English and Welsh mines, the average assay showing 80 deg. of metal, thus nearly reaching the possible percentage. Fires are made up in the coal-burning furnaces placed at the sides, and the burning gases and products of combustion are conveyed to the space above the smelting hearth. The charge is worked by hand rakes, and as lead is separated, it flows down to the tap hole. It is ultimately run into the tapping pot, sunk in the ground in front, and having been skimmed clean is cast into pigs in iron moulds. The waste gases and escaping fumes from these furnaces, as well as from all others in the works where the gases are brought into direct contact with substances containing lead, are conveyed to a large underground flue situated on the high land at the back of the works. This flue is 1¾ miles in continuous length. It is oval in section, the maximum and minimum diameters being, respectively 7 ft. and 6 ft. It is built of brick in the ordinary way, and arranged in an oval coil of 6½ turns. The total length of all flues on the works, including the one described, is 2 miles and 400 yards. This flue discharges into a chimney stack 258 ft. high and 12 ft. in diameter. This unusual length of flue is for the purpose of collecting the flue dust or "fume" which is carried over from the furnaces with the smoke. It is principally composed of sulphate, sulphide, and oxide of lead, and contains as much as 55 to 60 per cent. of metal. In the ordinary way the fume is got out by flushing the flues with water which is run into settling pools in the works, but once a year they are opened out and thoroughly cleared, when an additional quantity of 300 to 400 tons is taken from them, this being what the flushing process has failed to dislodge. Until this flue was built nearly the whole of this valuable material was discharged in the air, and was a notable instance of matter in the wrong place, being fatal to the surrounding vegetation.

From the working of the furnace there results a certain residue known as "grey slag" which is drawn out by the doors at the back. About 90 per cent. of the contained lead is got out at the first operation, and a considerable part of the remaining quantity is contained in the slag, and in order to recover this, the slag is worked over again. It is a small detail, but perhaps one worth noticing, that each furnace has been designed with a small oven, wherein the men cook their dinners. There are eleven of these furnaces at work, each having four attendants, who work in equal shifts. The fuel is a coal obtained from a pit a few hundred yards off. The grey slags and other residues are worked up by flowing furnaces, in which they are placed, together with suitable flues, and are run down at full smelting heat, until completely liquefied. All lead is thus reduced out and leaves a liquid slag, which, when set hard, is taken to the tip. The lead obtained in this way is technically known as slag lead, and is very hard, owing to the presence of antimony and other impurities, so that it requires to undergo a process of improving before it can be desilverised. These latter furnaces are of the reverberatory direct-acting type, resembling those used in copper smelting, and are worked at far higher temperature than the ones previously described, having a larger grate. The charge is about 1½ tons. From the tapping hole the charge of lead and slags is run into a large tapping pot, which retains the lead whilst the slags overflow and pass on to a cinder bed, known as the "slag run." After cooling, these slags are assayed, and if found worth the operation, are worked over again, if not, they are thrown on the tip. There are three of these flowing furnaces. The lead resulting from these processes contains a certain amount of silver, which it is the object of the desilvering process to extract. Messrs. Walker, Parker, and Co. also buy large quantities of lead, in addition to that produced on their works. The desilverising plant at the Dee Bank Works has been erected within the last year and a half, from designs by Mr. W. M. Hutchings, the manager, and is perhaps the most modern and complete of its kind in the country. The system of separation followed is known as the zinc process, which is found to be far more economical, especially in the matter of labour, whilst at the same time the lead is of a better quality, that produced by this firm having, we understand, a high reputation in the market. The plant consists firstly of several semi-spherical cast-iron pots, which are mounted in a setting of brickwork. This also forms a platform from which they are worked. The larger of these pots, of which the diameter is 6 ft. 6 in., is used for melting the lead, the scum from which is removed as it rises. Having been brought to above the melting point of zinc, a certain quantity of that metal is added, and the whole is then thoroughly incorporated. The pot is then allowed to cool for some hours, during which time a crust consisting of an alloy of zinc, lead, and silver forms on the top; the zinc having the property of extracting the silver from the lead, and rises with the former to the surface, as the cooling of the mass progresses. This crust is skimmed off by perforated skimmers into the second series of pots placed alongside. These are known as liquating pots. After the first process the quantity of zinc is considerably reduced, but if necessary, the lead is subjected to a second, and even to a third treatment, the total amount of zinc used depending on the quantity of silver present. When the lead is sufficiently desilverised, it is tapped through a spout in the bottom of the pot into a softening furnace, which is of the same type as those described, and is heated by its own fires. In this the zinc and other impurities contained in the lead are removed by oxidation at red heat, the impure matters forming at the top. When the tests show that the lead is perfectly pure, the fire is drawn and the furnace is cooled down until the crust floating on the top is hardened sufficiently to be skimmed off. This crust being eventually smelted, gives a hard description of lead. The lead remaining in the furnace after skimming is known as market lead, and is run into a pot, from whence it is run into pig moulds, arranged in a semicircle round the pot, and below its level in the casting pit. A swivel launder which can be turned to serve each mould in turn, prevents the necessity of using a ladle or shifting troughs, the spout or launder forming a radius of the pit, and pivotting on the centre, which is under the tapping hole in the pot. The flow of metal from the pot is controlled by a plug worked by means of a shaft with a thread turned on its upper part, and which works through the molten lead in the pot. It should be remarked that the arrangements for handling the material have been carefully planned. There are tram-lines laid all through, and there is a steam hoist for lifting the pigs to the higher level.

The crusts of zinc containing the silver are heated in the liquating pots in order to remove some of the excess of lead which they carry over, and the rich alloy left, which contains all the silver of the original charge, is taken away to be further treated in the distillery.

The distillation of the rich alloy is carried out by mixing it with a given proportion of culm, in plumbago retorts, when a large proportion of the zinc is brought away and distilled with cast-iron condensers, in which it is recovered for future use in the furnaces, whilst the lead and silver of the alloy are ultimately produced in bars of great richness, from which the silver is extracted by the final process of refining.

The plant now in use produces at present over 300 tons a week of market lead, but if necessary, double that quantity could be turned out, as there is a duplicate set of pots, not at present in use. This new plant also includes large and improved furnaces, and other appliances of considerable extent and recent design.

The process of "cupellation," or "bone ash test," followed for separating the last of the lead from the silver, is one of great antiquity, and remains practically the same in principle as it has been from time immemorial. Indeed, we believe that Dr Percy claims to have found a full description of it in the writings of the Old Testament. However this may be, we will give a brief record of the process as followed by Messrs Walker, Parker, and Co., as there may have been a few alterations in detail of late years.

The "rich bars" containing the silver are brought to the refining furnace, which is a small reverberatory furnace with a movable hearth. The latter consists of an iron frame, into which a container of bone ash has been rammed. The frame which forms the hearth is supported in its place in the furnace by crossbars and wedges. The lead containing silver is melted in the furnace, when liquid oxide of lead or litharge will form. A low blast from a fan is turned on at the back of the test, and the liquid litharge is driven to the front, where it flows off through gates cut in the bone ash and is received into small pots which are placed on wheels and drawn away to an open floor. As the lead is in this way drawn away, its place is taken up by fresh bars of the combined silver and lead, being fed down suitable pipes, so that they melt off continuously. The oxide of lead produced, carries with it very little of the silver, which is practically not oxidised. In this manner the silver goes on constantly concentrating in the test until the latter is full, when no more bars are added, and the silver is refined by several hours of strong fire with blast. It will be seen, therefore, that it is gradually separated by three separate processes; firstly, by means of zinc, which removes a greater part of the lead in the liquating pots; secondly, by distillation in plumbago retorts, when the zinc is removed; and thirdly, by refining in the bone ash tests. The annual production of silver at these works is about 13 tons per annum.

So far we have treated of the smelting and desilverisation of lead which forms the chief branch of the Dee Bank Works.

The litharge we have made reference to is an extensive article of commerce; it is not only obtained as a bye-product in these works, but is manufactured specially from pure lead, not containing silver, the process followed, however, being similar to that just described. The large cakes from the furnace are allowed to lie for several days on an open floor, when they gradually "fall," producing about two-thirds weight of flake litharge, which is in the form of small crystallised scales, the remainder being "coarse litharge" in lumps. The two are separated by sifting, and the latter is ground up and levigated.

The manufacture of red lead commences with the process of "drossing," which is carried on in ovens which very much resemble those ordinarily used by bakers, in general appearance. There is no chimney, however; the smoke and products of combustion collecting in the dome above the sole on which the dross is placed, and passing out at the oven door, there being a hood in the front into which they ascend. The operation is commenced by forming a dam across the front with dross left from the last operation. Behind this dam a charge of pure pig lead is melted, and as soon as it reaches a dull red heat, the workman commences working it with a long-handled rake, suspended about the middle by a chain and hook hanging in front of the door. By a peculiar action the bath of lead at a dull red heat is agitated and splashed about, being thrown to the back and sides as formed. A small quantity of antimony in the form of antimonial lead is thrown into the bath from time to time, as antimony in small quantities has the effect of increasing the oxidation of lead, in a somewhat remarkable manner. The whole charge, which consists of about 27 cwt., is drossed and converted into yellow oxide of lead in about six hours. The dam is then broken down and removed, and the dross is left in the oven to calcine for several hours longer, during which time it is repeatedly turned over for the purpose of facilitating the draining away of metallic lead entangled in it. This lead trickles down the sloping bottom of the furnace, and flows out at the oven door.

THE FESTINIOG RAILWAY: SPOONER'S CARRIAGE AND WAGON COUPLING.

(*For Description, see Page* 286.)

Fig 1

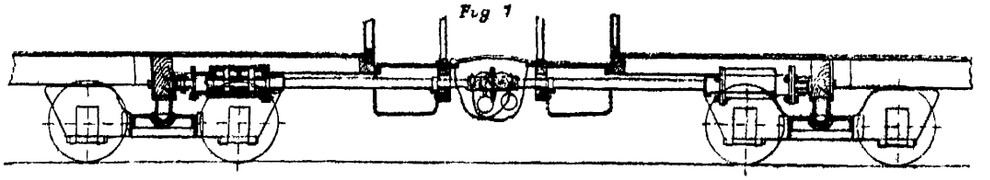


Fig 2

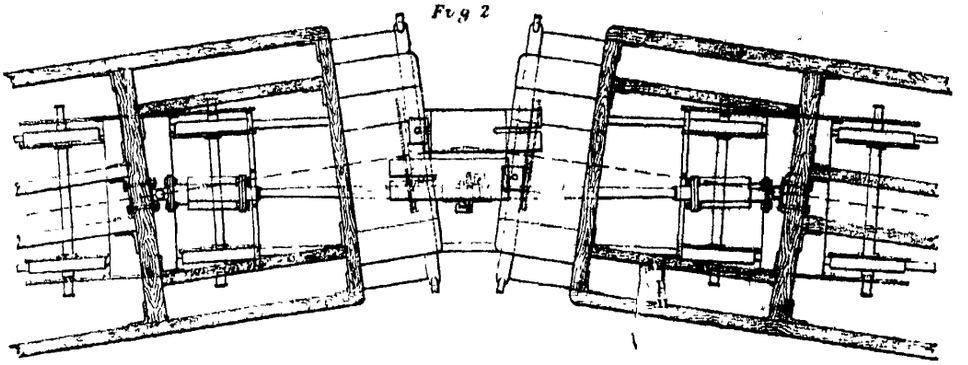
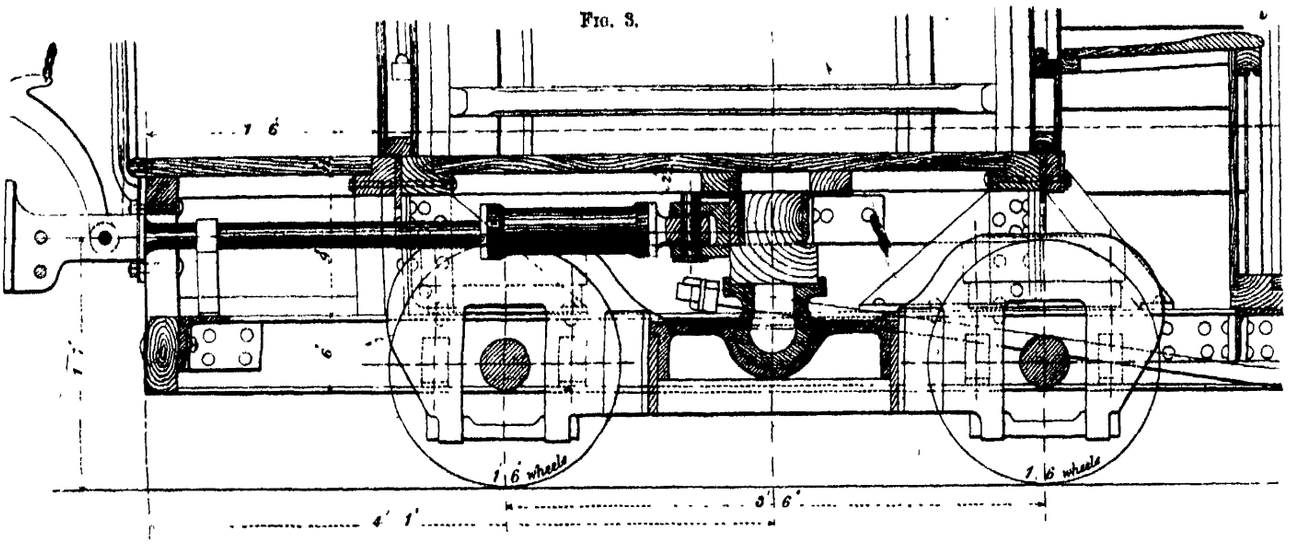


FIG. 3.



The dross is taken away and wet ground in an ordinary mill, and levigated. The coarser particles are collected in a settling vat, locally known as the "bran-tub," whilst the finer dross is carried forward to other settling tanks. The ground and levigated product is now yellow oxide of lead, and is taken forward to undergo the third stage, which consists of the process of colouring. A charge of about 35 cwt. is introduced into the bottom of the colouring oven, which in every practical respect resembles the last described. Here the dross remains forty-eight hours, being subjected to a low red heat, which has to be carefully regulated, and during which time it is carefully turned with rakes. By the absorption of oxygen from the atmosphere a higher oxide of lead is gradually produced, having the red colour characteristic of red lead. Great care is needed during the final process, as, if the heat in the ovens be allowed to become too high, the red lead already formed may be destroyed; if, on the other hand, the temperature be too low, the proper colouring does not take place. In order to complete the material for use, it is again ground and levigated, and finally dried in stoves. A large quantity of this material is produced for glass-making purposes It is made in the manner we have described, but requires additional care in its preparation, and all the ingredients have to be of exceptional purity. The ovens used for the production of this special kind are never employed for any other purpose.

The variety known as orange lead is very similar in composition when finished to red lead, but is made from somewhat different material. In this case, white lead is used in place of the blue lead as in the other process.

There is one mill for rolling sheet lead which consists of a pair of horizontal cast-iron rollers mounted in a suitable framing. They are 100 in. in length, and 23 in. in diameter. The top roller is raised and lowered by hand gearing, and runs freely in its bearings, the lower one being driven by the engine. The reversing is accomplished by means of a clutch. These rolls are situated in the centre of a long bench, which is fitted with small loose rollers for the sheets to run on, there being two live rollers for feeding immediately at the front and back of the mill. In order to produce the sheets the first operation is to cast a large flat sheet of lead. This is marked off by the foreman roller according to the size and thickness of sheet wished for, so that the final result may be exactly the article required.

The piece of lead having been cut off, is passed through the mill whilst quite hot, the rollers being brought closer together at each pass until exactly the required gauge is obtained. The sheet is then hauled away by a tackle, the fall being worked from the end of the bottom roll, which has a projecting drum placed on for the purpose.

The engine used on the works is of the old-fashioned beam type, with slide valve expansion gear. The cylinder is 32 in. in diameter and 6 ft. stroke, the boiler pressure is usually 26 lb. There are two new Galloway boilers and some of the old egg-ended type. This engine drives the rolling mill, the red lead nutts, and the fan used in the desilverising works. There are the usual offices and shops generally met with in works of this description, and which do not call for any special mention.

THE CHESTER WORKS.

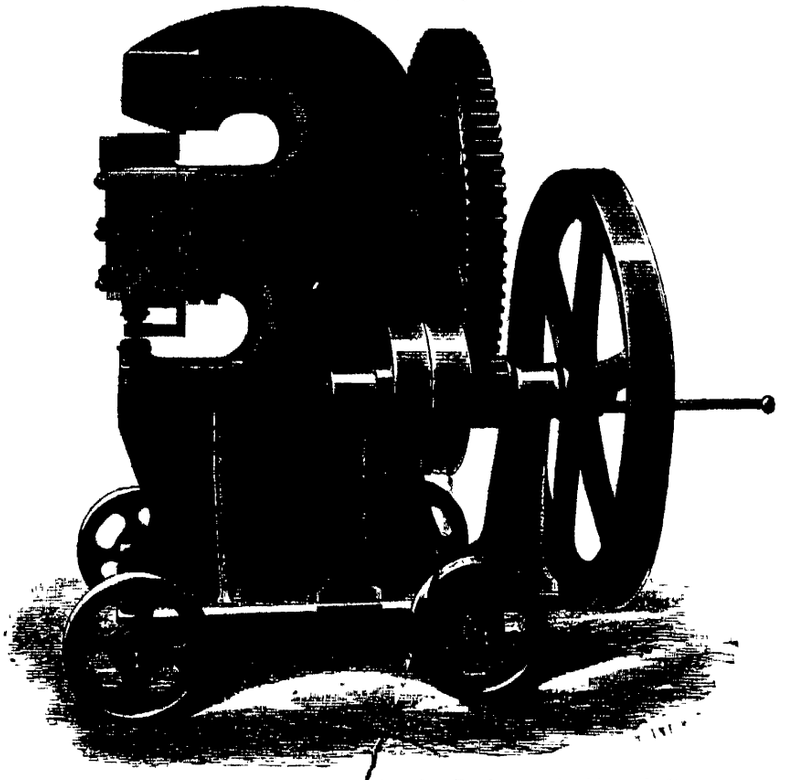
The Chester Works of this well-known house are situated on the canal, a short distance beyond the city walls. They are the chief factory of the firm, although their works at Elswick-on-Tyne are we believe of almost equal importance. There are other branches, at Liverpool, Glasgow, Bagillt (just described), in North Wales, and London, the shot-tower in Lambeth being about as familiar a landmark on the banks of the Thames as that at Chester is to the dwellers on the banks of the Dee.

At the Chester Works the principal products are shot, lead pipe, and white lead, both in the dry state and ground as oil paint. The shot-tower is 156 ft. high, and of the ordinary construction. The pigs of lead are taken to the top by a lift worked by steam power, 10 pigs of 1 cwt. each being the usual load. In the summit of the tower are two coal-fired furnaces, each having one pot, the general charge for which is 30 cwt. of lead. Each pot will be charged three or four times a day, making six to eight castings in all. When the lead has been melted, it is taken by ladle from the melting-pot, and is poured into what is technically known as a "card." This consists of a flat tray of wrought iron, with a long handle, and which is pierced with a number of holes in the bottom; the diameter of the holes regulating the size of the shot. The

PORTABLE PUNCHING AND SHEARING MACHINE.

CONSTRUCTED BY MESSRS. DAVIS AND PRIMROSE, ENGINEERS, LEITH

(*For Description, see Page* 294.)



bottom of the card is covered with a layer of "bed-scum," or "skimmings;" this is simply the dross that collects on the surface when lead is melted. The use of this bed-scum is to keep the lead from running through the holes in the card too rapidly, so that it will fall in globules or drops, rather than in a continuous stream, as in the latter case lead wire, instead of spherical shot, would be produced; but the bed-scum being porous, the lead simply filters through it gradually. Its melting point being higher than lead, it will not melt and float to the top, as it is firmly bedded in the bottom of the card. Should the lead be superheated, however—a contingency that may easily arise—the scum would melt, and the card would require re-charging.

The cards are placed in small wooden frames, opening from the top platform on to the interior of the tower, and the molten spheres of lead are allowed to fall through the air to the bottom, where they are caught by tubs of water. In this way the globules do not meet with any hard substance until they have been cooled and hardened. From time to time the operatives at the top of the tower draw up samples of the shot being made, and judge from its appearance whether they have the right amount of bed-scum in the card, according to the gauge of shot and grade of metal used. The art in dropping shot lies in these details, and in keeping the lead at the proper temperature. The shot is run from the tubs through shoots into an adjoining building, and on to a dryer; this is a flat tray with a steam space below. From here the shot is run into a polishing machine, consisting of a cylindrical iron vessel revolving rapidly in a horizontal position, and by their friction against each other, the shot are polished bright. From the latter machine a small bucket ladder elevates the shot, and pours it into a distributing box, whence it is taken by spouts to the hopper of the sizing apparatus. This consists of a revolving cylinder, placed horizontally or very nearly so, and pierced with different sized holes which gauge the shot. As the shot passes from the cylinder it falls on to an inclined plane set to a certain angle, and a few inches in front of this, and a short distance below, is placed a vertical partition. The truly formed spherical shot rolls down the plane with considerable velocity, and is carried right over the partition by its own impetus, whilst bad specimens lag on the way, and drop dead at the end of the plane, not having way enough to shoot clear of the partition, inside which they therefore fall, and are taken to the tower again to be remelted. After the shot has been tried in this way, it is packed in bags ready for sale.

The larger moulded shot is made in the familiar manner in which pistol bullets are cast by an ordinary bullet mould. In place, however, of one being produced at a time, 20 to 40 are cast at once in some cases. When the shot are taken out of the mould, the gate is cut off by a pair of hand shears, and the polishing is done in a machine similar to that last described, but into which large pieces of rough stone are placed.

In another part of the works is a mill for making the larger kinds of shot. This consists of a fluted brass roller, which revolves against a grooved plate. A solid lead wire is fed in by a pair of pulleys, and is cut into required lengths by a pair of shears working automatically, and at the same time is pushed on to the roller. The way in which the shot is formed in the corresponding grooves of the roller and plate will be obvious, twenty-five shots being made from each length. The patent, or dropped shot, which is made in the tower, ordinarily ranges from that known as A A, in which forty-one go to the ounce, to No. 8, of which it requires 482 to the ounce. Very fine shot, known as "dust," is, however, now frequently made, and is used for shooting small birds for the sake of their plumage, or for firing into "antique" furniture, in order to render it "worm-eaten."

For making the solid drawn lead pipe, hydraulic presses are used. These are placed vertically, the ram being on the ground level, and a floor above affording a working platform for the men. The machine consists of a cylinder for holding the molten lead from which the pipe is to be made. Fitting into this, and forming the bottom, is a ram which can be forced upwards from below. The top of the cylinder is closed by a die, with a circular hole containing a core, the annular space thus obtained forming the cylindrical pipe. The press is heated by fires which are placed round it, in order to prevent the molten lead being suddenly chilled and setting when first poured into it. It would be naturally impossible to make pipe from lead in a perfectly molten state, as it would all run into a shapeless mass immediately upon emerging through the die; it is therefore allowed to cool until on the eve of setting. In this way it is sufficiently firm when it emerges into the air to support its own weight, and is wound on reels into the familar coils seen in the plumbers' shops. A pressure of 2240 lb. to the inch is used for drawing ordinary pipe, but this is somewhat lessened as the operation proceeds. If the lead be allowed to get too cold in the press, the power is not sufficient for the purpose, and the pipe will not form; if, on the other hand, the lead is in too molten a state, it will spirt through the die with great violence, upon pressure being applied. On the occasion of our visit to these works, block tinned leaden pipe was being drawn. The operation is simple in the extreme. Molten tin is poured into a recess in the mould, so that the pipe rises in a bath of tin, sufficient of which adheres to the sides of the pipe. A certain quantity of tin is also poured inside the first length of pipe that comes through, and this forms on the inside in a similar way.

Some larger presses on the same principle for heavier pipes are heated in a hot-air flue instead of fires being placed round them. They are worked at a pressure of 6000 lb. to the square inch. In the smaller presses the molten lead is taken from the melting pot by means of a ladle and crane. In the larger ones, however, the melting pots are placed at a sufficient height to allow the metal to run in by gravity. They are tapped by means of a screw valve worked from above the pot, the spindle running down through the molten metal. Lead pipe is made in this way of various diameters, and of many gauges of metal or "strengths." The three grades for the latter are "thin," "middle," and "strong;" and in some cases these distinctions are again subdivided. Some very small lead pipe which is made for glass chandeliers is only $\frac{3}{32}$ in. in diameter, but $\frac{1}{8}$ in. is the smallest size for water pipe, and $\frac{1}{4}$ in. for gas pipe, on this firm's list.

The following are the ordinary descriptions of pipe manufactured by Messrs. Walker, Parker, and Co., although some which is considerably heavier than here set forth, is often made for special purposes.

Particulars of Lead Water Pipes.

Inside Diameter. in.	*Strength.*	*Weight per Yard.* lb	*Average Length.* yards.
	Thin	3½	35
	Middle	4	32
⅜	Strong	4½	28
	"	5	24 or 48
	"	5½	22 or 44
	Thin	3	39
	"	3½	35
	Middle	4	32
	Strong	4½	28
½	"	5	48
	"	6	38
	"	7	33
	"	8	29
	Thin	4½	28
	Middle	5	24 or 48
⅝	Strong	6	38
	"	7	33
	"	8	29
	Thin	5	24
	"	6	20
	Middle	7	25
	Strong	8	22
¾	"	8½	20
	"	9	19
	"	10	17
	"	11	16
	"	12	14
	Thin	7	25
	"	8	22
	Middle	9	19
	"	9½	18
1	Strong	10	17
	"	11	16
	"	12	14
	"	14	12
	"	15	11
	Thin	10	17
	"	11	16
1¼	Middle	12	14
	"	12½	13
	Strong	14	12
	"	16	11
	Thin	12	14
	"	14	12
1½	Middle	15½	11
	Strong	17½	9
	"	21	8
	Thin	15	11
1¾	Middle	17	10
	Strong	19	9

Inside Diameter. in.	Strength.	Weight per Yard. lb.	Average Length. yards.
	Thin	19	9
	Middle	23	7
	Strong	26	7
2	Thin	19	Barrelling in 12 ft. lengths.
	Middle	23	
	Strong	26	
	"	30	
	Thin	26	
2½	"	27	
	Middle	30	
	Strong	33	
	Thin	36	
3	Middle	42	
	Strong	44	
	Thin	45	
3½	Middle	49	
	Strong	52	
	Thin	48	
4	Middle	57	
	Strong	61	
5	Thin	73	
	Strong	84	
6	"	68	

Lead Gas Pipe and Patent Composition Gas Pipe.

Inside Diameter. in.	Weight per Yard.	Average Length. yards.
¼	12 oz.	75
⅜	19 "	56
½	2 lb.	28
¾	3 "	19
1	4 "	14
1	5½ "	10
1¼	9 "	13
1½	11 "	10

Pipes are made in pure block tin in the way we have described. In this department there is also a machine for transforming round pipe into that of oval section. This has been found very effective in preventing bursting in case of frost, some experiments lately made showing a good result Occasionally the pipe is fluted so as to be in section something like a double-headed rail Lead wire of various gauges, calm lead, which is of H section, for glazing, lead bars for builders' purposes, and many other sections, are drawn by the presses described, the only change required being that of the dies. The hydraulic pumps for working these machines have been mostly made to the designs of the engineering department of the firm. We noticed a very fine steel casting for a hydraulic cylinder which had been supplied by Messrs. John Brown and Co , Limited, of Sheffield.

White lead making is an important feature in these works This is carried on by the well-known "stack process," of which we may give a brief description. The pig is melted in a large pot holding 6 to 7 tons, from whence it runs by gravity through a spout on to the "wicket moulds" The flow is regulated by a valve similar to the one already described in which the spindle passes through the pot of molten metal. A clever arrangement has been introduced for casting the "crates" or "wickets" from which the lead is made. These, it should be stated, are small castings of lead about 6 lb. or 7 lb. each, which take the form of a grid or perforated plate The shallow open moulds for these are linked together, and form a continuous chain about 40 ft or 50 ft long This runs horizontally on a couple of drums, and as each mould passes under the spout of the melting pot it receives its due proportion of metal, which is carried on to the other end Here each mould as it revolves over the pulley deposits its load on to an elevator, composed of a continuous flat chain, by means of which it is carried to the floor above A small stream of whiting and water is run on to the moulds just before they take the lead, and this prevents adhesion ; there is also a small hammer which works automatically, and jars the mould as it turns over so as to make sure of the wicket leaving it

From the elevator chain the wickets are dropped on to a truck which runs on a tramway, and by this they are taken to the store to be used as required This store has lines laid in it, and has a small traverser in order to shift the trucks from line to line. The "stacks" in which the lead is "corroded" are 65 in number, and are simply rectangular brick erections about 22 ft square and 20 ft. to 30 ft. high, and hold about 50 tons each. In charging a stack several rows of cylindrical earthenware open-topped pots 7 in in diameter and 10 in. high are placed on the ground Above these are placed the "spars" or boards Between these rows are placed smaller pots, and the whole is filled with dilute acetic acid.

Above the smaller pots the leaden wickets are stacked, seven or eight being placed one above the other. The whole is then covered by a floor of planks placed at right angles to the spars on which they rest, so that their weight is taken by the larger pots, which act as columns of support. Above the planks a layer of damped spent tan about 9 in. or 10 in. thick is finally placed. These operations are repeated, layer being placed above layer until the stack is complete, when it is allowed to remain for about three months. The tan heats spontaneously to a temperature of from 140 deg. to 175 deg., and this promotes the corroding process by which the action of the acid changes the blue lead wickets into the dry white lead of commerce, or carbonate of lead. When the stack is opened the load is collected in small wooden trays and taken to the washing apparatus. This consists, firstly, of a hollow wheel, into which each tray is placed, and in that way the contents are tipped into a trough through which a stream of water flows. The lead is raked upwards against the stream, whilst such portions of bark as may have been in it are carried away. The lead then passes through a pair of grooved rollers of brass, and such fragments as may have resisted the action of the acid, have all the carbonate separated from them. These are collected to be recast into wickets to go into the stacks again. The pulp of white lead is then passed through smooth rollers, and thence to a riddle, where small fragments of blue lead that may have escaped the first process are arrested. Under these riddles are backs from which the pulp is fed into the hoppers of mills which have pairs of 4 ft. French burr-stones. From these again it is taken through a shoot to an agitator by means of an additional stream of water The agitator is a vertical cylindrical vessel 7 ft. in diameter, with a vertical shaft revolving in it. From this an arm projects at right angles, to which are suspended a number of copper chains that serve to agitate the mass of white lead and water. After passing through a second agitator somewhat smaller, it is run into a series of settling tanks, whence the water is pumped back to be used for the same purpose again, whilst the damp lead is placed in small earthen pans and conveyed to the drying stoves. There are six of these, and they consist of large brick chambers having iron racks round the walls sufficient to hold 30 tons of lead. The stores are heated by special furnaces, the gases from which ascend into cast-iron domes placed in them. It is computed that the usual temperature is between 200 deg. and 300 deg When dry, the white lead is packed for delivery.

For grinding the dry white lead into oil paint, there are the usual mills and mash tubs, beside which there is a machine of more modern construction. This consists of three rollers, with pug mills placed above them The powdered white lead is carried to a platform at the back, being hauled up a slope by steam power. It is then tipped into the hopper of a mill, when it passes through a pair of horizontal rollers. From there it falls into the pug mill, where it is mixed with the oil, which is laid on in pipes from a neighbouring tank. The mixed oil and lead then pass into another pug to be further incorporated together, and thence are carried in a spout to the rollers, by means of an automatic pushing-out arrangement, by which square flat cakes of material are continuously dropped on to the first roller. The rollers are three in number, and revolve with their axes in one horizontal plane. They are driven by a continuous train of spur gearing, but are geared respectively three to one to each other, the last or outer one revolving most quickly ; the centre roller has also a reciprocating motion in a line with its axis. The cake of oil and lead is delivered, as we have said, on to the first roller, and is sufficiently firm to adhere, when pressed between the two rollers. The second roller then takes it to the third, from which it is removed by a fixed scraper, and falls into the vessel placed for its reception. It will be easily seen, from the different speeds at which the rollers run, added to the reciprocating motion of the centre one, how thoroughly the lead and oil, or, in the commoner grades, the lead, barytes, and oil, become mixed together. The machine is put in gear by means of friction couplings. This mill has been found most effective in use, and, we may add, was erected to designs prepared in the engineering department of the firm, although we believe the principles involved are not altogether new.

The acetic acid used in the manufacture of the lead is made on the premises. The plant for this is very simple ; it consists, firstly, of eight cast-iron retorts, 9 ft. long and 3 ft. in diameter ; they are fired outside, having one furnace to each pair ; oak timber is put in these, and they are then closed and luted up. The pyroligneous acid which results is obtained by means of condensers, which are simply wooden troughs through which the branch from the retort is carried. The products of condensation are pumped up to a pan, and treated with lime, and after this are distilled ready for use.

Attached to the works are a foundry and machine shops. There are extensive cooperages and other necessary offices for carrying on large works of this nature. There are also three large engines for running the works, and smaller ones for pumping and other purposes of a like nature.

THE SALT MINES OF NORTHWICH.

THE property of this firm comprises several independent works in Cheshire, which are situated respectively at Winsford, Over, Moulton, Middlewich, Northwich, Marston, and Wincham. All these are white salt works, there being also rock salt works at Northwich and Marston. They form in the aggregate by far the largest salt works in this district, which is equivalent to saying they are the largest in the world ; the annual production is close upon a quarter of a million tons of salt per annum.

The Adelaide Works, at Marston, are those which it was proposed that the members of the Iron and Steel Institute should visit ; but as we have lately had on opportunity of inspecting the other works of Messrs. Verdin, we shall not altogether confine ourselves to those on the programme. It was proposed that the first part of the forthcoming visit should be devoted to the rock salt mine at Marston. This is 110 yards deep, and has two shafts sunk within a few feet of each other. The first 20 yards of the shaft are 5 ft. square, and are lined with a double casing of timber, with puddled clay between. Below this, for a further distance of 40 yards, there are cast-iron cylinders, 3 ft. 6 in. in diameter, which carry the shaft to a bed of rock that lies between two strata of rock salt. The upper bed has not been excavated, the quality not being considered good enough. The rock is 13 yards thick, and is bored to the same size as the iron cylinders. The lower part of the shaft consists of 23 yards of rock salt. Especial precautions have to be taken, in order to prevent water getting to the shaft, and at the back of the tubing, otherwise the rock salt would speedily dissolve, and the shaft would fall in.

The opening to the mine is bell-shaped, and the underground workings are very extensive, the rock salt being excavated to a height of 26 ft. The air is unusually pure for a mine, being, in fact, to all appearance as good as that on the surface ; this is to be accounted for by the loftiness of the workings. The exhaust air from the engines used in cutting the rock salt assists the ventilation, but we understand there are no other means of creating an artificial circulation.

The area already excavated is about 11 acres, and the roof of this large surface is supported by pillars of rock salt of exceptionally massive proportions, being 10 yards square, in place of the ordinary 8 yards ; they are placed 23 yards apart. This is a wise provision ; and no doubt some of the extraordinary subsidence to be seen in the neighbourhood would not have occurred, if better supports had been left in old times.

The engine, which is used for compressing air for the rock salt-cutting machines, to which we have made reference, is situated in a building on the surface, near the pit mouth. It has a single cylinder 30 in. in diameter, and was made especially for the work by Messrs. Walker Brothers, of Wigan. It compresses the air to 70 lb. to the square inch, and this is taken below through pipes suited to the formation of the tubes. The cutting machines are of much the same type as that used in coal mines, the cutting wheel, which works horizontally, being of steel. The operation of getting out the rock salt commences at the top, the upper part, which is the most troublesome, being got out by the air engine and by hand, and also by blast with powder ; this is for a depth of 6 ft. The remaining and lower part is blasted down as required, and as orders for the particular description of rock salt of which it is composed, are received. The shot-holes are made by hand, and a straw filled with powder is used as a fuze. There is practically no danger in this work, as the salt does not fly, and there is no firedamp in the mine. A series of tramways are laid down, on

which run small trucks carrying loose tubs, which are taken up the shaft. The hauling is done by ponies.

The illumination of the mine is by candles, both gas, the electric light, and paraffin lamps having been tried, but on the whole candles are found to be the most convenient. The winding engines are of the ordinary horizontal type, working a drum with a round rope.

At the pit mouth a branch canal runs between the two shafts, and a railway runs close by, so that the rock salt can be tipped direct into barges or railway wagons as required. By water transit, communication is obtained with the Trent and Mersey and the Bridgewater canals, and also with the Weaver Navigation by the Anderton lift, to which reference is made elsewhere. The mines when illuminated have a very pretty appearance, and as seen from the pit eye, or from the elevated parts, bear a strong resemblance to a city at night.

The rock salt is sometimes sent away in the lump just as it is brought from the mine, a great quantity in this state being shipped to Australia, America, Russia, and other countries as cattle salt. For other purposes, such as those of copper works and alkali works, or agricultural purposes, it has to be crushed and ground This is done at the pit mouth, where there is a mill of special construction, not unlike a large bone mill, and which is driven by a powerful pair of horizontal engines. There are first two sets of toothed rollers, which break the large lumps up into smaller pieces, and below these are smooth horizontal rollers The powdered salt is then taken by a small bucket ladder, and is either passed over blanks or else screens of the degree of fineness required. A good deal of rock salt is used for making salt cake by the Hargreaves process, to which purpose only the finest quality can be applied

On these works there are also extensive shops used for making and maintaining the plant required by the firm. There is a sawmill, driven by a 12 horse-power Roby engine; wagon shops for the erection and repair of Messrs. Verdin's somewhat extensive rolling stock, they having between six and seven hundred wagons in use at one time In the maintenance of the evaporating pans on the salt works, large quantities of plates are used The old plates and other scrap are forged into blooms on the works, which are rolled again into plates at a neighbouring mill. The exhaust steam from the hammers is used for drying trucks in the painting shops, or for drying timber This is a point requiring a good deal of care in rolling stock used for salt, as, owing to its action, timber remains saturated with moisture in a very troublesome manner. There is also a smiths' shop with several fires, together with machine shops containing lathes, drilling machines, and the ordinary machine tools, including hydraulic presses for the removal of wheels from wagon axles. The salt carts are hauled up inclined planes by steam power, and there is a locomotive which is used for the railway wagons.

At the Marston Works there are also brine springs, close to the mine. This is a combination seldom met with, as where there is brine it is difficult to gain the rock salt.

At the Adelaide Works are manufactured chemical and fishery salts, for which purpose the nature of the brine is particularly well adapted; and in their neighbourhood are some other works lately owned by the Victoria Salt Company, Limited. It is said that over 90,000*l.* has been spent upon them by the original proprietors. They have recently become the property of Messrs. Verdin and Son, and are now part of their extensive business. They are very similar to the Adelaide Works, but not so large.

The manufacture of salt from brine is the simplest thing possible, and is said to be conducted to-day on the same principle as in the days of the Romans Numberless patents have been taken out for schemes which have been suggested, but in the end they have nearly all been abandoned. Almost the only exception is the process by which patent butter salt is made. The plant in this case consists of circular covered pans fired from below, into which the brine is constantly fed. The salt as it forms is drawn to pockets in the sides by means of revolving rakes worked by a central vertical shaft. The waste gases from the furnace are conveyed in flues to beneath other pans of the ordinary open kind. The steam given off in the closed vessel is also used for a similar purpose. This system has been in operation at Messrs. Verdin's works at Winsford for some time on a somewhat extended scale. Although there is a theoretical saving in heat, the test of actual practice shows that it is more costly to produce salt in this way than on the old simple principle, and the patent pans will probably be dismantled at an early opportunity.

It may be mentioned that the different grades of salt very largely depend on the temperature at which they are produced, and in this way the product is often divided into "boiled" and "unboiled" salt, the former being produced by boiling the brine, and the latter when the evaporation is carried on at a lower temperature; it is no doubt needless to remind our readers that the stronger the brine the higher its boiling point. The brine also requires to be agitated during the process of evaporation. This is always done, excepting in the special case above referred to, by hand, the operator using a large rake with which he draws the salt as it collects to the sides Attention must be paid to keeping it away from the part over the furnace, otherwise the plates would speedily become burnt through, and care is required in moving hard scale as it forms on the bottom of the pans. The pans used are large rectangular vessels made of iron plating. Those at the Adelaide Works are 66 ft. long and about 2 ft. deep, but it is said that some of the new pans in this district are 140 ft. long and 30 ft. wide. As there is but one furnace to the pans—and that is only 4 ft. or 5 ft. long—it will be easily seen that there is considerable difficulty in keeping a large pan full of brine at a high temperature, and therefore the smaller pans produce the better qualities of salt. In old times leaden pans were used. There is one to be seen at Northwich which is 2 ft. 3 in. square.

The brine, which is drawn from the springs by pumping engines of ordinary type, is fed constantly into the pans, and the salt as it forms is, as we have stated, drawn to the side. Here it is filled into small square moulds, known as tubs, which form it into the rectangular lumps, weighing about 14 lb. each, and which are so familiar in domestic life. Some of the brine springs are more valuable than others, according to the quantity of salt held in solution. At Messrs Verdin's Winsford Works, the full saturation is about 27 deg., from this 2 lb 10 oz. per gallon is obtained Extensive stores are required for drying the lumps, and packing floors for putting the produce into sacks for shipment

To make the finest table salt, the lumps are ground in a mill, and the product is then passed over screens in order to exclude any chance impurity. Afterwards it is put through centrifugal machines which work at a very high velocity, making several thousand revolutions per minute, and it is then carefully packed in bags or jars, marked or labelled as necessary for exportation. A large quantity of the very finest salt is exported to America, the citizens of the United States being choice, even to fastidiousness, in the quality of the article they consume.

In the neighbourhood of the Newbridge Works at Winsford, Messrs. Verdin, who are the owners of most of the adjacent property, have built a model village, the greater part of the inhabitants of which are employed on the works. Substantial brick-built six-roomed cottages, with excellent domestic conveniences, are let at the rate of 3s. 6d per week, including rates and taxes. Four-roomed cottages are 2s. 6d., and some smaller ones even cheaper. There are also here an institute, with a billiard room containing two tables, a fine lecture-room capable of holding several hundred people, and a library and reading-room. This has not long been opened, and must in time lead to very beneficial results. A nominal subscription to the employés is charged which is sufficient to keep the place in order; the whole of the buildings and equipment having been presented by Messrs. Verdin

The Weaver Navigation, to which more particular reference has already been made,* plays an important part in the salt industry of this district, a large proportion of the product being taken to Weston Point in barges, and thence to Liverpool for shipment on board the ocean-going ships. Many of those crafts are fine steam vessels carrying over 300 tons of salt. It was the universal custom until within three years ago, for all the salt to be transhipped by manual labour As the limit of a man's strength to cast up salt from the hold of a barge to the deck, is 9 ft., this governed the depth of the craft. Within the last three years, however, Mr. Robert Verdin has designed a steam-hoisting arrangement, which he has patented, and which has completely revolutionised this branch of the export trade. Formerly the cost of transhipping and trimming salt was 1s 2d. per ton, but now it can be done for less than half that sum, and double the quantity can be handled in the same time. There is nothing very special in the arrangement, which consists of a skilful adaptation of a derrick and steam winch to the purpose The derrick works on a collar on the mast, and can be raised to plumb any part of the opening. In this way the salt can be lifted into the highest ships in the Mersey.

At the present time one does not hear very favourable reports of the condition of the salt trade. It was stated a short time ago, before a committee of the House of Lords, that the only profit on the salt business was obtained from the carriage; so that those firms who are not wealthy enough to keep their own steam craft are likely to be driven to the wall. However this may be, there are undoubtedly great complaints as to the state of the trade, and the weak houses appear to feel the pinch very keenly.

Any account of the salt industry of this district would be incomplete, unless some reference were made to the remarkable instances of subsidence of the land, evidences of which are to be seen on every side in the Northwich district. The River Weaver, which is the highway for all the water-borne salt, is constantly sinking, and unless Northwich Bridge had been bodily raised at times, there would probably be hardly room for a rowing boat to pass under it now At various parts of the course of the river, one meets with large meres, locally known as "flashes" One of these, at Wilton, is, we are told, about 80 acres in extent, and in parts 60 ft deep. These flashes are caused by the sinking of the land, and only a few years ago there was high ground 20 ft or 30 ft above the level of many of these pools In one part, not far from the mine we have described, there is an irregular-shaped basin in the high ground, of two or three acres in extent. The bottom of this is partly covered with water, said to be 30 ft deep, and the surface of which is 20 ft to 30 ft below the surrounding level. In one part of this basin there is to be seen about 200 yards of a railway bank, this length having dropped from the remainder of the track, which lies 20 ft or 30 ft. above it In the town of Northwich itself there are very few buildings the outlines of which are square. Walls lean all ways, and the brickwork shows lines of most devious courses Windows originally rectangular become what may be described as lozenge-shaped, and the floors of rooms abound in picturesque undulations Some of the houses are iron-bound, so that the brickwork may hold together, one in particular, which we noticed, was in a perfect cage-work of iron It is part of the regular experience of a Northwich landlord to have to "jack up" his property every few years, and in order to facilitate this, the walls are generally placed on heavy balks of timber, so that the whole may be comfortably lifted together. Unless these precautions are taken, the house will gradually sink into the earth, and we are informed that at the present time there is one dwelling in which the original first floor is now on a level with the ground, and the front door has been cut through the brickwork, in order that entrance may be made from the street into the first floor direct

At Winsford, close by there are also remarkable evidences of earth-sinking, and the houses have gone down so that rooms which were once bedrooms are now shops on a level with the street. The Town Hall has been raised 8 ft since it was built, a year or two ago The church has been raised seven times, and the Market Hall, which was originally entered by a flight of steps, has disappeared altogether. It is a delicate thing to discuss the reason for all this in the Northwich district, where party feeling runs very high on the question of subsidence. The landlords somewhat naturally object to maintain this continual struggle to keep their property above ground, and a short time ago attempted to bring in a Bill, by which a tax on the salt should be levied, the proceeds to be applied to maintain the buildings on the surface Although no one, we believe, altogether denies that the abstraction of salt causes the settlement in question, yet the salt-owners managed to make out so good a case, that a committee of the House of Commons came to the conclusion that the preamble of the Bill was not proved It is argued on the side of the salt-owners that the

* See ENGINEERING, page 241 *ante*.

REGENERATIVE FURNACE AT THE BLOCHAIRN IRON WORKS.

DESIGNED BY MR. JAMES RILEY AND MR. F. W. DICK, ENGINEERS, GLASGOW.

(*For Description, see Page 294*)

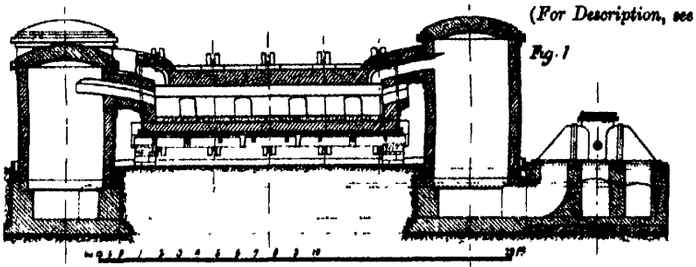


Fig. 1

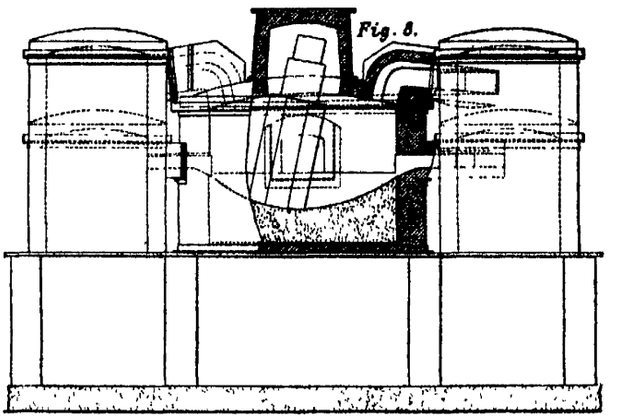


Fig. 8.

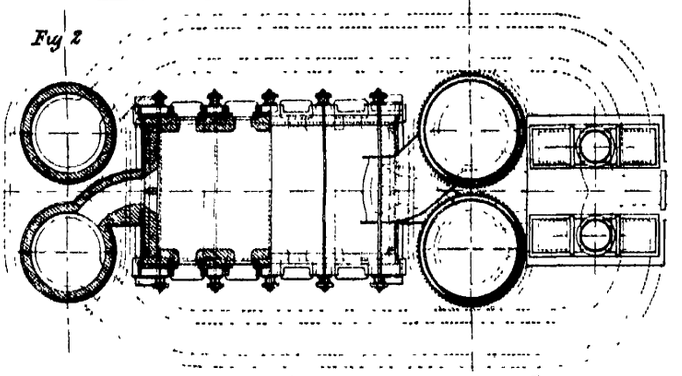


Fig 2

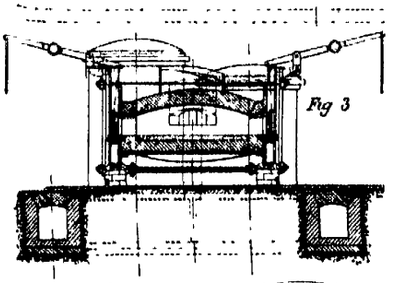


Fig 3

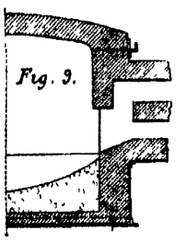


Fig. 9.

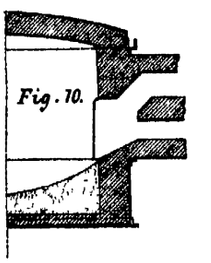


Fig. 10.

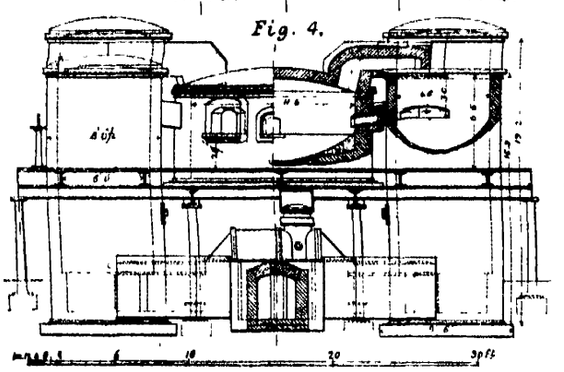


Fig. 4.

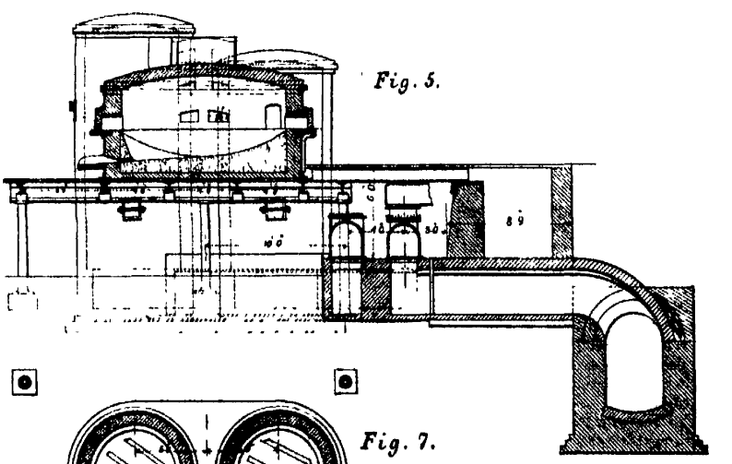


Fig. 5.

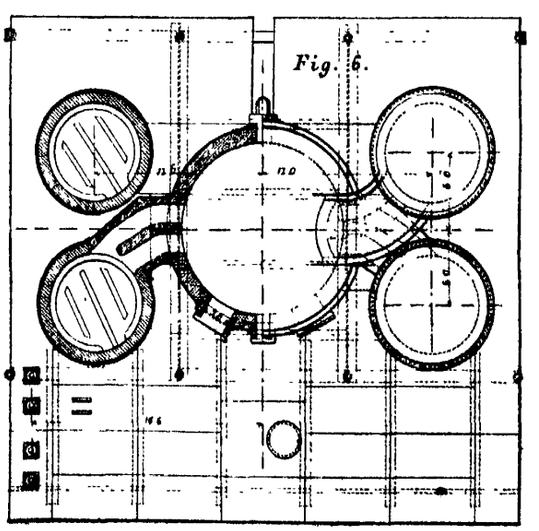


Fig. 6.

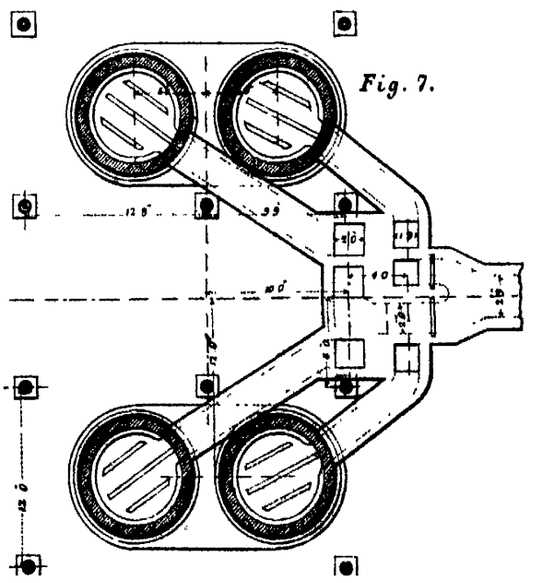


Fig. 7.

CARBONATING FURNACE AT THE FLINT CHEMICAL WORKS.

CONSTRUCTED BY MESSRS. CARRICK AND WARDALE, ENGINEERS, GATESHEAD-ON TYNE.

(*For Description, see Page* 298.)

Fig. 5

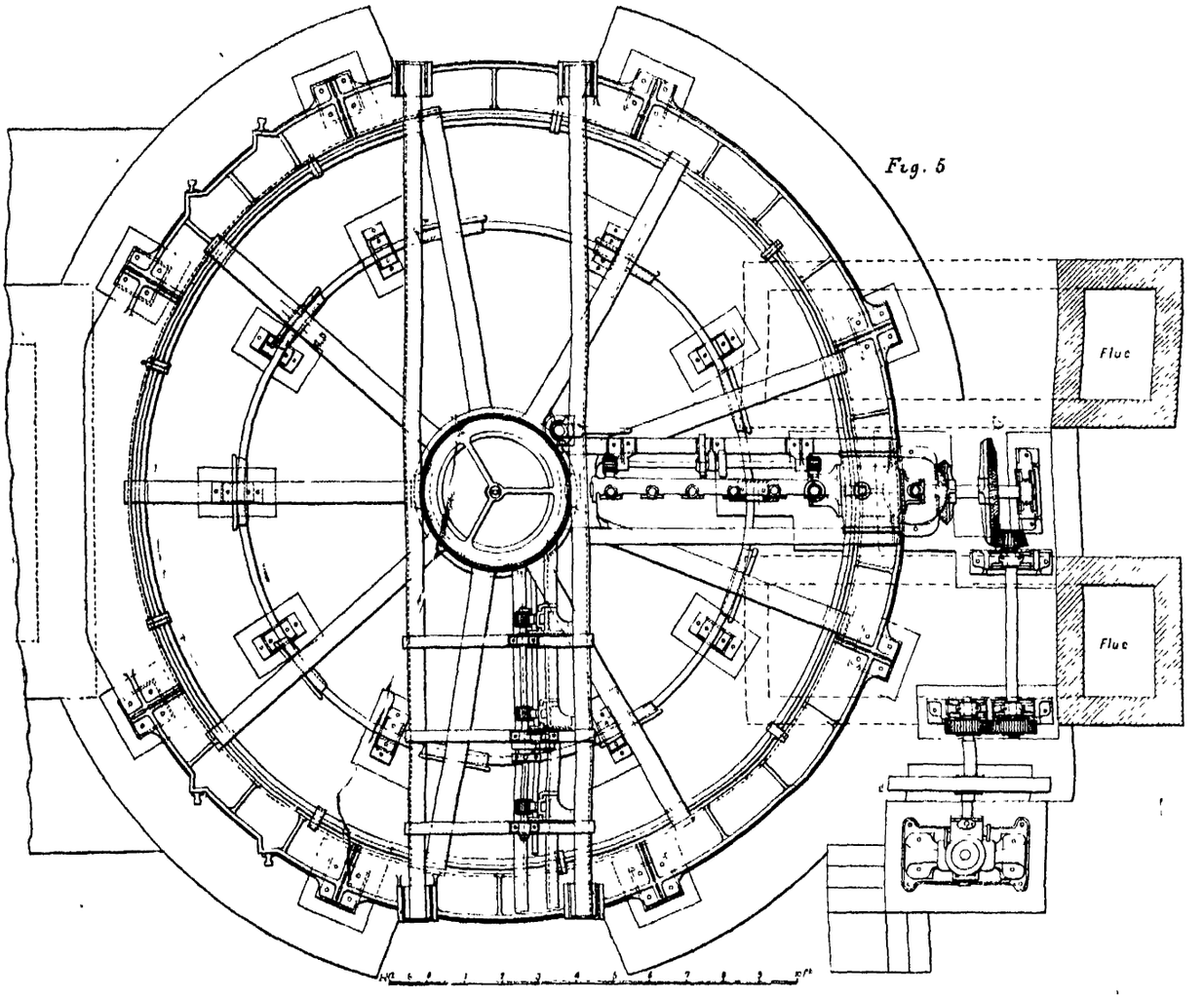
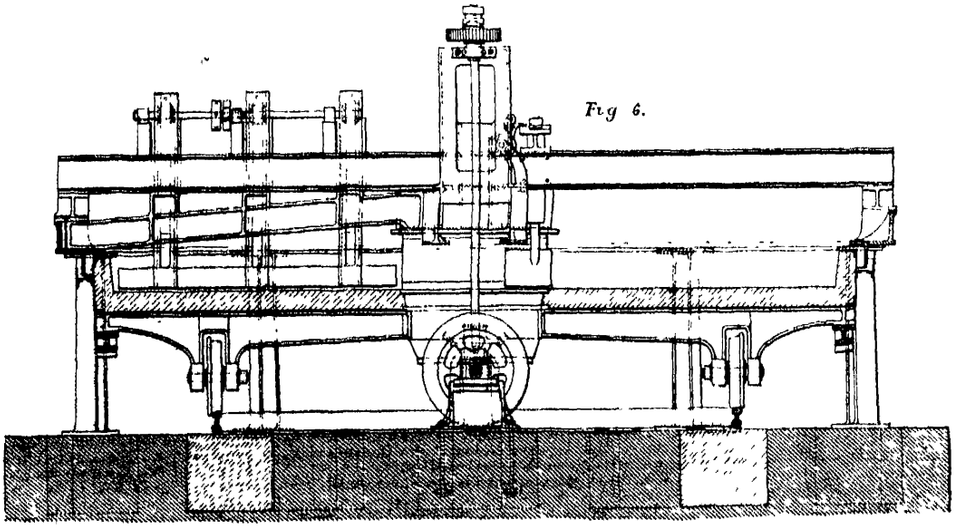


Fig 6.



brine springs are natural watercourses, and that the water is taken in at higher ground, so that it would in any case come to the surface, even if not pumped; and it is by brine-pumping that by far the greater part of the salt is now obtained. That being the case, the salt people say it can make no difference to the subsidence question, whether the salt is extracted artificially from the brine, or whether it is allowed to find its way into the rivers and watercourses, or to the sea direct However this may be, the saltowners claim that as a matter of law they have a right to any water found on their land, and there is no law by which they are compelled to consider where any substances, held in solution, may or may not be taken up. The interests of both landlords and saltowners are identical to a certain extent The salt trade is the staple of the district, 1,600,000 tons of white salt, and 166,740 tons of rock salt being produced in Cheshire during the year 1881 If any tax were placed upon the commodity which would unduly handicap this business, so as to drive it to other quarters, the landlords' property would be of little more value than the saltowners' workings.

PORTABLE PUNCHING AND SHEARING MACHINE.

ON page 289 we illustrate a punching and shearing machine constructed by Messrs Davis and Primrose, of the Etna Iron Works, Leith. It is designed to punch and shear plates up to ½ in thick The shears are placed above the punch, and being set at an angle, bars of any length can be cut through the middle. The depth of gap for both punching and shearing is 12 in. The slide is actuated by means of a crank-pin forged on the end of main shaft. A sliding block of phosphor bronze placed on this crank-pin works in a rectangular space slotted out of the slide, and thus imparts a reciprocating motion to main slide. On the other end of main shaft is the large spurwheel driven by a pinion on the second shaft. This second shaft is supported in two brackets and carries the fast-and-loose pulleys and the flywheel.

The machine is arranged to drive either by power or hand, and is mounted on wheels so as to be easily moved about. When fixed, it is found very convenient for small establishments, for cutting up bar iron and plates, and in large manufactories it is useful for occasional boiler repairs; the portable arrangement is much used about graving docks for the lighter work connected with ship repairs The total weight of the machine is 28 cwt.

METALLURGICAL NOTES.

UTILISATION OF SLACK.

A SOMEWHAT novel mode of using slack is described by Mr. Herbert Strickland in a letter to the *Mining Journal* of September 13. The method in question was applied to a reverberatory furnace working at the time in the concentration of pyrites to rich mattes The furnace has a fireplace of the "step-grate" pattern. At the back of this grate there are three cast iron semi cylindrical retorts or coking tubes, supported on the back of the fireplace, and on an end wall further back These tubes are open at both ends, but during working they are closed by doors at the back or charging ends. Below them is a honeycomb of brickwork to serve as an accumulator and regulator of heat. In working the furnace, the black or small coal is fed into these retorts, and is worked forward at such a rate that it is coked in traversing the length of the retort, where it falls over on to the step-grate, and is burnt in the usual manner. The gases from the coking issue at once into the fireplace, and are burnt to great advantage The coking in the retorts is effected by the waste heat from the furnace itself, which is drawn back along a flue under the furnace-hearth, and passes up through the honeycomb under the retorts, finally passing away to the slack by means of a flue on top of the furnace, this flue being used as a means for drying ores before smelting. The accounts given of the working of this furnace were very favourable, great saving of fuel being claimed for it.

DESILVERISATION OF LEAD BY ELECTROLYSIS

It is foretold by many prophets that the "metallurgy of the future" is destined to be very largely electrolytic, and Professor Keith, of New York, has now for several years been preparing to invade the ground of the old-established methods of lead desilverisation by his process for doing the work by electro-deposition. Accounts of his process have appeared from time to time in several papers, and a good description of the arrangements proposed was published in "Mineral Resources of the United States," 1883. Many difficulties had to be encountered and overcome, such as finding a suitable solution for use as an electrolyte, and obviating inconveniences caused by the unfavourable form in which the lead was liable to be deposited. But Professor Keith has finally reached the stage of having a special works erected for using his process. These works are at Rome, New York, and Professor Keith read a paper describing them at the recent meeting of the American Institute of Mining Engineers at Philadelphia. The lead to be treated is first melted and cast into thin plates, weighing about 7½ lb each. This is done by running from a spout, from the melting-pot or furnace, into moulds placed on a rotating frame or table. Two strips of copper are laid in each mould, so that they become fixed in the plate of lead, and serve afterwards for the suspension of the plates in the solution. With practice the workmen have obtained sufficient skill to cast one ton per hour in this manner. These plates are covered with muslin bags, and suspended in the solution as anodes, in concentric rings, alternating with rings of cathodes. The solutions are contained in vats, 6 ft. in diameter, made of asphaltic cement, there being thirty such vats at the works. The most suitable electrolyte has been found to be solution of sodium acetate containing dissolved lead sulphate. Scrapers are made to pass between the anodes and cathodes to brush off the deposited lead at intervals, and prevent its flowing across and so causing short-circuiting. A complete circulation of the liquor, which has been found to be very important, is obtained by drawing it off from the vats, pumping it overhead, and allowing it to flow back again. An Edison dynamo machine is used. The current has been as high as 1400 ampères, but a current of 1000 ampères [illegible] on found to allow of a solution and deposition of [illegible] t the rate of 10 lb. to 11 lb per vat per hour The [illegible]e in the muslin bags contains all the silver wit[illegible] timony, arsenic, and other impurities It ha[illegible] to be purified and refined, which may be done in [illegible]arious ways, according to the nature and amount of impurities present. The lead deposited collects at the bottom of the vats, and is removed at intervals for further treatment. It is stated to be very pure, even when the lead under treatment is very impure. For most purposes it will require to be melted and cast before use. It remains to be seen whether, on more extensive experience, this process will be found to be less costly than the Rozan or the zinc process, carried out in large plants capable of making a large and rapid production. With any moderately rich and not too impure lead, it seems doubtful whether Professor Keith will be able to show that any advantage would follow the introduction of his method where anything like ordinary conditions prevailed as to fuel, labour, &c, though it is not unlikely that rich and impure leads might be worked to advantage by it under some circumstances, such as great dearness of fuel and presence of easily available water power. Possibly the method might be so modified as to be made available for treating the lead zinc-silver alloy obtained in desilverising lead by the zinc process in place of the distillation now mostly in use. Many works would be inclined to try any "likely" idea in this direction, though they might hesitate very long before trying the electrolytic process on the bulk of their lead.

A NEW REGENERATIVE FURNACE.

*On a New Form of Regenerative Furnace.**

By Mr. F. W. DICK, Glasgow.

I HAVE pleasure in bringing to your notice a new form of regenerative furnace, in which considerable departures are made from the usual practice of furnace building.

The furnace—which is the joint invention of Mr James Riley and myself—presents several novel features, and in its design we have aimed at decreasing the cost of construction and maintenance, and at the same time retaining, and even adding to, the good points of the ordinary Siemens furnace. The new furnace does not in any way differ in principle from the Siemens furnace, but only in construction and arrangement of the various parts. Thus in the model before you—which is that of a 12-ton steel-melting furnace—there is the melting chamber or furnace proper, and four regenerative chambers, two for gas and two for air But instead of the furnace and regenerators forming parts of one structure of brickwork, they are separate from each other, and are contained in circular casings of wrought iron or steel plates rivetted together; and not only are the regenerators separate from the furnace, but they are separate one from the other, as shown by the model and the diagrams. From these it will be seen that the arrangement consists of a circular furnace body, placed on a platform supported by girders, while the regenerative chambers are placed in pairs at each end of the furnace. The furnace is thus left entirely clear underneath, a condition of things which insures the bottom being kept cool, and lessens the likelihood of the charge breaking through The regenerators not being underneath the furnace, are out of harm's way in the event of a break out; and further, it will be observed that the regenerators have nothing but their own weight to carry, and can never get out of shape. The furnace is not supported in any way by the generators, and this is a feature in the design which must commend itself, for a worse support than a mass of white-hot brickwork, on which to carry the weight of a furnace and its load of metal, can scarcely be conceived.

With the exception of using dampers to separately control the passage of the products of combustion through the gas and air chambers, no change has been made in the flue and valve arrangements. It is very necessary to be able to regulate the relative amounts of the heated gases passing through the regenerators, because it is thereby possible to regulate the relative amounts of heat stored up in the different chambers. Without this separate control, the tendency is for the gas regenerator to get more than its share of the waste heat, whereas it is more necessary that the air regenerator should be the more highly heated.

Before describing the furnace in detail, it may be of interest to show how it originated, the more especially as the steps are instructive. The design is really the outcome of experiments instituted by Mr. Riley, in 1880, at the Newton Works of the Steel Company of Scotland, Limited, to determine the fitness of the basic lining for use in the Siemens furnace. The difficulties then encountered gave rise to various changes in design, which eventually culminated in the form now before you.

A 14-ton furnace of the usual type was used for the trials. The first trouble encountered arose from the excessive quantity of slag. This difficulty Mr. Riley successfully met by placing a slag-spout at a higher level than the tap-hole. The bottom of such a large furnace proved troublesome and expensive to keep in repair, more especially as the best basic mixture had not at that time been positively determined. For this reason it was resolved to build a smaller furnace for experimental purposes. I therefore designed a 2-ton furnace for use in this work. It was of the common class, and with the exception of the slag-spout, contained nothing new in the design At this time considerable difficulty was experienced from the fluxing of the lining of the furnace at the junction of the acid and basic material. In the 2-ton furnace this difficulty was not sufficiently met. The design was therefore abandoned, and I designed (under Mr. Riley's direction) another 2 ton furnace having a movable bottom resting on a carriage, in order that repairs might be more quickly and easily executed, and that the separation of the acid and basic linings might be more complete. On estimating the cost of this last furnace, we found, to our mutual astonishment, that it was actually less than that of the first 2-ton furnace, notwithstanding the increased complication. An analysis of the costs showed that this was due to the disposition and the difference of amount of the cast-iron work in the two designs This led us to originate the design of the body of the Batho furnace, as it is erected at our Newton Works. In this furnace horizontal cast-iron girders, of the whole length of the body, are placed along the lines of pressure, i.e., along the sides of the path at the level of the metal, and along the springing of the straight roof. These girders are held apart by light cast-iron uprights. The whole furnace is self-contained, and sits in a frame of malleable iron beams, and is well clear of the floor. The cast-iron work was designed in such a way that one pattern did for all the girders, and one for all the uprights. This was a notable departure from the usual conglomeration of differently-shaped buckstaves, binders, and tie rods, &c., which go to make up the case of an ordinary Siemens furnace.

Although we had thus to some extent simplified furnace construction, the part which the casing and binding of furnaces played in the first cost had been so forcibly brought under our notice, and so much trouble had been experienced by furnaces going out of shape, that we resolved to push the search for improvement further. The circular form was at once looked to as a means of attaining sameness of form in all the buckstaves and bottom plates, and of dispensing with tie-rods and binders. We were the more inclined to favour this shape from its extreme suitability for the reception of a basic lining The circular form once adopted, the transition from the heavy, expensive, and easily cracked cast-iron casing to the shell of rivetted wrought iron or steel plates was an easy and natural step. The next thing was to support the furnace body independently of the regenerators. Being now freed from conventional notions in furnace design, it was at once recognised that more than equal advantages would be obtained by treating the regenerator chambers in the same way as the body, and inclosing them also in circular iron casings. The bricks, therefore, came to be used simply as non-conducting linings, and were not required to support the weight of any part of the structure; the quantity required being thus reduced to a minimum. Other refinements followed, such as the building of the roof of the furnace and the covers of the chambers in iron rings, in order that the walls might be relieved of side-thrust, and also that these parts might be lifted bodily and removed for repair, and for giving access to the checker-work. The flues were also reduced to mere iron shells lined a single brick thick. The regenerators were placed in pairs, gas and air together, at the ends of the furnace, and close to it. Small blocks were employed for the introduction of the gas and air to the furnace, built as shown in Figs. 9 and 10 (see page 292). These were used in order that the roof might be above all, and easily removable, so as to facilitate the charging of large pieces, and of pig-iron and scrap in bulk. In passing, it should be mentioned that the roof and covers rest loosely on sand joints on the tops of the side walls.

Owing to the difficulty experienced in handling so heavy a piece as the main roof, it was found advisable simply to pierce it with a central charging hole, and use a supplementary roof or cover.

This arrangement left us free to adopt the one thing required to make the furnace perfect; namely, the Batho connecting tubes. These, it will be observed, are shown in Figs. 1 and 2, and our experience of them has been so favourable that we intend to use them in all furnaces of this class.

Fig. 8 shows the arrangement of an experimental furnace of four tons capacity, which was erected at our

* Paper read at the Chester meeting of the Iron and Steel Institute.

Blochairn Works five months ago, and which has been in constant work ever since. For the last four months steel of soft quality has been produced by it, 3½ ton charges being got out under eight hours by the Siemens pig and-ore process. For the last month the furnace has been used for melting up broken rolls and large pieces of metal. The pieces, up to eight tons weight, are lifted by a crane and charged through the roof. A 3 to 4 ton piece takes about two hours to melt. A considerable saving is effected. It was our former practice to break these rolls by blasting with dynamite, at a cost of 12s 6d. per ton. The resulting pieces, from their size, were only worth 30s. per ton. The rolls are now being melted at a total cost of 6s. 8d. per ton for fuel, labour, and fixed charges, and are run into a marketable pig of superior quality.

This furnace has been quite successful in its working from the beginning, none of the hitches usually looked for in new things having occurred. Some useful experience and a good deal of confidence have been derived from working; so much so, that we are now proceeding with a 12-ton furnace, of which Figs. 4, 5, 6, and 7 show the design. It was at first thought that, as the flame does not travel along the roof, it would be possible to use common firebricks for the crown. These bricks began to run in a short time, and had to be replaced by silica bricks. Shortly after the furnace started work, one of the gas regenerators got choked owing to a careless furnaceman neglecting to reverse. The cover was lifted, a few of the top courses of bricks raked out, fresh ones put in, and the furnace started within three hours, and without being appreciably cooled. In emptying and renewing an ordinary Siemens chamber—and it usually must be completely emptied, no half measures being possible—the quickest time on record that I know of is twenty one hours, and that is a remarkable feat.* The saving of time in repairs is thus not one of the least advantages in this type of furnace. There is likely also to be less occasion for repair than usual. The furnace has been at work for too short a period to enable us to give this assertion all the weight we could wish. It can only be said that after five months' work the furnace is practically as good as new. The furnace is lined with 14 in of silica bricks, and the regenerators with 9 in. of firebrick work. The radiation is very slight indeed. The hand can be held within a ½ in. of the iron casing without discomfort.

Figs 4, 5, 6, and 7 show the design of the 12-ton furnace to be erected at our Blochairn Works. The body has a 14 in. silica-brick wall built in an outer shell of ⅜ in. steel plates. The internal diameter is 11 ft. 6 in. The roof is of silica bricks 9 in. thick, is dome shaped, and is bound by a T-iron ring, so that there is no thrust on the furnace walls, and the roof may be lifted off or on in one piece. There being no blocks in the furnace, and no thick places in the walls, it is equally cool all round. The bottom rests on the common flooring plates, and the air has perfectly free access to these plates.

The gas regenerators and the air regenerators are 6 ft. 6 in. internal diameter, are lined with 9 in firebrick work, and have outside casings of ⅜ in. steel plates. They stand loosely on the floor, carry only their own weight, and are only connected to the furnace by the Batho tubes. They are provided with doors at different levels for convenience in filling in or emptying the checker-work, and have sight holes well above the floor level, by which the condition of the inside may be observed while the furnace is at work. At their bottom parts they are connected by iron-plated flues lined 3½ in. thick with firebricks to the usual reversing and air and gas valve arrangement. The two dampers already referred to are shown, one controlling the gas chambers, and the other the air chambers. It will be observed that from the position of the floor line very little excavation is required.

Figs. 1, 2, and 3 show a heating furnace on the same principle. It is intended for use in our guide mill. The furnace bed is 12 ft. by 6 ft. Doors are provided on both sides, so that billets may be charged on one side and drawn at the other. The body is carried by two iron girders, which rest on brick piers at the ends, leaving a free space under the furnace, so that rods from the mill may be run under it if necessary. It would be possible to move this furnace from one position to another without pulling it down.

It may interest some of you to know that furnaces on this plan are likely to come into use for foundry purposes and for glass-making. The circular body is peculiarly adapted for glass-making purposes, where several men have to work round one furnace.

The advantages of the system are briefly these:

From the independence of the parts, from the fact that the brickwork has not to be made to support heavy weights, and from the simplified casings possible with the circular form, the amount of material required in the construction, the labour in erecting, and, as a consequence, the first cost, is reduced to a minimum. The cost of melting furnaces on this plan is less than three-fourths of the cost of the common type of furnace of equal capacity.

The repairs and up-keep are slight. That this is not altogether a matter of belief is shown by the condition of the 4-ton furnace after five months' work, and by the case I have instanced of a speedy repair of a choked regenerator. In this connection it should be pointed out that a spare furnace cover may be kept; or, if this is not considered desirable, then, in the event of the roof falling in, the binding ring may be lifted off and placed on the floor, a new roof built in it, and the whole lifted bodily into place in the course of four or five hours, without specially cooling the furnace. When a roof collapses in a Siemens furnace, the whole structure has to be booled down and centring put in on which to rebuild the roof. The roof of the new furnace is not, however, much affected, as it is removed from the cutting action of the flame.

From a consideration of the form of the parts and the manner of casing, it will be admitted that the furnace is not likely to give trouble by getting out of shape. The lining of the furnace cannot readily drop in, as it is "arched" all round.

It will be noticed from the plan that what are practically idle corners in a rectangular furnace are filled up. No partial vacuum can be formed there by the entering gases; eddies are prevented; and the flame pursues an even course across the furnace, instead of clinging to the walls. Further, the furnace walls recede just where the flame is most expanded. For these reasons the lining is much less liable to cut than in the rectangular furnace. This statement is borne out by our experience.

The whole surface is so open to the air that a break-out is not likely to occur; but should it happen, very little harm can be done, since there is nothing under the furnace to come to grief.

As the regenerators are quite separated from each other, and as the gas and air tubes are also apart, there can be no leakage from one to the other, and therefore no combustion can take place except in the furnace. This is a very important point, and rids us of a very pregnant source of trouble in the shape of undue wear and tear caused by gases burning in the ports and chambers.

Being cased in tight iron coverings, no cold air can be drawn into the regenerators or flues. Leakage in this direction frequently gives rise to much loss of heat.

When the regenerators become choked, the covers may be lifted and the chambers examined separately before commencing operations. Any one chamber, or the furnace itself, may be cut out of the system, cooled down and repaired, without cooling or in any way disturbing the other parts. The saving of time in effecting repairs is very great. The removal of a few of the top courses of checker bricks will generally be found to put the regenerators in order. Compare this with the usual necessity of waiting till the whole mass of a furnace cools, and taking out the whole of the checker work to get at those bricks on the top.

It seems to me almost superfluous to point out the peculiar adaptability of this furnace for the basic process. It is not even necessary to use basic bricks, since the circular body can be rammed with the same ease as a Bessemer converter. The easy and complete severance which can be made between the basic and acid lining renders the production of basic steel in the open hearth furnace both possible and feasible. It is the intention of the Steel Company shortly to resume experiments in basic working, and, with the new furnace, success is confidently anticipated.

* It usually takes about a week to change the checker-work in a Siemens furnace.

INEFFICIENT CONTINUOUS BRAKES.

TO THE EDITOR OF ENGINEERING.

SIR,—The attention of the directors of the Midland Railway Company has been called to a letter in your issue of the 5th instant, signed "Clement E. Stretton," in which he adverts to their supposed ignorance on the brake question, and states that "one of these gentlemen called upon me a few days ago to ask for impartial information as to the construction, practical working, and defects of the brake," &c.

The truth of this statement is denied by each director as affecting him, and at the desire of the Board I have written to Mr Stretton asking for the name of the gentleman referred to. But the directors do not like a public statement of this character to appear in your influential paper without contradiction.

Probably no board of directors in the kingdom has given so much attention to the question of continuous brakes as that of the Midland Railway, both by practical trials and by taking counsel with the most competent experts.

Directors must expect criticism, and they receive it in large measure from rival patentees, anonymous correspondents, and amateur railway managers.

I should not trouble you with any reply to the letter in question, but that it contains what appears to be either a misunderstanding or a misstatement of facts.

I am, Sir, your obedient servant,
JAMES WILLIAMS, Secretary.

Midland Railway, Secretary's Office,
Derby, September 18, 1884.

AUTOMATIC INJECTORS.

TO THE EDITOR OF ENGINEERING.

SIR,—Kindly allow us to state in answer to Mr Charles Dixon's letter in your last week's issue that Hall's injectors will restart themselves automatically any number of times without the slightest manipulation on the part of the attendant, if erected in accordance with our instructions. We do not know what Mr. Dixon's theory may be as to the arrangement of nozzles, &c., but we are prepared to give a practical demonstration of the above to any one who may care to visit our works.

If Mr. Dixon will put himself in communication with us we shall be happy to give him any further information on the subject that he may desire.

Yours truly,
FAIRBURN AND HALL.

Manchester, September 23, 1884.

THE BURSTING OF HOSE PIPES.

TO THE EDITOR OF ENGINEERING.

SIR,—I think it is remarkable that in the last "returns" to the Board of Trade made by the various railway companies in the country which show—or ought to—the failures of different kinds of brakes as used, the total number of burst hose pipes recorded against the Westinghouse system, viz., 265, out of the total number 397 failures, shows clearly the weak part of this brake.

The question I desire to ask is this, is india-rubber the only material available for this purpose?

If it is, it ought in my opinion to be very materially strengthened by being covered with canvas or some other durable material. I do not specify canvas in particular, for surely it would not be difficult to fix upon a proper material.

Now I dare say some at least of these burstings have been caused by the action of grease or oil, but I have heard it stated that on the Lancashire and Yorkshire Railway all the india-rubber used for working the automatic vacuum brake, they have unwisely adopted, is coated with a grease-resisting compound, but I do not know with what results.

Now I should like to know why it is that we see so many hose pipes not protected in any way against grease or oil. Both enter largely into railway working; I have seen both the Westinghouse and vacuum hose unprotected. What I should suggest would be not the adoption of double hose couplings as lately brought out by the Westinghouse Company, but a single hose as follows. A good strong india-rubber pipe (failing a better material being found) well coated with a grease or oil resisting compound, then the hose to be very tightly covered with a strengthening material, and over this another coat of the resisting compound; of course it might be found better to make the material used to strengthen the hose in one with the rubber on account of cheapness, in any case to my mind an experiment is well worth a trial, and I hope to hear of my suggestion being acted upon, because anything that would tend to improve the most commendable life-saving appliance for use on railway trains yet brought out, should have a fair and speedy trial, and I wish those who experiment all good luck in their endeavours to bring out a better hose pipe.

Your obedient servant,
September 24, 1884. HOSE PIPE.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was only a thin attendance on 'Change at Middlesbrough, many of the regular frequenters having gone to Chester to be present at the Iron and Steel Institute annual meetings. There is very little iron changing hands, and the tone of the market is dull. The only cheering feature in trade is the satisfactory exports from Middlesbrough, the total shipment of pig iron to date being 66,000 tons against 57,000 tons last month and 72,000 tons to corresponding period last year. No. 3 g m b f o b. has for the past few days been in fair request for prompt shipment, and 36s 6d per ton has been paid for some lots, 37s. being still the price for special brands of No. 3. The lower qualities are in poor demand, as our home trade, particularly in the North of England, remains depressed.

The Wages of Ironworkers.—As was anticipated the wages question in the manufactured iron trade of the North of England has been referred to arbitration. The employers claim a reduction of 5 per cent in wages and the operatives ask for an advance of 5 per cent. Dr. Robert Spence Watson, of Newcastle, has been asked to officiate as arbitrator, and although he has not yet signified his intention to accept the onerous position, it is believed that he will do so, and that the court of arbitration will be held on an early date.

Boats for the Nile Expedition.—Messrs Wake and Sinclair, of the Low Quay, Sunderland, have just completed four of the eight boats which they contracted to build for the Nile expedition. The boats have passed the Government inspector to his entire satisfaction. The other four will be despatched at the end of this week.

BLOCK SETTING MACHINE.—Messrs. Stothert and Pitt, of Bath, request us to state that they only constructed the machinery and gearing for the Mammoth block setting machine, illustrated by us on page 276 of our last issue, and which is now being used on the works of the north pier at the mouth of the River Tyne, not at the Coble Dene Docks as stated in the title of our illustration.

THE HEALTH EXHIBITION CATALOGUE.—The third edition of this catalogue has recently been issued. It contains several additions, the chief of which is an elaborate subject index to the exhibits of the United Kingdom. There is also a good deal of new matter in the foreign section, which includes references to the extensive contributions which have been recently made to the Exhibition by the Japanese Government.

KING'S COLLEGE EVENING LECTURES ON METALLURGY AND FUEL.—We are informed that the subject of the evening lectures in connection with Professor Huntington's department for the coming session, commencing on the 6th of October next, will be "The Properties of Metals and Alloys, and their Uses in the Arts." Especial attention will be paid to the metallurgical subjects required for the City and Guilds of London Institute examinations in metal platework, plumbing, and iron and steel. These lectures are to be given on Monday evening from 8 to 9, while on the same evening from 7 to 8, the Demonstrator of Metallurgy (Mr. W. G. McMillan) will give in addition a new course of lectures on "Fuel," to include the subjects necessary for the examination of the City and Guilds Institute in that subject. The laboratory will be open for practical work, as before, on Friday evenings from 7 to 9; it is also open as usual every day from 10 to 4 (on Saturdays till 1 only), for occasional students, as well as for the members of the College. Applied Science (Engineering) Department. We are glad to find that the fees for the evening classes are to be somewhat reduced this year.

CARBONATING FURNACE AT THE FLINT CHEMICAL WORKS.

CONSTRUCTED BY MESSRS. CARRICK AND WARDALE, ENGINEERS, GATESHEAD-ON-TYNE.

(For Description, see Page 298.)

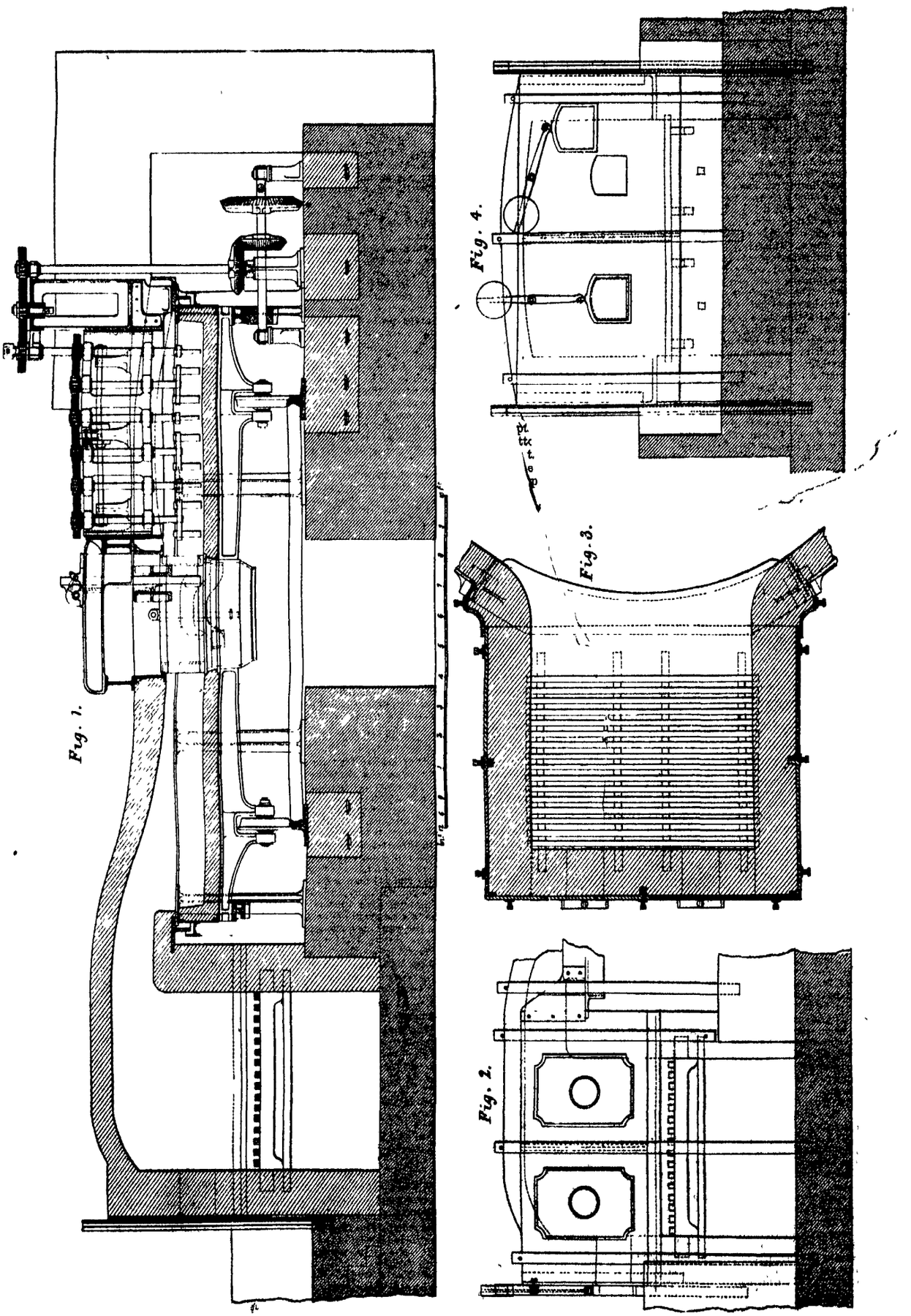


Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

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Advertisements intended for insertion in the current week's issue must be delivered not later than 6 P.M. on Thursday. The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. Serial advertisements will be inserted [illegible] all practical regularity, but absolute [illegible] cannot be guaranteed.

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The publisher begs to state that since January 1, 1883, the ordinary copies of ENGINEERING sent abroad are printed on thin paper. The illustrations being, however, so much less effective on thin paper, foreign subscribers are strongly recommended to order thick paper copies, which they can have by paying the difference in postage as indicated below.

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Foreign subscribers, especially when renewing their subscriptions, are particularly requested to advise the Publisher of the transmission of the Post Office Order, and the exact amount for which it is made payable. If this precaution is omitted, some difficulty is very likely to occur in obtaining the name of the sender.

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NOTICE TO AMERICAN SUBSCRIBERS.

We beg to announce that we have appointed the firm of John Wiley's Sons, 15, Astor Place, New York, the sole agents for ENGINEERING in the United States, and all subscriptions for the United States will in future be payable to them. They will also be prepared to receive advertisements for ENGINEERING, and will afford full information as to terms, &c., on application.

The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the office of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

ENGINEERING.

FRIDAY, SEPTEMBER 26, 1884.

CONTINUOUS BRAKES.

CLOSELY following the lead of Sir Edward Watkin and the Manchester, Sheffield, and Lincolnshire Company, whose letter to the Board of Trade we criticised last week, comes the manifesto of the Vacuum Brake Company, in the form of a letter to the *Times* of the 16th inst., from their chairman, Mr. Martin. The vacuum brake is now on its trial, and it is to be hoped that the discussion on the brake question which originated from the Penistone disaster may be kept up, and that the real truth on this important subject may be widely understood. Conceiving as we do that this question of efficient brakes is one of the very gravest importance for the public, we make no apology for referring to it again and again, and we shall not hesitate to use our columns for furthering the supply of a want which has been felt since trains were first set in motion.

The Vacuum Brake Company cannot be accused of undue haste, in replying to the unfavourable comments made upon the brake in use on the train which was wrecked at Penistone so long ago as the 16th of July, and we must confess that, unless the public are unusually blind, the cause Mr. Martin has at heart, is not likely to be assisted by such a letter as that which he has felt compelled to publish. Broadly stated, it resolves itself into a virulent attack on the Westinghouse brake, and it may be safely stated that the allegations against this system are either incorrect or misleading It is perhaps too much to expect that, as a banker, Mr. Martin should be able to write upon technical subjects relating to railways, or the appliances in use upon them, but it is not unreasonable to look for facts on matters as to which any one can, by taking the trouble, ascertain the truth for himself. It will no doubt occur to most people that even if all the statements Mr. Martin has made are correct, it could certainly not render any vacuum appliance more reliable, or remove the fact that twenty-four people were killed and sixty-two injured in a train supposed to be protected by that form of brake. It is, however, not the least curious part of Mr. Martin's letter that he ignores the Penistone disaster altogether, and that no defence of his brake is attempted, the general impression given by the letter being that if any brake has recently done wrong, it is the Westinghouse, and, indeed, Mr. Martin could scarcely have written with more feeling had this brake instead of his own been fitted to the train that caused such dreadful loss of life.

We have no intention of correcting all the misleading statements contained in this letter, as we consider our space may be more profitably employed, and they are too numerous, comprising as they do stock statements as to the Blackburn collision and the Board of Trade returns, the Euston meeting, the universality of the Clayton coupling, Sir Henry Tyler's connection with the Board of Trade, the progress of the Westinghouse brake on the Continent, &c. What will strike most people as a fairly good answer to all this is that the Westinghouse brake is now in use to the extent of some 80,000 *vehicles on the automatic principle only*, in all parts of the world, and that it *continues to increase as* we have shown at the rate of some 1200 per month. We may quote one paragraph, however, from Mr. Martin's letter, which will show how he has failed to acquaint himself with the subject. He says: "There is another great objection to the Westinghouse brake, viz., that the high pressure required to work it, is rapidly exhausted, and takes much time to restore. Hence, if the brake is frequently used, say, in coming down a heavy gradient of any length or in response to signals or otherwise, it becomes inoperative" There is of course no foundation to this charge, but if the word high is changed to *low*, it exactly describes the behaviour of the automatic vacuum brakes in use on the Midland and Great Western Railways. We recently published a report of Mr. Harrison's on the working of the Westinghouse brake on the North-Eastern Railway in which, referring to this very subject, he says: "It has been found especially useful for working steep inclines, of which there are many on the North-Eastern system, in some the gradients being as steep as 1 in 37."

On such a question it is natural to look for some consistency in principle, but Mr. Martin now informs us that they themselves have come to the conclusion that "on the whole an automatic brake is desirable," or, in other words, that had the train been fitted with an efficient brake complying with the Board of Trade conditions, the probability is that the consequences of the Penistone accident would have been averted.

It is, as we have remarked before, a sad fact, that only at the sacrifice of human lives, such lessons are to be learnt, but it seems that what is sufficient to convince one set of men is insufficient for another body, who are still in the main responsible for the possibility that at any moment we may have a repetition of Penistone or Downton, and who announce their intention of resisting the Board of Trade in any attempt to enforce those principles which have been found so essential. In addition to being now converted to the necessity of automatic action, however, the Vacuum Company announce their allegiance to the Board of Trade, for Mr. Martin says "it is high time the Board of Trade should interfere," and "let the Board of Trade by all means have the power to order railway companies to adopt some universal and interchangeable system of continuous brakes simple or automatic." Is Saul also among the prophets? we may ask.

In referring to the Euston meeting held in April, 1881, Mr. Martin claims that nine out of the twelve locomotive superintendents present recorded their opinion that the simple or non-automatic brake would meet all known requirements, the other three being in favour of automatic vacuum brakes. The Vacuum Brake Company being now convinced "an automatic brake is desirable," we quite fail to see how Mr. Martin can claim the support of the nine gentlemen referred to, and it would be interesting to know if they too have changed their opinion on a matter of such vital importance. Some light is thrown on the principles which animated the Vacuum Brake Company in the year 1881, by a letter from Mr. Martin which appeared in the *Times* on August 31st of that year. In this Mr. Martin speaks of the "ill-judged action of the Board of Trade" thwarting the progress of brakes, and again, "all that an automatic brake pretends to do is to apply itself in the rare event of the train coming in two during its journey, security against which can be far more easily and cheaply given by insisting on a given strength of drawbar"; and further, "it now only remains for the Board of Trade to withdraw their implied recommendation"; and the action of the Board of Trade is stigmatised as "well meant but unwise." It is clear, therefore, that Mr. Martin has undergone a remarkable conversion in several important respects, and we are encouraged to hope for a still further change on the subject of brakes.

It is only to be supposed that the non-automatic brake *is* now given up because it is less likely to be of service in those cases in which an automatic vacuum brake is, according to Mr. Martin, now found to be desirable. Upon this principle, however, the latter will also have to be discarded, for there are several important respects in which the Westinghouse brake is much superior, and owing to which it has saved life under circumstances where it was impossible for any vacuum brake to have been of the slightest use. As we have recently explained, there are no means in *automatic vacuum brakes of retaining the power, so that when it becomes necessary to disconnect the engine or any vehicle for shunting or other* purposes, the brakes must all go on, and can only be released by going to each carriage separately and destroying the power upon it On this account alone it is clear that an *automatic* vacuum brake is disqualified, as presenting obstacles to the carrying on of even ordinary traffic. To any one conversant with the practical working of our enormous railway system, the idea of incurring such delays as would inevitably result from the general adoption of such an appliance, is simply preposterous. So great was the inconvenience on the Great Western and Midland Railway, when but a very small part of their stock was fitted with this form of brake, that they were compelled to allow the power to leak away of itself in one and a half minutes, and thus to some extent diminish the delays In doing this, however, a dangerous feature was introduced which has frequently been condemned by Board of Trade inspectors as having led to accidents, and therefore it is not to be expected that such an alternative will ever be allowed; indeed it is one of Mr. Martin's boasts that his brake does not possess this defect of leaking off. It is further the case that as at present designed no vacuum brake can be worked on portions of trains intended to be slipped while running, and on which, therefore, the brakes cannot be applied automatically or by the driver or guard. While this is the case, no automatic vacuum brake can be held to comply with the Board of Trade conditions. In addition to this no vacuum brake can control carriages when drawn by an engine not fitted with the same brake, or when the continuity is broken by a vehicle having no brake at all, or one of a different form being inserted in the train. In these respects it is inferior to the old Fay or Newall brake, which though only able to be worked by the guard, was available under many circumstances in which an automatic vacuum brake could render no service. The Westinghouse system, on the other hand, greatly facilitates shunting, and admits of power being stored on detached carriages, capable of being worked under all the

above conditions by the guards or automatically in case of accidents. As showing that these qualifications are really necessary, we may draw attention to the case which occurred on the Great Western Railway on July 8, 1882, and which was commented on in our issue of October 13, 1882. In this case eleven carriages, out of twenty-three, which were intended to be slipped, broke away from the others, and it was only owing to a fortunate combination of circumstances that a serious accident was prevented. We may commend Colonel Yolland's remarks to Mr. Martin's attention, for he says that a proper warning of the circumstance would have been given if "automatic brakes running throughout the whole length of the train" had been provided. As we have explained, however, although the Great Western employ an automatic brake, it is perfectly useless in such a case, which was just one of those which the Board of Trade have persistently been urging the companies to provide against. Another case, in which no brake but the Westinghouse could have been of use, occurred near North Wootton on the 3rd inst., and was referred to in our issue of the 12th inst. In this instance a train containing 150 passengers was brought to a stand by the accidental application of the Westinghouse brake in about 70 yards, after the engine, which was not fitted with the brake, had left the line. The capability of storing up power against an emergency, in this case no doubt saved many lives.

We take it to be undeniable that the essential function of a brake is to save life, and that its power to do this in the greatest number and variety of situations, constitutes the first point in considering the relative merits of the various systems, and it is in our judgment, therefore, useless to consider the vacuum principle until it can first perform the same work under similar conditions as a brake on the other system. In saying what we have done there is no wish on our part to go beyond, or frame other conditions than those laid down by the Board of Trade, since the points we have mentioned are already anticipated by and included in these essential requirements of a really efficient brake.

THE FLINT CHEMICAL WORKS.

These important works are the property of Messrs. Muspratt Brothers and Huntley; they are situated on the estuary of the Dee, about eleven miles from Chester, and in direct communication with the London and North-Western Railway. The principal articles manufactured are sulphuric acid, salt cake, bleaching powder, soda ash, soda crystals, bicarbonate of soda, and caustic soda. We will treat of the manufacture of the former article first, as it is subsequently used in the production of all the others.

Starting on the quay in the works, where the vessels unload, we find large heaps of sulphur ore, which are brought round from Liverpool, where they have been transhipped from the larger craft sailing from Spain. This ore contains on an average about 49 per cent. of sulphur, and 3 to 3½ per cent. of copper, the remainder being chiefly iron. It is placed in a crushing mill, which is of simple construction, having jaws worked by a spring and cam motion. The crushed ore is elevated by a bucket ladder, and screened to take away any small pieces. These screenings or "smalls" are worked up under a pair of edge-runners, such as are used in an ordinary mortar mill; and having been made into cakes and dried, are put into the kilns with the rest of the ore. These pyrites kilns are of ordinary construction, being simply brick furnaces fitted with square firebars. Each fire is charged every 12 hours. A set of kilns containing 18 fires will consume 8½ tons per day. About 50 tons of ore per day in all is the average quantity "burned" at these works. The ore is heaped thickly on the bars, and very little draught is admitted, sufficient air only being drawn in to get 3 to 5 per cent. of free oxygen in chamber escapes. The products of combustion from the kilns are carried along the flues, and mingle with the fumes of gaseous nitric acid evolved from nitrate of soda and sulphuric acid, which is "potted" at the end of the kilns. The mixed gases pass into the Glover or de-nitrating tower, which is 30 ft. high from intake to summit, and is 10 ft. 6 in. by 8 ft 6 in. in horizontal section. It is composed of sheet lead of various thicknesses varying between 60 lb. to 12 lb. per square foot, the heaviest gauge being at the bottom. The tower is packed with flints and coke. The hot chamber and nitrous vitriols, which are caused to trickle downwards amongst the coke, and serve the double purpose of concentrating the vitriol, which is used for the second department of the manufacture of sulphate of soda or salt cake, and also of de-nitrating the nitrous vitriol from the Gay-Lussac absorbing towers, to which reference will shortly be made. Previous to the introduction of the Glover tower, the concentration was performed in leaden pans fired by hand. The fumes from the Glover tower pass into the vast leaden chambers, which are so noticeable a feature in vitriol-making plant; 24,000 cubic feet of chamber capacity is required for every ton of ore burnt per twenty-four hours. Steam is likewise admitted into the chambers.

In the works in question there are thirty-five of these leaden chambers, which vary in size between 100 ft. in length, and 21 ft. by 20 ft. in width, up to 183 ft. in length, and 24 ft. by 21 ft. in width. The sulphuric acid which collects in the bottom of the chambers is drawn off at intervals and carried to the top of the Glover tower to trickle downwards and be concentrated as already described. As the fumes and steam delivered into the chambers pass from one to another, the sulphurous fumes gradually become less, and the nitrous fumes pass on to the Gay-Lussac absorbing tower. This is also made of lead and packed with coke, and its use is to recover the nitrous fumes from the chambers which would otherwise escape. Vitriol is allowed to trickle down through the coke, and absorbs the nitrous fumes. It is afterwards run down the Glover tower in order that the chambers may be supplied with the necessary nitrous compounds. Oil of vitriol, if not required of any great strength, can be made without the Glover tower, whilst the Gay-Lussac tower is simply an economiser, or interceptor of waste product. The platinum vessels so well known in connection with sulphuric acid making, are used for rectifying the acid in order to obtain it pure. For the purposes required in the manufactures we are describing, traces of nitrous compounds and arsenic are, however, of no moment if remaining in the vitriol, and rectifying is therefore not practised. It would be manifestly impossible to give even an approximately full account of the various chemical reactions which take place in the manufacture of sulphuric acid, but it may be stated briefly that it is formed by the sulphurous gases and nitrous gases in the presence of the steam. It may be further added that the nitrous gases in the presence of air act as a vehicle to assimilate for the sulphurous gases a necessary atom of oxygen that the latter are not capable of taking up for themselves. The action may be illustrated by reference to the power which plant-life has of assimilating morganic matter for supplying nutrient principles of food to support animal life, the animal itself being unable to assimilate such matters.

For the purpose of transporting the vitriol from one part to another, what are technically known as "eggs" are used. These are cylindrical castings with semi-spherical ends. They are 8 ft. long and 3 ft. 6 in. in diameter, and the metal is 2½ in. in thickness. Each one will contain about five tons of vitriol. In order to convey the acid from one part to another, the egg is exhausted by suitable machinery and the vitriol is run in. The suction branch is then closed, and the delivery branch opened, and compressed air is pumped in, which forces the sulphuric acid to the required position. There are one single and two double air-compressing engines, with 8 in. air cylinders and 2 ft. stroke. The air pressure employed is 90 lb.

We will now pass to the salt cake making. This product, known chemically as sulphate of soda, is largely used in the manufacture of glass, but at Messrs. Muspratt's works it is consumed on the premises for making soda ash, &c. About equal weights of common salt and sulphuric acid are placed in an iron pan covered with a brick dome, and are subjected to the heat of a furnace. Hydrochloric acid gas is given off and passes along earthenware pipes into stone condensers built of Yorkshire flags. These condensers are about 5 ft. square and 50 ft. high, and are packed with coke down which water trickles, meeting the hydrochloric acid gas and forming hydrochloric acid. When the paste formed by the sulphuric acid and salt gets into a semi-dried state, it is pushed by hand rakes into a roaster. This is of the type known as a blind roaster, the burning gases from the furnace passing over and under the bed on which the mixture lies. These heating the pot or pan before referred to. Whilst in the roaster the mixture is well worked by the hand rakes. This process is now to a great extent superseded at these works by a mechanical furnace supplied by Messrs. Jones and Walsh, of Middlesbrough. This consists of a shallow circular pan covered in with tiles placed on iron supports; a central vertical shaft has arms attached, and is rotated by gearing driven by a small vertical steam engine. This keeps the mixture of salt and sulphuric acid agitated, and the boiling and roasting are carried on at one operation. These machines have been found to be highly successful at these works, and do away with the necessity for a great deal of laborious and most unpleasant hand labour.

Returning to the hydrochloric acid which had been formed in the stone towers, we find it is used in the production of bleaching powder, which is more familiarly known to users by the technical term of "chemic." This is produced by running the hydrochloric acid into large stone stills which have been charged with a certain amount of manganese ore. Chlorine gas is given off, and this is conveyed by pipes to large leaden chambers, on the floor of which there is a layer of about 6 in. of lime. The lime absorbs the chlorine gas and forms bleaching powder. The still liquor which remains is chloride of manganese. It is treated by Weldon's regenerative process, when the manganese is recovered in the form of a black mud, which is used in stills in place of ore. Before this process was adopted it required 16 cwt. of 70 per cent. manganese ore to make a ton of bleaching powder, whereas now the quantity of fresh ore required for a similar result may be roughly put down as 40 lb.

The production of soda ash is the next process that may be described. Given proportions of salt cake, limestone, and small coal are taken by a steam hoist to an overhead tramway, and are dropped through a hopper into a furnace of special construction, which works somewhat in the same manner as a Danks patent revolving furnace. On page 300 we give illustrations of this apparatus, which is manufactured by Messrs. Robinson, Cooks, and Co., of St. Helens. It will be seen that there is a large horizontal cylinder, built up of iron plates rivetted together, and lined with firebricks. It is 20 ft. long and 12 ft. 6 in. in diameter. It rotates on two steel carrying rings placed round the outside, and these run on four iron carriage wheels. A vertical engine gives the desired motion by means of spur gearing. There is a large furnace which supplies the heat, and although the mouth of the revolving chamber is brought as near as possible to the circular opening from the furnace, no joint is made, and probably an excess of air gets in. The heat is sufficient, however, for the purpose required. There are four of these furnaces in all, that which we have described not being the largest. When the charge has become sufficiently fluxed, the machine is stopped, and the material known as blackash is run out through a door in the side into small iron bogies. The blackash contains about 25 per cent. of alkali, and, when cool, is broken up into pieces about 9 in. square. It is then taken by a steam hoist and thrown into vats about 8 ft. square and 6 ft. deep, to be lixiviated with water in order that all soda compounds may be washed out. The residue remaining is taken to the "waste" tip. Sulphur might be recovered from this, and in some instances this is done, but it is questionable whether the result pays for the trouble spent on it. The soda or vat liquors are now run into large tanks, or settlers, so as to get rid of superfluous matters, and the liquor is then run off into large wrought-iron pans, which are placed at the end of the revolving furnaces so as to utilise the waste heat escaping from the latter. The liquor is here concentrated until the salts of soda fall, and the pan is full of salts. The pan is then tapped into a wrought-iron tank, on the bottom of which perforated plates are placed so as to separate the mother liquor from the sodium salts. The latter are a coarse greyish crystal, and contain about 20 per cent. of water. These salts are taken to a floor above by a steam hoist, and are then conveyed by an overhead tramway and dropped through a hopper into a McTear's carbonating furnace. This is another important piece of machinery, and was supplied by Messrs. Carrick and Wardale, of Redheugh-on-Tyne. It is illustrated on pages 293 and 296.

The furnace consists of a shallow pan of wrought-iron about 18 ft. in diameter, mounted on a cast-iron framing, above which is a fixed covering of brickwork. As the pan revolves the heated

brick hood and over the surface of the material inside. At the same time the material is stirred mechanically by means of three vertical shafts placed radially within the pan and driven by continuous spur gearing above. The pan is worked by gearing beneath, and runs on a racer. When the process is complete, the material is discharged through a circular hole in the centre. The latter is closed during the working by a cylindrical valve, which fits into a suitable seating round the circumference of the discharging aperture, and by raising this valve by means of a tackle above, the material is free to flow out. In order to clear the bottom of the pan a scraper is lowered, and extends from the circumference of the pan to the opening in such a direction that as the pan revolves the material is forced to the centre where the opening is. This scraper is raised when not in use to above the surface of the material by means of rack and pinion gearing above the brick covering. The soda ash produced in this way is either made into, or is used for making soda crystals. It should be mentioned that the soda ash is made of various strengths, common salt being ground with it in an ordinary mill with a pair of French stones. A good deal of this material is now sent away packed in bags, which are found to be cheaper and more convenient than casks. In order to make soda crystals, the soda ash is dissolved in water, and is pumped into large wrought-iron settlers. Here it remains until at a temperature of 92 deg. to 96 deg Fahr., when it is just on the point of crystallisation. It is then run into cast-iron cones about 10 ft. in diameter and 2 ft. 6 in. deep, and allowed to remain for about a fortnight, when the crystallisation is completed. It is then packed for sending away.

For the manufacture of bicarbonate of soda, the solid bottom part of the mass of soda crystals is taken and is broken into pieces about 1 ft. square. These are placed in tiers one above the other in lead chambers. Carbonic acid, generated from limestone and muriatic acid, is then forced into the chambers, and the resulting moist bicarbonate is placed in rooms heated by steam. When dry it is ground and sieved.

The liquor obtained from the lixiviation of the vats has, however, other uses besides the manufacture of soda ash in the manner we have described Much of it is applied to the production of caustic soda in the following way: The liquor from the settlers after lixiviation is run into a vessel called a causticizer, which consists of a horizontal cylinder 30 ft. long and 7 ft. in diameter. Through the axis of this there runs a shaft with arms attached, driven by an engine bracketted to it. This vessel is about two-thirds full of weakened vat liquor, and a certain amount of burnt lime having been added the doors are made up. Steam is then injected until a pressure of 30 lb. is got in the causticizer, and about 94 per cent. of the carbonate of soda is causticized. This is then run off into tanks, of the same shape as the causticizer, and allowed to settle when the lime falls to the bottom. The change that takes place in causticization is very simple. The carbonate of soda and hydrate of lime form hydrate of sodium (or caustic soda) and carbonate of lime. On page 301 we give an illustration of these causticizers, which were made to the order of the firm by Messrs. R. Daglish and Co., of St. Helens.

The clear liquor remaining is then syphoned off and pumped into wrought-iron pans placed at the end and fired by the waste heat from the "revolver" before described. The liquors from here are run into caustic pots of cast iron, which are 10 ft. in diameter and 6 ft. deep, and are each fired separately. When the fires are stopped the clear liquor is baled with a ladle into finishing pots and fired until the liquor in the pot is concentrated to a great degree and is brought to an excessively high temperature. The liquor is then cooled and ladled into wrought-iron drums. When cold it has the appearance of a block of white marble.

Attached to these works are various shops and offices. There is a machine shop and smithy. The cooperage is very extensive, and the wrought-iron drums used for packing are all made on the premises. For this purpose the sheet iron is cut to gauge by machine shears, and the ends are turned over by a bending machine of ingenious construction. The plate is then passed through rolls and rivetted with four or five rivets, when the cylindrical part is formed. The ends are cut circular by a machine, and are flanged by a steam press, after which the filling hole is stamped out. The ends are put in and U-pieces are placed over the chine to strengthen the whole.

A large branch of the Flint Chemical Works is devoted to the extraction of copper from the burnt ore taken from the roasting kilns, which have been described in connection with the manufacture of sulphuric acid. This ore contains about 4½ per cent. of copper, the rest being nearly pure oxide of iron. The burnt ore is mixed with salt, and is taken by means of a steam hoist to the crushing mill, which consists of a pair of chilled iron rollers weighing about three-quarters of a ton each. The crushed ore is carried in wagons on to the top of roasters, of which there are seven. These are ordinary blind furnaces heated by gas generated in producers placed close by. The latter are simply brick chambers, in which the coal is burnt with an insufficient supply of air to produce perfect combustion. The use of gas allows the workmen to have complete control over the heat of the roaster, a point to which attention has to be paid, as the ore must never be heated above a temperature of 800 deg. Fahr. Pieces of zinc are used for testing the temperature. The ore is treated in this way for some time, the result being that the sulphides and oxides are reduced to a soluble chloride.

The ore having been thus roasted is put into vats about 12 ft. square, and is washed first with a solution of brine, afterwards with weak *hydrochloric acid, and then with water in order to* free it from the acid. The liquor from these tanks is run into another range of tanks where it is allowed to settle. It is then carried by a steam injector to a higher range of tanks, and is treated with a solution of iodine, which has the effect of precipitating the silver and gold. The residual liquor is run into a lower range of tanks containing clean scrap iron, and is steamed until the copper is thrown down as a fine powder. This is washed in water through a fine sieve for the purpose of extracting any small pieces of iron that may remain, and is afterwards placed on a drainer, and ultimately dried on a hot-bed. The resulting precipitate contains about 82 to 83 per cent. of copper. The remainder is oxide of iron.

Returning now to the silver extracting process, the precipitate thrown down by the addition of the iodine solution, is collected in a large vat, and washed free from all traces of copper. The silver mud left is treated with clean scrap zinc, and steamed until all the *iodide of silver is decomposed*, and iodide of zinc is formed The latter is retained for treatment and use in the process again The silver mud resulting from this last operation is washed and dried ready for smelting It contains on an average 4000 oz. to 5000 oz of pure silver per ton, besides several ounces of gold. The iodine solution used, is made on the premises by dissolving iodine in water together with a small quantity of sulphite of soda, after which it is standardised for use.

The residue from the washings above described is nearly pure oxide of iron, there being only about 2 per cent. of impurities. This will no doubt be recognised by many of the members of the Iron and Steel Institute who visit these works as the familiar "Blue Billy," or purple ore used in fettling. About 300 to 350 tons of this are produced weekly here, and some of it is sold for blast furnace purposes, for which use it is said to offer many advantages to those who have plant of a type sufficiently advanced to deal with it, with a blast of 6 lb. or so, it is said to answer well. There are large heaps on the works, and on examination it will be seen that in these there frequently occurs dark metallic looking lumps. These were at first thought to be some accidental impurities; on analysis, however, these pieces were found to consist almost entirely of spongy masses of iron, which no doubt may be taken as an indication of the completeness of the way the process is carried out.

THE IRON AND STEEL INSTITUTE.

IN holding their autumnal meeting this year at the City of Chester, the Iron and Steel Institute have made a wide departure from their ordinary practice. Hitherto it has been the custom for the annual provincial meeting of the Institute to be held at some important manufacturing centre more or less directly connected with the iron and steel industry, and in pursuance of this custom it was originally proposed to make Sheffield the headquarters for the present year's meeting. Circumstances, however, into which we need not now enter, rendered it necessary—or at least desirable—to change the scene of the meeting, and it was then that the Council decided, as we have said, to depart from the established practice of the Institute, and to hold the meeting at Chester—a city more widely known for its great historical interest than for any connection it may have with the great industries which the Institute represents That the course decided upon was a wise one, there is every reason to believe, and up to the time of our present writing the Chester meeting promises to be as successful as any which have preceded it.

The proceedings were opened on Tuesday last, when the Institute was welcomed in its meeting room at the Town Hall, by the Mayor of Chester, Mr. C. Brown, by the Lord Bishop, and by the Dean of Chester. These words of welcome having been appropriately responded to by the President, Sir Bernhard Samuelson, the minutes of the last meeting were read and confirmed, and the list of retiring members of Council announced. The President then proceeded to state that in nominating his successor the Council had departed from their usual practice inasmuch as they had gone outside their own body and selected a gentlemen, the importance of whose labours in connection with metallurgical science was second to none, namely, Dr. Percy. This announcement was most favourably received by the meeting, and Dr Percy's nomination as the President for the years 1885-6, was then formally proposed by Sir B. Samuelson and seconded by Mr. I Lowthian Bell. The President next, in a few brief remarks, informed the meeting that the Institute continued to be in a most prosperous condition, that its members, including those proposed for election at the current meeting, numbered about 1400, and that it still maintained its international character, its foreign members continuing to increase in nearly the same ratio as its home members.

THE GEOLOGY OF CHESHIRE.

The reading of papers was then commenced, the first read being one "On the Geology of Cheshire," by Mr. Aubrey Strahan, M.A., F.G.S., of Her Majesty's Geological Survey. In this paper the author said that the geology of Cheshire includes nearly the whole of a well-defined geological basin. The central part of the country is occupied by a broad spread of red marl, extending in its greatest length from a little east of north to *west of south, and terminating near Shrewsbury.* This is the Keuper marl, and forms the upper division of the Trias, it is surrounded by a belt of lighter colour indicating the outcrop of the Bunter sandstone, or lower subdivision of the Trias. At the southern end the red marl is overlaid by a small patch of Lias. There is reason to believe that originally the Keuper marl had a wider distribution than the Bunter sandstone, and overlapped it in all directions. The structure of the Cheshire basin shows clearly that the great mass of red marl filling it owes its isolation to post-triassic movements, and to the consequent unequal action of denudation on the various strata. The marl once extended from the midland counties far up the north-west coast of England. The Lias formerly overspread the greater part of the area that was occupied by the red marl, perhaps even overlapping it altogether, as it does now in South Wales.

The Trias of Cheshire is subdivided into the following beds; thus

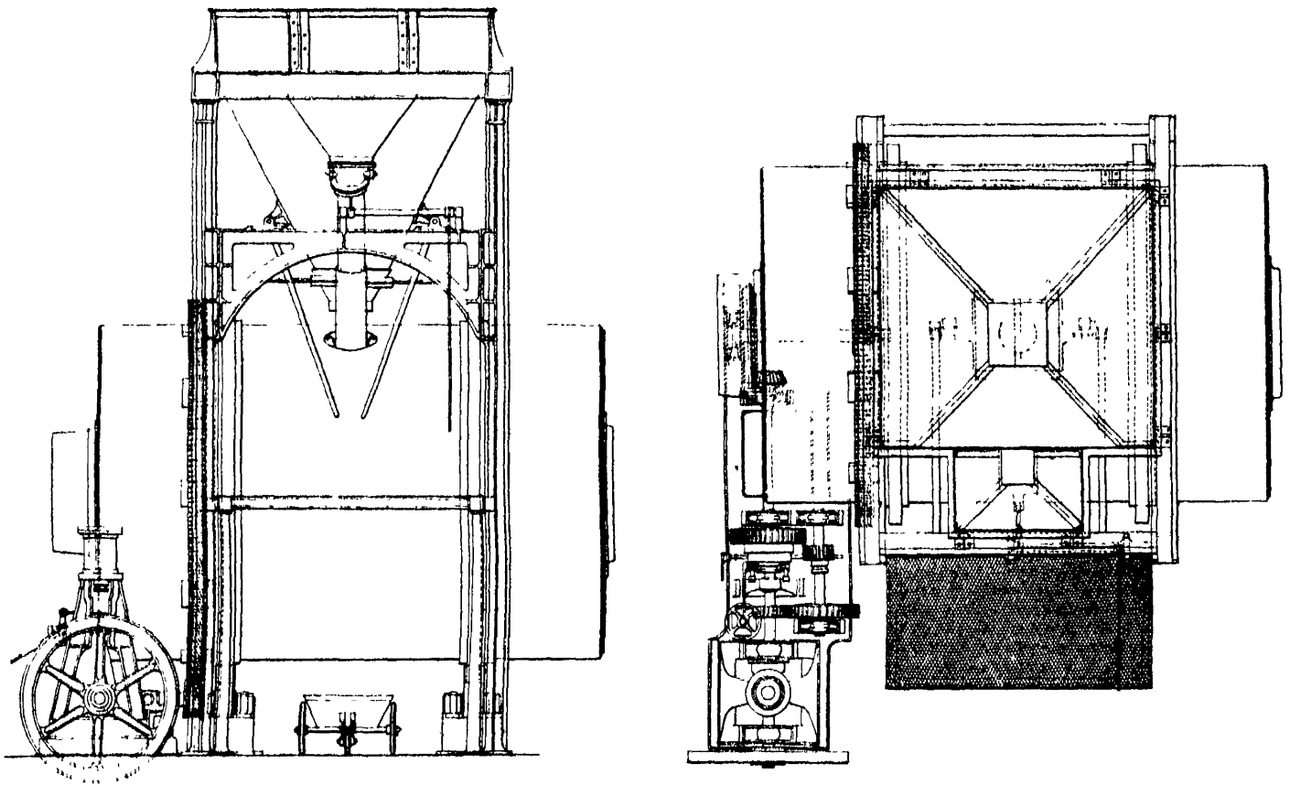
Keuper	Red Marl.
	Waterstones.
	Basement Beds.
Bunter	Upper Mottled Sandstone.
	Pebble Beds.
	Lower Mottled Sandstone.

The red marl consists of red clays and fine-grained flaggy sandstones deposited in very tranquil water. It contains casts of cavities once occupied by crystals of salt, known as pseudomorphs of rock-salt. These indicate the concentration of the water prior to the formation of the rock-salt beds. These occur at two levels; the top rock and the bottom rock, separated by a layer of marl about 30 ft. thick. The top rock is at Northwich 40 to 80 yards from the surface, and is 25 yards thick. The bottom rock is 35 yards thick. Though 150,000 tons of rock salt are mined yearly from the lower bed, it is not one-tenth of the quantity of white salt made from brine, which in 1880 reached 1,800,000 tons. The removal of this material has produced disastrous surface disturbances, while the breaking in of old rock pits has formed funnel-shaped abysses from 50 to 150 yards across. A Bill was brought into

BLACK ASH FURNACE AT THE FLINT CHEMICAL WORKS.

CONSTRUCTED BY MESSRS. ROBINSON, COOKS, AND CO., ENGINEERS, ST. HELENS.

(*For Description, see Page* 298.)



Parliament to provide compensation for this damage by a toll on the salt manufactured, but it was thrown out, the opponents urging that the subsidence was due originally to the action of natural brine springs, and to bad mining in former days. The Cheshire meres were pointed out as the site of old natural subsidences, but they are really shallow basins in drift sands, which naturally take this form.

The outcrop of the basement beds forms the line of picturesque hills from Frodsham by Helsby, Beeston and Peckforton, to near Shrewsbury, and thence by Hawkstone and Alderley Edge to North Cheshire. Near Alderley Edge the rocks are impregnated with copper. The outcrop of the rock is often repeated by faults, as, for example, near Runcorn and Delamere. These beds consist of three or four courses of hard sandstone, separated by bands of fine soft sandstone or seams of shale, the whole amounting to 250 ft. in thickness near Runcorn.

The Bunter sandstone has an upper and lower bed separated by a harder conglomerated sandstone known as the pebble beds, from its containing well-rounded liver-coloured quartzite pebbles. In some places the pebbles disappear. The outcrop of these beds forms a distinct feature, the hill on which Chester stands marking its position. It is also to be seen at Tattenhall, Tarvin, Barrow, Dunham, Saighton, and Christleton.

Turning now to the rocks on which the Trias of Cheshire rests, it will be seen that they are set in a frame of broken and folded Palæozoic strata, mostly of the Carboniferous age. On the west the Trias reposes on the Flintshire coal measures and millstone grit, and in Denbigh on the Permian rocks. Southwards they pass on to coal measures again and millstone grit. Similarly along the southern and eastern boundary they either rest on, or are faulted against, rocks varying in age from the Permian to the Lower Carboniferous. To the north in Lancashire they rest in part on the Permian and in part on the coal measures. There is therefore ample evidence of a uniformity at the base of the Trias, and in more than one instance the unconformable junction is actually visible. This indicates that a very long time elapsed between the conclusion of the carboniferous and that of the succeeding period, a sufficient time to admit of the carboniferous rocks being upheaved, bent into folds, and faulted, and hang simultaneously subject to denudation, so that the upper beds were completely removed along the crest of the folds before the red rocks were spread over them. It thus happened that the red rocks were deposited on a surface composed, like a mosaic, of a great variety of rocks, and though probably consisting in great part of the carboniferous, not necessarily composed of coal measures.

No experiments have yet been made to ascertain the nature of the rocks underlying the Trias of Cheshire. In Lancashire the coal measures have been reached through the Bunter sandstone close to its margin, but the deepest boring made at any distance from the margin merely resulted in an unexpected thickness of pebble beds. The Lancashire sinkings show that in the western part there is either no Permian or it is very thin. It has also been proved that the productive coal measures are overlaid by an enormous mass of measures in which no seam of any value occurs. The dip of the coal measures is, generally speaking, towards the south, in the same direction as that of the Trias, but at a more rapid rate. There would therefore be a great thickness of measures to traverse in addition to the increased thickness of Trias at any point further south. In would therefore seem in the Cheshire basin that, after penetrating the Trias an unknown thickness of Permian would be encountered, and the result would be probably the proving of the upper coal measures only of the Manchester field. The area of upheaval, separating the Cheshire coalfields near Stalybridge from those of North Staffordshire, is considered by Professor Hull to be connected with the Bala fault.

This brief review of the rocks of the Cheshire basin would seem to show that a very great mass of rock would have to be traversed in almost any part of the Triassic area before touching the productive coal measures.

This very able paper was followed by but a brief discussion, the first speaker being Professor T. M'Kenny Hughes, who remarked that on the meeting of a geological society Mr. Strahan's paper would probably have elicited a very warm debate, as it touched upon a number of very controversial points in geological science. It was, however, he observed, unnecessary for him to say anything of these points on the present occasion, as in such a discussion as he had indicated he and Mr. Strahan would be found arranged on the same side. There was, however, one point in Mr. Strahan's paper to which he might invite special attention. It was a theory advanced by Mr. John Phillips that hematite deposits were produced by the washing down into carboniferous limestone of iron in solution. Now Mr. Strahan had pointed out that in the Cheshire basin the Bunter sandstone was overlaid by an impermeable strata which would limit the filtration of water and so reduce any such washing-down action as Mr. Phillips had referred to, and it thus appeared to him (Professor T. M'Kenny Hughes) that any attempt to find hematite deposits on the fringe of the basin did not offer much chance of financial success.

Mr. G. J. Snelus next remarked that, as an unfortunate shareholder, he was bound to differ from a statement made by Mr. Strahan as to the copper which had been worked near Alderley Edge. The sandstone did not contain 2½ per cent. of copper—had it done so it could have been worked profitably. It never, however, contained more than 1½ per cent., and rarely more than 1 per cent., hence it could only be worked at a loss. The discussion then closed, the President, in proposing a vote of thanks to Mr. Strahan for his paper, remarking that he found it difficult to comprehend the action of the Northwich people in going to Parliament to obtain compensation for the damage caused by the subsidences which had taken place in their district. Considering the enormous extent to which the value of land in that district had been increased by the salt industry, he considered that the landowners should have accepted the bad with the good without grumbling.

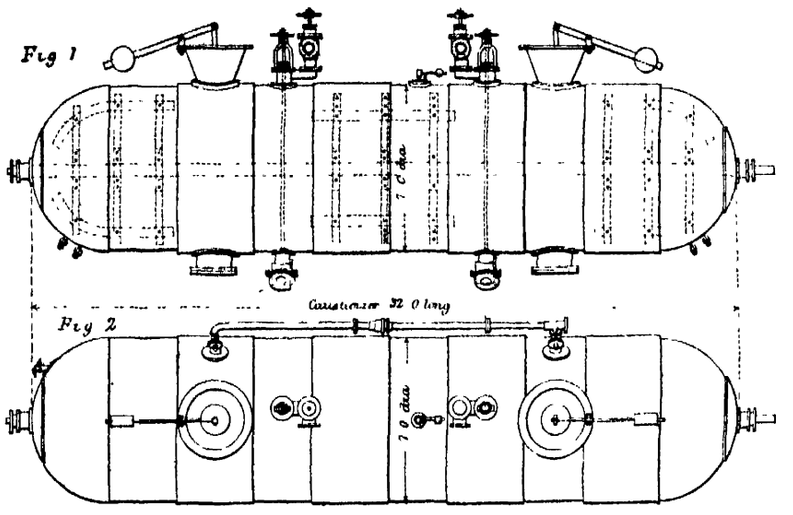
The Manufacture of Crucible Cast Steel.

The next paper read was one "On the Manufacture of Crucible Cast Steel," by Mr. Henry Seebohm, of Sheffield. This was an exceedingly well-written paper dealing with the manufacture of cast steel from the crucible steel maker's point of view—a point of view which has not before been laid prominently before the Iron and Steel Institute.

CAUSTICIZER AT THE FLINT CHEMICAL WORKS.

CONSTRUCTED BY MESSRS. R. DAGLISH AND CO., ENGINEERS, ST. HELENS.

(*For Description, see Page* 299).



We commence the publication of Mr. Seebohm's paper *in extenso* elsewhere in the present issue, and need not therefore give any abstract of it here, but we may say that it was well received by the meeting, and gave rise to an energetic and interesting discussion.

In calling upon the members for remarks on Mr. Seebohm's paper the President announced that he had received a letter from Sir Henry Bessemer, who regretted that the present state of his health did not allow him to be present at the current meeting. In this letter—portions of which were read by the President—Sir Henry remarked that he observed that Mr. Seebohm's paper gave a "nasty kick" at cast steel not made in crucibles. Considering, however, that nearly half the crucible steel now made in Sheffield was produced from Bessemer and Siemens steel scrap, there was certainly another aspect of the matter, and one to which justice could scarcely be done by remarks in the course of a discussion. This being so Sir Henry promised for a future meeting another paper on the subject dealing with it from a different standpoint—a paper which will certainly be looked forward to with great interest.

The discussion was then opened by Mr. Daniel Adamson, who observed that he had been greatly struck with the facts set forth in Mr. Seebohm's paper. It was quite certain that, as there set forth, the details of manipulation were of great importance, but he had found that the Sheffield makers could not yet supply with certainty steel of special qualities required. He had had experience of this in the difficulty of obtaining steel thoroughly fitted for making hardened journals and other wearing surfaces. He quite agreed with the author as to the first cost of tool steel being unimportant compared with its quality. He himself, and he believed plenty of other engineers also, would willingly pay even 2*s.* per pound for such steel, if by so doing a superior quality could be obtained. Speaking next of the barrels of fowling-pieces. Mr. Adamson remarked that it was now possible to use for such barrels a steel of such quality that it was almost impossible to burst them, or which prior to bursting gave such ample warning by distortion as to be absolutely safe. In conclusion he stated that more certainty as to quality was still required for high-class hard steel, and he believed that it was only through the aid of chemists that such certainty in the manufacture would be ultimately obtained.

M. Gauthier (who was indistinctly heard) next made some inquiries of the author as to the percentages of manganese and silicon in some of the Sheffield crucible steels, and Mr. G. J. Snelus, who spoke next, stated that he thoroughly agreed with Mr. Adamson as to the necessity of crucible steelmaking receiving more attention from chemists. The Bessemer and Siemens processes, he observed, had both had the assistance of chemists to a vastly greater extent than the older process, and he believed that Mr Seebohm's own undoubted success had been mainly due to his availing himself of scientific rather than rule of thumb methods. With reference to the question raised by the author in his paper as to whether manganese might not—like carbon—exist in steel in two forms, he (Mr. Snelus) considered that this was most probable. At one of the earlier meetings of the Institute at Merthyr he had read a paper on the condition of carbon in steel, and in this paper he had pointed out that if steel was crushed into powder, and this powder passed through a fine sieve, there would be obtained by this mere mechanical separation, two lots of steel containing different percentages of carbon, this experiment proving that a portion at least of the carbon existed in the steel in the form of a mechanical admixture. Later experiments had proved that the two lots of steel separated by the sifting process also contained different percentages of manganese, and the same with regard to sulphur; the percentages of silicon, however, were not affected by the sifting. Other engagements had prevented him from following up this course of inquiry, but he considered it deserving of further attention. The effect of occluded gases on the quality of steel also required further research, and he believed that when the action of such gases was better understood many points at present doubtful would be explained. Mr. Seebohm had alluded to the great value of Dannemora iron as a steelmaking material, and this he (Mr. Snelus) considered to be due to its almost entire freedom from phosphorus, it being probably more free from that material than any other iron made. Much had of late been done in the elimination of phosphorus in steelmaking, but no means had yet been devised of removing this small percentage of phosphorus—0.02 to 0.03 per cent.—existing in some of our irons. If this percentage could be reduced to 0.01 it would be of great value, the effect of even a minute percentage of phosphorus being important.

Mr. Edward Riley observed that he could quite corroborate Mr. Snelus's remarks as to the effect of small percentages of phosphorus, they having been entirely borne out by observations and analyses of his own of Swedish irons. Amongst other investigations he had examined into the qualities of steel suitable for making steel bullets for Nordenfelt guns, and he had found that while steel containing 0.02 per cent. of phosphorus would give good results, that in which the phosphorus amounted to 0.04 per cent. failed.

Mr. Perry F. Nursey, who spoke next, alluded to the remarks of Mr. Seebohm as to the use of "physic" in steelmaking, and said that he had lately had occasion to look into the quality of steel made at Maindy, near Cardiff, by the Jenkins process, a process which involved the use of some such "physic." He had seen an ingot of this steel poured and then made into a turning tool, which had been subsequently tested by Mr. T. Hurry Riches at the works of the Taff Vale Railway, against two other similar tools made of Mushet steel, and the other of the best Sheffield tool steel. The tools were tested in turning steel tyres, the speed of turning and rate of feed being the same in each case. The result was that the Mushet steel came out best, the Maindy steel second, and the Sheffield steel third.

At this point, the luncheon hour having arrived, the discussion was adjourned until the following day, the main bulk of the members, after partaking of the luncheon kindly provided for them at the Town Hall by the invitation of the Mayor of Chester, spending the afternoon in pleasant visits to Hawarden Castle and park, and Eaton Hall, while others, under the guidance of the mayor and other members of the local committee, inspected the Castle, walls, rows, &c., of Chester. In the evening the annual dinner of the Institute took place at the Grosvenor Hotel.

On the meeting being resumed on Wednesday morning the discussion on Mr. Seebohm's paper was continued, the first speaker being Mr. Hall (of Messrs. Jessop and Sons, Limited), of Sheffield. Mr. Hall maintained that the Bessemer, the Siemens-Martin, and the crucible processes of steelmaking were really not antagonistic, but that each had its special features of value. The Bessemer process, he asserted had not interfered with the crucible steel industry, which had increased steadily and was still increasing. In proof of this he stated that during the three years 1881-2-3, the quantity of high-class Swedish iron which had been imported into Sheffield for use in crucible steelmaking had exceeded that in any three previous consecutive years. During the three years named his own firm had imported 18,000 tons of such iron. He did not deny that large quantities of Bessemer and Siemens steel scrap were melted up in crucibles in Sheffield, but this was only used in making the cheaper steels to which Mr. Seebohm had referred. He joined the author in condemning the use of any but the very best steel for tool purposes.

Mr. I. Lowthian Bell, who spoke next, confirmed Mr. Snelus's remarks as to the probable existence of manganese in steel in two states, and mentioned that he had analysed some excrescences in steel ingots and found an excess of both manganese and silica, the latter arising from the expulsion of silicon from the mass of steel and its subsequent oxidation. With regard to the remarks which had been made as to the limited extent to which the chemist was yet able to assist the crucible steelmaker, it should be borne in mind that the science of chemistry, as applied to steelmaking, was as yet in an immature state, chemists not having yet mastered all details of steel manufacture. There was every reason for believing, however, that they would give increased aid in the future. As an instance of the aid chemistry could afford he quoted an instance in which the application of a new method of examination had revealed the fact that red-shortness in a certain class of iron was due to occluded oxygen. This, by the way, we may remark, is a point to which Mr. Parry, of Ebbw Vale, directed attention some time ago.

The discussion was then brought to a close by a few remarks from Mr Seebohm, who regretted that Sir Henry Bessemer had been unable to be present As to the Bessemer process the position with regard to which he had taken up in his paper was not one of attack but of defence. On the motion of the President a hearty vote of thanks was then accorded to Mr. Seebohm for his paper.

THE NORTH-EASTERN STEEL COMPANY'S WORKS.

The next paper read was one entitled "The North-Eastern Steel Company's Works and their Products," by Mr. Arthur Cooper, of Middlesbrough. In it the author said that he should only give a brief description of the works, as the members had visited them so recently, but should refer more particularly to the products, as soft qualities of steel or ingot iron were comparatively a new material. The works were commenced in November, 1881, and finished in June, 1883, and were specially designed to suit the basic process, and to use Cleveland iron. The converting plant consists of four 10-ton converters in a line, on a staging 22 ft. above the ground level. At the end of the converters stand three cupolas, each capable of melting 1000 or 1700 tons a week. The melted iron is tapped into a ladle, which is lifted to the level of the converter stage, and drawn by a small locomotive to the front of a converter where it is tipped. The converter stage, and that

from which the cupolas are charged, are on the same level, so that one locomotive serves them both. The spiegel cupolas deliver their charges into ladles, which are moved direct to the converters on the same level. Immediately behind the converters is placed the lining and bottom shop, and behind these the mills for the basic material.

The dolomite is calcined in a cupola with coke, and is then mixed with 10 per cent. of boiled tar. The bricks for the body are made by ramming the mixture into moulds, and baking it before it is removed from them. The plugs or bottoms are made in the same way. The bottom section in the converters and the side section are likewise rammed with basic material, cast-iron moulds being placed inside the casings for the purpose, and the coking being effected by making fires inside the moulds themselves. Between each pair of converters is fixed a ladle crane by means of which the finished steel is transferred to a casting crane in a 60-ft pit. In front of the casting pit is the cogging mill and the Gjers' soaking pits.

In laying out the works a weekly production of 2500 tons of ingots or 2000 tons of rolled material was contemplated, but the difficulties of starting a new plant, and the prejudice against basic steel, reduced the output for the latter half of 1883 to 24,264 tons of ingots and 18,957 tons of rolled material. Since then better progress has been made, as the rate of working since last June has been 47,000 tons of ingots and 40,000 tons of rolled material per six months. It was objected to soft steel that it was not possible to so control the proportion of carbon as to make rails of uniform quality. This, however, is not the case, and contracts have been satisfactorily executed for English, Scotch, and colonial railways. A large number of samples were exhibited before the meeting to show the quality of the material made from the ingots. Among these were steel sleepers, stampings, tin-plates, and the like. A slightly harder quality of steel, as now used for shipbuilding, that is, a steel having a tensile strain of from 27 to 31 tons per square inch, has been tested and sanctioned by Lloyd's. To further illustrate the qualities of the metal as supplied for boiler-making purposes, other specimens were produced, amongst which was a disc of steel 3¾ in. in diameter, and $\frac{7}{8}$ in. thick, in the centre of which a hole $\frac{1}{8}$ in. in diameter has been drilled, the hole having afterwards drifted out cold till it was 3 in. in diameter without showing *any signs of fracture*; a further disc of the same original dimensions drifted till it burst, which gave a diameter of hole of 3¼ in. when fracture took place.

In conclusion, the author said that it is quite certain that by the basic process a low steel or ingot iron can be produced regularly, having a tensile strain which would not fall below 23 tons or rise above 31 tons, with an elongation of 20 per cent. and upwards. This material could be made at a very much lower cost than the 27 to 31 ton steel used at the present time for shipbuilding, as with the range of 8 tons there would be no necessity for the steelmaker to concern himself about tests during the process, the pig being taken from the blast furnaces molten, the ingots hot from the casting pit, and as far as practicable rolled straight off into the finished product, as in the case of rails, saving heat, waste, time, and labour, amounting in all to a very considerable item per ton on the finished plate or angle.

Mr. Cooper's paper led to a lengthy and well-maintained discussion, although this wandered off somewhat to subjects with which the paper did not specially deal After a few brief remarks from M. Gauthier, the discussion was fairly opened by Mr. G. J. Snelus, who expressed his admiration of the arrangement of plant which Mr. Cooper had devised, and then proceeded to attack what he considered the excessive amount of testing of steel which was now demanded under many specifications. The cost of such testing as was now required amounted to a charge in some cases of as much as 8s. per ton on the steel. And he considered that after all it was comparatively useless. The testing of one plate in fifty, as was a common practice, afforded no guarantee as to the quality of the other forty-nine, while as in other cases when the samples were taken from what he might term the "fringe" of a plate, the results obtained were probably lower than samples from the solid plate would afford. As a substitute for the present system he advocated a simple bending test only of a sample from each plate, and he stated that Lloyd's would really be content with this, every cast, however, being tested by the makers for tensile strain, &c. Such a course would save from 2s. 6d. to 5s. per ton. It would be considered better in many cases to use heavier scantlings than to carry out such elaborate tests as were now enforced.

Mr. James Riley, of Glasgow, entirely disagreed with the remarks of Mr. Snelus on testing. He maintained that the present system of thoroughly testing every plate was in every way desirable, and he remarked that it was only by the results of such testing that steel had obtained its present high position. It might be quite correct that Lloyd's would be content with tensile tests of each charge and a bending test of each plate, but the Board of Trade, dealing with boilers and other important structures were, he considered, quite right in insisting on their present tests. As far as his only manufacture was concerned, he added, he should continue to carry out the present system of testing even if the authorities just named should agree to dispense with it.

In reply to this Mr. Snelus explained that what he particularly objected to was the manner in which the present system of testing was carried out without consideration for the convenience of the maker. At his own works they had had to load plates into trucks, and after these being so loaded the inspector had selected one plate in every fifty to be cut up and tested. This means much extra labour and consequent cost. If the plates were to be tested, the tests should be made by the makers at such times as not to cause delay in the execution of contracts.

Mr. Gordon, of London, expressed his agreement with Mr. Riley and his dissent from the views of Mr Snelus on the matter of testing, and Mr. Daniel Adamson followed on the same side, remarking that when he had bought plates of Mr. Snelus he had always tested every plate. Commenting on the table of tests of basic steel given by Mr. Cooper in his paper, Mr. Adamson wanted to know at what strains permanent elongation of the samples took place. This was a most important point, and he considered that the table as it stood was very misleading. Comparing two results in the table, namely, those of blows Nos 836 and 844, in which the breaking strains were 28 34 and 23.92 tons per square inch respectively, the elongations 23 per cent. and 29 per cent., and the reductions of area 55 3 and 59.3 per cent, he observed that these results as they stood did not enable a proper judgment to be arrived at as regarded the quality of the steel. The length of the sample was important. In testing samples with a lever testing machine in a way commonly adopted, the final section was the only record of the ultimate result, the point at which the load ceased to be carried not being obtained. The maximum load applied was not that which would be carried by the final section, this section being the result of the metal drawing out after the load began to drop. The strain under which the metal took permanent set was really that which they had to consider in choosing a material for certain purposes and determining the load which it was safe to put upon it For bridge construction he had long advocated the use of a steel with as high a breaking strain as 60 tons per square inch. Such a metal could be made to afford an elongation before fracture of some 12 per cent., while the strain at which it would take permanent set was a very large percentage of its breaking strain. He quite agreed with Mr. Riley as to the necessity of thorough testing and the keeping of a complete record of results. Alluding next to the Penistone accident, Mr. Adamson remarked that the frequent fractures of crank axles which occurred were not creditable to railway engineers and that they showed the necessity of greater testing and research to determine the proper materials and proportions. He considered that railway engineers should be less manufacturers and confine their attention more to the working of their lines and the carrying on of their traffic in safety. During the past twenty years or so marine practice had advanced far more than locomotive practice, and this he considered due to the designing of marine engines being in a greater number of hands than was the case with locomotives. With regard to some of the samples of basic steel exhibited by Mr. Cooper, he observed that in drifting out holes cold the rate at which the drifting was done was an element of importance. He had himself adopted a taper of 1 in 20 as the standard for the drifts he used for drifting out holes for testing steel plates.

Mr. E. A. Cowper entirely agreed with Mr. Adamson's remarks as to the importance of observing when testing the point at which permanent set took place. The limit of elasticity was certainly the limit which had to be taken into account as deciding the strength of a material for structural purposes.

Mr. Edward Williams next spoke in praise both of the arrangement of the North-Eastern Steel Company's Works and of the care exercised in working them. The basic process he considered would certainly succeed there if it succeeded anywhere. As to the quality of the material which could be produced by the basic process, he considered that proved, and he regarded the exhibition of samples by Mr. Cooper as scarcely necessary. Frequently as he had visited the North-Eastern Works, he added, there was a feature in the process which never failed to excite a certain feeling of wonder. At these works the molten iron was brought in a ladle containing some ten tons, from blast furnaces about a mile distant, and owing to blocks on the intervening lines, a period of three-quarters of an hour not unfrequently elapsed from the running of the metal from the blast furnace and its being poured into the converter. Notwithstanding this no trouble was experienced, and in another three-quarters of an hour the metal was lying on the benches in the form of rails without an atom of fuel having been consumed in its conversion beyond that burnt to provide the steam for the blowing engines and engines of the rolling mills. In conclusion Mr Williams asked why it had been deemed necessary to provide both soaking pits and reheating furnaces in the North-Eastern Steel Company's plant.

The next speaker was Mr. I'Anson, of Darlington, who considered the present system of testing to be necessary to eliminate variations in quality of material due to imperfections of manufacturing processes, he being followed by Mr. William Whitwell, who commended Mr. Cooper's paper as a straightforward description of a well-arranged plant for the basic process. As regarded the testing question, he could not help thinking that when Mr. Snelus complained of the elaborate nature of present tests, there must be some cause for insisting on such tests. Mr. Whitwell added that his firm had had most favourable experience of the basic steel produced by the North-Eastern Steel Company, it being possible to obtain it with a percentage of carbon lower than he could procure with certainty from either the ordinary Bessemer steelmakers or the makers of Siemens Martin steel.

Mr. Walmsley next inquired how many samples had been spoiled in making the specimens exhibited, and Mr. I. Lowthian Bell stated that they had now some 50,000 tons of basic steel rails laid on the North-Eastern Railway, and that they had found the quality as regular and satisfactory as that of rails made by the acid process. This experience, the President (Sir B. Samuelson) remarked, was corroborated by that of the Indian State Railways. With regard to an observation which had fallen from Mr. Edward Williams, he (the President) said that he certainly did not consider the exhibition of samples by Mr. Cooper unnecessary. As far as he was aware no such a series of samples of different varieties and sections of steel produced by the basic process had ever before been prepared and exhibited, and he considered these samples of high interest. With regard to the table of tests in Mr. Cooper's paper, it must be borne in mind that these referred to the lowest grade of basic steel, and they showed that a cheap steel of good quality could be produced. The remarks which had been made on testing showed, he thought, that there were two ways of ascertaining the same facts, and much might be done to promote the convenience of manufacturers in carrying out tests. He considered it a question quite worthy of serious consideration whether or not the Iron and Steel Institute as a representative body ought not to do something to establish standard modes of testing. Perhaps his successor, Dr. Percy, might be able to organise some inquiry of the kind.

Mr. Cooper, in replying to the discussion, stated that his test specimens were 8 in. long, this being the standard length adopted by Lloyd's and the Admiralty. He certainly did not shirk testing, but rather courted it. The latter part of his paper, he pointed out, dealt with the production of a cheap steel which he considered could in many cases be advantageously substituted for wrought iron.

In answer to Mr. Williams, he stated that they had provided both soaking pits and reheating furnaces, because they had but one mill, and it was not at all times possible to roll ingots right off, there being delays from changing rolls, &c. At present, in fact, they were not able to use the soaking pits so regularly as they should like to do. The specimens exhibited did not contain more than 0.4 per cent. of carbon. He was unable to answer Mr. Walmsley's question, as the samples had not been prepared by his firm, but by the various firms to whom the North-Eastern Steel Company had supplied steel. It was only fair to suppose, however, that the production of the samples was not attended by any serious difficulties, or these firms would not have been so ready to supply them. At the conclusion of Mr. Cooper's remarks a vote of thanks was, on the motion of the President, cordially accorded to him for his paper.

Regenerative Gas Furnaces.

The next paper read was one "On a New Method of Heating the Regenerative Gas Furnace," by Mr. Frederick Siemens. Of this paper, which was left for discussion with those which succeeded it, the following is an abstract.

Mr. Siemens said that hitherto it had always been considered that the first condition of furnace working was to make the space to be heated as small as possible, and to bring the flame into intimate contact with the lining and with the material under treatment. Personally he had for some time doubted the correctness of this view, and had now satisfied himself that in regenerative gas furnaces the flame should only radiate heat upon the material to be melted, and should not come into actual contact with it. Referring to the diagrams exhibited before the members, Mr. Siemens pointed out that in the latest form of furnace the flame either traversed it from end to end, or swept round it in a horseshoe form, clear of the material to be heated, and out of contact with the walls. The new method of heating required, he said, a large space for the development of the flame. It must be borne in mind that in a gas furnace the amount of fuel used does not depend so much upon the intensity as upon the quantity of heat required, whereas in the solid fuel furnaces large quantities of fuel must be consumed to obtain a high temperature. In a crucible steel furnace 2 per cent. only of the heat is taken up by the steel, the rest going to maintain the heat at steelmaking temperature. In a gas furnace for the same purpose the greater part of the heat of combustion is taken up by the steel. In a reheating furnace there is an economy of 33⅓ per cent. in favour of gas as against coal when the furnace is at work, and 80 per cent. if the temperature is merely maintained without any iron passing through.

Improved quality and increased output, with a longer life of furnace, are obtained when the active flame is not allowed to come in contact with the materials, the interruption of combustion by the interposition of solid bodies always tending to injure them. Besides flame is always more or less quenched when it is brought into contact with solid objects, and a good flame, or in other words, perfect combustion, can only take place in an open space. In illustration of his remarks the author mentioned a glass pot furnace at Dresden which now turned out 140,000 bottles a month in place of 80,000 before it was altered, and in which the life of the pots was now doubled. At Landore the reconstructed furnaces are expected to have a life five or six times as long as the old ones with an economy in fuel. In reheating furnaces it is of great importance the flame should not touch the metal, as it produces oxidation, and there are many other purposes, including boiler heating, to which the new system will be applicable, and the author believes that it will give results that will far surpass any that have been obtained hitherto, and that its application in the arts will be multiplied to a degree which even its warmest admirers would scarcely have thought possible a short time ago.

The paper was illustrated by diagrams of a steel-melting furnace, a heating furnace, and a crucible steel-melting furnace, showing the arrangements for admitting the gas and air.

The Manufacture of Open-Hearth Steel.

An excellent paper "On Recent Improvements in the Method of Manufacture of Open-Hearth Steel" was then read by its author, Mr. James Riley, of Glasgow. This paper we shall publish *in extenso* in an early number, but meanwhile we give an abstract of its contents.

Mr. Riley said, "At the time when nearly the whole of the steel made by the Siemens process was used for rails, I made proposals which I undertook would reduce the then cost of rails by about 1l per ton. Unfortunately they could not be adopted, and we had a lingering existence until the introduction of ferro-manganese enabled us to make plates, &c., for ship, bridge, and boiler work, and abandon the manufacture of rails. At that time it was good work to turn out 50 tons per week at a large furnace, and the total cost of labour in the melting shop and gas-producing works, was 14s. per ton of ingots. With a modern Siemens furnace 140 to 150 tons can be made per week, and in special cases 200 tons.

"The remodelling of the Blochairn Works, after they were acquired by the Steel Company of Scotland, gave us the opportunity of embodying in our newer practice the results of our experience at Newton. Two 20-ton Pernot furnaces were erected in haste as an experiment, but the results were not satisfactory. After three months' trial it was determined to employ Siemens furnaces, and in 1881 experiments were made for some weeks with a furnace lined with basic material, under the personal superintendence of Messrs. Thomas and Gilchrist It had, however, to be abandoned on account of difficulties resulting from the fluxing of the lining at the lines of division of the basic and acid material. For a few months furnaces of the Batho type were at work, and although not as yet perfect, it is arranged that some of the older furnaces that require to be renewed shall be replaced by these. The modification known as the Hackney port was also tried, and will be fitted to all the melting furnaces as they are stopped for repairs.

"We erected a row of twelve 15-ton furnaces; the ingots were cast in one long pit parallel to and close in front of the furnaces, and the relative positions of the hammers, mills, and melting shops were so arranged as to enable us to transfer the ingots to the hammers at such a temperature as it was thought would enable us to dispense with reheating. But when we tried to hammer the ingot with only its initial heat, we either found the centre too soft or the outside was too hard. The twelve furnaces all started work together on Sunday night and consequently all were ready for tapping at about the same time, and hence the ingots, being produced in batches, got cold before they could be hammered. To remedy this I devised a set of movable soaking pits, but afterwards arranged with Mr. Gjers for the use of his, and at the same time I determined, as far as possible, to substitute cogging for hammering Acting on this idea I reorganised the Blochairn Works There are now there eleven 15-ton furnaces and one of 25 tons In front of the furnaces is a line of railway on which runs a small locomotive with a carriage conveying a ladle for steel and a mould for slag About the centre of the furnaces and directly over the railway is a 20-ton lift, and exactly in front of this is a 20-ton casting crane provided with hydraulic engines for turning it on its axis, and a ram for turning over the casting ladle after each cast. This crane is placed in the centre of a semi-circular casting pit 40 ft. in diameter and about 3 ft. deep. Around the pit are erected three ingot cranes, and between the cranes are two sets of soaking pits, each of six cells of differing capacity for ingots of 30 cwt. and 60 cwt. each. The two outer cranes set the moulds in the pit ready for casting, and afterwards strip the ingots and deposit them in the soaking pits. The centre crane lifts the ingots from the soaking pits and places them vertically on the tipping carriage at the end of the feed rollers of the cogging mill. A hydraulic cylinder and ram are placed to take hold of an arm on the carriage and turn it down to deliver the ingot gently. The mill has rolls with 32 in. centres, and between the feed rollers there are arms to turn the ingot on flat or on edge.

"The melting furnaces are charged in rapid succession, and, on one coming ready for tapping, the carriage and ladle is placed in front of it, and the whole of the steel and slag run into the ladle, the latter overflowing into the slag mould. The ladle is then placed under the lift, and the contents poured into the casting ladle, from whence they are delivered into the moulds. After 20 minutes the moulds are stripped, the ingots are placed in the soaking pit, where they remain 55 minutes, and are then passed to the cogging mill. The slab is finished in 95 minutes; 14 for tapping and casting, 20 minutes in the moulds, 55 in the soaking pit, and 5 for cogging and shearing"

Mr. Riley's paper, like that which preceded it, was left for discussion with the paper by which it was followed.

A New Form of Regenerative Gas Furnace.

The last paper dealt with on Wednesday was that by Mr F W. Dick, of Glasgow, "On a New Form of Regenerative Furnace." This paper—which was only partially read on Wednesday, its completion being left for yesterday (Thursday) morning—we publish *in extenso* on page 294.

With the partial reading of Mr. Dick's paper the morning meeting of Wednesday was brought to a conclusion, and the members adjourned to the general railway station, where a special train, kindly provided by the London and North-Western Railway Company, was in readiness to convey them to Crewe. There are probably no works in the kingdom which have so frequently been visited by scientific societies during their provincial meetings as these at Crewe, yet the frequency of these visits by no means diminishes their interest Under the energetic management of Mr. F W. Webb, the resources of the works are constantly being enlarged and developed in a manner which has scarcely a parallel elsewhere, and which maintains them always in the foremost rank of the great industrial establishments of the world. The space at our disposal this week will not permit us to do more than mention the Crewe visit on Wednesday last, but we shall deal with it in our next issue, when we shall also be able to give an account of the proceedings on the later days of the Chester meeting.

On Thursday morning Messrs Siemens, Riley, and Dick's papers were discussed, and two other papers—"On the Recovery of Bye-Products from Coal," and "On Utilising the Bye-Products from Hoffman Coke Ovens"—by Messrs. Otto and Smith, were read and the discussion commenced, but at too late an hour for the account to reach us before we went to press.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, September 12, 1884.

THERE are inquiries in the iron market this week for *15,000 tons of structural iron. Orders for steel rails* this week foot up about 50,000 tons, at 27 dols. per ton. Five stations are to be built on the Sixth Avenue Elevated Railway line in New York, and a number of smaller contracts have been placed for structural iron, which will foot up about 1000 tons in all The structural iron manufacturers are quite busy, although not crowded; but from to-day's indications it would seem that a large amount of material will be ordered within the next thirty days, and that there will be no scarcity of work throughout the winter. The railroad companies are placing a good many orders; one order this week came from the Baltimore and Ohio Company for 5000 tons of structural iron, which went to Pittsburgh The outlook for the iron trade at present is a little more encouraging than for some time past, and manufacturers believe that a good many of the railway companies will place their requirements before the election, because there are probabilities that prices will be firmer after that event In other branches of the iron trade there is not much activity. The proposition to shut down the blast furnaces for a month has finally failed. The latest proposition is to recommend a month's suspension in about one-fourth of the producing capacity, the owners of that capacity to select the time when they will restrict. This amounts to nothing, they will do so anyhow, but not because of any advice given, but because the market conditions demand it. There is a fair movement in merchant bar, sheet iron, plate iron, merchant steel, and nails The demand is regular, and prices are steady One contract for 40 miles of wrought pipe has just been placed at Pittsburgh. *Twenty million* pounds of Lake copper have just been sold at 13 cents., to be delivered as called for; other metals are very dull. Advices from all the leading trade centres show a slight improvement in the volume of general business. The crops are beginning to come east, and there is a general improvement in trade conditions; it is not very great, yet sufficient to show that the worst has been passed. The textile interests are still afflicted with enormous stocks of goods. The Electrical Exhibition in progress here attracts great attention, and especially so because of the presence here of a number of British scientists of world-wide fame Lectures are delivered daily on scientific questions; the Exhibition is attended by thousands, and the displays are creditable to the originators and to the electrical interests of the country.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The warrant market was strong on Thursday forenoon, with business done at 41s. 9d. to 41s. 10½d. cash, also at 41s. 11d. to 42s. 0½d. one month; and sellers at the close were asking 41s. 11d. cash and 42s. 1d. one month, with buyers near. There were transactions in the afternoon market at 41s. 11d. down to 41s. 10d. cash, also at 42s. 0½d. down to 41s. 11½d. one month, with sellers at the close wanting 41s. 11½d. one month and buyers offering 41s. 11d., and the cash price nominally 41s. 9½d. Friday's market was also strong, and closed at the best point, being an advance of 3d. per ton on the day and of 6½d. on the week. Transactions were reported in the forenoon at from 41s. 10d. to 42s. cash, also at 41s. 11½d. up to 42s. 2d. one month, the close being sellers at 41s. 11½d. cash and 42s. 1½d. one month, and buyers at 1d. per ton lower. In the afternoon the quotations ranged from 41s. 11½d. to 42s. 0½d. cash, and from 42s. 0½d. to 42s. 2d. one month, the market closing with sellers at 42s. 0½d cash and 42s. 2½d. one month, and buyers offering ½d. less per ton. On Monday the warrant market was rather weak, and 1½d. of Friday's gain was lost. Business was done in the forenoon at from 42s. to 41s. 11d. cash, and from 42s. 2d. to 42s. 1d. one month, closing with buyers at 41s. 11½d. cash and 42s. 1½d. one month; sellers ½d. more. The quotations in the afternoon were from 42s. to 41s. 11d. cash, and from 42s. 2d. to 42s. 1d. one month. Finally the market closed at the nominal prices of 41s. 11d. cash and 42s. 1d. one month. A flat market prevailed yesterday, especially in the afternoon In the forenoon the quotations were 41s. 11d. to 41s. 10d. cash, also at 42s. 1d. to 41s. 11½d. one month. Business in the afternoon was transacted at 41s. 8½d. to 41s. 9½d. cash; buyers 41s. 9d. cash. To-day's business was first done at 41s. 9d. to 41s. 9½d. cash, also at 41s. 11d. to 41s. 11½d. one month, closing with sellers at 41s. 9½d. cash and 41s. 11½d. one month; buyers ½d. per ton less. Afterwards there was a severe drop, the quotations then being buyers at 41s. 7d. cash and 41s. 9d. one month. A considerable amount of animation has been shown in the pig iron market during the past week, and a somewhat brisk business has been done in warrants, large quantities of iron changing hands at advancing prices. So far as can be ascertained, the altered condition of the market has been mainly due to purchases being made by the trade to cover oversales, the influence leading to it being rumours of production being curtailed. As regards the reduction of the number of furnaces in blast, however, there does not seem to be any appearance of that taking place in the immediate future. It would seem that enormous losses are being made by producers of pig iron. It cannot be said that there is any marked improvement in the demand. The autumn requirements are proving to be rather better than were expected, and as the superior brands are not plentiful, the feeling is more quickly perceived. Special brands maintain high prices, and in several instances the prices have been advanced, owing to purchases having been made for prospective requirements. The reports from the United States and the Continent remain unchanged, but there is rather more business doing on Canadian account. The number of blast furnaces in actual operation is still 94, as last week, and as compared with 115 at this time last year. By the end of the present month the only furnace now blowing at the Castlehill Iron Works of the Shotts Iron Company will be blown out. Last week's shipments from all Scottish ports amounted to 11,021 tons, as compared with 13,167 tons in the preceding week, and 14,338 tons in the corresponding week of 1883. There were shipped to the United States, 1205 tons; Canada, 1200 tons; South America, 65 tons; India, 160 tons; Australia, &c., 490 tons; France, 265 tons; Italy, 50 tons; Germany, 1055 tons; Holland, 560 tons; Belgium, 50 tons; Spain and Portugal, 56 tons; other countries, 245 tons; and coastwise, 5631 tons. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores yesterday afternoon stood at 583,782 tons, as compared with 584,527 tons yesterday week, showing a decrease of 745 tons over the week.

A Hundred-Ton Weighing Machine—What is stated to be the largest suspension weighing machine in existence has just been constructed for Messrs. J. and G. Thomson, shipbuilders, Clydebank, by the well-known firm of Messrs. Henry Pooley and Son, Glasgow. In itself the machine weighs 2 tons 16 cwt., and is graduated to weigh from 28 lb. up to 100 tons; while it has been certified by the Board of Trade to bear a strain of at least 120 tons. The machine consists of an upper link or band of wrought Bessemer steel, by which it is suspended from the shears. Beneath this is the weighing machinery, and inclosed within a waterproof box is the graduated scale covered with nickel silver to prevent rust. The lower part comprises a link of Bowling iron, from which is suspended the article whose weight is to be ascertained.

NOTES FROM THE SOUTH-WEST.

South Wales Sliding Scale Committee.—A meeting of the Joint Sliding Scale Committee of Monmouthshire and South Wales was held on Saturday. It was resolved to appoint Mr. Kirkhouse, of Leeds, and Mr. Parsons, Newport, auditors of the coalowners' books for the four months ending the 31st of August, 1884, so as to ascertain the selling prices for that period, and the secretaries were instructed to request them to proceed with the work forthwith. The Gelli strike was discussed at considerable length, but we are given to understand that no mode of settlement of the question in dispute was arrived at. The Rhymney Company's Mandy Pit dispute, which arises out of a proposed change in the mode of payment for coal, was considered; the company hitherto paid for through-and through coal, but now proposes to substitute payment for large and small, notice to this effect, expiring on the 30th inst., having been given to the men. The matter received careful attention, but this being the first intimation of the question, no definite arrangement was arrived at.

Banbury and Cheltenham Railway.—The official inspection of the Banbury and Cheltenham Railway took place on Thursday, and the line will be partially opened October 1.

Newport.—The Powell Duffryn Company continues to send large quantities of coal from its Aberdare Collieries to Newport *vid* the Pontypridd and Caerphilly Railway. The first train of coal by this route from the Rhondda Valley was brought through on Wednesday. In the steam coal market the demand for the best qualities is fairly good; the demand for secondary qualities is, however, quiet. There is not much change to record in house coal. The iron ore market continues quiet. The shipments of manufactured iron have been but small, consisting only of 460 tons to Christianstad, and 224 tons to Rio Grande. There is not not much activity at the various local works. Last week's coal clearances amounted to 55,046 tons. From Bilbao there arrived 9950 tons of iron ore, and 2018 tons came to hand from other sources.

Ashton Vale Iron Company (Limited).—The report of the Ashton Vale Iron Company states that the operations of the past year resulted in a profit of 6544*l.*

Caerleon.—The Llwydarth Tin Plate Company has purchased the tin works at Caerleon, which have been idle for some time.

Cardiff.—There has not been any important change in the steam coal market. The tone generally is quiet. The shipments of patent fuel have been good, and this market has a firm appearance. In the house coal trade some shippers are well supplied with orders; the market generally, however, is easy. The iron ore market continues quiet. Last week's coal clearances were 135,148 tons. There were also sent away 2986 tons of patent fuel, 1456 tons of iron, and 700 tons of coke. From Bilbao there arrived 7374 tons of iron ore, and 523 tons came to hand from other sources.

Tramways in the West.—The half-yearly meeting of the Bristol Tramways Company was held on Wednesday, when a dividend at the rate of 4*l.* per cent. per annum was declared. It was stated by the chairman that it was the intention of the Board to carry the Redland line up to the reservoir on the Downs, and also up Park-street, provided they saw their way to the introduction of the cable system, which they were closely watching. The report was adopted. The half-yearly meeting of the Gloucester Tramways Company has also been held, and a dividend at the rate of 4*l.* per cent. per annum was declared. It was stated, as the cause of a larger dividend not being paid, that trade in Gloucester was very dull.

Water Supply of Cardiff.—A meeting of the Water Works Committee of the Cardiff Town Council was held on Friday. A letter was received from Messrs. Walker and Co., submitting the names of fresh sureties in connection with their contract for the Llanishen reservoir, and the committee resolved to accept them.

THE ENGLISH AND SCOTTISH BOILER INSURANCE COMPANY.—The chief offices of the English and Scottish Boiler Insurance Company (Limited), in Manchester, have been removed to larger and more convenient premises on the ground floor at 58, Fountain-street.

THE NILE EXPEDITION.—Of the numerous methods which have been suggested for surmounting the difficulties of ascending the rapids of the Nile, one of the most practical is probably that of conveying the boats and stores along a loop line of railway where the passage of the cataract is impracticable. This plan has been approved by Lord Wolseley, who last week telegraphed to the authorities at Whitehall asking that a portable railway should be forwarded to Egypt without delay. The commission was entrusted to Messrs. J. Fowler and Co., of Leeds, who received the order by telegram on the 11th inst. and had one of their portable railways completed last week, when it was sent off for shipment.

COMPETITIVE TRIAL OF ELECTRIC LAUNCHES.—A company of seven in the Electricity, including Mr. Courtenay, managing director of the Storage Company, Mr. Simpson, representative of Messrs. Siemens, Mr. Thornton, and others; a company of eight in the Australia with Mr. Stephens, Lieutenant Robinson, R.N., H.M.S. Vernon, Mr. A. Reckenzaun, and others started from Millwall at 1.55 on Saturday last, arriving at Charing Cross at 2.32, the Australia leading. The Reckenzaun motor on board the Australia took a current of 37 ampères with 100 volts. The Siemens O, propelling the Electricity consumed 47 ampères with 80 volts, but the accumulators of the Electricity were heavier than those on the Australia. The boats returned from Charing Cross at 2.40, made two stoppages of about ten minutes each, and arrived at Greenwich pier at 4.10 p.m. Both launches cruised about until six o'clock, when they were docked at Millwall on the Storage Company's wharf. The proceedings were very successful, and the whole party, consisting of some twenty-four gentlemen, some of whom were on the steam launch, expressed their admiration and congratulations. The cost of the Australia complete is 200*l.*

CRUCIBLE CAST STEEL.

*On the Manufacture of Crucible Cast Steel.**

By Mr. HENRY SEEBOHM.

THE old-fashioned method of converting bar iron into steel and afterwards melting it in clay pots to form ingots of cast steel, which are reheated and rolled or hammered to the size and shape required, has been so frequently described that I should not have ventured to bring the subject before the notice of the members of the Iron and Steel Institute had I not been requested to do so by the Council of the Society. It was suggested that, inasmuch as the Journal of the Institute did not contain a paper on this subject, the occasion of the annual meeting of the members being held in the town of Sheffield, the headquarters of the crucible cast steel trade, would present an appropriate opportunity for collecting the facts connected with such an important branch of industry.

These facts may, perhaps, be all the more interesting now that Sheffield has somewhat ungraciously failed to respond to the wishes of the Institute; not in the least degree from want of hospitality, but from a deeply-seated belief that the Patent Laws are so bad that it is more profitable to keep secret a mechanical improvement than to patent it. Sheffield inventors have learnt by bitter experience that secrecy is the only protection for improvements; and if they think that they have found a goose that is going to lay golden eggs, they look and double-lock the fowl-house door. It is said that there is no Act of Parliament through which you cannot drive a coach-and-four, and I am afraid that the Patent Laws are no exception to the rule, if you only have sufficient money to buy a strong enough team.

I may premise that I have nothing new to bring forward. No Sheffield firm has yet succeeded in discovering the philosopher's stone. We all have our little secrets, which we jealously guard (and they have no greater scientific value than the secrets of the Masonic fraternity), but in spite of the important and valuable discoveries which have been perfected during the last quarter of a century in the methods of producing cast steel, the old-fashioned crucible steel manufacturers of Sheffield still hold their own. They still convert bar iron into blister steel and melt blister steel into cast steel, and some of them have not been altogether unsuccessful in transmuting cast steel into gold.

The accumulated experience of a century has convinced the manufacturers of crucible cast steel that the finest qualities can only be made from bar steel which has been converted from iron manufactured from Dannemora ore. This iron is expensive; its average cost for the last forty years has been at least 25*l.* a ton; the process of converting it into steel is slow and costly; the process of melting in small crucibles is extravagant both in labour and in fuel, and consequently the best qualities of crucible cast steel can only be sold at a high price. So-called best crucible cast steel is sold at low prices by unscrupulous manufacturers and bought by credulous consumers, but though it is quite possible for high-priced steel to be bad, it is absolutely impossible that low priced steel can be good. The finest quality of steel cannot be made of cheap material or by a cheap process. Every year the attempt is made, and every year it signally fails. No one ever made a better try than Sir Henry Bessemer, but his failure was as complete as that of his predecessors. He attempted to produce an article at 6*l.* a ton to compete with one at 60*l.* a ton, and failed absolutely. It is true that his steel is a success, perhaps the most brilliant success of the century. I am not quite sure that he himself believes in his failure. In his lecture before the Cutlers' Company of London in 1880 he chaffed the steel manufacturers of Sheffield on their antiquated attachment to the rule of thumb, and twitted them with the assertion that the high price of crucible cast steel arose from a combination of trade interest on their part and of prejudice on the part of their customers. Sir Henry Bessemer may have half-ruined the wrought-iron trade, and revolutionised the pig-iron trade, but the crucible cast-steel trade holds its own in spite of his great discoveries. When railways were first introduced, and wagons and coaches were to a large extent driven off the road, many people thought that the price of horses would permanently fall, but exactly the contrary took place. Similar fears were entertained that the demand for crucible cast steel would seriously decline when Bessemer and Siemens steel came into the market. This has not been the case. The commoner qualities of crucible cast steel have been to a large extent superseded by Bessemer and Siemens steel, but the enormous quantities made by the latter processes have required for their manipulation, directly or indirectly, such a large quantity of the better qualities of crucible cast steel, that the total amount of the latter now produced in various parts of the world is probably double that which was required before the birth of its rivals.

Chemical analysis plays a very important part in the manufacture of iron, Bessemer and Siemens steel, and even of the comparatively small quantity of crucible cast steel which is still used for purposes in connection with which it is not required to be hardened and tempered. It is possible to judge very accurately of the quality of those metals from their chemical analysis, almost as much so as from the results of mechanical tests, such as the breaking strain and the contraction of the area of fracture. But in what we may call, for want of a better name, the legitimate cast steel trade, chemical analysis, though it tells us a great deal, does not tell us everything. The analysis of steel shows the amount of other ingredients which it contains besides the nine-tenths or more of iron which forms its basis. The amount of carbon, silicon, manganese, sulphur, phosphorus, copper, &c., may be

* Paper read at the Chester Meeting of the Iron and Steel Institute.

ascertained with tolerable accuracy, and the information thus obtained is often of the utmost importance; but it is quite possible to make a comparatively low-priced steel which shall show precisely the same chemical analysis as the best crucible cast steel; nevertheless it is found by practical experience to be inferior in quality. That this is a fact has been proved *over and over again* beyond all possibility of doubt. It is a sufficient reason why Sheffield manufacturers have been willing to pay such a high price for Dannemora iron for so many years; but it is *not a sufficient reason why so many* Sheffield manufacturers should ignore the results of chemical analysis altogether. Of every fact there must be some explanation, though we may, for the present at least, be ignorant of it. To say, with the Sheffield devotees of the rule of thumb, that the one steel possesses "body," and that the other does not, explains nothing, but merely adds to the synonymy of the subject by altering the nomenclature. If the metallurgical chemists could once convince themselves that this difference in quality is a fact, they would probably soon be able to give us an explanation. We already know much of the chemistry of steel, and what remains to be learnt is as certain to be some day discovered as the fact that Newton discovered the laws of gravitation. Mathematicians may never discover how to square the circle; mechanics will never discover a perpetual motion, nor will chemists ever discover the transmutation of metals; but the discovery of the chemical explanation of "body" is only a question of time. By way of stimulating inquiry, I venture to suggest two possible causes of body which may be worth consideration as a tentative hypothesis of its nature. The best razor steel contains 1¼ per cent. of carbon. It must be melted from evenly converted steel. It will not do to mix hard and soft steel together, or to melt it from pig "let down" with iron; though in either case the exact 1¼ per cent. of carbon may be the result. Steel made by the latter processes will not possess the requisite amount of body; consequently the cutting edge of the razor will not stand. It must be melted from steel converted from iron made from ore containing manganese. It will not do to add the manganese in the form of spiegeleisen or ferro-manganese. Carbon and manganese exist in combination with iron, not chemically combined in certain definite proportions, but as alloys, as mechanical mixtures in any proportion. We know that carbon exists in combination with iron in two forms, either as combined carbon or free carbon; is it not possible that manganese may also exist in two forms? and though the razor steel must have been boiled in the pot for half an hour after it was melted, to kill it and make the ingot pipe, is it not possible that the mechanical mixture of the carbon and the manganese is less homogeneous in steel made by the cheap processes than it is by that made by the old-fashioned method? It has been stated that the finest qualities of steel when hardened show a more perfect regularity in their crystallisation when examined under a microscope than commoner qualities, and I venture to suggest that a possible explanation of "body" in steel may be absence of injurious ingredients, combined with the perfectly homogeneous presence of the advantageous ingredients. Hardened steel is crystallised steel; and perfect regularity of crystallisation in steel which is required to be ground to a fine cutting edge may be a necessity which can only be secured by the slow and expensive old-fashioned method.

The principal reason why Bessemer and Siemens steel have failed so completely to supersede crucible cast steel for purposes where the better qualities are required, is that they cannot be made sound without the addition of silicon or manganese. In melting common steel (containing, for example, from 0.15 to 0.05 per cent. of phosphorus), the steel must be poured into the mould as soon after it has become perfectly fluid as possible, and as hot as the tensile strength of the pot will allow. In making the higher qualities of crucible cast steel (where the percentage of phosphorus ranges from 0.01 to 0.001) a similar mode of treatment would produce very strange results; the molten steel would boil over in the mould, the fracture of the ingot when cold would show a series of bubbles like a sponge, and its specific gravity would scarcely exceed that of wood. Some of these bubbles or honeycombs would weld up when the ingot came to be forged, but by far the greater number would be coated with an oxide which would make a weld impossible, and the bar, if it was not burnt up in the fire, would be so full of the imperfections technically called "seams" or "roaks," as to be perfectly useless. To obviate this disastrous result, it is necessary to boil the steel for nearly half an hour after it has become fluid, and then to allow it to cool down to a certain temperature before it is poured into the mould. This process is called, in the language of the votaries of the rule of thumb, "killing" the steel, and it is an axiom amongst them that the higher the quality of the steel the more "killing" it takes. It is in this part of the process of crucible cast steel melting that its special virtue consists, and the cost and quality of the cast steel produced depend in a large degree upon the skill brought to bear upon it. There is an old proverb in Sheffield, usually expressed in the terse vernacular of the country, but which may be refined into the expression that if you put his Satanic majesty into the crucible his Satanic majesty will come out of the crucible. The converse of this is by no means the case. Though you may convert iron into steel in the crucible, you cannot convert bad steel into good steel in the crucible; but though you may put the most angelically pure steel into the pot, you may by bad management, by not "killing" it properly, pervert it into Satanically bad ingots. Now this "killing" of the steel is precisely what cannot be done in the Bessemer or Siemens processes without the addition of such a large amount of manganese or silicon that the steel becomes brittle when hardened.

I do not know whether chemists are agreed on an explanation of the necessity for "killing" high-class steel. When iron is made into steel in a converting furnace, it is assumed that the oxygen in the air in the converting pot unites with the charcoal, and is soon made into carbonic oxide, which is occluded by the white-hot iron, and forced by it to part with as much carbon as is sufficient to reduce it to carbonic acid. It has been ascertained that metals have the power of absorbing or occluding many times their own bulk of gas, and possibly the carbonic oxide, when it has parted with the amount of carbon necessary to reduce it to carbonic acid, is not then expelled from the iron, but may remain in an occluded state, and requires to be expelled in the melting pot by boiling. Be this as it may, it is a fact that if it be required to make blister steel harder than about 1.4 per cent. of carbon, it is necessary to convert it twice over, possibly in order that in the interval it may part with some of its occluded carbonic acid so as to make room for a further occlusion of carbonic oxide.

Another fact which may throw some light upon this question is, that blister steel melted directly after being drawn from the converting furnace requires more "killing" than that which has been exposed to the air for some time, during which it has presumably had an opportunity of parting with some of its occluded gas. The addition of a portion of scrap steel materially assists the process of "killing," as would naturally be the case if we suppose that the scrap (which has been melted before) has parted with its occluded gas in the first melting. The fact that the presence of manganese or silicon helps largely to kill the steel may possibly be accounted for on the theory that the carbonic acid unites with the manganese or silicon and becomes a solid, or it may be that in an alloy of iron with either manganese, silicon, or phosphorus, the occluded gas is expelled at a much higher temperature than in pure iron.

Before describing the process of making crucible cast steel it may be useful to devote a few words to the nomenclature of iron and steel. This is almost as much a vexed question as that of zoological nomenclature, and might form the subject of a code of laws, which would probably be as complete a failure as those issued under the auspices of the British Association for the Advancement of Science, which have made confusion in the scientific names of birds and beasts worse confounded. In Sheffield we attempt to discriminate between iron and steel, which we regard as generally distinct, and each of which we subdivide specifically, though it must be admitted that neither our generic nor specific names are very scientific.

Pig iron is melted direct from the ore in a blast furnace, and contains from 3 to 5 per cent. of carbon. When remelted it is called "cast iron" or "metal."

Spiegel iron is precisely the same, but contains in addition from 5 to 15 per cent. of manganese.

Bar iron, often called wrought iron, is pig iron which has been smelted and deprived of nearly all of its carbon, either in a puddling furnace or by the Walloon, Lancashire, or other analogous process; the spongy mass or ball of iron is usually hammered or rolled into a bar, which for the Sheffield trade is generally 3 in. wide, § in thick, and from 6 ft. to 12 ft. long.

Puddled steel is precisely the same as "bar iron," except that the process of puddling is stopped when rather more than half of the carbon has been removed from the pig iron. There is consequently no hard and fast line between bar iron and puddled steel, the one intergrading to the other by imperceptible degrees. Although there are an infinite number of intermediate stages between the softest bar iron and the hardest puddled steel, and although it is impossible to state the exact percentage of carbon which marks the dividing line between one and the other, it is usual to call all puddled bars which cannot be hardened in water, bar iron, and all those which can, puddled steel. This dividing line falls somewhere near a mixture containing a half per cent. of carbon, and although it looks very vague and unscientific to use two terms which thus intergrade, no confusion of any kind, or misunderstanding, has ever been known to arise from their use.

Blister steel is bar iron which has been converted into steel in a converting furnace, and varies in the amount of carbon which it contains from ½ to 1½ per cent. There are, of course, an infinite number of degrees of carbonisation between "hard heats" and "mild heats," but for the convenience of the trade six of them have been selected, and have received names as follows:

	Per Cent. of Carbon.
No. 1. Spring heat	½
,, 2. Country heat	¾
,, 3. Single-shear heat	1
,, 4. Double-shear heat	1¼
,, 5. Steel-through heat	1½
,, 6. Melting heat	1¾

Bar steel is blister steel which has been tilted or rolled down to the size required.

Single-shear steel is produced by welding half a dozen bars of blister steel together. Only those bars are chosen in which the process of conversion has been so far carried on that the outside of the bar is steel and the centre of the bar iron. When these are welded together, and tilted or rolled down to a small dimension, the result produced is a mechanical mixture of iron and steel, a material which combines great tenacity with the capability of carrying a moderately hard cutting edge, and is much employed for certain kinds of knives.

Double-shear steel is produced by drawing down single-shear to suitable-sized bars, and rewelding two of them together, so that the mixture of iron and steel may be more perfect.

Cast steel is steel that has been melted in a "pot" (called a crucible in the encyclopædias), and poured into a "mould" (called a "form" in the learned books), thus becoming an "ingot," which is afterwards hammered or rolled to the size required. It may be made of various "tempers," varying in the percentage of carbon which they contain from three-quarters or less, to one and a half or more. The different tempers may be arrived at in various ways. For the great majority of purposes there can be no doubt that the best way is to put into the melting pot broken pieces of blister steel converted exactly to the temper required; and the more evenly the steel is converted, and the more carefully all bars which are harder or softer than the temper required, or which are "flushed" or "aired," are rejected the better. Blister steel, when carefully "taken up" or selected, will produce a cast steel which combines the greatest amount of hardness with the maximum amount of elasticity when hardened. It may, however, happen that for certain purposes "soundness" in the bar, the result of absence of "honeycombe" in the ingot, may be the most important quality required in the steel; for others the property of welding most perfectly may be the *sine qud non*; or the great evil to be avoided may be the tendency to water-crack in hardening; or the steel may be used for some purpose where it does not require to be hardened, and the object to be secured is the combination of the greatest amount of hardness and toughness when unhardened. In all cases the mode of manufacture must be adapted to the objects which it is most important to secure. In addition to the mode of operations already mentioned there are two other ways in which the same percentage of carbon may be secured. You may either put cut bar iron into the pot and "fetch it up" to the required temper with charcoal, or you may put broken pig iron into the pot, and "let it down" to the required temper with cut bar iron. A fourth *modus operandi*, which for most purposes is the best of all, might be enumerated, namely, the selection of blister steel slightly harder than the temper required, so as to admit of being slightly let down to the exact temper by the addition of a small quantity of somewhat milder cast steel scrap.

Bessemer steel and Siemens steel do not require definition, nor do they come within the scope of this paper.

The process of converting, or, as it generally called in the encyclopædias, the process of cementing iron into steel, is carried on in a converting furnace.

This furnace consists of two stone troughs, technically called "converting pots," each of them about 4 ft. wide, 4 ft. deep, and 12 ft. long, and placed side by side, with a fire underneath them, the flues of which conduct the heat all round each pot. These troughs or pots are built up of slabs of a peculiar kind of firestone, obtained in the neighbourhood of Sheffield, and possessing the property of not cracking if heated slowly to a high heat and allowed to cool slowly. The slabs are united together with a mortar made of ground fireclay. Over the two pots is built a vault of firebrick, and the whole is inclosed in a dome of red brick, to prevent as much as possible the heat from escaping.

At the bottom of each pot is placed a layer of charcoal, broken up into small pieces, from a quarter to half an inch square. On this a layer of bars of iron is placed, which is covered with charcoal; another row of bars of iron follows, and so on until the pot is filled with alternate layers of charcoal and iron; it is then carefully closed with a thick cover of "wheel-swarf," a silicious species of mud, which accumulates as the sweepin of the Sheffield grinding wheels, and is of course the material of the grindstone, worn away in the process of grinding, and mixed with the finest steel dust which has been ground away, a substance which will resist long exposure to great heat, and renders the top of the pot practically air tight. In order to test the progress of conversion, and to ascertain the precise moment when the fire should be allowed to go out, two or three bars of iron are allowed to protrude through a hole in one of the pots made for the purpose. These bars, technically called "tap bars," are drawn and inspected at or near the close of the process, and are tightly packed in white ashes where they pass through the end of the converting pot, so that no air may find its way to the charcoal inside.

The converting pots, full of alternate layers of iron and charcoal, and for all practical purposes hermetically sealed, are gradually raised to nearly a white heat, and kept at about that temperature for a week or more, according to the amount of carbonisation required. Another week is occupied in the process of cooling, which must be done slowly, in order to prevent the pots from cracking, after which the cover is broken up and removed, and the bars, which went into the furnace bars of iron, are taken out of it bars of "blister steel," so called from the bubbles or blisters which have arisen on the surface during the process of conversion. Some of the charcoal has been consumed during the week at which it was white hot, but a considerable proportion of it remains, and is taken out of the furnace as black as it went in.

(To be continued.)

THE BYE-PRODUCTS OF COAL.

*The Recovery of Bye-Products from Coal, with Special Reference to the Coke and Iron Industries.**

By WATSON SMITH, F.C.S., F.I.C.

IT is not my present object to describe or discuss methods of carbonising coal for the sake of obtaining coal tar and benzenes primarily; these have nothing to do directly with the iron and steel industries; but at the same time they have at the present an indirect bearing, and I must say a word with respect to these methods, as against those more especially for coking coal primarily, with recovery of bye-products.

I have an idea that these carbonising processes, as at present carried out, have already seen their best day. I may be asked my reason for this statement, and my

* Paper read at the Chester Meeting of the Iron and Steel Institute.

TABULATED ARRANGEMENT OF THE PRINCIPAL COKE OVENS.

Bye Products not Recovered.		Bye-Products Recovered.			
A	B	C.	D.	E.	Remarks on E.
—	—	Modified Recovery of Products.	Recovery or Non-recovery of Products at Will.	Full Recovery of Products or Uninterrmittent Close Distillation.	
Air admitted, and so partial combustion in the coking space itself.	I No air admitted into the coking space, but into the side flues, so as to mix with the gaseous products passing through openings in the oven walls into side flues. Thus complete combustion of all the products, and so the ovens are heated.	I Air admitted into the coking space, and so a partial combustion; moreover, the character of the bye-products recovered is modified by this admission of air. Gases not saved or utilised.	I. No air admitted into the coking space, but at certain stages of the process the volatile products can pass through spaces in the walls of the ovens into side flues, and mixing there with air, be burnt to heat the oven, or at will this through passage can be cut off, and the volatile products can be drawn off by an exhauster and condensed, the pure gas being returned into flues and burnt with air.	No air admitted into the coking space, and in all cases the volatile products are drawn off by exhauster subjected to cooling and condensation for the sake of tar and ammonia, and the gases are— I. Returned to the ovens and burned in the flues with— (*a*) Air admitted cold or (*b*) Air previously heated ("recuperated").	
Thus some coke is burnt.	Thus coke is not burnt.	Thus some coke is burnt and also some ammonia.	II In addition to I., in some cases Air admitted into coking spaces towards the close of process, forming a second or finishing stage; the half burnt gases furnished being burnt in the side or other flues.	II Or gases returned and burnt in conjunction with— (*a*) Small fireplace and solid fuel, (*b*) Or, fire of gas producers	
	II Heated air admitted into side or bottom flues.	II In addition to I, gases saved after condensation, but not utilised in the coke ovens themselves. III In additon to I., gases, after condensation, return for combustion, and are burnt in flues around the ovens or otherwise to heat them.	III. Or, in addition to II., the air admitted to burn the half-burnt gas may receive a previous heating	III. Or, gases not returned to ovens at all, but used as illuminating gas or otherwise, the ovens themselves being heated by— (*a*) Solid fuel. (*b*) Fire from gas producers.	
Meiler or mound (1)		I. Jones adapted Meiller . (1)	III Klönne's coke-oven . (1)	Knab's coke oven (1856) . (1)	
Beehive oven (2)	I. Jones' coke oven (1)	II and III Jameson's adapted beehive oven (2)		III. *a* Powels-Dubochet oven, constructed similarly to Carvès oven (1854) . (2)	At first not adapted to recovery of products, all volatile matter being returned to fire the ovens. Later modified for this purpose by Carvès and Haupart.
	I. Appolt oven (2)		(Kind of adapted bee hive).	I. *a*. Carvès oven (Carvès and Haupart) (modified Knab . . . . (2)	
	I Coppée oven (3)	III. Aitken's adapted beehive oven (2)		I. *b*. Simon-Carvès oven (Recuperated) . . (4)	
Lürmann's oven . (3)	I. Sachse oven (4)	III Lürmann's oven . (3) (Ger. Pat Suppl 17,203, 1881).		Pernolet's adapted Beehive . . . . (5)	See "Muspratt's Dict" iv, 959 and 960
	I Hiltawski oven (5)			I *a* Pernolet's earlier coke oven . . . (7)	
	I. Fransen oven (6)			II *a* Pernolet's coke oven . . . (8)	
	II. Muller oven (7)			I *a* or *b*. Adapted Coppée oven . . . (9)	See "Fischer's Jahresb." 1883, 1216 Modified Carvès oven Gas in side flues, and fired below by hand fire in fireplace
	II. R. Wintsek's oven (8)	II. Hutchinson's adapted beehive oven (4)	I. Otto's oven (adapted Coppée (2)	II *a* Otto's coke oven (10)	Still more recent forms than in D.
			III. Lürmann's oven . (3) (Ger. Pat 20, 2111, 1882)	II *b* Herbers and Otto's coke ovens . . . (11)	
		Under head C. come also:	II. R. de Solden hoff's oven (4) Ger. Pat. 25, 824, 1883).	I. *b* Hüssener's coke oven . (12)	
		I Recovery of tar and ammonia from blast furnaces fed with coal . . (4) Alexander and M'Cosh.	II Hutchinson's adapted beehive oven . (4)	I. *b* Ruppert's coke oven . . . . (13)	Modified Simon-Carvès oven Gas admitted in fireplace and side flues with air heated to 300 deg Ruppert has cold air and regulative arrangements.
		See specifications and drawings in Eng. Pats. 4117 for 1879, 1433 for 1880, 3735 for 1881.		I *b*. II.*b*, or III. *c*. Herbers's oven . . . (14)	Slightly modified Simon-Carvès oven.
		III. Recovery of tar and ammonia from gas producers . . . (5) W. S. Sutherland		I. *a* and *b*. Semet and Solway's coke oven . (15)	Also slightly modified Simon-Carvès oven, and very similar to Semet and Solway's oven.
				I *a*. Seibel's coke oven . . . (16)	Has an ingenious alternative regenerative heating arrangement for gas and air, or in some cases of air alone.
				I *b* Regenerative coke ovens of the Coal and Coke Works, Gottesberg . (17)	

reply may be of service to those interested in bye-products as recovered in coking coal for metallurgical purposes. When benzol (and consequently tar more or less) rose some little time ago very greatly in price, many people were somewhat misled through this artificial increase of value, and entertained wild notions of profit to be derived from carbonising coal in close retorts, primarily for the sake of this benzole, and oblivious of the strong probabilities of a subsequent descent in price, and of the questions, "What are we to do with all our gas or with all our coke?"

Suppose benzol falls in price to about 2s. per gallon or less, what are the carbonising works to do with all their gas if they burn their coke, and with all their coke if they burn their gas? I recollect that about the years 1868 and 1869, just such a similar rise in price of benzol occurred as recently, and the price of 14s. per gallon was reached, starting from something like an original 2s. 9d.; and at that time a patent was taken out by Dr. Caro, then a chemist in Manchester in the works of Messrs. Roberts, Dale, and Co., for extracting benzol vapours from coal gas, by passing the latter through various oils. At that time Caro's process received but little attention, and processes for carbonising coal received no attention. Moreover, then there were no competing processes for obtaining ammonia in increased quantities, and the price of sulphate of ammonia reached 20*l*. per ton, and for a long time after kept the price of 16*l*. Now, however, Caro's oil process itself, and various improvements of it, one notably by G. E. Davis, and another process by Mellor with nitric acid, are employed for the extraction of benzol. In short, events now indicate the future possibility of large quantities of benzol in the market. The question is, "Will the prices of benzol and ammonia bear this strain?" Answer, Ammonia will bear to a certain extent any strain, for the world must have ammonia. Benzol will not bear increased production. It has already fallen, just as it fell in 1870. In 1870 it fell to some 2s. 3d. for 50 per cent. benzol and 2s. 9d. for 90 per cent.; and then the naphthaline or naphthol colours had not been discovered, and had not entered into competition with the benzol or aniline dyes, as they now have. But now, besides this competition, we have the fact that immense carbonising companies have erected works and started processes mainly based on "the cry after benzol." It is these factors which I consider sufficient to warrant my statement that whereas after 1870 the price of benzol fell to about 2s. 3d., I believe it will fall lower now, and not a little lower. But if benzol descends in price so low, and the difficulty of disposing of such vast quantities of coke of the gas works types remains, it seems to me the coke question may assume to the carbonisers nearly what the alkali waste and blast furnace slag questions have assumed to the alkali makers and ironmasters. I know carbonisers would tell me, "Yes; but we expect householders will see the economy and efficiency of gas coke used in their firegrates." But I reply, they have not seen it yet, and they begin with prejudiced minds, because the gas stoves usually supplied from gas works are, through the water, &c., in them, given to split and fly in the firegrates; and, moreover, cokes leave such large quantities of ash, or, in the housewife's words, make "so much dirt." With well-prepared and preserved coke the exploding qualities—to my mind the most objectionable ones—might be prevented by the carbonisers, and the objection removed in the minds of householders in favour of brighter and hotter fires, and increased freedom from smoke and sulphurous acid. But all this remains to be done, and the average Englishman is but slowly persuaded to relinquish old-established customs even in favour of trivial alterations.

Now let me turn to another point, and do so by asking a question: Is it not possible to carbonise coal, to obtain tar and ammonia as bye-products, and make coke itself the principal product—this coke, be it remembered, constituting about 70 per cent. and over of the coal employed?—in other words, make a valuable coke? Yes, and the way to do this is by means of a coke oven, the article manufactured being metallurgical coke for use in the iron manufacture, tar and ammonia forming the bye-products, and benzol as well, in some cases. And here I presume the gas to be used in firing the coke ovens. In short, everything made must be a marketable product. But I suppose more, viz., that we shall not be attracted, as formerly, by the statements, "A new process and coke oven for the coking of coal and recovering bye-products." We shall ask, firstly, "What is your tar? and what does it consist of when you have recovered it? and what is its proportion, and that of its constituents respectively?" and, secondly, "How much ammonia do you recover, reckoned, say, as sulphate?"

This question of coke ovens and their respective merits has become a large one, and to make a discrimination and a classification possible of the chief of these forms of ovens, I have very much improved and enlarged a tabulated system I presented in September, 1883, to the British Association at Southport (Sect. B.); in fact, it will hardly be recognised again in the new one. It will, I hope, prove serviceable in giving at a glance a kind of bird's-eye view of the tract so far covered by coke ovens to the present date, and afford at the same time a notion of the development from certain original or root forms of certain improved systems, the improvements following the advance in scientific knowledge in the demand for abatement of the smoke and sulphurous nuisance, and in the demand for tar products. I have also endeavoured to give in a side column some data serving to indicate the nature of the tar products obtained from the various ovens arranged for recovering bye-products. With regard to the recovery of ammonia, I may just remark, that in all systems in which air is admitted into the coking mass, the yield of ammonia must be diminished; this is verified in the case of Jamieson's coke oven, and in the Alexander and M'Cosh process. I have already shown in the investigations I have made (see Appendix to Mr. Breckon's paper) of Jameson's coke oven oils, the Sutherland gas producer, and the Alexander and M'Cosh blast furnace tars, that the tars produced when air is admitted are also considerably modified in character.

Nature, &c., of Tar Products Recovered in Processes Adjoining.

Tar Valuable for Dyes and Colours.	Tar not Valuable for Dyes and Colours.	Tar probably Valuable, but Definite Data not to Hand.	Doubtful as regards Tar
.	*C (2)		C (1)
	*C (2')	D (3)	C (3)
	*C (5)	D (4)	C (4)
	*E (2)	D (2)	D (1)
*E (3)	*E (5)		
*E (4)	*E (7)	E (8)	
E (8)		E (9)	
E (12)	.	E (10)	
E (13)		E (12)	
E (15)			
E (16)			
E (17)			

* All the above are tabulated from personal experience or from reliable information

E_2, E_{12}, E_{13}, E_{15}, E_{16}, and E_{17} are judged to yield valuable tar from the known construction of ovens and nature of firing processes, and from the fact that they are all modified Carvès ovens.

The other forms tabulated are merely judged of from plans showing construction and details as regards firing (temperature).

References to works where plans can be seen, short accounts read, and references to patents obtained, &c.:

"Journ. Soc. Chem. Industry," vol. ii., 328.
" " " vol. iii., 101.
" " " vol. iii., Oct., 1884.
"Jahresbericht über die Leistungen d. Chem. Tech. für das Jahr 1883" (Dr. F. Fischer), xxix., p. 1213.
"Muspratt's Dictionary," iv., 958-966.
"Gurlt, Die Reretung d. Steinkohlenbriquettes," 1880, 28.
"Dr. Percy on Fuel," pages 149, 162-175, and 194.

An inspection of the annexed Table will indicate that gradually and in course of time and experience, &c., from three *root forms of coke oven* (and this way of putting it will I think both assist memory and make the matter clearest) various developments in the way of coke ovens for recovering bye-products have sprung. These are, firstly, the beehive—a sort of covered-in meiler or mound; secondly, the Coppée oven; and, thirdly, the Knab and Powels-Dubochet coke ovens. In adopting this plan I do not mean to assert that these root forms were in each case consciously planned from, but that, consciously or unconsciously, they are the root forms.

(*To be continued.*)

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

ILLUSTRATED ABSTRACTS OF RECENT SPECIFICATIONS PUBLISHED UNDER THE ACT OF 1883.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

Copies of Specifications may be obtained at 25, Cursitor-street, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, addressed to H. READE LACY, Esq.

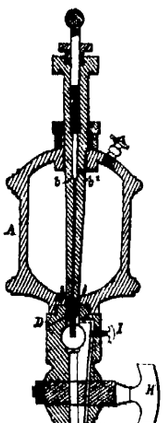
The date of the advertisement of the acceptance of a complete specification is, in each case, given after the abstract, unless the Patent has been sealed, when the date of sealing is given.

Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

SIGHT FEED LUBRICATORS.

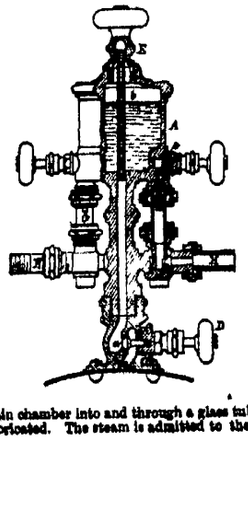
3916. W. P. Thompson, London. (*S. Reid and J. C. Thayer, Chicago, U.S.A.*) **Lubricators.** [6*d.* 1 *Fig.*] February 26, 1884.—A cylindrical reservoir of oil is provided at its top with a plug containing a passage leading to the sight feed tube. This passage also extends vertically, and is closed by a plug The other end of the sight feed tube is secured in an arm extending from a casting having an arm projecting into the side of the oil reservoir near its top. The passage in the casting communicating with the sight feed tube is provided with a valve, and also communicates with a condenser which rises above the oil reservoir, and supplies the "head" of water to force out the oil, it being in communication through the passage in the casting with the side of the reservoir and by a tube with the bottom. In the plug is a passage continued downward to the bottom of the reservoir and upwards to the feed passage. Steam being admitted to the condenser by a suitable valve, the condenser water passes to the bottom of the reservoir and up through the tube extending down from the plug to the sight feed tube which it fills At the same time the oil flows by the other passage in the plug A plug is provided for filling the reservoir, and a second plug at the bottom for drawing off the water (*Sealed May* 30, 1884).

6982. M. S Cabell, Quincy, Ill., U.S.A. Lubricators. [4*d* 3 *Figs.*] April 29, 1884 —The lubricant is fed by gravity and delivered in drops which are rendered visible through glasses. Referring to the illustration, a prolongation D is attached to the end of the hollow stem, through which steam is admitted to the cup vent A, and which is provided with valve seat *b*¹ and vent opening *b*²



The prolongation D passes beyond the valve seat *a* and projects into a fitting in line with sight openings; the oil trickles down the side of the extension D. In order to provide means for maintaining a circulation of steam in the fitting, a vent tube G is provided which may be made integral, as shown, with the fitting or as a separate piece of tubing. A valve or cock H is fitted below the sight openings and a separate valve I may be applied to the vent tube G. (*Sealed August* 1, 1884)

9237. A. M. Clark, London. (*W. A. Boyden, Jersey, N.J., U.S.A.*) **Lubricators.**—The oil drips from the lower



part of the main chamber into and through a glass tube and to the parts to be lubricated. The steam is admitted to the upper part of the oil cup through a central stem, the oil passing out at one or more side discharge pipes at the bottom Referring to the illustration, the oil cup A is placed upon a tubular shank B communicating by the passage *a* with the steam supply. The upright pipe *b* communicates with the passage *a* and traverses the cup A centrally The lower part of the cup is provided with as many outlet openings as may be required, each leading into a valve chamber *c*, and by a drip pipe to a glass tube G and the pipe H The cup A is provided with a hollow cap E. The passage *a* is provided with a valve. (*Accepted July* 26, 1884).

LUBRICATOR.

3916. W. P. Thompson, London. (*J. C. Thayer, Chicago, U.S.A.*) **Lubricators.** [6*d.* 3 *Figs.*] February 26, 1884 — The body of the lubricator consists of a glass cylinder and two caps drawn against the ends of the cylinder by bolts passing through them and the cylinder, suitable packing being provided between the caps and cylinder. The lower cap is provided with a passage for the outflow of oil, and with a suitably guided valve for opening and closing the passage A weighted vibratory lever is fulcrumed upon a suitable bearing within the reservoir, and when the lubricator is applied to the rotating part of the machine to be lubricated it alternately opens and closes the valve One end of the lever is weighted and the other end is bent at a right angle, and passes into a slot in the valve stem The extent of the movement of the valve stem is adjustable. (*Sealed May* 30, 1884)

LUBRICANT.

1252. J. Ratson, Tipton, Staff. Lubricant. [4*d.*] January 11, 1884.—This consists of a mixture of brown Yorkshire grease, wool oil grease, plumbago, quicklime, suet, and tallow, with or without the addition of currier's grease or dubbin The lubricant is preferably employed in the form of blocks or bars formed by pouring the melted lubricant into moulds. Instead of mixing the suet with the other ingredients, they may be cast round bars of the suet. (*Sealed September* 2, 1884)

STOP VALVES.

3144. J. A and J. Hopkinson, Huddersfield, Yorks. Stop Valves. [6*d* 6 *Figs.*] February 12, 1884 —The sliding part or valve proper is formed of two semi-cylindrical portions fitted together to slide in a cylindrical chamber whose axis intersects at right angles the axis of the inlet and outlet passages Referring to the illustrations, the two portions *a* of the sliding valve are formed with hollow bosses for the reception of a spring *b*, which presses the pieces apart and against their seat *c* In order to prevent the valve from turning on its axis, lugs or pro

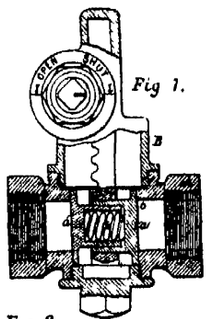


Fig. 1.

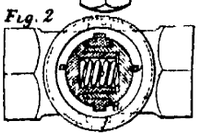
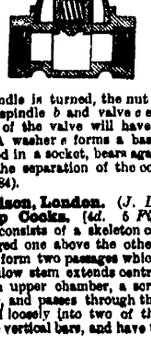


Fig. 2

jections on the ring or loop *d* of the spindle slide in grooves in the sides of the chamber, or a pin projects from the side of the chamber into the spaces between the two parts *a* The valve box lid B is constructed with a chamber connected with the box A, and the bottom of the box is formed with an aperture closed by a screw cap or cover, as described in Specification 4017 of 1883 Specification 3080 of 1882, and 4586 of 1881, are also referred to (*Sealed September* 12, 1884)

3147 In a subsequent specification [6*d* 9 *Figs.*] May 23, 1884, the valves are rendered water tight without the use of packing or stuffing around the spindle Referring to the illustration, the stopper spindle *a* is connected with a nut *d*, so as to insure their turning together while leaving the nut free to move independently of the spindle in an endwise direction. It will thus be seen that



when the stopper spindle is turned, the nut *d* will turn with it and move the valve spindle *b* and valve *c* endwise The stress due to the resistance of the valve will have no effect upon the stopper surface *a*¹. A washer *e* forms a base for the nut *d*. A spiral spring *f*, placed in a socket, bears against the face of the nut *d* and prevents the separation of the cone *a*¹ from its seat (*Accepted July* 22, 1884).

7270. H. J. Allison, London. (*J. H. Blessing, Albany, N.Y., U.S.A.*) **Stop Cocks.** [6*d.* 5 *Figs.*] May 6, 1884 — The plug of the cock consists of a skeleton cage composed of two circular discs arranged one above the other, and connected by vertical bars so as to form two passages which cross each other at right angles. A hollow stem extends centrally from the upper disc, and contains an upper chamber, a screw threaded portion and a lower chamber, and passes through the stuffing-box Segmental gibs are fitted loosely into two of the oppositely located passages between the vertical bars, and have their convex surfaces fitted to the bore of the casing A spring in the lower chamber presses against one of a pair of angle frames arranged in reversed positions between the gibs so as to press them outwards. A screw in the screwed portion of the stem can be screwed down to bear upon one of the angle frames and rigidly hold the gibs during the grinding (*Sealed August* 15, 1884)

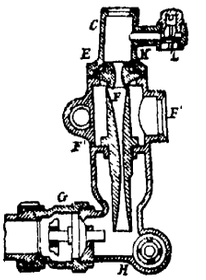
7271. In a subsequent specification [6*d* 4 *Figs.*] May 6, 1884, a combined check and stop valve is described The valve casing contains an inner cylindrical valve chamber joined to the casing at the four sides, and by an inclosed partition formed between the casing and the exterior wall of the chamber The valve chamber is formed with two valve seats, one above the other, and which are detachable from the valve chamber, each being composed of a flat annular metallic flange having a short cylindrical flange on one of its flat surfaces The valve seats are closed by two independent valves, the lower being always free to operate as a check valve, and the upper being provided with means whereby it can be forcibly retained upon its seat. (*Sealed August* 15, 1884)

VALVE SEATING.

47 J. Phillips, Wood Green, Middlesex. Seating for Valves. [4*d.* 2 *Figs.*] January 1, 1884 —An elastic disc is placed against the flat base of the body of the valve and has an orifice corresponding to that in the body of the valve. This disc forms the seating of the valve and is kept in place by means of a ferrule screwing into the body The valve body is of cup-like form and is attached to a valve spindle (*Sealed June* 6, 1884)

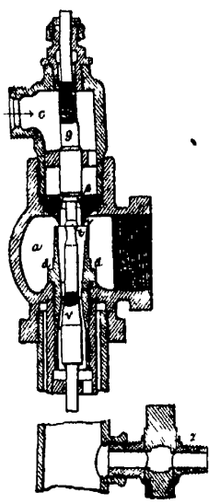
INJECTORS

6988 W. R Park, Taunton, Mass., U.S.A. Injectors. [6*d* 4 *Figs.*] April 29, 1884 —The object of this invention is to provide means for automatically preventing or relieving vacuum in steam pipes or chambers of injectors. A relief valve is applied between the steam valve and the discharge end of the steam nozzle Referring to the illustration, C is the steam chamber, E the steam nozzle, F the combining tube, F¹ the water chamber, F¹¹ the water supply pipe, G the check valve, and H the overflow valve From the side of the steam chamber C extends a passage in an arm K projecting from the chamber.



At the end of the arm is an enlargement provided with a vertical passage intersecting the passage in the arm K, and with a seat for the puppet valve A screw plug closes the upper end of the passage The relief valve serves to relieve any vacuum that occurs on starting the injector so that the flow of water to the overflow valve is not interfered with (*Sealed August* 8, 1884)

7961 In a subsequent specification [6*d* 4 *Figs.*] May 20, 1884, this inventor describes another injector, the construction of which is clearly indicated in the annexed illustration The operation is as follows: The controlling spindle or valve is in its lowest position, so that the plug *e* is upon its seat, the overflow *r* is opened, and the plug *s* removed from its seat by means of a suitable handle, permitting steam entering the steam chamber *c* to flow, the position of the parts being as shown The steam passes down



the combining tube *d*, and not by the overflow cock *z*, rapidly exhausting the air from the water chamber *a*, causing the water to flow through the combining tube *d* When there is a solid stream of water at the overflow cock *z*, the controlling spindle is raised until the steam opening at *e* is at its maximum, and at the same time the tapering portion *v* is drawn to the cylindrical portion of the tube *d* and the area of the throat diminished. The overflow cock is then closed and the water will pass in a continuous stream into the boiler. If the spindle be raised still further until the part *t* commences to diminish the steam area, the tapering portion *v* being also proportionately diminished, the duty of the injector can be regulated at will. (*Sealed August* 22, 1884).

SHAFTING.

4727 A. M. Clark, London. (*S. B. Jerome, New York, and A. O. Jennings, Southport, Conn., U.S.A.*) **Manufacture**

of Shafts, Axles, and Bars. [6d 9 *Figs.*] March 11, 1884.—Each shaft is constructed of one or more bunches of wire, which are held together by wires wound spirally round the same, or by clamps or other means. The shaft may have one central bunch of wires massed together and held compactly by wires wound spirally around it, and a series of similar bunches be placed around the central bunch, the whole being thoroughly bound together. The triangular spaces between the bunches may be filled with iron or steel rods. The collars or bearings may be shrunk upon and around the shaft, or they may be made in two or more separate longitudinal parts screwed in position by outer clamps (*Sealed June* 20, 1884).

SHAFT COUPLING.

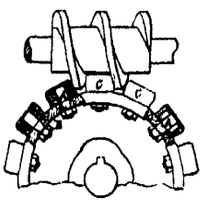
3427. R. C. Parsons, Leeds. Coupling for Shafting. [4d. 5 *Figs.*] January 31, 1884.—The object is to construct a coupling for connecting two revolving shafts in such a manner as to allow for their being somewhat out of line with each other and for end play, as well as for variations in relative speed. On the adjacent ends of the two shafts to be connected are keyed coupling discs, and between these two coupling discs are placed two other discs centred on the ends of the shafts but free to turn and slide longitudinally. A number of driving pins secured to one of the discs pass freely into holes in the adjacent coupling disc, which is secured to the other coupling disc by a number of bolts, each of which passes through a wide slot in the other disc, and is provided with a hemispherical washer and adjustable springs forcing the washers against the coupling disc. When the driving shaft overruns the driven shaft, the bolts take an oblique attitude and the springs being further compressed increase the friction on the jaws of the two discs (*Sealed May* 9, 1884).

SHAFT-REVERSING GEAR.

4553. C. Scholes, Low Harrogate, Yorks. Reversing Gear for Rotating Shafts. [4d 2 *Figs.*] March 7, 1884.—The shafts are arranged so that they can revolve independently of each other On the one shaft is fitted a sliding sleeve having at one end a bevel wheel and at the other a set of clutch teeth On the other shaft is fixed a bevel wheel having a hollow boss wherein the clutch teeth are free to revolve, but which when the sleeve is slid towards the shaft, pass into recesses. This bevel wheel is also in gear with a bevel wheel revolving on a stationary journal. It will thus be seen that the first shaft can be connected to the second directly through the clutch teeth, being entirely disconnected by drawing out the clutch teeth from the boss, and by a still further movement of the sleeve the movable bevel wheel will be geared with the wheel on the stationary stud and the shafts caused to revolve in opposite directions. (*Sealed June* 13, 1884).

WORMWHEEL.

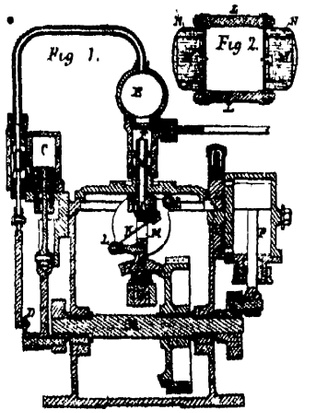
365. J. H. Abercrombie, Glasgow, and J. S. Bryce, Paisley. Screw Gear. [6d 9 *Figs.*] January 2, 1884.—Studs or pins which are cast or otherwise fixed in the rim of the wheel, and on which revolve small rollers, are used in lieu of the ordinary teeth of wormwheels The worm screw is of the usual form, but, on account of its construction, is proportionately



coarser in pitch than an ordinary screw for effecting the same work. The illustration shews a series of studs A formed with conical necks and fixed around the periphery of the wormwheel B by nuts. Rollers C revolve on the studs A and bear against the threads of the screw In order that the rollers may have a proper bearing, the studs are fixed on flat portions of the wheel. Several essentially similar constructions of wheel are shown and described. (*Sealed April* 9, 1884).

SPEED INDICATOR.

3874. E Tower, London. Indicating the Speed of Rotating Shafts. [4d. 8 *Figs.*] June 24, 1884.—A pump worked from the rotary shaft compresses air into a pipe communicating with a pressure gauge and having an escape aperture governed by a valve subject to the centrifugal force of a weight caused to revolve by gearing connecting it to the rotating shaft. Referring to the illustrations, the shaft A revolves and causes the pump C, worked by the crank and provided with a valve operated by the crank D, to compress air to a vessel E and chamber F, communicating with a pressure gauge. The shaft A also works a



tubular spindle H passing into the chamber F The bore of the spindle is fitted at its lower end with a valve I against which an arm is pressed by one end of a blade spring K, the other end of which is engaged in a notch in one of two tie bolts L connecting two cylindrical vessels M filled with a liquid and pivotted to a ring-shaped frame forming part of the spindle H The pressure in the chamber F is determined by the centrifugal force of the bolts L. The inertia of the liquid in the vessels M serves by its friction on the interior of the vessel and on the shells N to retard the movements of these vessels round their axes and to prevent sudden movements. A second pump P in communication with a gauge serves as described in Specification 3205 of 1879 to indicate the direction of rotation. (*Accepted July* 25, 1884).

PIPE JOINT.

4494. J. Thomson, Glasgow. Spherical Joints for Pipes. [4d. 3 *Figs.*] March 6, 1884.—The joint comprises spigot and faucet parts of spherical shape formed on the ends of the pipe. The faucet part extends to the middle of the joint and is formed with a flange to which is bolted a ring made in halves, which are bolted together after being put round the spigot piece. This piece forms a continuation of the spherical interior of the faucet part to which it is secured by bolts. Grooves are formed around the interior of the ring and faucet part and rings of lead are placed in these grooves, whilst a ring of india-rubber is placed at the inner part of the joint between the faucet and ring. (*Sealed May* 27, 1884).

PIPE FLANGES.

3865. W. E. Bock, London. (*La Société Obry et Grandclemange, Paris.*) **Metallic Flanges for Jointing Pipes, &c.** [6d. 4 *Figs.*] June 4, 1884.—The metallic flanges are formed from metal hammered or pressed into shape by upsetting or stamping, whereby joints or welds are avoided A metallic washer perforated with a central hole is cut out to the required dimensions, heated to a suitable degree, placed in a suitable die, upset or stamped in the die by one or more strokes of a screw press or blows of a stamp hammer or by hydraulic pressure. (*Accepted July* 25, 1884.)

CANVAS HOSE.

3189. J. Jones, Dublin. Manufacture of Suction Hose or Vacuum Tubing. [9d.] June 10, 1884.—The frame of the tubing is formed of copper, iron, or steel wire wound spirally on a mandrel, and around this frame is wound a covering of silk, cotton, linen, calico, or similar textile fabric previously prepared by being saturated in raw or boiled linseed or other oil capable of rendering the material air-tight The layers of fabric are then bound round with wire or cord wound in a spiral manner, and a layer of cloth may be wrapped round a cord or wire to preserve it from injury. (*Accepted August* 19, 1884).

WATER METERS.

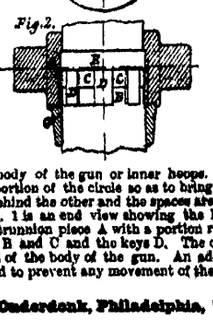
3985. L. H. Nash, Brooklyn, N.Y., U.S.A. Improvements in Water Motors. [6d. 7 *Figs.*] June 17, 1884.—The main feature of the invention is an eccentrically oscillating piston open from end to end, and provided with controlling studs carried by an arm extending inwardly from its inner surface, and through an opening in the side of the head of an abutment, so as to maintain the piston in sliding contact with corresponding studs carried by the external casing. The piston has a transverse web within which an oval slot is formed opening into a side slot, by means of which it forms a joint with a fixed abutment, while the piston web serves to carry the studs, which, with the case studs, control the eccentric movement of the piston and effect its division, and that of the case, into receiving and discharging spaces The web slot of the piston is so constructed as to form a joint with a projecting end of the abutment in every position of the piston's movement, while the side slot forms a bearing with the opposite sides of the abutment, the piston slot having such a form and length as to allow the piston to move over and swing upon the fixed abutment, so forming a joint which prevents communication between the receiving and discharging spaces at the point upon which the piston swings about the abutment. The movements of the piston are communicated to suitable registering mechanism, or this may be dispensed with and the apparatus used as a motive power engine. In three following Specifications (Nos. 9086, 9088, and 9089) the inventor describes, first, means for positively controlling the eccentric movement of an open ring piston so as to insure that a division of the interior of the piston will be intermittently formed at such positions in its movement as will bring its interior into communication with the inlet and outlet ports of the case; second, means for controlling the dividing function of the piston by mounting it upon an eccentric shaft, combined with an abutment which effects the division of the interior of the piston at certain points only of its eccentric movement; and, third, a meter in which both the interiors of the case and of the piston are divided into receiving and discharging spaces. (*Accepted July* 22, 1884).

CEMENT.

1419 L. Roth, Wetzlar, Prussia. Manufacture of Cement. [2d.] January 14, 1884.—This is manufactured by burning and pulverising a mixture of furnace slag with raw or burnt limestone, chalk, or dolomite, and with alkali salts such as potassic chloride, sodic chloride, rock salt, carnallite, saltpetre, soda, kainite, or potash, and finally adding bauxite. (*Sealed April* 22, 1884).

GUNS.

3606. E. Maitland, Woolwich, Kent. Locking Hoops for Ordnance. [4d. 5 *Figs.*] February 2, 1884.—The hoops, cylinders, tubes, and trunnion pieces are so arranged as to withstand both transverse and longitudinal strains and serve for securing and connecting one or more hoops These hoops have an internal ring of equal and alternate projections and spaces at one or both ends so as to pass over corresponding spaces and pro-



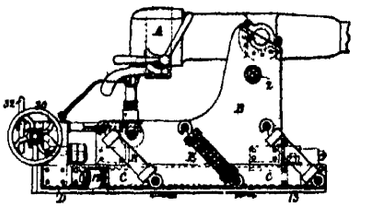
jections on the body of the gun or inner hoops. They are then turned round a portion of the circle so as to bring the projections into a line one behind the other and the spaces are then filled with key pieces. Fig. 1 is an end view showing the hoop detached. Fig. 2 shows a trunnion piece A with a portion removed to show the projections B and C and the keys D. The other end hooks over the collar E of the body of the gun. An additional hoop G may be employed to prevent any movement of the keys. (*Sealed May* 9, 1884).

4378. J. P. Onderdonk, Philadelphia, U.S.A. Fire-arms and Ordnance. [4d. 8 *Figs.*] March 4, 1884.—In order to resist the recoil of fire-arms, an air-chamber is provided in the stock of the gun and forms a false stock held in position by spiral springs. The sides of the chamber are made of elastic material. The chamber is provided with small vents for the escape of air. In a carbine, an air chamber is provided on each side of the breech. (*Accepted July* 15, 1884).

3667 W. Gardiner, London. Breech-Loading Guns. [6d. 12 *Figs.*] March 13, 1884.—The object is to improve the breech mechanism, so that the rapidity of firing may be increased The breech block is actuated by means of a lever and crank to open and close the breech. The hammer is provided with two arms or extensions arranged in the breech block in such a manner that one projects into the path of the crank whereby the hammer will be cocked when the breech is opened or closed. The rear is so arranged that it will engage with the other arm or extension when the breech is closed by the breech block, and either serves as a trigger or is acted on by the trigger. Two extractors are preferably employed, each arranged in front of the breech block with which it slides, and formed with a projection or flanges lying in front of the flange of the cartridge when in place. The breech block slides in a direction slightly more oblique than is usual, so that the act of opening the breech also withdraws the empty cartridge case. Each of the projections or flanges is inclined or curved rearwardly at its upper end, so that after the cartridge case has been slightly withdrawn it will be moved backward with accelerating speed, and ultimately be thrown out of the breech of the gun. The parts of the gun are constructed so that it can be readily dismounted by the aid of a metal rod or an ordinary nail of suitable size. (*Sealed July* 18, 1884).

GUN CARRIAGES.

6796. B. B. Mechkine, Paris. Gun Carriages. [6d. 7 *Figs.*] April 25, 1884.—Referring to the illustration, the cannon A is mounted on three superposed parts B, C, and D. The part B is composed of two vertical walls of metal united at their front by tubular tyres and central bolts 2, and at their rear by a bridge piece. This part is provided with bearings 4 for the trunnions of the gun The part C is composed of two longitudinal girders united at their ends by crossbeads, and provided internally with two longitudinal rails on which slide blocks on the lower part of B. The part D is the foundation plate provided in front with



an axis 13 around which the frame C with its carriage B is free to turn, and at its rear with two wings for the run of rollers 12 on the frame C Springs E unite the carriage B and frame C, and serve together with the friction of the slide blocks to diminish and control the recoil The cannon is turned horizontally round the bolt 13 by means of the handwheel 30, wormwheel and rack; the rack being fixed to the frame C, the carriage B carrying the worm-wheel is displaced The breech of the cannon is lowered or raised by means of the handwheel 32 operating by worm gearing an elevating screw in the bridge piece of the carriage B (*Sealed August* 1, 1884)

AMMUNITION.

4421. C S. Bailey, London. Cartridges. [4d 2 *Figs.*] March 5, 1884.—The object of this invention is to produce a perfectly gas-tight cartridge capable of being easily reloaded and adapted for hammerless guns. An outer cup or gas check incloses perfectly the percussion cap, and extends over a part of the base of the cartridge, in which position it is secured by embedding its sides in the base. The cartridge comprises the following parts. A paper tube, a base cup, a paper packing, and a flanged cap chamber containing the cap and anvil, having its open end covered with a cup or gas check. (*Sealed June* 10, 1884).

6514. T Nordenfelt, London, and V. A. Meurling, Christianstad. Manufacture of Gunpowder and like Explosive Compounds. [2d.] April 18, 1884.—Sulphur is dissolved in bi-sulphide of carbon by the aid of a gentle heat, and is thoroughly mixed with the finely powdered charcoal in a closed vessel containing a mechanical stirrer, and when the mixture is completed the solvent is evaporated. The saltpetre is dissolved in water, and added to the pulverised charcoal already impregnated with sulphur as described above, and the whole is mixed in a mechanical stirrer. (*Sealed July* 25, 1884).

DISINTEGRATOR.

3534. C. Schutze, Berlin. Disintegrators. [4d. 2 *Figs.*] February 16, 1884.—The machine is open all round and at the bottom, so that the material in being thrown out is projected against a movable and flexible mantle made of leather or rubber, and then falls to the bottom. The pins usually provided on the upper disc are suppressed, pins being provided only on the lower movable disc. The accumulation of ground material on the mantle is prevented, as it is kept in constant motion. A screen or guard prevents any ground material falling upon the strap. (*Sealed May* 27, 1884).

19,363. R. Sets and J. Schweiter, Clus, Baisthal, Swits. Apparatus for Grinding and Disintegrating Grains, Minerals, Ores, and such like. [6d. 6 *Figs.*] July 19, 1884.—The grain arrives tangentially between a rotating disc and a fixed jaw which partly covers the disc so that the path for the grain is practisely described by suitable shape, dimensions, and draw or grooving of the jaw, and the grinding process can thus be readily controlled. The vertical disc is mounted on a shaft running in suitable bearings. The grinding or fixed jaw has bearings slightly to one side of the centre and as near as possible to the exterior periphery of the disc. The lower part of the jaw is grooved or dressed and the upper joins the hopper. The jaw is held first in a fixed position by a spiral spring and is adjustable. The grinding surfaces are freed from products of grinding which may adhere by adjustable brushes guided by pins in eyes of the case. (*Accepted August* 22, 1884).

UNITED STATES PATENTS AND PATENT PRACTICE.

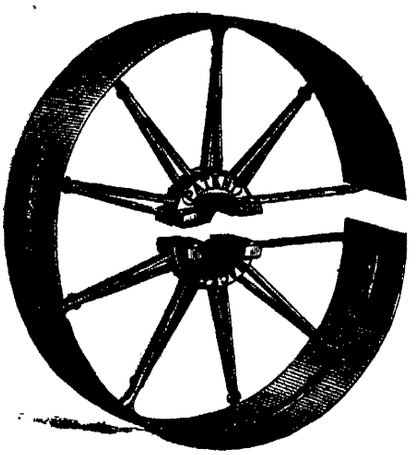
Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

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PATENT WROUGHT IRON SPRING PULLEYS,

Adopted by the Lords of the Admiralty, the War Department, the leading Engineers, &c.

L'EXPOSITION INTERNATIONALE D'ELECTRICITÉ, PARIS, SEPTEMBER, 1881.



INTERNATIONAL ELECTRIC EXHIBITION, LONDON, December, 1881.

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BOILERS

FOR

Hot Water Heating Apparatus.

HOT WATER VALVES.

FIRE & BURGLAR PROOF SAFES.

GOLD AND SILVER MEDALS, PARIS EXHIBITION, 1878. 5097

Illustrated Price Lists on application.

THE

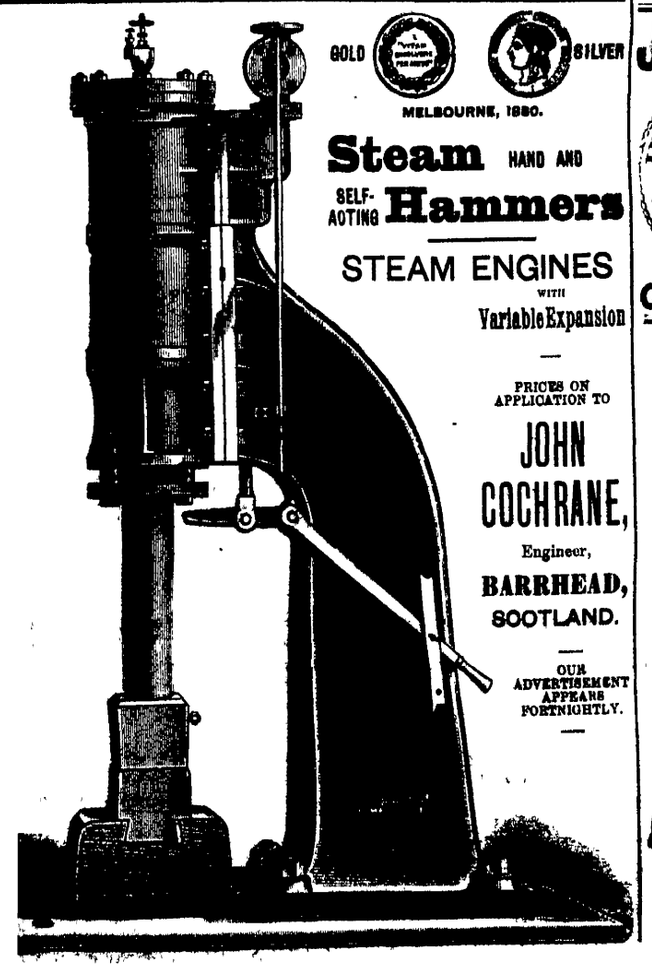
"LANCASTER"

THE Speciality of the "Lancaster" Steam Trap consists in the LOOSE DISC VALVE at the orifice of the discharge pipe in connection with a QUICK THREAD SCREW motion worked by the float. This Valve is FRICTIONLESS in action, and being loose CANNOT STICK to its seat. It is very prompt in its movements for opening and closing the discharge pipe and the working parts are VERY SIMPLE and EASILY EXAMINED. It also acts as a Safety Valve, as any excessive pressure exerted against the face of the loose disc valve would, by virtue of the QUICKNESS OF THE SCREW THREAD, force it open. Three of these Steam Traps were employed for draining the steam pipes with which I tested Messrs. A. HAACKE & Co.'s Fossil Meal Composition, at the recent Engineering and Metal Trades Exhibition, at the Agricultural Hall, London. They acted with REGULARITY and EFFICIENCY, one of the traps being specially put to a severe test in draining the DIRTY WATER collected by the Steam Filtering apparatus attached to the steam supply Pipes. Three other Traps of the same construction were connected with STEERING GEAR in different parts of the Hall and they, as well as the Steam Traps at Messrs. Haacke's Stand, were in action UNINTERRUPTEDLY during the whole time of the Exhibition, and gave ENTIRE SATISFACTION (Signed)

D. K. CLARKE, M.I.C.E.

LANCASTER AND TONGE, 4335

Engineers and Brassfounders. **PENDLETON**, near **MANCHESTER**, Patentees and Sole Makers.



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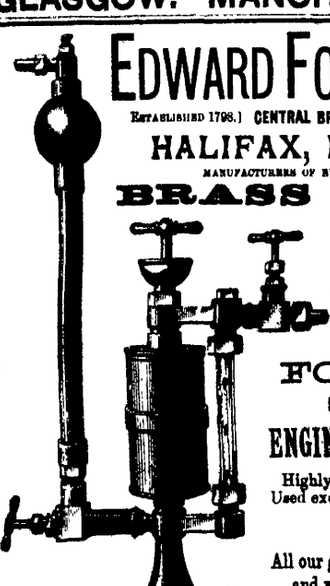
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FOR SPECIALITIES OF STEAM WHEEL VALVES, STEAM COCKS, ETC., ASK FOR ILLUSTRATIONS.



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Tug Steamer, 80 ft. by 11 ft. by 6 ft. 6 in. 80 I. HP. Constructed 1884.

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FOR
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OF
ALL TYPES RENEWED.



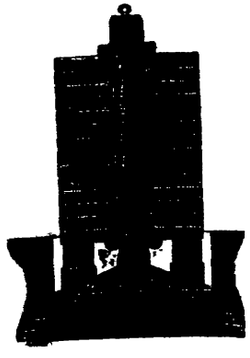
Tug Steamer, 240 ft. by 35 ft. by 8½ ft. deep. 1,000 I. HP. Constructed 1884.

Despatch Steamer, 160 ft. by 25 ft. by 7 ft. deep. 250 I. HP. Constructed 1884.

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TANGYES' IMPROVED HYDRAULIC ACCUMULATOR.



The accumulator consists of a strong cast-iron, or steel, cylinder, stepped into a heavy foundation plate, wrought-iron, steel or cast-iron, ram, carrying a heavy cast-iron head, to which is suspended, by means of strong wrought-iron bolts, a cast iron plate, which supports the plates forming the load; these latter surround the ram, and protect it from grit, dust, &c.

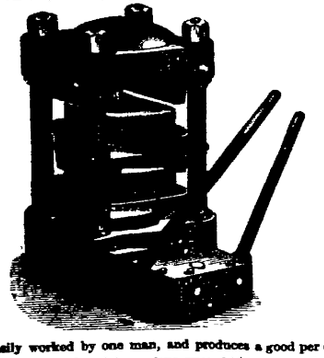
The fittings include safety valve, trip valve, stop rods, and stop plate.

Quotations on receipt of necessary particulars. 152

TANGYES' HYDRAULIC "OIL" PRESS

(WITH PRESSING BOXES)

For Linseed, Cotton, Rape, Olive, Castor, and other Oils.



This press is easily worked by one man, and produces a good per centage of oil

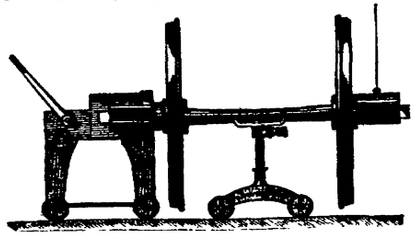
It consists of massive head and base, four wrought-iron screwed columns, cylinder, ram, pressing boxes, pair best gun-metal pumps in cistern, stop valve and working levers.

No.	Diam. Ram.	Power Tons	Price with 2 Boxes	Price with 4 Boxes
160	10 ins.	150	£40	£50
161	12 ,,	200	50	60

Roller Mills, £8. Seed Heaters, £8.
Hair Clamps, £3. Best Woollen Bars, 4s. 170

TANGYES' HYDRAULIC WHEEL PRESS

For forcing Railway Carriage, Wagon, and Locomotive Wheels on and off their axles.



Size	Diam. Ram	Run out	Power	Weight.	With 2 Pumps.
A	7 ins.	9 ins.	50 tons	12 cwts.	£40
B	9 ,,	9 ,,	75 ,,	23 ,,	45
C	10 ,,	18 ,,	100 ,,	50 ,,	90
D	12 ,,	18 ,,	150 ,,	75 ,,	110
E	12 ,,	18 ,,	200 ,,	— ,,	120

Hydraulic Pressure Gauge, £3 3 extra.

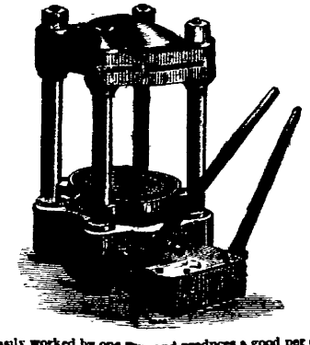
The C, D, and E sizes are generally as shown in illustration, and are for Locomotive Wheels. They consist of powerful Press with Cylinder and Ram, windlass draw-back gear, pair gun-metal pumps in cast-iron cistern, with stop and safety valves, mounted on four wheels. Also two cross-heads, wrought-iron tension bars, and ratchet screw elevator, on four wheels. These sizes are arranged to take off one and put on two locomotive wheels at a time.

The A and B sizes are for carriage and wagon wheels, and are somewhat differently arranged, having screw drawback, no elevator, and one cross-head only. They put on or take off one wheel at a time.

If made for Wheels with Solid Wood Centres, No. A £5, and No. B £10 extra. 151

TANGYES' HYDRAULIC "OIL" PRESS,

For Linseed, Cotton, Rape, Olive, Castor and other Oils.



This Press is easily worked by one man, and produces a good per centage of oil.

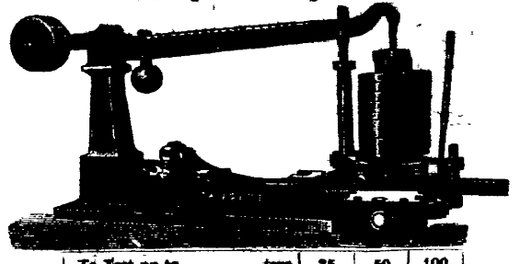
It consists of massive head and base, four wrought-iron screwed columns, cylinder, ram, round platen and drain pipe, pair best gun-metal pumps in cistern, stop valve and working levers.

No	Diam Ram	Power Tons	Price.
170	10 in.	150	£36
171	12 ,,	200	46

Roller Mills, £8. Seed Heaters, £8. 171

TANGYES' HYDRAULIC TESTING MACHINE

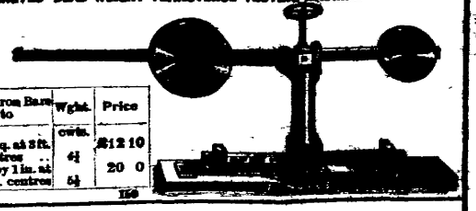
For Testing the Tensile Strength of Metals



To Test up to .. .. .. tons	25	50	100
Price, including a set of Clips £	75	150	250
Clips, per set	30s.	40s.	60s.
Ultimate Extension Indicator £	15	20	25

In ordering, say whether for round, square, or other section Iron. Above can be marked to suit weights of foreign countries.

TANGYES' DEAD WEIGHT TRANSVERSE TESTING MACHINE

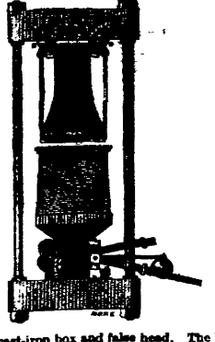


No.	To Test	Cast-iron Bars to	Wght.	Price
	cwts.		cwts.	
1	10	1 in. sq. at 3 ft. centres ..	4½	£12 10
2	40	2 in. by 1 in. at 3 ft. centres	5½	20 0

156

TANGYES' HYDRAULIC "TALLOW" PRESS

For Tallow Greaves, &c.



This Press has a strong cast-iron box and false head. The box measures 36 in. by 26 in. by 24 in., and has a perforated lining. The false head has rollers for running it on one side when changing the box. Pair of best gun-metal pumps, safety and stop valves.

No. 180.

Diam. Ram	Tested to	Weight	Price
6 ins.	50 tons	45 cwt.	£75

This Press may be had with Detached Pumps for hand or steam. 172

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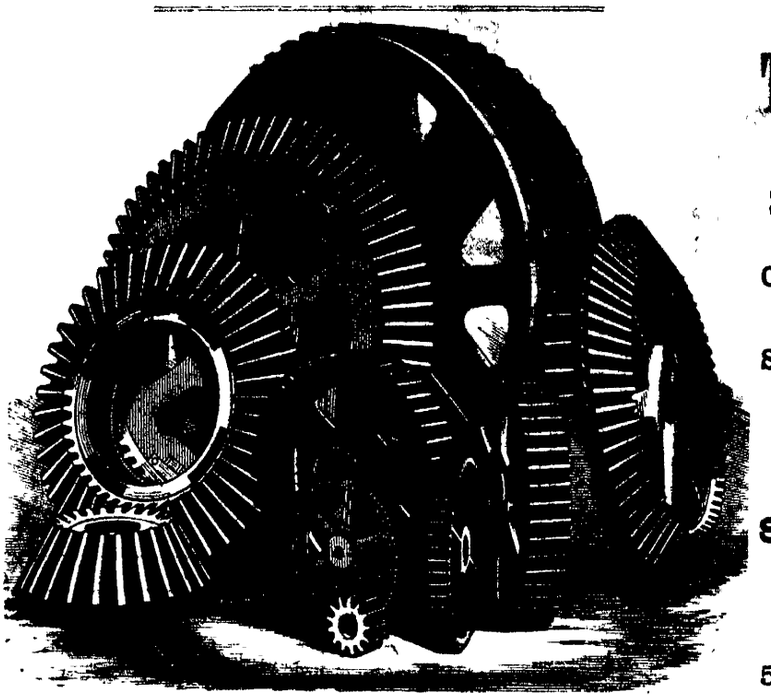
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FOR ALL PURPOSES

STEEL PLATES;

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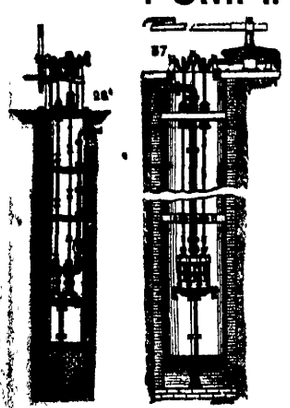
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HYDRAULIC AND GENERAL ENGINEERS, WHITEFRIARS ST., LONDON,

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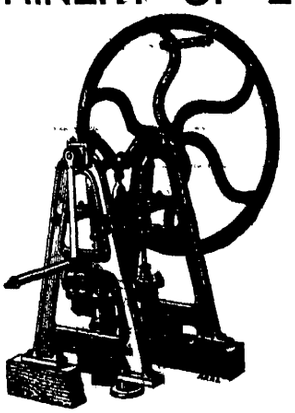
PUMPING MACHINERY OF EVERY DESCRIPTION.



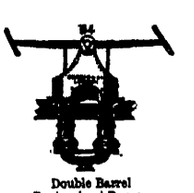
Deep Well Pumps for Hand Power. Deep Well Pumps for Horse or Cattle Power



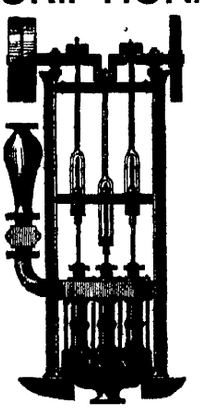
Improved Double Action Pump, for Hot or Cold Liquor



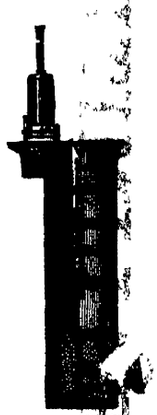
Single, Double, and Treble-Barrel Pumps, Hand or Steam Power.



Double Barrel Contractors' Pump



Treble Barrel Pumps, for Manufactories, Breweries, Distilleries, &c.



Deep Well Pumps [illegible] lined Engine & Boiler.



Steam Well Pumps.



Centrifugal Pump.



Portable Liquid Manure Pump.



Brass Lift Pump on Plank.



BORING TOOLS.

For Artesian Wells, Testing Ground, &c.



Wrought Iron Pump.



Force Pump on Barrow.



Double Barrel Fire Engine.



Hydraulic Ram, for supplying [illegible]

Pumps, Boring Tools, and General Contractors' Plant to be Let on Hire.

ILLUSTRATED CATALOGUES ON APPLICATION.

JAMES FARMER & SONS,

ADELPHI STREET IRONWORKS, SALFORD, MANCHESTER,

MAKERS OF

STEAM ENGINES, BLEACHING, FINISHING, DYEING & CALICO PRINTING MACHINERY,

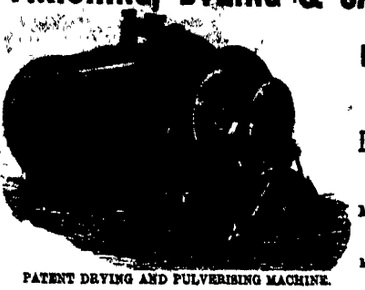
WIRE MACHINERY

Consisting of Continuous and other Rolling Mills, Wire Pointing Machines, Wire Looms, Wire Testing Machines, Wire Blocks, &c.



COPPER TUBE ROUGHING LATHE.

BRASS & COPPER TUBE MILLS. Wrought Iron TUBE MACHINERY.



PATENT DRYING AND PULVERISING MACHINE.

COMPLETE PLANT FOR

LINOLEUM MACHINERY

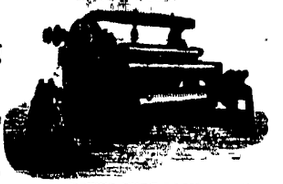
Two and Four Yards wide.

'PATENT'

Drying & Pulverising MACHINE

For Excrementitious Matter & other Materials and Compounds.

MACHINERY IN GENERAL



POWER WIRE LOOM 4859

FOR BRICK, TILE, & PIPE MACHINES,

JOHN WHITEHEAD & CO.,

ALBERT WORKS, PRESTON, LANCASHIRE,

HAVE BEEN AWARDED

FOURTEEN PRIZES by the Royal Agricultural Society of England,

INCLUDING THE SOCIETY'S SPECIAL SILVER MEDAL FOR SUPERIOR EXCELLENCE.

Also Awarded the PRIZE MEDALS of the INTERNATIONAL EXHIBITIONS of LONDON, 1851, 1862, and 1874; PARIS, 1855, 1856, 1867, and 1878.

ILLUSTRATED CATALOGUES FREE ON APPLICATION. 4907

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

Bell's Asbestos Works, Southwark S.S. "Ruapehu," Royal Albert Dock, 12th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure. ... 125 lbs. Vacuum. ..... 26 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 27 days 22 hours, being the fastest run from New Zealand on record. Yours obediently,

D HENDERSON, Chief Engineer, S.S "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 30th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory Yours truly,

Mr. J. Bell. G. M. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts,

Admiralty, Whitehall, 26th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to samples submitted.

Elastic core , ...square. Elastic core ..... round

To Mr. John Bell. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at any list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 30 per cent.; ¼ in., 100 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lessens the chance of a boiler, and saves its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It is put into the feed tank or boiler, as may be most convenient.

It is in tins and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Bradwell Park Colliery, Southwick, 1st February, 1884.

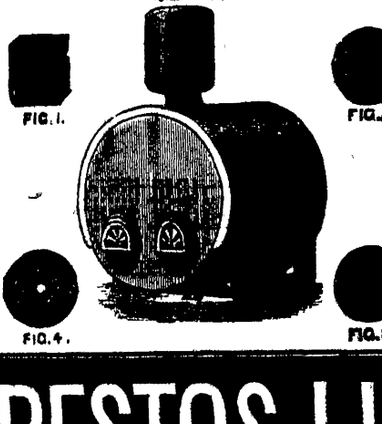
Bell's Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are working night and day, and for the last two, pumping and hauling Engines at the Colliery, and during that period we have not used more than one third the quantity of Hemp formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality

I am, dear Sirs, yours faithfully, THOMAS WINTER, Colliery Engineer.



BELL'S ASBESTOS.

The result of this unique mix of the purest quality only, and no attempt is made to compete with other manufactures by the supply of inferior materials at low prices. All "Bells" orders should be sent direct to the undermentioned depôts and not through agents or dealers.



BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metal and preserves it from rust; prevents the unequal expansion and contraction of metal exposed to weather; covers cheaper coal, much cheaper than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 H.P., gave the following results:—

Consumption on [illegible] ... ... 17 cwt.

One ton of coal was saved per week, and although the fire was raked out every evening [illegible] steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov 20th, 1882.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly, "W BAMPTON GRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

Mr. John Bell, Southwark, S.E. Granuliahs, Tavistock, 8th April, 1884.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W J CHALK, Assoc. M. Inst. C.E., Engineer and Manager

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without packering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ½ in. to 3 in. wide, and any thickness from 1-32nd in. upwards. Manhole covers can be fitted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at any price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and ½ millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts,

Admiralty, Whitehall, S.W., 17th May, 1884.

Sir,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT.

Mr. John Bell. Director of Navy Contracts

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanized Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REGD.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

4912

OR THE DEPOTS—

[illegible] STREET, S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 12, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

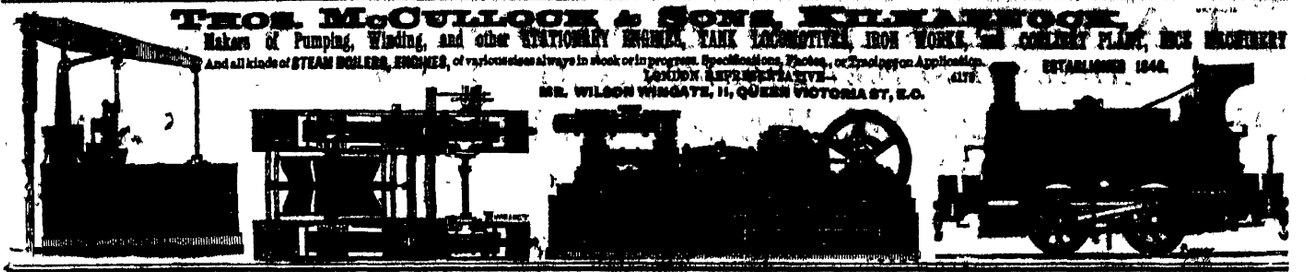
THOS. McCULLOCK & SONS, KILMARNOCK.

Makers of Pumping, Winding, and other STATIONARY ENGINES, TANK LOCOMOTIVES, IRON WORKS, and COMPLETE PLANT, RICE MACHINERY

And all kinds of STEAM BOILERS, ENGINES, of various sizes always in stock or in progress. Specifications, Photos., or Tracings on Application.

LONDON REPRESENTATIVE—
MR. WILSON WINGATE, 11, QUEEN VICTORIA ST, E.C.

ESTABLISHED 1842.



JOHN I. THORNYCROFT & CO.,

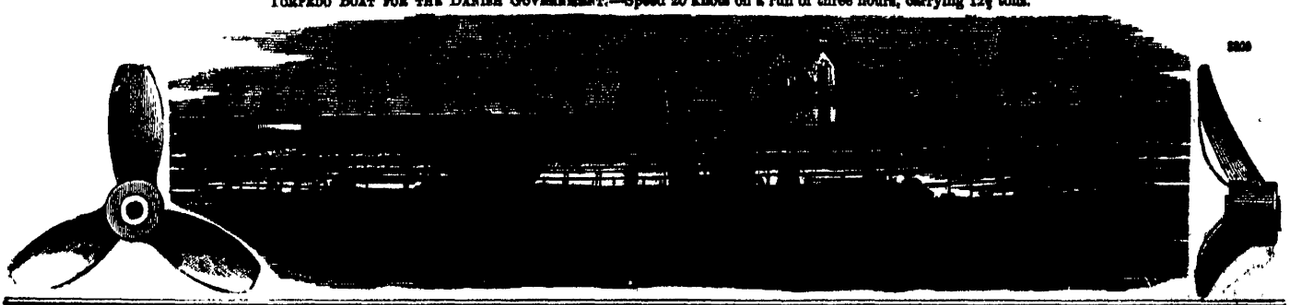
STEAM YACHT AND LAUNCH BUILDERS,

CHURCH WHARF, CHISWICK, LONDON, W.

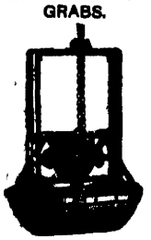
YACHTS AND LAUNCHES FOR SEA OR RIVER SERVICE, from 25 to 100 feet in length, and Speeds from 10 to 25 Miles per Hour

Thornycroft's Patent Screw Propellers made for all sizes of Vessels. Efficiency superior to any hitherto brought out.

TORPEDO BOAT FOR THE DANISH GOVERNMENT.—Speed 20 knots on a run of three hours, carrying 12¼ tons.



SINGLE CHAIN GRABS.



SUPPLIED TO ORDER WHEN PREFERRED.

WORKS: Holderness Foundry, HULL.

PRIESTMAN BROTHERS.

LONDON OFFICE: 52, QUEEN VICTORIA STREET.

CONTRACTORS FOR BARGES TO H.M. GOVERNMENT & THE INDIAN BOARD.

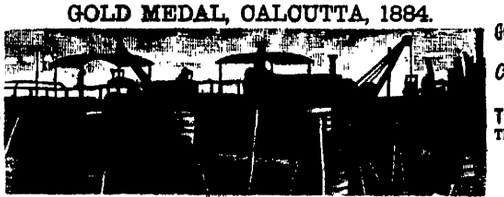
GOLD MEDAL, CALCUTTA, 1884.

AWARDS

DIPLOMA of HONOUR AMSTERDAM, Paris, Melbourne, Adelaide.

Contractors for Dredgers to

THE ENGLISH GOVERNMENT
THE CROWN AGENTS FOR THE COLONIES
The German Government
" French Government
" Italian Government
" Cape Government
" Danish Government
" Chinese Government
" Chilian Government



THE PATENT DREDGER EXCAVATOR & ELEVATOR.

AWARDS

GOLD MEDAL FISHERIES LONDON, Sydney, New Zealand, Tynemouth.

Contractors for Dredgers to

THE INDIAN BOARD
THE MERSEY DOCK & HARBOUR BOARD
The South Australian Government
" New Zealand Government
" Spanish Government
" Victorian Government
" New South Wales Government
" Dutch Government
" Queensland Government

DOUBLE CHAIN GRABS.

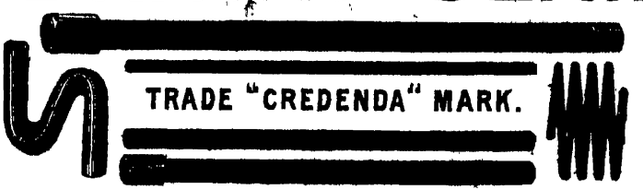


PARTICULARS, SHOWING GREAT ADVANTAGES, ON APPLICATION. 5057

—:PATENT:—

COLD-DRAWN SEAMLESS

THE CREDENDA COLD-DRAWN SEAMLESS STEEL TUBE COMPANY, BIRMINGHAM.



BIRMINGHAM WORKS & OFFICES: LEDSAM STREET, MONUMENT LANE STATION.

LONDON OFFICE: 4, WATER LANE, GT. TOWER STREET, E.C.

4999

FOR BOILERS AND STAYS, HYDRAULIC PRESSES, AIR RESERVOIRS.

STEEL TUBES.

BORING RODS, COUPLINGS, BUSHES, SPINDLES, COLLARS, BICYCLES & OTHER USES.



The "CLYDE" STEAM and BALLAST PUMPS.

"CLYDE" STEAM PUMP (STANDARD PATTERN).
LIST OF STANDARD SIZES.

Size Double-Acting.	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Price, with Gun-Metal Valves, Plunger, &c.
	in.	in.	in.	£ s. d.
1	4	[illegible]	4	17 15 0
2	[illegible]	[illegible]	[illegible]	21 10 0
3	[illegible]	[illegible]	[illegible]	25 0 0
4	[illegible]	[illegible]	[illegible]	28 10 0
5	[illegible]	[illegible]	[illegible]	32 0 0
6	[illegible]	[illegible]	[illegible]	35 10 0
7	[illegible]	[illegible]	[illegible]	39 0 0
8	[illegible]	[illegible]	[illegible]	42 10 0

For Feeding Marine and Stationary Boilers, Pumping Water Supply to Railway Stations, Manigers, Warehouses, Mines, Dye Works, Breweries, and for use as Stationary Fire Engines, and for General Contractors' Purposes; for Tar and other Thick Liquids.

"CLYDE" STEAM PUMP (PATTERN A).
LIST OF STANDARD SIZES.

Size.	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Capacity per hour.	Suitable for Boiler	Price, with Gun-Metal Valves and Plunger.
	in.	in.	in.	Gallo	HP.	£ s. d.
0A	[illegible]	[illegible]	[illegible]	360	10	15 0 0
1A	[illegible]	[illegible]	[illegible]	600	15	17 10 0
2A	[illegible]	[illegible]	[illegible]	1200	30	22 10 0
3A	[illegible]	[illegible]	[illegible]	1800	45	27 15 0
4A	[illegible]	[illegible]	[illegible]	2400	60	33 0 0
5A	[illegible]	[illegible]	[illegible]	3000	75	38 10 0

The "Clyde" Connecting Rod Steam Pump, with Swivel-box, capable of working horizontally, vertically, or in an inverted position.



"CLYDE" BALLAST PUMP (PATTERN B).
LIST OF STANDARD SIZES.

Size.	Steam Cylinder diam.	Pump Cylinder diam.	Stroke.	Delivery Pipe diam.	Discharge in Tons per hour.	Price.
	in.	in.	in.	in.		£ s. d.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

This Pump is very compact, and works with the greatest steadiness. The crosshead is of cast steel, and so arranged that it can be readily detached from the pump piston rod, if the engine is required to work alone. The Pump is reversible, that is, it can be easily changed the position of the Valves the suction can be converted into delivery and vice versa. 4750



TRADE DISCOUNTS AND FURTHER PARTICULARS ON APPLICATION.

LOUDON BROTHERS,

POWELL STREET, GLASGOW, } AND { UPPER THAMES STREET, LONDON.

Manchester Depot: 6, Todd Street, Corporation Street.

Cardiff Depot: T. BEER, 7, Bute Docks.

CLASS A.



LOCO. PATTERN, SINGLE LEVER.

THE HANCOCK

INSPIRATOR

ONLY GOLD MEDAL Paris, 1878. FIRST AWARD, Sydney, 1879.

60,000 IN USE.

THE DOMESTIC PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND RELIABLY.

No Adjustment.

Draws Water at 140°.

All Sizes lift water 25 ft.

Delivers to Boiler up to 212°.

ESTIMATES FOR FIXING COMPLETE with Guarantee to start in good working order, and all information on application to—



Feeds through Heaters.

Can be used as a Pump only.

No Valves or Wearing Parts.

Can be examined instantly.

THE HANCOCK INSPIRATOR CO., 108, Upper Thames St., London, E.C.

CLASS C.



Cheap Class of Machine.

STATIONARY PATTERN. 5115

Henry Bessemer and Co., Limited,

Manufacturers of Cast Steel,

SHEFFIELD.

FORGINGS

In Steel of any size.—Quotations given either for uses or finished complete.

STEEL CASTINGS

Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0.30 per cent. carbon, and to bear a tensile strain of 34 tons to the square inch.

TYRES AND AXLES.



SOFT CAST STEEL

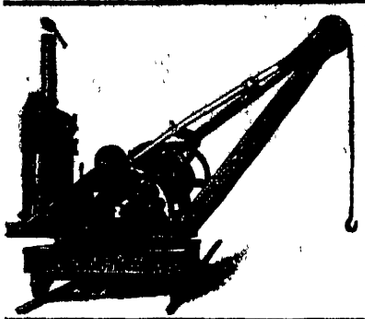
In bars and rods, for general use in Engineering Works.

BLOOMS, BILLETS, & SLABS

Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,

Of superior quality. 5127



EXORS. OF WM. BALMFORTH,

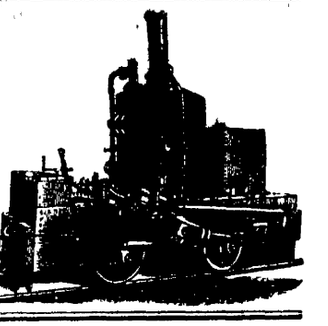
RODLEY, NEAR LEEDS.

MANUFACTURERS OF

LOCO. STEAM CRANES, CONTRACTORS' LOCOS., TRAVELLERS, HOISTS, AND ALL KINDS OF LIFTING MACHINERY.

4097

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes.





THE COALBROOKDALE COMPANY, LIMITED

MAKERS OF

STEAM ENGINES,

HORIZONTAL AND VERTICAL,

AND

OTHER MACHINERY.

MAKERS OF

STEAM PUMPS.

PARKER & WESTON'S PATENT

PUMPING ENGINES for Mines, Sewage and Water Works.

BOILER FEEDERS and SLIP PUMPS.

AGENCIES { LIVERPOOL - 19, SWEETING STREET. MANCHESTER, 29, PRINCESS STREET. 5130

WORKS & OFFICES: COALBROOKDALE, SHROPSHIRE.

DICK, KERR & CO., Engineers and Contractors,

(Five Medals awarded, Calcutta International Exhibition, 1883-4.)



SOLE MANUFACTURERS OF

KERR'S PATENT

PORTABLE RAILWAY

SUITABLE FOR MINES AND PLANTATIONS.

WAGONS & LOCOMOTIVES

FOR ANY CLASSES OF WORK.

Catalogues and Prices on application. 5014



101, LEADENHALL ST., LONDON, E.C. Works: Britannia Engineering Works, KILMARNOCK.

HANNAY'S PATENT

ELECTROGEN

FOR PREVENTING

CORROSION AND SCALE

IN ALL KINDS OF

STEAM BOILERS.

HANNAY'S MARINE APPLIANCES COMPANY, Ltd.,

67, GREAT CLYDE STREET, GLASGOW. 5006

POINTS & CROSSINGS

FROM EVERY SECTION OF RAIL.

Portable Railways and General Railway Plant.

HARTLEY & ARNOUX BROS.

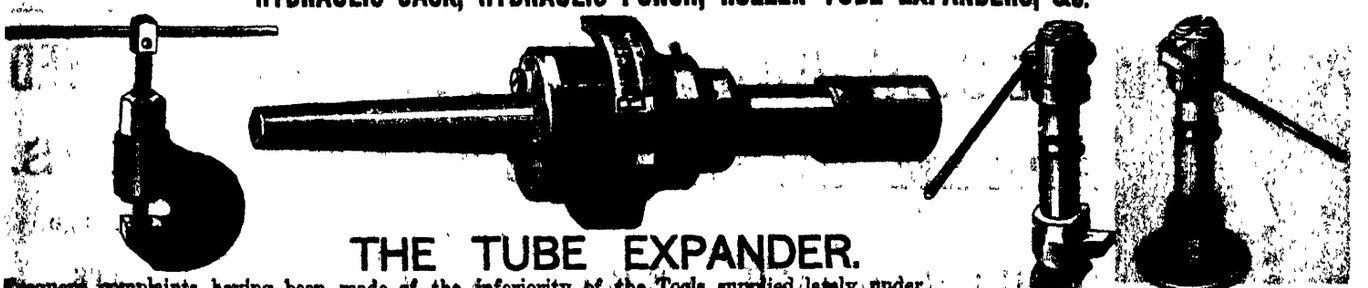
STOKE-ON-TRENT.

RICHARD DUDGEON,

114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF HIS

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, &c.



THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "DUDGEON'S ROLLER TUBE EXPANDERS," R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only are stamped as under:—

R. DUDGEON, N.Y., Patd. Feb. 5th, 1867, on the Guide-ring of each Tool, WITHOUT WHICH NONE ARE GENUINE.

Tools can always be obtained of R. Dudgeon's English Depot, 114, Fenchurch Street. Where convenient to get them through Merchants, care should be taken to specify "Dudgeon's own make" on the Order, lest as R. Dudgeon is charging with regret that imitations bearing his stamp counterfeited are being sold as his, he would respectfully recommend both Merchants and Users rejecting Expanders of his make to apply direct. In urging this he merely seeks to secure the identity of what is made by himself, by which he is content to stand or fall.

R. Dudgeon takes this opportunity of returning thanks for past favors, either by orders or recommendation, and it being his intention strictly to maintain the Quality and Workmanship as essential for such a Tool,

CATALOGUES AND PRICE LISTS ON APPLICATION TO R. DUDGEON, 114, FENCHURCH STREET, LONDON, E.C.

15 PRIZE MEDALS.] THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED, [15 PRIZE MEDALS.
4, WEST REGENT STREET, GLASGOW.
GLASGOW, 1874. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 3. GLASGOW, 1880, 2. LONDON, 1882, 1.



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 4784

100 TO 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

Crossley's Patent TWIN-ENGINES. Impulse every revolution. The steadiest running Gas Engine yet made.

THE "OTTO." GOLD MEDAL at Crystal Palace, & HIGHEST AWARD at Paris Electrical Exhibitions.



New Patent SELF-STARTER. Best, Safest, and Simplest made, may now be applied.

CROSSLEY'S NEW VERTICAL ENGINE, Requiring little floor space.

¼ TO 100 HP. IND. MANY IMPROVEMENTS. OVER 15,000 IN USE.

LONDON: 24, POULTRY, E.C. GAS ENGINE GLASGOW: 58, UNION STREET 4778

CHEAP GAS FOR MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·3 lb. per ind. H. P. per hour.

The DOWSON ECONOMIC GAS COMPANY, Ltd., 5, Great Queen St., Westminster, S.W. 4883

JESSOP'S CRANES

For Particulars see last Week's "ENGINEERING," or WRITE FOR HANDBOOK.

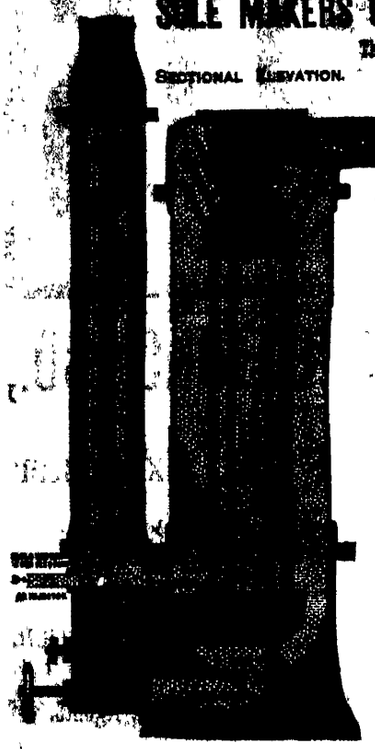
J. JESSOP & SON, LEICESTER. 5113

Or 113, CANNON STREET, LONDON.

TAYLOR & CHALLEN, ENGINEERS, BIRMINGHAM.

SOLE MAKERS OF WITHINSHAW'S PATENT FEED-WATER HEATER AND PURIFIER.

The saving effected by these Heaters is a remarkable fact, as will be seen by the two letters below.



SECTIONAL ELEVATION.

LETTER FROM MESSRS. THOMAS WHITE & SONS, HERTFORD MILLS, BALSALL HEATH, BIRMINGHAM
June 20th, 1883.

GENTLEMEN,—It is with pleasure we can inform you that WITHINSHAW'S 40-HP. FEED WATER HEATER, which you have fixed at our works, is giving us every satisfaction. Before it was put in we were stopping three and four times a day for want of steam. Now we can keep up the steam easily with *35 per cent. less coal*, besides, we are now *burning slack, costing us 30 per cent less* than we were giving before the Heater was put in. We have not only plenty of clean boiling water for the boilers, but we can, and are, taking boiling water for other purposes, which is a great convenience to us.

We shall be glad to show the Heater at work to anyone who you may wish to see it.

To Messrs. TAYLOR & CHALLEN, Derwent Foundry, Birmingham. Yours respectfully, THOMAS WHITE & SONS.

September 29th, 1883.

Messrs. TAYLOR & CHALLEN,

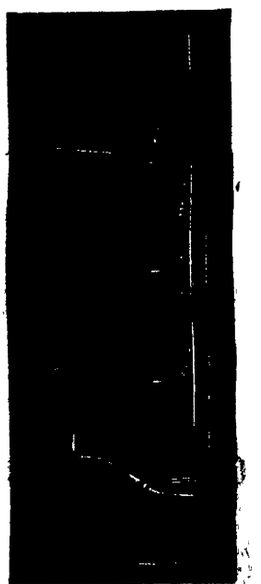
GENTLEMEN,—We have a further pleasure in stating that we are now doing as much work in one day as we were doing in a day and quarter before the Heater was put in.—Yours respectfully, THOMAS WHITE & SONS.

This Heater is the most powerful and economical yet brought out. The tubes are made of the best heat conducting metal, solid drawn. The hot exhaust is conducted to the top of the Heater, and is brought into close contact with the hottest water in the Heater, by charging the top chamber and the small inverted metal tubes. At the same time the exhaust has a free passage down the centre tubes, the remaining uncondensed steam passing to the bottom and up the out-going up-take. The cold feed water from the pump passing up and down the up-take, enters the bottom of the Heater as hot as the out-going exhaust steam.

The water capacity in these Heaters being very large, considerable time is given for the water to boil; this being done under the same pressure as the boiler, precipitates the impurities to the bottom of the Heater, and they are then blown off: the boiler being kept clear from deposit and scale, by being fed with clean boiling water from the top of the Heater.

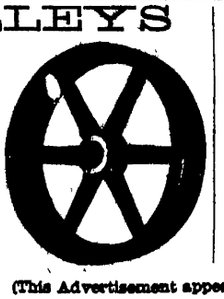
Where the Injector is connected with the Heater (as shown in the illustration), no pump is required, the exhaust steam only being used to boil feed water clean, and feed the boiler.

Patented in Great Britain France, Germany, Belgium.



PULLEYS

Cast of selected iron from carefully designed patterns, either whole, in halves, plain or shrouded, finished, or castings only.

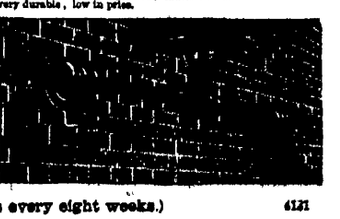


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THE "SHAFT-CARRIER."

A GREAT SUCCESS. THOUSANDS IN USE.

It can be fixed in any position (see cut); is self-adjusting and self-lubricating, position of bearing variable both vertically and horizontally, easily fixed, causes no undue friction, is very durable, low in price.



(This Advertisement appears every eight weeks.) 6121

PATERSON & COOPER,

ELECTRIC LIGHT ENGINEERS AND CONTRACTORS

76, LITTLE BRITAIN, LONDON. Steam Factory: POWNALL ROAD, DALSTON.

Complete Sets of Electric Lighting Machinery and Fittings for Lighting Hotels, Public Buildings, Factories, Mills, Ship

&c., &c.

ESTIMATES FOR INSTALLATIONS FREE OF CHARGE. EXPERIENCED MEN SENT TO ALL PARTS OF THE COUNTRY.

Licensees of the "Clarke and Bowman" Arc Lamp, and of Joel's Storage Batteries.

PATERSON & COOPER'S DIRECT CURRENT "PHŒNIX DYNAMOS

No. 1.—For	16	20	candle-power Lamps, or	2	Small Arcs, or	1	Large Arc			£36
No. 2.— „	30	„	„	„	3	„	„	2	„ „	54
No. 3.— „	75	„	„	„	7	„	„	4	„ „	80
No. 4.— „	120	„	„	„	12	„	„	7	„ „	120
No. 5.— „	200	„	„	„	24	„	„	14	„ „	180
No. 6.— „	300	„	„	„	...	...	...	...	...	250
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4095

Awarded a First-Class CERTIFICATE OF MERIT at Manchester, and a First-Class DIPLOMA OF MERIT at Tynemouth.

PATENT DIAGONAL ROCKING FIRE-BARS

—(Can be Fixed in a Few Hours.)— ARE ECONOMICAL, DURABLE, SMOKE-CONSUMING. —(No Attachment to Boiler necessary.)—

Numerous Official Tests show an average economy of over 10 per cent. *These Patent Bars last Years where ordinary Bars last only Months.*

Recently supplied to the order of the eminent builders of the engines and boilers of the most powerful Ironclad afloat for use in the whole of the furnaces, to work with "Forc Draught," MAKING THE THIRD Ironclad fitted. Used by the most eminent Engine and Boilermakers (Marine and Land), Railways, Home and Foreign Governments, &c. 5119

Agents having connections among Steam Users Required in Principal Towns. — Particulars of the Manager at the Offices, 268, Gresham House, E.

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PHOSPHOR BRONZE

The Best and Most Durable Metal for Bearings and Bushes of every Description; Hydraulic Pumps, Pinions, Valves, &c. &c. Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c.

SOLE MANUFACTURERS UNDER SEVERAL PATENTS— 1475

The PHOSPHOR BRONZE COMPANY, Limited, Sumner & Emerson Streets, Southwark, London, S.E.

Calcutta, 1884.—HIGHEST AWARD.



THE SAVILE STREET FOUNDRY AND ENGINEERING CO.

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

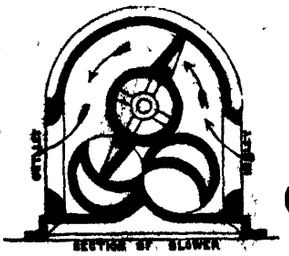
Baker's Patent Rotary Pressure Blower and Gas Exhauster

—:o:—

BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.



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HALL'S PATENT STONE BREAKER.

—:o:—

General Machinery of Every Description

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AMERICAN MACHINERY AND TOOL IMPORTERS

21, CROSS STREET, FINSBURY, LONDON, E.C.

ESTABLISHED IN 1862.



C. C. & Co. have just removed to much larger premises with ample show rooms and warehouse, and will carry a greatly increased stock of all the best American tools.

SOLE AGENTS FOR

THE ONLY GENUINE AMERICAN MORSE TWIST DRILL,

WITH CENTRE GRINDING LINE, STOCKS AND DIES, REAMERS AND MILLING CUTTERS,

Stephens' Patent Vices, Horton Chucks, Cushman Chucks, Westcott Chucks, Sweetland Chucks, Stanley Rule & Level Co.'s Planes, &c., &c., Gould's Manufacturing Co.'s Pumps, and a great variety of New American Tools.

New Catalogue for 1888 just issued, 215 pages Quarto, sent on receipt of One Shilling in Stamps.

(THE LARGEST CATALOGUE OF AMERICAN TOOLS EVER PUBLISHED IN GREAT BRITAIN) 4124



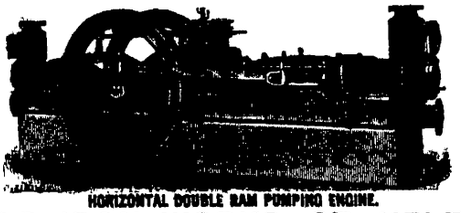
DOUBLE RAM PILLAR PUMPING ENGINE.

W. NEILL & SON,

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HORIZONTAL DOUBLE RAM PUMPING ENGINE.



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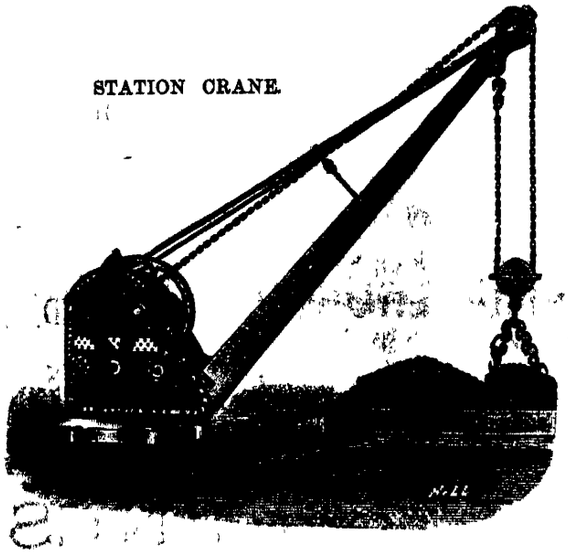
BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.

COWANS, SHELDON & CO., LTD.,

ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.

STATION CRANE.



STEAM ACCIDENT CRANE.

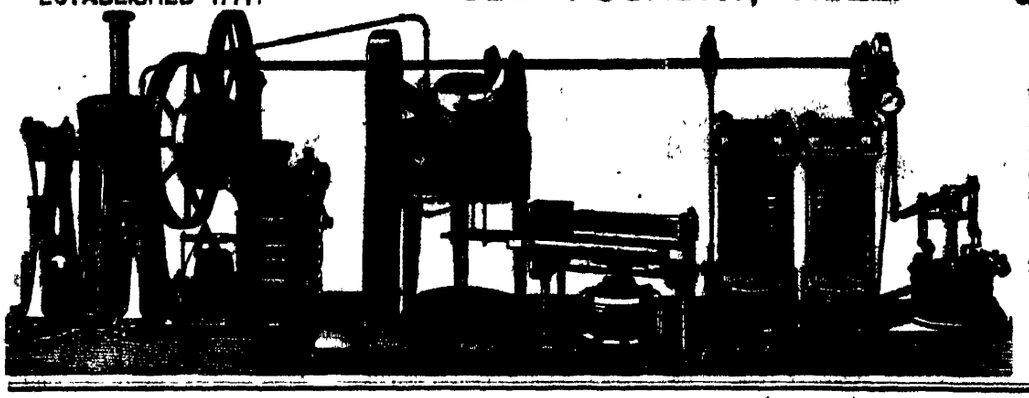


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ESTABLISHED 1777. OLD FOUNDRY, HULL. GOLD MEDAL, CALCUTTA.



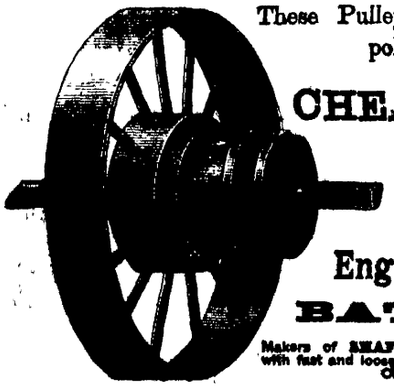
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ANGLO-AMERICAN
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For crushing Linseed, Cotton Seed, Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent. in labour and power, and 2 to 4 per cent. in Oil.
(See *Engineer*, May 6, 1881, and Nov. 23, 1883.)

300,000 TONS OF OIL SEEDS PER ANNUM,
Are Crushed by Mills made on this system by us.

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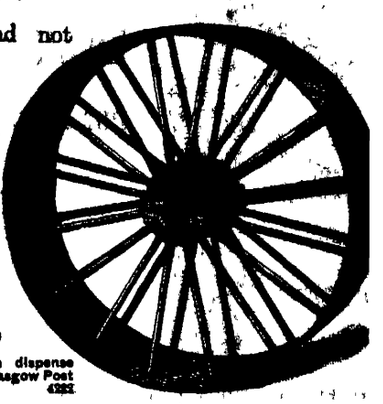
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These Pulleys are TURNED IN A LATHE, and not polished on a Grindstone like those generally sold.

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Illustrated Circular Post Free.



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BATLEY, YORKSHIRE,

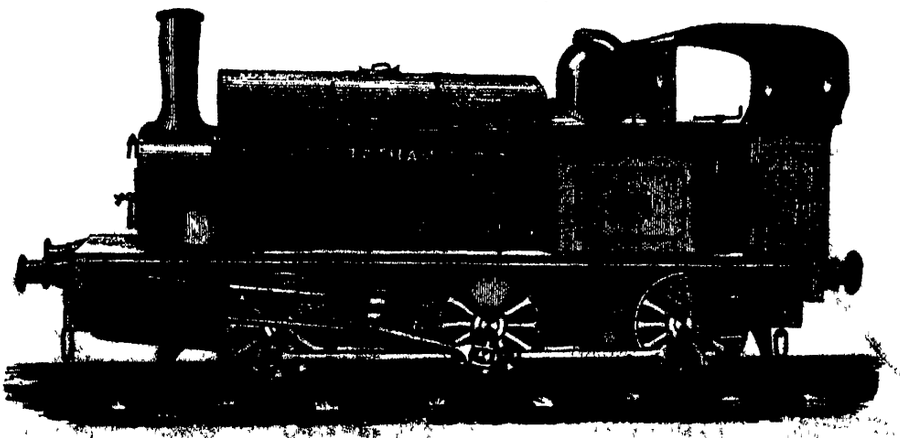
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FOR CASH or DEFERRED PAYMENTS.

LOCOMOTIVE TANK ENGINES

OF ALL SIZES AND TO SUIT ANY GAUGE OF RAILWAY.

For Main Line or Branch Railways, Contractors, Ironworks, Collieries, &c

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SEE HALF-PAGE ADVERTISEMENT SEPT. 19th, Page 33.

RAILWAY PLANT!!

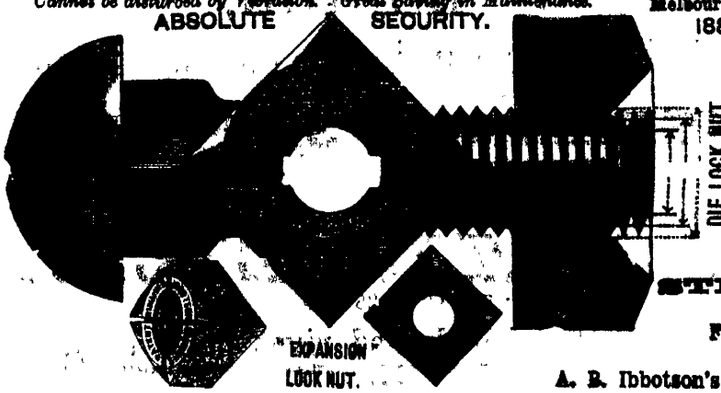
SEE HALF-PAGE ADVERTISEMENT SEPT. 5th, Page 33.

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Patent Steel Lock Nuts and Steel Fish Bolts.

Cannot be disturbed by Vibration. Great Saving in Maintenance.

ABSOLUTE SECURITY.



FIRST-CLASS MEDALS, LONDON, PARIS, SYDNEY, ADELAIDE, &c.

18 GOLD MEDALS Melbourne Exhibition, 1880—81.

ONLY FIRM awarded GOLD-MEDALS for Nuts and Bolts, Buffers Couplings, Cradles, Springs, Steel Sleepers, Rail Joints, &c.
GOLD MEDALS for Steel, Files, Saws, Steel Forgings, Railway Appliances, &c.

IBBOTSON BROTHERS

AND COMPANY, LIMITED,

GLOBE IRON AND STEEL WORKS

SHEFFIELD.

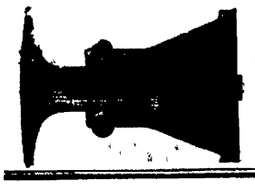
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STEEL OF EVERY DESCRIPTION

STEEL FORGINGS, AXLES, &c., RAILWAY SPRINGS OF ALL KINDS.

Files (Hand Cut only), Saws, Edge Tools, and Patent Automatic Central Coupling Buffers.

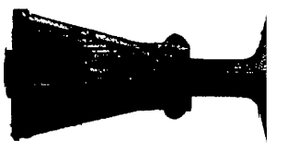
A. B. Ibbotson's Patent Steel Die and Expansion Lock Nuts, and Steel Bolts Railway Fastenings, &c., &c.



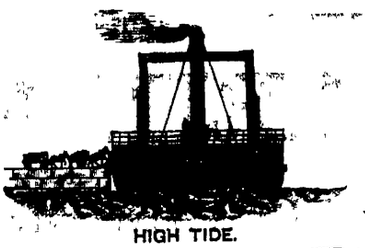
GEORGE TURTON'S PATENT WROUGHT IRON BUFFERS,

AND PATENT COMPOUND CAST STEEL SPRINGS. {4120 3813

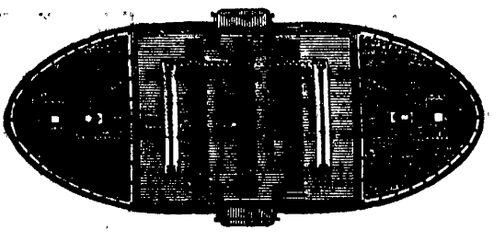
LONDON OFFICE: 4, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W.



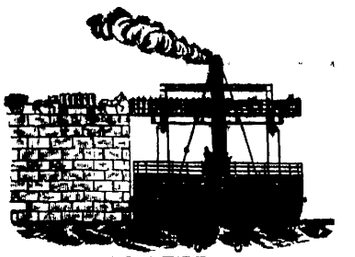
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HIGH TIME.

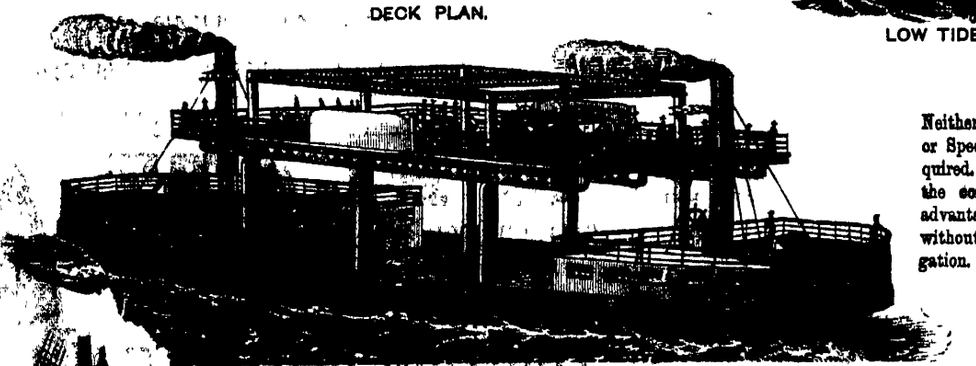


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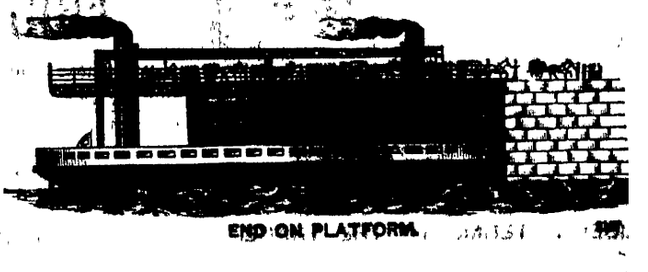
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SCOTLAND,

CONSTRUCTORS.



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Manufacturers of the only Patent Safety Starting, Turning, or Barring Engine.

Makers of STEAM ENGINES up to 3,000 HP.

With Patent Automatic Cut-off Motion. Adaptable to Stamper Valves, Slide Valves, and Corliss Valves, which can also be applied to existing Engines.

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On Condie's principle, with Patent Valve Motions, from 3½ cwt. to 25 tons.

Wrought-Iron and Steel STEAM BOILERS with drilled rivet holes only.

MILL-GEARING IN ALL ITS BRANCHES.

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BLEACHING MACHINERY.

ALSO THE ONLY MODERN PLATE-GLASS MACHINE MAKERS. 4736

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HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 5001

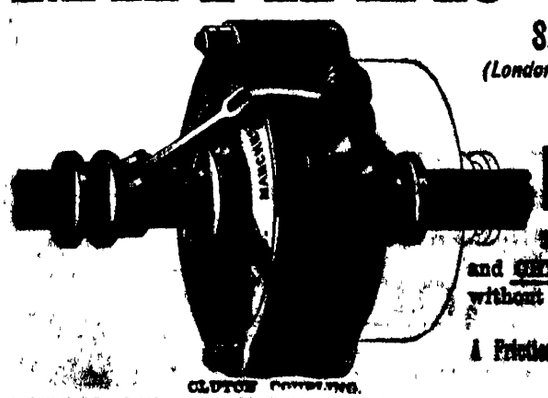
MATHER & PLATT,

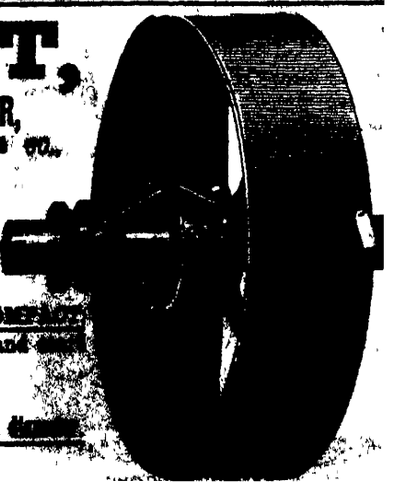
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(London Representatives, Messrs. LEWIS CLARK & CO., 27, Leadenhall Street, E.C.)

— PATENT —

FRICTION CLUTCH.





These Clutches are SIMPLE, DURABLE, CONSTANT and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.



4572

THE

Oldham Boiler Works Company,

LIMITED,

AND REDUCED,

(Late JOSEPH PRITCHARD & SONS).

ESTABLISHED 1816.

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MAKERS OF ALL TYPES OF

IRON AND STEEL

STEAM BOILERS,

ON THE MOST MODERN PRINCIPLE.

By Patent Machinery, specially adapted for Drilling, Rivetting, and Flanging.

ALSO SOLE MAKERS FOR LANCASHIRE, YORKSHIRE, AND CHESHIRE, OF

MIRFIN & NIELD'S PATENT

COMBUSTION CHAMBERED BOILERS,

WITH INCREASED FLUE-HEATING SURFACE.

Works: OLDHAM, ENGLAND.

LONDON AGENT: Mr. G. W. BLOW, 11, QUEEN VICTORIA STREET, E.C. 4885

THE

Patent Steam Boiler Co.

HENEAGE STREET, BIRMINGHAM.

London Office: 31, Queen Victoria St. Mr. GERALD KNAP, Representative.

Telegraphic Address: "ROOT." (SOLE PROPRIETORS OF THE EUROPEAN PATENTS.)

Agents: Slom & Walker, Calcutta, &c.; T. Tait & Co., Melbourne, N. Z., New Zealand; A. Shaw and Co., London, for Queensland; Mason, Firth, Sydney, New South Wales and Victoria.

SPECIAL ESTIMATES FOR MARINE BOILERS

THE "SAFE AND SURE" TUBULOUS STEAM BOILER

—(ROOT'S PATENT.)—

240 HP. "Root" Boiler.

Sizes from 10 to 300 HP., and of modified construction (but of equal strength) 1 to 8 HP. Nom. For Mountain Transport, made in pieces of 250 lbs., at special prices. An ordinary Mechanic can put together. Now working in a variety of situations all over the world, and in confined positions underground, &c. All parts made to gauge and kept in stock. Boilers of any power up to 6 [illegible] days' notice. The Prices of our ROOT Boilers have been reduced; Lists on application. No accident to life or limb has ever been recorded against this Boiler. Tested to 600 lbs. per square inch with cold water. Large Steam Drums to 300 lbs. Suitable working pressure 150 lb.

THE "UNIVERSAL" SECTIONAL STEAM BOILER

for Stationary purposes, on "Root's" system.

"Universal" Boiler.

This powerful steam Generator has been recently introduced to meet the views and requirements of many steam users. It is suitable for general application. Made in sizes from 5 to 300 HP Nom. Attention is solicited to the advantages of this Boiler, viz.: Cheapness, Economy, Ample Steam and Water Space; Rapid Circulation, Prevention of Ingrustation, Safety, High Power, Impossibility of Priming, Easily Cleaned, Durability, &c. This Boiler may be placed in space vacated by cylindrical boilers of far less power. 5152

References to the Birmingham Corporation (1,365 horse-power); Messrs. Cochrane and Co., Middlesboro' (1,500 horse-power).

T. W. LAPWORTH, Manager and Secretary. For Estimates, Drawings, and full particulars, address— THE PATENT STEAM BOILER CO., Head Office, 28, Heneage Street, Birmingham.

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Turned true and bright to Whitworth's Gauges, any length, from 2 in. to 3 in. diameter, 14s. per cwt. at Nottingham. Also Couplings, Pulleys, Plummer Blocks, Hangers, Machine-made Spur, Bevel, and Mitre Wheels, Friction Gearing, &c.

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THE CLAY CROSS COMPANY,

COAL, LIME, & IRON WORKS, CLAY CROSS, near CHESTERFIELD,

SUPPLY HOUSE, GAS, AND STEAM COAL,

AND ARE MAKERS OF

PIG IRON, GAS and WATER PIPES, and ALL CASTINGS

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CHANNEL IRON

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6 × 6	= 7 "	5 × 3	= 3½ "
6 × 3½	= 5½ "	5 × 2½	= 2½ "
6 × 3	= 5 "	5 × 2	= 2 "
5 × 3½	= 4½ "	4 × 3½	= 3 "
5 × 3	= 4 "	4 × 3	= 2½ "
4 × 3½	= 3½ "	4 × 2½	= 2 "
4 × 3	= 3 "	4 × 2	= 1½ "
4 × 4	= 4 "	3 × 3	= 1½ "
3½ × 3½	= 3 "	3 × 2½	= 1¼ "
3 × 3	= 2½ "	3 × 2	= 1 "
2½ × 2½	= 1½ "	2½ × 2	= 1 "
2 × 2	= 1 "	2 × 1½	= ¾ "
1½ × 1½	= ¾ "	1 × 1	= ½ "

SECTION OF JOISTS.

8 × 8	= 101lbs.	4½ × 8	= 121lbs.	7 × 3½	= 141lbs.	5½ × 5½	= 94lbs.
8 × 6	= 90 "	5 × 4½	= 39 "	7 × 3½	= 90 "	9 × 4½	= 39 "
8 × 4	= 7 "	5 × 3	= 11 "	8 × 4	= 23 "	10 × 4½	= 23 "
6 × 4	= 11 "	6½ × 3	= 14 "	8 × 4	= 28 "	10 × 5	= 25 "
6 × 5	= 13 "	6½ × 3½	= 16 "	8 × 5	= 29 "	10 × 5	= 32 "
6½ × 1½	= 6 "	6 × 5	= 29 "	8 × 6	= 34 "	10 × 6	= 30 "

12 × 5	= 48lbs.	12½ × 7½	= 100 "
12 × 6	= 56 "		
14 × 6	= 60 "		
16 × 6	= 63 "		
17½ × 6½	= 63 "		
10 × 8	= 35 "		
10 × 7½	= 100 "		

Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to 2". 5126

TEES.		CHANNELS.	
5½ × 5½		12 × 5	
4 × 4½		9 × 3	
5 × 3		8 × 2½	
5 × 3		7 × 2	
5 × 2½		6 × 2	
4½ × 3		5½ × 2	
4 × 3		5 × 2	
3½ × 3		4½ × 1½	
3 × 2½		4 × 1½	
2½ × 2		3½ × 1½	
2 × 2		3 × 1½	

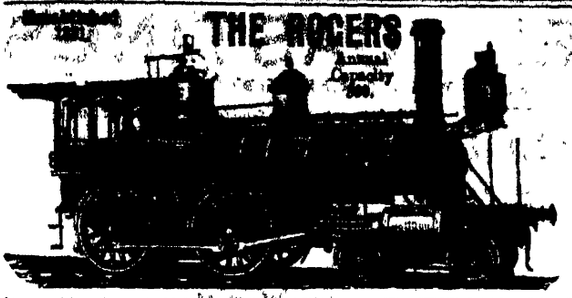
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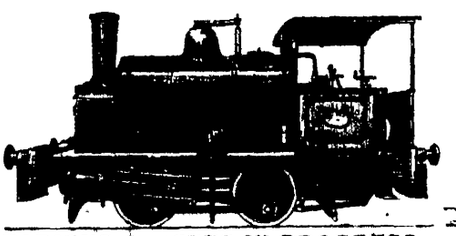
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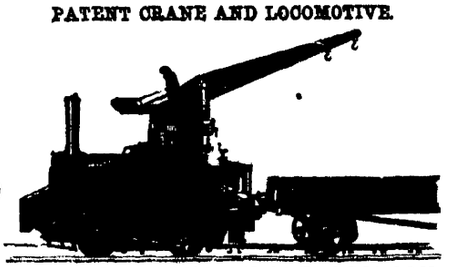
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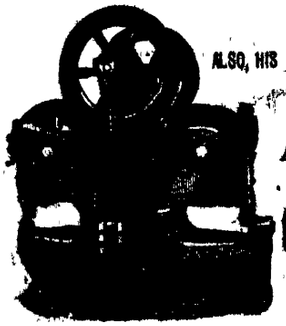
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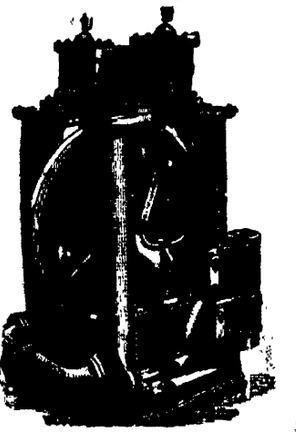
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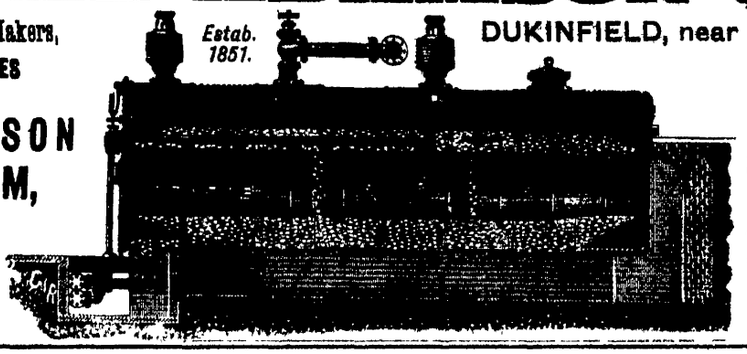
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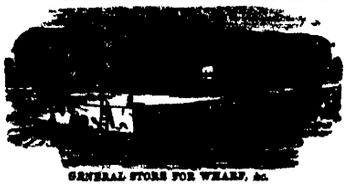
Borough Laboratory, 8, St. James's Square, John Dalton Street, Manchester, 15th September, 1876.

An analysis of a sample of this shows it to contain neither Free Alkali nor Acid. It is purely Vegetable matter, and has no *injurious action upon Iron.*

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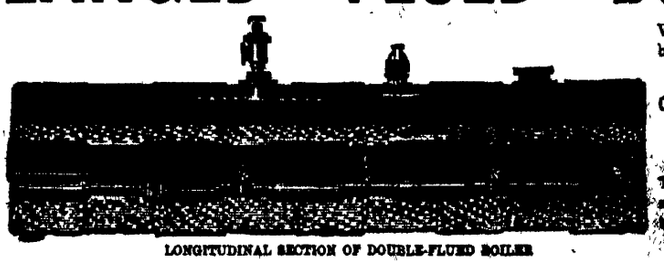
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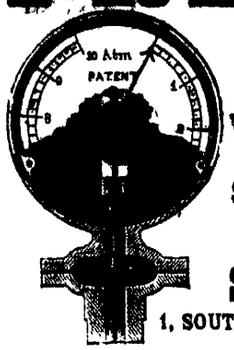
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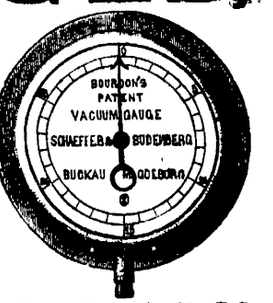




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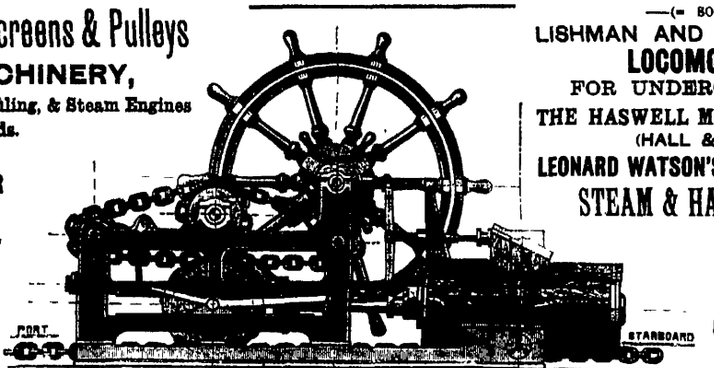
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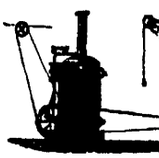
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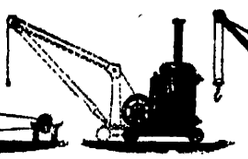
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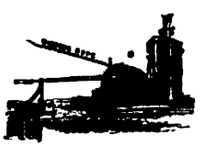
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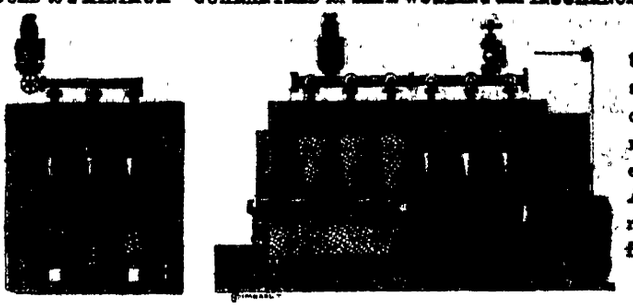
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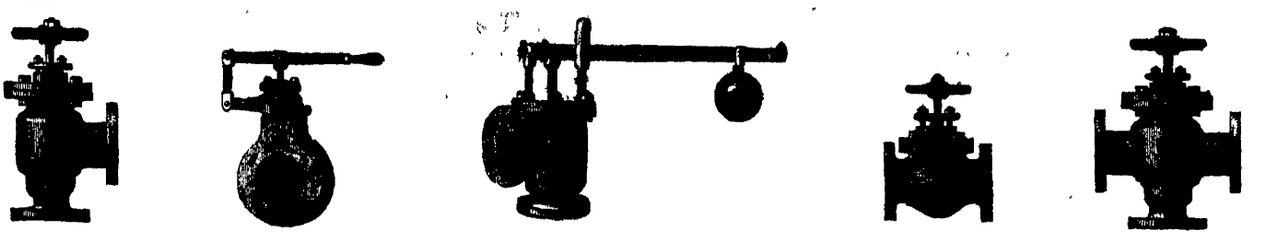
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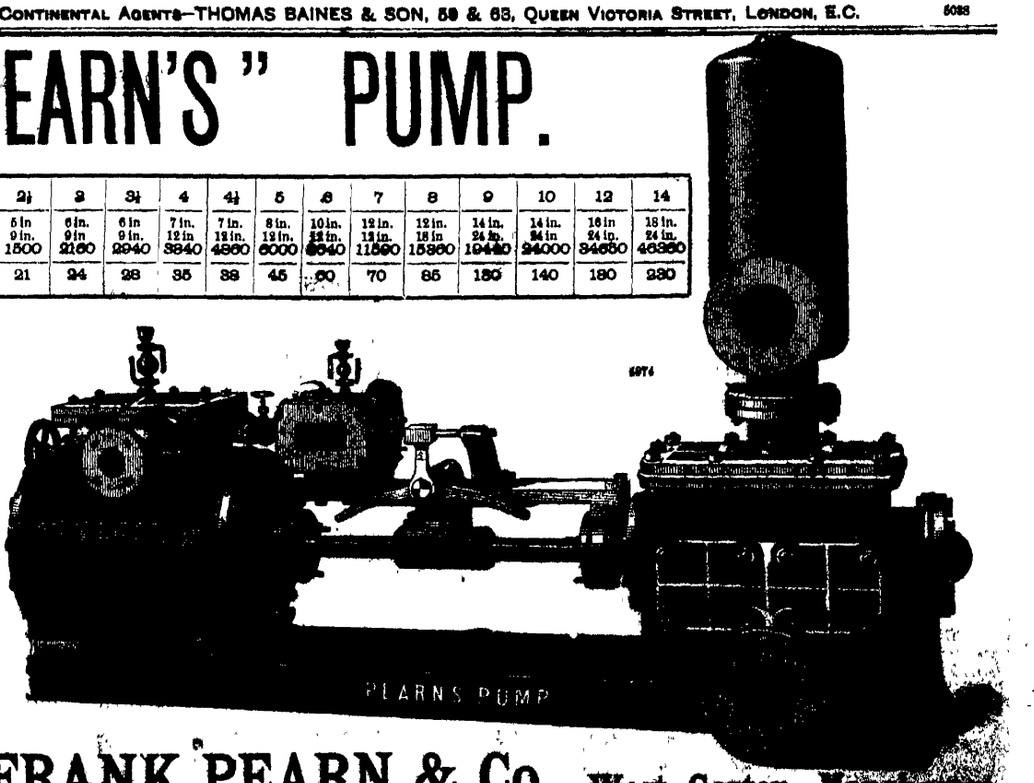
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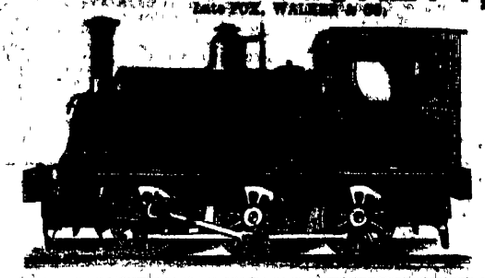
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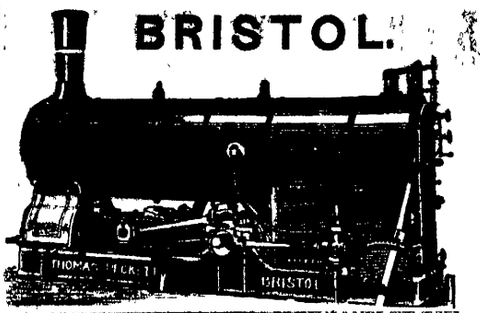
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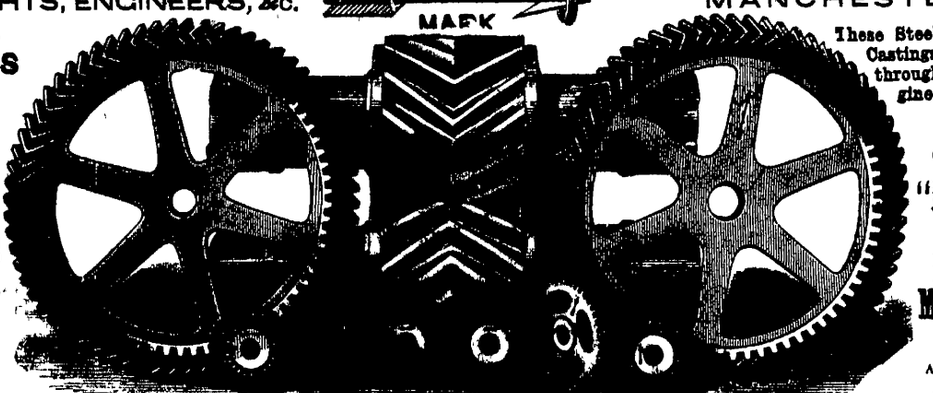
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CASTINGS.

PULLEYS
EITHER FOR
Straps or Ropes,
Spur or Bevel
Mortice Wheels
with Machine
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These Steel or Iron Wheel Castings can be obtained through almost any Engineer, Millwright, or Machinery Merchant.

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"P. R. Jackson & Co.'s MACHINE-MOULDED WHEELS."

And each Wheel should bear the above TRADE MARK

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RICHARD C. GIBBINS & Co.

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Warehouse Cranes and Pile Drivers,

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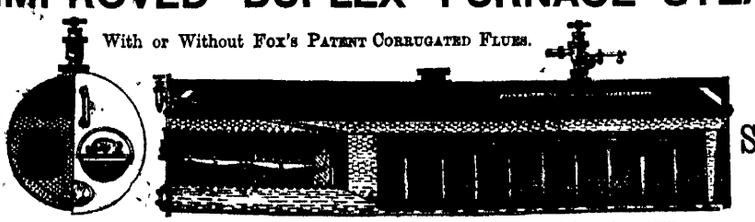
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PENMAN'S IMPROVED DUPLEX FURNACE STEAM BOILER.

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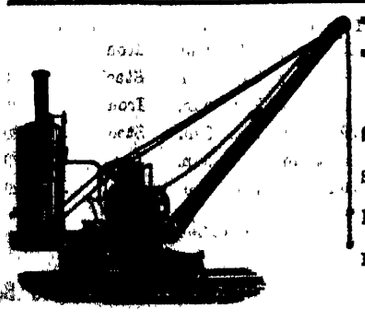
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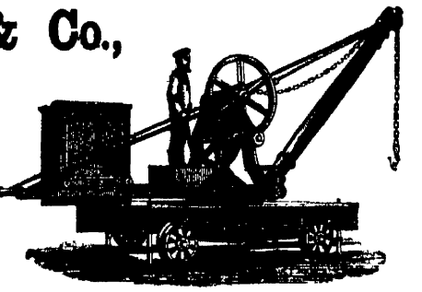


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DONKEY FEED PUMPS.
Horizontal & Vertical Steam Engines & Yacht Engines
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The PORTER-CLARK PROCESS

Removes Lime, Magnesia, and Iron from **Hard Waters**, and thus, the **causes of Incrustation in Boilers and Pipes** This Process is in use in Paper Mills, Breweries, Sugar Works, India rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c One Railway Company employs it for feed water to the extent of **1,000,000 gallons** daily, and one of the London Water Companies at two of its Pumping Stations It is also in use in County Asylums, Public and other Schools, and Private Mansions The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich, are rendered soft and clear 5226

DESCRIPTIVE CIRCULAR ON APPLICATION.

JOHN MARSHALL & SONS,

GLASGOW TUBE WORKS, GLASGOW,

MANUFACTURERS OF

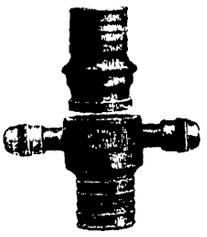
LAPWELDED IRON BOILER TUBES

FOR MARINE, STATIONARY, AND LOCOMOTIVE BOILERS, &c. 4761

WROUGHT IRON AND STEEL TUBES OF EVERY DESCRIPTION.

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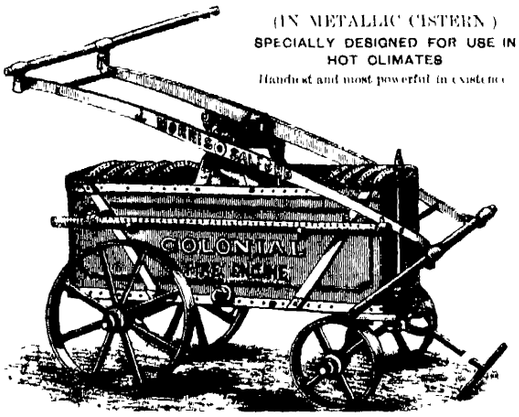


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NEVER GETS OUT OF ORDER
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HOSE PIPES of Copper Rivetted Leather, India Rubber, Canvas and Rubber-Lined Canvas

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FIRST PRIZE AT PARIS, VIENNA & PHILADELPHIA.

HAVE ALWAYS ON HAND A LARGE NUMBER OF

NEW STEAM BOILERS

MADE BOTH OF IRON AND STEEL,

READY FOR DELIVERY.

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	Length		Diameter	Material	Working Pressure
Three Galloway Boilers	30 ft	by	7 ft 0 in	Iron	70 lbs
Four " "	28 ft	by	7 ft 0 in	"	70 lbs
Two " "	28 ft.	by	7 ft 0 in	"	80 lbs.
One " "	26 ft.	by	7 ft 0 in	Steel	90 lbs.
One " "	24 ft.	by	7 ft. 0 in	Iron	80 lbs.
One " "	24 ft.	by	7 ft. 0 in.	"	70 lbs
One " "	24 ft.	by	6 ft. 6 in.	"	65 lbs

	Length		Diameter	Material	Working Pressu
One Galloway Boiler	18 ft.	by	6 ft 0 in.	Iron	70 lbs.
Three Two flued "	30 ft.	by	8 ft 0 in.	Steel	80 lbs.
One " "	30 ft.	by	7 ft. 6 in	Iron	70 lbs.
Five " "	30 ft.	by	7 ft. 0 in.	Steel	90 lbs.
One " "	22 ft.	by	6 ft. 0 in.	Iron	70 lbs.
Two One-flued "	30 ft.	by	7 ft 0 in.	Steel	80 lbs.

Total, 26 Boilers completely finished, besides many others in progress of construction. 4836

Address, W. & J. GALLOWAY & SONS, Manchester, who will furnish detailed Specification and Prices of any of the above Boile

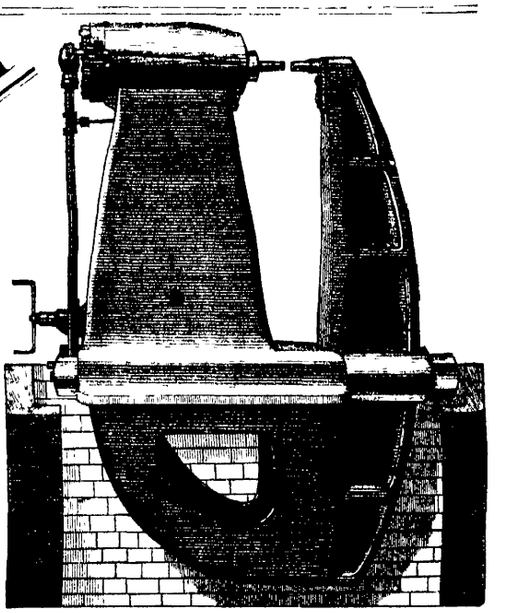
HYDRAULIC RIVETTING MACHINES.

TWEDDELL'S SYSTEM

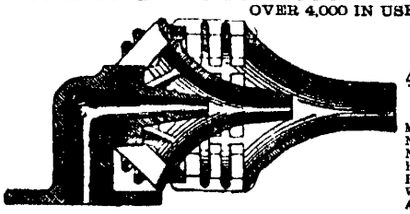
France, Belgium and Holland—
Mr. H. CHAPMAN, 10, Rue Laffitte, Paris;
Germany and Austria—
Mr. G. DIECHMANN, 41, Bahnhofstr, Essen, a/d Ruhr;
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Sole Makers AND Co-Patentees,
FIELDING & PLATT,
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Apply to RALPH HART TWEDDELL,
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HIGH PRESSURE MARINE BOILERS.
Best and Cheapest Means of Preventing Unequal Expansion.
"WEIR'S" PATENT HYDROKINETER.
OVER 4,000 IN USE.



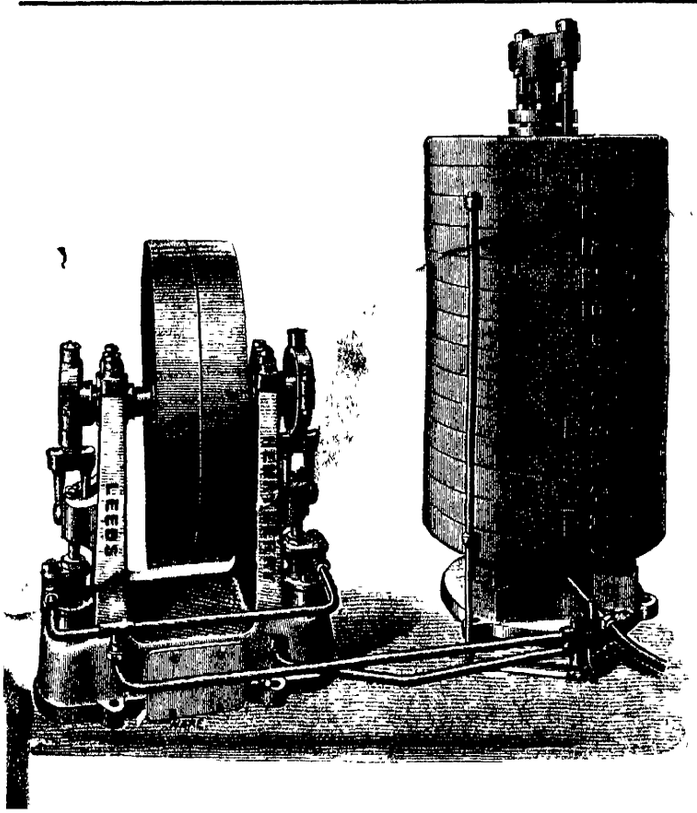
G. & J. WEIR,
49, JAMAICA STREET, GLASGOW.
MENZIES & BLAGBURN, KING STREET, NEWCASTLE-ON-TYNE WM REID & CO., 5, NEW LONDON STREET, LONDON, E.C A & R BROWN, WATERLOO ROAD, LIVERPOOL. R HUGHES & CO., FULTON STREET, DITTO W S VON ESSEN, ENGINEER, HAMBURG, AGENT FOR SCANDINAVIA & GERMANY 6281

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"SPECIAL CLAY MILLS."

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(CORNISH, LANCASHIRE, AND VERTICAL)
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GENTLEMEN,—We have now had one of your Portable Engines and 7 feet pan Mortar Mills, in constant work for the last twenty months, and have great pleasure in stating that they have given us every satisfaction, and for construction, strength, and workmanship are the best we have seen.—Yours respectfully,
Messrs SMEDLEY BROS J & R BOWDEN (Builders)

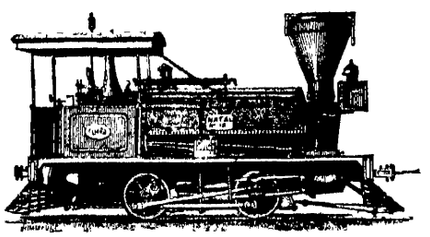
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VERTICAL Combined Engines and Boilers. 5109
HORIZONTAL ENGINES



HYDRAULIC RIVETTERS
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Of all descriptions and any size, for Ironworks, Collieries, Contractors, Docks, Manufactories, Branch Railways, &c., &c.

Specially designed for any circumstances, or to suit any Gauge of Railway 4291

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4387

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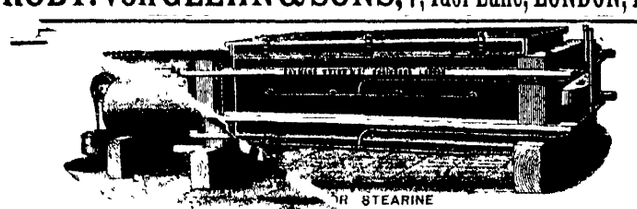
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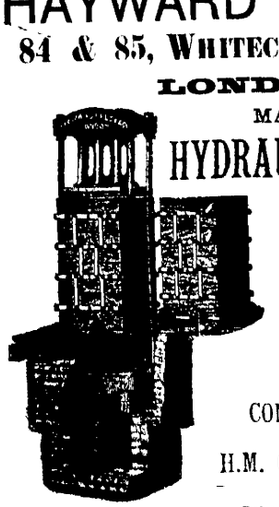
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CONTRACTORS TO H.M. GOVERNMENT.



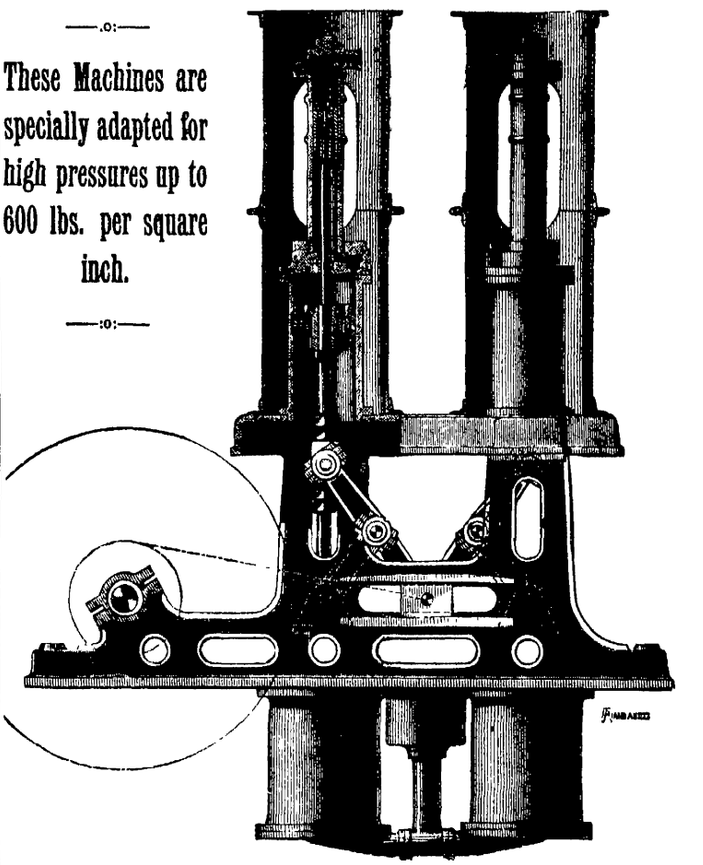
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OWEN'S PATENT AIR COMPRESSOR.

These Machines are specially adapted for high pressures up to 600 lbs. per square inch.



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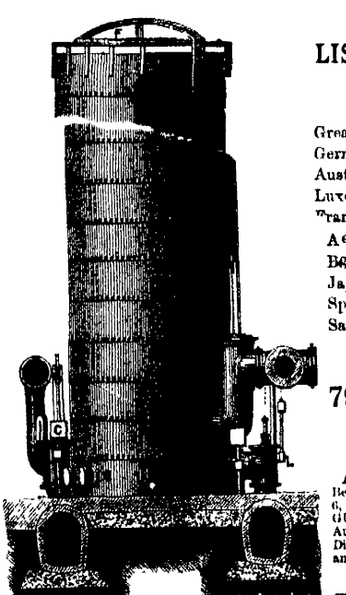
OLIVER & CO., Limited,

Broad Oaks Ironworks, Chesterfield. 4578

London Office: 9, NORTHUMBERLAND ST., CHARING CROSS, W.C.

FIRE BRICK HOT BLAST STOVES

(WHITWELL'S PATENT).



REFERENCE—A, Gas Valve B, Hot Blast Valve C, Chimney Valve. D, Cold Blast Valve E, Lower Cleaning Doors F, Upper Cleaning Doors. G, Air Inlets for Combustion of Gas NOTE Dimensions vary according to size required

LIST OF STOVES IN WORK OR CONSTRUCTION.

	Stoves	Blast Furnaces
Great Britain	241	74
Germany	99	26
Austria	40	14
Luxembourg	16	3
France	110	36
America	228	73
Belgium	43	11
Japan	3	1
Spain	12	4
Saxony	3	1
Total	795	243

795 STOVES IN WORK OR CONSTRUCTION.

AGENTS.—Germany, Herr MAUCO, Bonn; France, Belgium, and Luxemburg, M MAURICE, SEITER, 6, Rue de L'Oratoire, St Honore, Paris, and M GUYENET, Engineer, 83, Boulevard Magenta, Paris Austria, M P KUPELWIESER, Witkowitzer Eisenwerk Direction, Witkowitz; America, Messrs. WITHERO and GORDON, Pittsburgh.

WILLIAM WHITWELL

STOCKTON-ON-TEES. 487



THE CLYDE RIVET WORKS CO., GLASGOW,
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Ship, Boiler, Girder Rivets, Railway Spikes, Screws, Screw Bolts, Nuts.
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MAKERS OF THE CELEBRATED

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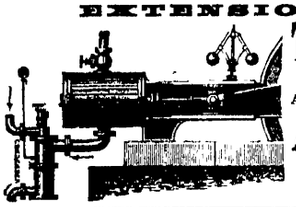
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The EJECTOR CONDENSER,
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Applied to all classes of Steam Engines and Steam Pumps saving from 25 to 50 per cent. in fuel

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ADVANTAGES
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VARIOUS SIZED BOILERS
IN STOCK AND PROGRESS

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Marine, Lancashire, Cornish, Rastrick, and the ordinary Cross Tube Vertical Boilers,
IN IRON OR MILD STEEL.
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THE

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EMPIRE WORKS,
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MANCHESTER.

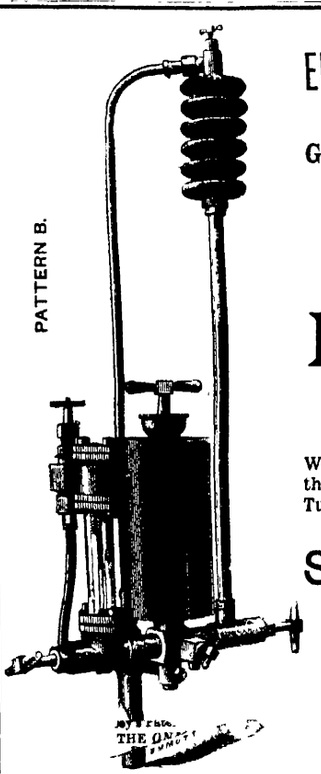
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GRANDISON'S
Empire Lubricator

Which shows each drop of oil passing into the steam through the medium of a Glass Tube, and is the BEST APPARATUS now known for Lubrication of

STEAM ENGINES,
LAND OR MARINE.

PATTERN B.



Lubricators sent on approval to any part of the kingdom, and references given to users in all parts of the inhabited world.

4763

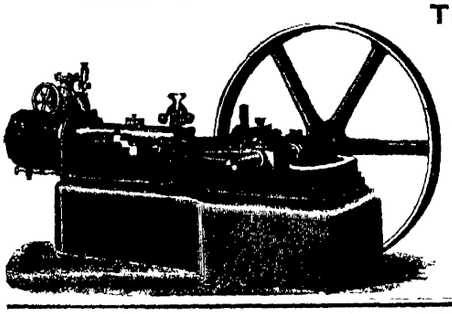
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BRITANNIA IRONWORKS, GAINSBOROUGH, AND MARSHALLS' BUILDINGS, 79, FARRINGDON ROAD, LONDON, E.C.

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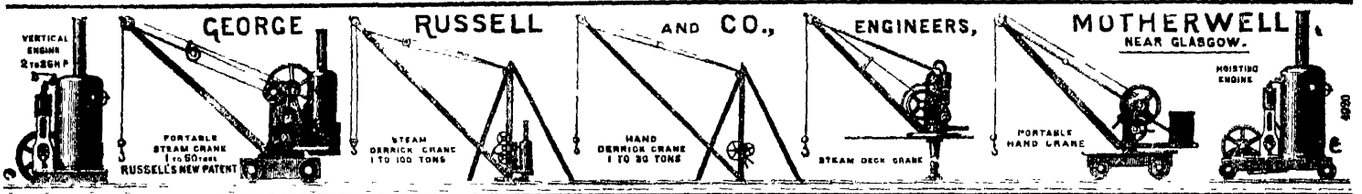
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4930

SOLE MAKERS

The Pulsometer PATENT STEAM PUMP

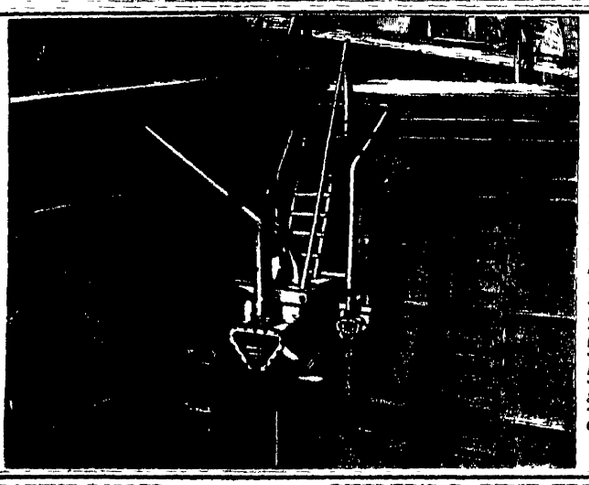
Is admirably adapted (amongst many other applications for Draining and Emptying Docks

The illustration shows a No 11 and a No 7 Pulsometer capable of discharging together about 82,000 gallons per hour When the dock is empty the smaller pump can be kept working slowly if there is any leakage to contend with

ADVANTAGES.

No Engine-house required, and no oiling, cleaning, or skilled attendance. Valves will pass small chips, &c, freely. Great Durability and Simplicity.

NUMEROUS REFERENCES FROM FIRST-CLASS FIRMS ON APPLICATION.



Pulsometer Engineering Co.,

LIMITED

NINE ELMS IRON WORKS, LONDON, S.W.

And 61 & 63, QUEEN VICTORIA STREET, E.C.

AGENCIES in NEWCASTLE, LIVERPOOL, GLASGOW, MANCHESTER, ABERDEEN, BRISTOL, &c

The Pulsometer is admirably adapted for all difficult and awkward situations, and where the Pump is required to be suspended on a chain as in all tidal and well-sinking operations. In cases where a large proportion of solid matter has to be raised it stands pre-eminent, as it no moving parts to cut out except two simple and easily replaceable valves. The absence of exhaust steam is a great convenience in confined spaces. 4889

By Royal Letters Patent.

PATENT ROLLED

SHAFTING

IN IRON AND STEEL

and

BUTLER'S PATENT FRICTIONAL COUPLINGS.



The Kirkstall Forge Co., Leeds, SOLE MAKERS 4901



B. & S. MASSEY, MANCHESTER.

PATENTEES AND MAKERS OF

DOUBLE & SINGLE-ACTING STEAM HAMMERS.

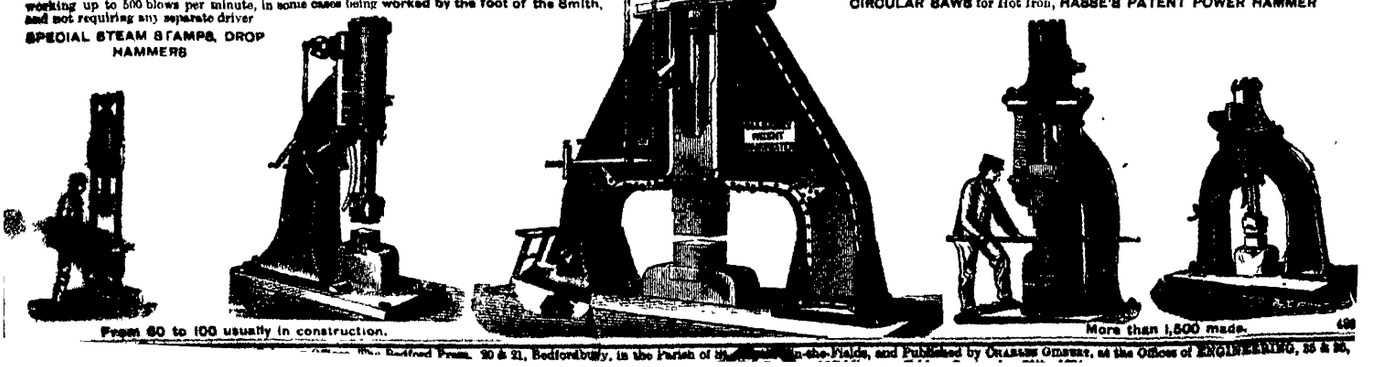
Received the ONLY Medal for Steam Hammers at the Paris Exhibition of 1878.

Of all sizes, from half cwt. to 20 Tons, with Self acting or Hand Motions, in either case giving perfectly DEAD BLOW, while the former may be worked by hand when desired Large Hammers, with Improved Framing, in Cast or Wrought Iron Small Hammers, working up to 500 blows per minute, in some cases being worked by the foot of the Smith, and not requiring any separate driver

Also PRIZE MEDALS at Paris, 1867; Havre, 1868; Highland Society, 1870; Liverpool, 1871 Moscow, 1872, Vienna, 1873, Scientific Industry Society, 1875, Leeds, 1875, Paris, 1875, Manchester and Liverpool Society, 1876; U. S Centennial, Philadelphia, 1876; Sydney (Australia) 1880 North East Coast, 1882; Amsterdam, 1883

CIRCULAR SAWS for Hot Iron, HASSE'S PATENT POWER HAMMER

SPECIAL STEAM STAMPS, DROP HAMMERS



From 60 to 100 usually in construction.

More than 1,500 made. 498

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Portland Cement,

manufactured by

Francis and Co.,

4714

The celebrated Nine Elms Brand, established 1810
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Using 25 to 75 % less Gas

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Any other Engine.

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Impulse every Revolution. Very Steady in Running

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Screw Steamers having speeds up to twenty-six miles an hour Paddle Steamers having draughts down to 6 inches of water Machinery constructed for boats built abroad 4778

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Steam Launches in Stock.— VOSPER & CO, Broad Street, Portsmouth, Build in Steel, Iron, or Wood, Sea-going Launches, fitted either with their Patent Silent Engines or ordinary ones. 3551

V & CO 'S Steel Boilers work well in salt water

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See Advertisement Sept 19, page 20

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Switches, Crossings,

Turntables, Water Cranes, Girders, Bridges, Roofs, Pipes, Pumps, Wagons, Tanks, Engines, Boilers, Cranes, Works NEWPORT, MON

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Steam Boilers, Ready for Delivery.

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Iron Roofs, Sheds, Buildings, HOUSES. Best work, reduced prices Dixon's special CURVED IRON Roofs are the most economical for spans up to 45 ft. Catalogues, Designs, Estimates, on application ISAAC DIXON, Windsor Ironworks, Liv[illegible]

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HYDRAULIC MACHINERY
"WILLIAMS'" PATENT CAPSTANS
LAND AND MARINE STEAM ENGINES
DISTILLERY AND BREWERY PLANT
FLOUR AND RICE MILLS
WATER AND GAS VALVES, CRANES, LOCK GATES, &c. PUMPING MACHINERY
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Tubes. MARINE, LOCO', STEAM, BORING, COLLIERY LARGE TUBES LAP WELDED TO 12in DIAM

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5054

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See Illustrated Advertisement, page 25

George Russell & Co., ENGINEERS and BOILERMAKERS, ALPHA STEAM CRANE and ENGINE WORKS, MOTHERWELL, near GLASGOW SILVER MEDAL, PARIS, 1867 4921

Steam Hammers.— Massey's Patent Hammers RECEIVED THE *ONLY* PRIZE MEDAL PARIS 1878

More than 1500 made

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HATHORN, DAVEY, & CO, LEEDS

H, D, & Co have Patterns of "Differential" Engines of all sizes from 5 to 600-horse power, and have facilities for supplying very powerful Engines and Pumps at a short notice 4756

Locomotive Tank Engines designed and constructed by MANNING, WARDLE, AND COMPANY, Boyne Engine Works, Leeds. 2487

See their Illustrated Advertisement, page 43

Locomotive Tank Engines, TRAMWAY ENGINES AND CARS

Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough 5206

See Illustrated Advertisement, page 10

The Patent Corliss Engine And PATENT CORLISS GEAR ENGINE, with special improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N B These engines are made Horizontal or Beam, Condensing, Non Condensing, and Compound Also makers of Rice Mills, and Paper Mills, and General Engineers. Machinery shipped or trucked direct from the premises 3508

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Steel Hydraulic Cylinders.— HENRY BESSEMER & CO, Limited, SHEFFIELD

See Advertisement last week, page 36 3627

Tweddell's Hydraulic Rivetting Machines

14, DELAHAY STREET, WESTMINSTER, LONDON, S W 4807

See Illustrated Advertisement last week, page 51

L. Sterne & Co., Limited. ENGINEERS, Sole Makers of

Clerk's Patent Self-Starting Gas Engine.

HIGHEST AWARD, BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881

GOLD MEDAL, CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifiers, WITH STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels, Emery Machines, Spiral Springs.

The Crown Iron Works, GLASGOW.

The Crown Iron Works (Hollinwood), MANCHESTER.

10, Victoria Chambers, WESTMINSTER.

City Office and Show Rooms, 40, CANNON STREET, E.C

10, Rue Laffitte, PARIS. 2568

International Inventions

EXHIBITION, London, 1885
DIVISION I, INVENTIONS DIVISION II, MUSIC

Patron
HER MAJESTY THE QUEEN
President
H R H THE PRINCE OF WALES, K G

Applications to Exhibit must be made on Printed Forms, which will be supplied on application to the SECRETARY, International Inventions Exhibition, South Kensington, S W These must be filled up and returned on or before the 1st November, 1884 G 835

University College, London.—

A Course of Ten Lectures on "Valve Gear and Valve Gear Diagrams," for practical men, will be given by Professor Alex B W Kennedy, M Inst C E, on Tuesdays at Six, commencing 7th October The first lecture is open to the public Fee for the Course, One Guinea G 936

TALFOURD ELY, M A, Secretary

The Yorkshire College (Leeds)

CIVIL AND MECHANICAL ENGINEERING CLASSES Professor A BARR, B Sc, C E The ELEVENTH SESSION begins, in the New Buildings of the College, on the 7th OCTOBER The prospectus may be had (free) from the SECRETARY also prospectuses of other Technical Classes, as well as of the general department of Science and Arts

University College, Bristol.

ENGINEERING DEPARTMENT

PROFESSOR H S HELE SHAW

The SESSION 1884 85, BEGINS on OCTOBER 7th The Department of Engineering includes separate courses for those intending to become Civil, Mechanical or Electric Engineers, or Surveyors or Architects

Students in Mechanical Engineering who study during the six winter months at the College, can spend the rest of the year in the workshops and offices of various firms in and near Bristol

Surveying and Fieldwork occupy a prominent place in the Civil Engineering Course during the Summer Term, and arrangements have been made with leading Civil Engineers and Architects for the entry into their offices of Students who have passed through the respective courses

Information with regard to the lodging of Students can be obtained on application

Calendar, containing full information, price 1s, by post 1s 3d —For Prospectus and further information apply to

ALFRED E STOCK, G 726
Registrar and Secretary

Metallurgical Department,

King's College, London, under the direction of Prof A K Huntington

In the Laboratory metals and alloys are examined mechanically with the aid of powerful testing machinery, as well as chemically Extraction and manufacturing processes investigated and assays and analyses made

A few free entries to the division of studies (day or evening) are obtainable through the City and Guilds' Institute 5953

Mr Busbridge's Drawing

CLASSES will RE OPEN the SECOND WEEK in OCTOBER, for MACHINE DRAWING, Architectural Drawing, Building Construction, Practical Carpentry, and Geometry Fee £6 6s for whole Course of seven months A large number of valuable prizes are offered

Distribution of Prizes in the Guildhall by Lord Carlingford, 3rd November The Lord Mayor will preside, supported by the Sheriffs, Sir T Brassey, M P, and others—Prospectus free from Mr BUSBRIDGE, Hermitage, Herbert Road, Plumstead G 899

reely.

Sim TENDERS

BRIDGE, [illegible] REFERENCES AND RAILWAYS.

APPLICA -CONTRACT No 1

BARRY DOCK [illegible] the Directors of

CONTRACT FOR WORKS are prepared to

NOTICE IS HEREBY GIVEN, that [illegible] Section

the Barry Dock and Railways Co [illegible]

receive

Tenders for the Constru IN

of BARRY DOCK, situated at Barry [illegible] Glamorganshire, and of certain RAILWAYS (about seven miles in length) in connection therewith

The Drawings, Specification, Bill of Quantities, Form of Contract, and Form of Tender, may be seen on and after Wednesday, the 1st October, between the hours of Ten and Four, at the Office of Messrs J W Barry and H M Barry, 28, Delahay Street, Westminster, S W, and copies of the documents and of certain of the drawings may be obtained there on payment of Two Guineas

Tenders are to be delivered addressed to Mr G C Downing, Secretary of the Barry Dock and Railways Co, Aroma Chambers, Cardiff, and endorsed "Tender for Works, Contract No 1," at or before noon on Tuesday the 14th October, 1884

The Directors do not bind themselves to accept the lowest or any Tender G 942

TO CONTRACTORS AND OTHERS

THE TOWN COMMISSIONERS OF DUNDALK, being the Sanitary Authority, invite

Tenders for the Construction

of WATER WORKS for the Supply of the Borough

Plans, Specifications and Form of Tender may be seen at the Town Hall, Dundalk, or at the Offices of the Engineers, Messrs R Harbard and A W W Tyrrell, M M Inst C E, Westminster Chambers, on and after 1st October, and all Tenders must be sent in on the printed forms in sealed envelopes, endorsed "Tender for Water Works," and addressed to E. Ferrar, Esq, Town Clerk, Dundalk, on or before the 25th of October

One Guinea will be charged for Copies of the Specification and Form of Tender, which will be returned on receipt of a *bona fide* Tender

The Commissioners do not bind themselves to accept the lowest or any Tender G 850

By order,
EDWARD FERRAR,
Town Hall, Dundalk, [illegible] September 1884. Town Clerk

DARLASTON URBAN SANITARY AUTHORITY

SEWERAGE WORKS —(Contract No 2).

TO STEAM ENGINE MANUFACTURERS AND MACHINISTS.

The Local Board of Darlaston acting as the Urban Sanitary Authority invite

Tenders for the Manufacture

and ERECTION in Darlaston of Steam Engines, Boilers, and Air Compressors in Duplicate, Lime and Alumina Mixers, Shone's Patent Pneumatic Ejectors, together with all fittings necessary for the proper completion of the Machinery

The Drawings and Specifications can be inspected, and further information obtained at the Offices of the Engineer, Mr Edward Pritchard, M Inst C E, 2, Storey's Gate, Westminster, S W, and 37, Waterloo Street, Birmingham, from whom a Copy of the Specification, Form of Tender, and other particulars can be obtained on payment of One Guinea.

Sealed Tenders, properly endorsed, to be delivered to the undersigned on or before the 23rd day of October, 1884

The Local Board do not bind themselves to accept the lowest or any Tender sent in

By order, G 917
Darlaston, JOSEPH CORBETT,
25th September, 1884 Clerk to Local Board

OUDE AND ROHILKUND RAILWAY COMPANY, LIMITED

The Directors are prepared to receive

Tenders for the Supply of:—

PERMANENT WAY CRANES
SWITCHES AND CROSSINGS
TROLLEY WHEELS
TYRES
SHAFTING
MOROCCO HIDES

Specifications and Drawings may be seen at the Office of Mr W F Batho, Consulting Engineer of the Company, 9, Victoria Chambers, Westminster, S W, from whom Copies of the same may be obtained on payment, which payment will not be returned

Tenders, endorsed with the names of the Stores to which they refer, should be addressed to the undersigned, and delivered in sealed envelopes, at the Offices of the Company, as under, not later than Eleven o'clock in the Morning of Wednesday, the 8th October proximo

The Directors do not bind themselves to accept the lowest or any Tender

By order of the Board,
29, Martin's Lane, C C JOHNSTON,
Cannon Street, London, E C, Managing Director
29th September, 1884 G 910

TO ENGINEERS

THE COMMISSIONERS OF IRISH LIGHTS, being desirous of obtaining

Tenders for the Supply, Deli-

very at the District Stores, Kingstown, and Erection on Rauad Point Lighthouse, Lough Swilly, County Donegal, of a NEW LIGHTHOUSE LANTERN AND OPTICAL APPARATUS for same, Notice is hereby given that the work will be let in the following sections, viz

Contract No 1—DIOPTRIC APPARATUS, &c
" No 2—SECOND ORDER LANTERN, with Girders, Floor, &c

Any person tendering will be allowed to tender for either or both sections

Drawings may be seen, and Specifications and Forms of Tender obtained on application at the Engineer's Office, between the hours of Ten a m and Four p m on any day (Saturdays excepted)

Tenders must be made out on the prescribed Forms, sealed, marked on the outside with the name and number of the Contract, addressed to the Secretary, and delivered at this Office, on or before noon on Wednesday, the 15th day of October prox, after which no Tender will be received

The Commissioners do not bind themselves to accept the lowest or any Tender By order,
OWEN ARMSTRONG,
Irish Lights' Office, Dublin Secretary,
19th September, 1884

APPOINT[illegible] G 888

W[illegible] LMENTS OPEN.

IRON[illegible]ated, a Small Capitalist to ASSIST PATENTEE in making a machine to develope an existing Patent Drawings and patterns ready —Apply, in first instance, to ALPHA, 12 Malvern Road, Dalston, N G 920

Wanted, a good Draughtsman for Engine Work, for large Engineering Works in the North of England State age, references, and salary required —Address P, Post Office, Middlesbrough G 929

Wanted, a Clerk in a Ship Repairing Yard, who is fully acquainted with the pricing and drawing accounts for the Engineering branch of the business —Apply by letter, stating experience and salary required, to T HOOPER, 11, Richmond Road, Cardiff G 928

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Agents Wanted, to push First-class MACHINERY OILS commanding a large and successful sale Liberal commission —Address BOA 291, Post Office, Liverpool 5283

Lists of Berths Vacant or WANTED See "ENGINEERING REVIEW," weekly 1d —E. & F N SPON, 16, Charing Cross, London, or of all News Agents 5262

SITUATIONS WANTED.

Wanted, Employment in an Engineer's Office. The advertiser, aged 20, has just completed two years' training in an engineering school —Address, W W, 12, Florence Villas, Feltham, Middlesex G 927

Basic Steel Works.—Wanted, a SITUATION as Manager, by a competent engineer, holding a very responsible position in a Basic Steel Works. Has designed and erected a Basic Works on the most modern principles —Apply GRIT, Offices of Engineering, 35 and 36, Bedford Street, Strand, London, W C G 846

A Draughtsman (age 24), accustomed to the designing and erection of wrought iron structures, SEEKS RE-ENGAGEMENT Fair knowledge of general engineering, highest references, London preferred —Address, H S, 33, Walcot Square, Kennington Road, S E G 931

Assistant Engineer (33) Disengaged, thorough draughtsman, leveller, and surveyor, accustomed to drainage, water and municipal work at home and abroad —ASSOC M INST, C E, 17, Lorn Road, Brixton G 930

Mechanical Engineer, thoroughly practical and competent, DESIRES EMPLOYMENT, good designer, quick draughtsman, extensive experience in works and office.—A M I C E, 92, Dalberg Road, Brixton, London G 945

Situation Wanted, by Fitter, to take charge of machinery, or lead in fitting shop, held similar situation, good references —Address, W JONES, Little Chart, Ashford, Kent G 933

Engineering Surveyor, experienced, is PREPARED to ASSIST Civil Engineers temporarily or otherwise, accurate leveller —Address, G 932, Offices of Engineering G 932

To Wrought-Iron Tube MAKERS —The advertiser, having a good district connection among consumers, WISHES to REPRESENT a good firm, on Commission —Address, TUBES, Offices of Engineering, 35 and 36, Bedford Street, Strand, London, W C G 921

Agency. — Engineer, having London Office and connection with sugar growers, wishes to REPRESENT machinery manufacturers and others, salary and commission —M, Offices of Engineering G 941

WANTED, &c.

To Engineers and Others.— WANTED, an ENGINE, 200 HP Ind, 90 lbs steam, New or Second hand, must be fitted with Automatic Expansion Gear and Sensitive Governor —Address, H E, Messrs Street Brothers, 5, Serle Street, W C G 947

Oil Presses.—Wanted, Two second hand four box presses, with 12 in rams and cylinders, guaranteed, boxes not required —Reply, giving full particulars and maker's name, to K R, care of Mr J E Berendsohn, 28, Bishopsgate Street, E C G 940

Cast Iron Tank.—Wanted, to PURCHASE a Second hand Cast iron TANK, 3 ft to 4 ft deep, 5 ft to 10 ft wide, and any length —Reply to X, care of Mr W Tremlett, Dundalk G 882

Wanted, a Powerful Dredger, capable of digging out 8 metres (25 ft) in depth, in stiff clay with stones Would be bought or taken on hire for a series of years —Address, B H, 7822, care of Aug I Wolff & Co, Advertising Agents, Copenhagen, K Denmark G 924

"Engineering."—Wanted, Copies of Jan 11th Will give 1s for each —Address, J G W, Offices of Engineering G 939

List of Machinery W[illegible] Wanted or [illegible] on SALE See "ENGINEERING REVIEW," weekly 1d —E & F N SPON, 16, Charing Cross, London, or of all News Agents 5262

FOR SALE.

For Sale, One Pair of Compound Surface Condensing MARINE ENGINES AND BOILER, 130 HP Nominal 5209

F GILMOUR & CO, Engineers, Glasgow

For Sale, The Universal Pulveriser. Will grind all kinds of Refractory Materials, Ores, Stones, &c Weight 4 tons New —Apply, C E HALL, Standard Iron Works, Washford Road, Sheffield 5240

For Sale, Largest Stock in England, Engineers' Machine Tools, Steam Hammers, Steam Engines, Wood working Machinery, all sizes, best materials and workmanship, low prices, send for stock list —SCOTT BROTHERS, Halifax

For Sale, 9 in. Double Cylinder PORTABLE ENGINE, by Clayton and Shuttleworth, in good condition; being replaced by larger engine.—Apply to STRACHAN & CO, Fronie Hall Mills, Stroud, Gloucestershire. 5282

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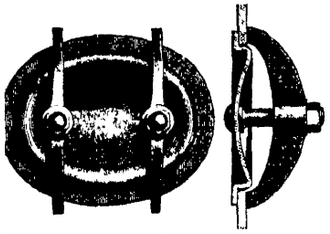
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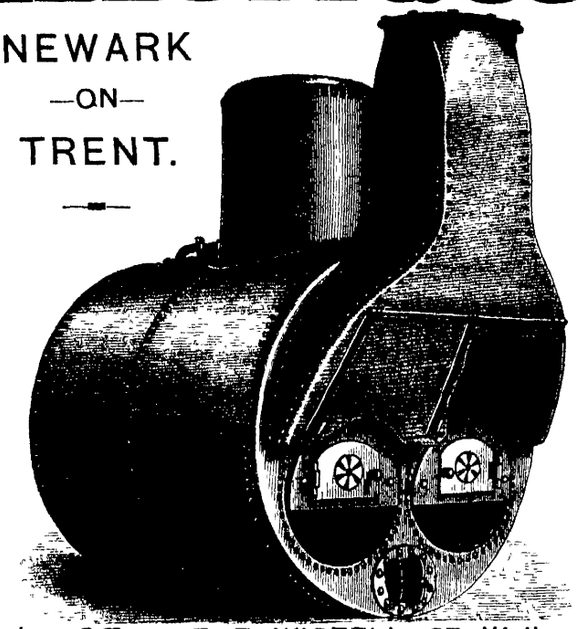
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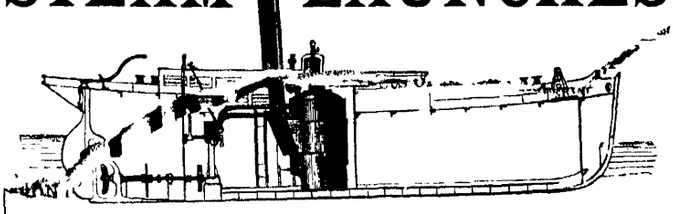
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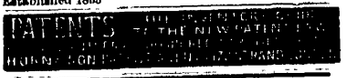
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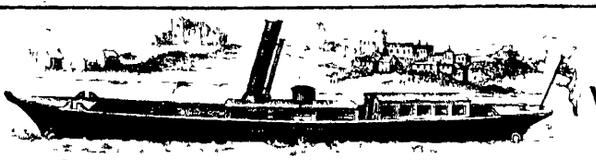
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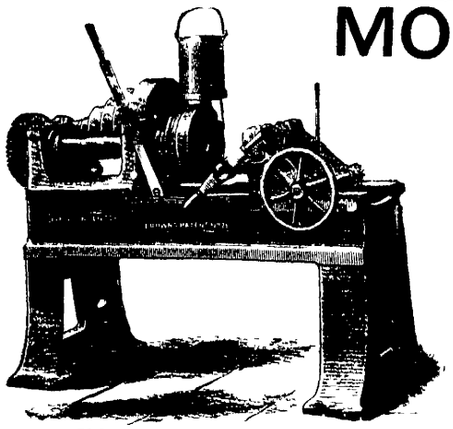
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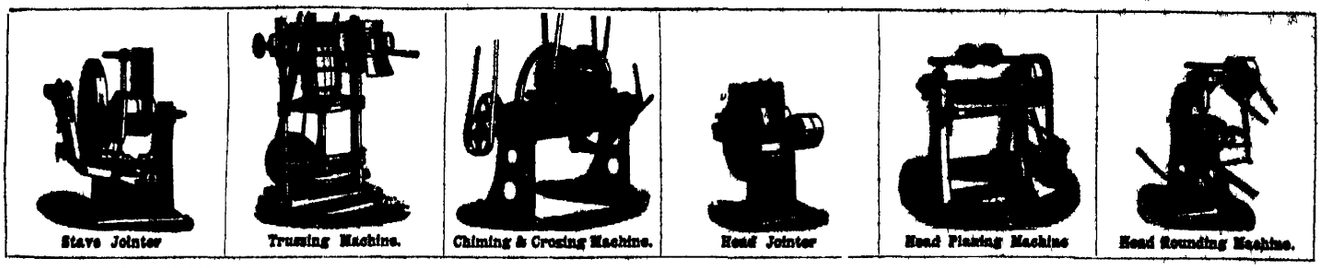
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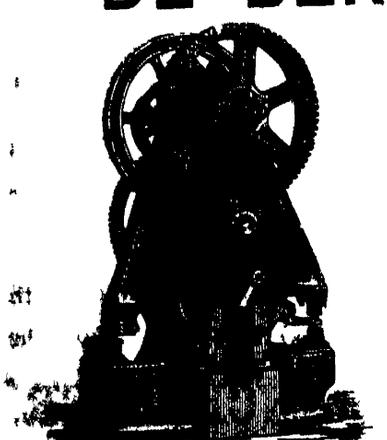
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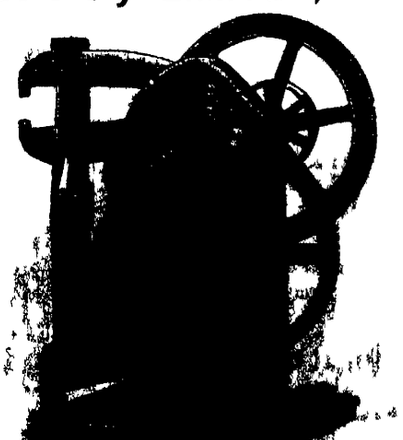
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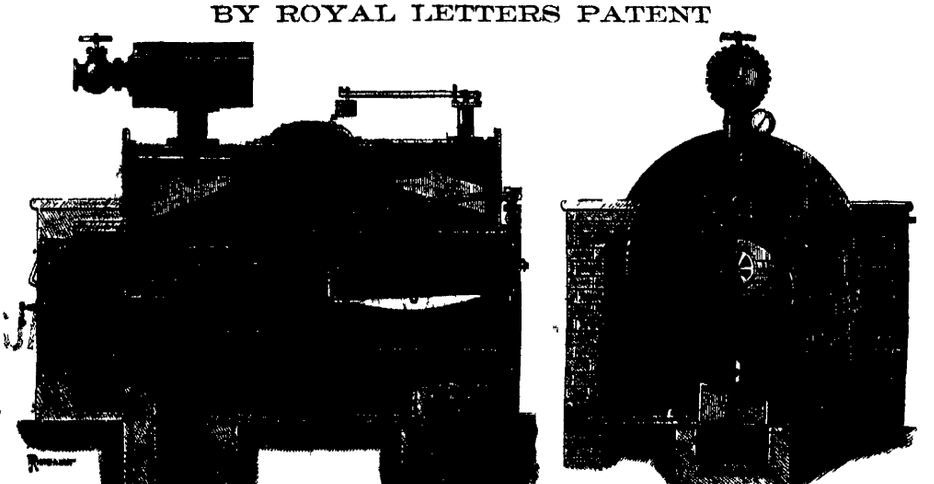
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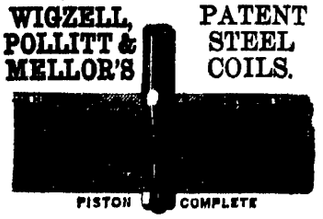
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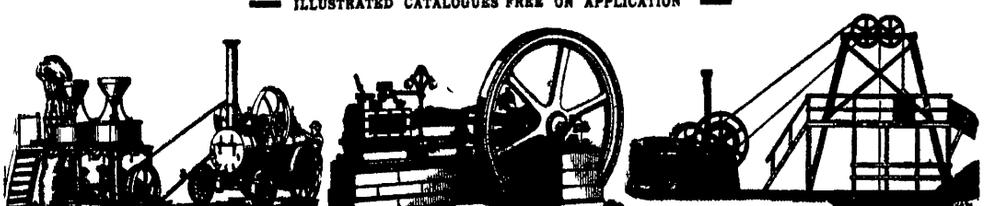
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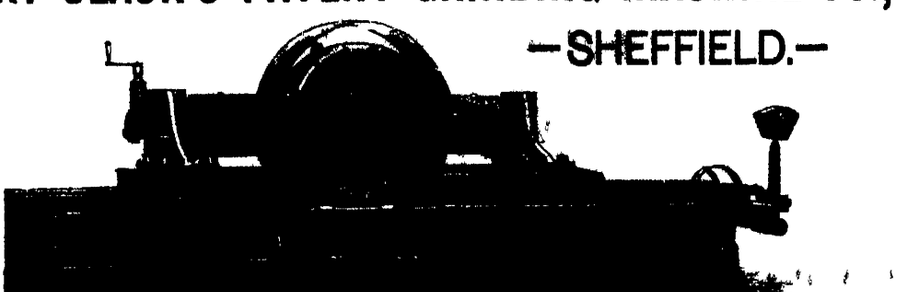


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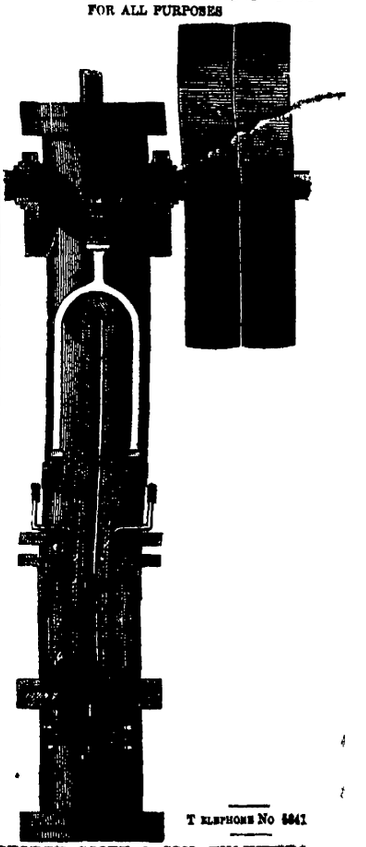
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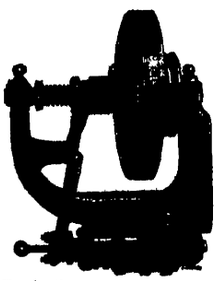
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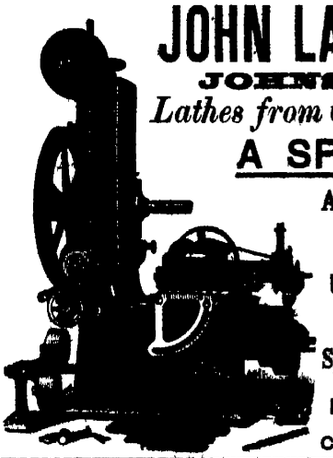
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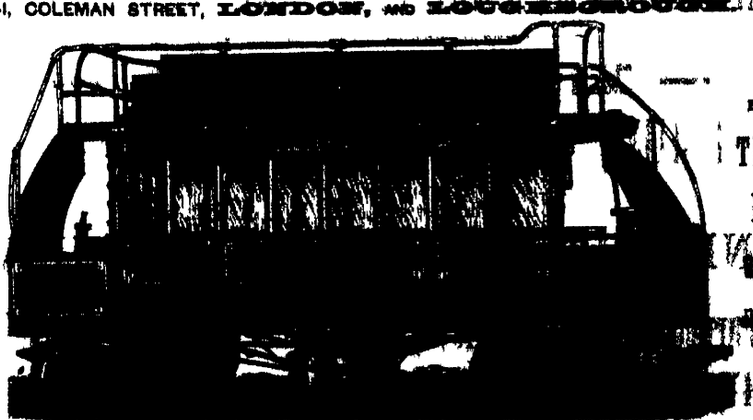
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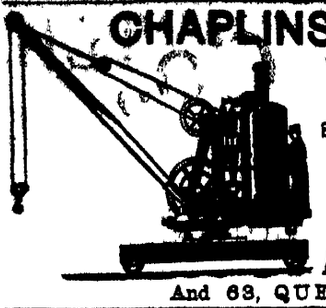
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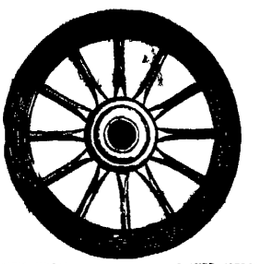
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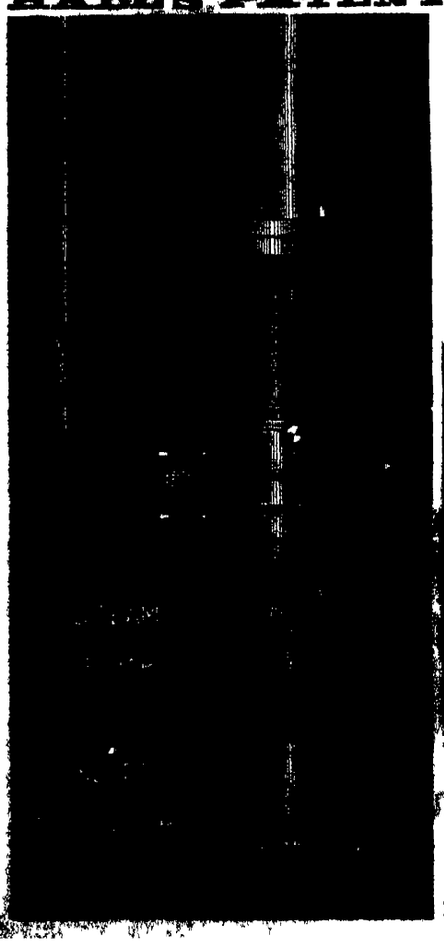
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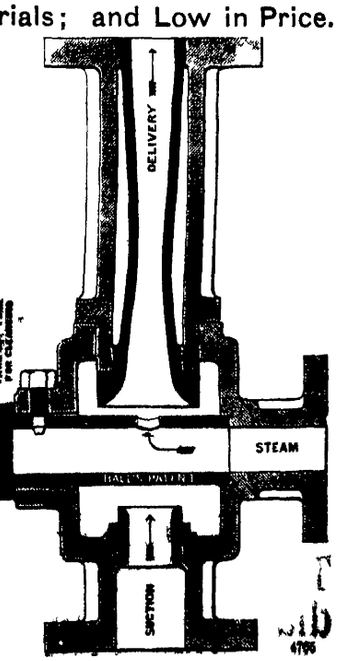
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20 B	6,000	20 0 0	11/16	3
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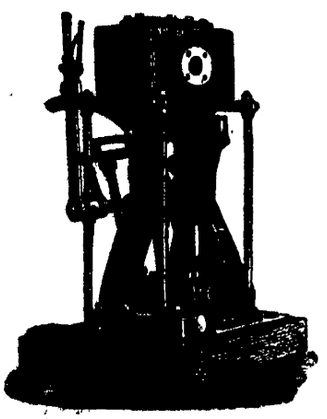
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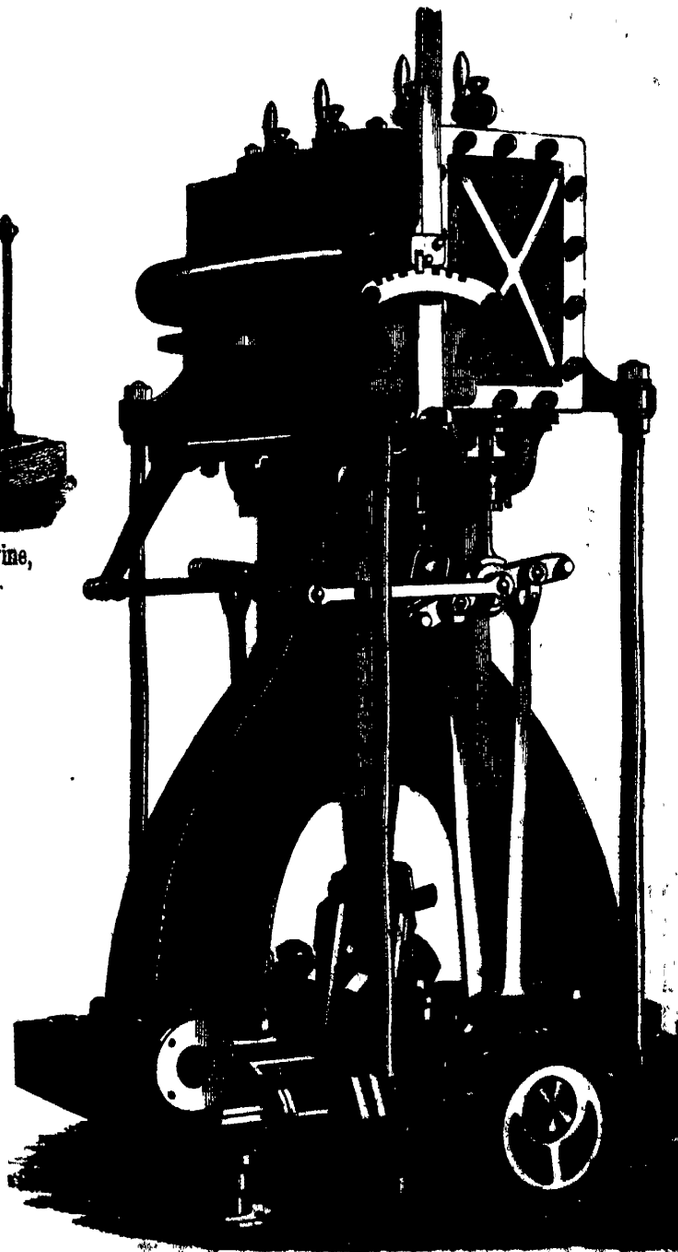
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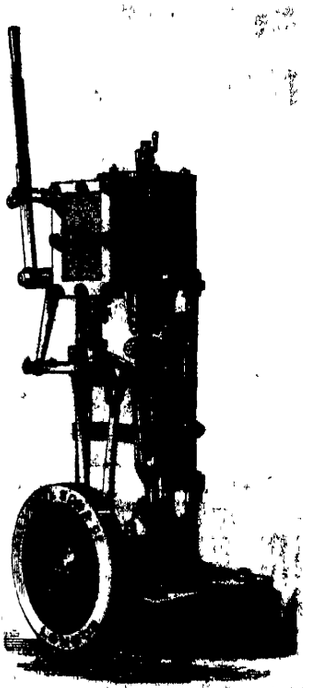
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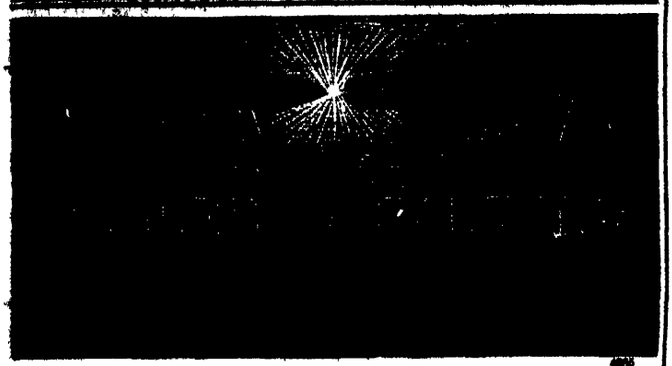
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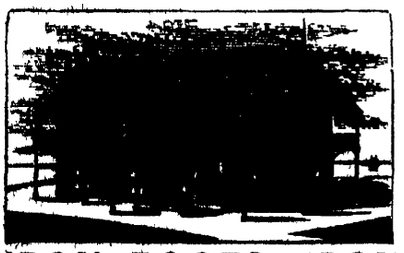
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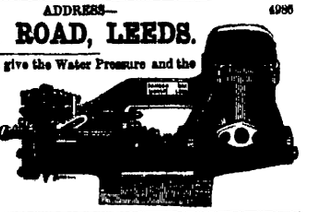
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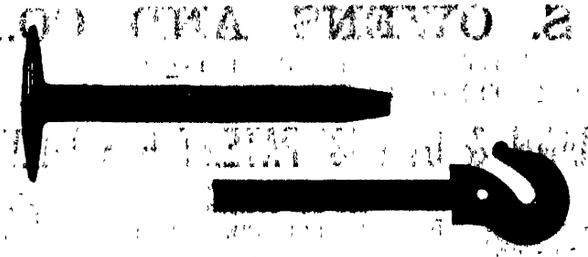


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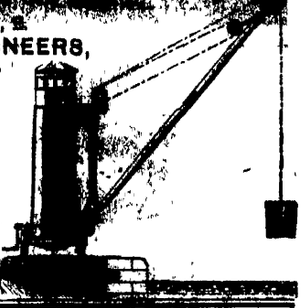
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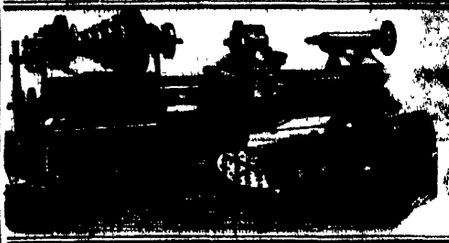
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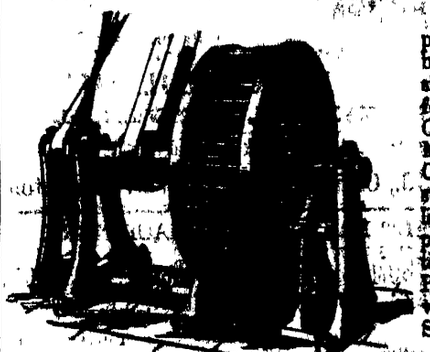
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No Agents. All Machines will be [illegible] Trade Mark ("Carr's Disintegrator") in three places, viz.: [illegible] Fast driving Pulley.

A Descriptive Pamphlet will be sent free on application, containing [illegible] of the Estate of the late Inventor.

PHILIP TRIGGS, [illegible] CHAMBERS, DERBY.

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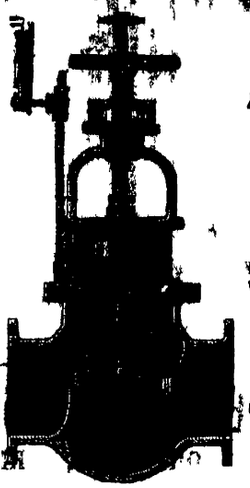
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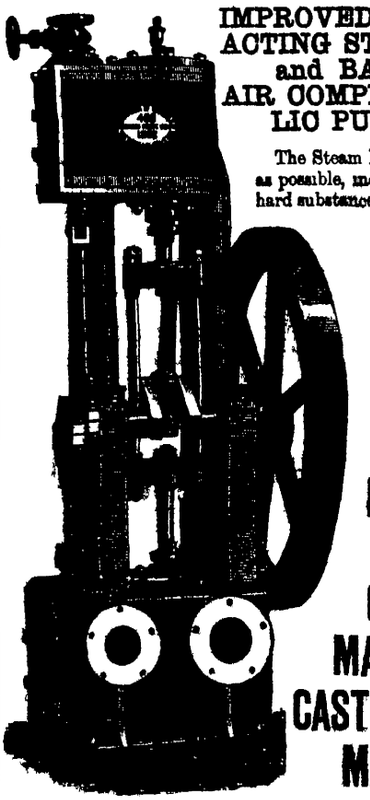
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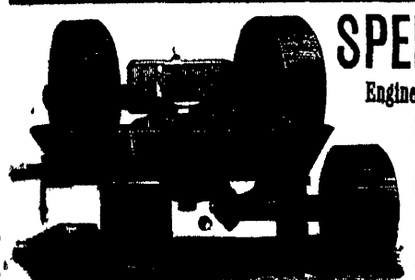
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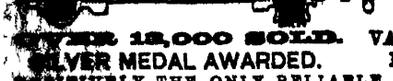
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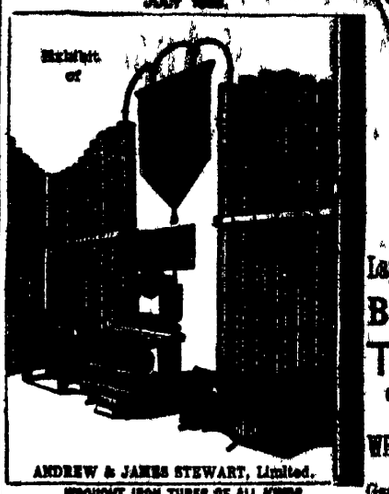
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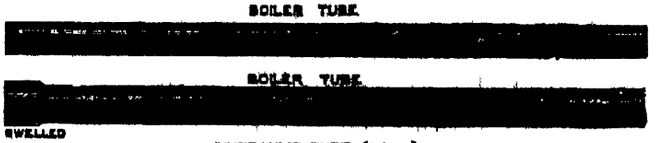
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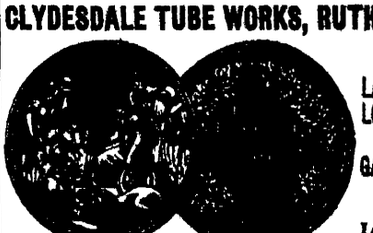
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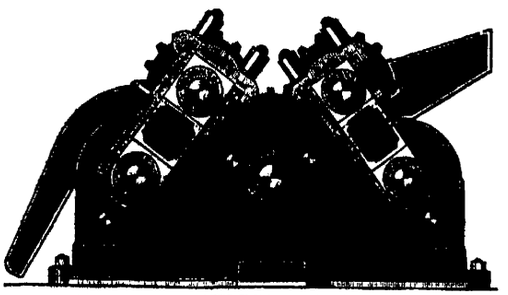
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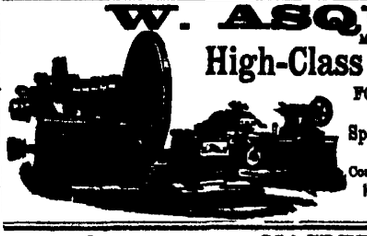
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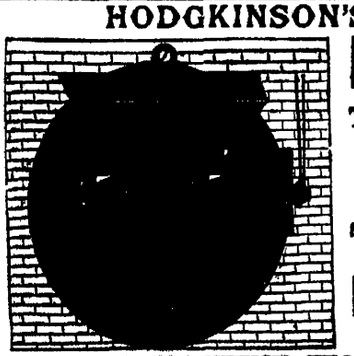
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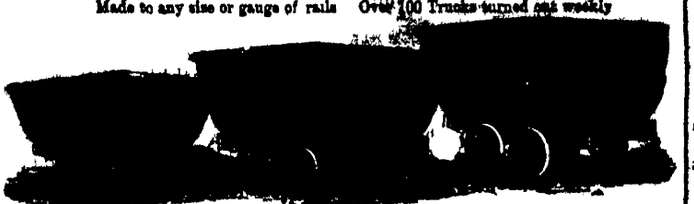
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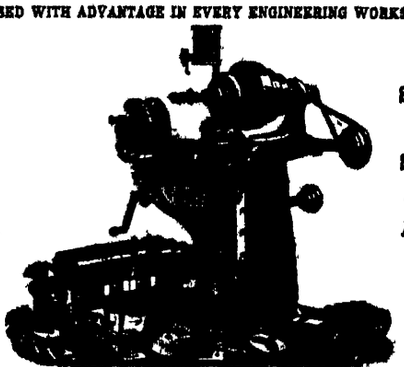
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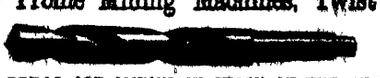
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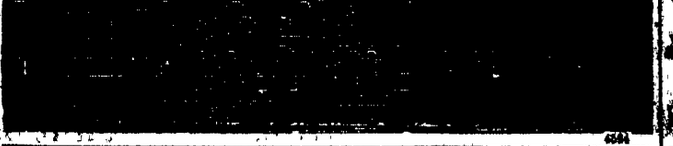
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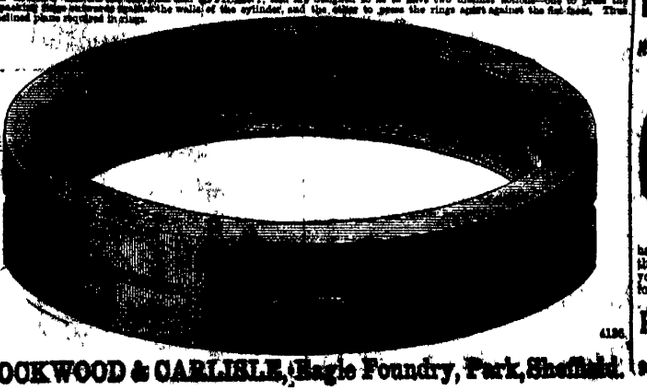
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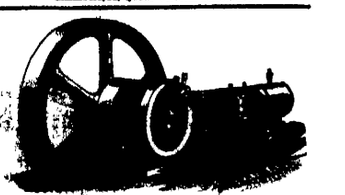
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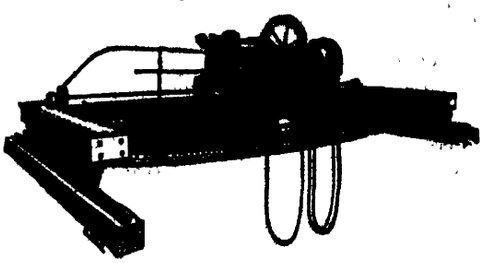
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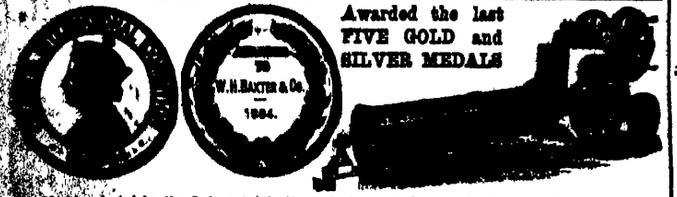
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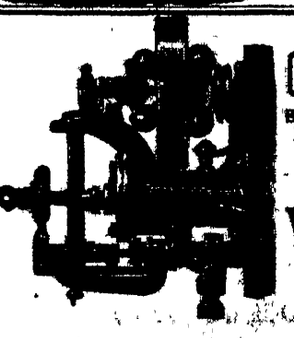
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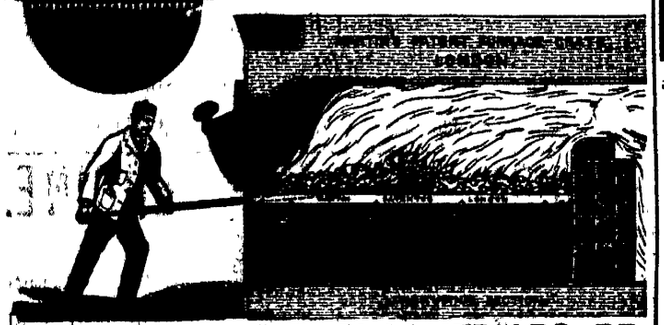
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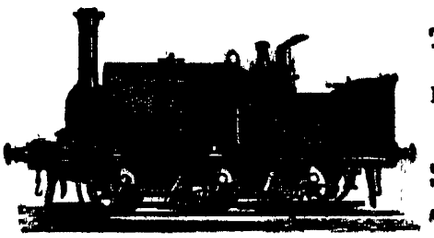
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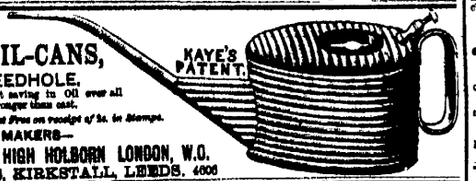
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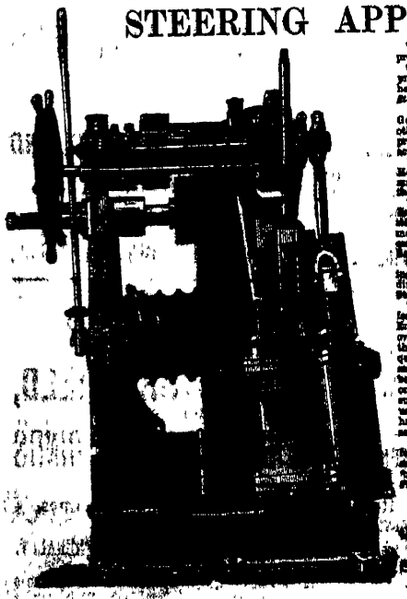
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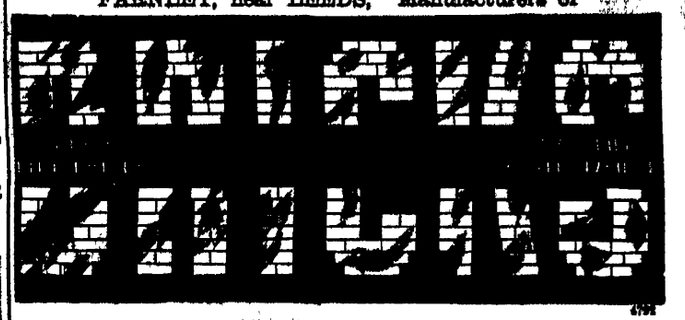
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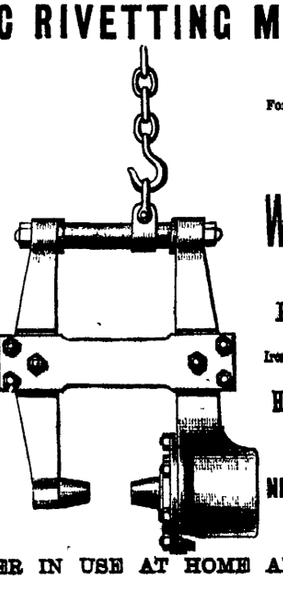
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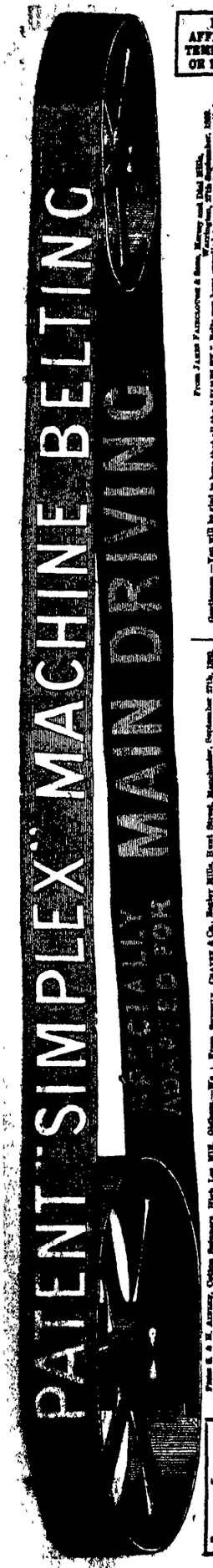
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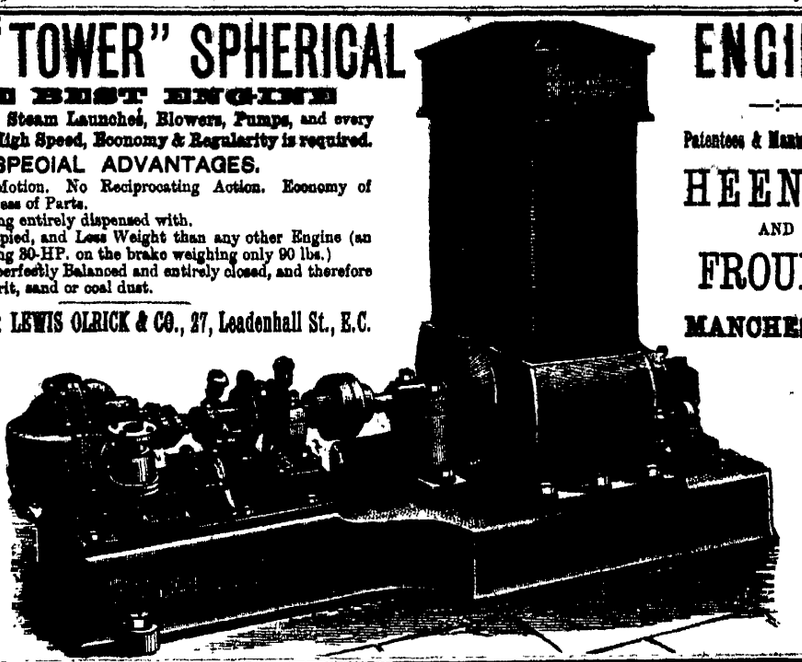
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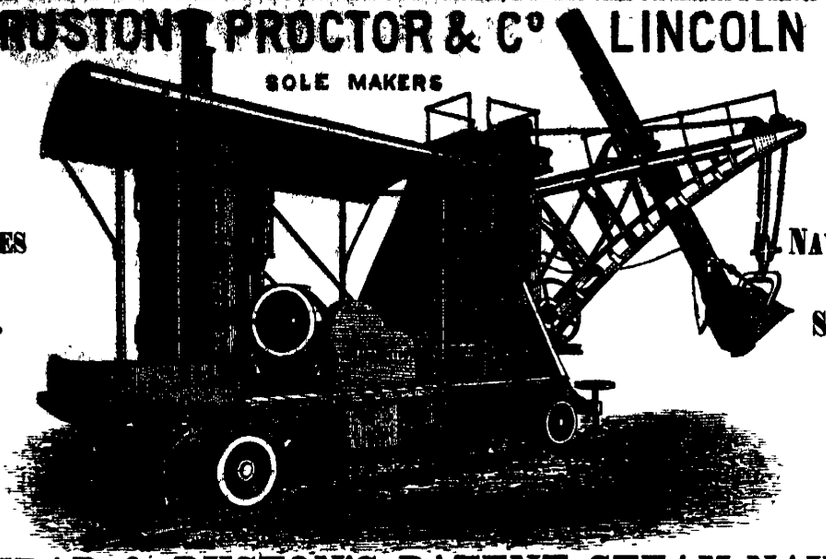
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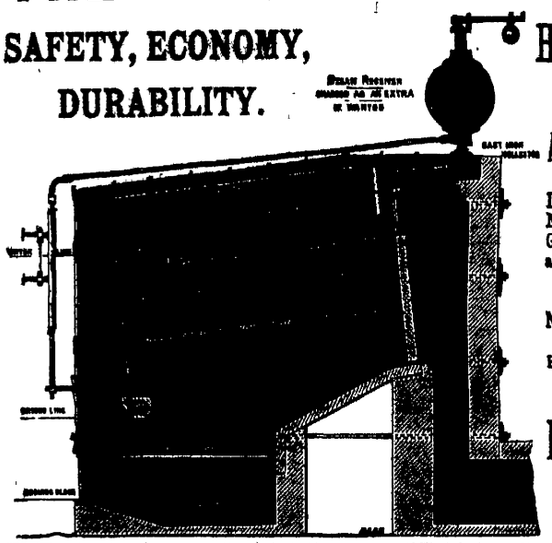
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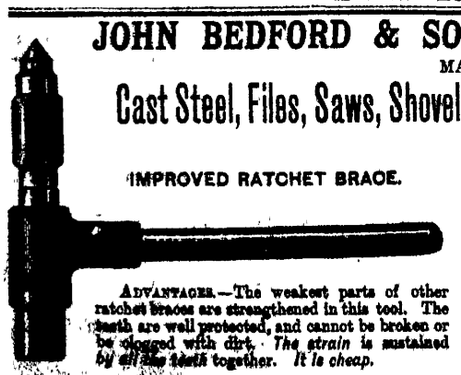
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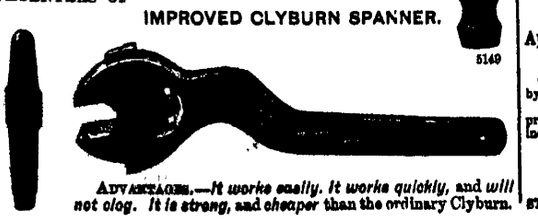
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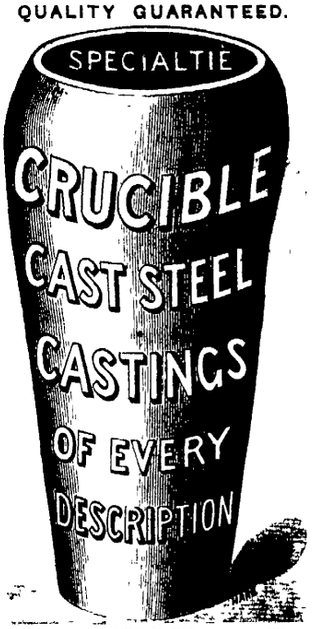
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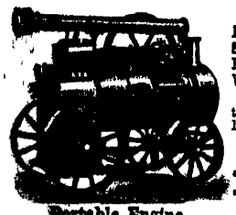
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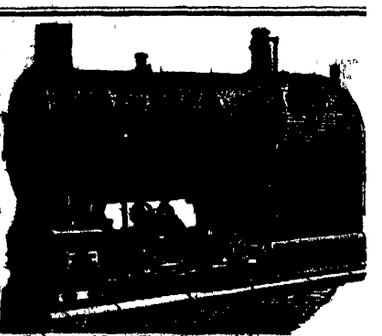


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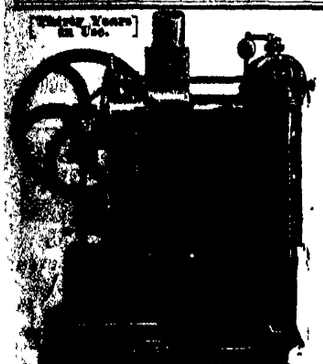
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AN Advertisement having been inserted in sundry papers by Messrs. F. REDDAWAY & Co., setting forth that Mr. GANDY has been ordered to pay their costs, about £5,000, in reference to the action brought by him against them, Mr. GANDY Gives Notice that as yet no costs have been paid to Messrs. F. REDDAWAY & Co. by him, that the decision referred to is now under Appeal, and that the amount of costs named is grossly exaggerated, and it is premature to say by whom the costs will ultimately have to be paid.

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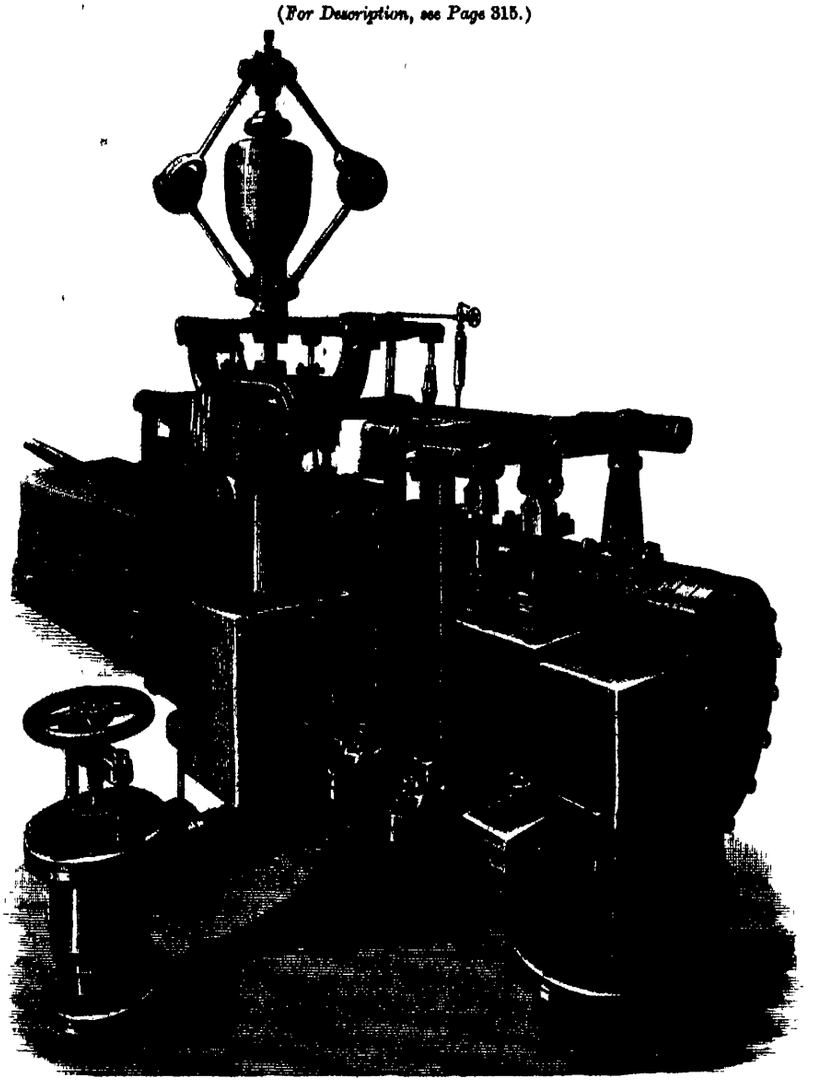
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CONSTRUCTED BY MESSRS. A. F. CRAIG AND CO., ENGINEERS, PAISLEY.

(*For Description, see Page* 315.)



THE IRON AND STEEL INSTITUTE.

In giving an account last week (*vide* page 299 *ante*) of the autumnal meeting of the Iron and Steel Institute at Chester, we described only the proceedings on the first day, Tuesday, the 23rd ult., and those on the morning of the following day. We have now to deal with the proceedings during the later part of the gathering.

The London and North-Western Railway Works at Crewe.

As mentioned by us last week, the afternoon of Wednesday, the 24th ult., was devoted to a visit to the London and North-Western Railway Works at Crewe, a party of 330 being conveyed to Crewe by a special train kindly provided by the London and North-Western Railway Company, the train being hauled by one of Mr. Webb's new compound locomotives. On their arrival at Crewe the visitors were received by Mr. Webb and first conducted to the drawing office, where a luncheon had been hospitably provided by the company. This over, Mr. Webb briefly addressed the members, giving some concise statistics as to the working of the London and North-Western system, and his remarks were of so much interest that we think it best to give them *verbatim*. He said: "It may interest some of the members to know that during the last decade, our mileage has increased some eight millions of miles per annum. Our mileage to-day is over 48 millions of miles. Going into days, hours, and minutes, that means 131,520 miles a day, 5480 miles per hour, 91 miles per minute, and 1½ miles every second of time. This, gentlemen, will represent a journey round the world about every four hours; and I am glad to say that our machinery is so perfect that we can go round the world an average of three times without losing either a split pin or a cotter. To show you what this mileage means, in wear and tear, I may state that we have at the present time 6395 men employed in these works; 8776 at the out-stations; and 605 in the signal department, or a total of 15,776 in the mechanical department of the railway. Our engine stock to-day is 2462, our wagon stock nearly 50,000, and our carriage stock 6000. To show you the progress of the railway during the last twenty years, I have had taken out, as a sample, the weight of the limited mail train. In 1864, the total weight of the carriages was 54 tons 19 cwt., the average weight of each carriage being 6 tons 17 cwt. In 1874, the total weight was 75 tons 3 cwt., and the carriages averaged 9 tons 8 cwt. In 1884, the trains weighed 165 tons 4 cwt., and the carriages averaged 12 tons 14 cwt. each. The problem I have had to solve has been rather a difficult one. It was how to move this weight of train (which is constantly increasing) without having two engines, or without making an engine so cumbersome as to destroy the road. We have endeavoured since the meeting of the Institute five years ago to solve that problem by compounding our engines, and thus economising our fuel and our water. It has been stated outside by people who know nothing about it, that I am 'nursing' these engines. I have nursed them to such an extent that I have had nearly a milion of miles out of them, the first compound engine, 'Experiment,' turned out two years and a half ago, being responsible for 150,000 miles in that time. When you were here the last time I had the pleasure of showing you a small sample of steel permanent way. Since that time we have further experimented, and we have got at the present time about fifteen miles down on the main line. I hope to be able to show you to-day that this is not a very difficult thing to make; and I trust, for the sake of the steel works in this country, that our railway directors will be prepared to give the thing a fair trial—either the system we have here or some better one. As another item which may interest the members of the Institute, seeing that at present all our steel-making and heating furnaces are on the gas principle, I have had taken out the consumption of fuel in all the furnaces throughout the works. Last year we dealt with 53,844 tons of material, and that in some instances passed through the furnaces twice and sometimes three times. Taking it in that way, it represents 81,665 tons of material passed once through the furnaces. The total quantity of coal and slack used for the gas furnaces was 37,067 tons, or 9 cwt. 3 lb. per ton of iron and steel dealt with. The result of our working on the gas principle is that we are enabled to live in comparative comfort in the town. You will observe that although the works are in full working order, the town is almost smokeless. The flowering plant which you see on the table has been placed there not so much to shown what can be grown in Crewe as to show what can be grown alongside of steel works where the furnaces are on

the gas principle. It will bear touching without dirtying your hands."

At the conclusion of Mr. Webb's remarks, the President, Sir Bernhard Samuelson, suitably acknowledged the courtesy of the London and North-Western Railway Company in again throwing open the Crewe Works to the inspection of the members of the Iron and Steel Institute (who, we may mention, had paid two former visits,* namely, in 1875 and 1879), and in proposing a vote of thanks to the directors he spoke of the excellent manner in which the company was served in their various departments, and referred to the straightforward way in which all matters of accounts were dealt with, while referring to Mr. Webb's remarks about "nursing," he observed that it would be well if all the works in the United Kingdom had such a "nurse" to take care of them. A few remarks being made by Mr. Webb in reply, the party then commenced their inspection of the works.

Outside the drawing office there had been arranged a number of locomotives representing the chief types now made at Crewe,† and these were examined with much interest, particularly one of the latest compounds constructed on Mr. Webb's system. Adjoining these were also placed a few early locomotives, including an example of the well-known four-wheeled Bury type with gab-motion, the engine "Dwarf," constructed by Mr. George England for working passenger traffic, and others of historical interest. Entering the special train the visitors were first conveyed to the steel works, where there are four 5-ton Bessemer converters, these with five Siemens furnaces in the adjoining shop being capable of producing 30,000 tons of steel per annum. Steel castings are now being largely used at Crewe to replace forgings, and one of the open-hearth furnaces is reserved entirely for their production. In this department the visitors were shown the casting of a steel wheel for a passenger engine, this being done in a mould which is caused to revolve at a speed of 60 or 70 revolutions per minute. The steel is poured into the mould through a central git about 4 ft. high. At the Crewe Works the Siemens furnaces are mounted a considerable height above the general floor level, the ingot moulds, &c., standing on this latter level and the molten steel being brought to them in ladles running on raised gantries. The steel wheels for locomotives to which we have just referred are an excellent job and promise to largely supplant the usual wrought-iron forged wheels, which, with their numerous welds, are by no means all that could be desired, however carefully they may be made.

From the steel works the visitors passed on into the department where the chairs for Mr. Webb's steel permanent way‡ were being rolled and stamped to shape. The bars forming the chairs are rolled from the crop ends of rails, cut to lengths, reheated, stamped up into the proper form for the chair brackets, and punched for rivetting, the time occupied in stamping and punching a chair bracket from the time the bar is drawn from the reheating furnace being three-quarters of a minute only. In the rail mill, which was next visited, the mill was found at work rolling Mr. Webb's steel sleepers; this sleeper section being also used at Crewe for the flanges of bridge girders, &c. Of the rail mill (a three-high mill) and of the fine Corliss engine which drives it, we need not speak here, as the whole arrangement was fully illustrated and described in ENGINEERING, vol. xxiii., page 359, when we also gave a series of indicator diagrams showing the power developed by the engine during successive passes of a rail.

Visiting next the points and crossings shop, the members saw the putting together of the parts of Mr. Webb's steel permanent way. The sleepers, while hot, are, as well as the chair brackets, dipped in a bath of tar, and the brackets and sleepers are rivetted up with a layer of thick tarred paper interposed between the surfaces. The rivetting is done by hydraulic power, and from first to last the whole of the details of the manufacture of this permanent way are admirably worked out, while the permanent way itself is, we understand, giving excellent results in the line. The points and crossings shop abounds with special machine tools, which we have no space to describe here. Amongst them may be mentioned multiple planing machines for switch rails, a machine with two planing heads (capable of being set to take cuts at any desired angle with each other) for planing the sides of points, and a heavy milling machine for finishing points.

A hurried visit was next paid to the boiler shop, where a number of Mr. Tweddell's hydraulic rivetters are in use, and where the members had an opportunity of examining the special form of fire-hole ring—or rather, of flanged junction between the inside firebox and casing—which Mr. Webb has now employed for some years past. This detail was illustrated on page 266 of the twenty-ninth volume of ENGINEERING. The locomotive boiler shells at Crewe are made exclusively of steel, and are fitted with copper fireboxes and brass tubes. As we have pointed out on former occasions, the most extreme care is taken to thoroughly test, both mechanically and by chemical analysis, every boiler plate used, while a complete register is kept of the results of the tests and of the position of each plate in the boiler of which it forms part. As a boiler-making material the steel employed at Crewe leaves nothing to be desired. The rivet holes in unflanged plates are, we may add, all punched, the plates being annealed after punching. The holes in the joint around the firehole to which we have referred above are drilled through both steel and copper plates by a very neat little special machine, another special machine turning off the edges of the plates. Passing on to the flanging shop, the visitors were next shown the flanging, under a powerful hydraulic forging press, of a steel cylinder cover for the 26 in. low-pressure cylinder of one of the new compounds, while under another hydraulic press, made by Messrs. Fielding and Platt, of Gloucester, the bending of a crank axle for the same class of engine was shown. It will be remembered that in this type of engine the front driving axle has a single crank in its centre, to which the connecting rod of the low-pressure cylinder is coupled, and this crank is produced by bending a straight steel bar 10 in. in diameter, the result being an exceedingly good job.

The next department visited was the boiler-making shop (where examples of the copper rings used for making dome and other joints were shown); the erecting shop, where the composite frames for carriages 42 ft. long, with radial axles, were being prepared; the new iron foundry opened about two years ago; the tender shop; and the brass foundry. This latter is a new building where the pots are heated entirely by gas, and where there is a small gas furnace on the hearth of which charges of 5 cwt. or so, are melted.

A short walk next brought the visitors to the steel forge containing the reversing plate mills, Ramsbottom's duplex hammers, large circular saw driven direct by a Brotherhood's three-cylinder engine, steam hammers employed in the forging of steel tyres, tyre mills, &c. This is a department which we have described on former occasions, and we need merely say here, therefore, that thanks to the excellent arrangements made, the visitors last Wednesday week had good opportunities of witnessing all the chief operations for which the plant has been designed. One of the reversing mills, we may mention, was engaged in rolling the steel bars of channel section now so largely used in the carriage frames of the London and North-Western stock.

The limited time available did not admit of an examination of the iron forge, but, entering again the special train, the visitors were next conveyed to the old works, when the stamping forge was first examined. The stamping done at Crewe is admirable, and the process is very largely employed. Adjoining this forge is the spring shop, where all the furnaces are heated by gas, and where some handy special machines for putting on and removing spring buckles were shown in operation.

Passing next into the wheel shop, the visitors had the opportunity of examining a number of cast steel wheels finished and unfinished. Here also, amongst a number of special tools, was Mr. Ramsbottom's original machine for cutting out the throws of cranks, Mr. Webb's curvilinear shaping machine for finishing the inner side of wrought iron wheel rims, and the quartering machine and portable machine for re-turning crank-pins, both illustrated on page 260 of our twenty-ninth volume. Here also we noticed a number of crank axles of a new pattern, with the crank-pins considerably larger in diameter than the main journals, and with the webs also increased in width towards the crank pin end.

Proceeding next to the fitting shop Mr. Webb showed his visitors examples of the chief details of his standard types of engines and explained their special features.* Amongst other things he directed special attention to the form of ejector used in connection with the vacuum brake which the London and North-Western Company are now fitting to their trains and to his pattern of engine brake valve. The large ejector used for creating the vacuum for applying the brake, has by the side of it a very small ejector which is constantly in use and which maintains in the brake pipes a slight vacuum which is employed to keep out of action the brakes on the vans, these brakes being arranged to apply themselves automatically in the event of the slight vacuum just referred to being destroyed by the fracture of the brake pipes. The brake valve just mentioned, and which Mr. Webb is applying to all his engines, is provided with a lever which if moved in one direction applies the steam brake on the engine only, it being intended to be thus worked when the engine is detached from a train. Moved a short distance in the other direction the lever causes the application of the vacuum brake only, while if pulled further in the same direction it applies both the vacuum and the steam brake simultaneously. This arrangement, which is very neatly worked out, has been devised by Mr. Webb to enable either or both brakes to be worked by the movement of a single lever.

In the adjoining erecting shop the visitors had the opportunity of examining in course of erection one of Mr. Webb's new compound engines. Inasmuch as this type of engine was fully described in the interesting paper read by Mr. Webb before the Institution of Mechanical Engineers at the Liège meeting last year, which paper we published *in extenso* on page 125 of our thirty-sixth volume, when we also gave a two-page engraving of the engine, we need not enter into details of the latter here. We may say, however, that the compounds continue to give good results on the London and North-Western, and that quite apart from any economy of fuel which may result from their use, the fact of their possessing the advantage of a coupled engine without the use of coupling rods—rods which give more and more trouble as speeds are increased—renders them a type worthy of the serious attention of locomotive engineers. That the whole of the details of the design have been admirably worked out need scarcely be stated, but we think that there were few of the visitors who examined the engine in progress at Crewe last week who did not come away with their faith strengthened in the future of compound locomotives.

After leaving the erecting shop and passing through the stores, the party again entered the special train and were conveyed through the timber department to the millwrights' shop, where crane-work, &c., is carried out. Here the visitors were shown a very interesting relic of the past in the shape of one of Trevithick's early high-pressure engines, which Mr. Webb rescued from a scrap heap last year and had re-erected at Crewe. This engine, which has a cast-iron boiler with wrought-iron return flue, was intended to be worked at 90 lb. per square inch, and it bears a name plate with the words "No. 14, Hazeldine and Co., Bridgnorth." We shall in an early issue give engravings of this engine, but meanwhile we may say that the cylinder, which is vertical, is cast in one with the back end of the boiler, this end and the barrel being in one piece. The front end to which the furnace and

* Accounts of the two former visits paid by the Iron and Steel Institute to Crewe, will be found in ENGINEERING, vol. xx., p. 238, and vol. xxviii., p. 264. The works were also visited by the Institution of Mechanical Engineers in 1872, an account of this visit being given in ENGINEERING, vol. xiv., p. 94.

† We have from time to time published illustrations of most of the recent types of London and North-Western locomotives, and it may be convenient here to give references to our notices. They are as follows. Four-coupled passenger locomotive, vol. xix., p. 185; four-coupled tank locomotive, vol. xxiv., p. 473; goods locomotive with Joy's valve gear, vol. xxx., p. 294, and vol. xxxi., pp. 92, 454, and 590; and compound passenger engine (Webb's system), vol. xxxvi., p. 125. We also, in vol. i., pp. 36, 37, illustrated the "Tiny," the first of the little locomotives constructed for working on the 18 in. gauge line which runs through the Crewe Works, while in vol. xxii. p. 178, we gave engravings of the "Billy" and "Dickie," two later types of engines constructed from Mr. Webb's designs for the same service. A special type of locomotive boiler with water bar grate designed by Mr. Webb for shunting engines using anthracite fuel was illustrated by us in vol. xxx., pp. 232, 233, and another special type of shunting engine, of which an example was seen in use at Crewe, last week, in vol. xxx., p. 184.

‡ An illustrated description of this arrangement of permanent way appeared in ENGINEERING, vol. xxxi., p. 7.

* Engravings of the standard patterns of connecting and coupling rods will be found on page 93, vol. xxxi., of ENGINEERING.

return flue are attached is united to the barrel by a bolted joint. Mr. Webb had to renew the chimney, firehole door, and front of flue, as these parts had been broken up before the engine came into his possession. The cylinder is vertical, the piston rod being attached to a long crosshead, from the ends of which connecting rods extend down to cranks on a shaft below. These connecting rods had also been broken up, but Mr. Webb has replaced them by rods as nearly like the old ones as possible. The original pump was also smashed, but Mr. Webb has fixed one to show the arrangement of the connections, the feed being passed through a heater on its way to the boiler. At the present time when funds are being raised for the founding of a scholarship* in recognition—somewhat tardily it must be admitted—of the great mechanical genius of Richard Trevithick, this old engine has a special interest, and an examination of it appears to carry us back to the time when some eighty years ago Trevithick so valiantly fought against obstinacy, prejudice, and ignorance to obtain recognition for the merits of high-pressure steam and the non-condensing engines of which he was the originator.

The last department of the Crewe Works visited by the members of the Iron and Steel Institute was the chain testing shop, a new building which has been fitted up with the most complete appliances for the work. The chain to be tested having been annealed by being passed through the fire, is laid in a trough in the floor arranged like those in Lloyd's testing houses, and provided with covers to prevent injury from being caused by the flying of a fractured link. When thus laid in the trough, one end of the chain under test is connected to an exceedingly neatly arranged lever testing machine for indicating the strain applied, while the other end has a pull exerted upon it by hydraulic power until the desired test strain is obtained. The testing machine, together with the hydraulic pumps, &c., were all made by Messrs. Tangyes, Limited, and are an admirable job. The London and North-Western Company now have all their crane and hoist chains, couplings, &c., periodically examined and tested at Crewe, the result being an almost entire immunity from fracture in service.

Leaving the chain testing department the visitors again entered the special train, in which they were conveyed back to Chester, they having—thanks to the excellent arrangements made on their behalf—certainly made the very best use of the short time at their disposal for examining the vast establishment at Crewe.

Regenerative Furnaces and the Manufacture of Open-Hearth Steel.

We mentioned last week that the proceedings at the morning meeting on Wednesday the 24th ult. were concluded by the partial reading of a paper by Mr. F. W. Dick, of Glasgow, "On a New Form of Regenerative Furnace." On the members reassembling on Thursday morning, the 25th ult., the reading of the paper (which we published *in extenso* on page 294 of our last issue) was completed, and the discussion was then taken on it jointly with the papers by Mr. Frederick Siemens, of London, and Mr. James Riley, of Glasgow, which preceded it. Of both these papers we gave abstracts on page 303 of our last number, while Mr. Riley's paper we also publish *in extenso* with its diagrams on page 316 of the present issue.

In asking the members to discuss the papers before them, the President referred to the presence in the room of Mr. Frederick Siemens, the inventor of the regenerative furnace, and expressed a hope that he would join in the discussion. The latter was then opened by Mr. E. A. Cowper, who referring to the large capacity for combustion in Mr. F. Siemens' new furnaces observed, that he (Mr. Cowper) had made many experiments on securing perfect combustion at high temperatures, and that he had found such large capacity for combustion quite essential. It had to be borne in mind that the flame, owing to the expansion of gases by heat, occupies a space vastly in excess of that occupied by the air and gas consumed, and it was essential to perfect combustion that the flame should be formed without the gases being cooled by coming in contact with solid bodies which deprived them of heat. In his regenerative blast-heating stoves, special attention was paid to bringing the gas and air together so as to promote their ready admixture, and a large chamber was provided for the completion of the combustion before the flames came in contact with the bricks of the regenerator chambers.

Mr. Josiah Smith, of Barrow, highly commended the arrangement of steel plant which Mr. Riley had described in his paper. He (Mr. Smith) had seen the plant in use, and he had been much struck by its working. The intermediate pouring he considered an important feature, and he regarded it as essential to uniformity. He had long been intending to adopt this intermediate pouring at Barrow. In conclusion, he asked Mr Riley whether the slagging arrangement, described in the paper, was now in regular use; it had not been started when he (Mr. Smith) examined the plant.

Mr. I. Lowthian Bell next made some remarks as to the saving of 25 per cent. claimed by Mr. Siemens as the result of the application of his system to the heating of boilers. Mr. Bell doubted this saving, as it could not be accounted for by a large percentage of unconsumed carbon escaping from boilers fired by gases in the ordinary way. In boilers fired by coal, it was commonly assumed that the amount of air admitted to the furnaces was some 100 per cent. in excess of that chemically required for perfect combustion, but some experiments of his own on boilers fired by gas tended to show that in boilers so fired the excess of air did not exceed 20 per cent., while no unconsumed hydrogen was discharged, and the only waste could be that resulting from the discharge of imperfectly consumed carbon. He doubted, however, if this source of loss could be so great as to account for a diminution of efficiency to the extent of 25 per cent.

Mr F. W. Dick, commenting upon Mr. Siemens' furnace, observed that at the works of the Steel Company of Scotland they had some time ago tried furnaces with raised roofs, to increase the capacity for combustion. In a melting furnace, however, the conclusion at which they had arrived was, that it was essential to success to keep the combustion close down to the surface of the metal under treatment. Mr. Edward Reilly next placed before the meeting some statistics showing that the Siemens furnace can be successfully used for the basic process, and M. Gauthier remarked that in France the basic process was being successfully used for the manufacture of the very softest qualities of steel from phosphoric pig.

Mr. John Gjers observed that whenever steel has to be cast at a long distance from the furnaces, it is necessary either to provide means for the transportation of the ladle into which the steel is originally run, or to re-teem the steel. Prior to Mr. Riley adopting this latter plan at his works it had only been used at the Darlington Steel Works, where he (Mr. Gjers) introduced it As the inventor of the soaking pit he had been greatly interested by the plant at Blochairn, and he considered that the greatest credit was due to Mr. Riley and those under him for the manner in which the arrangements had been worked out. Speaking as a patentee it was not often one got hold of a man who knew exactly what he wanted, and who recognised a good thing when he saw it. Mr. Riley, however, had visited the works at Darlington, and on examining the working of the soaking pits there, had abandoned further experiments, and decided to adopt the system. In conclusion Mr. Gjers stated that up to the present time upwards of 300,000 tons of steel had passed through his soaking pits at the different works where they were established, and that the saving in the loss by oxidation resulting from their use was found to be an important item.

Mr. R. Jenkins, of Consett, stated that he had been much interested in Mr. Riley's arrangement, and he inquired whether Mr. Riley considered that if ten to fourteen Siemens furnaces were placed in a row as described, they could be worked to their full capacity without risk of the casts clashing with each other, and overrunning the capacity of the soaking pits?

Next in reply to an inquiry from Mr. John Head, as what were the features of the "Batho tubes" and the "Hackney port" to which reference had been made in the papers of Mr. Dick and Mr. Riley, Mr. Wailes stated that the novelty in the Batho arrangement consisted in the air and gases being brought up outside the furnace proper in place of through flues built in the furnace. In the ordinary arrangement there was always the chance of the air and gas becoming intermingled through cracks in the brickwork between the flues, while with the Batho tubes this was impossible. The Batho arrangement also greatly simplified the construction of the furnace, the latter becoming merely a box with air circulation all round. As regarded what was generally known as the "Hackney port," it consisted in placing the air port above or nearly above the gas port, the arrangement being such that the currents of air and gas conduct themselves to the point of combustion without being guided by the roof,* the mixed gases being deflected downwards by the air. With furnaces made as suggested in Mr. Siemens' paper, perfect combustion might be obtained, but he doubted if the necessary heat would be got upon the hearth. To insure successful melting the combustion must take place upon the surface of the charge—radiant heat alone was not sufficient.

Mr. John Head maintained that the Hackney port was not a novelty, it having, he asserted, been described in a patent taken in 1871 and having been used in France. He considered it, moreover, inferior to the inclined air and gas ports now used The Batho tubes he regarded as cooling tubes placed in a bad position. As shown in Mr. Dick's diagrams the brick lining of these tubes would not be sufficient to prevent material loss by cooling In the ordinary Siemens furnaces there was no trouble by leakage between the gas and air ways if these were properly built, as they always should be. He further condemned the construction of the roof of Mr. Dick's furnace and the arrangement of the dampers. The difference of the draught through the air and gas regenerators was, he stated, a difficulty of Mr. Dick's own creation, and arose from the air regenerator being made higher than that for gas. The difference of capacity of the two regenerators should have been obtained by increasing the diameter of that for air, not by augmenting its height. The two-damper arrangement he considered inferior to that employed in Siemens furnaces, where a single damper was so placed between the gas and air outlets that it could control both.

In reply to these remarks Mr. Wailes stated that the loss of heat by radiation from the Batho tubes was in practice entirely unimportant, the tubes were very short and the gas and air passed through them at a high velocity. Mr. Caldwell, of Motherwell, then made an attack on the practice of cogging blooms for plates instead of hammering them, and notwithstanding that the President observed that this point appeared to be disposed of by the acknowledged high quality of the plates produced by the Steel Company of Scotland from cogged blooms, he maintained that trials which they had made at Motherwell entirely supported the views he had expressed.

Mr. Daniel Adamson next pointed out the tendency of ingots to become unsound owing to the contraction of the interior after the exterior had set, the ingots becoming, as he aptly expressed it, "hide-bound." He considered that if an ingot was cut in two and allowed to cool as slowly as possible in a soaking pit, it would be much more likely that a thoroughly sound mass of steel would be obtained As regarded the question of cogging *v.* hammering, he believed that one process would produce just as good a result as the other.

Mr. Edward Williams, who spoke next, went further than this, and gave it as his decided opinion that the practice of cogging steel blooms was preferable to hammering. Under the process of hammering as usually carried out, the steel became beaten down in a series of steps and was much punished; if it was possible to employ a hammer face acting over the whole surface of the bloom, the result would of course be different. As regarded the solidity produced there was no difference between cogging and hammering. He quite agreed with Mr. Adamson, as to the desirability of preventing ingots from setting hard outside while the interior was still in a fluid state. In conclusion he highly commended Mr. Riley's plans and expressed his opinion that the use of hammers for treating steel blooms would ultimately be generally discarded. Mr. E. P. Martin, of Dowlais, also expressed similar views, and observed that as the ingots are not treated at a welding heat, the use of the hammer cannot effect any welding up of hollows and cannot be better than cogging.

Mr. Frederick Siemens next replied to the discussion on his paper. As to the economy of 25 per cent. in the working of boilers in his system to

* Subscriptions for the Trevithick Memorial Scholarship will be received by the honorary treasurer, Mr. Henry Chapman, 113, Victoria-street, London, S.W. The fund is one which deserves every support from engineers.

* The arrangement here referred to is shown in Figs. 1 and 4 on page 292 of our last week's number.

HORIZONTAL ENGINE WITH CRAIG AND MOTION'S VALVE GEAR.

CONSTRUCTED BY MESSRS. A. F. CRAIG AND CO., ENGINEERS, PAISLEY.

(*For Description, see Page* 315.)

Fig. 1

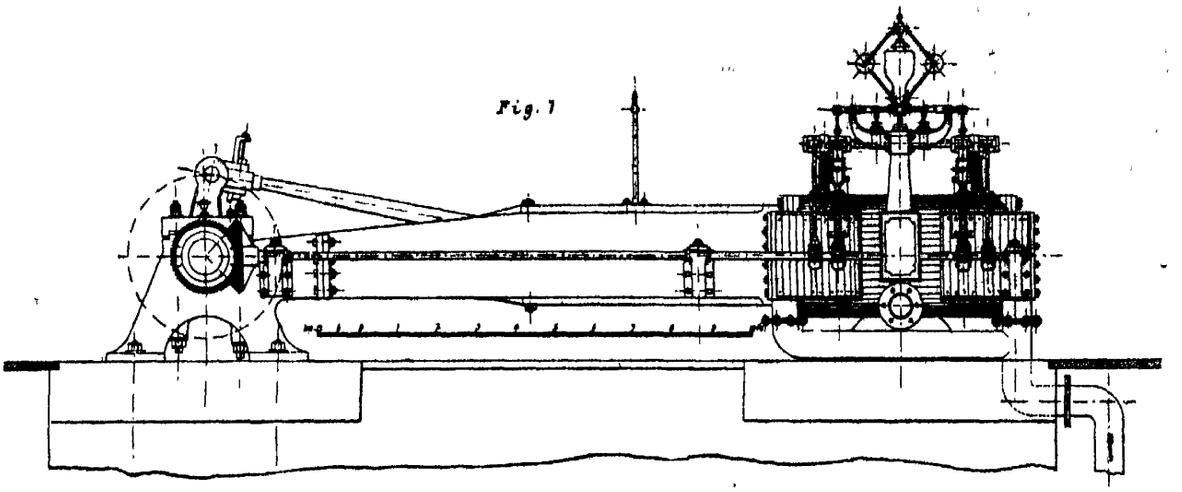
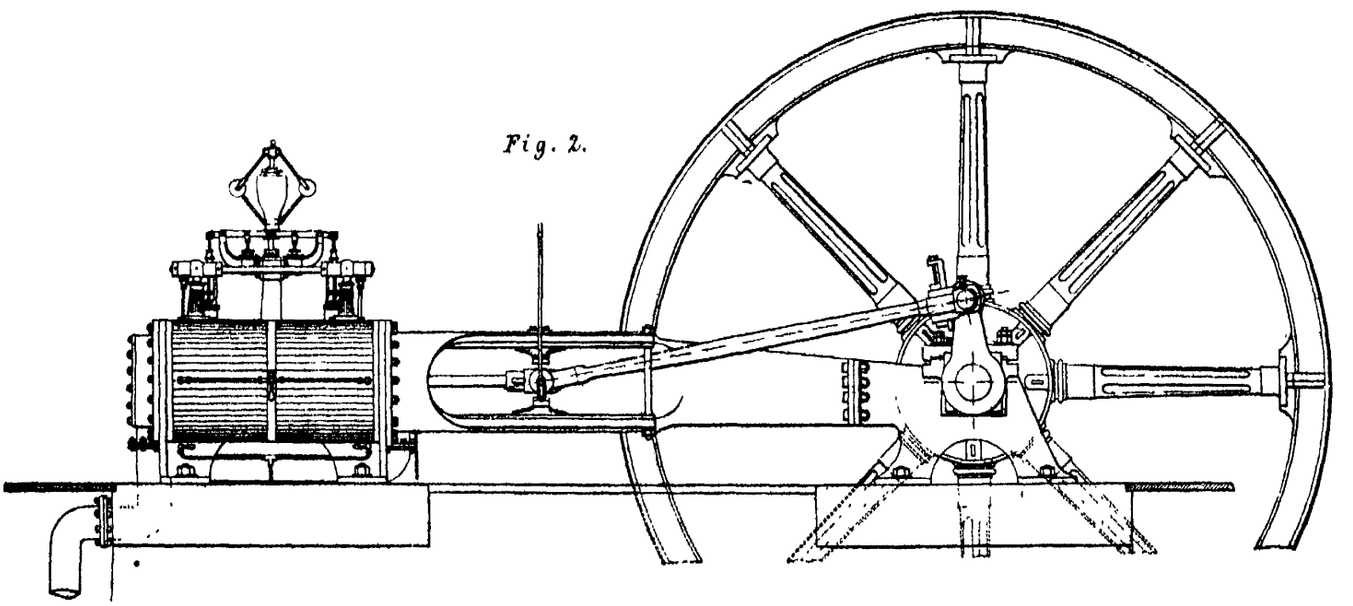
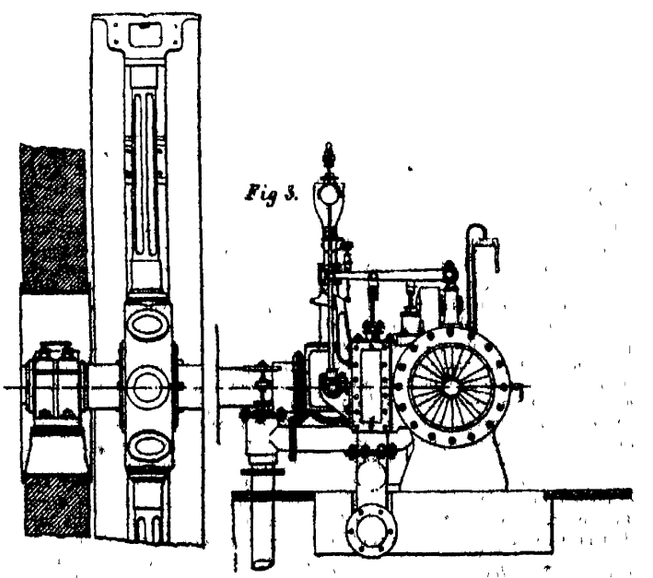


Fig. 2.



which Mr. Bell had referred, it was due to good combustion, increased intensity of heat, clean heating surfaces, and consequent increased efficiency of heat absorption. Under ordinary conditions imperfect combustion took place in the immediate neighbourhood of the boiler surfaces, owing to the local cooling of the gases, and the result was the formation of a smoky layer, which diminished the effect of radiant heat. His figures as to saving had been obtained by a comparison of boilers heated on his system with boilers heated by gas burnt in the ordinary way; if the comparison had been made with boilers worked with solid coal the saving would probably have been greater. Mr. Dick had stated that they had tried high-roofed furnaces at the works of the Steel Company of Scotland, but Mr. Dick's diagrams did not show such roofs on his furnaces. He (Mr. Siemens) also built his furnaces with separate roofs like Mr. Dick's. He had intended to leave the theoretical aspect of the question under discussion to be dealt with in a future paper; but there were great differences of opinion as to the theory of combustion, and he might say a few words on the subject. The process of combustion was marked by a number of special stages quite independent of each other, and these might be considered in detail. There were, however, as he had stated in his paper, two main stages, viz.: first, the essentially chemical process of actual combustion; and, second, the subsequent dealing with the products to utilise the heat evolved. It was essential to

Fig 3.



plete combustion that there should be ample capacity in which this combustion should take place. During this stage radiant heat was very powerful. Subsequently, when combustion had been completed, radiation was weak, and it was necessary to deprive the products of their heat by

DETAILS OF HORIZONTAL ENGINE WITH CRAIG AND MOTION'S VALVE GEAR.

CONSTRUCTED BY MESSRS. A. F. CRAIG AND CO.,' ENGINEERS, PAISLEY.

(*For Description, see Page* 315.)

Fig. 4.

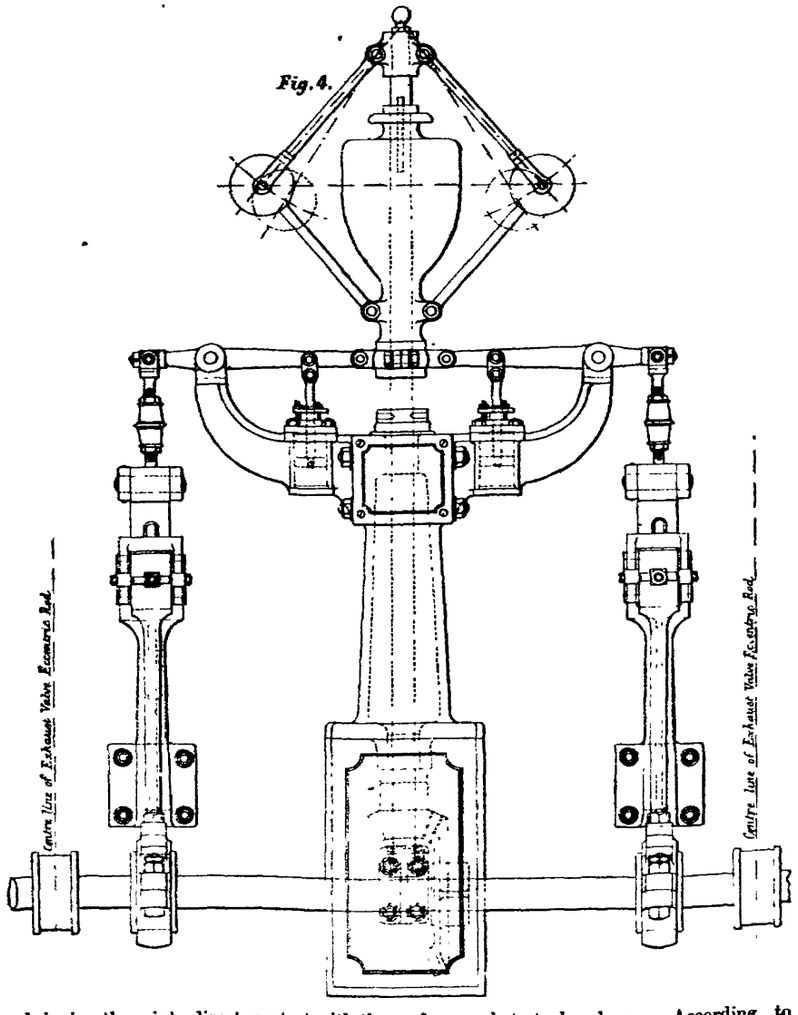


Fig. 5.

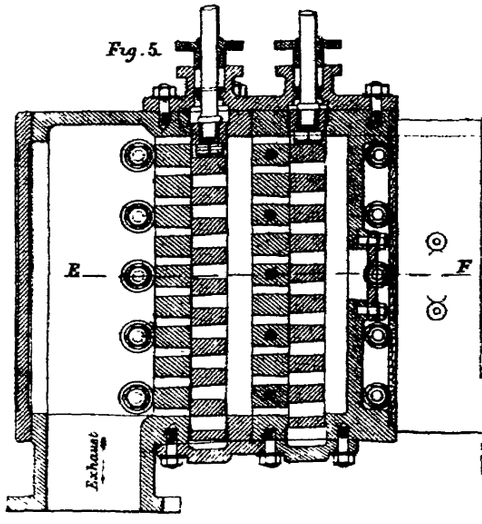


Fig. 6.

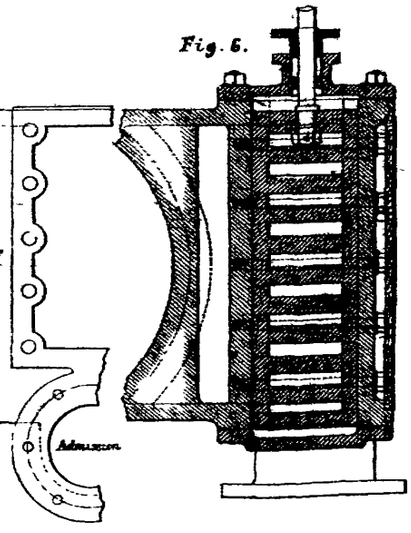
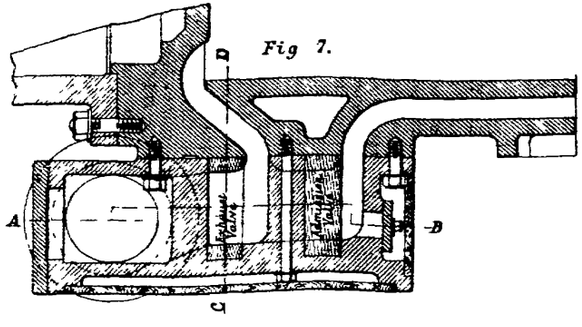


Fig 7.



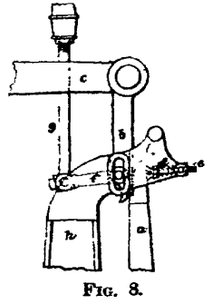


FIG. 8.

bringing them into direct contact with the surfaces to be heated. Flame exercises a violent destructive action on surfaces with which it comes into contact—this being generally known as the "cutting" action of flame—and, according to one theory, this arose from the particles of the gases being, during the process of combustion, in intensely rapid motion On the whole, however, he considered that the electric theory best explained what took place According to this theory flame was nothing but a series of electric discharges, very minute, but very numerous. According to the motion theory the introduction of a solid body into the flame limited the motion of the particles, and so caused decrease of temperature and incomplete combustion, there being formed in contact with the surfaces a layer of smoke which obstructed radiation. According to the electric theory the introduction of a solid body in a similar way interfered with the electric discharges, while it was itself injured or cut away by such discharges. It must be borne in mind that a flame radiated heat internally as well as the outside, and thus a flame, double the diameter of another, radiated four times as much heat as the smaller flame, and not twice, as would be the case if the flames were solid bodies. The gas used in Cowper stoves produced comparatively little flame and hence its radiative power was low, and it was necessary—in order to utilise the heat—to bring the products of combustion into intimate contact with the bricks to be heated. In conclusion, he observed that it was only by doing away with the smoke nuisance that he hoped to excite general interest in his system.

Next Mr. James Riley also replied. Answering

the question of Mr. Josiah Smith, he stated that the slagging arrangement described in his paper was now in regular use, while in reply to the query of Mr. Jenkins he observed that it was found quite practicable to maintain a regular sequence in the casts from the furnaces forming the range. This question was one which had appeared to him a serious one when he first considered the arrangement, but in practice all was found to work well, and they had had no loss of make from the adoption of the system, on the contrary, the output per furnace was greater than it had been under the old system of working each furnace independently. The new system was also found to give special facilities for the selection of material for different purposes during the passage of the steel through the soaking pits, and if necessary they could even sample a charge while the ingots were in the soaking pits, there being ample time. At the Newton Works of his company the ladle lift was placed at the end of a row of fourteen furnaces instead of at the centre, and the height of the lift was 20 ft., the steel having to be raised from furnace level to mill floor level. This, however, was found to involve no practical inconvenience. With regard to cogging v. hammering, he had no great prejudice for either system and used both, but experience had shown him that the practice of cogging ingots was the best At the Newton Works, the soaking pits were 40 yards from the furnaces and they worked through four of them to the hammers without difficulty.

Mr. Dick also replied to the discussion on his paper. With regard to what had been said by Mr. John Head as to the lining of the Batho tubes, he stated that the lining of these tubes was the same thickness as the roof of the furnace. The lining could be made thicker if desirable, but it was a matter of common experience that linings if too thick burn away until the loss of heat by radiation was sufficient to preserve them. As to the use of two dampers it involved no complication. In conclusion he stated that he should at any time be glad to show Mr Head the high-roofed furnaces, to which he (Mr. Dick) had referred as having been tried at the works of the Steel Company of Scotland. On the conclusion of the discussion, votes of thanks were passed to Mr. James Riley, Mr. Frederick Siemens, and Mr. Dick, respectively, for their papers.

The Utilisation of Bye-Products obtained from Coal during the Coking Process.

The next paper read was one by Professor Watson Smith, of Owen's College, Manchester, "On the "Recovery of Bye-Products from Coal, more espe- "cially in Connection with the Coking and Iron "Industries." This was a comprehensive paper on which a great amount of labour had been bestowed, but owing to its length it had to be read in abstract. We commenced its publication *in extenso* in our last issue. It was succeeded by a paper "On the most "Recent Results obtained in Germany in Utilising "the Bye-Products from Hoffmann Coke Ovens," by Dr. C. Otto, of Dalhausen, the two papers being discussed together. We shall publish Dr. Otto's paper in an early issue.

The discussion was opened by Professor Wanklyn, who had prepared a short paper on the carburisation of limed coal on Cooper's system. The time available, however, only allowed of short extracts from this paper being read As to the influence of the practice of coal-liming on the coke, Professor Wanklyn observed that in coke made by the ordinary process the quantity of sulphur was less than in the coal from which it was derived, but in coking limed coal the whole of the sulphur originally contained in the coal went into the coke and was massed there. The sulphur, however, was not evolved during the combustion of the coke, but was retained in the slag, and Professor Wanklyn contended that on this account coke from limed coal was fit for use in smelting. As regarded the increase of ammonia obtained by the addition of lime to the coal, it was undoubted; at the Tunbridge Wells gas works the increase amounted to 30 per cent.

Mr. I. Lowthian Bell, who spoke next, agreed that during the coking of limed coal the sulphur might become massed in the coke, but it was still there, and he feared that in the blast furnace it would be "unmassed," and that the sulphur would be transferred to the iron. He had no doubt that, as stated in Professor Watson Smith's paper, excellent results could be obtained with the Simon-Carvès oven; but cokemakers must not grumble if they found that ironmasters did not regard all firm and solid coke as satisfying smelting conditions. His firm happened to own two collieries which yield cokes of different qualities for smelting, and it so happened that in this case the worse coke was that which appeared most hard and solid. He had found that one coke dissociated the carbonic acid formed in the process of smelting, this carbonic acid being converted into carbonic oxide. In this way as much as 1½ cwt. per ton of coke charged was carried off without ever having reached the lower part of the furnace at all. This waste, calculated from the composition of the waste gases, was found to agree exactly with the results of practical working. As regarded Dr. Otto's paper, the results there recorded as to the water evaporation effected in a boiler by the waste heat from coke ovens—namely, an evaporation of 1 to 1½ lb. of water for every pound of coal coked—were fully twice as good as those obtained in this country.

Mr. G. J. Snelus observed that there was a great difference in the duty which different cokes would do. West coast coke was not so good as east coast coke, and in comparing the results of Cleveland furnaces with those on the west coast full allowance was not always made for this. The action which had been described by Professor Wanklyn as taking place during the coking of limed coal was in his opinion undesirable. They did not require the sulphur fixed, but unfixed. The elimination of sulphur during the coking of coal was a matter which deserved careful attention. The elimination might, he suggested, be effected by the application of superheated steam during the coking process, and although this would involve some loss of coke it might be desirable to incur this loss rather than to have the sulphur in the blast furnace.

Mr. Charlton, who had recently returned from a visit to Westphalia, corroborated the statements in Dr. Otto's paper In the Hoffmann ovens he had seen made in 48 hours, coke which was as good as that usually obtained in the Simon-Carvès ovens in 72 hours; thus with the Hoffmann ovens a less plant was required for a given output. The Hüssener ovens described in Professor Watson Smith's paper were also excellent ovens; they effect the carburisation in 60 hours. In the first fifty ovens erected difficulty had been experienced owing to the clogging of the hydraulic main by tar. This had now been quite got over by forming the main with a water seal on one side. He had also noticed when examining the ovens just referred to, that the cooling of the coke (outside the ovens) was done by hose-pipes controlled by men standing on the tops of the ovens, from which position they could see well where the water could be best applied. The benches on which the coke was cooled were somewhat steeply inclined so that any excess of water ran off quickly, and this perhaps accounted for the very small percentage of water found in the coke.

Mr. A. L. Steavenson, of Durham, who spoke next, observed that at the Middlesbrough meeting last year, Mr. Thompson, of the Clarence Works, had stated that if he had continued to use the Simon-Carvès coke in the furnaces under his charge, he would have had to increase the quantity of coke per ton of iron by 12 per cent. Altogether he (Mr. Steavenson) considered that the problem of producing a high class coke for smelting purposes and at the same time utilising the bye-products, was not yet solved. As far as the coke was concerned there was therefore no advantage in the methods of coking under consideration. Then as to the tar, it had been shown by Professor Watson Smith, that its price was so variable that it could not be relied upon as a profitable product. Lastly, it might be supposed that in the ammonia we really had a bye-product of value, but it had been stated that the coal which gave the best results as regarded the production of ammonia during coking, were those least suitable for the manufacture of coke for smelting purposes. As regarded the employment of recuperators to which reference had been made in the papers, the bricks could not be got to stand. At Pease's West the recuperators were not in use.

The President observed that the experience of his firm as to the coke made in Simon-Carvès ovens did not agree with that of Mr. Thompson, but in the time now at their disposal it would be impossible to complete the discussion, and the latter would therefore be adjourned until the spring meeting in London next year. The meeting was then brought to a close by the according of hearty votes of thanks to the Mayor of Chester, to the London and North-Western Railway Company and Mr. Webb, to the local committee, to the proprietors and managers of works kindly thrown open to the members, and to the President, Sir B. Samuelson, for his able conduct in the chair.

Excursions.

The afternoon of Thursday, the 25th ult., was devoted to an excursion to Northwich, where the party divided, one division being conveyed by steamer (provided by the Weaver Navigation Trustees) down the River Weaver to inspect the canal boat lift at Anderton, and the locks and flood sluices at Dutton, under the guidance of Mr. Lionel B. Wells, the engineer to the River Weaver Navigation; while the second division continued their journey by rail to Marston, where they examined the White Salt Works and the Adelaide Salt Mine, of Messrs. Verdin and Sons. Of the River Weaver Navigation and the works upon it just mentioned, we gave a full illustrated account on page 291 *ante*, while we also described Messrs. Verdin and Sons' salt works and mines on page 290 *ante*. With regard to the latter, however, we may mention that on the occasion of the visit yesterday week, Messrs. Verdin had had the Adelaide mine most tastefully decorated by many thousands of lighted candles arranged in suitable designs, while a further illumination from time to time by coloured fires produced most effective and charming results.

It had been originally proposed that there should be on this same afternoon an alternative excursion to the Flint Alkali Works, but this intention was abandoned, although the works in question were open to the inspection of the members any time during the week. An illustrated account of the Flint Alkali Works appeared on page 298 *ante*. On the afternoon of the 25th ult., also, the Very Rev. Dr. Howson, Dean of Chester, received many of the members in the Cathedral, which he described as well as the adjoining ruins of the Priory and the Church of St. John the Baptist. In the evening the members took part in an interesting conversazione at the Town Hall, to which they were invited by the Chester Society of Natural Science.

Friday, the 26th ult., the last day of the meeting, was devoted to an excursion into North Wales. This comprised a trip to Blaenau Festiniog, *vid* the Vale of Llanberis and Bala, and an inspection of the Festiniog Slate Quarries and of the celebrated narrow gauge Festiniog Railway, an account of which appeared on page 283 of our last issue. Conveyed by this narrow gauge line to Mynfford Junction the party next proceeded by special train to Carnavon, where the castle and walls were inspected, then to Menai Bridge Station to examine the Menai suspension and Britannia tubular bridges, then to Conway, where the castle was visited, and finally back to Chester. This was a heavy day's work, and unfortunately the weather was less favourable than could have been desired.

Besides the regular excursions there were numerous works in Chester and its neighbourhood most freely thrown open to the inspection of the members, and undoubtedly everything was done by the local committee to render the meeting a success. Of several of the works thrown open we have already published notices,* and we now append some others, while further descriptions will appear in early issues.

The Lloyd's Cambrian Chain and Anchor Testing Company's Works.

These testing houses are at Saltney, about 1½ miles from Chester, and are one of the establishments called into existence by the Chain, Cables, and Anchor Act. The largest machine is capable of exerting a breaking strain of 250 tons. There is also a tensile machine which is licensed to 130 tons, and an anchor testing machine equa to 80 tons. The arrangements are of the ordinary description and call for no special notice. There is also a pair of Tweddell's hydraulic shears by Messrs. Thompson, Boyd, and Co., of Newcastle, for cutting iron up to 2¾ in. in diameter.

The Chester Water Works.

This company has two pumping stations, situated near to each other, at Boughton, which is a short distance from Chester, up the river. The intake is about a mile and a half above the city, on the Dee.

* An account of the Hydraulic Engineering Company's Works will be found on page 228, of the Sandycroft Foundry on page 261, of the Dee Oil Works on page 277, and of the Dee Lead Works on page 267 *ante*.

The water passes into a pipe 2 ft. in diameter, which is carried through the meadows, and ultimately discharges into a well that contains the suction branch of the pumps. The pumping engines are of the horizontal compound condensing type, and were made by the Hydraulic Engineering Company; they have cylinders 14 in. and 26 in. in diameter, and 36 in. stroke. There are two double-acting pumps, 16½ in. in diameter. Steam at 120 lb. pressure is supplied by a Crossland boiler, a second one being kept in reserve. There is a variable expansion valve on the high-pressure cylinder. The latter is steam-jacketted; the covers of the low-pressure cylinder are also jacketted. The pumps have india-rubber valves, and Wipperman and Lewis' patent automatic air injector is used in connection with the air vessels. The old beam engine originally used for pumping, is kept as a reserve. The boilers are fitted with McDougall's mechanical stoker, which appears to give great satisfaction, after a trial in practical work of between three and four years. A modification of the usual method of fitting this apparatus has been suggested by Mr. Dugdale, the chief engineer to the company, and is now carried out with very beneficial results: the hoppers are placed an inch or so from the boiler front, and through the space thus formed, air passes down, and is directed to the furnace by means of an iron plate; this has the double effect of heating the supply of air admitted above the grate bars, and keeping the hoppers cool. Only the slightest trace of smoke is said to have come from the chimney shafts of the company, and this is attributed to the mechanical stokers fitted in this way. If this be the case it is a pity that some of the neighbouring works do not adopt the same system.

The pumps we have described, raise the water a height of 75 ft., and discharge it into a subsiding reservoir which is placed on the higher ground a short distance away. From thence it flows by gravitation on to the filter beds, of which there are seven, a new one being now in course of construction. These are of the ordinary sand and gravel type, the depth of filtration being 8 ft. From the filters, which have a combined area of 5628 square yards, the water flows into a pure water tank, and from thence is pumped into an elevated wrought-iron tank of 268,000 gallons capacity, placed on a brick tower 72 ft. above ground level. This is sufficient to command the highest building in Chester.

The pumping machinery at the upper works consists of a pair of Messrs. Hathorn, Davey, and Co.'s differential pumping engines, the cylinders being horizontal and placed in line; they are 18 in. and 36 in. in diameter, and 5 ft. stroke. The pumps are double-acting, 26 in. in diameter, and 5 ft. stroke. The valves are of special construction, on a principle suggested for this purpose by Mr. Dugdale; an annular valve of india-rubber fits over a conical seating, in which holes are bored for the passage of the water. Originally double-beat valves were fitted, but these were fitted to be unsuitable.

With the arrangement at present in use, we understand that the pumps can be run at any required speed with perfect smoothness. The boilers for these engines are of the Lancashire type, and work at 60 lb. pressure; they are also fitted with the same type of mechanical stoker, the power for which is taken from the donkey pump. The latter is of novel construction, having four plungers placed radially round one circular valve box. The latter is divided into four parts by partitions, in each division there is a pair of valves; in this way each plunger has its own valves, but there is a common suction and delivery branch. The result is that a continuous stream is obtained without an air vessel, and the valves work very quietly; at 120 revolutions, and feeding against 60 lb. boiler pressure, this was very noticeable. The arrangement was got out by Mr. G. Crowe, one of the engineers of the company. There is also at this station a beam engine which is held in reserve.

The average daily supply of water is one and three-quarter million gallons, and the extent of mains in the streets about 35 miles. Inasmuch as the pumping work done at the upper and lower works is identical both as regards the volume of water pumped and the lift, an excellent opportunity is afforded of comparing the economy of working of the two sets of pumping machinery, the steam pressure at the lower works being double that at the upper. Last year the consumptions of coal were: At the lower works, 968 tons 2 cwt. 3 qrs.; and at the upper works, 1261 tons 7 cwt.

The Mostyn Iron Works.

These works are situated on the estuary of the Dee, about twenty-one miles from Chester, and adjacent to the Holyhead branch of the London and North-Western Railway. There are three furnaces, which were formerly used for the production of pig iron, but since the year 1880 they have been principally utilised for the production of spiegeleisen, and are now exclusively employed for this purpose. They are of the ordinary type, iron-plated, two of them being 65 ft. high from hearth to top, and 20 ft. in diameter at the boshes. The third is of the same description, and is 40 ft. high and 12 ft. in diameter. There are six coil tuyeres to each of the larger furnaces. The blowing engine is of the ordinary beam type, with Cornish valves. The steam cylinder is 40 in. in diameter and 7 ft. stroke. The blowing cylinder is 100 in. in diameter. At the back of the furnaces there are 15 cast-iron pipe blast-heating stoves, heated by the waste gases. For lifting the materials to the furnace platform, there is a steam hoist worked by a single-cylinder vertical engine. The distribution of steam in the cylinder is entirely non-automatic. It is effected by a three-way cock worked by a hand lever. The smaller furnace is charged from the platform of the larger ones by means of a shoot, through which the materials are passed. There is close by an ordinary calcining kiln for dephosphorising ore. The coke ovens are of the ordinary beehive type. There are two ranges, or 120 in all. The waste gases are conveyed by flues above, to heat a battery of egg-ended boilers.

The coal-washing machine is on Shepherd's patent principle. There are a pair of rollers which further crush the coal after being washed. The works are illuminated by electricity; there being a six-light Brush machine which has given very satisfactory results. Steam is plentiful on these works, as there is a good deal of waste heat.

Up to within a short time ago, a colliery attached to the works was worked by this company. Unfortunately this has become flooded within the last few weeks, and at the time of our visit the pumping engine was employed in attempting to reduce the water. The winding engine was also engaged upon the same work.

The Palmerston Slate Quarries.

These quarries are the property of the Welsh Slate Company, and are situated a short distance from Dinas terminus of the Festiniog Railway. They are of considerable extent, and when in full work give employment, we believe, to above 600 men. The slate as blasted out is brought in large blocks—sometimes to 4 or 5 tons weight—to the sheds, and here it is split up by hand, by means of hammer and chisel. The ease with which a practised workman will divide a huge block of slate into pieces of a manageable size, must be seen to be appreciated. He first makes a cut in the direction that may be described as across the grain, which is technically known as the Plerry or Plerau. He will then insert his chisel between the laminæ in plane with the cleavage, when the slab will break off at the place where the cross cut has been made. Pieces so obtained are sawn up into square slabs upon a table which feeds up automatically to a circular saw. There are 70 of these machines at the Palmerston works. The slabs are then split by hand through the cleavage, into plates of the proper thickness for roofing purposes, and are cut to the required shape, either by hand or by a machine. The latter consists simply of a couple of blades placed in a revolving frame, which, with a fixed knife, form a double pair of shears. There is a rack for gauging to the required size.

For preparing slabs up to 12 ft. in length, a planing machine is used. In this the table to which the slab is fastened, is caused to traverse beneath the cutting tool, which is fixed in an overhead beam. The tool is about 8 in. wide and has a chisel-shaped cutting edge. The depth of cut is regulated by a set screw. We believe about ¼ in. is usual for a roughing cut. We did not see the latter machines in use, as on the occasion of our visit the works were not going, in accordance with a monthly custom obtaining in these parts.

Trade Marks in Russia.—The Russian Customs Department have issued an order, dated 3rd September, 1884, that goods bearing trade marks with effigies of the Holy Virgin, St. George, or other saints, will not be admitted into the Russian empire.

HORIZONTAL ENGINE WITH CRAIG AND MOTION'S VALVE GEAR.

We give this week on pages 312 and 313, engravings of a horizontal engine recently constructed by Messrs. A. F. Craig and Co., of Paisley, for the works of Messrs. J. P. Coats, thread manufacturers of that city. A special feature in the engine consists in the arrangement of the valves and valve gear—an arrangement which has been patented by Messrs Craig and Motion. In addition to the illustrations already mentioned, we give a perspective view of this valve gear on page 309.

The engine illustrated has a 25-in. cylinder with a 48 in. stroke, and it is run at 60 revolutions per minute. The general design of the framing is neat and substantial. Referring to the detail views Figs. 5, 6, and 7 on page 313, it will be seen that the cylinder is provided with very short direct steam passages and that the valves are all flat grids, there being two steam and two exhaust valves, actuated independently. The positions of the valves relatively to the cylinder and each other will be quite clear on an examination of Figs. 5 and 7, while the general views on page 312, the enlarged view of governor and its attachments in Fig. 4, on page 313, and the perspective view on page 309, explain the arrangement of gear by which the valves are actuated.

Referring to these views, it will be seen that the exhaust valves, which have constant travel, are actuated *direct by eccentrics fixed on a shaft which runs parallel* with the centre line of the engine, and is driven from the crankshaft by mitre gear. The steam admission valves are also driven by eccentrics on the same shaft, but are operated through the intervention of trip gear which is under the control of a high-speed governor. The arrangement of the trip motion is probably best explained by the diagram Fig 8, on page 313. From this view it will be seen that the upper end of each steam valve eccentric rod *a* has formed on it a catch or notch, which, as the rod rises, engages the lower end of a part *b*, which is jointed to one end of the valve lever *c*. A spring *d* surrounding a rod *e*, which is jointed to the upper end of the eccentric rod *a*, tends to keep the catch on the latter always engaged with the lower end of the part *b*.

Jointed to *b* is a small bell-crank lever *f*, the horizontal arm of which is coupled by the rod *g* to the governor. Let us now suppose that the eccentric rod *a* to be rising. As it does so the notch acting upon the part *b* lifts the latter and with it the valve lever *c*, thus opening the admission valve. This goes on until by the rising of *b* the bell-crank *f* is caused to partially rotate, its vertical arm then thrusting against the upper end of the eccentric rod *a*, and eventually causing it to disengage from the part *b*, this part then falling and allowing the valve to close and cut off the steam. It is evident that the point in the stroke of the engine at which the closure of the steam admission valve occurs, depends upon the position of the horizontal arm of the bell-crank *f*, and this again is controlled by the governor acting through the rod *g*.

This arrangement of trip gear is very simple, and we understand that it works smoothly and silently, giving good control under variable loads and cutting off the steam entirely when necessary. We have received some indicator diagrams from the engine illustrated showing an excellent action of the valves. The difference between the initial pressure in the cylinder and the boiler pressure is very small. Our illustrations show the governor provided with dashpots, but in practice these are found unnecessary, the governor being quite steady without them, it having very light work to do. The closing of the admission valves is cushioned by dashpots connected to the valve lever behind the valve spindles. These dashpots are open to the atmosphere on the top side of the pistons while the air admission to the underside takes place simply through one or two small holes. This arrangement has given no trouble.

Messrs A. F. Craig and Co. are, we understand, now applying the arrangement of valves and valve gear we have described to a pair of compound intermediate receiver inverted engines which they are making to indicate 400 horse-power. These engines are being built by Messrs. Craig to drive a large paper mill, and we hope later on to have more to say about them.

Bona and Tunis Railway.—The inauguration of this line has been postponed. The postponement is attributed to quarantine difficulties.

Lectures on Valve Gear.—The classes in the Department of Applied Science and Technology, of University College, London, reassemble again to day (Friday), and we notice that during the ensuing term a course of ten lectures on valve gear will be delivered by Professor Alex. B. W. Kennedy. The lectures will take place every Tuesday at 6 p.m. (commencing next Tuesday), and the first will be open to the public. We understand that the course has been specially arranged to be of service to practical men, and we have no doubt that in Professor Kennedy's hands the subject—on which much enlightenment is desirable in many quarters—will be clearly and exhaustively dealt with. The engineering laboratory at University College also opens next week.

THE MANUFACTURE OF OPEN-HEARTH STEEL.

*On Recent Improvements in the Method of the Manufacture of Open Hearth Steel.**

By Mr James Riley, Glasgow

Early in the year 1875, in a report I then prepared with reference to Siemens Steel Works, I made the following remarks: "I am desirous of stating what I hold necessary to be done in order to keep abreast with the Bessemer steel makers in this and other countries. I am convinced that, with existing arrangements and appliances, very little, if any, further economy in manufacture can be accomplished, and I am doubtful if we are not even now beaten by other manufacturers, with the certainty that this will be the case when the improvements now being gradually adopted by the Bessemer manufacturers are more fully and perfectly realised Feeling this, I take it to be a matter of life or death to the company that many and extensive alterations should be at once adopted; and I have given much anxious thought to the question of what should be done in this serious emergency"

At that time nearly the whole of the steel made by the Siemens process was used in the making of rails, and I undertook that if my proposals were adopted I would reduce the then cost of rails by about 1*l* per ton Unfortunately this could not be done, and we had a lingering, miserable existence until the introduction of ferro manganese by our French friends enabled us to turn our attention to the production of special classes of steel—first plates, angles, &c, for use in ship, bridge, and boiler construction, and next material to be used in substitution of the best charcoal iron, then solely used in the manufacture of the finest qualities of tin plates I need not refer at this time to all the many and varied obstacles with which we had to contend in introducing what used to be called the "new material, many of them have been more or less made known to you in the past years Suffice it to say that the enormous growth of the consumption of "mild steel for these and other purposes enabled the makers of Siemens steel to abandon the unprofitable manufacture of rails for the remunerative one of which I have just spoken, but earlier in our history there was no other outlet for our steel.

At that time each furnace had a large staff of highly paid men to work it, and yet it was considered very good work indeed when 50 tons of ingots were made in one week even at the newer and larger furnaces The total cost of labour in the melting shop (including the labour at the gas producing works) was not less than 14s per ton on the ingots made. My desire was to largely reduce this excessive cost of labour, as well as the cost of repairs, the consumption of fuel, and the standing charges, and I expected to accomplish my purpose by remodelling the shop and other arrangements for working, by largely increasing the capacity of the melting furnace, and consequently, it was hoped, its productive power As I have said, circumstances, did not then admit of the proposed changes being carried into effect, but in the following years some of these proposals were carried out (both by myself and others) and my expectations were more than realised With a modern 12 ton Siemens furnace, "good work" requires that 140 tons to 150 tons of ingots shall be made weekly per furnace, while in some "special cases the make has reached 200 tons of ingots in one week from one furnace.

It is perhaps superfluous for me to add that the result of all this was that, on the whole, the makers of Siemens steel had for a time a fairly remunerative business

Recently, however, the demand for these products has been more than equalled by the largely increased and increasing powers of production, and the competition for the business offering has been so keen that the margin of profit, becoming gradually narrowed during the last two or three years, has now almost, if not entirely, disappeared

At our last meeting in London, in the course of discussion on a kindred topic, we were told that if "skill and brains were brought to bear on our operations, the cost of making steel plates, &c, could be so reduced that we should, by selling more cheaply, create such an increased demand that all our works would be kept fully constantly, and, it might be, profitably employed

That our brains have been sorely exercised during the last anxious year or two "goes without saying, but it is not for me to say whether the needful "skill has been exercised as well

ence by the great demand for "mild steel." I would now direct your attention to the more recent efforts in the direction of improvements in which I have been anxiously engaged

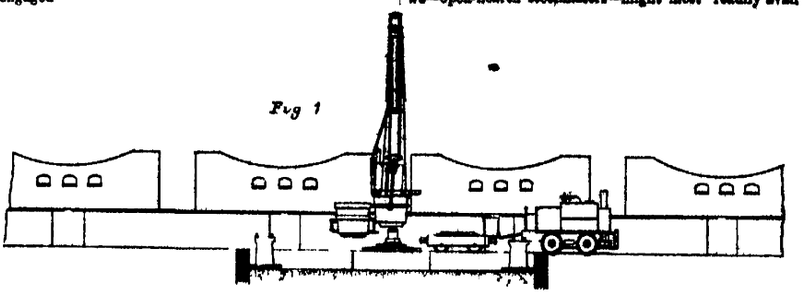


Fig 1

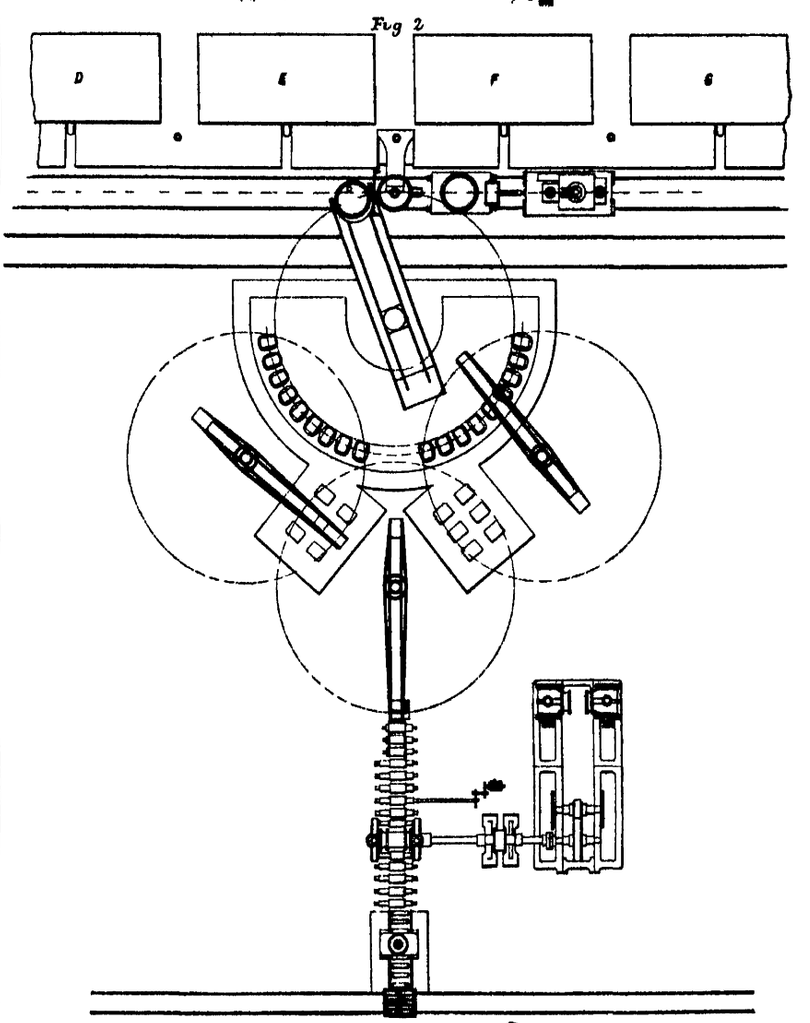


Fig 2

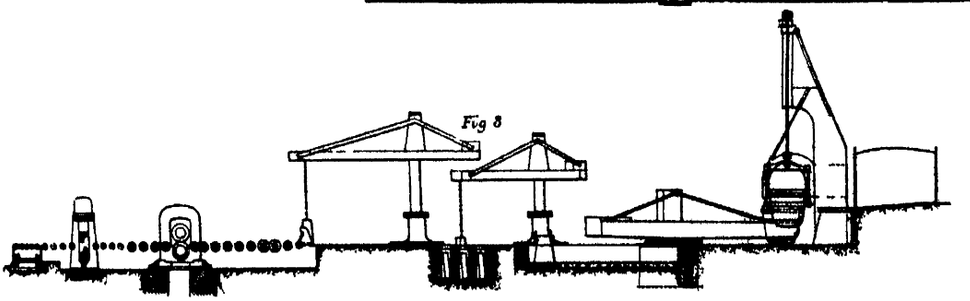


Fig 3

I have already referred in brief terms to the improvements made by ourselves at our Newton Works, and by others in the erection of the newer works called into exist

The remodelling of the Blochairn Works, after they were acquired by the Steel Company of Scotland, gave us the opportunity of embodying in our newer practice the results of our previous experience at Newton, more especially in the melting department which had to be created. My first plans were for a shop with twenty 12-ton furnaces, afterwards modified to twelve 15-ton furnaces. I had for some time been extremely anxious to try the "Pernot" furnace, in which I thought I recognised the means by which we—open-hearth steelmakers—might most readily avail ourselves of the basic process, then exciting so much attention, and causing some of us so much anxiety Now the opportunity offered, and the first furnaces erected were two 20-ton Pernot's. These were hurried on as quickly as possible, so that by the results obtained from them I might be guided in deciding what type of furnace

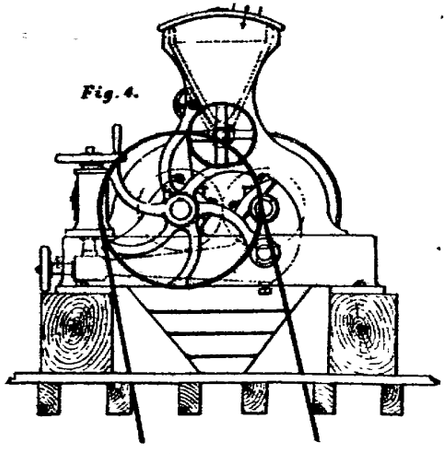
* Paper read at the Chester meeting of the Iron and Steel Institute

THE ALBERT BRIDGE FLOUR MILLS: MESSRS. MARRIAGE, NEAVE, AND CO.

MR. FREDERIC BATH, ARCHITECT, LONDON AND SALISBURY.

(*For Description, see Page* 319)

Fig. 4.



ROLLER MILL.

Fig. 5.

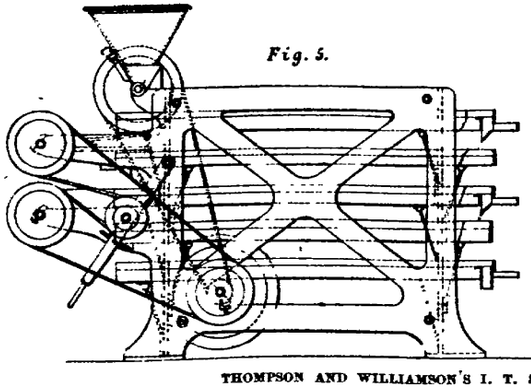
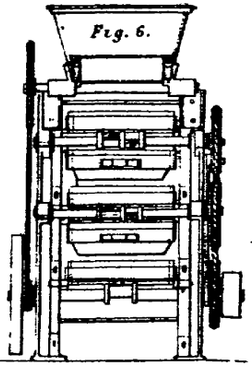
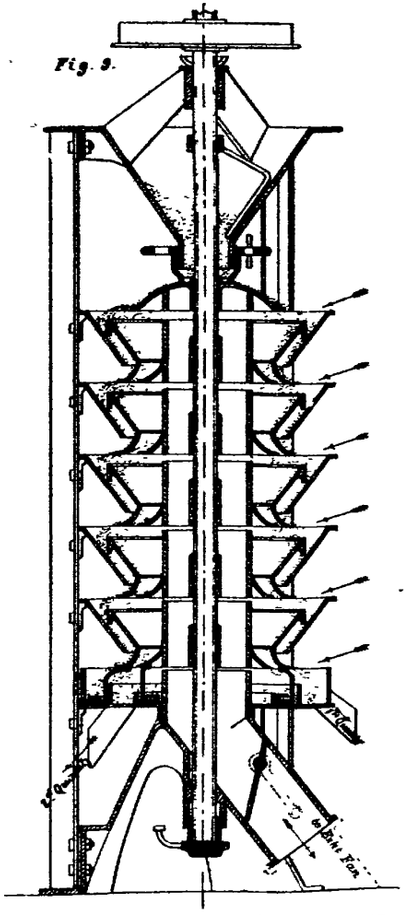


Fig. 6.



THOMPSON AND WILLIAMSON'S I. T. SIZER.

Fig. 9.



THOMPSON AND WILLIAMSON'S CENTRIFUGAL PURIFYING MACHINE.

Fig. 7.

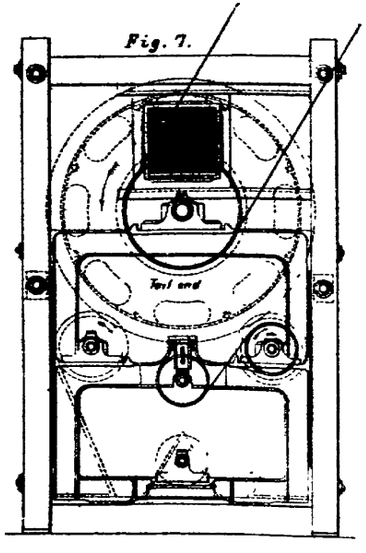
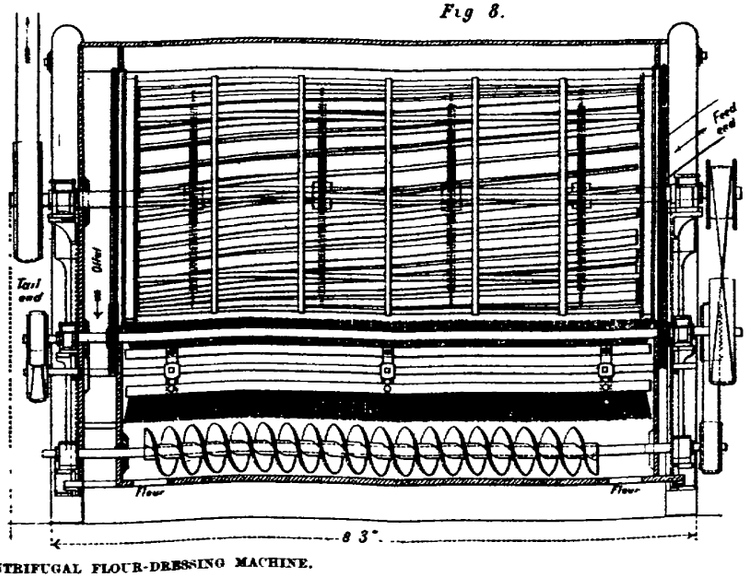


Fig 8.



SUTCLIFFE'S CENTRIFUGAL FLOUR-DRESSING MACHINE.

should be adopted for the whole shop. They were fine furnaces, admirably designed and constructed, as we had the advantage of some drawings given me by our lamented friend Mr. Holley. The mechanical arrangements were perfect, but the results were not satisfactory. I have never felt satisfied with the results of those trials, but in our then circumstances I was compelled to stop them after three months' trial, and we proceeded to erect, as rapidly as possible, Siemens furnaces, as perfect in every respect as we could make them.

Perhaps, as I am now speaking of furnaces, it will be most convenient for me to state that in 1880 we made experiments, extending over some weeks, with a Siemens furnace lined with basic material, under the personal superintendence of Messrs. Thomas and Gilchrist. We had to abandon the process principally on account of the difficulties and troubles caused by the fluxing of the lining at the lines of division of the basic and acid material, in spite of every precaution then possible to us.

I may also state that for some months past we have had at work furnaces of the type known as the "Batho" furnace, and although time is required for the realisation of all the economies promised by the inventors, yet we have been so satisfied with their suitability to our circumstances that my directors have arranged for a few more to take the places of the older Siemens furnaces which now require to be renewed.

In this connection I may also be allowed to call attention to a valuable modification of the Siemens furnace, known to us as the "Hackney" port. So satisfied are we of the advantages derived from its use that this modification will be made at all our melting furnaces as they are stopped for repairs.

I need not make any special reference to another type of furnace which we have had in use for some months, as it is to form the subject of a special paper by Mr. Dick.

As I have already indicated, we erected at Blochairn a row of twelve 15-ton furnaces; the ingots were cast in one long pit, parallel to, and close in front of, the furnaces, the tops of the ingots being level with the general

floor, so that bogies or wagons could be rapidly passed to other departments. The charging floor was, of course, at a higher elevation, approached by a slight incline at one end of the shop.

We had so fully realised at Newton the serious disadvantage and loss due to the relative positions of the hammers and mills and the melting shop, that we were constantly devising schemes to obviate them.

At Blochairn I made these relative positions such as would, I hoped, enable us to transfer the ingots from the casting pits to the hammers at a temperature that would perhaps allow us to dispense with reheating, or at all events to reduce this reheating to a minimum. My hopes were not fulfilled. When we tried to hammer the ingot with only its initial heat, we either found the centre too soft (and it would spurt out when struck by the hammer), or, on the other hand, the outside was so cold and hard that it cracked, and the slab could only be rolled into a defective plate.

With regard to the charging of the ingots hot into the reheating furnace, my purpose was to a large extent frustrated by what may seem a trivial cause, but yet one which, in reality, was very difficult to deal with.

The twelve melting furnaces were so many independent centres of operation. The men came in on Sunday night and charged their furnaces all at the same time, with about the same weight of charge, and as a matter of course all of them were ready for tapping about the same time on the Monday morning, and all through the succeeding week, except in so far as this was affected by the slight variations in the speed at which the furnaces were working. Thus we would have the whole of the furnaces cast within a short time of each other, and a crowding of ingots to the reheating furnaces; then a long pause of twelve or fourteen hours, followed by another rush of casting. During the pause, the ingots were, of course, getting cold, and as they were mostly of large size, this was a serious matter, not alone on account of the cost of reheating them, but because of the cracks which were set up both in the course of cooling and reheating.

It is obvious that the cure for all this was to make the furnaces charge and cast in succession; but there were many reasons why this could not be done at that time; into these I need not now enter.

I have said that we were incessantly at work on this matter of preventing the ingots getting cold, especially at Newton, where we suffered more than at Blochairn. At last I devised and experimented with what I may term a movable set of soaking pits for conveying the ingots to the hammers shortly after they were cast. By this means was able to accomplish the hammering of the ingots into labs without reheating. Subsequently, however, my directors authorised me to arrange with Mr. Gjers for the use of his patent soaking pits, and the outcome of this decision has been the practical remodelling of all our working arrangements, which I will presently describe.

Our first intention was to put the soaking pits down in convenient relation to the hammers at one end of the melting shop, but further consideration led me to determine against this course. For two years or so previously we had been cogging part of the slabs for plates as a matter of necessity, as we had not sufficient hammer power at Blochairn to meet all demands. We had found the plates made from cogged slabs equal to those made from hammered slabs, and with proper mechanical arrangements we saw that we could make the former at a somewhat less cost than the latter, especially in the case of very heavy slabs. Further, on many occasions I had had serious difficulties with the hammermen. Now, having arrived at a crisis, I determined, as far as possible, to substitute cogging for hammering.

The most convenient position for the proposed new cogging mill and soaking pits seemed to be about the centre of the line of melting furnaces, where, fortunately, there was an available engine of about sufficient power to work the mill. When, however, we came to consider the mode of working, I saw that the crucial point was the delivering of the ingots to the soaking pits in something like regular succession, and I was again brought face to face with the old difficulty regarding the casting of the furnaces, as well as with the difficulty of conveying the ingots from the casting to the soaking pits. We gave a great deal of thought to this matter, and I had some conversation thereon with Mr Gjers. At last it was decided that it would be better to make one central casting pit for all the furnaces, with the object of compelling successions of casting, and of avoiding the necessity for carrying the ingots. This decision also enabled me to accomplish another long desired end, which was to obtain the advantage due to agitating the steel. Failing Mr. Allen's "agitator," which we could not conveniently use in our works, I saw the possibility of adopting the method of pouring from one ladle to another, which had been so successfully inaugurated by Mr. Gjers at Darlington, and this was kept in view as a principal object of the changes and alterations contemplated.

My directors having authorised the carrying out of these proposed changes at both the Newton and the Blochairn Works, and those at the latter (which were not so extensive and difficult as those at Newton) having been about completed, I have now pleasure in directing your attention to the diagrams (see page 316) which show our new arrangements, and of which Fig. 1 is a transverse section or side elevation, Fig. 2 a plan, and Fig. 3 a longitudinal section or elevation of the melting shop at the Blochairn Works.

The twelve melting furnaces are designated by the letters A to M inclusive; the M furnace is sufficiently large to hold a charge of 25 tons, all the rest are known as 15-ton furnaces. In front of and parallel to the furnaces are lines of railway, of which the nearest runs over the old casting pit, which has been filled up except at a few points where it has been left open as provision for casting in the case of any accident to the machinery in the new arrangements. On this railway runs a small locomotive, which moves from point to point in front of the furnaces, a special carriage conveying a ladle for the steel and a mould for the slag.

A specially-designed hydraulic lift of 20 tons power is erected between the furnaces E and F and directly over the railway just referred to.

Directly in front of this lift is a 20-ton casting crane of ordinary type, except that it is not made to lift. It is, however, provided with hydraulic engines for turning it on its axis, and also carries on one side a small cylinder and ram for turning over the casting ladle after each cast, so that any slag or skull may be easily cleared out and the nozzle pot may be readily changed. This crane is placed in the centre of a semicircular casting pit 40 ft. in diameter and about 3 ft. deep.

At convenient points round the casting pit are erected three ingot cranes, each capable of lifting five tons, in two powers of three tons and two tons each. Between the cranes are two sets of soaking pits, each with six cells of differing capacity for ingots of 30 cwt. or 60 cwt. each.

The two outer cranes set the moulds in the pit ready for casting, and afterwards strip the ingots and deposit them in the soaking pits.

The centre crane lifts the ingots from the soaking pits and places them vertically on the tipping carriage at the end of the feed rollers of the cogging mill. A hydraulic cylinder and ram are placed convenient to this tipping arrangement. The ram, taking hold of an arm of the carriage, turns it down, so that the ingot is deposited easily and without shock on the feed-rollers of the mill.

The cogging mill has hollow steel rolls, with 32 in. centres, and having edging grooves at each end, the top roll being balanced by hydraulic power in cylinders placed under the bedplate, and having a lift of 14 in.

Instead of turning the screws in the ordinary manner, the boxes are made to revolve, motion being communicated from a small Willans engine through a shaft carried on the top of the housings, and having two worms taking into wormwheels fixed on the screw boxes.

Between the feed-rollers of the mill are arms designed for handling the ingot, which is turned by them on flat or edge and placed in front of the grooves as may be desired, the arms being actuated by hydraulic cylinders placed under the feed rollers.

This mill is in charge of and operated by one man, assisted by two boys, one of whom works the screwing gear at the rolls, and the other the turning and the feeding gear.

The mill is driven by an engine with two cylinders, 36 in. in diameter and 4 ft. stroke, and is geared 2½ to 1. The steam pressure is 90 lb., cut off at three quarters stroke. The rolls make 28 revolutions per minute, and have a periphery speed of about 180 ft per minute.

A set of hydraulic shears is in course of construction, having a working pressure of 1000 tons, and calculated to shear slabs 24 in. by 8 in. in section. These will be placed behind the mill and will have feed-rollers, which will receive the slab from the mill and pass it on and through the shears to carriages, which convey the slabs to the reheating furnaces of the plate mills.

Having thus described the apparatus, may I now describe the *modus operandi*?

The melting furnaces are charged in rapid succession on the Sunday night, and on one coming ready for tapping (about twelve hours later), the locomotive places the carriage and ladle in front of the furnace, the charge is tapped into the ladle, the whole of the steel and slag being run into it, while the latter overflows into the slag mould on the carriage.

By this means we save the steel which ordinarily is found at the bottom of the slags in the pool in front of the furnace, and we have the slag in such a form, and so free from steel, that it is easily disposed of without the necessity of being broken up.

Being brought under the lift, the ladle is raised until certain brackets or horns, placed on each side of its pouring lip, come in contact with brackets, attached to the lift, and so placed that they keep the pouring lip of the ladle in the same horizontal plane until all its contents are discharged into the second or casting ladle, which is easily brought about by continuing the lifting of the ladle after the pouring lip has become stationary in the brackets. The casting crane having received into its ladle the whole contents of the first ladle, is now moved round over the moulds in the casting pit, into which the charge is cast in the ordinary manner.

The time occupied by the operations of tapping the furnace, transferring the steel to the second ladle, and casting into moulds, is fourteen to fifteen minutes, a shorter time than is required by the old method.

You will have noticed that this arrangement for transferring the steel obviated the necessity for a lifting casting crane.

This transferring of the steel was a source of great anxiety to us all. It was known to us that some method of transferring had been tried elsewhere, and had been found impracticable. We also knew that the temperature of Siemens steel is much lower at the time of tapping than is that of Bessemer steel, and it was feared that the charge might be so chilled in the operation that it could not be cast through the nozzle of the second ladle, or that, if this were done at all, a heavy skull would be left in the ladle. Neither of these evil results has been experienced, the fact being that we have less skull now than we had under the old practice. The men know that if they cast their charge short of heat this will inevitably be discovered, and they will suffer; and the ladles, being constantly employed, are kept hotter, so that the first steel poured into the second ladle is very hot, and is not chilled when it falls on the bottom. After standing about 20 minutes from casting, the moulds are stripped and the ingots placed in the soaking pits, where they remain about 55 minutes, being then passed through the cogging mill and reduced to the required section, after which they are sheared to the specified weight and passed on to be reheated and rolled into plates.

It may be said, therefore, that the slab is finished in 95 minutes—14 or 15 minutes for tapping and casting, 20 minutes in the moulds, 55 minutes in the soaking pits, and 5 minutes in cogging and shearing.

The advantages of the new casting arrangements are very considerable. The whole operation is much more under control, and is more methodically carried out; less plant is required in ladles, carriages, travelling cranes, and moulds; the cost in labour is much reduced; the shop is freed from débris, and is cleaner and pleasanter to work in. The advantages of the other portions of the arrangements—the soaking pits and cogging mill—are great in every way. The cost of labour is largely reduced, that of fuel is saved altogether; the loss of steel by reheating is reduced from say 2½ per cent. to almost *nil*, our returns showing this loss in the soaking pits to be only 0.02 per cent., and, in addition, the indirect economies by reason of improved quality of slabs, less defective plates, &c., are more important than you would credit if I were to venture to state them.

Besides this, the comfort and orderliness with which the work can be done is largely increased, and is appreciated by the workmen themselves.

Of the machinery I may state that the cogging mill and gear were made at our own works. The large hydraulic shears are now approaching completion in the hands of Messrs. Tannet, Walker, and Co., who also made the casting and ingot cranes.

I believe I am correct in stating that the latter are the finest and most complete cranes which have yet been made, either by that or any other firm. They have a range of 40 ft. in diameter, and are supplied with hydraulic turning and racking gear, most admirably designed, and I am glad to say that on the whole they have proved satisfactory in operation. The ladle lift was supplied by Messrs. Fielding and Platt, of Gloucester, and is a capital job.

In conclusion, I have only to say that I desire to acknowledge the hearty co-operation and assistance I have constantly received from Mr Dick (the manager of Blochairn Works) in the course of the extensive and important changes which I have briefly attempted to describe, as well as from Mr. Packer the manager, and Mr. Swaine the engineer, of the Newton Works, in the similar operations now in progress at the latter works.

Bridge Building in Bohemia.—An old iron bridge has just been replaced by one of later construction on the North Bohemian Railway, near Kuttenthal. At the point in question the line crosses a ravine, 98 ft. deep. The span of the bridge was 131 ft. 2 in.; the weight of the truss 80 tons. The method of reconstruction adopted was to erect each bridge span upon rollers, and then, by means of a locomotive, to pull it above the place it was to occupy on the top of the old bridge. The span was then raised by hydraulic jacks and the rollers removed. As soon as the old bridge was removed the new truss was lowered a distance of 15 ft. to its final bearing upon the piers. Trains were stopped during the operation of substituting the new truss, but the total period of stoppage was less than forty-eight hours.

Railway Brakes.—Colonel Rich has just reported on a collision that occurred on July 26 at Wigan Station, on the London and North-Western Railway by which three persons were injured. After reviewing the circumstances of the case and the evidence of several guards and engine-drivers, Colonel Rich proceeds: "I would strongly recommend the London and North-Western Railway Company to adopt one of the automatic continuous air brakes. The company considered the sectional patent chain brake a very good one some years since, when all other unprejudiced persons, who were qualified to judge of such matters, considered it a very faulty mechanical contrivance, and in no way suited to the requirements of the day; and it does not fulfil the Board of Trade requirements. I am informed, that the London and North-Western Railway Company, are now adopting for their main line trains, a collection of several kinds of patent brakes, among which is the Smith's plain vacuum, with an automatic arrangement on the last brake coach, by which the chain brake is brought into action. The railway inspecting officers of the Board of Trade were asked by the company's locomotive superintendent to inspect this arrangement about two years since, when it was applied to the Irish Mail. All the inspecting officers disapproved of it, after inspection and consideration. I understand that the London and North-Western Railway Company, propose to continue the use of the chain brake, on their local and branch trains. I would suggest to the directors the desirability of giving this matter their consideration. The liability they are incurring by using an inferior kind of brake, which does not comply with the requirements of the Board of Trade, and the outlay that the company are incurring by fitting their stock with brakes which cannot be approved, and which must sooner or later be again changed, are serious. The company should be warned, by the slight collisions that have occurred on the railway with the brake now used, all of which have cost money, and many of which would have been prevented by the proper use of a good, continuous, automatic brake. The automatic air brakes have now been successfully used for several years by many of the large railway companies in the United Kingdom. They meet the requirements of the Board of Trade. If the special train had been fitted with a good automatic continuous brake, this collision would not have occurred."

THE ALBERT BRIDGE FLOUR MILLS.

In our issue of September 19th we published on a two-page plate sections of the Albert Bridge Flour Mills, Battersea, and we now give a third section together with separate views of some of the machines. These mills, which have lately been built by Messrs. Marriage, Neave, and Co., were planned and arranged by Mr. W. H. Williamson, of the firm of Thompson and Williamson, milling engineers, Wakefield, who supplied the whole of the machinery; the architectural portion of the work is from the designs of Mr. Fred. Bath, of London and Salisbury, who superintended the erection of the building. These mills have been started with the avowed object of competing in the London market with Vienna and American flour, and the proprietors have spared no expense to render them as perfect as possible in every respect. The building is situated on a most convenient site on the south bank of the Thames between the Albert and the old Battersea bridges, with a long return frontage on the dock lately opened by Mr. Allen Ransome. Large coasting steamers, sailing barges, and indeed any sort of craft that can pass the bridges can enter the dock and lie in deep water under the hoists, to discharge or to receive cargo.

The building is divided into three independent portions by fireproof walls; these are the granary, the wheat-cleaning house, and the mill. The two former are shown in the large engraving on the following page, and the latter are illustrated by two parallel longitudinal sections in our issue of September 19. One of those sections shows the rows of machines standing next to the wall, and the other the rows next to the centre of the rooms, the mill being designed to admit six rows in all, three on each side of the centre line. The clearest way to describe the process of gradual reduction devised by Mr. Williamson, will be to follow the wheat through the building, explaining the various operations to which it is subject, from its entrance, until it leaves in the form of flour. The grain is lifted from the barge by a hoist, and delivered on the first floor, from whence it is sent down the delivery shoot into the basement, to have the free dust and dirt with which it is mixed, removed by two Barnard and Lea separators, which together are capable of dealing with 150 quarters an hour. This process effects a rough separation, and renders the subsequent operations of mixing more healthy for the men, while it also keeps the stored grain in better condition. The wheat is next raised by two elevators to the top of the building, and is delivered into vertical distributing shoots which open into the various wheat garners on the floors below. There are fourteen of these distributing shoots, and each is divided by partitions into four compartments, corresponding to, and opening into, the four floors below. Each compartment is provided with a valve at the top, and thus the man in charge of the elevators can direct the stream of wheat into any one of the 56 garners below him, without descending from the upper story. The same shoots serve to draw off the wheat from the garners, and to deliver it to the ground floor, where it is mixed in the required proportions, and raised again by the elevators, to be shot into the mixed wheat bins adjoining the walls of the wheat-cleaning house.

These bins communicate with the adjoining building by iron slides in the dividing wall, and their contents run into an elevator which carries them again to the top of the house from whence they descend through each cleaning machine in succession, these being placed as shown in the engraving, one below the other on the various floors. The first is an Eureka zig-zag separator; this removes barley, oats, and other matters foreign to the wheat, which then passes over a pair of powerful Stopes' magnets. These arrest all the nails, pieces of wire, and other fragments of iron and steel, which, if they remained, might damage the grinding machinery. Mather's decorticator is the next machine, and consists of three grindstones upon the same spindle, each working in a separate trough. The wheat is fed into the first trough, and works its way in succession through all three, being subjected on the way to a powerful scrubbing or grinding action which rubs off the beard and all the loose dirt. It then goes to the Eureka smutter, or if it be really clean wheat it it may go to the smutter first, missing the decorticator. Here it suffers a second scrubbing, not so severe as the preceding, and then it is delivered to a powerful Victor Brush machine, where it is passed in succession between four sets of fixed and revolving brushes, arranged on a central spindle, and then the cleaning is complete, except that a small quantity of cockle seed remains to be extracted. If the wheat berry were a round plump body like an egg, the cleansing processes would not need to be so numerous or so searching as these are, but it must be remembered that it has a crease which forms an excellent receptacle for dirt, along one side, and it has a beard at one end which likewise harbours dust. The first must be brushed out, and the latter scrubbed off, before the grain is fit to be ground, for since one of the tests of flour is whiteness, it follows that every particle of dust that is mixed with it takes off a certain proportion of its value.

The cleaned wheat is then lifted by an elevator and delivered to one of the bins next the wall of the mill. These bins hold from 40 to 50 tons each, and are of the same capacity as those for the mixed wheat. The grain is drawn from each of these bins by iron sluices in the fireproof wall between the buildings, and is delivered to an elevator which feeds it over a set of magnets to an automatic grain weigher which registers every 50 lb. entering it. By means of this instrument the miller can tell at what speed the grain is passing through his machinery. The wheat next goes to a Penney grader on the first floor, where it is divided into three qualities by the size of the berries, and is then passed to the cockle cylinders where the few remaining foreign seeds are removed. The grain is then ready for the grinding or rolling process, the two smaller sizes going to one mill, and the larger to another.

By reference to our former two-page plate it will be seen that the roller mills are arranged six in a row. The first two, starting from the left hand, of the row next the wall, take the two products from the grader, and the remaining four form four successive breaks, there being thus five breaks in all. In addition to this there is a pair of smooth rolls to flatten out the bran. It may be well to explain for the benefit of those of our readers who are not familiar with the art of milling, that the object of these breaks is not to make flour, but to divide the grain into bran and broken wheat kernel, known as semolina and dunst. A certain amount of flour is unavoidably made in the breaking process, but it is kept as small as possible. The semolina is ground into dunst, and the dunst into flour in the smooth mills of the second row.

The rolls (Fig. 4, page 317) for the breaking operations are of the hardest chilled iron and are corrugated Those of the first two breaks lead on with the back edge of the groove, and the subsequent breaks with the sharp edge. Mr. Williamson also prefers that rolls of the earlier breaks should have straight corrugations, and those of the latter ones should be spirally grooved, and should have a greater differential speed than those which precede them. The first set split the grain along the crease, the next set break each half into two or three pieces, the next carry the division still further, and so on, until at last there is nothing in the mill but bran and dunst. Between the breaks the grain is subjected to two processes. The small quantity of flour which has been made is removed, and the broken particles are assorted according to their sizes. Thus the first breakings are elevated to No. 1 scalping reel, which is a rotating cylinder clothed with plated wire gauze. The flour goes through the meshes, and the semolina and broken wheat is delivered on to the sizing machine (Figs. 5 and 6) on the floor below. This has five reciprocating screens, sloping alternately in opposite directions. The crude product is delivered to the first, and the semolina falls through it, and is led into the head of the second screen, where the largest size of semolina is separated, and so on throughout the series of five sieves in each machine, the broken wheat falling over the tail of the top sieve, which descends to the second break rolls on the ground floor, being known as the first shreading. The broken wheat carries with it some loose bran, which is removed by aspiration as it falls through the hopper of the roller mill.

This process is repeated at every break. Each time the loose flour is removed and the remainder of the product is divided, according to size, into five qualities, the largest running down to the next mill. The final delivery is bran, which is cleaned in a bran duster on the upper floor, above the scalpers, and is fed into sacks ready for sale. The material which passes through the sieves is semolina of varying degrees of fineness according to the size of the mesh; similar sizes from different machines being mixed together ready for the next process, which is carried out on centrifugal purifiers. These (Fig. 9) each consist of a hopper with an adjustable orifice through which the semolina flows in a thin sheet over a convex disc mounted on a vertical rotating shaft. The particles are carried round as they slide over the disc, and fall from its edge tangentially, the heavier being carried by the greater centrifugal force to a greater distance, and falling into the outer hopper, while the lighter drop into the inner one. As all the particles are of the same size, having been separated by sieves of the same mesh, it follows that the centrifugal purifier divides them according to their specific gravities, the heavier being the better quality and being used for the best varieties of flour. The inner hopper is in rotation, and again throws out the semolina, the selection being repeated five times in all. At the same time an inward current of air, as indicated in the figure by the arrows, carries all the particles of cerealin into the central trunk and away to the dust room. From the purifier the different semolinas are led to smooth rolls, with light pressure, to free any adherent bran.

The resultant flour is dusted out, and the finer semolinas thus produced, together with the finer varieties obtained in the breaking process, and gathered from the scalping reels, are then freed from flour, and passed on to other sizing machines to be re-sized, each product being separately purified on centrifugal purifiers, as already explained. The heaviest of these is reduced on smooth rolls, and is dressed in Sutcliffe's centrifugal dressing machines (Figs. 7 and 8) producing the "patent flour." The next heaviest is made into "bakers' flour," while the third quality, with the soft tailings of previous dressings, is again dusted and sized on a separate sizer and special purifiers, and is rolled and dressed to produce flour of lower qualities. The flour is delivered into bins on the second floor, immediately over the Eureka flour packers, by which it is automatically weighed into sacks.

The boiler house adjoins the granary and also fronts the dock; provision is made for the three boilers in all. The boiler, which is of the Galloway type, is fed by Vicar's patent mechanical stoker, and has Livet's system of boiler setting. The chimney shaft is inclosed within a tower, and a spiral staircase winding round it, communicates with each floor. The tower is surmounted by a water tank in which is kept a constant supply of water, and connected with this Messrs. Beck and Co., of Southwark, have fitted fire hydrants and lengths of hose on every landing within the tower, which in case of fire enables every portion of the premises to be reached by fire hose, whilst the tower itself is a fire escape from all portions of the premises.

The engine is of the tandem compound-condensing type, capable of 280 indicated horse-power. It was built by Messrs. Pollitt and Wigzell, of Sowerby Bridge, and the power is transmitted by means of square leather ropes from the rim of the flywheel. This is a novelty in main driving which is being introduced by Mr. Williamson At present five ropes 1½ in. square transmit the whole power required for granary, wheat cleaning, and the mill; each of the two former departments can be disconnected from the mill by clutches From the foregoing it will have been seen that the operations of the mill are confined as far as possible to separate floors.

In the basement are the main driving shafts; over the ground floor are the roller mills arranged in symmetrical order, fourteen in all, six of which are grooved and for breaking purposes. On the first floor the products from the purifiers, the cockle machine and the breakings can all be handled, and the finished flours are here taken off by the packers, and can be examined separately. Two powerful exhaust fans for working the purifiers and the aspirators on the rolls, are in this room with wind trunk connections. On the second floor arranged in symmetrical order, are nineteen of the manifold I. T. purifiers and the three bins for the three qualities of flour made. On the third floor are seven I. T. sizing machines disposed for convenience of access and removal of the sieves. On this floor three mixers are provided for blending flours, as also a bran packer (the offals being packed in the upper floors and separate and distinct from the flours). On the fourth floor are the four hexagonal scalping reels for the breaks with a centrifugal for the fifth break, here are also five Sutcliffe centrifugals for dressing the various sorts of flour. On the fifth or roof floor are three Sutcliffe centrifugal reels for dusting and scalping purposes and a large Stanair's bran duster, as also the twelve elevator heads and shafting for driving same.

The machinery throughout is arranged in an orderly manner, the elevators are in perfect line, the spaces between them being utilised as passage ways between the machines, every reel is accessible on all its sides without waste of space, and indeed this applies to almost every machine in the mill.

It remains only to add that in the premises and machinery of this firm there is evidence of wide experience and judicious expenditure of capital, and the whole demonstrates that English engineers and millers have determined that the cream of the flour market shall no longer fall into the hands of the foreigner.

PUMPING ENGINE AT EASTBOURNE WATER WORKS.

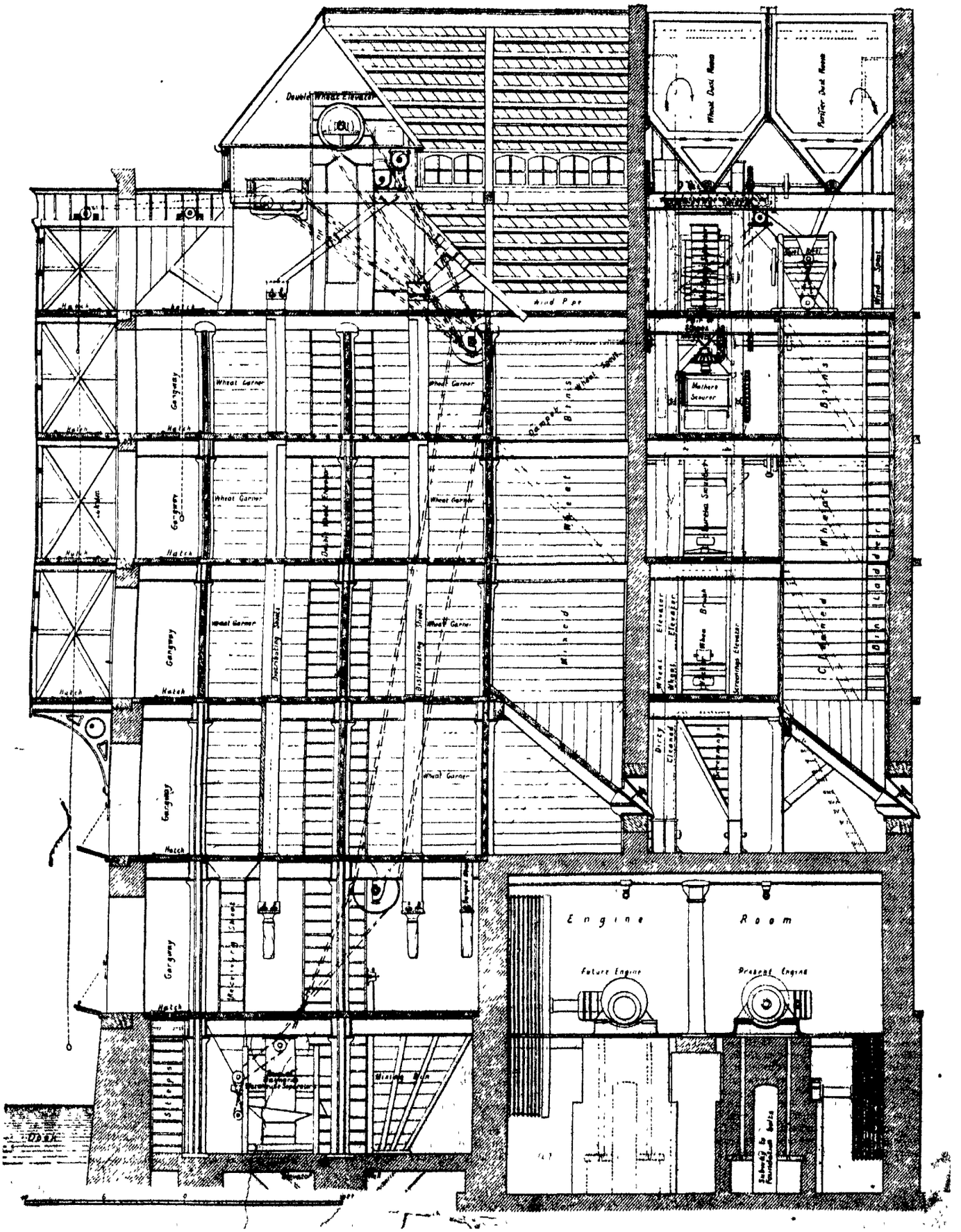
We give this week a two-page engraving of a compound pumping engine erected at the Eastbourne Water Works by Messrs. Moreland and Son, of Old-street, London, E C We shall, in an early issue, publish further illustrations of the pumping machinery at these works, and for the present, therefore, we defer giving the descriptive particulars.

Alnwick Water Supply.—The water supply of Alnwick having been unsatisfactory during the recent dry season, the local authorities have determined to take the matter thoroughly in hand, and have instructed Mr. J. P. Spencer, C.E., of Newcastle-on-Tyne, to report upon the subject, and advise them as to the best means of providing a sufficient supply, and also with a view of providing additional storage and enlargement of the present water works, so as to provide for the increased demands of the district It is expected the report will shortly be sent in, and after that the requisite constructional works will be commenced as early as possible next winter.

THE ALBERT BRIDGE FLOUR MILLS: MESSRS. MARRIAGE, NEAVE, AND CO.

MR. FREDERIC BATH, ARCHITECT, LONDON AND SALISBURY.

(*For Description, see Page* 319.)



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The publisher begs to state that since January 1, 1882, the ordinary copies of ENGINEERING sent abroad are printed on thin paper. The illustrations being, however, so much less effective on thin paper, foreign subscribers are strongly recommended to order thick paper copies, which they can have by paying the difference in postage as indicated below.

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NOTICE TO AMERICAN SUBSCRIBERS.

We beg to announce that we have appointed the firm of John Wiley's Sons, 15, Astor Place, New York, the sole agents for ENGINEERING in the United States, and all subscriptions for the United States will in future be payable to them. They will also be prepared to receive advertisements for ENGINEERING, and will afford full information as to terms, &c., on application.

The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

ENGINEERING.

FRIDAY, OCTOBER 3, 1884.

THE CONSTRUCTION OF ORDNANCE.

IN a recent issue (see page 274 *ante*) we discussed in some detail several of the points raised by Mr. J. A. Longridge in his book on "The Application of Wire to the Construction of Ordnance," and on which he is at issue with the Woolwich and other gunmaking authorities. These points referred to the employment of slow-burning powder; to the use of a thick homogeneous A tube; to the relative merits and demerits of the Armstrong and Woolwich systems, and to Mr. Longridge's claim of constructing a successful wire gun twenty years ago. In the present article we propose to refer to three other points raised by Mr. Longridge. These are: that accuracy in shrinking on hoops in a hooped gun, or laying on wire in a wire gun, is essential; that the practice of chambering is to be condemned; and that distinct portions should be used for giving circumferential and longitudinal strength.

With regard to the first, Mr. Longridge says that accuracy in laying on is essential and practicable. Woolwich may think it essential, but does not consider it practicable. Sir William Armstrong does not think it essential providing the tension obtained is in excess of that indicated by theory. The latter view appears to us to be quite untenable if we can take Mr. Longridge's investigations on the subject as true, and we certainly do not see how they can be contradicted. The wire or coils should be put on at such a tension that in firing they are strained to the elastic limit of the material. This being done, we have for any particular gun the maximum strength compatible with safety. If now the laying on tension is in excess of this, when the gun is fired, the coils will be strained beyond their elastic limit, and we have a new state of affairs altogether. The gun in this state may be able to stand a greater strain than that for which it was intended, in which case there is an excess of strength, or else it may be the other way, and so be unsafe. Mr. Longridge discusses this in detail, and shows what the proper laying on tension for the 13 in. Armstrong gun should be. It is a great pity that the actual tensions of laying on for this particular gun are not given, and the comparisons made on this basis, although perhaps not much could have been deduced from this, as Sir William Armstrong trusts to the gun shaking itself into place; a very dangerous proceeding we cannot help thinking.

With reference to the Woolwich view, we can quite understand accuracy of laying on being impracticable with heavy coils shrunk as has hitherto been done, but if the wire construction is adopted, this difficulty would exist no longer There can be no doubt that theoretically Mr. Longridge's views are correct, and we hope that they may have an opportunity of being put to a practical test.

In condemning the practice of chambering, Mr. Longridge says: "The truth appears to be that chambering and air spacing are only expedients for reducing the strain on the gun." No doubt this is the case, but why not adopt these expedients, if by so doing a greater muzzle velocity can be obtained without unduly straining the gun? Let us examine the case quoted by him. He gives us the drawing of a 13 in. gun unchambered, and shows that with 413 lb. of powder with a gravimetric density of .9, he can produce higher results than with 500 lb. of powder in Sir William Armstrong's chambered gun, the only objection being an increase of 25 per cent. pressure. It must be borne in mind, then, that his gun must be 25 per cent. stronger than the other one. Now it will be admitted that there must be a limit of strength to all constructions, so the question before us appears to be: Given the strain that a certain gun can stand, how can we get the best results from it—with a chamber or without? Mr. Longridge professes to be able to build a gun that will stand 33 tons (about) on the square inch, that is, the pressure developed by powder of gravimetric density .9 (Messrs. Nobel and Abel). Now suppose Sir William Armstrong's gun to be so constructed, and the chamber filled with powder of gravimetric density .9, we could insert here no less than 677 lb. of powder, so that if a gun can be made to stand a strain of 33 foot-tons, then without exceeding this pressure, we get a greater effect by chambering it out. We have been arguing here on the assumption made by Mr. Longridge that heavy charges of this density (.9) can be ignited completely before the shot starts. As a matter of fact this is not the case, and the chambering and air spacing, though they may reduce the pressure on the gun by giving more room for the expansion of the powder gas, yet at the same time they tend to increase it by the facilities they give for the ignition of the charge. We probably could never succeed in getting a greater pressure than 30 to 35 tons with powder, but there can be little doubt that if guns can be made strong enough to stand the strain, explosives will not be wanting to give the pressure. As we have said before, we hope to see the day when gun-cotton or a modification of it may come into use.

The author's objection to Sir William Armstrong's method of obtaining longitudinal strength by means of wires running parallel to the axis, on account of not being able to adjust these ribands to an equal tension, does not seem to us to hold good. If the circumferential wires can be laid on with the degree of accuracy explained by him, surely the longitudinal ribands can be treated in much the same way. Even if all the wires were not exactly of the same tension at first starting, we are inclined to think it would be of little importance, as the strain on each would be so much below the elastic limit, and even supposing one or two to give, there would still remain the others. In the case of the two supports advocated by Mr. Longridge, if one went, the gun would be *hors de combat*.

The second objection, namely, the difficulty of calculating the exact circumferential tension in laying on, when there are non-resisting layers interposed, is not so easy to meet, and we are quite unwilling to combat Mr. Longridge's statements on the subject. We fail to see ourselves why the non-resisting layer should affect the laying-on tension, which we understand from the formulæ given to be dependent only on:

1. The internal pressure.
2. The moduli of elasticity.
3. The distance of the specific coil of wire from the centre of the gun.

Woolwich appears to be working on much the same lines as Elswick in this respect, for we hear that the longitudinal strength there, is obtained by wrought-iron segments interlaced with the coils. In both cases we see endeavours made to provide separate material for the longitudinal strength, except indeed that the core has to take a part of the longitudinal strain. There can be no doubt that one material cannot do double work, and since we must have an outside covering for the wire, it certainly appears to be a good plan to utilise this for longitudinal strength.

We have now touched upon most of the points discussed by Mr. Longridge in his valuable work. Though a great deal can be said on both sides in the way of argument, yet there are many points which can only be settled by actual trial. One of these stands out strongly. Mr. Longridge proposes to give us guns stronger than either Woolwich or Elswick profess to make; he anticipates that he will be able to carry out his proposals, and we repeat what we said at the commencement of our criticism, that the idea is well worthy of a fair trial, and we hope to see Mr. Longridge invited to superintend the construction of a gun built entirely on his own principles.

THE WEATHER OF SEPTEMBER, 1884.

THE weather of September commenced cool and unsettled, the middle portion became fine and warm with mists and dews locally, and the latter part was cold, wet, and changeable. Referring to extreme positions of the British Isles to which the Isle of Man is central, the mean atmospheric pressure and temperature were as follows.

Positions.	Mean Pressure.	Difference from Normal	Mean Temperature.	Difference from Normal
	in	in.	deg	deg
North	29 80	above 0.04	53	above 1
South	30.02	,, .05	60	,, 1
West	29 89	,, 03	57	,, 2
East	29.97	,, 09	58	,, 2
Central	29 94	,, .07	58	,, 2

The distribution and frequency of rain may be inferred from the following statement.

Places.	Rainy Days.	Amount.	Difference from Normal
		in	in
Sumburgh	28	4 69	above 1 19
Scilly ..	18	2 40	below 1.41
Valencia ..	21	3 46	,, 1 49
Yarmouth ..	14	5 05	above 1 90

Pressure was above the normal value generally, but markedly so in the east and central districts, where also the excess of temperature was greatest. The amount of rain was much above the average in the east and north, and much below in the south and west districts. The resultant of the daily general directions of the winds is from S.S.W., though the normal resultant is W. by S. The southerly direction of the resultant accounts for the excess of temperature. During the middle period of the month, easterly and south-easterly winds were prevalent. The barometer attained 30.5 in. on the 18th, and fell to 29 in. on the 27th.

The highest temperature, 84 deg., was recorded at Loughborough on the 17th; the lowest, 33 deg., at Brookeborough on the 5th. On the 4th, 1.13 in. of rain was measured at Jersey, and 1.02 in. at Yarmouth; on the next day 2.57 in. was measured at Yarmouth, so that in these two days more than the seasonable quantity for the entire month fell. On the 7th, 1.73 in. was measured at Donaghadee, and, 1.14 in. at Mullaghmore. Lightning and thunder occurred in places on the 1st, 2nd, 4th, 14th, 21st. Aurora was observed in the north on the 17th and 18th. The heat of the 16th and 17th was very oppressive, due to the calm and moist condition of the atmosphere. An estimate of clear days gives ten to the north and east districts and only three to the south district; while overcast days varied from seventeen in the west to nine in the south. The duration of bright sunshine, estimated in percentage of its possible duration, for the four weeks ending September 29th, was 37 for these islands on the whole, Channel Isles 49, east England 41, south-west England 39, east Scotland, north-west England, and South Ireland 37, south England and west Scotland 36, north Scotland 34, central England 33, north-east England 32, and north Ireland 30.

THE PHILADELPHIA ELECTRICAL EXHIBITION.—No. I.

By Mr. C. T. Woodbury, Boston.

It is certainly in accord with the fitness of things that the city of Benjamin Franklin should hold the first Electrical Exhibition in America. On Tuesday, the second day of September, the Electrical Exhibition, under the auspices of the Franklin Institute, was opened to the public with suitable inaugural ceremonies on the part of the civic authorities, and of the Institute; consisting of an address of welcome by the mayor of the city of Philadelphia, followed by an oration by William P. Tatham, President of the Franklin Institute, after which the Honourable Robert E. Pattison, governor of the State of Pennsylvania, officially announced the Exhibition to be opened.

Visitors to Philadelphia during the Centennial Exhibition of 1876, will remember the station of the Pennsylvania Railroad Company in the western part of the city. The large passenger station which this company has built in a more central portion of the city, has caused them to vacate the station used in 1876. This former station is now used for an electrical exhibition, in addition to an annexe, constructed for the purpose, and covering about 1½ acres of ground. The roof of the main portion of this annexe is sustained by Gothic arched trusses, forming a large hall, surrounded by wide galleries. In the centre is a fountain with jets of water playing in different directions, and the pool environed by the verdure of a collection of plants. From the roof trusses are suspended arc lamps, which add to the volume of light from the lamps at the exhibits upon the floor, whose perfect illumination gives a vivid realism to the varying tints of colour in the faces and garb of the numerous spectators present.

A portion of the old railway station has been converted into an audience-room for the purpose of lectures upon electrical subjects. Upon the walls of one side are painted two large maps, about 20 ft. in diameter, of the hemispheres, showing on this large scale the position of the various submarine cables in the world. Upon the opposite side is a map of the globe according to Mercator's projection and about 30 ft. in height and 55 ft. in width. As upon the maps of the hemispheres, the various submarine cables are projected; while upon other portions of the walls electrical and other physical constants are tabulated in figures so large that he who runs may read.

The lectures to be delivered in this hall are not confined to the scope of the specialist, nor to audiences of general education and taste, but on certain days, lectures are given to detachments of children from the public schools. Careful attention to the speakers, and close observation of the Exhibition afterwards, is encouraged by the fact that 72 prizes of five dollars each are to be given to that number of the school-children who write the best "compositions" upon the subject, "What I saw at the Exhibition." Original spelling as well as original seeing is tacitly encouraged by the fact that the notice states that no demerits will be made on account of errors in spelling or grammar.

The boilers supplying steam to the 2000 horse-power of engines operating the dynamos are situated in a shed outside of the buildings. Some of them are the well-known Babcock and Wilcox type of boilers, others a Harrison sectional boiler, and the remainder are locomotive boilers, some being still on their running gear, others upon masonry.

The term international, as applied to this Exhibition, is a misnomer, save as all science is international, knowing neither frontier nor race, but at the present writing the foreign exhibits are quite insignificant. As far as we have seen the only foreign entry is in the department of electro-metallurgy, and consists of fac-similes of coins and medals sent by Messrs. Ready, of London, electrotypers to the British Museum. These cases contain reproductions of some of the best examples of die-sinker's art from 400 B.C. to the 17th century. Nothing heretofore exhibited in the United States has equalled this collection, which presents fac-similes whose perfection defies detection. Here are examples of medals by Pisano of Italy, the Philip and Mary medal (1554) by Trezzo, Charles V. of Germany (1537) by Reitz, Marie de Medicis by Dupré, while especial interest is taken in the medallion of a female head by Durer (1508). It is true that some of the most important instruments of precision in the exhibits of James W. Queen and Co. and the Electrical Supply Company, have been made outside of the United States, and are properly labelled with their maker's name, but they are goods which form a portion of the stock in trade of these enterprising houses. If any sin of omission has been committed in not citing exhibits foreign to the United States, forgiveness is to be expected; as at this time of writing after the Exhibition has been open fourteen days, there is no published catalogue, official or otherwise, and many unarranged exhibits.

The synopsis of classification is well arranged and is as follows:

Synopsis of Classification.

Section I. Production of Electricity.

Class 1. Apparatus for Electricity of High Electromotive Force.—Class II. Voltaic Electric Apparatus.—Class III. Thermo-Electric Apparatus.—Class IV. Magneto-Electric Apparatus.—Class V. Dynamo-electric Apparatus.—Class VI. Mechanical Motors; Steam, Gas, Water, Heat, and Wind Engines.

Section II. Electric Conductors.

Class I. Telegraph Wires.—Class II. Telephone Wires and Cables.—Class III. Electric Light Circuits.—Class IV. Underground Conduits for Electric Conductors.—Class V. Submarine Cables.—Class VI. Insulating Materials for Conductors.—Class VII. Electrical Joints and Connections.

Section III. Measurements.

Class I. Measurements of Dimensions.—Class II. Measurements of Speed, Force, and Energy.—Class III. Electrical Measurements.—Class IV. Photometric Measurements.

Section IV. A.—Applications of Electricity.

Apparatus requiring Electric Currents of Comparatively Low Power.

Class I. Electric Telegraphs.—Class II. Telephones, Microphones, Photophones, and Radiophones.—Class III. Fire and Burglar Alarms.—Class IV. Annunciators.—Class V Electric Clocks and Time Telegraphs.—Class VI. Electric Registering Apparatus.—Class VII. Electric Signal Apparatus.—Class VIII. Electro-Medical.—Class IX. Applications of Electricity to Dentistry.—Class X. Applications of Electricity to Warfare.—Class XI. Applications of Electricity to Mining and Blasting.—Class XII. Applications of Electricity to Spinning and Weaving.—Class XIII. Electrical Traps and Snares.—Class XIV. Applications of Electricity to Pneumatic Apparatus.—Class XV. Applications of Electricity to Musical Instruments.—Class XVI. Applications of Electricity to Writing and Printing.—Class XVII. Electrical Toys.—Class XVIII. Electrical Conjuring Apparatus.—Class XIX. Miscellaneous Applications of Small Currents.

Section IV. B. Applications of Electricity.

Apparatus requiring Electric Currents of Comparatively Great Power.

Class 1. Electrical Illumination.—Class II. Electro-Metallurgy.—Class III. Other Applications of Electro-Chemistry.—Class IV. Storage Batteries and Accumulators.—Class V. Electric Motors. Transmission of Power.—Class VI. Electro-Magnetic Brakes.—Class VII. Miscellaneous Applications of Large Currents.

Section V. Terrestrial Physics.

Class. I. Atmospheric Electricity.—Class II. Terrestrial Magnetism.—Class III. Apparatus used by Governments for Weather Signal Stations.

Section VI. Historical Apparatus.

Section VII. Educational and Bibliographical.

The most complete features of the Exhibition very naturally consist of apparatus and appliances for electric illumination; then the Bell Telephone Company and the makers of several other telephones who are awaiting judicial action in the hope of decisions permitting them to make, vend, and use other methods of the electrical transmission of articulate speech than the undulatory current used by Mr. Bell.

There are perhaps fewer of the quaint devices for showing the adaptation of electricity for miscellaneous purposes than would be expected in an exhibition held within the borders of Yankee land.

A few highly polished nickel railings at times give spectators who place their hands upon it a charge that really startles them. The guilty party who touches the switch is so far away that an *alibi* could be proven in a manner that would satisfy the soul of old Weller. In the space devoted to the Thomson-Houston Electric Light Company, there is a table containing a huge electro-magnet, to the coils of which the current is slowly given and withdrawn. As a consequence, a few harmless nails upon the table suddenly start up and with tremulous motion approach the shape of branches of trees, and then quietly subside.

In such company it might have been fit to have exhibited the harness used by a New England College professor, whose researches in other lines will receive due credit later in the description of articles at the Exhibition. The crupper and breeching are lined with smooth copper, which is connected to the terminals of a secondary coil in the carriage. When the circuit is closed by means of a spring switch operated by the foot of the driver, the shock proves a *vis a tergo* which induces the brute to look alive to new efforts.

The general visitor to the Exhibition, as well as the specialist, finds the relics of the early electrical inventions to be of great interest. In an anteroom of the main hall, are numerous electro-magnets and coils made by Joseph Henry in 1827. Four years later, he made the first telegraph which received by sound; and the same year he constructed an electric engine.

Near by are the original telegraph instruments of Samuel F. B. Morse; on one of them some garrulous person has announced on a card the inventor of the instrument, in a pedantic inscription followed by doggeral whose senseless lines are even impaired with words in capitals, italics, and old English.

Here we see two frictional electric machines, the cards on one stating that it was owned by Franklin, the other modestly claiming that it was used by him. The bridge between these old machines with their glass spheres, and the modern Holtz machines may seem a short one, and the results of both equally far from applied science, but who can measure the service done to mankind by Franklin in turning attention to the careful consideration of electrical phenomena?

The Patent Office Department has contributed models of early telegraphic inventions by Morse, House, and Kirchoff, while the stock printing telegraphs by Edison and others, attract a far more wholesome interest than is exhibited by the feverish speculators who watch the tape bearing the record of market fluctuations, eager to learn whether fortunes grow or vanish. Here we see models of telephonic apparatus relative to patents of Bell, Edison, Dolbear, Gray, and others.

The great principle which has made possible improvements upon these crude devices of other days has been the more precise methods of workmanship, therefore it is appropriate that the standards and comparator of the Pratt and Whitney Company have been assigned a position in the vicinity. The actual reason why they have been placed here is because there are no dynamos in the neighbourhood, and it was feared that the possible magnetisation of their steel bars by the proximity of a strong magnetic field, might produce some physical change which would interfere with the accuracy of their dimensions. This exhibit is under the charge of Mr. George M. Bond, who is well known as being one who, like the Puritan knight, Hudibras,

"Can discern and divide
A hair 'twixt south and south-west side."

Readers of Engineering have had an opportunity of learning, in the recent publication of Mr. Bond's lectures before the Franklin Institute, of the skill and persistent investigation necessary to bring this system of standards to the present state of unparalleled accuracy.

In the adjoining cases are some of the standard scales and screws made by Professor W. A. Rogers,

of Harvard Observatory, the colleague of Mr. Bond in this work for the Pratt and Whitney Company. One screw about 1¼ in. in diameter with a thread of $\frac{1}{\pi}$ in. pitch has a linear error of .00003 in. in a length of 15 in.

With the hope of avoiding the accidents to person and property which have occurred at exhibitions and other places where electric lights have been used, the Committee have prepared the following:

Rules for the Installation of Electric Apparatus, at the Franklin Institute International Electrical Exhibition, adopted by the Committee on Electrical Installation.

Prefatory.

The following rules and regulations have been adopted for the purpose of securing the highest possible safety both to life and property. It is therefore earnestly requested that all exhibitors will give their hearty co-operation in carrying them into effect.

Rules.

1. All space granted to exhibitors in the International Electrical Exhibition must be occupied in accordance with the rules and regulations of the Committee on Electrical Installation, and all exhibitors must agree to submit to the said rules before such space is allotted to them.

2. No circuits shall be run in the Exhibition buildings until full plans and particulars thereof are first submitted to the committee, and approved by them.

3. No changes shall be made in any circuits without the consent of the Committee.

4. Any question pertaining to the installation of electrical apparatus that does not fall within the scope of these rules must be referred to said Committee for decision.

Circuits.

5. All circuits must be insulated and metallic throughout their entire extent—*i.e.*, no ground connections are to be used.

6 The conductors of all main circuits must have such a weight per running foot as will enable them to carry the current employed without heating.

7. When circuits are taken from large to small conductors, and the large conductor carries such a current as would dangerously raise the temperature of the smaller wire, if accidentally diverted through it, an approved automatic safety device must be introduced into the circuit of the smaller conductor, whereby the circuit will be automatically interrupted whenever the current passing through the smaller conductor is in excess of safety. Similar automatic safety devices must be used in all circuits run in the vicinity of electric light and power circuits.

8. All circuit wires for electric light or power currents must be insulated with some approved incombustible material.

9. Circuit wires exposed to moisture must have, in addition to their insulating covering, a coating of some waterproof material.

10. No paraffined or wax-covered wires are to be used in situations or under circumstances where they may be exposed to a high temperature.

11. When the electromotive force of the current exceeds 300 volts, the different parts of a circuit outside the electro-generator or the apparatus which it energises, must not approach one another nearer than 6 in.

12. Aerial wires must not have a greater drop than 1 ft. between points of support.

13. All circuits are to be run so as to permit ready and frequent inspection by the committee.

14. When practicable, the positive or outgoing conductor must be clearly marked so as to distinguish it from the negative or return conductor.

15. As far as practicable continuous wires must be employed. Whenever joints are necessary, they must be made in such a manner as to insure a good and durable contact, and said joints must afterwards be insulated.

16. Wires fastened to walls and ceilings must be rigidly attached to the same by suitable insulating fastenings. In no case will loose loops in the same be permitted.

17. Where circuit wires pass through walls, floors, or ceilings, a special insulating, incombustible tubing must be used to incase the wire.

18. All electric light and power circuits must be tested, as often as the Committee may direct, for accidental grounds or contacts, and if such are found, the currents shall in no case be permitted in such circuits until such ground or defects are removed.

19. No circuits shall be placed underground within the building.

20. All underground conduits, in use as such, must be placed outside the main building, as may be directed by the Committee, and all circuits connected therewith must be provided with safety devices.

Systems of Electric Lighting.

21. Dynamo-electric machines must in all cases be thoroughly insulated from the ground, and be surrounded by a railing so as to prevent the approach of the public nearer than 2 ft.

22. All dynamo-electric machines must be furnished with means to prevent the dangerous heating of their coils on the extinguishment of part of their lights, and if such means be not automatic in action, a competent person must be in charge of the machine while it is running.

23. Electric arc lamps must be provided with an automatic switch or cut-off, so that the lamp will be automatically cut out from the circuit whenever the current traversing its coils reaches a dangerous limit.

24. All electric arc lamp-frames must be insulated and provided with a hand switch to cut out the light when so desired.

25. All electric arc lights used in the building must be protected by glass globes, furnished with a wire netting outside the globe, to keep the globe in place in case of accidental fracture. Broken or cracked globes must be promptly replaced by sound ones. The bases of the globes must be inclosed so as to prevent the fall of heated particles.

26. A suitable device must be placed on all arc lamps to prevent the fall of the lower carbon, on the failure of its holder.

27. The Committee reserve the right to adopt special preventives in all cases where the safety of the public seems to demand it.

28. The Committee reserve the right to modify these rules in particular cases where it is considered that circumstances warrant such modifications.

29. In all cases requiring prompt action, the exhibitors must be governed by the decisions of the electrician until the matter can be acted upon by the Committee.

In conformity with Sections 5 and 18, the circuits are tested with a Woodbury testing apparatus which consists of a Siemens armature in the field of a battery of five permanent magnets. There is no commutator, and the alternating current passes through the coils of a polarised electro-magnet whose armature vibrates a striker between two small bells, whenever the circuit is complete. At the end of the case are two reels, each of which contain steel tapes (·002 in. in thickness and $\frac{1}{16}$ in. in width), which form flexible conductors, which are connected to objects by means of spring clips at their ends. The driving wheel and reels are turned by means of a crank, which is held at one side by a spring clip when not in use. The armature is wound to 400 ohms resistance with 6000 ft. of No. 40 wire. The whole is contained in a hard rubber case 1¼ in. thick, 4 in. wide, and 8 in. long, and weighs 3 lb.

The bells will ring when the external circuit has a resistance of 7000 ohms. The difficulty in using certain forms of magneto-telephone call-bells has been that the discharge of the static charge on the surface of the conductors has been sufficient to ring the bell when there was no ground connection to complete the circuit when testing an electric lighting system for grounds. This instrument contains certain features to guard against this result, and a static charge of a micro-farad is necessary to ring the bell in that manner.

Some measurements of one of these testers gave the following result, with a resistance of 400 ohms in the circuit.

Revolutions of Crank per Minute.	*Electromotive* Force in Volts.	Current in Ampères.
60	2 00	.0050
120	3 96	.0099
180	6.04	.0151
240	7 96	.0199

THE ELECTRICAL CONFERENCE AT PHILADELPHIA.

On Monday, September 8, the conference of American Electricians was opened in the Lecture Hall of the International Electrical Exhibition, in the presence of about 800 persons. To the oppressive heat, under which the members of the British and the American Associations, and the visitors to the conference, suffered equally, must, perhaps, be ascribed the absence of success which characterised the meeting. With the cooler weather of the following Thursday night, the meeting of the American Association closed, and most of the members left, so that the welcome change did not work much benefit for the conference.

The conference was called under an Act of Congress, authorising the President of the United States to nominate a Commission, which was to issue invitations to a national meeting of electricians to be held in connection with the Electrical Exhibition at Philadelphia, that is, under the auspices of the Franklin Institute. The Commission comprised the following members of the executive committee: Professor Henry A. Rowland, of the John Hopkins University, Baltimore, President; Professors Snyder and Barker, of the Philadelphia High School Observatory and University respectively, secretaries; Dr. William Wahl, of the Franklin Institute; and Professor Simon Newcomb, of the U.S. Almanac Office, Washington; Professor Brackett, of New Jersey College; Mr. R. A. Fisk, of San Francisco; Professor B. Willard Gibbs, of Yale College, New Haven; Professor Houston, of Philadelphia; Professor Trowbridge, of Harvard College, Cambridge; Professor Van Dyck, of New Brunswick; and Professor Charles Young, of Halstead Observatory, the retiring president of the American Association. The Commission had issued invitations to more than 150 United States electricians, as well as to a number of Canadian and English engineers.

When the conference would meet was apparently involved in mystery until Monday, the 8th ult., when it was suddenly announced for the afternoon of that day. The duration of the conference was only determined by the meeting itself towards the close. At the opening ceremony, Professor Newcomb rose to introduce the President, Professor Rowland, with a few appropriate words. Professor Rowland seemed determined upon a thorough research into the antiquity of scientific investigation. He began with Archimedes, who, 2000 years ago, gave us the lever and the pulley, and the laws and applications of hydrostatics and specific gravity; who destroyed the Roman ships and collected the sunbeams. After paying the tribute due to that great philosopher, Professor Rowland eulogised the power of knowledge and the reward of earnest study. "If the world would only pursue those things," he said, "which are high, and right, and noble, its reward would not be confined to the minds of men. Physical rewards await it as well, and disease, that principal cause of human misery, would almost pass away when the effect of inheritance from the present generation had passed. So the pursuit of pure science brings not only the rewards I have mentioned, but the physical rewards of applied science, and the pursuit of applied science gives wealth which may again be employed to further pure science. So the two react on each other to produce that perfect whole, modern science, pure and applied. This moral law of the universe is well illustrated by the well-known story of Solomon. . . . So the world, when it chose knowledge and truth above all things, acquired, not only the treasures of pure theoretical science, but also the wealth, and riches, and honour which come from applied science, such as the world has never seen before, and could see in no other way."

After this characteristic deviation, Mr Rowland returned to facts and names, passing at one step over 1800 years, from Archimedes, to the father of electrical research, Dr. William Gilbert. His rapid review soon brought him to modern names, and comparative and absolute measurements, and then he moved in the realm of theory—into regions where very few of the audience could trust themselves, and where we cannot follow unless by repeating his own words. "Electricity is not force, not energy, it must be more of the nature of matter; and, as we never have been able to separate electricity from matter, electricity is a property of matter. The theory of matter includes electricity, magnetism, and light; it includes gravitation, heat, and chemical action; it forms the great problem of the universe. When we know what matter is, then the theories of light and heat will also be perfect, and then only shall we know what is electricity, and what is magnetism." Professor Rowland concluded with an earnest appeal to the country for the culture and support of both pure and applied science. Amid a general applause following this able address, Sir William Thomson, as vice-president, addressed the meeting, after which it adjourned to the following afternoon.

Routine business made little progress during the second meeting. Lieutenant Greely, of Arctic fame, had been announced to speak, together with Lieutenant Allen and Professor Abbe, on behalf of the United States Signal Service. Professor Abbe, however, had to express his regret at the absence of his colleagues. He presented a letter from General Hazen, analysing the work of the Signal Service, and its proposed extensions. The matter was referred to a committee, to submit a preliminary report in three months, either directly to the conference or to the commission. Professor Trowbridge then moved for the adoption of the ohm, as defined by the Paris Congress. Sir William Thomson related that different opinions had prevailed at Paris, but that ultimately the length of the mercury column to represent the standard of resistance, had been fixed at 106 centimetres, although Lord Rayleigh's and Glazebrook's experiments yielded a figure by about one quarter per cent. higher. As the very exact determinations of the ohm made by Professor Rowland were by about two-tenths below the 106, Sir William trusted that the Americans would readily accept this ohm. In this Sir William was corrected by Professor Rowland, who stated that his first researches had

indeed given those lower values, but that his latest experiments and investigations, which were not entirely completed, closely agreed with Lord Rayleigh's calculations. Professor Kimball gave a short account of those investigations, in which he has assisted Professor Rowland. The system employed is a modified Kirchoff method, using coils one millimetre thick, and 25 centimetres apart. Professors Rowland and Kimball have satisfied themselves to one part in three thousand, that the B. A. unit equals 0.864 absolute units, and that the specific resistance of a column of mercury of one metre length, and one square millimetre section, is .9539 B. A. units. These two combined resistances yield 106.278 centimetres as the length of the mercury standard of resistance. As the Paris units, the ohm, the ampère, and the volt are practically already in use in America, the conference resolved to recommend to the Congress of the United States the legal sanction of these standards. The light and the power standard questions led to a somewhat irregular debate. Professor Trowbridge, as referee, did not favour the theoretical and costly light standard of M. Viole, which the Paris Conference legalised after a lengthy discussion, chiefly in default of anything better. The proposal of Dr. Werner Siemens promised better for the practical electrician, but reasonable objections had been raised to it, and it would be best to refer the matter for the present to a committee, to await the results of exhaustive tests that are being contemplated. The same resolution was passed with regard to the watt, and the new metric horse-power of 1000 watts, which Mr. Preece proposed, when this matter was settled so far as this conference is concerned. Several members opposed the suggestion of committees, unless preliminary reports were to be presented during the sitting of this meeting. Motions were lost on one side of the large hall, only to be brought forward again from the other, until Professor Graham Bell rose to state that they wished to hear a little more about the motions upon which they were requested to vote. Under these circumstances, the suggestions and invitations of Professor Tatham, President of the Franklin Institute, to repair to the hall of the Franklin Institute, was warmly cheered, and a motion for the adjournment of the meeting immediately carried.

Professor Snyder opened the Wednesday morning sitting at the Franklin institute by recommending the establishment of an international bureau for the fixing and verifying of physical standards. Standards of length and mass have been fixed in the United States by the Coast Survey. The Lake Survey has also taken up the standards problem, and some Government offices and private and public institutions have further determined and reproduced standards; but all the isolated efforts ought to be united, and the Government ought to make standards of all kinds accessible to every one. Professor Snyder therefore suggested that Congress should remit the determination and reproduction of standards to a special department, which should be supplied with a laboratory to carry on original research. Professor Rogers, of Harvard College, designated the general desire for Government action as neither creditable to the State nor to the people, but believed that it must be admitted that the interests of the nation would best be watched by placing the matter under Government control, yet with perfect freedom of action. Professor Hilgard, Superintendent of the Coast and Geodetic Survey, Washington, made a long statement, the purport of which it would be difficult to define. Although expressing himself in favour of a national bureau (the international did not meet with much approval), some of his remarks, that the Government did quite enough when making the use of the metric measures optional, and that no standards can be defined by legislation, admit of an entirely different interpretation. Lieutenant Allen, of the Signal Service, contributed a very interesting paper, which had, however, little direct bearing upon the question before the meeting, the desirability of a standard bureau. His exact and minute researches into the accuracy and reliability of air, mercury, and alcohol thermometers at different temperatures, however, did not fail to impress the conferees with the necessity of having proper means and apparatus for the division of temperature and standards—a task which is generally not thought to involve particular difficulties. A motion that the paper should be printed *in extenso* was carried. Professor Newcomb urged that there was no real antagonism between the speakers, and that specially appointed scientists who know the responsibility cast upon them, would best perform their task. Sir William Thomson added some more illustrations to the cases of inaccuracy in thermometers, which Lieutenant Allen had mentioned, and which are far surpassed by the inaccuracy of electrical instruments; if America should precede England in letting the people benefit by the investigations carried on in the laboratories of Harvard College, Cambridge, of MM. Mascart and Helmholtz, then England would have to send her instruments over to the States to get them verified and adjusted. Mr. Preece emphatically protested against this idea of Sir William Thomson. In England, he remarked, we are quite as sensitive to Government interference, but we always are glad to avail ourselves of Government aid if we are in trouble. The American Government will have to be pressed as the English Government was pressed by the British Association Committee until at last they have joined the Bureau International. It was ultimately resolved that a committee should be appointed to draft a motion to be placed before Congress. The report of this committee, accepted on Friday, runs to this effect: "That this conference deems it of national importance that Congress, in pursuance of its constitutional authority to fix a standard of weight and measures, should fix standards of electrical measures, and in order to secure the use of such standards, should establish a bureau charged with the duty of examining and verifying instruments for electrical and other physical measurements." We may now leave this subject, which excited much disagreement, and which was repeatedly referred back to the committee, although the gist of the motion was probably generally approved of. Among the other speakers upon the question we will only mention Professors Abbe, Keith, of New York, Kogle, and Silvanus Thompson. Many irrelevant points were introduced into the debate; Professor Fitzgerald, for instance, at a late stage of the debate, alluded to pure water and milk standards.

(To be continued.)

ELECTRIC LIGHTING AT THE INTERNATIONAL HEALTH EXHIBITION.

No. VII.

Over two thousand of the incandescence lamps in the Health Exhibition are the manufacture of Messrs. Woodhouse and Rawson, of 11, Queen Victoria-street, E.C., and are specially notable in that their performance marks a step in the only direction in which a substantial decrease in the cost of the electric light can be expected. The price of fuel and the amount consumed to provide a given amount of power are not likely to be lessened, nor is it probable that the efficiency of the dynamo, which is already above that of most other machines, will be improved. Thus of the three conversions of energy, which usually obtain in the production of the electric light, namely heat into mechanical motion, motion into electrical current, and current into light, the former two offer little scope to the inventor in search of economy, and it is the last only which invites his attention. The light emitted by an incandescence lamp represents a miserably poor proportion of the current energy consumed by it; and it is generally understood that 3 to 4 watts are required per candle-power at a degree of incandescence which permits of a reasonably long life for the filament. This, however, is rather a loose method of stating such an important condition, and as the light varies as the sixth power of the current, a very slight alteration in the energy consumed in the lamp, above the amount required to bring it to incandescence, makes a material difference to the light produced. It is, however, the practice of manufacturers to state that the lamps give so much light with so much current passing through them, with such a difference of potential at the terminals, and when this is reduced to watts, per candle-power, the quotient is usually from 3 to 4. The lamps exhibited by Messrs. Woodhouse and Rawson are guaranteed by them to consume only 2½ watts for every candle power of light that they emit, and thus a saving is effected of at least 25 per cent. The economy not only affects the fuel bill, and the cost of attendance and supervision, but also the first outlay for engines, dynamos, and leads, and the heavy annual amount that must be charged against the plant for interest, depreciation, and amortisation. This is one of the most serious items in electric lighting. The remaining charge, that for renewal of lamps, is of course unaffected, as it is not professed that the new filament has a greater durability than the ordinary one. Unfortunately the period of lighting at the Exhibition only amounts to about 500 hours, and hence is not sufficiently extended to form a test on this point, which is, of course, one of great importance to a consumer.

The whole of the western side of the Exhibition ground is lighted by these lamps, the current being supplied by the large Ferranti generator. Beginning at the entrance to the Aquarium they extend through it and some of the adjacent annexes as far as the club dining-room over the Western Quadrant. They are carried in several different forms of fittings, but are all characterised by the same general appearance, the outline of the filament being lost in a glowing ball of light, which appears to fill the centre of the globe. When the lamp is examined cold it is found that the filament is composed of a ribbon or tape of carbon bent into a horseshoe form, the plane of the ribbon being at right angles to the plane of the horseshoe. The method of manufacture is kept secret, but it is understood that most of the carbon is deposited, and is not structural. The lamp-holder has already been illustrated in these columns,* and consists of a boss or bulb of wood or vulcanite traversed by two conductors. These, at the outer end, have binding screws for connection to the main leads, and at the end nearest the lamp they terminate in short spiral springs, which hook on to platinum loops on the lamp, as in the well-known Swan holder. These springs are kept in tension by three elastic fingers, which project from the holder and stand at equal distances around the lamp, pressing against the bulb and tending to force it away from the springs. This form of holder gives a very firm contact with the platinum loops, and maintains it effectually against all vibration, such as may arise from dancing and the slamming of doors.

In addition to lamps of the kinds used in general illumination, Messrs. Woodhouse and Rawson make others of a smaller size for particular purposes, with a special "hair filament" which consumes only 1½ watts per candle-power. One of these fitted to a laryngoscope is illustrated on the opposite page. The instrument consists of an ebonite handle carrying at one end a pair of terminals and at the other a small lamp and an adjustable mirror. The button in the centre serves, when pressed, to switch the lamp into circuit. The current is generated by a three-cell battery of a modified Leclanché type, which will maintain the filament in incandescence for ten minutes at a time, after which it must be allowed to rest and depolarise. Ten minutes, however, is more than ample time for the internal examination of a throat, at least the patient would probably feel it to be so. Below we give a list of Messrs. Woodhouse and Rawson's lamps:

Description.	Electromotive Force of Stock Patterns.	Usual Size of Bulb.
		in.
Extra special surgical ..	2.5 to 3.5	½ by ¼
Special surgical .. .	Do.	¾ ,, ⅜
Round ,, ...	Do.	½
Flat ,, ...	Do.	½ by ⅜
Fairy lamps	3 to 5	¾
2 to 3 C.P. lamps ..	3 ,, 6	1¼
5 ,, ,, . .	8 ,, 14	2¼
7 ,, ,, . ..	10 ,, 16	
10 ,, ,, . .	14 ,, 60	
15 ,, ,, . ..		
20 ,, ,, low, E.M.F.	38, 40, 45 48, 50, 52 54, 58, 67	
20 C.P. lamps, high, E.M.F.	100, 105, 110	
25 C.P. lamps	40 to 100	
50 ,, ...	Do.	
100 ,, ...	Do.	

A large assortment of fittings are displayed by the firm on a stand in the west corridor. These comprise ammeters and voltmeters, switches, cut-outs, and the like. The first are distinguished by having no permanent magnets, so that their constants are not liable to variation, and consequently their scales can be marked in ampères. A very ingenious means of determining the maximum current which shall be transmitted along a conductor, for instance, the wire leading from a street main into a house, is provided in Cunynghame's adjustable magnetic cut-out. This consists of a pivoted frame carrying two contact pieces

* See ENGINEERING, vol. xxxvi., page 440.

which dip into two mercury cups. The current is led by a fixed conductor into the first cup, traverses the frame to the second cup, and then passes round the convolutions of an electro-magnet fixed behind the frame. The attraction of the magnet constantly tends to pull over the frame and raise the contacts out of the mercury, thus breaking the circuit. The position of the two and the weight of the frame are so adjusted that the latter does not move until the current exceeds the amount for which the apparatus is set, when the frame suddenly moves and the circuit is interrupted. The frame normally rests against an adjustable stop, and can be fixed at a greater or less distance from the magnet, and thus the maximum current then can be allowed to pass may be varied very considerably.

This instrument can be modified so that it will come into action when the electromotive force, and not the current, exceeds the normal. In such case

FIG. 1.



FIG. 2.

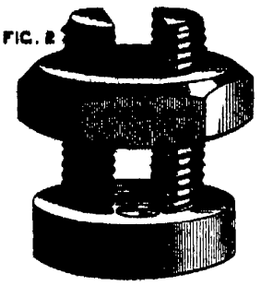


FIG. 3.

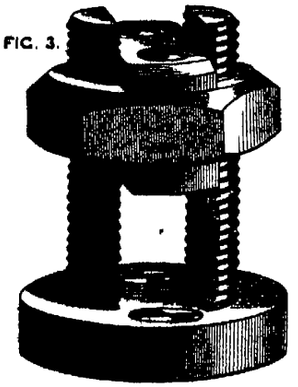
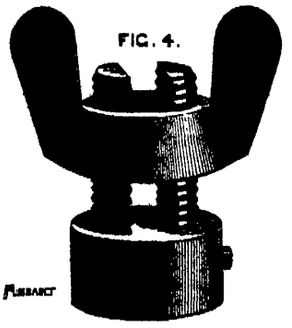


FIG. 4.



the magnet is wound with a coil of high resistance, and is placed between the two conductors the potential of which is to be governed. The main current passes through the mercury, and when the frame is lifted the current is broken.

The switches which are exhibited, are of very simple construction and cannot fail to be comprehended by the most unskilled attendant. Each consists of a fixed jaw and a sliding tongue-piece, which is pushed into the jaw to make contact, and is withdrawn from it to break the circuit. The tongue is of moderately thin brass plate, about $\frac{7}{8}$ in. wide, and at the end which enters the jaw it is doubled back into a hook, which has to be compressed when it is pushed home. By this arrangement the contacts are subject to a strong rubbing action, and are held in firm union, while so much force is required to draw them apart, that the two are separated suddenly and completely. When a number of these switches are used to connect the main lead to branch circuits they are mounted side by side on a board. The tongues are held in a common guide which receives the current, and the jaws each form the terminal of a separate sub-circuit.

At the same stand a large variety of terminals of all kinds are shown. Three, of a special make, are illustrated below. In these the screw is slotted from top to bottom, so that the lead can be laid into it with ease and certainty. Even if it be of too large diameter to enter, it can be flattened by hammering, and then be inserted edgeways. Two of the terminals illustrated have nuts which clamp directly on to the conductor, and the third has a die piece which travels up and down with the nut, and makes a long contact with the upper side of the lead. Messrs. Woodhouse and Rawson manufacture all kind of electric light apparatus, and their stand contains numerous specimens of carbons, batteries, safety junctions, conductors, and all the other requisites of complete installation.

One of this year's novelties at the Health Exhibition is the Bernstein or Boston incandescence lamp, which differs from all others in the peculiar formation of the carbon conductor, which is not a filament, but a hollow carbon tube. This tube is prepared by carbonising an extremely fine hollow ribbon of woven silk. The advantages claimed for this lamp are a considerable increase of the illuminating surface, and a high efficiency. According to measurements taken by the Scientific Commission at the Vienna Exhibition, the mean efficiency of the Bernstein lamp is 294 candles per horse-power. There are two installations of these lamps in the Exhibition, the first in the Central Gallery, and the second in the machinery bar. The first includes 38 lamps of 90 candle power each arranged in two parallels of 19 in series, each lamp taking 50 volts and 4.5 ampères. The current is supplied at a potential of 950 volts by a Hochhausen dynamo running at 1100 revolutions, and delivering its current into main leads composed of seven strands of No. 18 wire, from which there branch service leads of seven strands of No. 20 wire. In the machinery bar there are 40 lamps of 50 candle power, arranged in 10 parallel, four in series, each lamp taking 25 volts and 4.5 ampères. These figures show an efficiency of 2.5 watts per candle in both series of lights.

Dr. Maier, of Blenheim Street, New Bond Street, W., represents the makers of the Bernstein lamp in this country, and we are indebted to him for the above particulars of its efficacy.

METALLURGICAL NOTES.

The Use of Water Gas.

In *Stahl und Eisen* (1884, No. 6), V. Ehrenwerth, writing of the relative merits of water gas and ordinary producer gas, comes to the conclusion that for all the main metallurgical uses there is at present no prospect of the water gas being introduced and superseding the other, the chief reasons given being that the plant for production of water gas is considerably more costly than ordinary producers, and that the gas from the latter already allows of the production of temperatures sufficient for the requirements, and as high as our furnace materials can stand with advantage. Nevertheless, he considers that water gas has a great future in some special industries, because it enables us to obtain high temperatures without previous heating of the gas and air, and these high temperatures can also be obtained with a flame less liable to cause oxidation. The gas is in use at Essen for welding with great advantage. For domestic firing, the only great advantage of water gas over ordinary producer gas would be the much smaller mains that could be used for conveying it. But taking this into account, and comparing the relative costs of water gas and ordinary illuminating gas as now laid on for domestic use, the conclusion is that water gas is rightly called the "fuel of the future." But it must be rendered strong-smelling, so that danger of poisoning and explosions, from undetected leakages, may be less than would be the case with an almost odourless gas.

American Lead and Silver Works.

A writer in the *Berg und Hüttenmännische Zeitung*, describing a tour he made among the principal lead and silver works of America, is very much struck by the excellent arrangements he saw in many of them for desilverising lead. In some of these works, by carefully adapted plant, the manual labour is reduced to a minimum, arrangements being such that the lead passes from one stage to another of the process wholly by gravitation and without being handled at all. Indeed the best of these plants are as systematically and efficiently erected, with regard to the objects in view, as are those in the much more imposing industry of iron and steel. The arrangements in question may well strike the writer as excellent in comparison with most of those in similar works in Germany, where in many instances, even where works have been comparatively recently much modified, operations are carried on in a manner anything but economical or practical. The process in use in almost all American works for extracting silver from lead is that by means of zinc, only one works of any importance having used another process, the Rozau or steam Pattinson method. The leads worked are almost always too impure for use direct in the extraction process, and have to be first of all purified in large reverberatory furnaces, "softening" or "improving" furnaces. These are so placed that the purified lead from them can be tapped down direct into the large cast-iron pots, in which the desilverising takes place by successive additions of zinc. The pots usually hold from 20 to 25 tons of lead, and it is mostly the practice to have the furnaces of a corresponding capacity, so that a furnace-charge, after purifying, frees one pot. But in one case named the furnace holds 65 tons of lead, or three-pot charges. This is a very large amount of metal to have in hand at one time, and in case of the lead breaking out, as sometimes occurs, must cause a serious "mess." (The largest furnaces of this class in use in this country hold about 35 tons.) These furnaces are nearly always built with rivetted wrought-iron pans, lined with firebrick, to contain the lead; the pans being supported on iron rails, and freely cooled all round by access of air. In some cases water cooling is applied to the outside of the pan. After extraction of the silver the lead is purified from the zinc remaining in it (from $\frac{1}{2}$ to $\frac{3}{4}$ of one per cent.) by oxidation in furnaces similar to the "softening furnaces" as above. In some works it is tapped from the furnace into a pot, and finished by being "poled" with green wood, while in others steam is passed into the lead for the same purpose. But as lead can be freed from zinc perfectly by simple oxidation in the furnace, it appears to be quite superfluous either to pole or to steam it. The lead from the pots again passes by simply tapping down suitable launders into the furnace for removing the zinc, and from this furnace again either into pots or direct into the pig moulds. In some cases the lead is drawn from the furnace by means of a syphon, but it is more usually tapped through a spout. Whether direct from the furnaces or from a pot into which the furnace is first discharged, the pigs of market lead are generally cast by means of a pivotted launder working over a large semicircle of iron moulds, but an arrangement is also in use whereby the moulds pass under a fixed spout by means of a revolving table or frame. The alloy of silver-lead-zinc obtained in the process of silver extraction, is in America universally treated by distillation in plumbago retorts. The furnace generally in use for this operation is the very ingenious one introduced by Faber du Faur, in which the whole furnace body, being hung on trunnions, can be tilted over after each operation to empty out the residual silver-lead, without in any way disturbing the fire or the retort, which latter is thus much less liable to injury. Excellent as are these arrangements in American works for the economical handling of large quantities of lead, it is probable that they are quite equalled by a few of the best establishments in this country. Notably, there are one or two plants at work on the Rozau process, in which mechanical appliances for saving of labour have been brought to very great perfection.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, September 13, 1884.

The slight improvement in two or three branches of the American iron trade, noted last week, still continues, but the general condition of things is rather disheartening for this time of the year. The blast furnace owners, though unwilling to agree to any organised restriction of production, are gradually decreasing the output; this has had a favourable effect, and production is now very little in excess of the demand, and prices consequently are firm, and may advance a little for some kinds. Average sales of good makes, in 100 to 500 ton lots, are being made at 19 dols. to 20 dols. for No. 1 foundry, 18 dols. to 19 dols. for No. 2, and 17 dols. to 18 dols. for grey forge. The demand is not heavy, but moderate lots are moving freely, as the firmness of prices leads consumers to believe that bottom prices have been reached. The steel rail trade is also in better condition, and demand is active at 27 dols. to 28 dols. at mill, with a good deal of inquiry, and indications that the demand will continue steady at about these figures. The iron mills throughout the country are working far below full capacity. A large number are standing entirely idle. Bar iron is dull, at prices ranging from 1.50 cents to 2 cents, according to quality and location of mill. The nail mills are still running full, and stocks are heavy, but prices are weak at 2.10 dols. to 2.20 dols.; steel nails are being manufactured successfully by several firms in the west, and are offered at

prices a very little higher than those charged for iron nails, and the iron nail is regarded as doomed, since its rival meets with general acceptance. Foreign material is generally dull. Steel wire rods are quoted nominally at 45 dols. to 46 dols.; sample lots of steel blooms are selling actively at 36.50 dols. to 38 dols. at tide water; 2000 tons of 20 per cent. spiegeleisen sold at 26.75 dols.; Bessemer is not in demand, and is quoted nominally at 19 dols. The demand for barbed wire is increasing throughout the west, and some of the mills will probably have to resume production, in order to increase the stocks. Hardware of all kinds is also more active in western markets, though less improvement is seen in the east. The Cambria Iron Company operating a huge plant and employing 5000 men at Johnstown, Pa., have announced that wages will be reduced from 10 to 20 per cent. October 1. The greatest reduction will be made in the highest salaries paid, and the company agree at the same time to reduce the price of house coal, and the rents of dwellings owned by them, 10 per cent. Under this arrangement, it is probable that the reduction will be quietly accepted. The management state that it is made necessary by the declining demand and prices of their productions. The strikes in the mining regions of Pennsylvania and Ohio still continue. At Pittsburgh only 1000 miners of the 8000 are at work, and the strikers show no signs of weakening.

ELECTRIC LIGHTING NOTES.

The Cleethorpes Gas Company have placed two patent Sugg's and Bray's gas lamps in position at Cleethorpes, one of 230 and the other 200 candle-power, to demonstrate the efficiency of gas lighting in competition with the electric light. Cleethorpes is at present illuminated by means of the latter light, in conjunction with oil lamps, but the result is far from satisfactory. The new gas lamps have been burning now for some time, and have proved quite capable of holding their own against the electric light, their illumination, moreover, being of a much steadier description than that given by the arc lamps.

The Admiralty authorities at Portsmouth have been considering the advisability of fitting incandescence electric lamps to the signal and masthead lights of such of their ships as are provided with electric machinery, and recently a trial was made of the relative efficiencies of the new and old methods of lighting. H.M.S. Crocodile, which was lying by the South-Western Railway jetty, had 50 candle-power Edison lamps fitted in her side and masthead lanterns, while an ordinary oil lantern was placed on the jetty alongside for purposes of comparison. The party who were making the tests, entered a launch and steamed to the St. Vincent training ship, about a mile distant, from which point the electric light was so much more brilliant than the oil lantern, that no relative comparison could be made. The Crocodile was then signalled to replace the 50 candle-power lamps by 16 candle-power, and when the change was effected it appeared as if the electric light were about double the power of the standard lamp. The launch then steamed out another mile to the Clarence Pier, when the oil lamp disappeared in a slight haze, the incandescence lamps being still perfectly visible. The following gentlemen were present at the trial: Captain Carr, H.M.S. Crocodile; Captain Douglas, H.M.S. Serapis; Captain Dyer, H.M.S. Sultan; Mr. Marshall, Assistant Constructor, Portsmouth Dockyard, and other naval and dockyard officials, together with Mr. Lane, the electrician, Portsmouth, and the Edison and Swan Company's engineer. The results were so satisfactory that it is expected the Admiralty will avail themselves of the great advantage for signalling purposes which the electric light offers.

CONTINUOUS BRAKES.

To the Editor of Engineering.

Sir,—The return relating to continuous brakes has recently been published, and I have for my own information made a summary which I trust may be of interest to your readers.

Since the previous return, Barker's hydraulic brake has been removed and becomes extinct; there are now thirteen systems or inventions in use. Three are applied by air pressure; four are vacuum brakes; three are applied by manual power; two are chain brakes; one is a screw brake, and the following Table gives in detail the number of engines and vehicles fitted with each:

Brakes which appear to fulfil the Board of Trade Conditions.

	Engines.	Vehicles.
1 * Clark and Webb's chain		562
2. Sander-Bolitho automatic vacuum	1092	6,500
3. Smith's automatic vacuum	388	1,881
4. Steel McInnes	3	36
5. Westinghouse automatic	1345	12,645
Total	2828	21,646

In the above Table brakes are included which "appear" to be efficient, but I very much doubt if the "chain brake," or the engines with the Sanders-Bolitho ejectors and non-automatic steam brakes, ought to find any place in the list.

The following are the brakes which do not even pretend to fulfil the necessary conditions:

	Engines.	Vehicles.
6. Clark, Wilkin, and Clark		117
*. Clark and Webb		5,917
7. Fay's		1,367
8. Fay and Newall's		430
9. Newall's		390
10. Parker-Smith's (screw)		3
11. Smith's vacuum	1133	6,668
12. Webb or L.N.W. vacuum	289	572
13. Westinghouse pressure	42	296
Total	1469	15,550

It will thus be seen that:

Total which appears to comply	2828	21,646
" which does not comply	1469	15,550
" not fitted	2081	11,668
Total rolling stock therefore	6378	48,864

During the past half-year, the return states that 407 engines and 2333 vehicles have been fitted with brakes, but of this total it appears no less than 181 engines and 816 vehicles have been provided with systems which make no claim to efficiency; this fact must be considered very unsatisfactory.

The second part of the return which relates to the "failures" has already been referred to in your columns; for purposes of comparison it is absolutely useless on account of the incorrect information given by certain companies. "Failures" are of very different values, and unless the class to which a case belongs is taken into account it is impossible to judge fairly. It would be a great advantage if the return contained a summary in which cases could be placed under one of the three heads, also a column would be of great use in which to record "brake successes," or instances in which accidents have been averted or the consequences mitigated. At present a great fuss is made about a "delay of a minute;" but if a brake avert an accident, or saves the lives of a number of passengers, that fact is not recorded and seldom becomes known outside the railway circle.

Since writing the above, I have seen and replied to the letter addressed to you by the secretary of the Midland Company (p. 295). It will be necessary for me to explain that I have no interest of any kind in any form of continuous brake and therefore only wish to consider the question impartially from the mechanical and public safety points of view. No one can dislike, more than myself, to see an important discussion take a turn which in any way can be considered personal, I therefore wish at once to withdraw all that part of my letter which has any reference to the directors in person.

The brake question is simply one of fact; I know which is the best brake at present in use, but I am not prejudiced, all I desire is to see the very best brake adopted and fitted to all trains before another repetition of the Penistone disaster occurs.

I am, Sir, yours faithfully,

Clement E. Stretton.

Saxe Coburg-street, Leicester, September 27, 1884.

To the Editor of Engineering.

Sir,—I see the newspapers give a long portion of room to Mr. Martin to "sit upon" my letter to the *Times*; I see also he has got it put in Manchester, Leeds, and other papers as an advertisement; I can't afford to do so, so he has an unfair advantage over me, so I hope you won't deny me room to defend myself. My letter wasn't to advertise the Westinghouse, but just to show what we drivers feel about the brake matters.

Mr. M. calls me an "*anonymous*" express driver, so I suppose he wants you to believe I am not a real living man. He knows and you know that I daren't have had my name printed because of being discharged, and I couldn't quote the Board of Trade returns because of the same reason; but the *Times* had my name, address, names of brakes, references, and all about it before they put in my letter; you see, Sir, it stands to sense a big paper like that does not put in a letter and write an article on it without being sure.

Next Mr. M. says, he doesn't know of a line which has tried *four* brakes; why, Sir, some have tried six or seven. Only look at the North-Eastern, Great Eastern, Brighton, Midland, South-Western, Lancashire and Yorkshire; come, Mr. Martin, had not all these over four sorts?

To say which four I used would be at once to say who I am; but I will say this much, one of those I found I daren't trust was the Smith's vacuum, and another the automatic vacuum. He goes on to say "the Westinghouse takes time to get pressure," but he doesn't say it "has a stock of air ready in the big reservoir," and his vacuum has to get its power *when wanted*; he says, "no matter how often the vacuum is used it is not impaired;" that tale won't go down with us drivers; what, get a vacuum in a train instantaneously? no never, it can't be done!

Mr. Martin says "leave the selecting of a brake to those *who alone have the necessary knowledge.*" Hear, hear, we drivers reply. We are according to that to be the men to choose, we have the knowledge and the moral responsibility he speaks of, and I don't think any man that has to choose a brake ought to have a "*pecuniary incentive in a company to induce him to do so.*"

I am glad my letter has made a stir in the matter, and I hope it may do good and make things safer for me, my mates, and all the passengers as well.

An Express Driver.

RECONSTRUCTION OF ORDNANCE.

To the Editor of Engineering.

Sir,—Allow me to return you my sincere thanks for the first instalment of your promised articles commenting on the book by Mr. Longridge. The question of wire guns is an old one well known to the very best manufacturers of fowling-pieces, and nothing of that kind could surpass their Damascus twisted barrels.

According to the theory of Smeaton, hammering is better than filing, "never let a file come where a hammer can go," and questions of internal and external tension are actually settled by the difficulty of securing the trunnions, which interfered with the complete forging of the inside and outside of large long guns, more especially when it is expedient to draw them out under a hollow hammer and anvil with a suitable curve and to face them up over a mandrel without using a file. Hence, in order to meet your remarks on the strains on the trunnions, allow me to remind you of my previous proposals (as shown in drawings at the Royal United Service Institution, Whitehall), of balancing long guns in equilibrium on double pairs of trunnions (like Rear-Admiral Albini's automatic gun-carriages for a double-check-bridge stay). By this I divide and conquer the strain and give a lever and fulcrum easy balanced movement of extreme elevation and extreme depression to a barbette overall fire, on double sliding bearings formed by detached trunnions on clasp straps not contracted on to the guns and the joints caulked tightly on to prevent slipping. The trunnions rise and fall on two socket grooves at right angles to each other in the cheeks of the gun-carriage, which thus form a port-hole or embrasure for the gun, and the gun itself can be strengthened longitudinally by two straps forming a long ridge for the sights, and a bridge cover for the head of the captain of the gun.

Yours sincerely,

Genoa, September 24, 1884. George Fawcus.

THE ELECTRIC LIGHT AT THE HEALTH EXHIBITION. MULTIPOLAR DYNAMOS WITH TWO BRUSHES.

To the Editor of Engineering.

Sir,—In Engineering of the 19th inst. appears a letter from Mr. Eck, in which he writes, "You are in error in describing the doing away with the four superfluous brushes [Mr. Eck is writing of a hectopolar dynamo] as an invention of Mr. Mordey, and as a novelty exhibited for the first time at the Health Exhibition." Thus far I agree with him. As to the rest of the letter, I beg to state that the machines he specifically mentions were *Elphinstone and Vincent* dynamos, built by Messrs. Patterson and Cooper to the order of Lord Elphinstone and myself; and that the commutator plates of these machines were by my orders, and in accordance with my instructions, connected together in groups of three, to enable two brushes to be used in place of six. The machine at the Reform Club was installed and worked under my own supervision. All the Elphinstone and Vincent machines at the International Fisheries Exhibition last year were "*Two Brush*" machines, as are those at the Health Exhibition this year. At the request of the chairman of the Anglo-American Brush Corporation an Elphinstone and Vincent machine was sent to their works. It was worked on several occasions, and the special attention of the directors was called to the mode we adopted for grouping the currents, by both Lord Elphinstone and myself. (The "*Victoria*" we were shown had a multiplicity of brushes.)

Finally: The date of my patent (partly a communication from Lord Elphinstone (then abroad) and in which one of the claims is for thus grouping the currents derived from armature coils, is the 18th of May, 1882 (No. 2340). Mr. Mordey's patent being January 24, 1883, is of later date.

I am, Sir, yours very faithfully,

September 29, 1884. Charles W. Vincent.

THE INFLUX INJECTOR.

To the Editor of Engineering.

Sir,—In your issue of the 12th September we notice a letter from Messrs. Fairburn and Hall complaining of the publicity given to the automatic action of our "influx" injectors in the account of them published in your issue of September 5th.

In reference to Messrs. Fairburn and Hall's statement that they also have for some time made injectors that will stop and start automatically, we understand them to refer only to those injectors which are placed below the level of the feed-water; indeed, very frequently in the feed-water.

There is nothing in such, so-called, automatic action but what the makers of any ordinary injector could undertake, and for our part we do not claim for our injectors the term of automaticity on these grounds.

If, however, Messrs. Fairburn and Hall will do us the favour of accepting our definition of (genuine) automaticity we shall be glad if they will notify it by publicly accepting the following challenge, the result of which, if accepted, perhaps you will kindly undertake to insert.

Conditions of challenge:

"A No. 3 injector to lift its feed-water 10 ft. and start, working dry at the overflow, by merely opening an ordinary steam cock—quickly or slowly. While working the suction pipe to be withdrawn from and replaced in the water at intervals of, say, one second, the injector to 'automatically restart' each time the pipe is so replaced; or, the steam cock itself to be repeatedly shut and opened, the injector to again 'automatically restart.'"

We are, yours truly,

Holden and Brooks.

St. Simon-street, Salford, September 16, 1884.

THE PROPERTIES OF INDIA-RUBBER.

To the Editor of Engineering.

Sir,—Can any of your subscribers refer me to a work on india-rubber containing the information requested below, or, in the absence of such work, will they kindly give me the information itself?

Data Wanted.

The weight required to stretch the under-mentioned india-rubber cords (cylindrical in form and suspended) respectively 1 ft., 2 ft., 3 ft., 4 ft., 5 ft., 6 ft., 7 ft., and 8 ft., as well as to the limit of their stretching power.

Diameter in Inches.

1.1.1.1. 2.2.2.2. 3.3.3.3. 4.4.4.4.

Length in Feet.

1.2.3.4. 1.2.3.4. 1.2.3.4. 1.2.3.4.

Of course it will be seen that the limit of elasticity for a 1 ft. cord of 1 in. diameter will be below 8 ft., but as I am not certain where the limit is reached I have made the 8 ft. apply to all.

As I have no knowledge of the law for the elasticity of india-rubber, I conclude that the answers to the information requested will give sufficient data to determine it.

I should also be glad to know of any information regarding the behaviour (more especially with regard to its durability) of india rubber immersed in salt water for any considerable time without a protecting covering of any other material.

I am, Sir, yours obediently,

September 29, 1884. Frank West.

NOTES FROM THE NORTH.

Glasgow, Wednesday.

Glasgow Pig-Iron Market.—Last Thursday's warrant market was steady, with transactions reported on forenoon 'Change at 41s. 7d. cash, also at 41s. 8½d and 41s. 9d. one month, the close being sellers at 41s. 7d. and 41s. 9d. cash and one month respectively, and buyers offering ¼d. per ton lower. Business was done in the afternoon at 41s. 7d. and 41s. 6½d. cash, also at 41s. 9d. and 41s. 8½d. one month, the market closing with prices nominally at 41s. 6½d. cash and 41s. 8½d. one month. The market was firmer on Friday, and prices recovered 1d. on the previous day's decline, though there was still a decline of 4½d. on the week, being within a 1d. of the preceding week's advance. Transactions took place during the forenoon at 41s. 6½d. up to 41s. 7½d. cash, also 41s. 8½d. and 41s. 9d. one month, the close being buyers at 41s. 7½d. cash and 41s. 9d. one month, and sellers near. In the afternoon business was reported at 41s. 7d. and 41s. 7½d. cash, also at 41s. 9d. one month, and at the close of the market there were buyers at 41s. 7½d. cash and sellers at 41s. 8d., and the month's price was nominally 41s. 9d. The warrant market met with an improvement of 1d. per ton during the day on Monday, but it subsequently weakened, and the close was at prices slightly over those ruling at last week's close. Business was done during the forenoon at 41s. 7½d. to 41s. 9d. cash, also at 41s. 9½d. to 41s. 10½d. one month, and buyers at the close were offering 41s. 9d. cash and 41s. 11d. one month, with sellers at ½d. per ton higher. Transactions took place in the afternoon at 41s. 9d. down to 41s. 8d., also at 41s. 10½d. down to 41s. 9d. one month, the close being sellers at 41s. 8d. cash and 41s. 10d. one month, and buyers offering ½d. per ton lower. Yesterday's warrant market was dull, and prices fell 1d. per ton. Business was transacted during the forenoon at 41s. 7d. and 41s. 7½d. cash, also at 41s. 8½d. and 41s. 9d. one month, and the close was buyers at 41s. 7½d. cash, and 41s. 9½d. one month; and in the afternoon iron changed hands at 41s. 7½d. and 41s. 7d. cash, also at 41s. 9d. and 41s. 8½d. one month, with sellers at the close wanting 41s. 7d cash and 41s. 9d. one month, and buyers offering ½d. less per ton. Business was done this forenoon at 41s. 7d. and 41s. 7½d. cash, also at 41s. 8½d. to 41s. 9½d. one month, and at the close there were buyers at the top quotations, with sellers near. In the afternoon up to 41s. 8½d. cash was paid, and 41s. 10d. one month, and subsequently there were sellers at 41s. 8½d. cash and 41s. 10½d. one month, with buyers near. The warrant market has shown much less activity during the past week than there was in the preceding week, the result mainly of operations in the market having largely gone in on the realising tack, and selling out the iron which they purchased in the preceding week. They seem to have been actuated by the fact that the rumours as to the blowing out of some G.M.B. firms were not founded. It is now certain that the Monkland blast furnaces will be continued in operation for some time to come. Much caution is being displayed by investors, and the amount of speculative business doing from day to day is on a limited scale. Strange to say, the special brands of makers' iron still continue to be very scarce, and the prices in all cases remain firm; indeed, at least two brands—Gartsherrie and Shott's No. 1—have been advanced in price another 6d. per ton. It is reported that the movement in favour of employing hematite pig iron instead of special Scotch brands is now taking shape, and it is thought that it will compel makers to arrange for a larger supply of their best brands, or have the mortification of seeing the consumers helping themselves elsewhere. There are now 93 blast furnaces in actual operation, one having been damped out this week at Dalmellington Iron Works. At this time last year there were 114 furnaces blowing. Last week's shipments of pig iron from all Scottish ports amounted to 9242 tons, as compared with 11,021 tons in the preceding week, and 13,238 tons in the corresponding week of last year. They included 1400 tons to the United States, 500 tons to Canada, 110 tons to South America, 110 tons to Australia, &c., 305 tons to France, 3146 tons to Germany, 290 tons to Russia, 309 tons to Holland, 100 tons to China and Japan, and lesser quantities to other countries. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood at 583,597 tons yesterday afternoon, as against 583,782 tons yesterday week, showing a decrease for the week of 188 tons.

The Locomotive Trade.—The locomotive engine works are well employed on orders that have to be pushed forward with vigour. In the returns of shipments of machinery, &c., from the Clyde to foreign and colonial ports reported last week, there were included five locomotives for Calcutta, valued at 8500*l.* There are rumours of inquiries being in the market just now for a large number of additional locomotives for the East Indies. Rapid progress is being made with the new locomotive engine works now in course of erection by the Clyde Locomotive Company, Limited, close by the Hyde-park Locomotive Works at Springburn, Glasgow.

Short Time and Dismissal of Workmen on the Clyde.—A few days ago Messrs. James and George Thomson, shipbuilders and engineers, Clydebank, issued a notice intimating that on and after to-day, October 1, in consequence of dull trade, the workmen employed by them would be put on short time, namely, seven hours per day. Last Saturday Messrs. A. and J. Inglis, Pointhouse, Glasgow, dismissed seventy-eight workmen from their shipbuilding yard, owing to the slackness of trade, together with a number of their engineers and helpers, and it is anticipated that at next pay-day they will dispense with the services of a further batch of their workmen. The Govan Shipbuilding Company also on Saturday morning discharged between thirty and forty of their employés.

Another Iona.—It has just been announced that Messrs. J. and G. Thomson, of Clydebank, have contracted with Mr. David MacBrayne to build a new steamer of the dimensions of the Iona for the West Highland trade. The steamer is to be ready to take up her station next season.

The New Railway Scheme for Gourock.—The engineer of the Caledonian Railway Company is at present busily engaged in the preparation of the specifications and working plans for the extension of the company's Glasgow and Greenock line of railway to Gourock, so that its construction, together with the quay at that place, may be contracted for without delay. It may be remembered that the Bill authorising this extension was passed in the last session of Parliament.

The Lanarkshire and Ayrshire Railway.—The half-yearly ordinary general meeting of the shareholders of the Lanarkshire and Ayrshire Railway Company was held in Glasgow last Wednesday, at which a report was submitted which stated that the construction of about 6½ miles of railway authorised by the Company's Act of 1883, was progressing satisfactorily. It also stated that the directors will lose no time in proceeding with the extension lines to Ardrossan, Irvine, and Kilwinning authorised in last session of Parliament, the contracts for which they hope to have let early next year.

Clyde Shipbuilding Trade.—During last month there were thirty new vessels launched on the Clyde of an aggregate of 38,718 tons, being the largest output for the month of September yet recorded. The total output during the past nine months is set down at 237,312 tons, being 55,378 tons short of the amount of new shipping launched during the corresponding period of last year, though it is nearly twice as great as the output in the three quarters of the year 1879. Seven of the steamers launched last month gave the large aggregate of 27,260 tons, one of them being the Etruria, 8000 tons. Others ranged from 2800 tons up to 5000 tons. Messrs. Elder and Co. alone launched three vessels of a total of 14,650 tons. There are now only seventy seven vessels on the stocks, or fifty fewer that at the close of August, 1883. Several of the yards are practically if not absolutely without any new work; others have one vessel each, ten have two each, five have three each, in four other yards there are four new vessels each, one has five, and Messrs. Russell and Co., Port-Glasgow and Greenock, have ten vessels in hand.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday there was only a thin attendance on 'Change, and although the conversation of some of the frequenters was more hopeful, the tone was lifeless. No. 3, however, was still firm at 36s. 6d. per ton, special brands realising 37s. So long as the shipments of pig iron from Middlesbrough continue so satisfactory, prices are likely to be maintained for No. 3. The demand for the lower qualities is poor, and values keep low on the basis of 34s. per ton for No. 4 foundry, and 33s. 6d. for No. 4 forge. The home demand is sluggish and hopes of an improvement this autumn are all but abandoned. This unfortunately applies to nearly every branch of the iron and steel trades, but particularly to shipbuilding and railway materials. Shipments of pig iron from Middlesbrough during the month of September reached 89,751 tons, 24,845 tons of which have been sent to Scotland, and 21,000 tons to Germany. Hematite iron is dull and 44s. per ton for Nos. 1, 2, and 3 west coast ports, and manufactured iron is steady at 5*l.* per ton for ship-plates and 4*l.* 15 for angles, less 2½ per cent. at works. The rolling mills are running short time and there is great lack of specifications.

The Wages Question.—There is some unexpected delay in the settlement of the wages question in the North of England iron trade. The board of arbitration agreed to refer the matter to Dr. R. S. Watson, of Newcastle on-Tyne, but that gentleman has not yet signified his intention to accept the onerous position. The fact is that while the wages question was under discussion by the board some of the delegates said that if an arbitrator awarded a reduction the men would not submit to it. It is hoped that Dr. Watson will accept the post of arbitrator, and that the men will signify their readiness to abide by his award whether it be in their favour or against them.

Engineering and Shipbuilding.—On the northern rivers these industries remain dull. Recently inquiries have come to hand, and a few orders have been secured for steamers, but the shipbuilding trade is so prostrate that anything like its usual healthy condition is not anticipated till next spring. Marine engine builders are getting very short of work.

Gunboats for the Queensland Government.—On Friday, in the harbour off the Tyne, the first vessels of war owned by the Queensland Government, the gunboats Palumal and Gayundal were thoroughly tried and gave every satisfaction. The boats have been built and armed by Sir W. G. Armstrong, Mitchell, and Co., of the Tyne, and their engines have been supplied by Messrs. R. and W. Hawthorn, of Newcastle. They are twin vessels, each being 120 ft. long, and 26 ft. beam, with a draught of 9½ ft. Their armaments consist of one 8 in. 12½ ton gun forward, one 6 in. 4 ton gun aft, and four Nordenfelt machine guns so placed that three will bear on a broadside. The boats attained a speed of 10½ knots per hour.

A New Marine Engine.—About six months ago Messrs. Richardson, Duck, and Co., of Stockton, built the steamer Burgos for Messrs. H. Briggs and Sons, of Hull, and her engines were fitted by Messrs. Blair and Co., of Stockton, being triple expansion 140 horse-power, and 160 lb. pressure on the square inch. The Burgos sailed from Plymouth for China on August 23 at 3.15 p.m., carrying 2500 tons of cargo dead weight, and arrived at Port Said on September 7 at 3 a.m., distance from Eddystone Lighthouse to Damietta Lighthouse 2932 miles. The time occupied was 346.5 hours, and the average rate 8½ knots per hour. In smooth water she makes an average of about 9 knots. The bunkers had been completely filled at Plymouth, special care being taken to see that they were well trimmed. On arrival at Port Said the bunkers were again filled, and only 120 tons could be got into them. The consumption had been about 8½ tons per day, which is a very considerable saving upon the consumption of the ordinary compound engines, which is not usually less in a ship of the same class than from 12 to 14 tons. This is a matter which will no doubt attract the general attention of the shipping community.

The Coal and Coke Trades.—The fuel trade is steady.

NOTES FROM SOUTH YORKSHIRE.

Sheffield, Wednesday.

Amberyate Patent Railway Wheel and Wagon Company, Limited.—An extraordinary general meeting of the shareholders of the above company has been held at the offices of Messrs. Tasker and Shuttleworth, Wharncliffe Chambers, Sheffield, to receive from Mr W. Fisher, as the surviving liquidator, a report and statement of the winding up of the company. The shareholders present accepted the statement, and resolved that the liquidation be closed and the company dissolved.

Opening of New Chemical Works Tankersley.—On Saturday the extensive new works for the manufacture of chemicals, erected at Tankersley, near Sheffield, by Messrs. Newton, Chambers, and Co., Limited, were formally opened in the presence of the directors.

The Price of Coal.—For some years past it has been the custom of the colliery owners in this district to put up the price of coal on the 1st of October. Already some of the coal agents in the town have received notice from colliery proprietors of an advance, and others it is expected will take the same course. The advance varies from 6d. to 10d. per ton, and that, it is thought, is quite as much as the trade will bear at the present time.

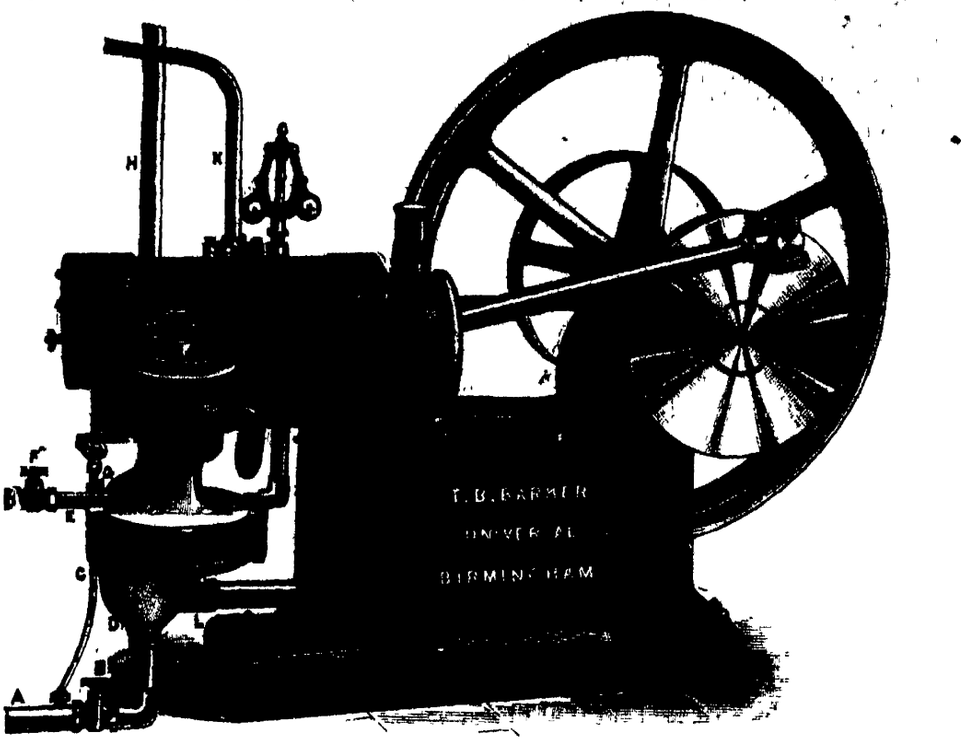
A Benighted Village.—The denizens of Wadsley, near Sheffield, appear to be of anything but an enterprising character. They have, in public meeting assembled, resolved to defer for three years the question of supplying this populous community with gas, although the latter has been offered to them at the price of one halfpenny per week for each 6*l.* 10s. house.

The Penistone Disaster.—We are informed that a meeting of the friends of the killed and injured in the above accident is to be held on Tuesday the 7th instant, at the Queen's Hotel, Manchester, to arrange for some joint action with a view to recover damages from the Manchester, Sheffield, and Lincolnshire Railway Company.

The Originator of Steam Navigation.—M. de Lesseps is promoting a statue in honour of the Marquis de Jouffroy, as the originator of steam navigation. The French Academy of Sciences recently named a committee, with the creator of the Suez Canal as its reporter, to specify the part taken by Jouffroy in the important discovery which has revolutionised navigation. The reporter clearly established the fact that, if Papin first conceived the idea of applying steam as a motive power in navigation, the practical application of the idea was first realised by Jouffroy, who in 1780, built a boat 140 ft. long by 14 ft. wide, which steamed up stream on the Saone, at a rate of two leagues per hour. This was the first pyroscaph, and it is contended that it preceded Fulton's steamboat by a quarter of a century.

THE "UNIVERSAL" GAS ENGINE.

CONSTRUCTED BY MESSRS. T. B. BARKER AND CO., ENGINEERS, BIRMINGHAM



In the West Annexe of the International Health Exhibition there is shown a neat form of non compression gas engine suitable for moderate powers. It is manufactured by Messrs. T. B. Barker and Co., of Scholefield-street, Birmingham, and is named by them the "Universal." The method of its action is exceedingly simple. The piston, in moving forward, draws in behind it a mixed charge of gas and air during the early part of the stroke. When the requisite amount has been admitted, a small port in the end of the cylinder is exposed and a blue gas flame sucked through it, with the result that the combustible mixture is exploded and the piston driven forward to the end of its stroke. The exhaust valve is then opened and the returning piston drives out the products of combustion ready for the reception of a fresh charge. Referring to the above illustration, it will be seen that the engine has a horizontal cylinder with a long piston, to which the connecting-rod is directly pivotted. The gas and air are admitted through lift valves in the casing at the cylinder end, and are raised by the partial vacuum which is created in the cylinder as the piston moves outwards. The amount of gas which is delivered at each stroke is regulated by the governor, and by a cam on the rotating shaft parallel to the cylinder. This cam is so shaped that at one part of its revolution it presses back a spindle and opens a valve. It does not, however, do this directly but through the intermediary of a movable wedge-shaped distance piece, which stands between the cam and the spindle. This piece is connected to the governor, rising and falling with it, the thick part of the wedge being opposite to the spindle when the engine is running slowly, and the thin part when the speed is greater. When the rate of revolution exceeds a fixed amount, the wedge is raised so far that the gas valve is not opened at all. The main gaspipe is shown at A, and is connected to the flexible bag D, the upper orifice of which leads to the valve controlled by the governor. The exhaust valve is on the opposite side of the engine from the observer, and communicates with the pipe H, its opening and closing being effected by a valve on the side shaft.

The ignition valve is at the end of the cylinder and forms the most novel part of the design. It is a flat disc carried on a central stud, and held against the rear cover by a spiral spring, which can be tightened up by a nut. The periphery of the disc is cut into ratchet teeth which gear with a pawl worked by a small crank at the end of the side shaft. At each revolution of the engine the pawl suddenly moves the disc to the extent of one tooth, and then leaves it stationary until the crank again comes round. A number of fine radial slits or ports are cut in the disc, corresponding to the number of ratchet teeth, and in the cylinder cover there is also a port which for an instant in each revolution corresponds to and is seen through a port in the moving disc. A blue flame from the jet G burns opposite the cylinder port, and when the latter is momentarily exposed, it is drawn into the cylinder and ignites the explosive mixture.

The cylinder is water jacketted, the fluid entering by the tap F and pipe E, and leaving by the pipe K. The engine is made in seven sizes of ½, ¾, 1, 1½, 2, 3, and 4 horse-powers, and appears very well adapted for the purposes of small manufacturers, as it is exceedingly simple, and can be readily managed by a person quite unskilled in the management of machinery. The consumption of gas is stated to be from 40 ft. to 50 ft. per hour.

NOTES FROM THE SOUTH-WEST.

Newport.—In the steam coal market a fair amount of business has been done in the best qualities, but secondary qualities have been dull. The house coal trade presents a more satisfactory appearance. In the manufactured iron trades, &c., prospects continue gloomy. Last week there were only cleared 480 tons of tin plates to New York, 272 tons of iron to Rouen, and 259 tons to Rio Grande: Last week's coal clearances were 50,668 tons. From Bilbao, 14,080 tons of iron ore were received.

Bristol and Cardiff Coalfield.—At the usual meeting of the Council of the Bristol Chamber of Commerce on Wednesday, under the presidency of Mr. W. Howell Davies, the chairman reported that the Shipping Committee of the Chamber had addressed the following letter to the Bristol Town Council, with a view to their taking action on the subject: "Gentlemen,—We beg leave, on behalf of this Chamber, respectfully to direct your attention to the importance of a railway between Avonmouth Dock and the Severn Tunnel, especially as the dock has now become the property of the city, and the tunnel so near completion. Such a line of railway will enable South Wales coals, iron, tin, and other goods to be brought to the dock, thus enabling vessels to load in the dock without having to proceed to the other ports in the channel for cargoes, thereby giving facilities for an export trade."

The Gadlys Tin Works.—Preparations are being made for the restarting of the Gadlys Tin Works, Aberdare. This concern, which gave employment to several hundred persons, has been idle for some time, but now Mr. Hosgood has succeeded in floating a company, composed principally of Neath and Swansea gentlemen, and an early start of the works may be anticipated.

Heavy Traffic on the Taff Vale Railway.—The aggregate quantity of goods and minerals conveyed over the Taff Vale Railway and its connections last year was 9,421,803 tons.

Penarth Dock and Barry.—The Taff Vale Railway Company is said to favour the establishment of a line between Penarth Dock and Barry. A survey of the ground over which the branch would have to proceed has been made, and it seems likely that the undertaking will be promoted in the next session of Parliament by the Penarth Dock, Harbour, and Railway Company, whose interests are identical with those of the Taff Vale Railway Company. The new line, if carried out as proposed, will run from the Taff Vale Railway, near Penarth Dock, to Barry, a distance of 4½ miles, and will have a double set of rails.

Cardiff.—During the past week the steam coal market cannot be said to have undergone any change. The house coal trade is quiet. The iron ore trade continues dull. Last week's clearances comprised 127,412 tons of coal, 725 tons of iron, and 625 tons of patent fuel. From Bilbao there were received 4812 tons of iron ore, and 607 tons came to hand from other sources.

Gloucester Wagon Company (Limited).—About 800 forgemen, millmen, fitters, smiths, and drillers in the employment of the Gloucester Wagon Company (Limited), have struck. It appears that for some months past the men have been dissatisfied with the conduct of Mr. Merryless, the submanager of the iron works, who, it is alleged, has cut down the prices of work, and has caused work hitherto done at the works to be executed elsewhere. The strike has now continued for several days.

The Barry Dock.—It appears that the area of the proposed Barry Dock will be 40 acres with a basin of 8½ acres, and a timber pond of 15 acres. It is also in contemplation to construct about 26 miles of railway, in connection with the dock. It is expected that the dock and railways will be opened for business in about four years.

A Railway Directory.—The forthcoming issue of the "Railway Companies' Directory" for 1885, edited by Mr. Percy Lindley, will give the directors, officers, and agents of the railways of the United Kingdom, together with the capital subscribed, expended, and available, receipts and expenditure, dividends, and mileage, compiled from official sources.

The New Tay Bridge.—In a report to the directors of the North British Railway, dated August 20, Messrs. Barlow and Son, the engineers, say: During the past half-year the cylinder foundations of fourteen piers have been put in. The total number of piers whose foundations are in, is 486, leaving thirty-seven to be done. All the four pontoons are now at work sinking foundations. The operations of testing cylinders is now being carried on on both sides of the river with satisfactory results. The new girders for the esplanade at Dundee have been erected, and the erections of girders will continue from that point southwards. All the cofferdam work on both sides of the river has been completed. The piers for the arching at Wormit are built up to springing level, and the staging and centres for turning the arches are being fixed. The wrought-iron superstructures or shafts of piers are being proceeded with at Glasgow. The ironwork for the girders and flooring of the viaduct is well advanced, and a considerable portion has been delivered at Dundee and Wormit.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF RECENT SPECIFICATIONS PUBLISHED UNDER THE ACT OF 1883.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in Italics.

Copies of Specifications may be obtained at 25, Cursitor-street, Chancery-lane, E.C., either personally, or by letter, enclosing amount of price and postage, addressed to H. BARNES LACK, *Esq.*

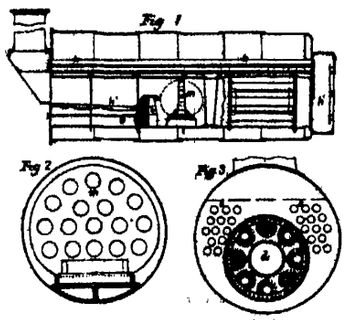
The date of the advertisement of the acceptance of a complete specification is, in each case, given after the abstract, unless the Patent has been sealed, when the date of sealing is given.

Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

BOILERS.

672. R. Abell, Derby. Improvements in Steam Boilers. [*4d.* 2 *Figs.*] January 4, 1884.—The furnace bridge and the usual combustion chamber behind it are dispensed with, and in their place is provided a flue, proceeding from a flat semi-circular disc, forming the back end of the firebox, to a chamber at the back of the boiler. From this chamber suitable tubes proceed back to the front of the boiler and open into a similar chamber forming the smokebox. (*Sealed August* 15, 1884).

485. W. H. Mirfin, Manchester. Steam Boilers and Furnaces for the Same. [*6d.* 10 *Figs.*] January 3, 1884.—Referring to *Figs.* 1 and 2, the boiler is formed with one or more compound flues *d*, *d*¹ as described in Mirfin and Nield's Specification 5060 of 1880, combined with a series of smaller horizontal tubes *h* extending from end to end of the boiler, and arranged on each side of the large compound flues. The gases, after passing through the main compound flue *d*, *d*¹, enter a box *h*¹, and return through the tubes *h* to the chimney. In a modification, the furnaces are at one end at the exterior of the boiler, the gases first passing through an external flue under the exterior of the boiler, and then



as described with reference to Fig. 2. Referring to *Figs.* 1 and 3, behind the firebridge is a hollow metal box *l*, which may form part of the firebridge, and has oblique transverse partitions. Air from the ashpit enters by holes in the bottom of the box *l*, and, rising, passes out through a series of slits in a perforated segmental air distributor. The openings from the ashpit into the box *l* are regulated by a grid plate, whose position is controlled by means of the rod *o*. This air-heating chamber is combined with an igniter consisting of a perforated refractory block or discs adjustable to and from the firebridge, and mounted so as to be capable of being swivelled to adjust the space between it and the sides of the flue according to the draught. (*Sealed September* 2, 1884).

FORCED CIRCULATION OF WATER.

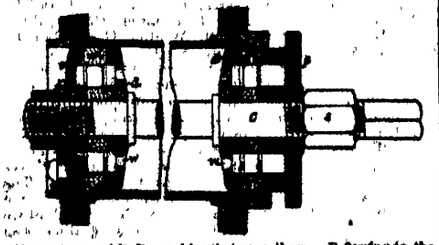
5012. J. T. Bintley, Colchester. Improved Apparatus for Causing Circulation of Water in Steam Boilers. [*4d.* 3 *Figs.*] April 4, 1884.—One or more screw propellers are mounted within the boiler, and are moved by suitable gearing actuating a spindle passing through a long stuffing-box, or motion may be imparted by causing the feed water to impinge on the blades of the propeller. (*Sealed September* 12, 1884).

FIREBARS.

5499. T. Dugard, London. (*J. Muller, San Francisco, U.S.A.*) **An Improvement in Grate Bars.** [*4d.* 3 *Figs.*] March 20, 1884.—These consist of tapering parallel plates each having a groove along the top surface of the plate, and provided with tongue pieces on their opposite sides bevelled downwards and inward to the plates and arranged in "staggered" position. The plates are maintained in proper position by parallel-edged spacing blocks. (*Accepted August* 26, 1884).

TUBE STOPPING.

5215. J. Brotherhood, Kiel, Germany. Apparatus for Closing Leaky Tubes of Boilers. [*4d.* 7 *Figs.*] May 29, 1884.—The apparatus comprises a spindle, each end of which is screw-threaded, and carries two discs, one of which is adapted to be moved to or from the other by turning the axis, and



so compress an elastic packing between them. Referring to the illustration, the spindle C is provided at each end with discs *d* and *e*. The discs *d* rest against shoulders on the spindle C, and an india-rubber disc *f* is placed between each pair of discs *d*, *e*. The tool being introduced into the tube from the smokebox, the tightening at the front end is effected by means of the screw nut *s*. The rear end disc *e* has an eccentric neck *g* fitted against a sector *g* secured to the disc by a pin, and bearing against the bottom of the tube. This end is tightened by turning the spindle, the disc *e* being prevented from turning by the friction of the sector *g* against the wall of the tube against which it is pressed by the eccentric neck. Apertures *w* admit water to cool the discs *f*. One of the collars on the spindle C may be formed of two lock nuts so as to be adjustable, and the tube may be in two parts. (*Sealed September* 9, 1884).

TUBE CLEANER.

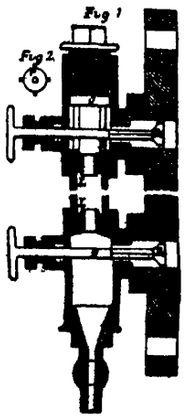
7751. C. Allen, Weston, Lanc. An Improved Apparatus for Cleaning the Tubes of Multitubular Boilers and for other Similar Purposes. [*4d.* 4 *Figs.*] May 13, 1884.—The apparatus consists of a long spring fork carrying upon the ends of its tines a scraper, formed as the hollowed frustrum of a cone divided longitudinally into two or more parts, and each part is attached to one of the tines, the connections being made from within the base of the cone. The cutting edge is formed by bevelling the hollow portion of the cone. The different portions of the scraper are provided with guides to insure their concentric closing. (*Sealed August* 19, 1884).

RAISING CHIMNEYS.

9688. J. T. Smith, Market Deeping, Northampton. Improved Means for Raising and Lowering the Chimneys of Portable and other Engines. [*6d.* 7 *Figs.*] June 5, 1884.—A ring embracing the chimney at or near its base has a short arm projecting forwards from it from which a stay passes to the upper part of the chimney, and to which a long lever handle can be attached. The end of the lever may be made to engage in a hook attached to the chimney at some distance up from its base. The embracing ring may be made in parts and bolted together so as to embrace any size of chimney. (*Accepted July* 25, 1884).

WATER GAUGES.

9366. E. A. Brydges, Paris. (*V. Agnès, Longuyon*). **Gauge Glass Fittings.** [*4d.* 6 *Figs.*] April 12, 1884.—The illustration clearly shows the construction of the fittings. The holder or plug C is, at its upper end, provided with a female screw into which a plug or bolt H is screwed. By means of the plug H, the



bronze disc J and forked piece I, the india-rubber ring Z is pressed on to the end of the glass tube L to effect a tight joint. As will readily be seen, the glass tube L can be easily and rapidly replaced. In order to provide for breakage of glass, the plug C is provided with a valve P guided in a stuffing-box, and open or closed by means of the handwheel. (*Sealed July* 29, 1884)

PRESSURE AND VACUUM GAUGE.

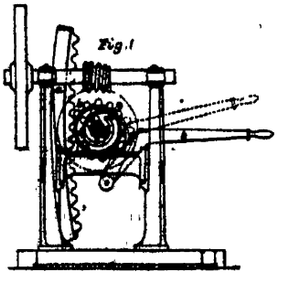
9418. E. Marsden, Sheffield. Improvements in Steam Pressure and Vacuum Gauges. [*4d.* 3 *Figs.*] June 26, 1884.—A metal diaphragm is suitably mounted in a metal casing, and has on either side of it concave cavities. These cavities are filled with mercury, and the one communicates with a pipe leading from the boiler or condenser as the case may be, the other communicating with a vertical glass tube provided on either side with suitably marked index scales. If used to register the pressure of water the diaphragm is electro-plated. (*Accepted August* 1, 1884).

CALORIC ENGINE.

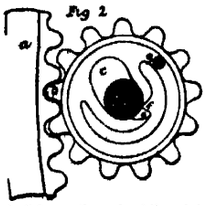
6145. F. Kneefort, London. Improvements in Hot-Air or Caloric Engines. [*6d.* 2 *Figs.*] April 3, 1884.—The object is to prevent the noise usually caused in this type of engine, by the air entering and leaving the open end of the cylinder. The invention consists in arranging an independent working cylinder in combination with two chambers, within each of which works a displacer, one of the chambers being connected on one side of the piston of the working cylinder and the other on the opposite side. This permits of the same air being used continuously, thereby obviating the necessity of connecting the interior of the cylinder with the atmosphere. Motion is imparted to the displacers by a rod, driven by a crank, moving a suitable lever to which are attached by links vertical rods connected to the displacers. (*Sealed August* 18, 1884).

BARRING ENGINES.

9622. J. Musgrave and A. Walsh, Bolton. Safety Gear for Starting Engines. [*6d.* 5 *Figs.*] February 6, 1884.

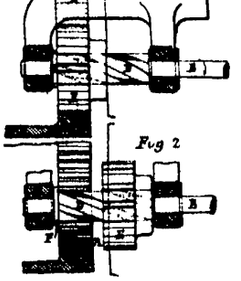


—Referring to the illustrations, the pinion or starting wheel *b* can be thrown into gear with the teeth of the flywheel *a* of the engine by a lever A, and as soon as the flywheel becomes the driver, this wheel *b* drops out of gear, it being mounted loosely, by means of the radial slot *c*, on a shaft *d* driven by worm gearing. The shaft *d* has a catch *e* that bears against a projection *f* on the side of the



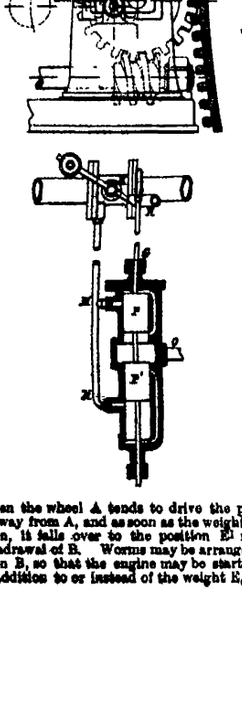
pinion when the shaft forms the axis of the pinion. The pinion is guided out of gear by a stud *g* secured to the framework and projecting into a groove in the pinion which is partly supported on the stud and partly on the shaft, and is always clear of the driving wheel when thrown out of gear, and cannot get into gear unless raised by the lever. (*Accepted August* 15, 1884).

6234. C. J Galloway and J. H. Beckwith, Manchester. Safety Gear for Starting Large Fly and other Wheels. [*4d.* 2 *Figs.*] April 25, 1884.—This consists of a shaft having on it a pinion geared with the wheel and fitted to slide along a helical feather or its equivalent so inclined that when the pinion is driven by the wheel, it is caused to slide out of gear. Referring to the illustrations, the shaft B is supported in bearings C, and between the bearings are formed helical grooves



and ridges D. A pinion E correspondingly grooved is mounted on the shaft. In order to start the wheel A, the pinion E is put in gear with its internal teeth by sliding it along the shaft as shown in Fig. 1, and on turning the shaft B in the direction of the arrow, the wheel A will be caused to revolve, the pinion being strained against the collar F. When the wheel A begins to move faster than the pinion, the pinion will be turned as a nut on the shaft and forced out of gear as Fig. 2. (*Sealed September* 5, 1884).

10,262. R. Matthews, Hyde, Cheshire. Safety Gear for Starting Large Flywheels or Driving Wheels. [*4d.* 3 *Figs.*] July 19, 1884.—Referring to Fig 1, the pinion B gears with the wheel A to be driven and with the driving worm. The shaft of the pinion B works in bearings D, which are free to slide backwards and forwards, and have jointed to them a tumbling



weight E. When the wheel A tends to drive the pinion B, the bearings slide away from A, and as soon as the weight E passes its vertical position, it falls over to the position E¹ rapidly completing the withdrawal of B. Worms may be arranged above and below the pinion B, so that the engine may be started in either direction. In addition to or instead of the weight E, the arrange-

ment shown in Fig. 2 may be adopted The pistons P^1 P^2 are connected to the vertical rod, Fig 1, and when B is in gear with A are in the position shown, steam entering by N and pressing up the piston and tending to keep the wheels in gear; when B moves away from A, the piston P^1 descends closing the supply port N and opens the passage from under P^2 to the exhaust O, and P also descending closes the passage from above P to O, and opens the supply M, the steam pressing down the piston P and causing B to be drawn out of gear with A The rod G may be connected to catch H which holds a lever K, so that the stop or throttle valve of the barring engine to which it is connected is kept open. But when the pinion is forced out of gear the rod G after descending a certain distance pulls down the catch H and permits the valve to be closed by the descent of the loaded lever K. (*Accepted August* 19, 1884).

SUPERHEATING AND REGULATING.

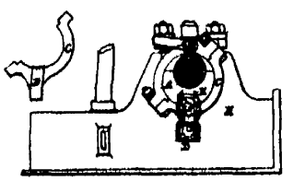
8485. H. H. Lake, London. (*J. P. Garadot, Neuville-sur Saône*). **Improved Apparatus for Superheating and Regulating the Supply of Steam or other Motive Fluid to Engines.** [6*d.* 2 *Figs.*] February 18, 1884.—The steam is expanded and superheated on its way from the boiler to the working cylinder by being passed into an intermediate cylinder set so as to be acted upon by the products of combustion and capable of having its capacity increased or diminished by a suitable piston. Motion is communicated to the piston of the intermediate cylinder by a screw working in a boss fixed in the piston, and actuated by the governor of the engine through the medium of a pair of bevel wheels, acting, according to the velocity of the governors, the one or the other upon a similar bevel wheel by which motion is imparted to the screw (*Sealed July* 18, 1884).

DISTRIBUTING VALVE.

4896. E. G. Martin, Cork. A Valve for the Admission, Distribution, Exhaust, and Cut-off of Steam Supplied to the Cylinder of a Steam Engine. [6*d.* 10 *Figs.*] March 5, 1884.—The valve consists of two cylinders, an inner and outer one, fitting accurately the one within the other The outer cylinder has ports leading to each end of the engine cylinder, and an exhaust port The inner cylinder has three steam compartments and an exhaust compartment, the divisions being effected by dividing walls provided with suitably-shaped apertures for the passage of the steam into the ports of the outer cylinder. The passage of the steam from one compartment to the other of the inner cylinder is so timed that the pressure on each of the partitions which separate the live steam compartment from the exhaust compartment is always equal and in opposite directions, so maintaining the valve in equilibrium. (*Accepted July* 29, 1884).

VALVE GEAR.

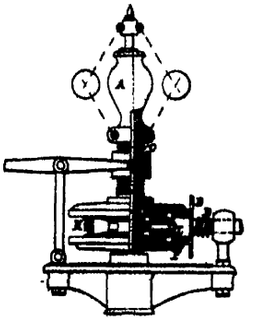
10,196. C. P. Holst, Amsterdam. Valve Gear for the Distribution Valves of Steam and other Motors. [4*d.* 2 *Figs.*] July 15, 1884.—A prism or sliding block is rigidly attached to the eccentric rod, and is arranged to work in guides oscillating on a pin carried by the framing of the engine, or a pin attached to the eccentric rod is connected to a radius rod The illustration shows the first method The eccentric strap C carries



a sliding block D rigidly attached to it and guided by an oscillating guide block E. The guide block E is carried by a pin supported by a plummer block attached to the framing H. The motion for the valves is derived from the pin K. By this arrangement a line drawn through the centre of the sheave A and a given point on the eccentric rod passes through a given fixed point. (*Accepted August* 15, 1884).

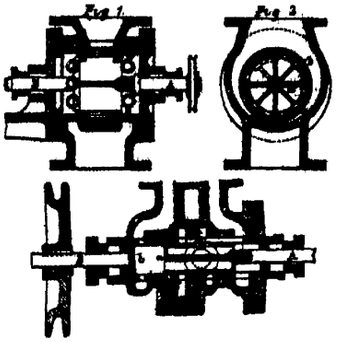
GOVERNORS.

5906. G Revet, Belbec, France. Governors Applicable to Steam Engines or Engines Driven by any Gas or Vapour. [6*d.* 3 *Figs.*] April 1, 1884.—Referring to the illustration, which clearly shows the construction of the governor, the disc F revolves with the governor A and the disc K is driven in the opposite direction by means of the disc H pressed against the disc E and F by a spring D. The speeds of the discs will be equal as long as they are equidistant from the centre of B, and in this position the bevelled rollers K L working between



the discs E and F will remain stationary with regard to the motion round the governor; but if the governor should rise or fall, and with it the discs E and F, their speeds will be no longer equal, and the two pinions will revolve around the governor, and turn the screwed sleeve O, which rises and falls with the governor balls, adjusting the nut until the balls return to their normal position. As will be seen the governor first effects the cut off or throttling, and then returns to its normal position without changing the position of the valve. A screw and rack may be substituted for the screw and nut. (*Sealed September* 5, 1884).

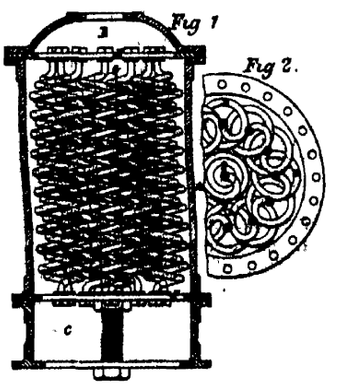
8277. W. Murdock, Glasgow. Governors for Motive Power Engines. [6*d.* 11 *Figs.*] April 3, 1884.—The apparatus comprises a hollow cylindrical valve *a* divided by a longitudinal partition into two compartments, each having a lateral port in its side. This valve *a* is surrounded by a second cylindrical valve *b* having ports in its side communicating with steam admission and exhaust ports cast all round the valve casing and with ports also cast all round the casing leading to the opposite ends of a governor cylinder The compartments of the valve *a* open at opposite ends into the cylindrical valve *b*. The two valves *a b* are carried by separate spindles A B revolving in the same direction, the spindle A being driven from a motor running at the required uniform speed and the other driven from the engine to be controlled. The slightest overrunning of the valve *a* over the valve *b* or *vice versâ* opens the steam port or exhaust port in the valve *b* through one compartment of the valve *a* to one end of the governor cylinder and the exhaust port or steam port at the valve *b* through the other compartment of the valve *a* to the other end of the governor cylinder. The piston of the governor cylinder acts on the throttle valve of the engine to be governed and also acts on the



spindle A to impart to it a longitudinal motion taking the helical ports out of line with the ports of the valve *b*, so that the motion of the piston of the governor cylinder ceases. In a modification, steam is admitted from the centre of the internal valve *a* to the governor cylinder instead of from the side. The arrangement of revolving valves is also adapted for use as a throttle or steam supply valve for the main engine. Referring to Fig 2, the ports or orifices in the valves *a b* are over each other and open to the same extent so long as the valves run at uniform speeds, but when one valve overruns the other the orifices open or close on each other according as the speed of the main engine is less or greater than that required. The two valves can only overrun to an extent limited by steps. (*Accepted August* 19, 1884).

CONDENSERS.

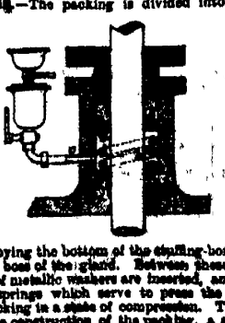
7990. J. Kirkaldy, London. Surface Condensers and Heaters. [6*d* 6 *Figs.*] May 8, 1884 —These are constructed with the cooling or heating surfaces composed of alternately right and left-handed spiral worms erected parallel with one another, and with the coils of each worm passing into the spaces between the coils of the adjacent worms. Referring to the illustrations, the outer casing A is provided with a steam chamber B at the top and chamber C for condensed water at the bottom The spiral worms D pass at their upper ends through the top tubeplate E, and at



their lower ends through the bottom tubeplate F, the coils of one worm passing into the spaces between the coils of the worms which are on either side of it, the spiral worms being alternately right and left-handed to permit this interlocking. The water is admitted to the casing through the pipe G, which extends to nearly the top of the casing, and is provided with holes at its lower part through which water is forced into the lower part of the casing. The overflow water passes off at an outlet near the top of the casing. (*Sealed September* 23, 1884).

STUFFING-BOXES.

8245. R. S. Keogh, Brockley, Kent. Packing for Stuffing-Boxes.—The packing is divided into two separate



layers, one occupying the bottom of the stuffing-box and the other the top next the boss of the gland. Between these two layers of packing, a pair of metallic washers are inserted, and between the washers strong springs which serve to press the washers apart and keep the packing in a state of compression. The illustration clearly shows the construction of the packing, a single spring S being employed to press the washers W apart and compress the packing P. An oil pipe O serves to introduce lubricant into the stuffing-box. (*Sealed September* 2, 1884).

CRANKSHAFTS.

941. E. Foster, Newcastle-on-Tyne. Improvements in Crankshafts and Crank-Axles. [6*d.* 10 *Figs.*] January 8, 1884.—The crank-pin, together with its two webs, are made in one piece. The webs are shrunk on to the ends of the shafts, and are further secured by a number of keys of any desired form, the ends of each shaft being enlarged so as to admit of the keys being driven in from the outside of the webs. (*Accepted August* 22, 1884).

SPRING PACKING.

8282. H. H. Taylor, Sheffield. Improvements in or Applicable to the Construction of Spring Packings for Pistons and other Analogous Uses. [6*d.* 9 *Figs.*] January 26, 1884.—This packing consists of a duplicate arrangement of spring rings, seated within the castings of the piston ring and expanded radially and vertically by an intermediate ring. The spring rings are formed with their inner surfaces at an angle, and the expanding ring is correspondingly formed as regards its external edge. (*Accepted July* 25, 1884).

7433. M. V. Schiltz, Cologne. Improvements in Packings for Pistons, Piston Rods, and Analogous Moving Parts. [4*d.* 2 *Figs.*] May 8, 1884.—The packing consists of a series of rings of metal, each having several slits, parallel to the axis of the piston or other part, so as to form a number of parallel flaps, each having sufficient elasticity to yield to the pressure of the elastic fluid and so form a tight fit. In fitting the packing the rings are placed so that the slits of any ring are covered by the flaps of the contiguous ring or rings. The rings may be longitudinally split and provided in the joints with transverse grooves and keys, or toothed edges. (*Sealed August* 29, 1884).

8304. W. Buckley, Sheffield. Improvements in Metallic Packing Rings for Pistons, Pump Buckets, Valves, and for other Similar Purposes. [6*d.* 14 *Figs.*] May 27, 1884.—The ring is made broad enough to occupy nearly the whole space between the flanges of the piston. One one edge of the ring and on its inner side there is a flange, or inner ring, the inner surface of which may be either of a parallel or other suitable form. The piston springs acting on the inner surfaces of the flange ring will extend the broad ring to the sides of the cylinder at the same time forcing the flange ring against the flanges of the piston, thus giving both a lateral and vertical action. (*Sealed September* 16, 1884).

PACKING.

8289. A. L. Normandy, London. An Improved Asbestos Packing for Preventing Leaks in Joints under Pressure. [6*d.*] January 30, 1884.—The material consists of paper, millboard, or cloth made of asbestos, and saturated with substances that will render it impervious to moisture. The saturating process may be carried on under a pressure, a vacuum, or by the aid of heat. (*Sealed May* 9, 1884).

CHAIN LINKS.

8991. T. F. Hall, Marietta, Ohio, U.S.A. Drive Chain Links. [4*d.* 3 *Figs.*] April 29, 1884.—The link consists of two straight cylindrical side bars, and a similar straight bar at one end forming the pivot bar to the next link, the socket or bearing at the opposite end in which the pivot bar works being straight, and having its throat or slot curved on the side next to the pivot or hook end, and concave on the opposite side next to the end bar. (*Accepted August* 19, 1884).

PISTONS.

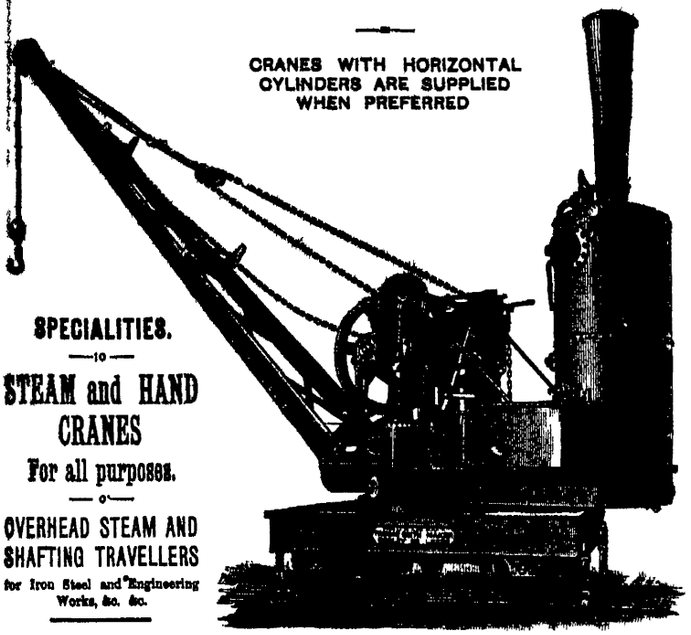
7218. G. Dieckmann, New York, U.S.A. An Improved Piston. [4*d.* 5 *Figs.*] May 5, 1884.—The piston is made with cup-shaped or concave faces decreasing in thickness towards the piston ends to enable it to tighten against the walls of the cylinder in proportion as the pressure increases. The tightening pieces may be made in overlapping sections connected together by elastic bands. (*Sealed August* 12, 1884).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 28 and 26, Bedford-street, Strand.

NEW ZEALAND GOVERNMENT RAILWAYS.—The general manager of the New Zealand Government Railways has just presented his report upon the working and progress of the lines in 1883 He states that 49 miles of rails have been laid against 36 miles in the previous year. Only 293 miles, out of 893 miles, are now laid with rails below the standards, taken at 53 lb. for the main line and 40 lb. for the branches. The consumption of sleepers has risen since 1879-80 from 50,000 to 160,000. The bridging is heavy and expensive to maintain, being chiefly of timber. In the Christchurch district there are 6 miles 76 chains of bridging; in the Dunedin district there are 3 miles 60 chains; in the Invercargill district there are 1 mile 43 chains—a total of 14 miles 27 chains. The cost of maintaining this will increase annually. During the year 90 miles of live fences have been planted, and 20 miles of ground have been prepared; 95 acres of plantations of trees have been made, and 50 acres of ground have been prepared. Extensive additions have been made to station accommodation, and appliances at Invercargill, Addington, Parkfield, Chaneys, Valette, Mahene, Palmerston, Burkes, Burnside, Henley, Mataura, Thuf, Winton, Gore, Waipahi, Stirling, Milburn, Waikouaiti, and Edendale. Numerous cranes, weighbridges, and improvements to water services have been added. The expenditure by the maintenance department has been: For maintenance, 189,677*l.*; public works department, 31,106*l.*; general public, 2,848*l.*; total, 197,485*l.* Six new private sidings have been erected and 99 leased. The revenue from leases now amounts to 832*l.* per annum. In the locomotive department five new tender engines have been added to the stock. The stock of wagons has been increased by 466, the carriage stock by 12, and the tarpaulins by 486. The expenditure on wagon renewals has been heavy. Brown coal has been chiefly used, giving good economical results. The workshop accommodation has been largely increased, and is now, with some exceptions, fairly equal to the present requirements. The engine shed accommodation is insufficient for the stock.

SMITH'S STEAM CRANES.



CRANES WITH HORIZONTAL CYLINDERS ARE SUPPLIED WHEN PREFERRED

SPECIALITIES.

STEAM and HAND CRANES
For all purposes.

OVERHEAD STEAM AND SHAFTING TRAVELLERS
for Iron Steel and Engineering Works, &c. &c.

LOCOMOTIVE & PORTABLE STEAM CRANES
IN STOCK AND PROGRESS,

Having all the most recent improvements, including

RAPID MOTIONS
For working Expeditiously

Adapted for Docks, Public Works, Railways and Iron, Steel, and Engineering Works &c.

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NEW DOCK WORKS, HULL
And 10 *to*
BLACKFRIARS RAILWAY BRIDGE EXTENSION, LONDON
And many other Important Works, both at Home and Abroad

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THOMAS SMITH, Steam Crane Works, RODLEY, near LEEDS.



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Of all descriptions on the Single and Double-Rope Systems; Self Acting, and Driven by Steam, Water, or Horse Power
Carrying from 50 to 1,000 tons per day Over 150 miles erected in all parts of the world. For Particulars and Estimates apply to
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TRADE MARK
PHOSPHOR MANGANESE BRONZE
THE BEST KNOWN BRONZE FOR BEARINGS, AND WEARING PARTS OF MACHINERY, &c.; SEE OUR CIRCULAR.

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LONDON OFFICE 70 BISHOPSGATE STREET — J. B. GUTHRIE, AGENT
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Steam & Hand Cranes, Crab Winches, and all kinds of Lifting Tackle
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SILVER MEDAL, MELBOURNE

Improved Gas Valves.

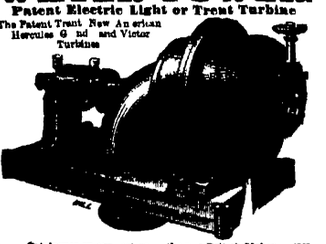


ALSO MAKERS OF
VALVES
FOR
WATER STEAM,
AMMONIACAL
LIQUOR
TAR
AND
CHEMICALS
AND SOLE MAKERS OF
J. Beale's New Patent Gas Exhausters

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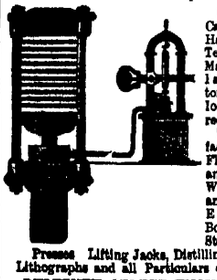
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Engineers and Machine Tool Makers
To Governments and Leading Works
Tools always in stock and progress (immediate delivery)
LATHES 6 in and 7 in Slide Surfacing and Screw cutting 6 7 8 and 10 ft 1 eds
LATHES 8 in do do 8 ft 10 ft and 12 ft beds.
LATHES 9 in do do up to 20 ft. beds.
LATHES 10 in and 12 in do do up to 28 ft. beds
PLANES 2 ft. by 2 ft by 4 ft. 5 ft. and 6 ft long
PLANES 2 ft 6 in by 2 ft. 6 in by 6 ft and 8 ft long
Our Patent Square Centreing Facing and Chamfering Machines will square centre any length of shafts.
Over 500 in use
SLOTTERS, 7 in., 8 in., 10 in and 12 in stroke
Bench Drills, Pillar Drills, Radial Drills Milling Screwing, Screw and Stud Making Machines, &c
Price Lists Free, which will favourably compare with any Tools for shipment securely packed
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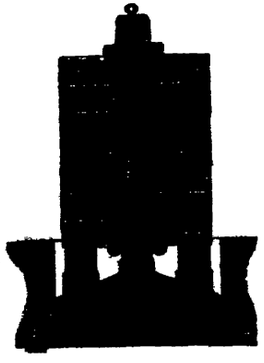


McTear's Patent Calcining Furnaces, Haworth's Patent Tea Leaf Rolling Machines Kirk's Patent Refrigerators for producing Ice—no chemicals required
They also Manufacture all kinds of Flour, Rice, Corn and Sugar Mills Water Wheels High and Low Pressure Engines, Steam Boilers Tanks Oil Stills Hydraulic Presses Lifting Jacks, Distilling Plant, &c.
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PULTENEY STREET ENGINE WORKS,
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TANGYES LIMITED CORNWALL WORKS, BIRMINGHAM

LONDON · 35, Queen Victoria Street. NEWCASTLE: St. Nicholas Buildings. MANCHESTER: Deansgate. GLASGOW: Argyle and Hope Streets.

TANGYES' IMPROVED HYDRAULIC ACCUMULATOR.



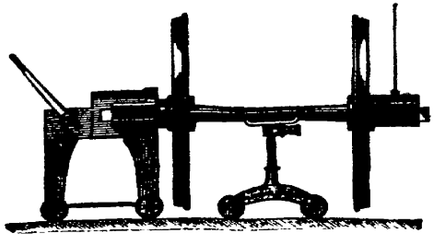
The accumulator consists of a strong cast-iron, or steel, cylinder, stepped into a heavy malleable plate, wrought-iron, steel or cast-iron, ram, carrying a heavy cast-iron head, which is suspended, by means of strong wrought-iron bolts, a cast iron plate, which spans the plates forming the load; these latter surround the ram, and protect it from [illegible], dust, &c.

The fittings include safety valve, trip valve, stop rods, and stop plate.

Quotations on receipt of necessary particulars. 152

TANGYES' HYDRAULIC WHEEL PRESS

For forcing Railway Carriage, Wagon, and Locomotive Wheels on and off their axles.



Size	Diam. Ram	Run out	Power	Weight.	With 2 Pumps.
A	7 ins.	9 ins.	50 tons	12 cwts.	£40
B	9 ,,	9 ,,	75 ,,	23 ,,	45
C	10 ,,	18 ,,	100 ,,	50 ,,	90
D	12 ,,	18 ,,	150 ,,	75 ,,	110
E	12 ,,	18 ,,	200 ,,	— ,,	120

Hydraulic Pressure Gauge, £3 3 extra.

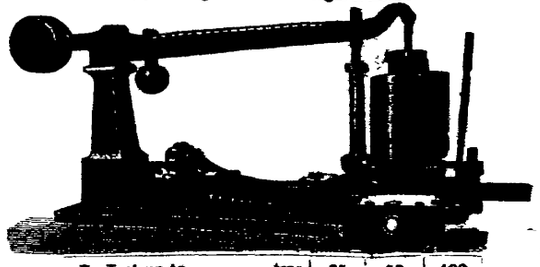
The C, D, and E sizes are generally as shown in illustration, and are for Locomotive Wheels. They consist of powerful Press with Cylinder and Ram, windlass draw-back gear, pair gun-metal pumps in cast-iron cistern, with stop and safety valves, mounted on four wheels. Also two cross-heads, wrought-iron tension bars, and ratchet screw elevator, on four wheels. These sizes are arranged to take off one and put on two locomotive wheels at a time.

The A and B sizes are for carriage and wagon wheels, and are somewhat differently arranged, having screw drawback, no elevator, and one cross-head only. They put on or take off one wheel at a time.

If made for Wheels with Solid Wood Centres, No. A £5, and No. B £10 extra. 151

TANGYES' HYDRAULIC TESTING MACHINE

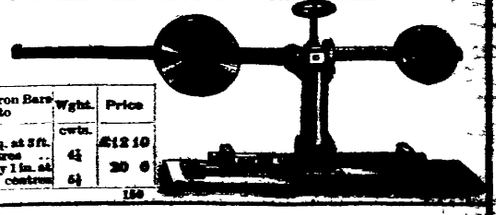
For Testing the Tensile Strength of Metals



To Test up to . . . tons		25	50	100
Price, including a set of Clips	£	75	150	250
Clips, per set		30s.	40s.	60s.
Ultimate Extension Indicator	£	15	10	25

In ordering, say whether for round, square, or other section Iron. Above can be marked to suit weights of foreign countries.

TANGYES' DEAD WEIGHT TRANSVERSE TESTING MACHINE



No.	To Test	Cast-iron Bars up to	Wght.	Price
	cwts.		cwts.	
1	10	1 in. sq. at 3 ft. centres	4¼	£12 10
2	40	2 in. by 1 in. at 3 ft. centres	6¼	20 0

150

TANGYES' HYDRAULIC "OIL" PRESS

(WITH PRESSING BOXES)

For Linseed, Cotton, Rape, Olive, Castor, and other Oils.



This press is easily worked by one man, and produces a good per centage of oil.

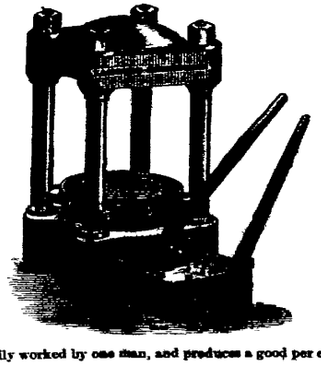
It consists of massive head and base, four wrought-iron screwed columns, cylinder, ram, pressing boxes, pair best gun-metal pumps in cistern, stop valve and working levers.

No.	Diam. Ram.	Power Tons	Price with 2 Boxes	Price with 4 Boxes
169	10 ins.	150	£40	£50
171	12 ,,	200	50	60

Roller Mills, £3. Seed Heaters, £3.
Hair Cleaners, £2. Best Woollen Bags, 4s. 170

TANGYES' HYDRAULIC "OIL" PRESS,

For Linseed, Cotton, Rape, Olive, Castor and other Oils.



This Press is easily worked by one man, and produces a good per centage of oil.

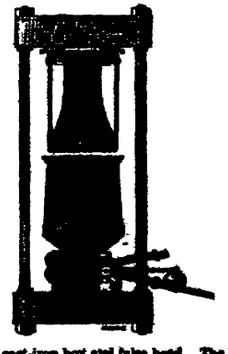
It consists of massive head and base, four wrought-iron screwed columns, cylinder, ram, round platten and drain pipe, pair best gun-metal pumps in cistern, stop valve and working levers.

No.	Diam. Ram.	Power Tons.	Price.
170	10 ins.	150	£36
171	12 ,,	200	46

Roller Mills, £3. Seed Heaters, £3. 171

TANGYES' HYDRAULIC "TALLOW" PRESS

For Tallow Grooves, &c.



This Press has a strong cast-iron box and false head. The box measures 26 in. by 26 in. by 24 in., and has a perforated lining. The false head has rollers for running it on rails when changing the box. Pair of best gun-metal pumps, safety and stop valves.

No. 180.

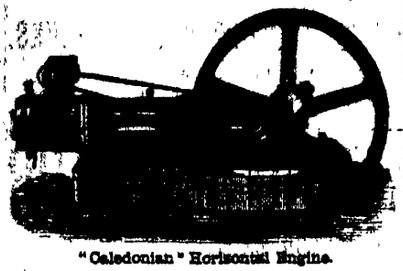
Diam. Ram	Tested to	Weight	Price
6 ins.	50 tons	45 cwt.	£[illegible]

This Press may be had with Detached Pumps for hand or steam. 179

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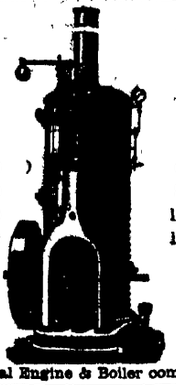
SHANKS'S HORIZONTAL AND VERTICAL HIGH-PRESSURE STEAM ENGINES.

THESE ENGINES ARE THE CHEAPEST AND MOST POWERFUL IN THE MARKET.



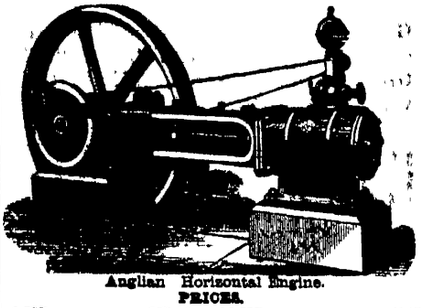
"Caledonian" Horizontal Engine.

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4 HP.	... ... £35	16 HP.	... ... £120
6 HP.	 45	20 HP.	 150
8 HP.	 60	25 HP.	 200
10 HP.	 70	30 HP.	 270
12 HP.	 88		



Vertical Engine & Boiler combined.

PRICES.	
2 HP.	£70
3 HP.	80
4 HP.	90
5 HP.	100
6 HP.	£110
8 HP.	150
10 HP.	175
12 HP.	200



Anglian Horizontal Engine.

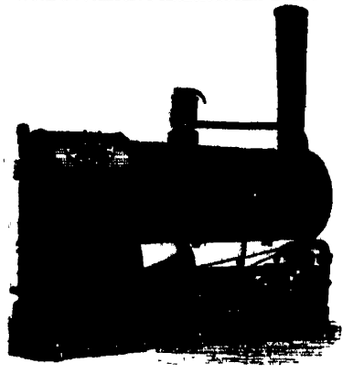
PRICES.			
6 HP.	... ... £57 10s.	16 HP.	... ... £145
8 HP.	... ... 77 10s.	20 HP.	 175
10 HP.	 95	25 HP.	 210
12 HP.	 110	30 HP.	 240

MARINE ENGINES

of MASSIVE CONSTRUCTION and LARGE WEARING SURFACES. The Smaller Surfaces are CASE-HARDENED, and all others provided with GUN METAL BEARINGS, with suitable provision for adjustment.

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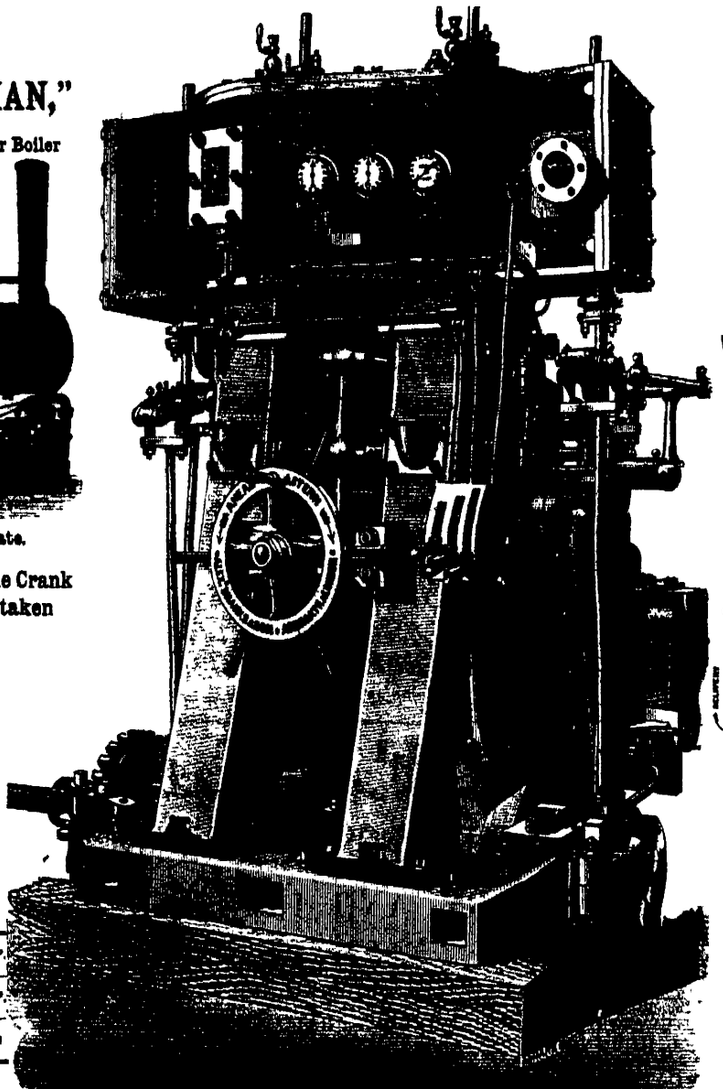
With Locomotive Multitubular Boiler



Combined on one Sole Plate.

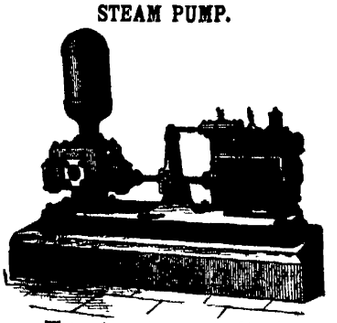
The Engine having a Double Crank enables the power to be taken from either side.

The above is the cheapest and most convenient form of Engine with Locomotive Boiler in the market.



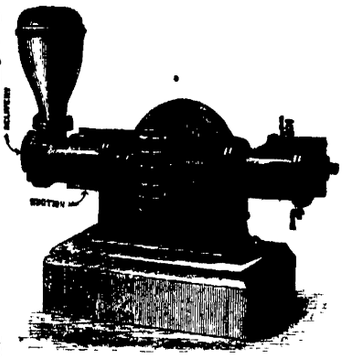
Size of Engine	4 HP.	6 HP.	8 HP.	10 HP.	12 HP.
Size of Boiler	6 HP.	8 HP.	10 HP.	12 HP.	14 HP.
Engine & Boiler as above	£120	£155	£210	£260	£300

SHANKS'S IMPROVED DIRECT-ACTING STEAM PUMP.



The utmost regularity in reversing and steadiness in working secured.

SHANKS'S IMPROVED EXPANSIVE STEAM PUMPING ENGINE.



THE SIMPLEST MADE. ACTION CERTAIN.

Prices, Illustrations & Particulars on application.

ALEX. SHANKS & SON will be glad to furnish, on application, detailed Specifications for Engines up to 1000 I. HP., with suitable Boilers, fixed on board complete, or securely packed for shipment.

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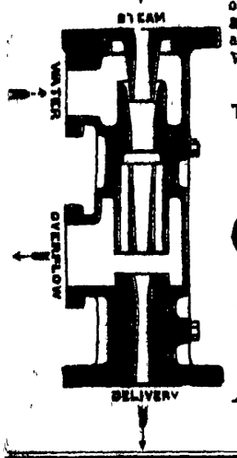
GALVANIZED CORRUGATED AND PLAIN SHEETS.
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For Supplying Stationary, Locomotive, Agricultural, or Marine Steam Boilers with Water.

Fig. 1.



The Self-acting Injector possesses the following great advantages over all other Injectors:—It is perfectly Automatic, and cannot fail to work. It will lift its water supply 15 ft.; and can, when specially ordered, be made for greater lifts. It will work with more ease and certainty with hot water than any other Injector. If it ceases working from any cause (for instance, shortness of water, and consequent admission of air), it will re-start Automatically immediately the cause is removed. It will work equally well at any pressure from 10 lb. to 200 lb. It may be fixed in any position above or below the water supply.

The combining and receiving Cones of Fig. 2 can be taken out and cleaned without breaking any pipe joints.

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Upwards of **100,000** *of Gresham's Patent Injectors are now in use.*

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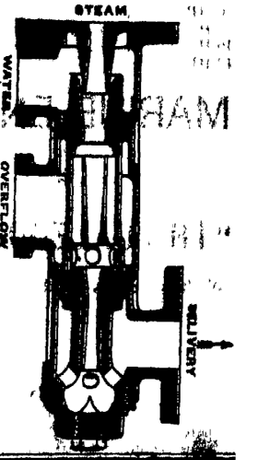
Craven Ironworks, South Hall Street, Ordsal Lane, Manchester.

LONDON OFFICE:

A. L. SACRE, 60, QUEEN VICTORIA STREET, E.C.

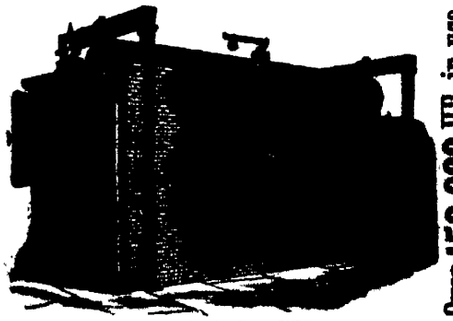
AGENTS—Glasgow: WILLIAM LESTER, 65, Renfield Street. Newcastle-on-Tyne: TANGYE BROS., St. Nicholas Buildings. Birmingham: TANGYES Limited, Soho. 5089

Fig. 2.



THE BABCOCK AND WILCOX CO.

(NEW YORK & GLASGOW)



Over 150,000 HP. in use.

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WATER-TUBE STEAM BOILER.

Safe, Economical (as to space and fuel), and Durable; Having Perfect Water Circulation, and Spacious Steam-room; Easy of Transportation, and perfectly Accessible for Cleaning external and internally.

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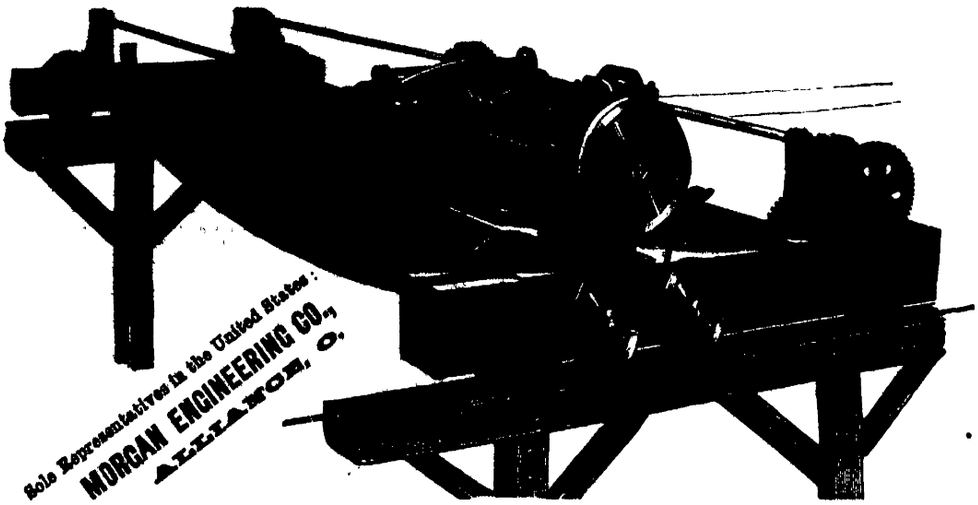
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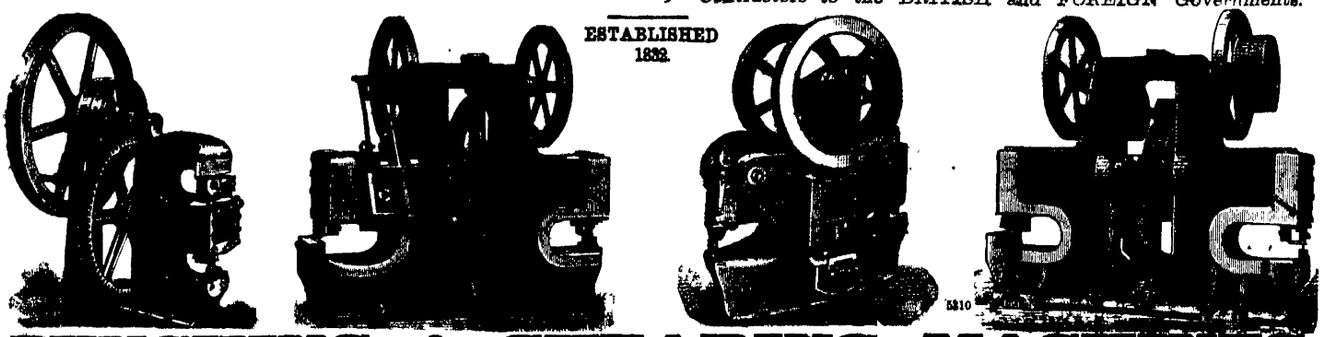
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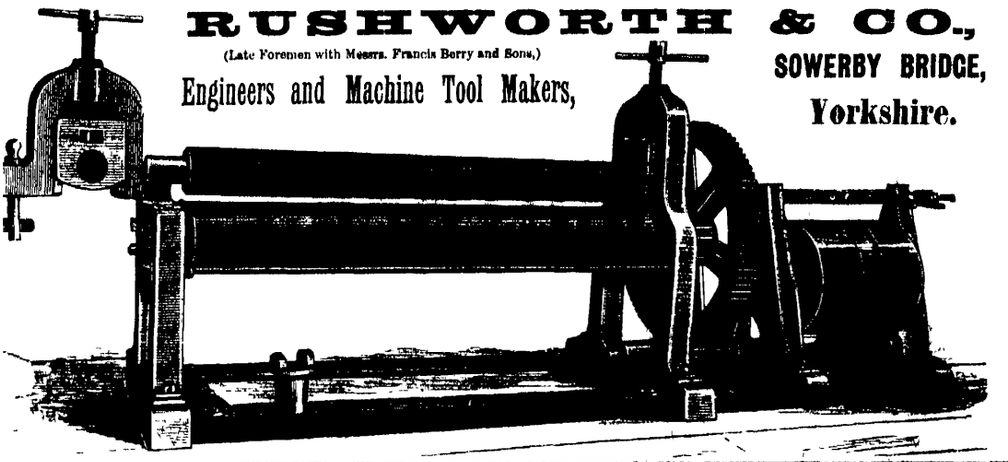
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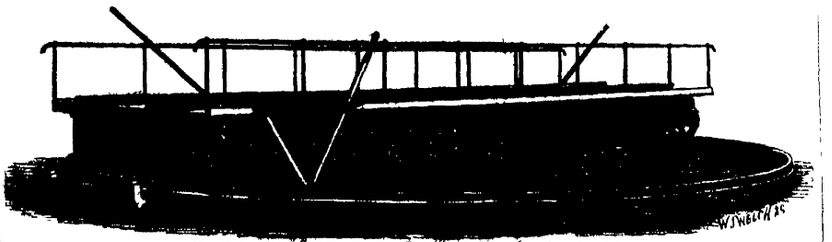
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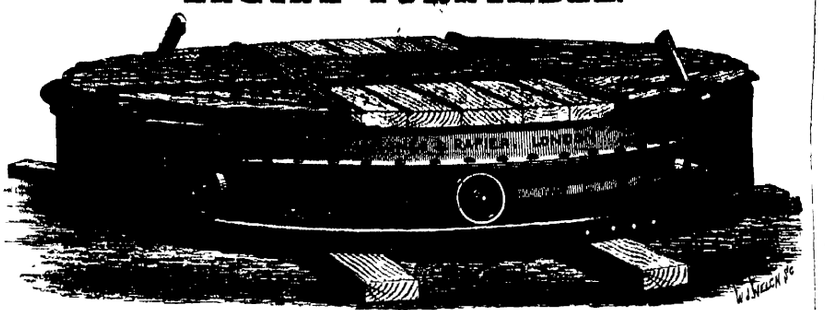
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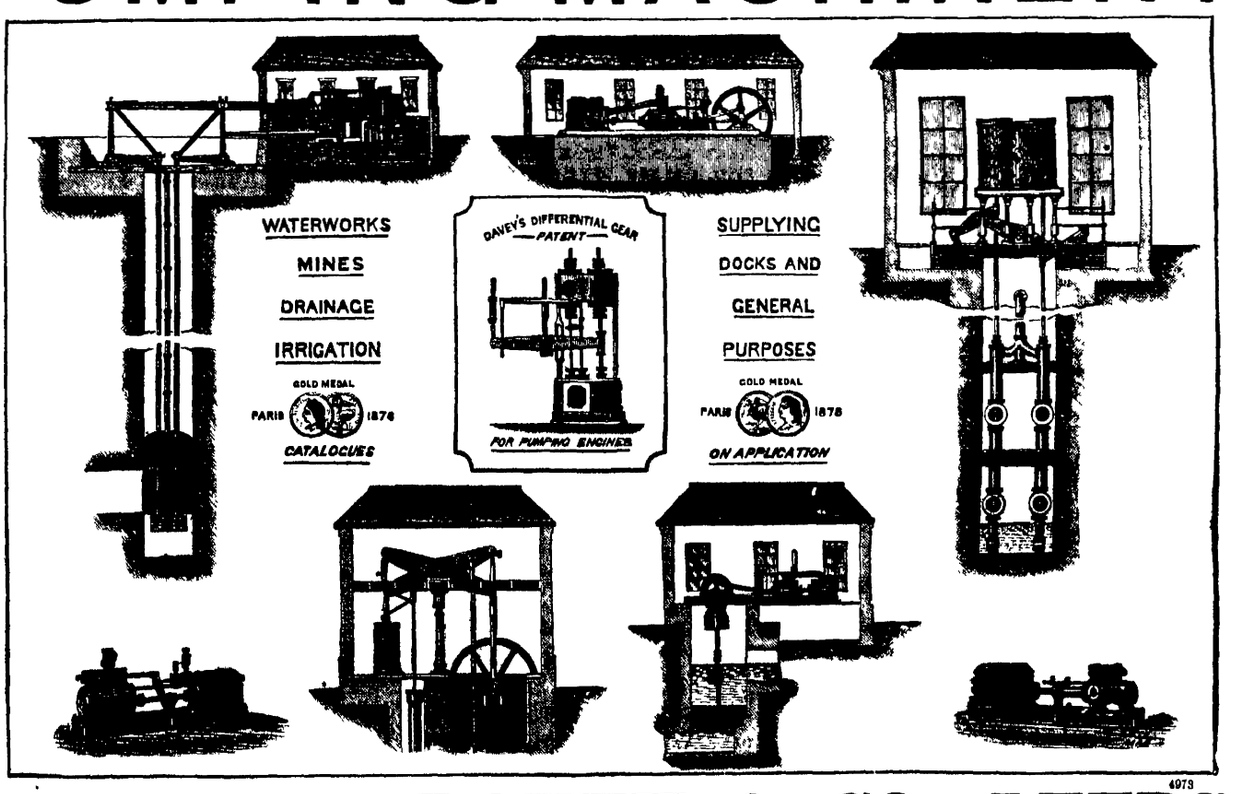
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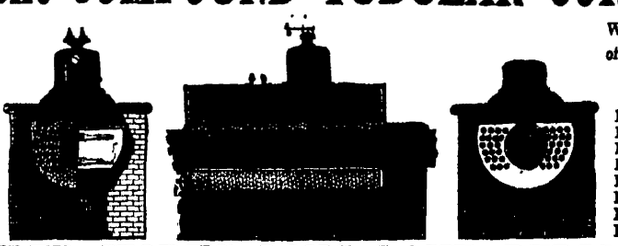
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12ft.	,,	6ft. 0in.	,,	40	,,
13ft.	,,	6ft. 6in.	,,	50	,,
14ft.	,,	7ft. 0in.	,,	60	,,
15ft.	,,	7ft. 6in.	,,	70	,,
16ft.	,,	8ft. 0in.	,,	80	,,
17ft.	,,	8ft. 0in.	,,	90	,,
18ft.	,,	8ft. 0in.	,,	100	,,

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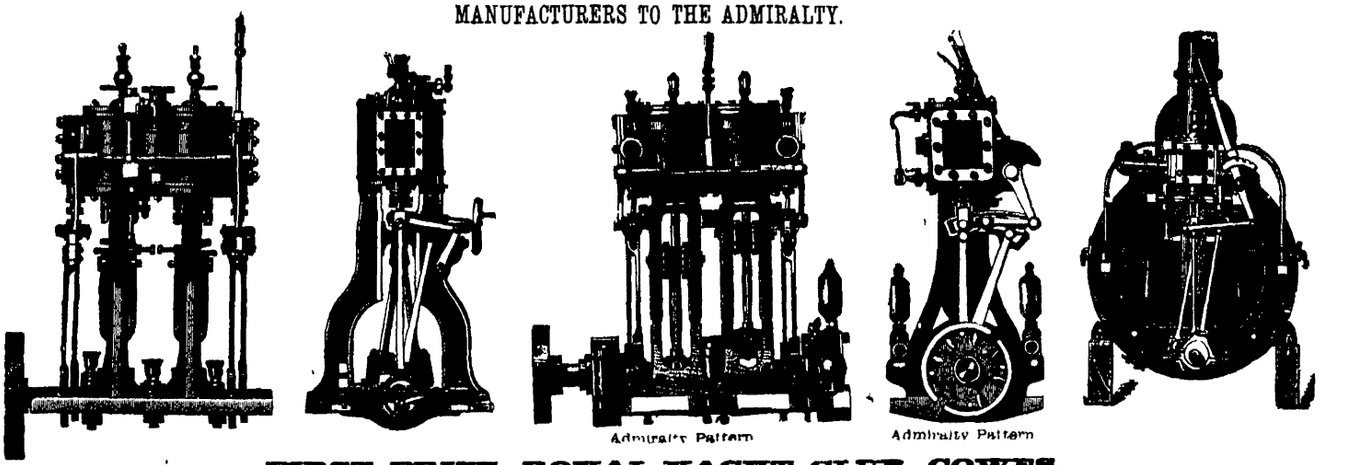
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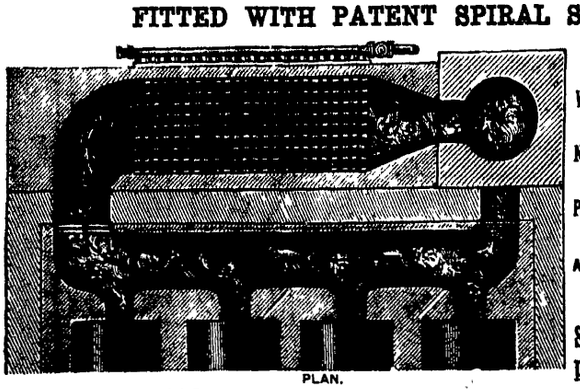
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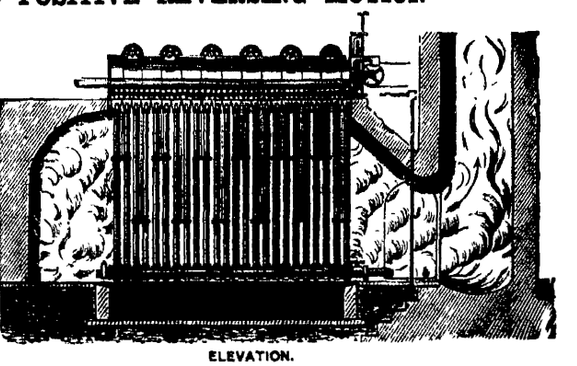
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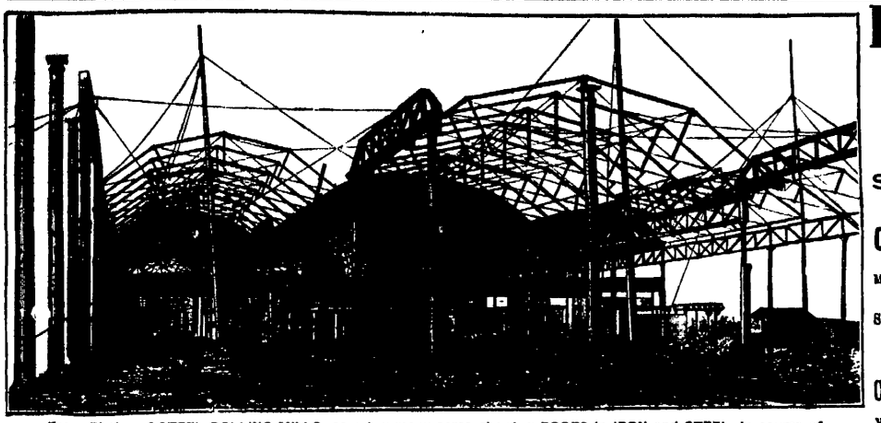
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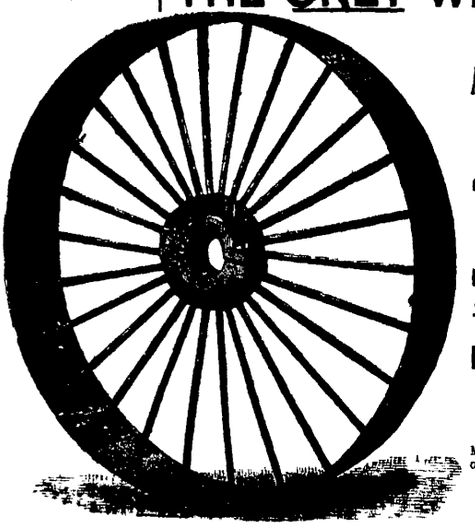
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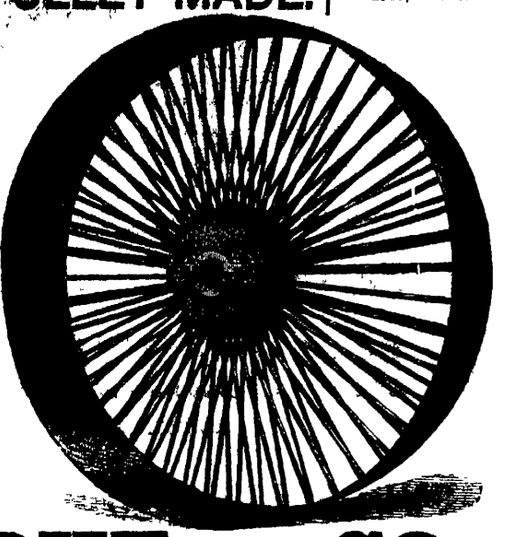
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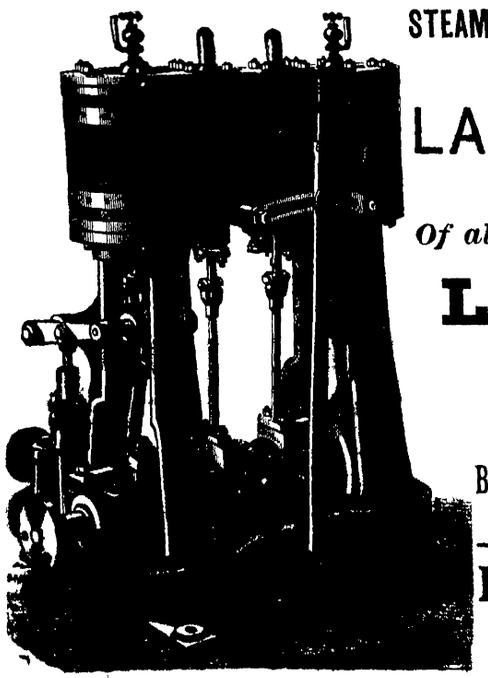
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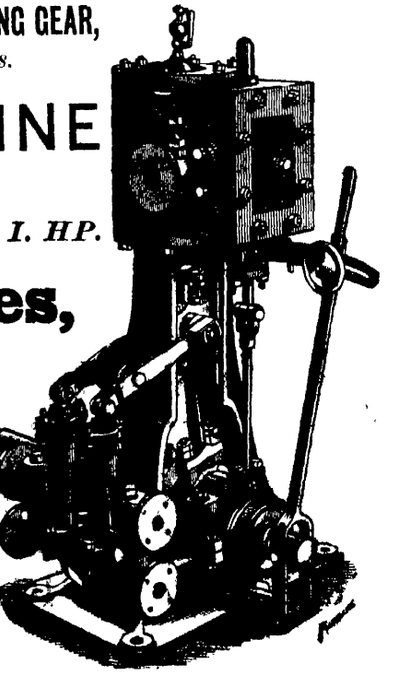
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4926

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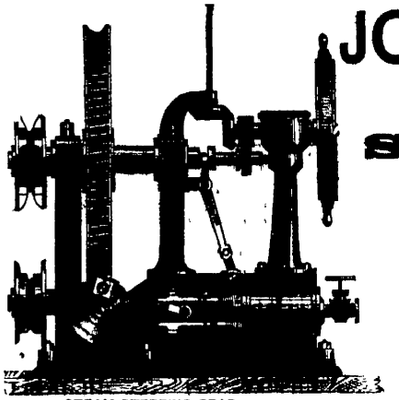
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5101

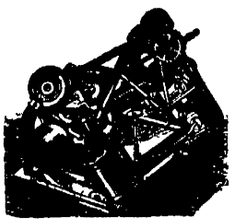
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ENGINEERS AND BOILER MAKERS, &c.

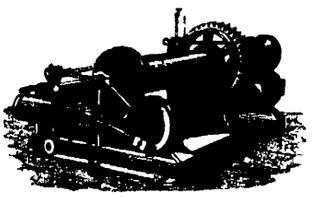
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New Zealand Shipping Co., Limited.

R.M.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,664 miles continuous steaming without renewal.

Steam Pressure.... ..110 lbs. | Vacuum . . . 26 inches.

My experience does not show an equal result from any other packing

The voyage from New Zealand to Plymouth was accomplished in 27 days 22 hours, being the fastest run from New Zealand on record. Yours obediently,

D HENDERSON, Chief Engineer, S.S "Ruapehu"

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 10th, 1884

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing It is especially valuable when high pressures are employed, as in cases where other packings have perished owing to high temperatures, your packing has invariably stood well I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory Yours truly,

Mr. J. BELL. G H. CLARKE, Sup Engineer

Department of the Director of Navy Contracts, Admiralty, Whitehall, 20th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core..... .square. | Elastic core ... round

To Mr JOHN BELL. JOHN COLLETT, Director of Navy Contracts

The Patent Block Packing is square, as Fig 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark



— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices All home orders should be sent direct to the undermentioned depots and not through agents or factors.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up adheres to metal and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP, gave the following results —

Temperature on Plated 154 deg.

" Covering 94 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering —

Offices of the Wimbledon Local Board, Wimbledon, Nov 28th, 1883.

"Dear Sir —It may interest you to know that we save exactly 40 per cent in fuel through using your covering —Yours truly, 'W SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

Gunnislake, Tavistock, 8th April, 1884.

Mr. JOHN BELL, Southwark, S.E.

Sir —I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results Since it has been in use we have saved fully half our coals and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries and is fully exposed to all weathers. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W J CHALK, Assoc M. Inst, C.E., Engineer and Manager

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors It is kept in stock in pads of 100 ft., from ¼ in to 2 in wide, and any thickness from 1 16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is supplied in sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by depriving the free oxygen that is in the water entirely checks pitting and corrosion. It also [illegible] incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1 16 in thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 30 per cent.; ¼ in., 120 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the hard tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

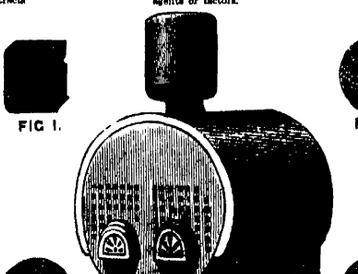


FIG 1.

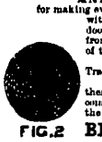


FIG.2

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material Made in sheets measuring about 40 in. square, from 1-64th in to 1 in., and ¼ millimetre to 20 millimetres thick Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts, Admiralty, Whitehall, S. W., 17th May, 1884.

SIR,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,

MR JOHN BELL. Director of Navy Contracts

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality

I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



FIG.4.



FIG.3.

BELL'S ASBESTOS EXPANSION SHEETING, Patent

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanized Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REGD.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

OR THE DEPOTS— 4943

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

READING IRON WORKS, LIMITED.

HORIZONTAL CONDENSING - ENGINES	VERTICAL - - - - BOILERS
COMPOUND CONDENSING - ENGINES	CORNISH OR SINGLE FLUE - BOILERS
BOTH CLASSES NON-CONDENSING ENGINES	LANCASHIRE OR DOUBLE FLUE BOILERS
VERTICAL, to 12 Horse-Power - ENGINES	MULTITUBULAR - - - BOILERS
AUTOMATIC EXPANSION- - ENGINES	SEMI-PORTABLE - - - BOILERS
PORTABLE, HIGHEST CLASS - ENGINES	And VERTICAL - - - BOILERS
SEMI-PORTABLE - - - ENGINES	In COMBINATION with VERTICAL ENGINES
TRACTION - - - - ENGINES	

FOR CATALOGUES AND INFORMATION APPLY TO 4781

THE READING IRON WORKS, LIMITED, READING, BERKS.

THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

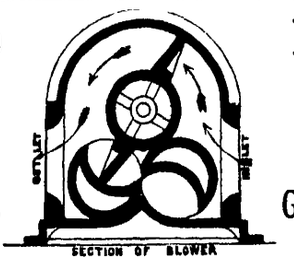
Baker's Patent Rotary Pressure Blower and Gas Exhauster

—:o:—

BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

—:o:—

HALL'S PATENT STONE BREAKER.

—:o:—

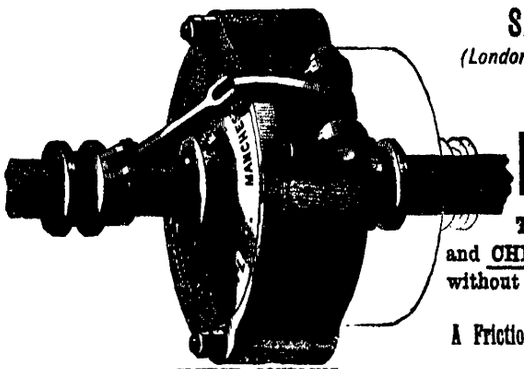
General Machinery of Every Description.

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4658

MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.)



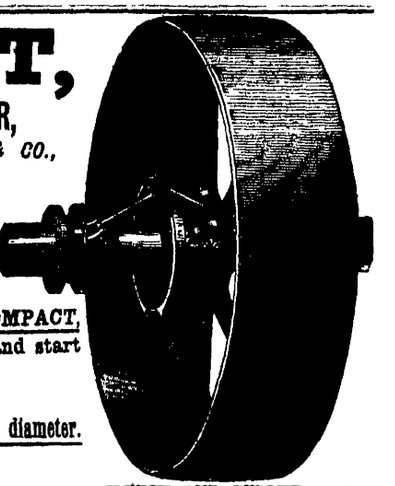
CLUTCH COUPLING.

— PATENT —

FRICTION CLUTCH.

These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.



CLUTCH AND PULLEY 5260

LIBERAL TERMS TO THE TRADE. PRICES ON APPLICATION.

GOODFELLOW & MATTHEWS,

(LATE B. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS.

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED, AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION.

HARDINGHAM's Patent Sectional STEAM BOILER

ANNULAR WATER-TUBE SYSTEM.

FOR

FULL PARTICULARS,

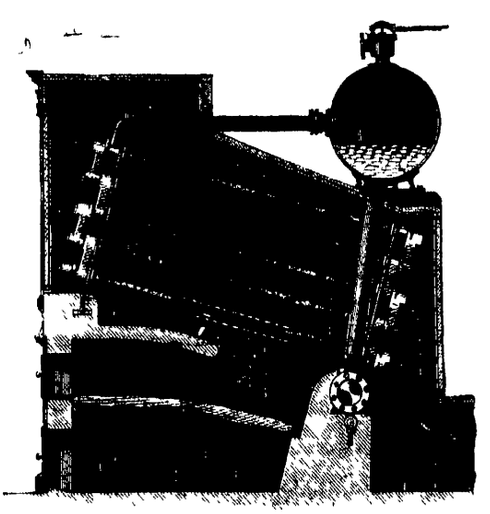
Apply to

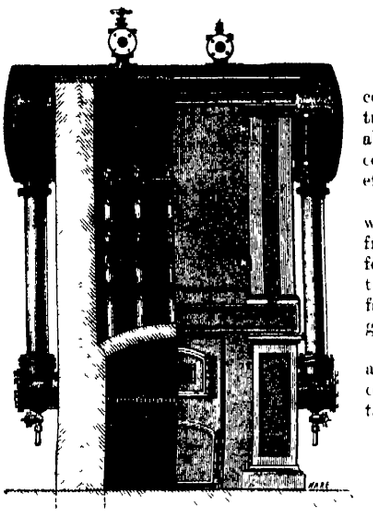
G.G.M. Hardingham

Engineer,

191, Fleet Street,

LONDON, E.C.





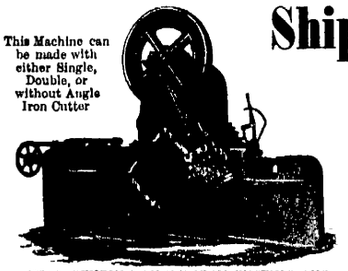
By this improved construction of Water-tube Boiler, considerable economy in first cost and in working is effected

Although the water-ways are exceptionally free from liability to fouling, the construction affords peculiar facilities for their regular inspection.

The system further allows of extreme compactness being attained.

4957

Shipbuilders' and Boilermakers' Tools.



This Machine can be made with either Single, Double, or without Angle Iron Cutter

BEAM-BENDING ANGLE IRON CUTTING AND HORIZONTAL PUNCHING MACHINE

SMITH BROTHERS & CO.,

KINGSTON ENGINE WORKS, GLASGOW,

MAKERS OF ALL KINDS OF

Punching and Shearing Machines, Plate-Bending Rollers, Beam-Bending and Horizontal Punching Machines (with either Double, Single, or without Angle Iron Cutter Combined), Plate-Edge Planing Machines, Keel Plate or Garboard Strake Bending Machines, Plate-Straightening Machines, Countersink Drills, Single-Drill Verticals, &c., &c.

PRICE AND PARTICULARS ON APPLICATION

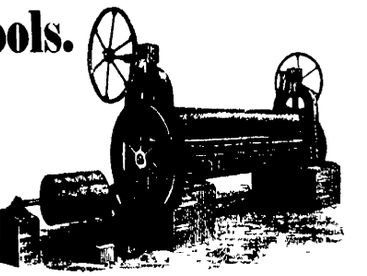


PLATE BENDING ROLLERS

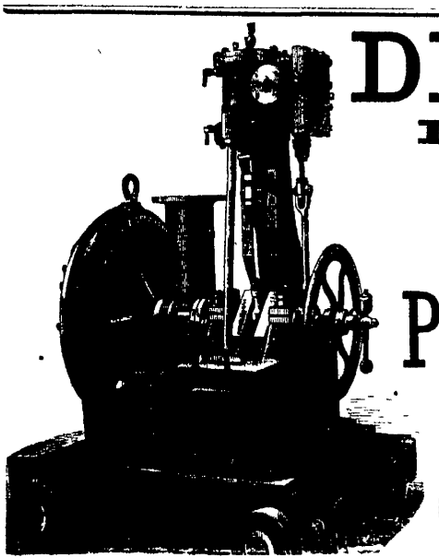
INTERNATIONAL HEALTH EXHIBITION.

CENTRIFUGAL PUMPING MACHINERY

FOR IRRIGATION,

Suitable for India, Egypt, and Elsewhere.

SIMPSON AND COMPANY, of PIMLICO, LONDON, have on EXHIBITION, close to the Water Companies' Pavilion, a CENTRIFUGAL PUMP capable of delivering 10,000 Tons of Water per Hour.



DRYSDALE & CO.

LONDON ROAD, GLASGOW.

DIRECT-ACTING

Vertical Centrifugal

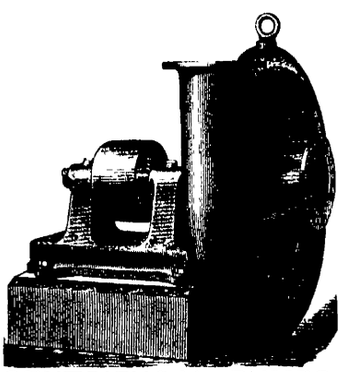
PUMPING ENGINES

FOR

Circulating or Ballasting Purposes.

RECEIVED AWARD AT THE NORTH-EAST COAST EXHIBITION, TYNEMOUTH, 1882.

4981



CENTRIFUGAL PUMPS.

ORMEROD, GRIERSON & CO.,
St. George's Ironworks, Hulme, Manchester,
Have the largest assortment in the trade of
PATTERNS OF SPUR WHEELS, BEVEL WHEELS, AND MITRE WHEELS, WITH TEETH CUT BY MACHINERY.
Also Fly Wheels, Driving Pulleys, and Drums can be supplied Bored and Turned if required
Catalogues on application Also Manufacturers of Blast Engines, Colliery and other descriptions of Stationary Engines and Boilers, Mill Gearing Cranes and Turntables, &c.
London Office 5, WESTMINSTER CHAMBERS VICTORIA STREET, S.W. 5328

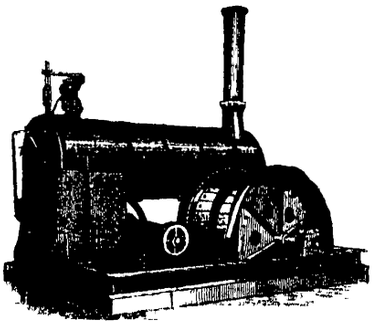
JAMES GOODWIN AND COMPANY,
Ironfounders, Engineers, and Bridge Builders.
CONTRACTORS for RAILWAY PLANT, viz. Cast Iron Chairs, Sleepers, Tanks, Water Cranes, Axle Boxes, Screw Piles for Bridges, Piers, and Wharfs, Blast Furnace Castings, Ingot Moulds, and every description of Plant for Collieries, Iron Works, &c
Also all kinds of Castings for Engineers and Tool Makers Manufacturers of Iron and Steel Bridges, Iron Roofing and Buildings, and General Structural Work. (Bridge Works at Motherwell). 2247
Works, Ardrossan, Johnstone, and Motherwell
Shipping Ports Ardrossan, Glasgow, Greenock, Leith

EDWARD HAYES, Engineer, STONY STRATFORD.
(LONDON OFFICE: 12, GREAT ST. HELENS, E.C.)
STEAM LAUNCHES
Speed from 10 to 25 miles per hour.

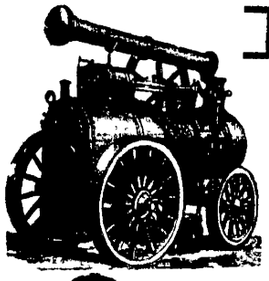
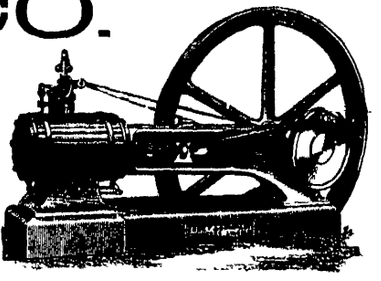
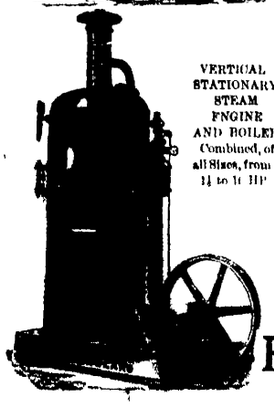
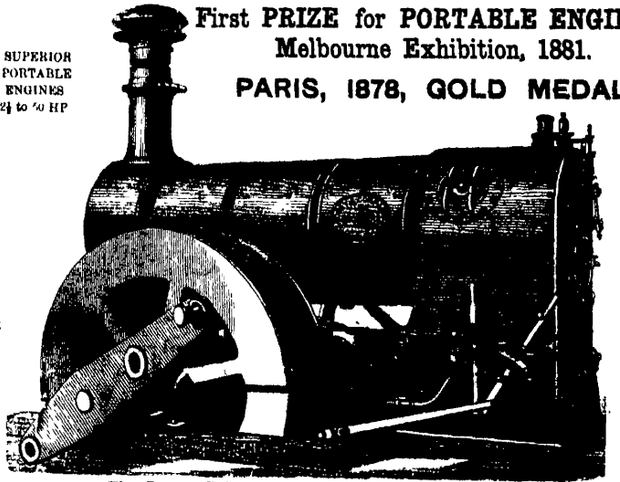
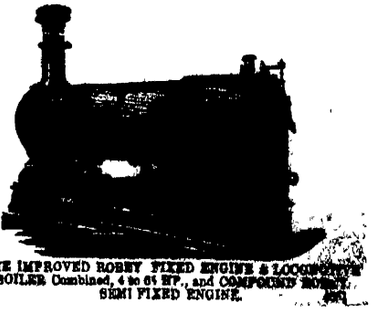
MACHINERY constructed for Boats Built Abroad.
Engines and Boilers kept in Stock.
BUILDER OF STEAM TUGS AND LAUNCHES.
Specialty in Small STEAM TUGS for towing Barges and Lighters. 5103

MACHINERY OF ALL DESCRIPTIONS SUPPLIED UPON THE
PURCHASE-HIRE SYSTEM
By the **MACHINERY PURCHASE HIRE CO.,**
147, QUEEN VICTORIA STREET, LONDON, E.C.
—TERMS ON APPLICATION.—

SHAFTING
Turned true and bright to Whitworth's Gauges, any length, from 2 in. to 8 in. diameter, 12s. per cwt. at Nottingham. Also Couplings, Pulleys, Plummer Blocks, Hangers, Machine-made Spur, Bevel, and Mitre Wheels, Friction Gearing, &c.
H. HIND & SON, NOTTINGHAM, AND 62, BLACKFRIARS ROAD, LONDON, S.E. 4187

JOHN FOWLER & CO., LEEDS, ENGLAND,

MANUFACTURERS OF
Steam Cultivating Machinery — Traction Engines — Patent Compound Yorkshire Semi-Portable and Fixed Engines — Semi-Portable Engines — Horizontal High-Speed Stationary Engines — Hauling, Winding, and Pumping Engines — Patent Automatic Expansion Valve Gear and Governor, for ensuring Economy, Regularity, and Safety—Boilers of all types, adapted for every kind of fuel and country -Steel Portable Railway, for Sugar, Cotton, and Indigo Plantations, Contractors' Works, Military Depots, Workshops, Mines, Timber Yards, Agricultural Holdings, &c.— Locomotives of various gauges. 3061
CALCUTTA EXHIBITION, 1884, FIVE FIRST PRIZES.
Budapest Agricultural Meeting, 1882—Two Gold Medals and other Awards
Vienna Agricultural Meeting, 1882 — Special Diploma for excellency of work
Sydney Exhibition, 1880—Three First Prizes.
Hanover Agricultural Meeting, 1881—Gold Medal and Diploma of Merit. [and other Prizes
Paris Exhibition, 1878—Grand Prix, Gold Medal.

LIGHT FORGINGS. | BRAKE WORK. WAGON IRONWORK.
GLASGOW HYDRAULIC FORGE CO., LIMITED, Sentinel Works, Polmadie, Glasgow, and Canal Road, King's Cross, London. 5135

ROBEY & CO.

SUPERIOR PORTABLE ENGINES 2½ to 70 HP
First PRIZE for PORTABLE ENGINES, Melbourne Exhibition, 1881.
PARIS, 1878, GOLD MEDAL.

HORIZONTAL FIXED ENGINE, 4 to 60 HP.
☞ References can be given to upwards of 9 000 Engines now at work

VERTICAL STATIONARY STEAM ENGINE AND BOILER Combined, of all Sizes, from 1½ to 16 HP

The Patent "Robey" Mining Engine, 4 to 65 HP.

Prices and full Particulars of the Machinery here illustrated on application to the Manufacturers.
ROBEY & CO., Globe Works, LINCOLN, ENGLAND.
THE IMPROVED ROBEY FIXED ENGINE & LOCOMOTIVE BOILER Combined, 4 to 65 HP., and COMPOUND ROBEY SEMI FIXED ENGINE.

EHRHARDT'S

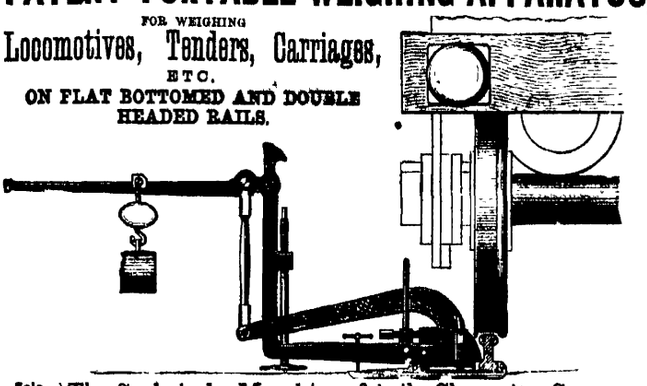
PATENT PORTABLE WEIGHING APPARATUS,

FOR WEIGHING

Locomotives, Tenders, Carriages,

ETC.

ON FLAT BOTTOMED AND DOUBLE HEADED RAILS.



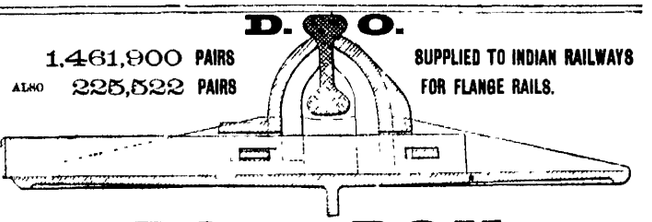
Sole Makers: The Sachsische Maschinenfabrik, Chemnitz, Germany.

Sole Agents and Licensees (to whom apply for prices and further information),

JAMES SCOTT & SON,

Engineers & Exporters of all kinds of Machinery, 10, Tib Lane, Cross Street, Manchester. 5273

D. O.



1,461,900 PAIRS

ALSO 225,522 PAIRS

SUPPLIED TO INDIAN RAILWAYS FOR FLANGE RAILS.

D-O. AND D-O-M.

PATENT TRANSVERSE CAST IRON PLATE SLEEPERS,

For any Gauge and for any form of Rail; without Wooden Keys or any perishable part.

As in use on Guaranteed and State Railways in India.

COST IS LESS THAN INDIGENOUS TIMBER.

Vide "Minutes of Proceedings of the Institution of Civil Engineers," Nov, 1881, Vol LXVII, p 87).

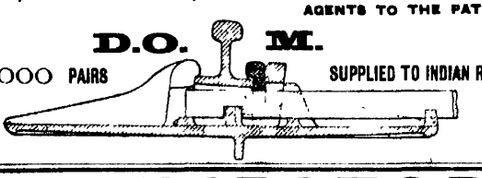
FOR PARTICULARS APPLY TO

MESSRS. THOMSON & BROWNING,

3, VICTORIA STREET, WESTMINSTER ABBEY, S.W.

AGENTS TO THE PATENTEES.

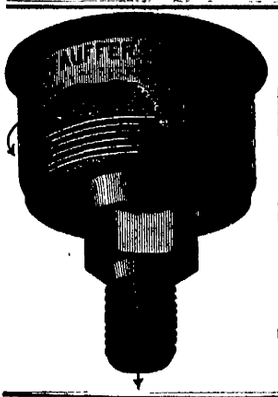
D.O. M.



330,000 PAIRS

SUPPLIED TO INDIAN RAILWAYS.

5175



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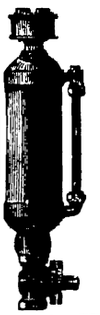
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AIR INJECTORS

FOR ALL PUMPING ENGINES.



Beating Valves rendered noiseless.

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DEAR SIR,—Referring to your letter of the 23rd instant, I have much pleasure in stating that the two Air Injectors supplied for the Liverpool Pumping Stations have been in use about two years, and that during that time they have acted satisfactorily and have maintained a uniform volume of air in the air vessels.—Yours truly,

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INSTANTANEOUS in action,

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Width of jaw	Opens	Size of Bar	Price
3 in..	6 in	1¾ by 1 in	32s
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5 in	10 in	2½ by 1¼ in	50s.
6 in	12 in	3 by 1¼ in	70s
7 in	14 in	3½ by 1¾ in	100s.

Easily and quickly adjusted without using the screw, saving time, secure grip obtained by screw and lever, the best combination for the purpose; screw is never exposed and only used for tightening the grip, opens double the width of the jaws, few and simple in its parts, not liable to get out of order, there being no cams, toggles, hooks and clutches, strong and durable, working parts wrought iron and steel

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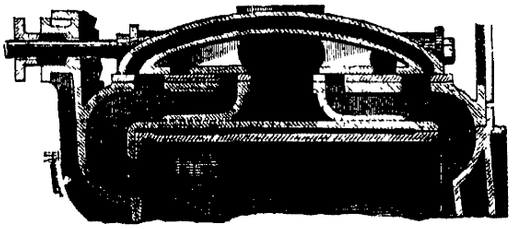
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THOM'S PATENT ECONOMICAL SLIDE VALVE.

SAVES IN STEAM THE CAPACITY OF THE PORTS AND CLEARANCE EACH REVOLUTION



This slide valve embodies the "Trick" arrangement, applied to a valve having positive and negative exhaust lap at both ends The negative exhaust lap forming a communication between the opposite ends of the cylinder just before the exhaust opens to the condenser, as shown by the arrows; so that the steam at the terminal pressure is transferred from one side of the piston to the other, compressed nearly up to initial pressure, and used over again on the return stroke This valve can be adapted to suit either single, double, or triple-ported L.P. cylinders.

Advantages: Economy, Less Friction, Less Weight, & Less Shock on engine turning centres.

WORKING IN STEAMERS UP TO 5,000 TONS. CONSUMPTION GREATLY REDUCED.

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Steel and Iron Sleepers.

TEN TIMES MORE ENDURABLE THAN TIMBER.



In use upon many Railways in England and the Colonies

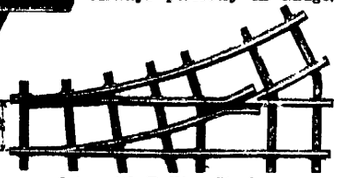
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Can be shifted without damage

Always perfectly in Gauge.

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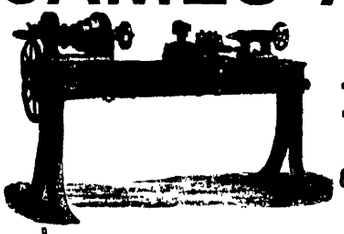


Narrow Gauge Railway, from 16 in. to 36 in, in use in the Cleveland and many other Mines.

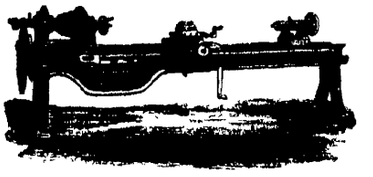
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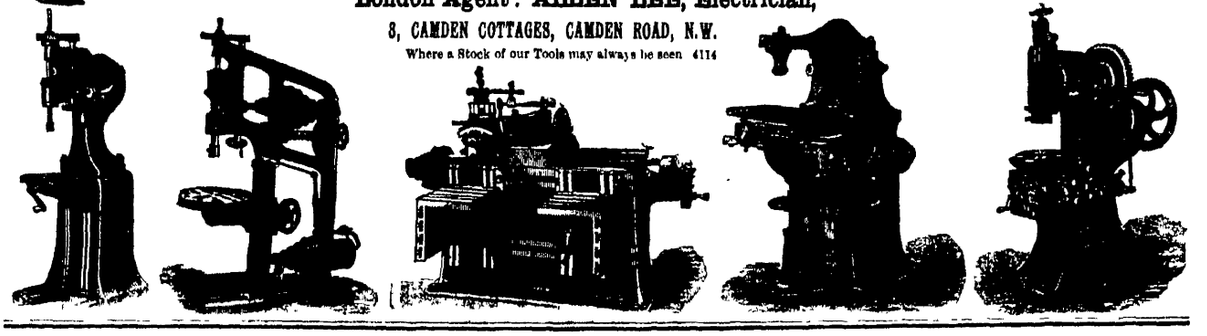


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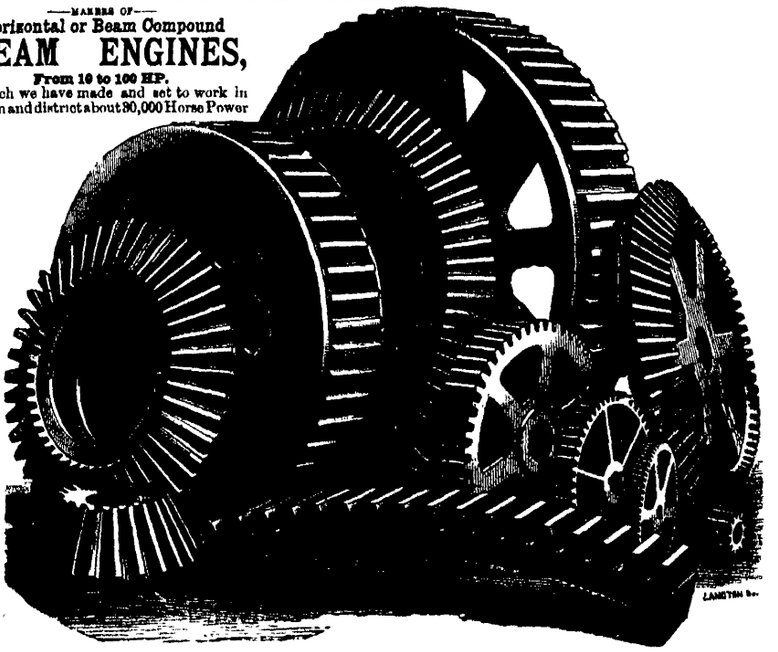
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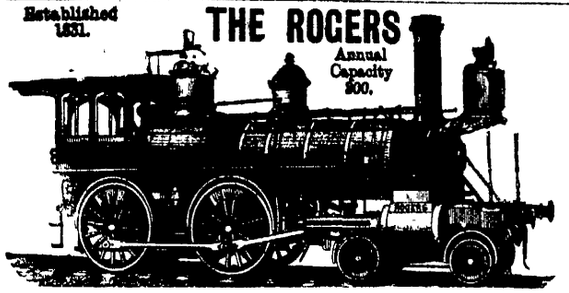
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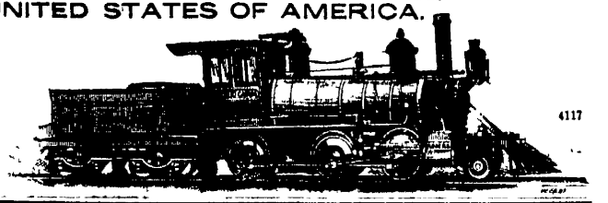
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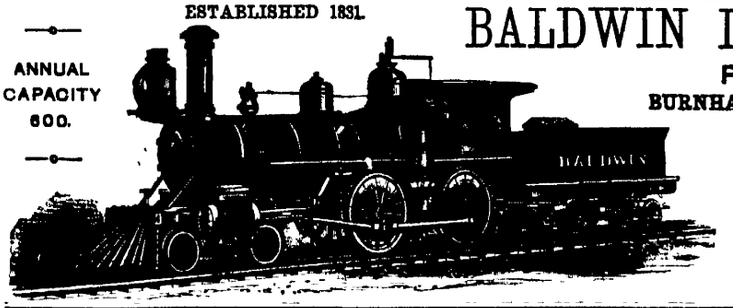


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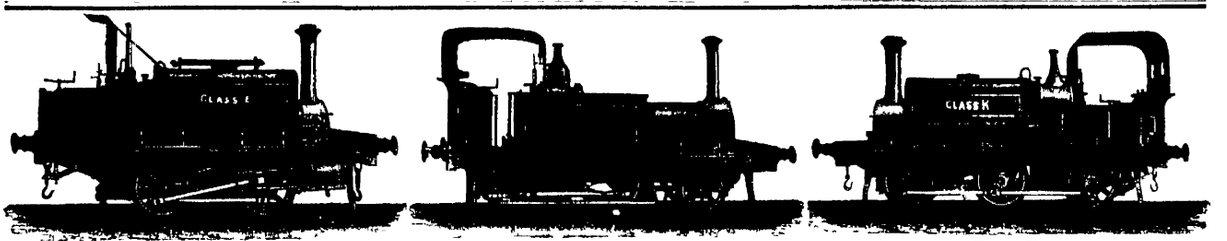
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Adapted to every variety of service, and built accurately to standard gauges and templates. Like parts of different engines of same class perfectly interchangeable.
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BUTTWELDED GAS, STEAM, and WATER TUBES.

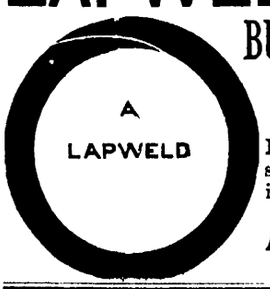
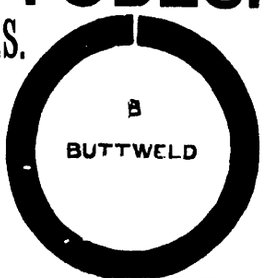
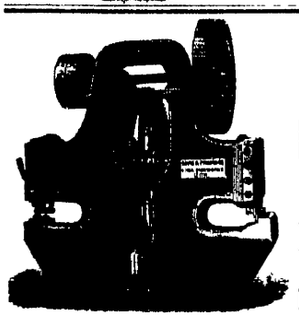


DIAGRAM SHOWING LAP AND BUTT WELDS.

These two Engravings, representing sections of Lapwelded Wrought Iron Tube (at A) and Buttwelded (at B) show conclusively the superior strength of Lapweld, which has nearly four times the surface in contact in the Weld over that given in Buttweld.



All Gas, Steam, or Water Tubes over Two-inch size are made Lapwelded by us. 4864

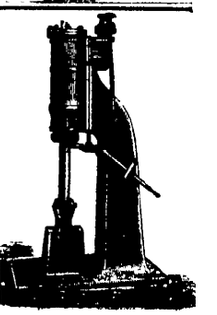


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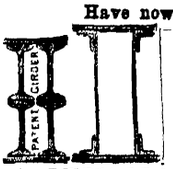


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8 × 4	3½ × 3½
6 × 6	3 × 3
6 × 3½	2½ × 2½
5 × 3½	2 × 2
4 × 3½	1½ × 1½
4 × 4	1 × 1

SECTION OF JOISTS.

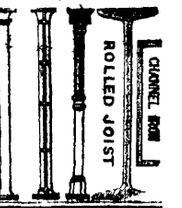
8 × 8 = 101lbs.	4½ × 8 = 181lbs.	7 × 2½ = 141lbs.	9½ × 3½ = 241lbs.
8 × 1½ = 5 ,,	6 × 4½ = 23 ,,	7 × 3½ = 20 ,,	9½ × 4½ = 29 ,,
4 × 1½ = 7 ,,	6½ × 2 = 11 ,,	8 × 4 = 22 ,,	10 × 4½ = 33 ,,
6 × 3½ = 12 ,,	6½ × 3½ = 16 ,,	8 × 5 = 30 ,,	10 × 5 = 36 ,,
4½ × 1½ = 8 ,,	6 × 5 = 29 ,,	8 × 6 = 34 ,,	10 × 6 = 56 ,,

Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to ½"

12 × 5 = 42lbs.	12 × 3
12 × 6 = 56 ,,	4 × 4½
14 × 6 = 60 ,,	6 × 3
16 × 6 = 68 ,,	8 × 3½
17½ × 6½ = 82 ,,	8 × 4
19½ × 7½ = 100 ,,	9 × 3½

TEES. CHANNELS.

5½ × 5½	12 × 3
4 × 4½	9½ × 3½
6 × 3	9½ × 3½
8 × 3	8 × 3½
5½ × 3½	5½ × 3½
9 × 3½	6½ × 3½
1½ × 1½	3½ × 1½
1 × 1	1½ × ½



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HIGH-PRESSURE, CONDENSING, & COMPOUND STEAM ENGINES.

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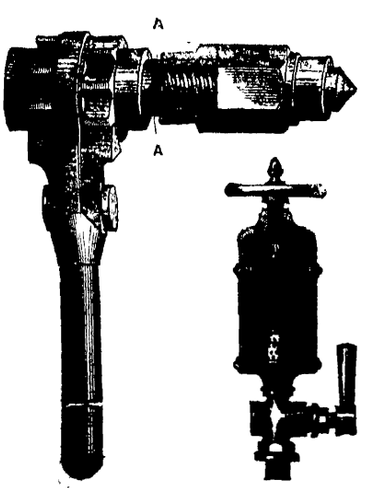


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PATENT DIFFERENTIAL RATCHET BRACE.—PATENT OPEN TOP SUET LUBRICATOR.



These BRACES, which have been several years before the public, and are MUCH APPRECIATED by them, NETTLEFOLDS have lately CONSIDERABLY IMPROVED by enclosing the SCREW in a SLEEVE (A) which always PROTECTS it from INJURY either from DIRT or BLOWS. This SLEEVE also acts as a GUIDE for the NUT, thus keeping it steady throughout the whole of its traverse, and consequently enabling the drilling to be effected with PERFECT ACCURACY.

The SUET LUBRICATOR has effected a saving of 70 per cent. in the cost of lubricating material used for Nettlefolds' Engines, and has now been fully tested in their works on 15 Cylinders working to 750-horse power.

Messrs. HICKS, HARGREAVES & Co. write:—"We find the saving in *excess* of that stated in Messrs. Nettlefold & Chamberlain's Report—viz, 70 per cent, and the cylinders to which these Lubricators have been applied are in beautiful condition. We shall adopt them for all our engines."

By this Invention the steam is lubricated before passing to the valves, while the supply of grease is uniform and constant.

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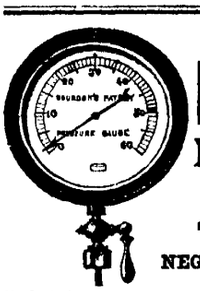
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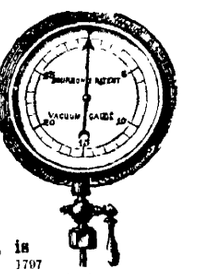
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COAL, LIME, & IRON WORKS, CLAY CROSS, near CHESTERFIELD,

SUPPLY HOUSE, GAS, AND STEAM COAL,

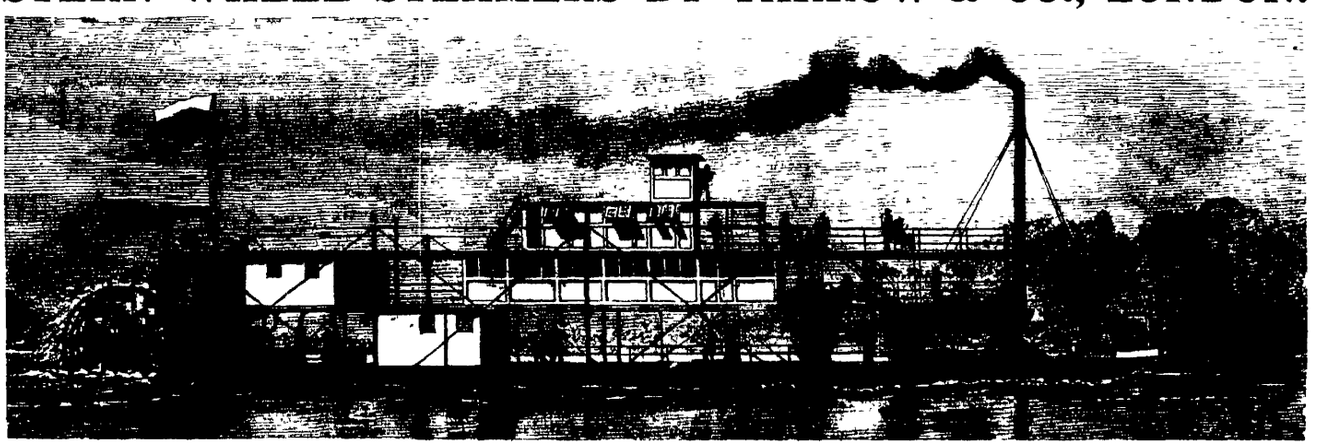
AND ARE MAKERS OF

PIG IRON, GAS and WATER PIPES, and ALL CASTINGS

In connection with Gas and Waterworks, Collieries, Engines, Pumps, &c. 5125

London Offices and Exhibition Rooms: 53, QUEEN VICTORIA STREET, E.C. (opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents.

STERN WHEEL STEAMERS BY YARROW & CO., LONDON.



"INEZ CLARKE," 130 ft. by 28 ft., Speed 15 Miles an hour, Draft 16 Inches "STEPHENSON CLARKE," 100 ft. by 24 ft., Speed 13 Miles, Draft 13 Inches 2017

BERKLEY STREET, BIRMINGHAM.



RICHARD C. GIBBINS & Co.

STEAM & HAND CRANES,

PORTABLE, WHARF, DERRICK, FOUNDRY, OVERHEAD, TRAVELLING,

Warehouse Cranes and Pile Drivers,

1691

Warehouse Lifts and Hoists,

CRABS, JACKS, PULLEY BLOCKS, SCREW COUPLINGS, PLATELAYERS' TOOLS, &c.

11, QUEEN VICTORIA ST. LONDON, E.C.



WATER PURIFICATION

JOHN HENDERSON PORTER, PATENTEE,
1 & 2, TUDOR STREET, LONDON, E.C., furnishes the necessary Plant

The PORTER-CLARK PROCESS

Removes Lime, Magnesia, and Iron from **Hard Waters**, and thus, the **causes of Incrustation in Boilers and Pipes** This Process is in use in Paper Mills, Breweries, Sugar Works, India rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c One Railway Company employs it for feed water to the extent of **1,000,000 gallons** daily, and one of the London Water Companies at two of its Pumping Stations It is also in use in County Asylums, Public and other Schools, and Private Mansions The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich, are rendered soft and clear 5220

DESCRIPTIVE CIRCULAR ON APPLICATION.

15 PRIZE MEDALS. THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED, 15 PRIZE MEDALS.
4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 3 SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 3. GLASGOW, 1880, 2. LONDON, 1882, 1



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD 4794

New Patent Barring Engine.

AUTOMATIC MOTION FOR MOVING INTO GEAR, AND FALLS OUT OF GEAR AUTOMATICALLY WHEN MAIN ENGINE STARTS.

The SIMPLEST, SAFEST and BEST, and also the CHEAPEST Automatic Safety Apparatus for Turning Main Engines.

Sole Makers: HICK, HARGREAVES & CO., ENGINEERS, MILLWRIGHTS, AND BOILER MAKERS.
SOHO IRONWORKS, BOLTON. 5199

BRIDGE FOUNDATION CYLINDERS.

THE STOCKTON FORGE CO.,
STOCKTON-ON-TEES.
Make a Specialty of this work, turning out over 100 tons per week; also large quantities of Railway Chairs. 4809

R. HORNSBY & SONS, Limited,

[Established 1815] General and Agricultural Engineers, Ironfounders, Boilermakers, &c. [Established 1815]

MAKERS OF IMPROVED STEAM ENGINES OF EVERY KIND, FROM 2½ TO 100 HP.

PORTABLE
With Inside or Outside Cylinders

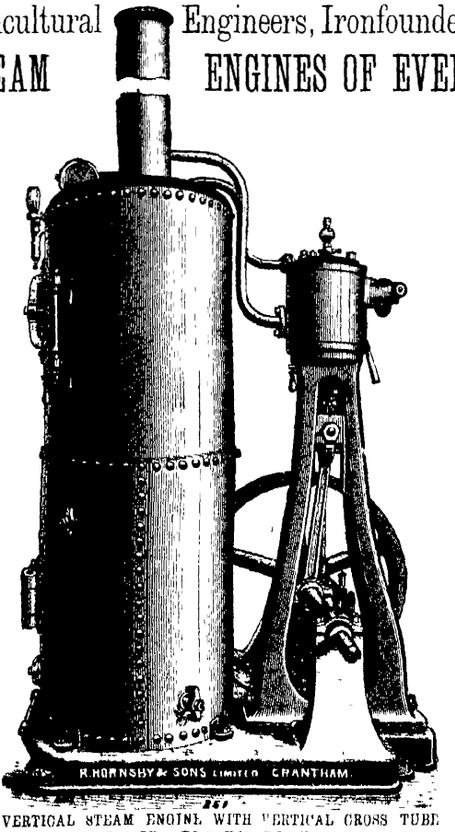
SEMI-PORTABLE
With Inside or Outside Cylinders

VERTICAL with Cross-Tube Boilers.

VERTICAL with Vertical Tubular Boilers.

HORIZONTAL STATIONARY
Both Simple and Compound with or without Condenser

COMPOUND
UNDERTYPE STATIONARY,
And with or without Condensers



VERTICAL STEAM ENGINE, WITH VERTICAL CROSS TUBE BOILER, 2 TO 12 HORSE POWER

HORIZONTAL
WINDING ENGINES
Both Direct-acting and with Gearing

TRACTION ENGINES.

Hornsby's Patent Automatic Expansion Gear
CAN BE FITTED TO MOST OF THEIR ENGINES

BOILERS:
LANCASHIRE, CROSS TUBE,
CORNISH, MULTITUBULAR,
VERTICAL, EGG ENDED, &c. &c.

The New Hornsby 1884 Twine Binder, winner of the First Prize of £100 of the R.A.S.E., and the First Prize of £100 of the Highland and Agricultural Society of Scotland (being the two largest prizes ever offered), besides other high class Awards

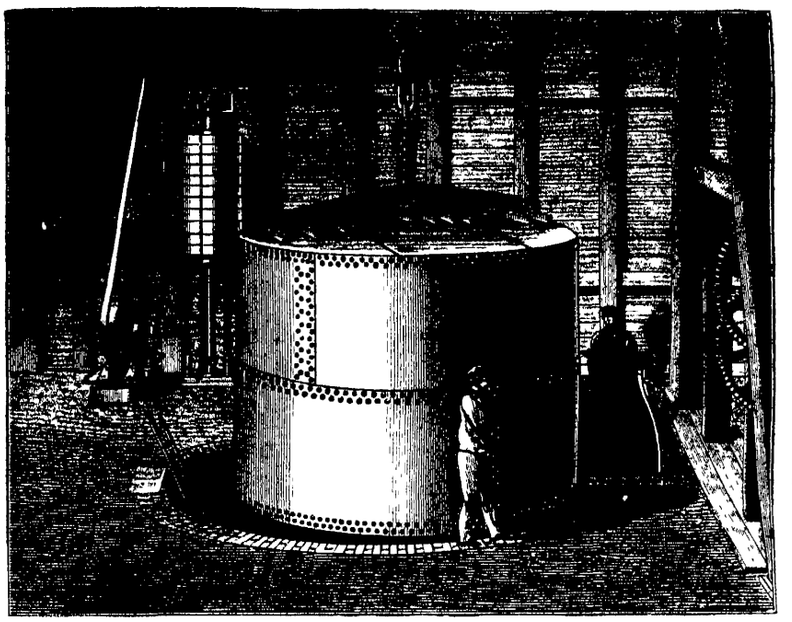
For Particulars of the most modern improved and successful Agricultural Machinery including the R.A.S.E. First Prize Mowers, Reapers, Ploughs, Dressing Machines, Corn Screens, Turnip Cutters, Root Pulpers, &c., ILLUSTRATED CATALOGUES in English, French, German, Spanish, Russian, &c., sent Gratis and Post Free on application

Plough Shares of Chilled Cast Iron, Wrought Iron Malleable Iron and Steel of Patterns to suit every Variety of Work, and made to Local Patterns if desired

At the most important Exhibitions and trials since 1874, R. HORNSBY AND SONS' Specialties have gained 565 PRIZES, including 69 Gold Medals, 126 Silver Medals, and 323 FIRST PRIZES.

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London Office: 84, LOMBARD STREET. Telephone No. 1294 South African Depot: EDINBURGH BUILDINGS, DOCK ROAD, CAPE TOWN.

HYDRAULIC RIVETTERS



OF THE MOST RECENT TYPES.

Punching, Shearing, Bending, Forging, Hoisting,

AND OTHER HIGH-PRESSURE

HYDRAULIC MACHINERY

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ANDERSON & CALLWEY

Hydraulic Labour-Saving Machine Makers,

CREMORNE WORKS, 4085

CHELSEA, LONDON, S.W.

RAGOSINE OIL

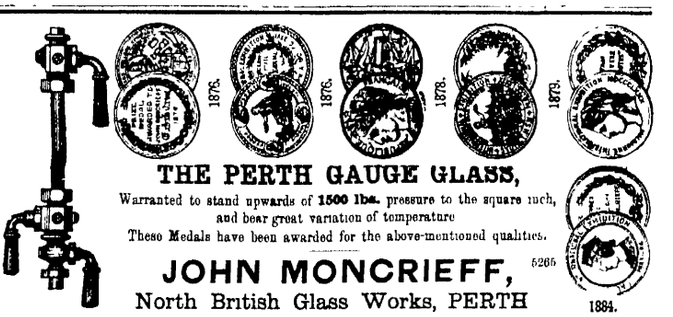
THE RUSSIAN NATURAL LUBRICATING OIL. Gold Medal, Paris, 1878.

Pure Hydro-carbon, free from acid. Body superior to Olive or Lard Oil | Never gums or clogs. Never freezes or thickens.

No. V 2s. 6d. PER CAL.

RAGOSINE & CO.,
7, IDOL LANE, LONDON, E.C.,
And Love Lane, Quayside, Newcastle-on-Tyne.
Works—BALACHNA and CONSTANTINOW, RUSSIA
Price Lists and full particulars on application 4779

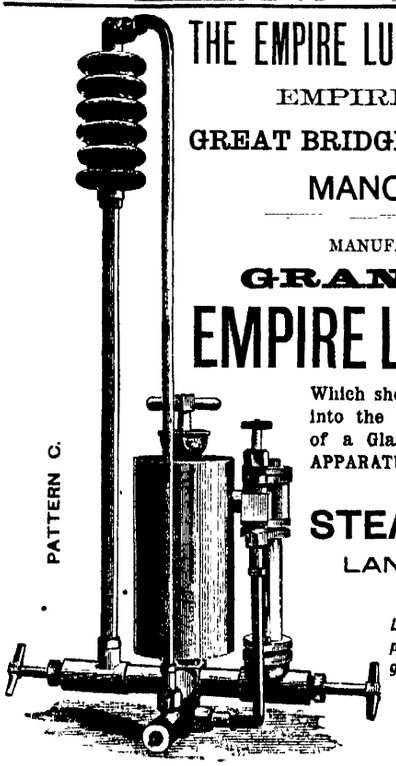
No. VIII 2s. 0d. PER CAL.



1873. 1876. 1876. 1878. 1873. 1873. 1884.

THE PERTH GAUGE GLASS,
Warranted to stand upwards of **1500 lbs.** pressure to the square inch, and bear great variation of temperature
These Medals have been awarded for the above-mentioned qualities.

JOHN MONCRIEFF, 5265
North British Glass Works, PERTH



PATTERN C.

THE EMPIRE LUBRICATOR COMPANY,

EMPIRE WORKS,
GREAT BRIDGEWATER STREET,
MANCHESTER.

MANUFACTURERS OF

GRANDISON'S

EMPIRE LUBRICATOR

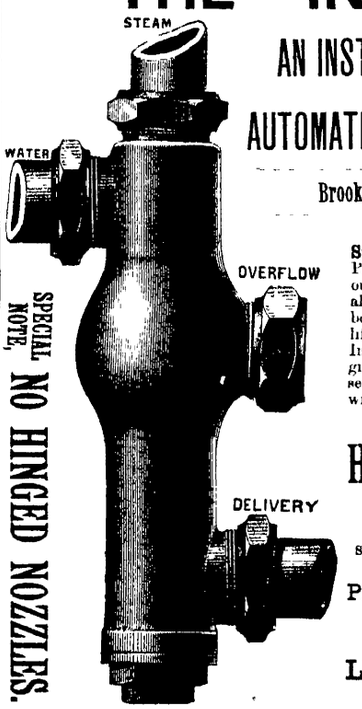
Which shows each drop of oil passing into the steam through the medium of a Glass Tube, and is the BEST APPARATUS now known for Lubrication of

STEAM ENGINES,
LAND OR MARINE.

Lubricators sent on approval to any part of the kingdom and references given to users in all parts of the inhabited world.

FURTHER PARTICULARS ON APPLICATION 4769

THE "INFLUX"



SPECIAL NOTE, NO HINGED NOZZLES.

AN INSTANTANEOUS STARTING
AND
AUTOMATIC RESTARTING INJECTOR

Brooke, Holden, & White's Patent.

The **only** Lifting Injector **devoid of Spindles,** Levers, Adjustable Internal Parts, or **hinged** Nozzles which lifts without manipulation and restarts automatically **Instantaneous action** on Steam being turned full on Works equally well lifting up to 12 ft., or as a "non lifter" Invaluable for Locomotives, Traction Engines, Marine, and other Boilers Can be seen working on application, or reference will be given as to their perfect reliability

For Prices, &c, apply to

HOLDEN & BROOKE,

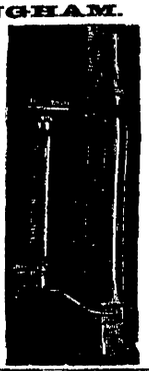
ST. SIMON WORKS,
SALFORD,

SOLE MANUFACTURERS—Also Sole Makers of
BORLAND'S 5080
PATENT BOILER DRILL
For Drilling Boiler Shells

LICENSEES FOR THE SOUTH.
LEWIS OLRICK & CO.,
LEADENHALL ST., LONDON.

TAYLOR & CHALLEN,
ENGINEERS,
BIRMINGHAM.

SOLE MAKERS OF
WITHINSHAW'S PATENT
Feed Water
HEATER.



The most powerful Invented
Great Saving in Boilers, Coals, and Labour.

LARGE HEATING SURFACE

Solid Drawn Brass Tubes.
Free Expansion
No Scurf adheres to the Tubes
—o— 4837
List on application



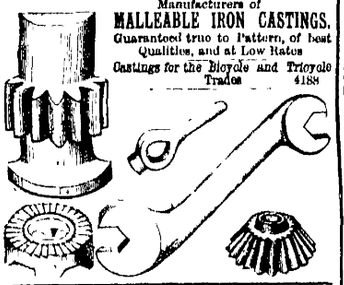
MATHER'S PAN MILL
For Red Lead, Putty, Crushing Lumps, &c.

What Users of Machine say

Messrs Gwynne & Co, London "Are satisfied with it" Hayward Bros & Co, London "It saves time, &c" Mr H Mobbs Northampton "I am satisfied with it" Mr W Allchin, Northampton "It is most useful" Messrs Clayton & Shuttleworth, Lincoln "We like it very much" Messrs Tangye Bros, Birmingham "Work is better than hand" Messrs Foster & Co, Lincoln "We think it well worth the money" 5104
Price with handle £1 18s As above sketch, £2 2s
G R MATHER, WELLINGBOROUGH, ENGLAND

W. R. PALMER,
LIMITED,
~~BACOT STREET FOUNDRY~~,
BIRMINGHAM.

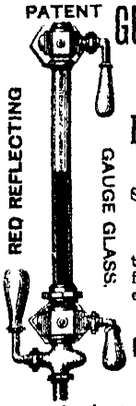
Manufacturers of
MALLEABLE IRON CASTINGS.
Guaranteed true to Pattern, of best Qualities, and at Low Rates
Castings for the Bicycle and Tricycle Trades 4188



GOLD MEDAL, PARIS, 1878.

GAUGE GLASSES
AND
ENAMELS
For Iron, Cast-iron, Copper, &c

PATENT GUILBERT MARTIN



Patentee and Manufacturer of the
PATENT
RED REFLECTING GAUGE GLASS,
Showing through the water a Broad Red Line.

N B - All Glasses are of the finest quality, and manufactured expressly to resist extreme pressure

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1 & 2, FALCON STREET,
Aldersgate Street,
LONDON, E.C.
REPRESENTED BY
E. M. HAMBURGER.

The above line shown in black is of a rich Red. 5002

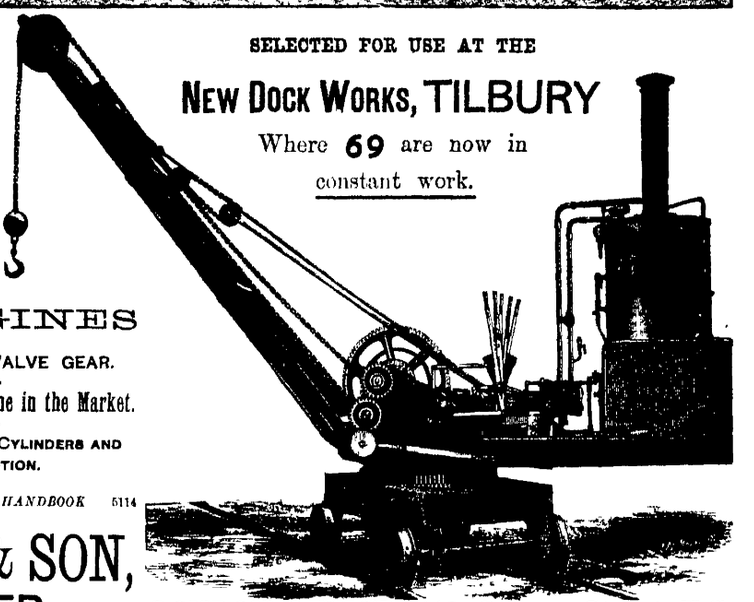
JESSOP'S CRANES

SPECIALITIES:
CRANES,
TRAVELLERS,
WINDING ENGINES,
HOISTS,
WINCHES,
—PUMPS,—
MILL ENGINES
FITTED WITH
COLLMANN'S PATENT VALVE GEAR.

Cheapest and Most Efficient Crane in the Market.

ALL OUR CRANES HAVE TWO CYLINDERS AND LINK REVERSING MOTION.

SEND FOR ILLUSTRATED HANDBOOK 5114

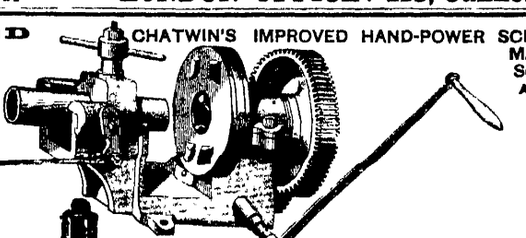


SELECTED FOR USE AT THE
NEW DOCK WORKS, TILBURY
Where 69 are now in constant work.

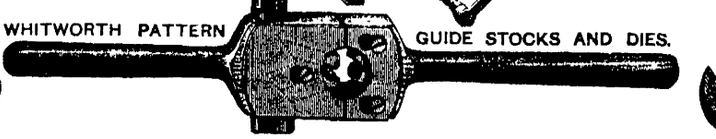
J. JESSOP & SON,
LEICESTER.
LONDON OFFICE: 113, Cannon Street, E.C.

AWARDED
A
Gold & Silver Medal
AND
Two 1st Class Certificates at
Calcutta Exhibition, 1884.

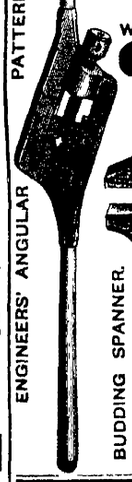
CHATWIN'S IMPROVED HAND-POWER SCREWING MACHINE, SCREWING AT ONCE OVER.



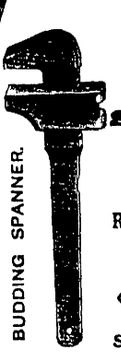
PATTERN STOCKS AND DIES.



WHITWORTH PATTERN GUIDE STOCKS AND DIES.



ENGINEERS' ANGULAR BUDDING SPANNER.



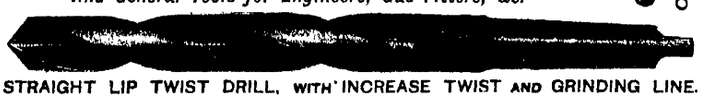


CLYBURN SPANNER



PATENT SOLID DIE STOCK FOR GAS TUBES SCREWING AT ONCE OVER

THOMAS CHATWIN,
GT. TINDAL STREET, BIRMINGHAM,
MANUFACTURER OF
STOCKS, DIES, AND TAPS,
PATENT HAND-POWER SCREWING MACHINES. TWIST DRILLS,
STANDARD CYLINDRICAL GAUGES, RIMERS,
CLYBURN, BUDDING, AND OTHER SPANNERS,
RATCHET BRACES, TUBE CUTTERS, TUBE WRENCHES, TUBE VICES,
And General Tools for Engineers, Gas Fitters, &c. 4324



STRAIGHT LIP TWIST DRILL, WITH INCREASE TWIST AND GRINDING LINE.

FUEL ECONOMISER

GREEN'S PATENT

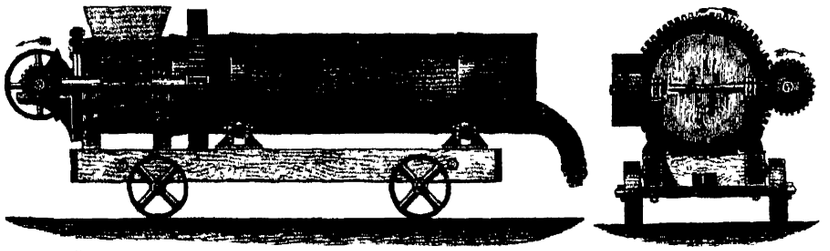
Has been awarded the GOLD MEDAL at the CALCUTTA EXHIBITION, in addition to TWELVE MEDALS previously given at other Exhibitions 5081

ST. ANN'S SQUARE MANCHESTER. WORKS: WAKEFIELD

BUTTERS BROS., Contractors' Engineers,

PERCY CRANE & ENGINE WORKS, LAMBHILL STREET.

OFFICES: 93, HOPE STREET, GLASGOW.



"Patent Concrete Mixer," capable of mixing 80 to 100 cubic yards per day of 9 hours.

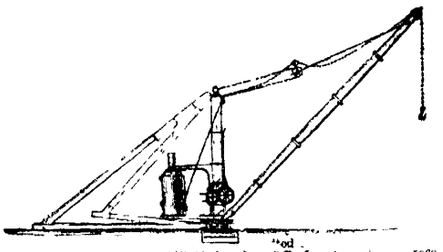
PRICE £90, AS SHEWN.

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SCOTCH DERRICK CRANES,

AS SUPPLIED TO

Forth Bridge Works; Sir Thos Tancred; Arrol & Co., Contractors; New Bute Docks, Cardiff; Messrs. T Nelson & Co., Contractors; and principal Contractors in England, Ireland, and Scotland.



STOCK SIZES to Lift 1½, 2, 3, 5, or 7 Tons, Queen's 5068

MADE UP TO 30 TONS.

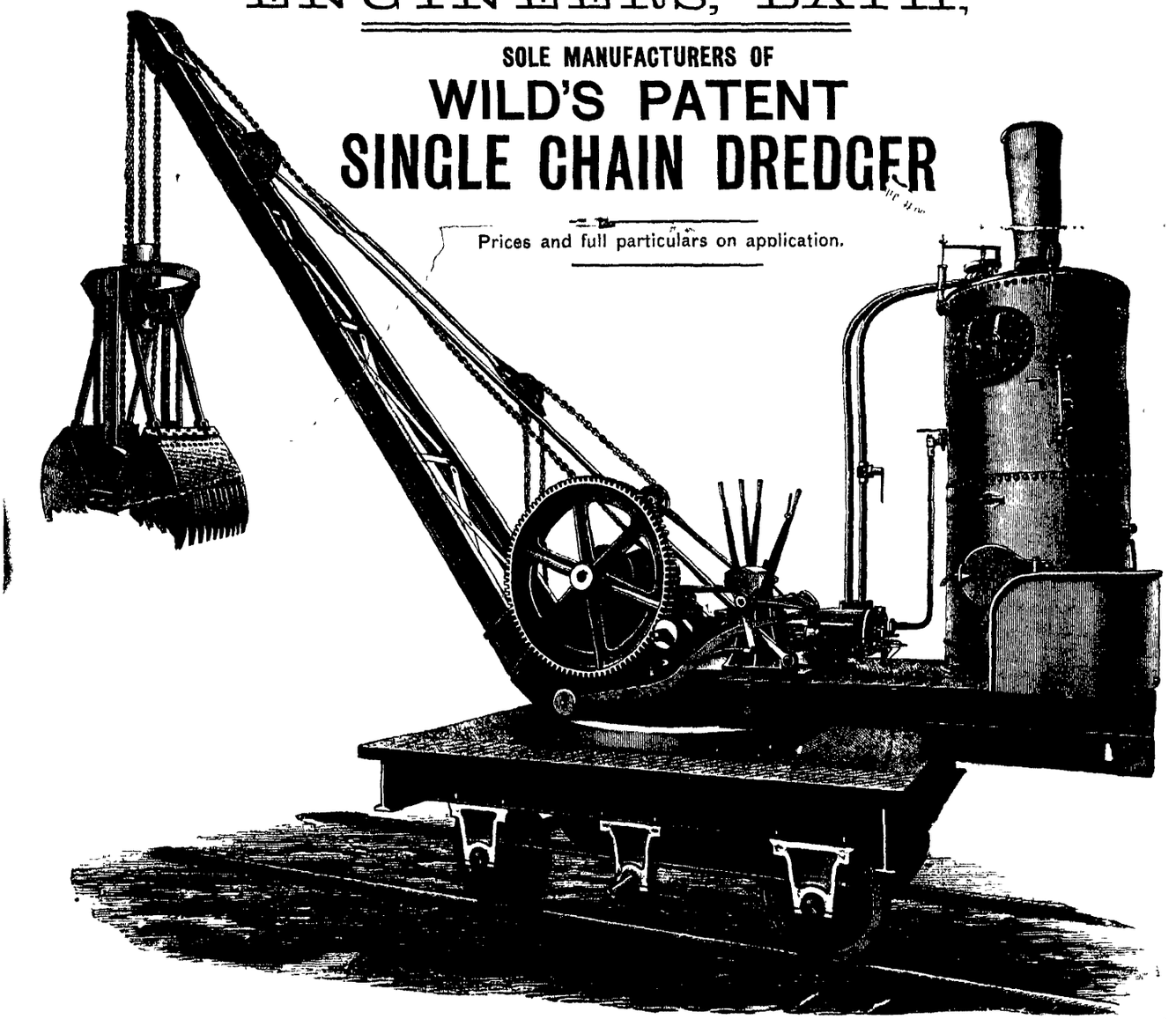
STOTHERT AND PITT, LIMITED,

ENGINEERS, BATH,

SOLE MANUFACTURERS OF

WILD'S PATENT SINGLE CHAIN DREDGER

Prices and full particulars on application.



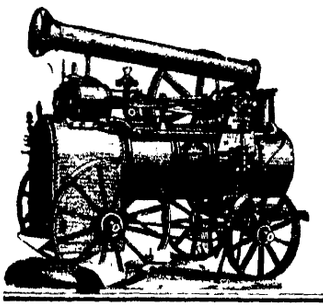
LONDON OFFICE: 30, WALBROOK, E.C. (WHERE A WORKING MODEL MAY BE SEEN. 4681)

MARSHALL, SONS, & CO., LIMITED,

[TELEPHONE No. 6648.

BRITANNIA IRONWORKS, GAINSBOROUGH, AND MARSHALLS' BUILDINGS, 79, FARRINGDON ROAD, LONDON, E.C.

MANUFACTURERS OF PORTABLE, SEMI-PORTABLE, HORIZONTAL, FIXED, VERTICAL, AND TRACTION ENGINES, THRASHING, CORN GRINDING, SAWING AND TEA PREPARING MACHINERY.



PORTABLE ENGINES, 1½ TO 35 HORSE POWER,

Adapted for all Countries, and constructed to burn Coal, Wood, Straw, Vegetable Matter and Refuse as Fuel.

Also fitted with Patent AUTOMATIC EXPANSION VALVE GEAR, for ensuring Great Economy in Fuel and Regularity of Speed under varying loads when required

CALCUTTA EXHIBITION, 1884—FIVE GOLD AND THREE SILVER MEDALS.
AMSTERDAM EXHIBITION, 1883 — THE DIPLOMA OF HONOUR.
ELECTRICAL EXHIBITION, CRYSTAL PALACE, 1882 — GOLD MEDAL.
MELBOURNE, 1881 — HIGHEST AWARD FOR ALL EXHIBITS; FIVE GOLD MEDALS.
SYDNEY EXHIBITION, 1880 — TWO SPECIAL AND FOUR FIRST PRIZES.
PARIS EXHIBITION, 1878—TWO GOLD MEDALS AND OTHER PRIZES.

Catalogues in English, French, German, Spanish or Russian Free on application. 2529

THWAITES BROTHERS,

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British Exhibits—Section G.

THWAITES BROS obtained the Highest Awards, viz for Steam Hammer, First class Certificate and Silver Medal, and for Root's Patent Improved Blower and Engine, another First class Certificate and Silver Medal

Awarded Prize Medals at Paris, London, Vienna, Manchester, Leeds, Falmouth, and the Exhibitions in America

ROOT'S PATENT BLOWER

Is the best Machine for forcing or exhausting hot or cold air

5,000 BLOWERS SUPPLIED SINCE 1867 Saves 50 per cent in Fuel and Power

ROOT'S PATENT MINE VENTILATOR

ROOT'S PATENT GAS EXHAUSTER

ROOT'S PATENT BLOWERS.

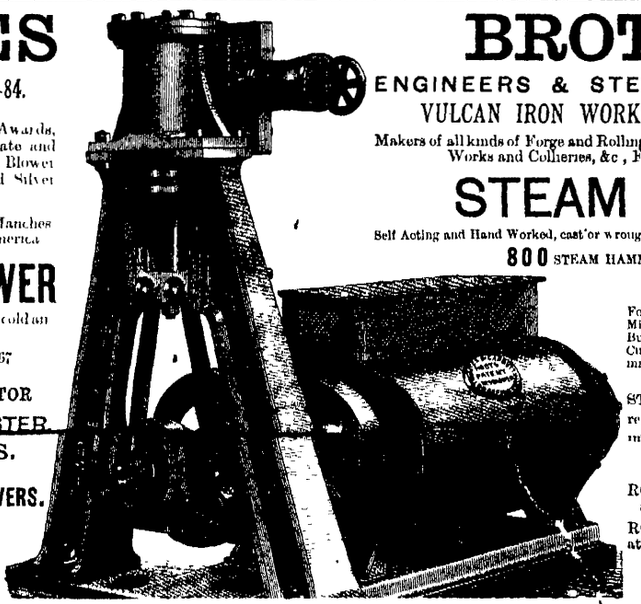
With Direct Acting Duplex Engines

ROOT'S PATENT ROTARY HAND BLOWERS.

1,000 supplied instead of Bellows

SEE THE NEW PATTERNS,

The "Vulcan," and Root's PATENT PORTABLE FORGES.



ROOT'S PATENT BLOWER AND DIRECT-ACTING ENGINE.

ENGINEERS & STEAM HAMMER MAKERS,

VULCAN IRON WORKS, BRADFORD, YORKSHIRE.

Makers of all kinds of Forge and Rolling Mill Machinery, Steam Engines for Mills, Iron, Works and Collieries, &c, Forge, Foundry, and Travelling Cranes.

STEAM HAMMER,

Self Acting and Hand Worked, cast or wrought iron standards, any design, from ½ cwt. up to 100 tons

800 STEAM HAMMERS HAVE BEEN SUPPLIED

SPECIAL STEAM HAMMERS,

For Engineers, Machinists, Shipbuilders, Steel Tilters, Millwrights, Coppersmiths, Railway Carriage and Wagon Builders, Colliery Proprietors, Ship-smiths, Bolt Makers, Cutlers, File Makers, Wheel Boxing, Wheel Boss Trimming, Spade Makers, Welding Boilers, Tubes and Stamping

STEAM HAMMERS of any size, up to 10 tons, ready for immediate delivery, fitted with our improved Valves, which save 25 to 50 per cent. of steam.

ROOT'S BLOWERS and PORTABLE FORGES any size, are kept in stock for instant delivery.

ROOT'S PATENT MINE VENTILATOR, fixed at Chilton Colliery, Ferry Hill, is the best and most efficient Mine Ventilator in this Country.

Price Lists and Particulars on application. 4391

THE "HALL" TYPE-WRITER

THE ONLY PORTABLE AND COMPLETE MACHINE EXTANT.

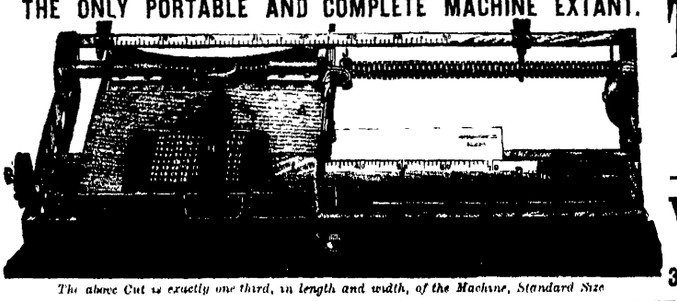
—: *Price £8 8s.* :—

WEIGHT, 8 lbs

SIZE, 14 in. by 7 in. by 9 in.

Writes 30 to 40 words a minute.

PROSPECTUSES, TESTIMONIALS, AND ALL PARTICULARS POST FREE, FROM



The above Cut is exactly one third, in length and width, of the Machine, Standard Size

WITHERBY & CO.,
74, Cornhill, E.C.;
325A, HIGH HOLBORN, LONDON, W.C.

IMPORTANT TO USERS OF BELTING.

GANDY v. REDDAWAY AND OTHERS.

Advertisements have been issued and largely circulated in this country and abroad by Mr. Maurice Gandy, in which he gives prominence to our name without mentioning the whole of the facts in connection with the above action It is therefore necessary for us to inform the Users of Belting that the ACTION of

GANDY v. REDDAWAY & CO. and Others was dismissed as regards us, WITH COSTS TO BE PAID BY GANDY to

F. REDDAWAY & CO., the Patentees and Sole Makers of REDDAWAY'S BELTING.

We claim to manufacture the BEST and STRONGEST Cotton Belting in the Market, by Machinery of special construction and of our own invention.

Calcutta Exhibition, 1884—Awards for Cotton Machinery Belting in competition with other Manufacturers:

F. REDDAWAY & CO., FIRST PRIZE SILVER MEDAL.

SOLE MAKERS OF 5062

REDDAWAY'S PATENT CAMEL HAIR BELTING. | REDDAWAY'S PATENT MACHINE-MADE CANVAS HOSE.

—: F. REDDAWAY & CO., PENDLETON, MANCHESTER :—

[Registered at the General Post Office as a Newspaper]

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

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Portland Cement,
manufactured by
Francis and Co.,
5333
The celebrated Nine Elms Brand, established 1810
Medals London, 1851, Philadelphia, 1876, Paris, 1878
Offices: Vauxhall, London Works, Cliffe Rochester

Portland Cement,
genuine and of the best quality, is supplied by the WOULDHAM CEMENT COMPANY for home consumption and export.—For prices, &c, address, 20, Lime Street, London, E C 1730

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MANUFACTURERS OF
Portland Cement
Of the Greatest Strength and best Quality Roman and Lias Cement. Blue Lias Hydraulic Lime, Ground and Unground
RUGBY, WARWICKSHIRE.
WORKS NEW BILTON AND NEWBOLD 4867

Locomotive Tank Engines
designed and constructed by
MANNING, WARDLE, AND COMPANY,
Boyne Engine Works, Leeds. 2687
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Locomotive Tank Engines,
TRAMWAY ENGINES AND CARS
Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough 5206
See Illustrated Advertisement last week, page 10

R. E. Crompton and Co.,
ELECTRIC LIGHT ENGINEERS,
MANSION HOUSE BUILDINGS, E.C. 4812
See Advertisement Sept 19, page 20

Atkinson's Gas Engines,
SELF-STARTING, COMPOUNDED, SIMPLE AND ECONOMICAL
BRITISH GAS ENGINE AND ENGINEERING CO, 11, QUEEN VICTORIA STREET, LONDON
See Advertisement last week, page 26

Over 15,000 "Otto" Engines
AT WORK,
Using 25 to 75 % less Gas per Brake HP. than
Any other Engine.
Crossley's Patent Self-Starter,
Safest, Best, and Simplest made, may now be applied. 4776
Crossley's Patent Twin-Engine
Impulse every Revolution. Very Steady in Running
HIGHEST AWARD AT PARIS ELECTRICAL EXHIBITION.
Crossley Bros., Ld., Manchester.

Steam Launches. — Messrs. YARROW and COMPANY, Poplar, London, are prepared to contract for—
Screw Steamers having speeds up to twenty-six miles an hour. Paddle Steamers having draughts down to 6 inches of water Machinery constructed for boats built abroad 4778

Steam Launches, fitted with really efficient and accessible tubular boilers. For small steamers, steam lighters, salt flats, &c, these boilers will be found unrivalled — Apply, COCHRAN and CO, Birkenhead See page 4 4749

Steam Launches in Stock.— VOSPER & CO, Broad Street, Portsmouth, Build in Steel, Iron, or Wood, Sea going Launches, fitted either with their Patent Silent Engines or ordinary ones 3551
V & CO 'S Steel Boilers work well in salt water

Forrestt & Son, London, SHIP AND LAUNCH BUILDERS ENGINEERS 4467

G. F.G. Des Vignes, Chertsey, Surrey, Builder of First class High-speed Steel Yachts, Launches, & Torpedo Boats Estab 1869 3794

Miller & Tupp, Steam Launch BUILDERS, HAMMERSMITH, LONDON Illustrated Price Lists, with Photos, Six Stamps 4547

Lifts and Hoisting Machinery. —R WAYGOOD & CO, Falmouth Road, S E Apply for Illustrated Catalogues 5198

John Spencer and Sons, NEWBURN STEEL WORKS, NEWCASTLE-ON-TYNE
SPRINGS, BUFFERS, STEEL CASTINGS, FORGINGS, TOOL STEEL, FILES SPRING STEEL, &c SIEMENS STEEL BLOOMS AND BARS 3706
PARLIAMENT MANSIONS, VICTORIA ST, LONDON, S W

Johnson & Phillips, Telegraph ENGINEERS, ELECTRICIANS, and CONTRACTORS, 16, Union Court, Old Broad Street, E C Works and Wharf at Charlton, S E
Makers of all Machinery, &c, for the complete equipment of Telegraph Cable Factories and Steamers, Electric Leads, Cables, and Carbons, &c 4762

Steam and Hand Cranes, OVERHEAD TRAVELLING CRANES (Hand and Power for Driving by Cotton Rope or Tumbler Shaft), DIRECT ACTING STEAM HOISTS, AIR COMPRESSORS, HYDRAULIC PRESSES, HYDRAULIC CRANES AND LIFTS, DONKEY PUMPS
HENRY J COLES,
89, SUMNER STREET, SOUTHWARK, LONDON 4827

Steel Hydraulic Cylinders.— HENRY BESSEMER & CO, Limited, SHEFFIELD
See Advertisement, page 51 3627

Stannah's Pendulum Pumps. For Prices see alternate weeks 3238

Willans' Patent Compound ENGINES, for marine and general purposes Stock sizes from 6 to 150 I HP Special patterns for Electric Lighting —WILLANS & ROBINSON, Thames Ditton, Surrey 5283

Iron Roofs, Sheds, Buildings, Houses Best work, reduced prices Dixon's special CURVED IRON ROOFS are the most economical for spans up to 45 ft Catalogues, Designs, Estimates, on application ISAAC DIXON, Windsor Ironworks, LIVERPOOL. 4833

George Russell & Co., ENGINEERS and BOILERMAKERS, ALPHA STEAM CRANE and ENGINE WORKS, MOTHERWELL, near GLASGOW SILVER MEDAL, PARIS, 1867 4921

SIEMENS STEEL PLATES, ANGLES, RIVETS, BARS, FORGINGS, CASTINGS, &c
The Landore Siemens-Steel CO, LIMITED, LANDORE, R.S.O., SOUTH WALES 4961

WIRE TRAMWAYS.
W. T. H. Carrington, 9 and 11, FENCHURCH AVENUE, E.C Removed from 76, Cheapside, E.C 5005
See Illustrated Advertisement last week, page 27

A First-Class Lubricant.

"Engelbert's Lubricator."

SEE ADVERTISEMENT LAST WEEK, Facing end of Reading Matter 4919

Hunter and English, ENGINEERS AND MILLWRIGHTS, IRON AND BRASS FOUNDERS, BOW, LONDON, E.
DREDGING MACHINERY
HYDRAULIC MACHINERY
"WILLIAMS'" PATENT CAPSTANS
LAND AND MARINE STEAM ENGINES
DISTILLERY AND BREWERY PLANT
FLOUR AND RICE MILLS
WATER AND GAS VALVES, CRANES, LOCK GATES, &c PUMPING MACHINERY
HUNTER'S PATENT FLOATING CRANE FOR DOCKS, &c.
STEAM LAUNCH MACHINERY 4955

Boiler Tubes, Iron, Steel, and HOMOGENOUS
EDWIN LEWIS AND SONS, Wolverhampton 4868

Iron Boiler Tubes.— THE CALEDONIAN TUBE COMPANY, COATBRIDGE, near GLASGOW.
Having Special Stock, Shipments and Repairs executed very rapidly 4938

Tubes. MARINE, LOCO', STEAM, BORING, COLLIERY
LARGE TUBES LAP WELDED TO 12in DIAM
Joseph Aird, TUBE WORKS, GREAT BRIDGE, STAFFORDSHIRE.
LONDON OFFICES
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MANCHESTER
QUEEN'S CHAMBERS, 5, MARKET ST
MR L W SUTCLIFFE, M.S., AGENT 5189

James Russell and Sons, LIMITED,
CROWN TUBE WORKS, WEDNESBURY
London Warehouse 108, Southwark Street, S E.
Leeds Warehouse 6, Mark Lane, Briggate
Price Lists on application 5001

Iron and Steel Tubes.— JAMES EADIE AND SONS, CLYDESDALE TUBE WORKS, RUTHERGLEN near GLASGOW 5195

Steam Hammers (with or without guides) Hand worked or Self acting TOOLS for SHIPBUILDERS & BOILER MAKERS DAVIS & PRIMROSE, LEITH, N B 4376

The Patent Corliss Engine And PATENT CORLISS GEAR ENGINE, with special Improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N B These engines are made Horizontal or Beam, Condensing, Non Condensing, and Compound Also makers of Rice Mills, and Paper Mills, and General Engineers. Machinery shipped or trucked direct from the premises 3599

Hardingham's Patent Sectional STEAM BOILERS (annular water tube system) Efficiency, economy, accessibility, compact ness, safety —For full particulars, apply to G G M HARDINGHAM, Engineer, 191, Fleet St, London, E C

Steam Boilers, Ready for Delivery
W. & J GALLOWAY & SONS, Manchester, always keep a large stock of "GALLOWAY" and "TWO-FLUED" Boilers ready for dispatch 5080

Field's Patent Boilers and TUBES
LEWIS OLRICK & CO, London 5046
See Illustrated Advertisement last week, page 25

40, KING STREET, COVENT GARDEN, W C
Thomas Kell and Son, Litho- graphers, &c, execute every description of Lithography, Chromo lithography, Engraving, and Printing, Engineering, Architectural, and Pictorial Drawing in best manner Paper Drawing, photo-lithography, &c —40, King St, Covent Garden, W C 3462

Steam Cranes.
Thomas Smith,
STEAM CRANE WORKS, OLD FOUNDRY, 4345
RODLEY, NEAR LEEDS
See Illustrated Advertisement last week, page 27

International HEALTH EXHIBITION
PAUL PFLEIDERER'S PATENT
Bread-Making Machinery
In Bakery Section. 4755
86, UPPER GROUND STREET, BLACKFRIARS, LONDON, S E.

London Mutual Boiler In- SURANCE COMPANY, LIMITED Established in 1874 for the INSURANCE and PERIODICAL INSPECTION of all kinds of Land and Marine Boilers throughout the United Kingdom —For particulars apply to the Secretary 17, Queen Victoria Street, London, E C 4759
The Assured are secured against loss from claims established under the Employers' Liability Act, 1880

The "Differential" Pumping ENGINE.—DAVEY'S PATENT for Draining Mines, Water Supply of Towns, Irrigation; Supplying Docks, Pumping Sewage, and General Pumping Purposes
HATHORN, DAVEY, & CO, LEEDS
H, D, & Co have Patterns of "Differential" Engines of all sizes from 5 to 500 horse power, and have facilities for supplying very powerful Engines and Pumps at a short notice 5456

HIGHEST AWARD, PARIS, 1878
Goldsworthy's Emery, Emery Cloth, Glass Paper.
MANCHESTER 4818

East Ferry Road Engineering WORKS CO, LIMITED, Hydraulic Engineers, Millwall, London, E. Parkes's Patent Portable Hydraulic Cranes, Lifts, and Hoists Duckham's Patent Suspended Weighing Machines 5124
See Illustrated Advertisement last week, page 14

Dredgers and Excavators.— HIGHEST PRIZE AT TYNEMOUTH FOR HYDRAULIC DREDGERS

Bruce and Batho,
9, VICTORIA CHAMBERS, 4743
WESTMINSTER, S W
See Illustrated Advertisement last week, page 7

L. Sterne & Co., Limited. ENGINEERS,
Sole Makers of
Clerk's Patent Self-Starting Gas Engine.
HIGHEST AWARD,
BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881
GOLD MEDAL,
CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifiers, WITH STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels, Emery Machines, Spiral Springs.
The Crown Iron Works, GLASGOW.
The Crown Iron Works (Hollinwood), MANCHESTER.
10, Victoria Chambers, WESTMINSTER.
City Office and Show Rooms, 40, CANNON STREET, E C.
10, Rue Laffitte, PARIS. 2588

International Inventions

EXHIBITION, London, 1885
DIVISION I, INVENTIONS DIVISION II, MUSIC

Patron
HER MAJESTY THE QUEEN
President
H R H THE PRINCE OF WALES, K G

Applications to Exhibit must be made on Printed *Forms*, which will be supplied on application to the SECRETARY, International Inventions Exhibition, South Kensington, S W These must be filled up and *returned on or before the* 1st November, 1884 G 885

University College, Dundee

ENGINEERING DEPARTMENT, PROF J A EWING

The Classes in this Department OPEN on MONDAY, 13th October

The course in Engineering extends over three years, and in addition to general scientific subjects, includes
(I) The general Theory of Engineering
(II) Lectures and Field Works Practice in surveying, levelling, and setting out,
(III) Electrical Engineering with practical laboratory instruction, and use of a workshop, and
(IV) Engineering Drawing
For particulars apply to G 957
SHIELL AND SMALL, Secretaries

TENDERS

CHATHAM PIER

The Local Board of Health for Chatham are prepared to receive

Tenders for the Construction

of the proposed IRON PIER on the site of the existing Sun Pier on the Medway at Chatham, and *the MAINTENANCE the rof for Twelve Months after* completion of the Work

Plans and Drawings may be seen, and Specifications *and Quantities may be obtained, on payment of One* Guinea, at the Office of Messrs LAW & CHATTERTON, Civil Engineers, 46, Queen Anne's Gate, Westminster, on and after Wednesday, the 15th inst

Sealed Tenders, endorsed "Tender for Chatham Pier," must be addressed to the Clerk, Local Board Offices, Chatham, on or before Wednesday, the 29th inst

The lowest or any Tender will not necessarily be accepted

Chatham GEORGE WINCH, G 908
3rd October 1884 Clerk to the Local Board

TO CONTRACTORS

CARDIFF CORPORATION WATERWORKS, LLANISHEN SECTION, CONTRACT No 5

The Waterworks Committee of the Corporation of Cardiff are prepared to receive

Tenders for the Construction

of FILTERS and SERVICE RESERVOIR, Boundary Walls, Fencing, Pipe Laying, Roads, and other works connected therewith, situate near the Heath, about two miles from Cardiff

Plans and Drawings may be seen after Monday, the 13th instant, at the Offices of the Waterworks Engineer, Mr J A B WILLIAMS, Queen's Chambers, Cardiff, and printed copies of the Specification, Form of Tender, and Bill of Quantities may be obtained on payment of Five Guineas, which will be returned after the receipt of a bond fide tender

Tenders must be delivered in a sealed envelope, endorsed "Tender for Filters and Service Reservoir," and must be addressed to and left with me, the undersigned, before Ten o'clock of the morning of Friday, the 24th day of October

The Corporation do not bind themselves to accept the lowest or any Tender

J L WHEATLEY, Town Clerk
Town Hall Cardiff 4th October, 1884 G 956

THE SOUTHERN MAHRATTA RAILWAY COMPANY, LIMITED

The Board of Directors of the Southern Mahratta Railway Company, Limited, is prepared to receive

Tenders for the Supply of

IRON UNDER FRAMES and IRONWORK, &c, for Low-sided Goods Wagons, Timber Trucks, and Covered Goods Wagons
WHEELS and AXLES
AXLE BOXES
LAMINATED and VOLUTE SPRINGS
INDIA RUBBER ATTOCK S BLOCKS, &c
LAMPS, and
PORTABLE FORGES, &

As per Specifications and Drawings, to be seen at this Office

Tenders are to be delivered in sealed envelopes, addressed to the Secretary, marked "Tender for Under frames" &c, or as the case may be, not later than Twelve o'clock at noon on Wednesday, the 29th October, 1884

The Company is not bound to accept the lowest or any Tender By order of the Board,
(Signed) EDW Z THORNTON,
Secretary's Office, 11, Lombard Street, E.C Secretary
2nd October, 1884 G 955

DARLASTON URBAN SANITARY AUTHORITY

SEWERAGE WORKS —(CONTRACT No 2)

TO STEAM ENGINE MANUFACTURERS AND MACHINISTS

The Local Board of Darlaston acting as the Urban Sanitary Authority invite

Tenders for the Manufacture

and ERECTION in Darlaston of Steam Engines, Boilers, and Air Compressors in Duplicate, Lime and Alumina Mixers, Shone's Patent Pneumatic Ejectors, together with all things necessary for the proper completion of the Machinery

The Drawings and Specifications can be inspected, and further information obtained at the Offices of the Engineer, Mr EDWARD PRITCHARD, M Inst C E, 2, Storey's Gate, Westminster, S W, and 87, Waterloo Street, Birmingham, from whom a Copy of the Specification, Form of Tender, and other particulars can be obtained on payment of One Guinea

Sealed Tenders, properly endorsed, to be delivered to the undersigned on or before the 23rd day of October, 1884

The Local Board do not bind themselves to accept the lowest or any Tender sent in

By order, G 917
Darlaston, JOSEPH CORBETT,
25th September, 1884. Clerk to Local Board.

TO CONTRACTORS AND OTHERS

THE TOWN COMMISSIONERS OF DUNDALK, being the Sanitary Authority, invite

Tenders for the Construction

of WATER WORKS or the Supply of the Borough

Plans, Specifications, and Form of Tender may be seen at the Town Hall, Dundalk, or at the Offices of the Engineers, Messrs R. HASSARD and A. W. W TREFFRY, M M Inst C E, Westminster Chambers, on and after 1st October, and all Tenders must be sent in on the printed forms in sealed envelopes, endorsed "Tender for Water Works," and addressed to E FERRAR, Esq, Town Clerk, Dundalk, on or before the 25th of October

One Guinea will be charged for Copies of the Specification and Form of Tender, which will be returned on receipt of a *bond fide* Tender.

The Commissioners do not bind themselves to accept the lowest or any Tender

By order, G 860
Town Hall, Dundalk, EDWARD FERRAR,
11th September, 1884 Town Clerk

VENTNOR LOCAL BOARD

TO CIVIL ENGINEERS

Competitive Designs are in-

VITED for the CONSTRUCTION of an IRON PROMENADE PIER and LANDING STAGE to be ERECTED at Ventnor

A Lithographed Plan of the Site with instructions and particulars of competition may be obtained on *application to Mr R S* SCOTT, C E, Surveyor to the Board, Local Board Offices, Ventnor, I W

The author of the design which in the opinion of the Local Board is the best suited for the place and which complies with the instructions furnished, will be appointed at the usual commission to carry out the *works*

Plans, &c, are to be sent in to the undersigned on or before the 8th day of December next

By order, A HOUSTON,
Town Clerks Office, Ventnor, I W, Clerk to the Board
7th October, 1884 G 962

APPOINTMENTS OPEN.

LOUGHBOROUGH LOCAL BOARD

APPOINTMENT OF SURVEYOR.

The Local Board for the

District of Loughborough, in the County of Leicester, require the services of a duly qualified person to perform the duties of
SURVEYOR TO THE BOARD
and
WATERWORKS MANAGER

The person appointed will be required to devote the whole of his time to the service of the Board, and will not be permitted to hold any other appointment, or undertake any other work Salary £200 per annum

Applications, stating age, previous experience, and present employment with testimonials, to be sent to me not later than the 27th inst

Selected Candidates will have notice when to attend before the Board

By order,
JOHN JARRATT,
Town Offices, Loughborough, Clerk to the Board
7th October, 1884 G 970

The Commissioners of Sewers

for the Levels of Caldicot and Wentlooge, in the County of Monmouth, require the SERVICES of an experienced VALUER of Masonry and Earthwork, to inspect the walls and other sea defences on both levels, and assess the sum required (1) for putting the same into an efficient state of repair, and (2) the cost on an average of years to maintain the same when so repaired, with a view to commute the liabilities by payment of an annual rent charge

The Level of Caldicot extends from the mouth of the Wye, near Chepstow, to the mouth of the Usk, at Newport, and the Level of Wentlooge, from the mouth of the River Usk, at Newport, to Rumney Bridge near Cardiff, a distance, in the whole, of about 7½ miles

No expenses incurred before appointment by any of the Candidates will be allowed Previous experience in engineering work of the kind indispensable

Applications, stating amount of remuneration required, to be sent in to the undersigned on or before the 18th October inst

By order G 949
Usk, H STAFFORD GUSTARD,
1st October 1884 Clerk to the Commissioners

Wanted, for a Foreign

Arsenal, a SUPERINTENDENT of the GUN FACTORY Must be a man of experience, and competent to take the sole charge of the Manufacture of Modern Breech loading Cannon – Address, stating age, and full particulars of past experience, and enclosing copies of testimonials, to JULIUS ALLMANN AND CO, 2, Victoria Street, Manchester G 950

Colliery Manager.—Required,

at once, a first class MANAGER to superintend an extensive undertaking abroad, superior administrative capacity, with a knowledge of Mechanical Engineering and working of Collieries Railways essential – Apply, with testimonials, and stating salary expected, by letter, to X X X, care of J W VICKERS, Nicholas Lane, Lombard Street, London, E C G 960

Wanted, a good Draughtsman

for Engine Work, for large Engineering Works in the North of England State age, references, and salary required – Address Box 17, Post Office, Middlesbrough G 951

Wanted, Two or Three

thoroughly efficient LOCOMOTIVE DRAUGHTSMEN Address, stating experience and salary required, SHARP, STEWART AND CO, Ltd, Manchester G 963

Wanted, a Draughtsman with

experience in the construction of Coal Staiths and designing of Hydraulic Machinery – Address, G 954, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 954

Agents Wanted, to push First-

class MACHINERY OILS commanding a large and successful sale Liberal commission.—Address BOX 201, Post Office, Liverpool 5228

Wanted, for about Twenty

Patternmakers, First class FOREMAN, accustomed to large and small high-class engines and mill gearing, liberal salary to really good man – Address, G 977, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 977

Lists of Berths Vacant or

WANTED See "ENGINEERING REVIEW," weekly 1d – E & F N SPON, 16, Charing Cross, London, or of all News Agents. 5262

SITUATIONS WANTED.

Wanted, by an Energetic

Engineer, EMPLOYMENT either at home or abroad, has home and colonial experience in work shops and office, is willing, if necessary, to invest small amount to secure appointment in a genuine concern, can give exceptional references –Reply to A R ROBERTSON, 11, Great St Helens, E C G 973

As Assistant Engineer, Civil

or Mechanical, or Chief Draughtsman, at home or abroad Three years Engineer and Representative on the continent of a leading firm in Westminster Good mathematician, electrician and linguist, highest references – Address, N D, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 983

Wanted, Employment by

Mechanical Draughtsman, salary moderate – Address, C, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W C G 976

Draughtsman (good Mechan-

ICAL) is open to any kind of EVENING EMPLOYMENT –Address, C R, 188, Sloane Street, S W G 980

Civil Engineer's and Sur-

VEYOR'S ASSISTANT requires SITUATION Neat and quick draughtsman, good leveller, speaks German and French fluently excellent testimonials —M N, Bookstall, Hayton, Liverpool G 984

Agency.—Engineer, with

good connection, wishes to REPRESENT Iron or Brass Founders, Engineers, Boiler Makers, Tool Makers, or to push the sale of any new invention or specialty – R., Offices of ENGINEERING, 35 and 36, Bedford Street Strand London, W C G 987

Agency for Germany Wanted

by an energetic and experienced Engineer First class references
Address, M M ROTTEN, 97, Königgratzerstrasse, Berlin C 959

To Wrought-Iron Tube

MAKERS —The Advertiser, having a good district connection among consumers, WISHES to REPRESENT a good firm, on Commission –Address, TUBES, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 966

PARTNERSHIPS.

To Civil Engineers in practice.

—The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright
WHEATLEY KIRK, PRICE and GOULTY, 52, Queen Victoria Street, London, E C 5202

WANTED, &c.

Wanted, the following

Second hand MACHINE TOOLS, of first class make and in good condition One Shaping Machine, 16 in stroke, One Gap Lathe, sliding, surfacing, and screw cutting, 10 in centres, and about 20 ft bed, One Double geared Drilling Machine, 24 in centres, compound table –Address, S, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 948

Wanted, a Powerful Dredger,

capable of digging out 9 metres (29 ft) in depth, in stiff clay with stones Would be bought or taken on hire for a series of years –Address, E H, 7822, care of AUG I WOLFF & Co, Advertising Agents, Copenhagen, K Denmark G 924

Wanted, 14 HP. Horizontal

ENGINE, Second hand, in first rate condition State lowest price delivered in Liverpool and where to be seen – Address, G 952, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 952

Wanted, Two Shipbuilders'

MODELS of STEAMERS new or second-hand, of best finish, to illustrate appliances for loading at an exhibition, length 10 or 12 ft Half models will not do – Address, G 967, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C G 967

Lists of Machinery Wanted or

on SALE. See "ENGINEERING REVIEW," weekly 1d – E & F N SPON, 16, Charing Cross, London, or of all News Agents 5202

FOR SALE.

For Sale, One Pair of

Compound Surface Condensing
MARINE ENGINES AND BOILER,
190 HP Nominal. 5299
J GILMOUR & CO, Engineers, Glasgow

For Sale, Stone Breaker, size

12in by 6in Weight 2 tons, with Hall's Patent Elastic Steel Connecting Rods –Apply, C E HALL, Standard Iron Works, Washford Road, Shefficld 5340

For Immediate Sale, a First-

Class 6 in SCREW-CUTTING LATHE, all complete, best materials only –Address, G 971, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W C G 971

For Sale, 9 in. Double Cylin-

der PORTABLE ENGINE, by Clayton and Shuttleworth, in good condition, being replaced by larger engine.—Apply to STRACHAN & CO, Frome Hall Mills, Stroud, Gloucestershire 5232

For Sale, being superseded by

engines of higher power, a pair of High Pressure Condensing STEAM ENGINES Cylinders, 26 in. diam, 3 ft. 6 in. stroke, with cold water pump for same –Can be seen at work at the Manufactory of the LONDON PORTLAND CEMENT CO, Ltd, Northfleet, Kent, to whom enquiries may be addressed G 53

For Sale, by the Mortgagees,

the NORTHFIELD IRON WORKS, Rotherham, Yorkshire (Freehold) 22 puddling furnaces, 18 in forge-train, 14 in bar mill, guide and hoop mills, "Colliers" tyre mill Railway and canal to works – Apply to Messrs. MACREDIE & EVANS, Chartered Accountants, Sheffield G 828

For Sale, Steel Launch, Twin

SCREW (in progress and nearly finished), 55 ft long by 13 ft. beam, 6 ft 6 in deep, draught 3 ft. 6 in, engines 10 in and 15 in by 14 in stroke. No wood work fitted, can be shipped in three sections, designed for high speed and light draught —For Specification and price, apply to LOUDOUN BROTHERS, 111, Bothwell Street, Glasgow, and 156, Upper Thames Street, London G 980

For Immediate Sale, at low

prices for cash
SECOND HAND
AIR COMPRESSOR, on air receiver, 2 steam cylinders, each dia, air cylinder, diameter
LANCASHIRE BOILER, 18 ft 8 in by 7 ft diameter
Twenty HORIZONTAL and VERTICAL ENGINES, cylinders from 3 to 20 in dia, second hand and new
10 in TANK LOCOMOTIVE, by Fletcher, Jennings, and Co, 4 wheels coupled.
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10 ton SELF CONTAINED WEIGHING MACHINE
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ECLIPSE ROCK DRILL, on tripod and weights, and about 60 lbs Steel Tools
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always in stock or progress.—HUDSWELL, CLARKE and CO, Railway Foundry, Leeds, Sole Makers of RODGERS' PATENT WROUGHT IRON PULLEYS See Illustrated Advertisement, page 38

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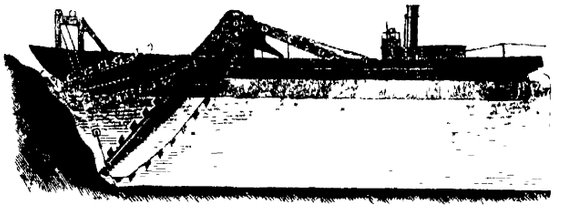
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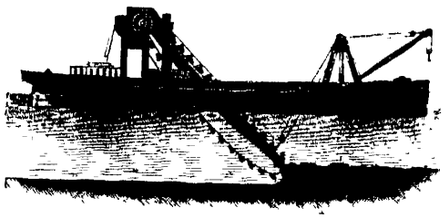
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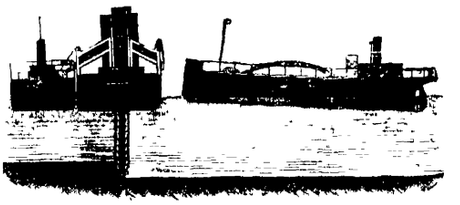
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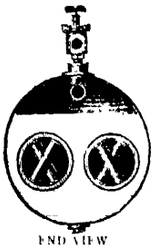
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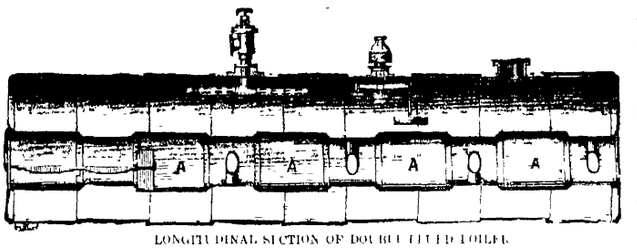
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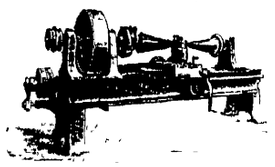
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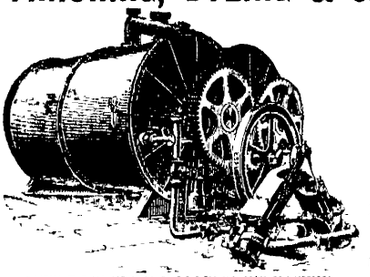
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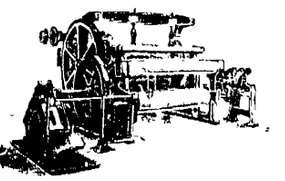
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For Excrementitious Matter & other Materials and Compounds

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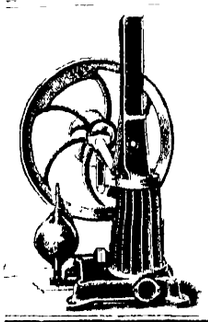
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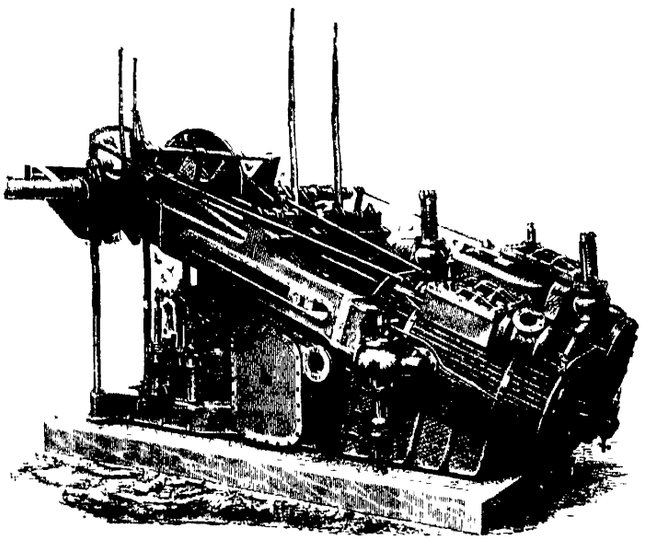
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6 OF THESE BLOWERS WERE SUPPLIED WITH THE 150 N°4 TO HEARTHS FOR THE INDIAN STATE RAILWAYS OCTOBER 1882
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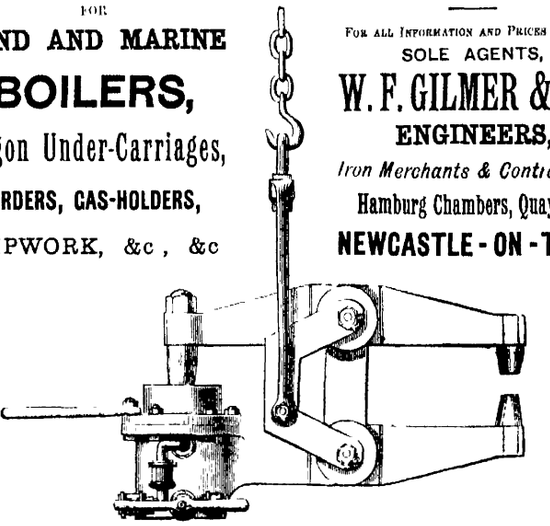
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2-CYLINDER DISCONNECTING COMPOUND ENGINES
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4-Cylinder Disconnecting Triple-Expansion Engines,
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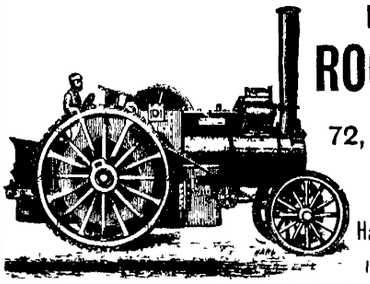
For Illustration of 4-cylinder Twin Screw Engines, see ENGINEERING of this day fortnight 5229

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FOR
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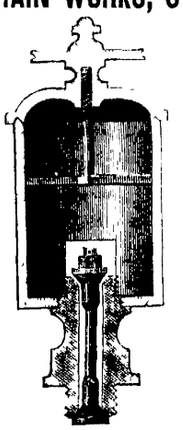


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A Clear Saving of 50 per cent. in Oil, Tallow, or Grease.

Cannot get out of order.



Perfectly Clean in working.

One Month's free trial allowed.

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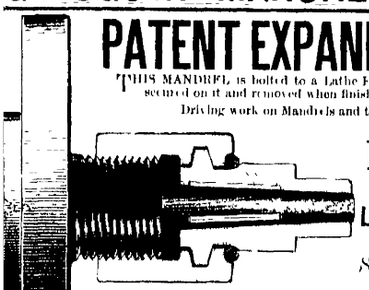
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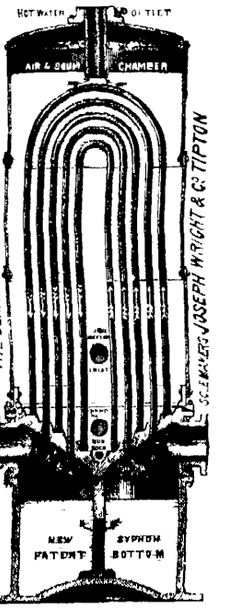
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THEY HAVE NEVER BEEN SURPASSED FOR STRENGTH, UNIFORMITY OR DURABILITY, *AND ARE MADE BY SPECIAL WORKMEN FROM IRON OF SPECIAL QUALITY, PREPARED EXPRESSLY FOR THIS COMPANY ONLY.*

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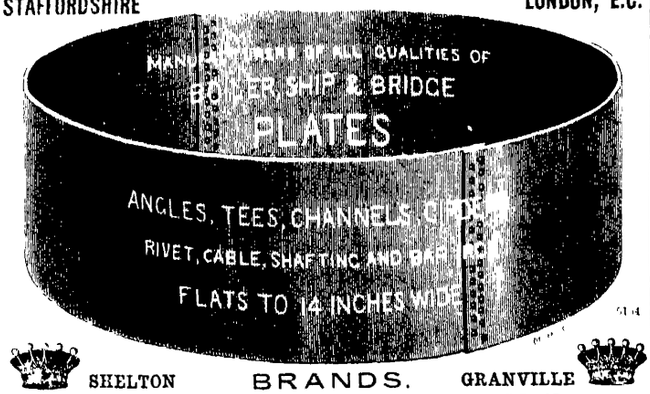
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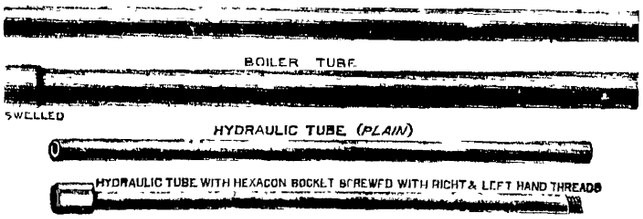
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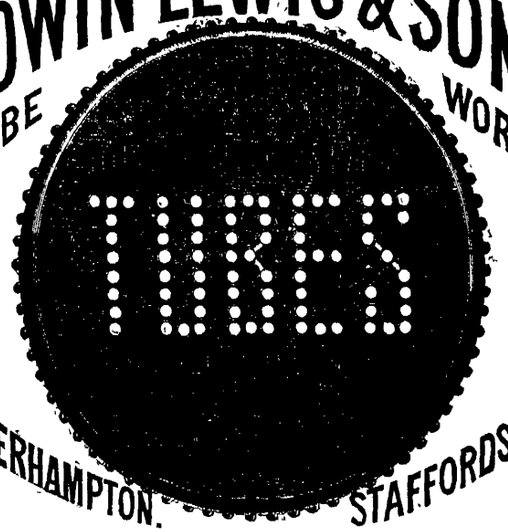
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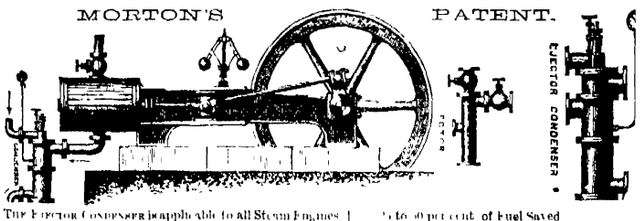
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Royal 1869
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Ayrshire 1876
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Royal Cornwall 1877
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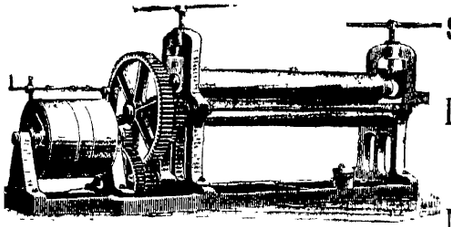


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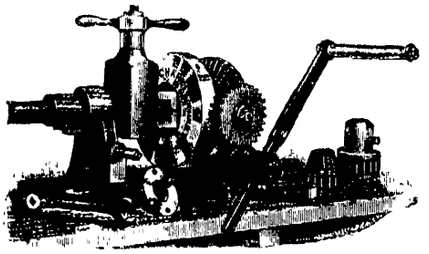
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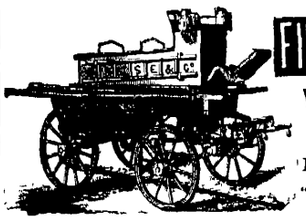
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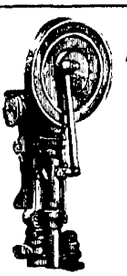
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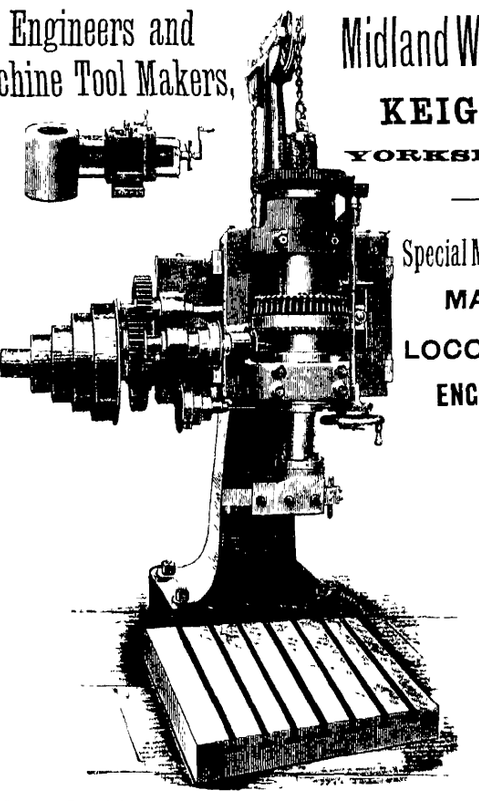
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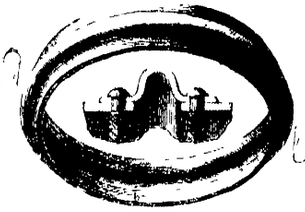
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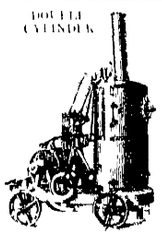


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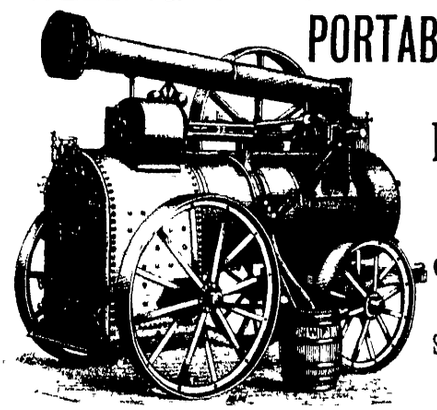
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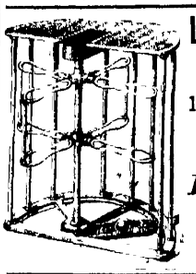
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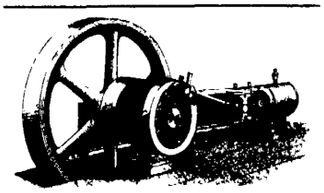
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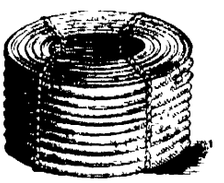
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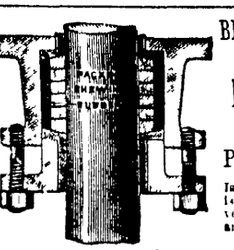
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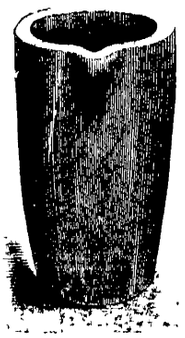


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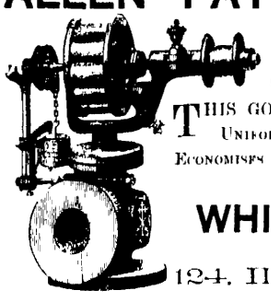
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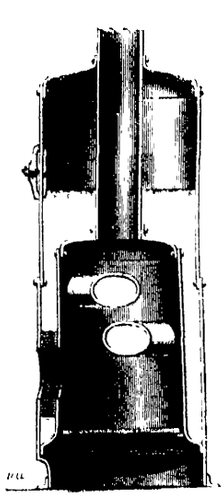
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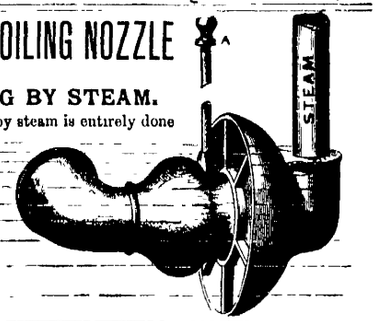
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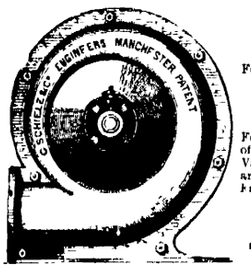
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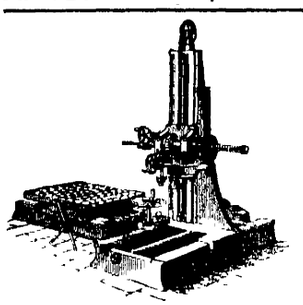
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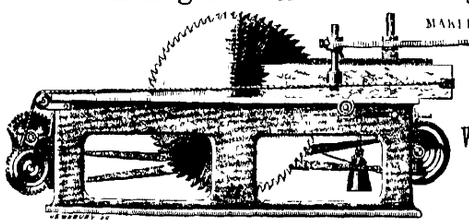
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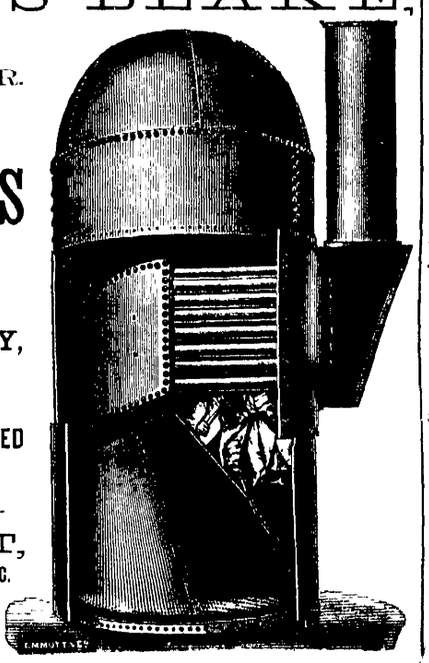
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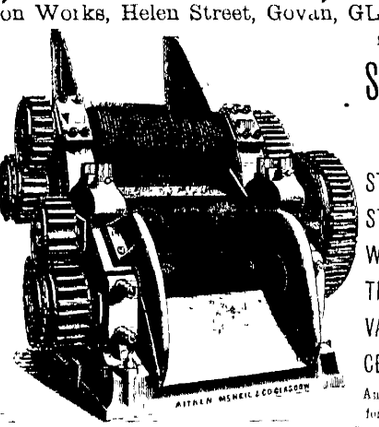
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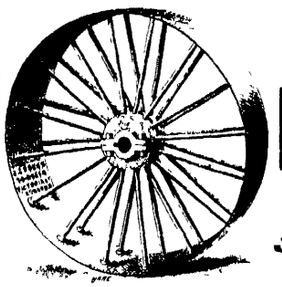
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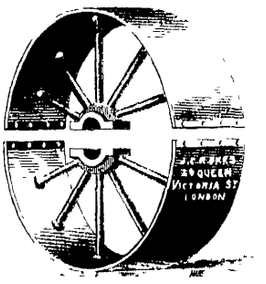
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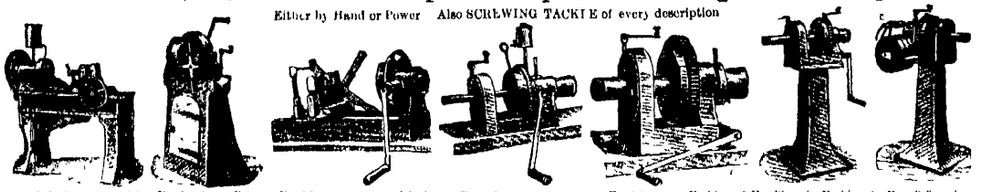
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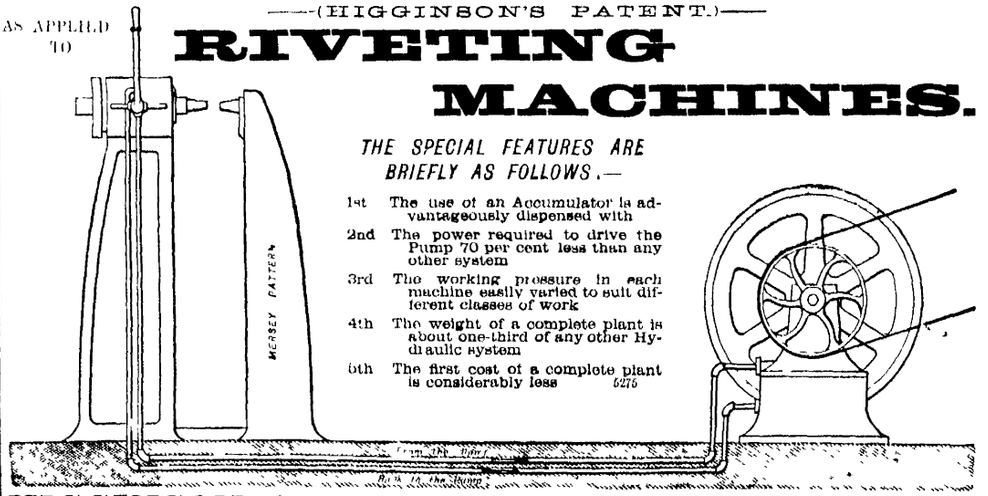
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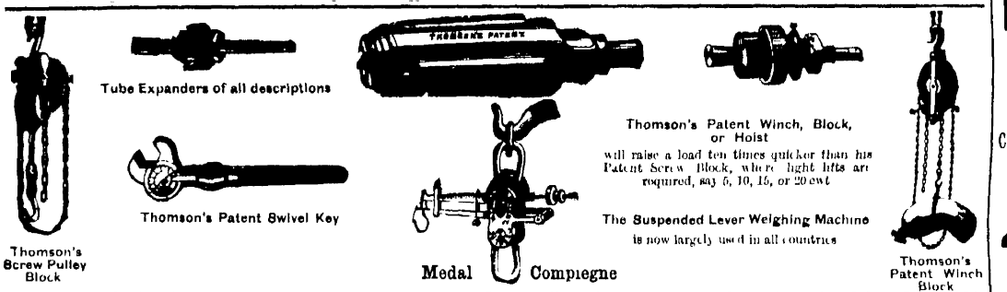
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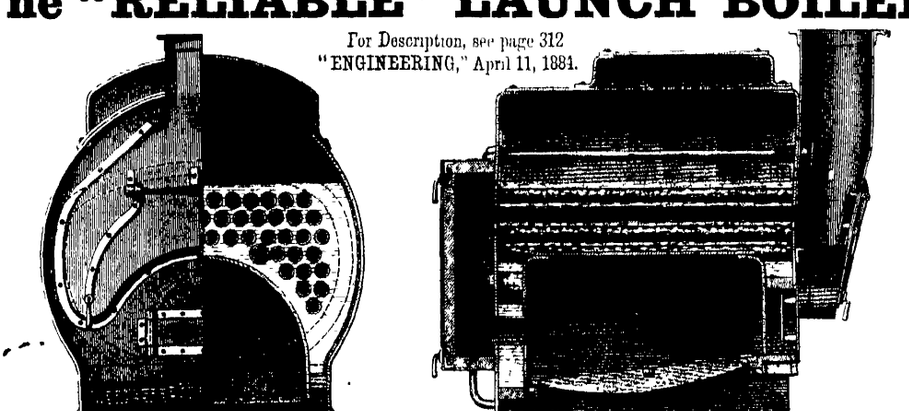
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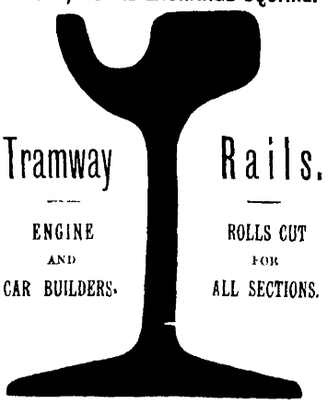
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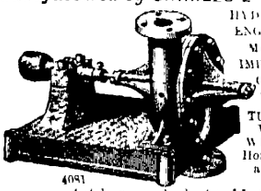
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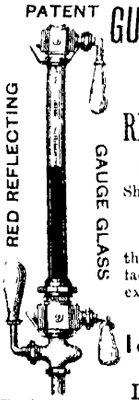
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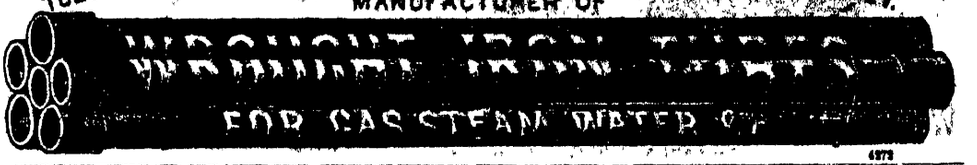
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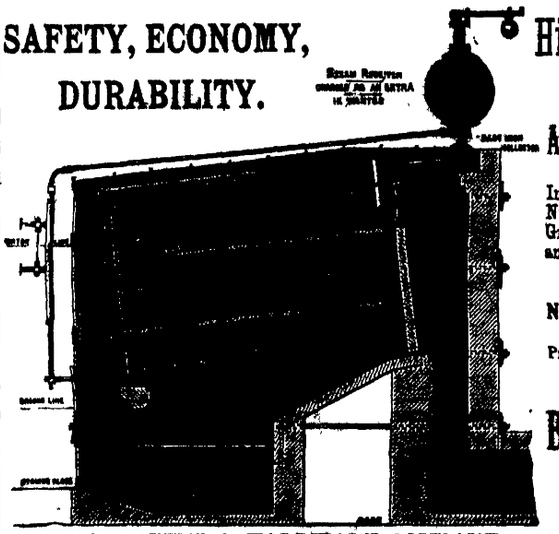
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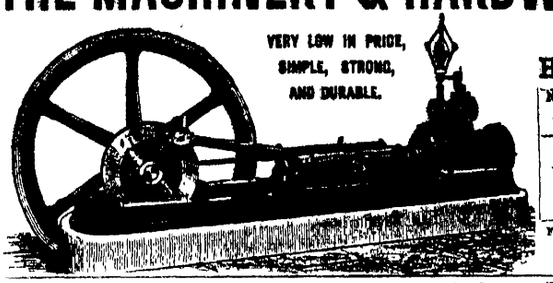
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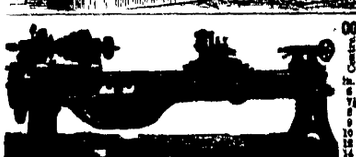
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4	6 by 12	3 6	81 10	14	12 by 24	7 0	89 10
5	7 ,, 14	4 6	40 0	20	14 ,, 28	8 6	115 10
7	8 ,, 16	5 0	47 10	24	15 ,, 30	8 6	142 0
9	9 ,, 16	5 0	55 0	28	16 ,, 36	8 7	173 10
12	10 ,, 20	6 0	68 10	32	18 ,, 36	8 9	194 10

Full sized Cylinders with Loose strokers. Pirect-Acting High-Speed Porter's Governors, Pumps, Fly-wheel, and out and Pedestal complete, all finished in first-class style. Prices for Manchester.

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Centres.	Class B. Sliding & Screw cutting.	Sliding, Surfacing & Screw cutting
ft. ft.	£ s.	£ s.
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CORNISH BOILERS, One Flue

2 hp	4	6	8	10	12	14	16	20	25	30	35 hp
£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
21 0	32 0	46 0	58 0	65 0	78 0	87 0	92 0	109 0	137 0	163 0	186 0







4-Jaw'd Chucks with Steel Jaws

Dia.	Price.
In.	£ s. d.
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10	4 5 0
12	4 16 0
14	5 10 0
16	6 12 0
18	7 14 0
20	8 10 0
24	11 0 0
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36	18 5 0

CIRCULAR SAW BENCHES, With Rising and Falling Tables.

Table inches.	With take Saw diam.	Price. £ s. d.
42 by 24	24 in.	16 10 0
56 ,, 28	30 in.	20 0 0
42 ,, 28	36 in.	25 10 0
72 ,, 36	42 in.	33 10 0

VERTICAL CROSS TUBE BOILERS.

1 hp	2	3	4	5	6	8	10	12	14	15	16	18	20 hp
£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
15 0	22 0	25 10	31 0	35 0	45 0	58 0	70 0	82 0	90 0	96 0	99 0	107 0	115 0

Cheap Drilling Machines.

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28 in. dia. Double Gear	£27 10
30 in. ,, ,, ,,	32 10
36 in. ,, ,, ,,	42 0

Other sizes quoted on application.

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THE DEE IRON WORKS.

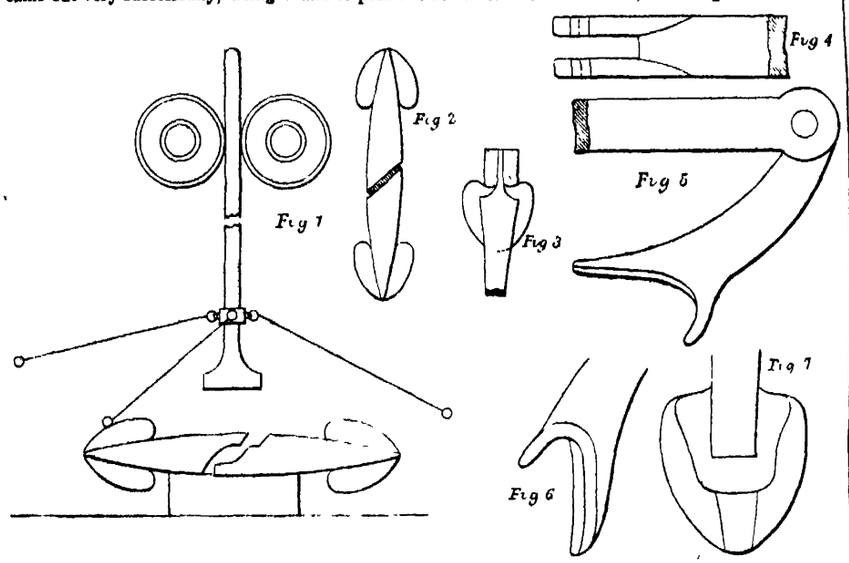
The business now carried on by Messrs. Henry Wood and Co. at the Dee Iron Works situated at Saltney, about two miles from Chester, was originally established at Stourbridge in the year 1780. The Saltney Works were built about the year 1847 for the exclusive manufacture of large anchors and cables. There are also branch establishments at Stourbridge and Liverpool, whilst an affiliated concern is carried on by Messrs. George Wood and Co at Limehouse, in the east of London. The principal seat of manufacture is, however, at the works we are about to describe and which were amongst those thrown open to the members of the Iron and Steel Institute during the recent Chester meeting.

The chief articles manufactured are anchors and chains of various descriptions. Here were forged in the year 1847 the anchors for the Great Eastern, some of which weighed seven tons each; whilst those whose memory carries them back to the first Exhibition, will recollect the heavy 5 in. chain that this firm contributed, and which, it may be mentioned, gained a prize medal. As another point of historical interest we may refer to the great international anchor trials which were carried out in 1852, when the Trotman and Porter anchors, made by Wood Brothers—the then style of the firm—came out very successfully, being found to possess the greatest holding powers by 40 per cent. This, however, is ancient history, but in the present day we still find the Saltney firm manufacturing anchors and cables of the largest size. The latest Cunard liner, the Umbria, almost the largest ship afloat, has received her outfit of ground tackle from these works. The links of the bower cable are of 2⅞ in. iron. A sample of this chain, which we saw on the occasion of our visit, was tested to destruction at the Lloyd's proving house adjacent, and broke at a strain of 213 tons 6 cwt., which is about 76 per cent. above the Admiralty standard.

As we pass from the offices we come to shop No. 1, which is used for making cable and mooring swivels, and shackles and general forging. Here there are four fires. Adjoining this is another shop, in which work of a similar description is carried on, but which is capable of taking heavier jobs, there being two ground fires here. Another shop close by is used for lighter work of the same kind. We now pass to anchor shops Nos. 2 and 3, where anchors between 12 cwt. and 40 cwt. are forged. Here are large swing hand beetles or drop hammers used for welding up the crowns of anchors. These beetles consist of a bar of iron 24 ft. 6 in. long, at the end of which is a head for striking the blow. This is suspended by chains running over pulleys placed in the roof above, and is hauled up to a height of 20 ft. by eight men, and when allowed to fall through that distance gives a heavy blow.

On this side of the works there is a foundry where castings used for studded cable and in anchor work are made. Here also are cast parts for ships' windlasses, capstans, &c. Next to this foundry is a smithy where the general smiths' work, principally in connection with crane chain fittings, is carried on. Hooks for a working load up to 60 tons are here made. Above is a fitting shop with lathes, planing, and other machine tools. At the time of our visit some pillars for copper rolling mills were here in hand.

In anchor shops Nos. 4 and 5, anchors up to 160 cwt. are forged. Here are suspended 8 cwt beetles or drop hammers on the same principle as those already referred to, but worked by power. We give below in Fig. 1 a sketch of this apparatus. The shank is of flattened section, and when the hammer is required to be raised, is gripped by the two friction pulleys. One of the latter is keyed on to the driving shaft, whilst the second runs in a shifting frame having a horizontal motion. This is controlled by a lever worked by the smith from the ground level. When the hammer has been raised to the required height the operator releases it from between the friction pulleys, and it descends on to the work below. Attached to the head of the hammer are three or four guide chains, and by means of these the blow is directed to any required part within a given radius, so that the work itself need not be shifted in order to make a weld of considerable area. In this shop are three large ground fires, which it may be noticed require 3 tons of slack to make them up to their full capacity. The crown weld of a 5-ton anchor would be in the fire three hours, and in greatest section would be 18 in. by 24 in. Near each fire there is a tripping pit about 6 ft. deep. This is for the purpose of turning the anchor over when being taken from the fire to the anvil. The heat is got on the underside, and the blow must be on the same side to make the weld No. 5 anchor shop is similar to that just described.



We now pass to forge No. 1, where there is a 80 cwt. steam hammer by Messrs. Tannett, Walker, and Co., of Leeds. There is also a Nasmyth steam hammer of 25 cwt. Here are a large pair of crocodile shears, and two heating furnaces with steam boilers above. The shop is commanded by suitable cranes, and is capable of dealing with forgings of 10 tons weight.

Near here is a 60 horse-power horizontal engine, which drives two 72 in. fans used for supplying blast for the forges. They are geared by belt and spur gearing to the engine, and run at 1200 revolutions per minute. This engine also works the beetles referred to. There are four Cornish boilers, averaging 28 ft. long and 6 ft. in diameter. They are worked at 40 lb., and one is heated by the gleed oven which is attached to it. Gleed is a description of soft coke used exclusively by the chain makers. It is made from a highly bituminous coal, and care is taken to eliminate all sulphur during its preparation. Near these boilers are link bending machines and a pair of "Jack-in-the-box" shears. In these the lower jaw is worked by a cam motion from below. This allows the knife to drop to its full extent immediately the cut is made, and so gives the workmen plenty of time to place the work in position ready for the next operation. This machine will cut a piece of bar iron 3½ in. in diameter with a scarf 7 in. long. The link in the straight is taken from these shears and put into a heating furnace, and from thence taken to either of the link-bending machines referred to. One of these is of the vertical type, whilst the other works horizontally. In the former the end of the straight link is placed under a stud on a revolving mandrel, and is then firmly wedged in its place by means of a part of the mandrel which is made to take out for the purpose The mandrel is oval in shape, and is of the necessary size to make the link which is formed on it by means of a roller. The mandrel revolves whilst the roller remains above it, but the requisite vertical motion, required by the latter on account of the oval shape of the mandrel, is obtained from an eccentric worked from the main shaft. Links up to 3 in. diameter are bent on this machine In the horizontal machine the mandrel is placed on a plate from which an iron stud projects. This engages in a slotted hole in the mandrel, which, of course, is oval in plan, in order to turn out the link of required form. The bottom of this mandrel has teeth cast on it, and is worked by a spurwheel, keyed on a vertical shaft. The latter is driven by worm and wheel above. The shifting end to the mandrel is here also used to hold the link firmly under the stud fixed for the purpose, and as the mandrel revolves it turns the link by causing it to press against two rollers. The operation is very slowly conducted, in order to prevent injury to the fibre of the iron. Links from 3 in up to 6 in are turned in the latter machine, but even larger sizes could be worked if required, for such purposes as heavy mooring chains or other work of a similar nature. Both these machines are driven by a small beam engine, having a 16 in. cylinder with a 30 in. stroke.

In the cable department we come first to shop No. 1, which contains fourteen fires. Here cables are made from 1 in. up to 1¾ in., both by side and end work. In "side work" the links are cut with a scarf, and are bent by the machine, whilst in the "end work" the chain is made by hand direct from links in the straight which have been cut off square Both studded and short link, or unstudded cable, are made here. The studs are the short pieces of cast iron that are placed across the links to enable the latter better to take the strain. In cable shop No 2 there are five fires. Here the next range of sizes, those between 1¾ in to 2¼ in., is made Shops Nos. 3 and 4 have ten fires, and provide for cable from 2¼ in up to 3 in. No. 5 shop is used for large mooring chains and work of especially heavy description. There are two down fires and a jib crane for shifting the work Chain up to 6 in. rectangular section is made here. It will perhaps be of interest to note that in chain of the latter description the links are made of heavier section at the ends, in order to allow for wear. At the back of No. 3 cable shop is a hydraulic chain testing machine, which will test up to 105 tons and take lengths of 31 yards.

From the cable department we pass to two anchor shops, known as Nos. 7 and 8, where small anchors, kedges, &c., are made. Near here there is a hydraulic anchor testing machine of the ordinary type; this firm, we believe, being accorded special privileges by the Government in the matter of testing their own anchors. We now come to another forge where there is a 35 cwt. Nasmyth steam hammer and two heating furnaces. Here anchor work and general forgings are turned out. In forge No. 4 is a 20 cwt. Nasmyth hammer and one heating furnace, together with shears, &c. Forge No. 5 has a 15 cwt. steam hammer, by Massey. Above most of the heating furnaces steam boilers are placed.

In the centre of the works are situated shops set apart for the manufacture of crane chain, crane lashings, and colliery chains. These have always been an important branch of manufacture at the Saltney Works, Messrs. Wood making a point of producing a chain of special quality for these important uses. There are thirty-six fires in this department, and close by is a testing house in connection with this section of the works.

Messrs. Wood manufacture eight or nine different types of anchors. These consist of the ordinary iron stock anchor, the Admiralty, the Rodger's (old and improved), Porter's, Trotman's, Martin's, and lastly Wood's improved anchor with solid palm. The last four are swivel anchors. There are also Norris's and Batteley's patterns; these are also swivel anchors. With regard to "Wood's improved," we cannot do better than quote

1000-LIGHT FERRANTI ELECTRIC GENERATOR.

CONSTRUCTED BY THE HAMMOND ELECTRIC LIGHT COMPANY, LONDON.

(*For Description, see Page* 333.)

Siemens Exciter D 9

Fig. 1.

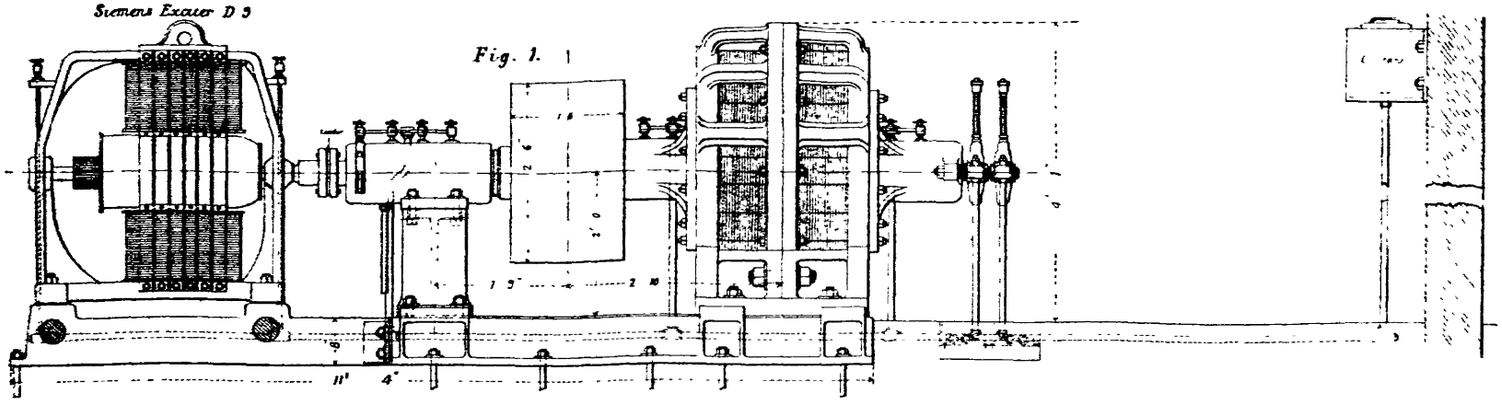


Fig. 2.

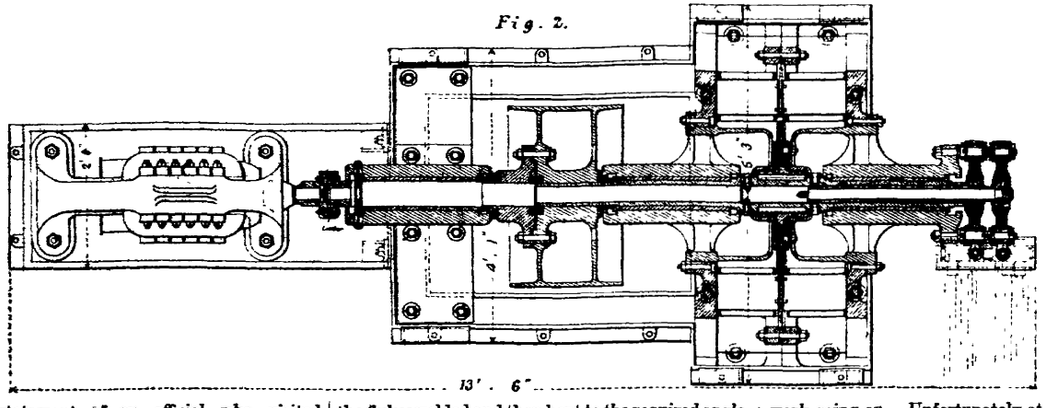
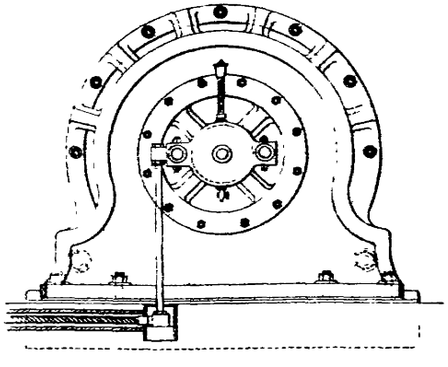


Fig 3.



from the statement of an official who visited these works with a view to reporting on the anchors here made. "The accompanying sketches (Figs. 2 to 7) show the forms and position of the welds, and it will be seen that there are no abrupt alterations of form, and great effective sections of solid metal are left on each side of the pieces, and the spaces afterwards to be filled up are not of very great depth and can be made up effectively. This it is impossible to do in the case of some anchors." "The shanks of the anchors made on the Trotman principle have the jaws formed by welding pieces on to the bar, as shown in Fig. 4, and it would appear that if the scarfs are made long, strong attachment should be secured by this method. The two arms are forged in one piece, the flukes welded and then bent to the required angle. 'Wood's improved' have solid forged palms with Trotman's shank and toggles, as shown in Fig. 5, whilst Trotman's palms are welded on as in Figs. 6 and 7."

In addition to the articles we have named, Messrs. Wood also manufacture windlass purchases, spindles, and boxes, chain gipsies, screw steering apparatus, and ships' castings of various kinds. In the smithy are made knee moulds, scrap forged iron, heavy shafting, cranks, and general smith's work for different purposes.

From what has been said it will be seen that the Dee Iron Works offer a good deal that is interesting for the study of those who are connected with heavy forging, supposing there is a fair amount of work going on. Unfortunately at the present time the anchor trade, in common with other branches of marine industry, is in a somewhat depressed state. There is, however, even now enough work in hand to make the works well worth a visit.

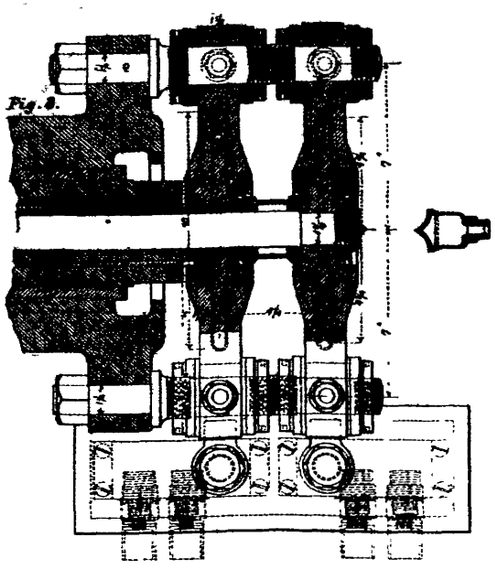
THE FRENCH IRON TRADE.—The iron trade has not improved of late in the French department of the Nord. Orders have continued scarce and the rolling mills have only been working about 18 or 20 days per month.

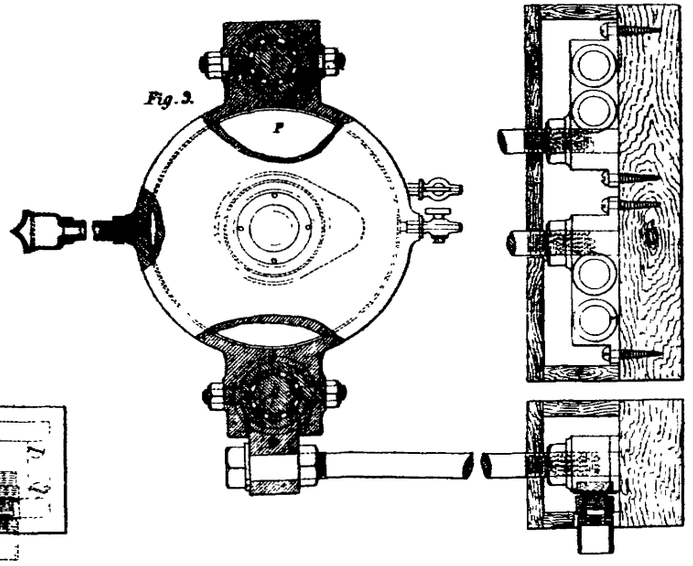
THE FRENCH TELEPHONE CASE.—The experts appointed by the Civil Tribunal in Paris, to report upon the action brought by the Société Générale des Telephones against various manufacturers are M. Clérac, telegraph engineer; M. Pothier, Ingenieur-en-Chef des Mines and Professor of Physics at the Ecole Polytechnique; and M. Perissé, civil engineer.

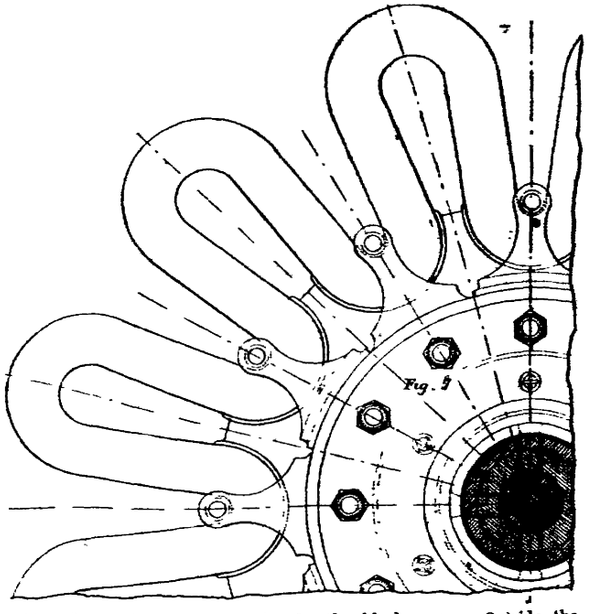
THE NEPEAN TUNNEL.—The longest tunnel in the southern hemisphere has been recently completed. It will conduct the waters of the Nepean and Cordeaux rivers to the Cataract River, at a point from which they will be led by a canal to Sydney to form the water supply. This tunnel, which is about 7 ft. in height by a little over 9 ft. wide, extends from the Nepean to the Cataract River, a distance of 4½ miles. It is three years ago, last July, since Messrs. Topham, Angus, and Smith began to drive the tunnel through the sandstone, and as soon as they commenced work the contractors knew that they must lose a very large sum of money over the task they had undertaken; but Mr. Topham, who represents the firm on this contract, stuck to his engagement pluckily and honestly, and the work has been well done from first to last. The contract was for a little under 70,000*l.*, but the outlay has been many thousands of pounds in excess. There need be little fear of a water famine in Sydney when the Nepean and Cataract dams have been constructed.

1000-LIGHT FERRANTI ELECTRIC GENERATOR

CONSTRUCTED BY THE HAMMOND ELECTRIC LIGHT COMPANY, LONDON.


Fig. 1.


Fig. 2.


Fig. 7

ELECTRIC LIGHTING AT THE INTERNATIONAL HEALTH EXHIBITION.

No. VIII.

SINCE the close of the Fisheries Exhibition, Messrs. Ferranti, Thompson, and Ince have combined with the Hammond Electric Light Company, the business being carried on under the name of the latter firm. Consequently, although the Ferranti machine forms one of the most interesting exhibits at the Healtheries, it is now to be found in the catalogue under the name of the Hammond Company, who in addition exhibit a 40-light Brush machine, and thus provide both incandescence and arc lighting. The Brush lamps are mostly situated in the grounds, but neither they nor the dynamos by which they are fed, call for an extended notice at our hands, for probably no system has received so much attention from the press and has undergone less modification since its introduction than this.

The incandescence lighting is effected by a large Ferranti dynamo capable of supplying 1000 lamps, and similar in construction to that which we illustrate on the present page and on pages 332 and 336. The one shown in the engravings is part of an electric light plant recently erected by the Hammond Company at the Works of Messrs. Colman and Co., of Norwich.

Fig. 1 is an elevation of the dynamo and the Siemens machine by which it is excited, mounted together on one baseplate. Fig. 2 is a sectional plan, Fig 3 an end elevation of the Ferranti dynamo; Figs. 4 to 6 show enlarged sections of the armature driving boss and the connections; Fig. 7 is an elevation of the same; and Figs 8 and 9 are sections of the new mercury collectors, showing the connections to the main leads. Since last we illustrated this dynamo considerable improvements have been made in its general construction. The main frame of this size of machine is made up of four parts. The sides have each 24 magnet cores cast upon them, and likewise carry, by means of arms or brackets (Figs. 1 and 3), an outer ring which serves to bolt the machine together and also to protect the armature. Round one-half of this ring a recess is turned and a corresponding projection is formed on the other, thus insuring that the two parts of the machine shall come true together. The bearing bosses are cast separately for ease in machining and also to allow of the bearings being got at easily.

The principal dimensions are shown on Figs. 1, 2, and 3. The weight of the cast-iron frame is 3 tons. When complete, without the pulley, the dynamo weighs 4 tons 10 cwt. The magnets are wound with double cotton covered wire 3·5 mm. in diameter, each coil being built on a separate mould and slipped on to its magnet core afterwards. The coils are forty-eight in number, and when coupled up in series have a resistance of 16 ohms. In practical use the two sides are coupled up parallel, and an exciting current of 30 amperes is used. The main bearings are 18½ in long; they are of phosphor-bronze, close bushes being used. The spindle is Whitworth fluid compressed steel made hollow for lightness, and also to carry the main conductors to the outside collectors. Its diameter in the bearings is 4¼ in. The enlarged section (Fig. 4) shows the method of insulating and fixing the armature and the conductors. For convenience the section in Fig 4 does not follow a straight line through the armature, but is bent at the centre 30 deg. The reason of this is that each arm or division of the armature is different from the one at either side of it, and consequently if the section followed a straight line it would only illustrate one-half of the arrangements for the collection of the current.

Referring to Fig 4, C is the hollow armature spindle, carrying within it two concentric copper conductors, to which all the copper strips on the armature are electrically connected at their ends. Upon this spindle there is mounted the driving boss D, which is fixed by two feather keys. The boss is made in two parts, like a face coupling, and the screens by which the halves are united bind it against a ring E on the shaft, and thus it is prevented from moving endwise. This boss has half as many arms as there are sinuosities in the armature, that is, six, and as shown in Fig. 4, it secures every alternate depression by a screw F. The armature is entirely insulated from both sides of the boss and from the screws by vulcanised fibre, which is represented in the engraving by the black spaces. Outside the driving boss, but electrically separated from it, there is the outer boss G G, likewise made in two parts, and furnished with six arms which correspond to the six indentations or depressions of the armature not provided for by the arms on the driving boss. These arms have rivets and ferrules, as shown in the lower part of Fig. 4, but unlike those on the driving boss they are connected, one by one, to one set of ends of the strips on the armature, and thus the boss G provides a path for the current on its way to the collectors.

The other set of ends of the strips are connected at equal distances to a brass star or shaping piece H which forms a foundation for the armature. The arms of the star, as shown in Fig. 4, are cut off on a level with the rivets F F. The current is led from the star by the studs I I to the ring J J, and through it and the studs K K to the copper tube L L, on the end of which there is mounted one of the collector discs. The other current passes, as already explained, through the boss G and the studs M, to the internal conductor N, and the other collector disc. These two conductors are first fixed in place with ivory distance pieces, and then a fluid non-conductor is forced into the intervening spaces, and in setting unites the whole into one solid mass.

The armature is of the well-known Ferranti type (Fig. 7) and needs no general description. In the machine from which our illustrations are taken, it consists of eight strips of bare copper tape 9.5 mm.

wide by 1.5 mm. thick, with vulcanised fibre tape, 0.5 mm. thick interposed between the adjoining layers. Each strip makes four complete convolutions, its length being 93.4 ft. The copper in the armature weighs only 54 lb., and is so tightly wound and firmly held that it will stand a great amount of rough usage, and even of violence, without detriment. The actual measured resistance between the two collector discs is .0062 ohm.

At 600 revolutions per minute the electromotive force at the terminals is 110 volts, 10 volts being allowed for possible loss in leads. This margin is capable of being regulated by the exciting current from the Siemens D 9 series-wound dynamo.

Probably the most novel and striking feature in the electric exhibits at the Health Exhibition is the ingenious arrangement devised by Mr. Ferranti for forming a perfect sliding contact between the collector discs and the main leads which convey the current to the lamps. All forms of brushes and bearing blocks interpose a considerable resistance in the circuit, because they must be covered with a film of lubricating material, and at the best, make only a series of intermittent contacts, which become less and less continuous as the surface of the collector is impaired by sparking. Mr. Ferranti has therefore discarded all elastic appliances between his fixed and rotating appliances, and in place of them has filled the space with a film of mercury under pressure, which from its perfect fluidity adapts itself to both surfaces, clinging to them with an even force which insures absolute contact over a large extent of surface, with the minimum of resistance.

The collectors are shown in Figs. 1 and 2, and to a larger scale in Figs. 8 and 9. They are formed entirely of steel and cast iron to prevent amalgamation, and each consists of a disc P fixed to one of the central conductors, and rotating within a case or cover bored to such a size as to leave a clearance space between the two. These cases are made in halves, the division being diametrical, and are mounted upon trunnion pieces R R carried by intervening ivory non-conducting pieces upon the studs Q Q, which project from the main bearing. One of the trunnion pieces for each collector has an extension which is permanently connected by a copper bar to the main leads laid beneath the ground (Fig. 9). The mercury is introduced into the case by the cup and pipe at the top, and when the machine is at rest it lies in the lower part, from which it can be withdrawn by a tap. When the collector rotates its friction carries the mercury with it, while the centrifugal force drives the fluid towards the edge of the disc, spreading it in a film over both faces and the periphery of the collector, and pressing it against the surfaces with a force which is measured by the height the mercury rises in the gauge glass. A head of 3 in. can be maintained with practically no heating, and a perfect contact obtained without friction. Any stray drops which escape from the disc get into the grooves in the casing and run down the gutter, shown in dotted lines in Fig. 9, into the bottom again.

The method of oiling is peculiar and interesting. An oil tank is placed as shown in Fig. 1, but at a considerably greater elevation in order that there may be a head of several feet at the bearings. From the tank, pipes are led to all the places needing lubrication, the continuity of the pipe being maintained into the bearing. The last inch or two is of glass, and above this there is an adjustable valve by which the flow can be regulated until it is seen to fall drop by drop through the glass tube. Should the bearing show signs of becoming warm, the valve can be opened, and the full pressure be brought to bear to force the oil between the two surfaces.

The Hammond Company have a complete system for incandescence lighting, including switches, fusible cut-outs, junction-boxes, and all the rest of the small fittings which exercise so great an influence upon the satisfactory working of an installation. They are all made to gauge, and are interchangeable throughout. Great care is taken to make good contacts, and a special form of coupling has been devised, resembling a union joint in pipe-work, which insures the surfaces being brought into the most intimate contact, and rigidly held there. The switches all break the circuit at two places simultaneously, and present the most ample contact for the passage of the current. The lamp-holders are a modification of the well-known Swan pattern, and the cut-outs are so designed that they can be renewed in a moment when fused. The whole system bears evidence, as a glance at our illustrations will show, of an amount of mechanical and engineering skill that is not excelled in the productions of any other electrical firm; every detail shows marks of careful consideration, and an inspection of the workshops in Appold-street, Finsbury, demonstrates that the manufacture is carried out on a rigid system, which assures that the care exercised in the drawing office shall be supplemented by accurate workmanship and splendid finish.

PATENT MUSEUM LIBRARY, SOUTH KENSINGTON.

To the Editor of Engineering.

Sir,—For a practical illustration of a retrograde movement, I would respectfully commend your readers to the Patent Museum Library at South Kensington.

Under the old *regime* (*vide* "Searcher's" letter in your issue of March 7, 1884, p. 217), it was possible to see the printed specifications of patents (as a favour, and when they were not "in the colonel's private room," as I invariably found them to be) about 5 o'clock on the Saturday evening, or, that is, about seven hours after they could be consulted at the Patent Office in Southampton Buildings, a distance of certainly not more than five miles separating the two places. This, however, for a Government department *was fairly good* work. But, under the new order of things, when everything else connected with patents is advancing with gigantic strides, South Kensington is (as she ever was) far behind in the race, for now I find that the printed publications are not visible until Monday morning, that is, forty-eight hours are required to convey them five miles, truly a marvellous performance in these days of underground railways (N.B. Temple to South Kensington, return fare a few pence, time occupied on the double journey by any one, *not* in Government service, about one hour)

And the cause of all this delay is, as one of the attendants informed me, with more candour than discretion, simply because the Science and Art Department does not care to entrust any one in the Patent Museum Library with the necessary funds to pay for the carriage of the publications, hence they go through the long performance of being taken to the Science and Art Department Stores, checked in, examined, &c., and an unknown quantity of red tapism is expended where there is no occasion whatever for it.

Perhaps the subordinates of the library were most to blame for the errors mentioned in "Searcher's" letter, but here I take it is a clear case against the heads of the departments concerned. Apologising for thus troubling you,

I remain, Sir, yours obediently,

An Aggrieved One.

RAILWAY BRAKES.

To the Editor of Engineering.

Sir,—Many letters and articles have recently appeared in the papers upon this subject; but it appears to me that most of the letters are inaccurate, and are chiefly inspired by a desire to advertise the Westinghouse automatic brake, and many of the articles, being founded upon misstatements in the letters, are scarcely calculated to give the public a correct idea of the position of the brake question at the present moment.

Amongst others, much comment has been made upon a letter in the *Times* of the 10th inst., purporting to be written by an "Express Driver," who, after expressing in somewhat flowery language the comfort which he feels with a brake which can be applied *by himself* with "one turn of his wrist," somewhat illogically advances this as an argument in favour of "automatic" brakes. Upon this, he proceeds to condemn every form of continuous brake, except the Westinghouse automatic, which he says "*never fails*; it has saved my life or limbs five times, and I say that *it is the best*."

Upon this illogical letter the *Times* founded a leader practically advocating the adoption of the Westinghouse automatic brake without further inquiry. As, however, the writer of this article speaks of railway companies as if they were commonly in the habit of using engines "*notoriously addicted to breaking their cranks*," it is pretty evident that he had no deep acquaintance with his subject.

Now an investigation of the Board of Trade returns for the years 1880 to 1883 shows, that during four years the Westinghouse brakes ran 71,000,000 miles with 3900 failures, being about 55 failures for each million miles run; whilst the vacuum brakes during the same period ran 107,500,000 miles with only 1074 failures, or only about 10 failures for each million miles run; showing a ratio of 550 failures of the Westinghouse brakes to 100 failures of the vacuum brakes. So far for "Express Driver's" brake which "*never fails*."

I do not wonder he declines to disclose his name, and gives no reference to authentic returns of the accidents he refers to as having occurred within his experience.

The *Saturday Review* in an article last week alludes to the above figures, and compares them with an anonymous letter signed "E. L. A.," which appeared in the *Times* of the 18th inst. "E. L. A." quotes 11 instances of failures of the simple vacuum brake, and 11 instances of the automatic vacuum brake employed by the Midland Railway, and because these are described by "E. L. A." in what the *Saturday Reviewer* calls "thrilling terms," he calls upon me to give "some more decided statements something more like the elevens of 'E. L. A.,'" and intimates that until I do so he considers "the preponderance of evidence is against" me.

In the first place, I do not propose to attempt to describe railway accidents in "thrilling terms"; but were I to imitate "E. L. A." there would be no difficulty whatever in doing so with reference to a great many of the 3900 failures of the Westinghouse brake above referred to.

I prefer, however, to rest my case with regard to the brakes upon what appears to me to be the only fair test, viz., the aggregate of the authentic returns of the Board of Trade over the last four years; as it appears to me that these figures are entitled to far more weight than the selection and description in "thrilling terms" of a few cases.

Whilst, however, commenting upon "E. L. A's." letter, I may observe that he suffers from a failing common to Mr. Westinghouse's advocates, viz., a tendency to appeal to the Board of Trade returns where they tell against vacuum brakes, and to quote the Board of Trade as infallible when they deduce from their returns the conclusion that it is essential automatic brakes should be adopted; but at other times, to dispute the accuracy of these returns, because they tell in the aggregate, and indeed, also, fatally, in particular instances, against the Westinghouse brake. I prefer on my part to accept the only official returns which we have, and to draw my conclusions from them, and I venture to think that the bulk of the public will agree with me.

There is no doubt that the chief cause of the failures of the Westinghouse brake is the complication of its various parts. Mr. Westinghouse had up to the end of August, 1883, taken out 28 brake patents, containing 150 claims of various kinds, and to those familiar with his brake it is quite unnecessary to dilate upon the enormous complication of his apparatus as now employed, and particularly upon the dangers incident to the employment of his triple and other valves.

That this is not merely my own opinion, is shown by the report of Colonel Yolland on the Blackburn accident, dated 6th October 1881, where he says (p. 20). "The Westinghouse automatic air pressure brake is a very clever ingenious piece of mechanism, made up of a very great number of separate parts to give it the automatic action; but, as is well known, the greater the number of parts in any piece of mechanism the greater is the liability of failure, and I consider that *the liability to apply itself when not required* and when there is no accident, and *to fail to act or go on when absolutely required* by an engine driver, constitute two grave defects in its present construction."

Colonel Yolland reported that the Blackburn accident was caused: First, by the use of the permissive block system at the Blackburn Station; secondly, by the failure of some of the complicated mechanism of the Westinghouse brake to act when required, thus rendering it useless beyond the engine.

Consequent upon this report, the Board of Trade by circular under the hand of the President the Right Honourable J. Chamberlain, M.P., in January, 1882, specially directed the attention of all the railway companies in the kingdom to the imperfections of the Westinghouse brake, and it is rather hard that they should now be taken to task for not rushing into a large expenditure to adopt it, as if there were no other apparatus which could save the lives of the public.

Again, Major-General Hutchinson, in October, 1880, reported that the disastrous collision in the Bleamoor Tunnel was caused by one of the inherent weaknesses of the Westinghouse system (or, indeed, of any compressed air system), viz., the blowing off of the brake couplings, and consequent application of the brakes when not required. It is well known, on the other hand, that this class of accident cannot happen to any vacuum brake, as the only pressure on the apparatus is the external pressure of the atmosphere, and the automatic vacuum brake now employed is of the simplest construction, having only one valve, and that a ball valve of the most ordinary description, which will work, practically for ever, without lubrication or attention of any kind. It is this simplicity which has, I believe, recommended vacuum brakes to all practical railway engineers, and which is, notwithstanding the loud trumpeting of Mr. Westinghouse's friends, fast bringing about their universal adoption.

The vacuum brakes are one and all so simple in their construction that they *require no skilled labour* to understand, and keep them in working condition, and when once fitted demand no special knowledge to apply them with safety.

Mr. Westinghouse, on the other hand, is obliged to issue elaborate directions to his own, and to the railway employés, who have to go through a regular course of instruction before they are competent either to apply the brake with safety, or to keep it in repair. The neglect of any of these instructions is a source of great danger to the public, apart altogether from the question of expense involved in them, which also necessarily militates against the universal adoption of the brake. To meet the many defects of his apparatus, Mr. Westinghouse is constantly devising and patenting new and complicated valves, and other apparatus, every one of which increases the danger, by increasing the chances of failure, as pointed out by Colonel Yolland.

Many of the anonymous correspondents who have written to the papers on this subject, have indiscriminately attacked all railway companies which use vacuum brakes, as being remiss in the performance of their duty to the public, speaking as if the question of "simple" as against "automatic" brakes were mere A B C, and incapable of discussion without corrupt motives on the part of those who oppose the latter. Further, assuming this difficult question to be settled, they speak (as I have already said) as if there were no automatic brake in the kingdom except that of Mr. Westinghouse.

There is no doubt that even up to the present time some of the largest railway companies in the kingdom

have preferred to use a "simple" vacuum brake to any "automatic" brake. It is equally true that the Metropolitan District Railway have likewise preferred, up to the present time, to use Mr. Westinghouse's simple compressed air brake to any automatic brake. It is, however, scarcely fair to assume that the determination of these companies to use "simple" instead of "automatic" brakes was arrived at recklessly, and without due consideration.

On April 8, 1881, a meeting was held at Euston Station, under the presidency of Mr. F. W. Webb, the locomotive superintendent of the London and North-Western Railway, for the purpose of considering the brake question, and of enabling Mr. Webb to report to his Board, not merely his own opinion, but that of other competent railway engineers.

That meeting was attended by the chief locomotive superintendents and engineers of the following railways. London and North-Western Railway, Great Northern Railway, Midland Railway (2), Great Western Railway, Lancashire and Yorkshire Railway, South-Eastern Railway, Manchester, Sheffield, and Lincoln Railway, Great Southern and Western of Ireland Railway, London, Chatham, and Dover Railway, London and South-Western Railway, and Metropolitan Railway.

The whole brake question was at that meeting very fully discussed, and ultimately a unanimous conclusion was arrived at, *that vacuum brakes, whether simple or automatic, are preferable to compressed air brakes, whether simple or automatic.* Nine out of the twelve preferred the simple vacuum brake to any automatic brake; the other three being in favour of the adoption of the automatic vacuum brake.

A form of universal coupling to insure as far as possible universality of adoption of continuous brakes by allowing the interchange of rolling stock, was also at this meeting agreed on unanimously, being that now known as the "Clayton" coupling.

This coupling is now used on the three trunk lines to the north, viz., the London and North-Western, the Midland, and the Great Northern, also on the Lancashire and Yorkshire, the Great Western, the Manchester, Sheffield, and Lincoln, and other important lines. It is not adapted to the Westinghouse system, which is therefore now one of the great impediments, if not the chief impediment, to the adoption throughout the country of one system of continuous brakes.

It is apparently in consequence of his having been the chairman of this meeting with results so disastrous to the interests of the Westinghouse automatic brakes, that Mr. Webb, of the London and North-Western, has been assailed in the most scurrilous manner, by some of the correspondents who have written in the Westinghouse interest upon the subject.

Apart altogether, however, from this, it is absurd to suppose that twelve men occupying the position of those above referred to, and with the full weight of the responsibility for the lives of so large a proportion of the travelling public upon their shoulders, would combine to pass resolutions of a corrupt character upon so important a subject.

It is curious to observe that the two railways which have persistently run "simple" brakes, the one Westinghouse and the other vacuum, viz., the "Metropolitan District" and the "Metropolitan" lines respectively, have enjoyed almost complete immunity from accidents, whilst some of the employers of Mr. Westinghouse's "automatic" have suffered heavily.

Mr. Westinghouse's supporters are never tired of referring to the brake trials at Newark in 1875, when, however, the brake question, as compared with the present state of knowledge on the subject, was in its infancy.

It is only within the last few years that the defects of the Westinghouse automatic brake have made themselves apparent in actual working, and it is in like manner during the last few years that it has been discovered that the "automatic vacuum" brakes supplied by my company, are at least as powerful and efficient as the Westinghouse, if not more so, and far surpass it in point of certainty, simplicity, and economy.

Many insinuations have been made against Sir Henry Tyler by injudicious advocates of the vacuum brake. All that can be fairly said is that all the recommendations which emanated from the Board of Trade before he became the paid vice-president of Mr. Westinghouse's company, were of such a character that it was supposed (erroneously) that no brake could comply with their conditions except the Westinghouse. At that time my company had had but little opportunity of showing what could be done with automatic vacuum brakes, but I doubt if Sir Henry Tyler were now in the same position, whether he would repeat the step he then took.

Since he left the Board of Trade we have shown that the automatic vacuum brakes are in every way more reliable than compressed air brakes, and I think I may assert with confidence that, if the four responsible advisers of the Board of Trade were now asked, on their present state of knowledge, to recommend a brake for universal adoption, they would certainly *not* recommend the Westinghouse automatic, or any automatic compressed air brake, but would recommend one or other of the forms of automatic vacuum brake.

My pecuniary stake in the question is small, and I can afford to take, and I hope do take, a somewhat independent view of the question as between Mr. Westinghouse and my company; and, apart altogether from my position as chairman of the Vacuum Brake Company, I consider that Parliament should, either through the Board of Trade or otherwise, compel railway companies to adopt some interchangeable system of continuous brakes. I may also say that the opinion of myself and my company's directors is that an automatic brake is desirable, although there is still room for doubt, whether the increased safety which this form of brake gives in a certain class of accidents, more than compensates for the liability to produce another class of accidents, which is inseparable from the use of all automatic brakes, no matter how simple. The opinion of the advisers of the Board of Trade, however, on this matter, and various considerations which it would take up too much room to discuss, but which are founded upon the experiences of the last few years, would seem upon the whole to render it desirable that automatic brakes should be adopted.

I hope to assist in promoting legislation from this point of view in due season in my place in Parliament; but I am not prepared to ask Parliament to confer upon the Board of Trade, or any other public department, the right of dictating to railway companies what apparatus they are to use, whether in the case of brakes or any other railway *matériel*.

This is a responsibility which ought to be cast upon the boards of the railway companies and their technical advisers, and of which I trust no public department will ever relieve them, although at the present moment it might possibly benefit my company.

I assert that it is absurd to suggest that railway boards and engineers cannot be safely left to select the form of brake, if once it is rendered compulsory that they should within any reasonable period agree amongst themselves, which should be universal and interchangeable.

It is well known that the verdicts of juries, and "damages," are the great safeguards of the public in stimulating railway companies. Remove these, *as will be done if any public department orders the companies to adopt any particular invention* (no matter how good at the moment), and I fear that we shall indeed repent such action at our leisure.

I am, Sir, yours obediently,

RICHARD B. MARTIN,
Chairman Vacuum Brake Company, Limited.

32, Queen Victoria-street, London, E.C.,
September 25, 1884.

AUTOMATIC INJECTORS.

To the Editor of Engineering.

SIR,—We have no wish to run down Messrs. Holding and Brooke's influx injector, which may be good or may not. Our object in writing to you on the 12th ult. was simply to correct what might have been a misapprehension, *i.e.*, as regards novelty. We can only reiterate that the injectors which we have been manufacturing for the past six years will do all that is claimed as novel in your article of the 5th ult., and we shall be happy to give a practical demonstration of this to any of your readers who may care to visit our works.

We have no desire to become personal in the matter, or to attack any other firm. We must therefore decline to enter into any controversy with Messrs. Holding and Brooke as regards the merits or demerits of their injector.

Yours truly,

FAIRBURN AND HALL.

Manchester, October 7, 1884.

THE MECHANICAL EQUIVALENT OF HEAT.

To the Editor of Engineering.

SIR,—Of course "H." (in your issue of 12th inst.) is correct in what he says, and nothing I have written has been contradictory. But what I have been trying to instil into him, is, that one portion of the work done by a falling mass may be expended in lifting another mass, or in moving dashers (as in Joule's experiment), or in working machinery (as when the weight of a hydraulic accumulator descends) and the other portion is but expended as pressure against that which arrests the descent.

I also mean to say that, generally, and in the cases named particularly, we only require to learn the measure of the portion of work which lifts weights, moves dashers, and works hydraulic machinery.

An analysis of the work done by a falling weight during descent, which I am preparing, will surprise "H.," and will prove that though we may roughly speak of, say, a weight 4 lifting a weight 3, the *real* work done by gravity is not the moving of M 4 + M 3 = M 7, nor the lifting of M 3, but is only the causing of the *accelerations* of the two masses; one of whose *pressure* is completely balanced throughout the motion, and three fourths of the other's is so likewise. There is but one-fourth the natural pull of gravity on mass 4 to give pressure *and* acceleration to one-fourth of mass 4 and to give acceleration to three-fourths of mass 4 and to mass 3 whose *pressures* are *balanced* throughout their motions.

The *real* work done by gravity is thus small as compared with the visible and outward *advantage* to us, and which we *call* work, and which is M 3 raised through space x.

I may remind "H." that the argument in the latter part of his letter in issue of June 20th last, depends on the specific heat for constant volume being correct; whether it is correct or not will be shown in a letter of mine now in our Editor's hands; the same letter will also show if the other portion of his letter is correct.

I am, Sir, yours faithfully,

Chester, September 22, 1884. G. PINNINGTON.

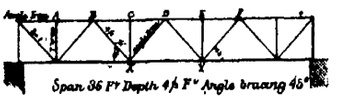
A QUESTION IN GIRDER DESIGNING.

To the Editor of Engineering.

SIR,—Would you kindly decide for us the following question of strength of girders?

A girder bridge has recently been constructed in Melbourne by one of our oldest and most experienced engineers of the subjoined form.

The cross girders are placed on the points A, B, C, D, E, F, G, and overhang the main girders several feet on each side. The weight of planking and broken stone of the road amounts to 2½ tons on each of the above points. A 15-ton steam roller was used for rolling down the road, and owing to the cross girders overhanging the main girders and there being no footpath on one side of the road, one main girder was liable to and, I believe, did bear the whole weight of the roller. The length of the roller being equal to C E, these points would each be loaded with $\frac{1}{2}^{5} + 2\frac{1}{2}$ or 10 tons, while the others carried



only 2½ tons. Under these circumstances the bars B X and F Y would endure 15⅔ tons tension, but they consist only of 4½ × ½ iron with two ¾in rivet holes side by side, leaving only 1½ square inches of iron to bear a tension of 15⅔ tons. As you will see by the inclosed cutting from a local newspaper I have protested against this as dangerous, but have been stigmatised as a "theorist" by the engineer while the local authorities would not even inquire into the matter.

If you consider me to be right, kindly say so, that I may in making a further attack be fortified by your opinion.

W. C. KERNOT.

University of Melbourne, August 11, 1884.

[Professor Kernot is quite correct in his deductions from the facts he states. If the lateral overhang of the roadway is sufficient to allow the weight of the road roller to be thrown almost entirely on one girder, the load is a dangerous one to apply to the structure.—ED. E.]

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES

MIDDLESBROUGH, Wednesday.

Quarterly Meeting of the Cleveland Iron Trade.—Yesterday the quarterly meeting of the iron and allied trades of the North of England was held in the Royal Exchange, Middlesbrough. There was a comparatively thin attendance and the tone of the market was still depressing. From Middlesbrough there are continued good shipments of pig iron, and this is the only redeeming feature in the staple industry. The season, however, is advancing, and the Baltic will soon be closed. In view of the dull prospects over the winter months the combination pig makers anticipate difficulty in maintaining prices unless they resort to a further curtailment of the production. Such a step, however, is surrounded with difficulties and complications, and nothing definite has yet been done in the matter. No. 3 g.m.b. for prompt shipment has been sold at 36s. 6d. to 36s. 9d. per ton, but for delivery over a few months it can be obtained at less money. The lower qualities are in poor request at 33s. 6d. to 34s. Manufactured iron is steady at the low prices which have ruled so long, namely 5*l.* for ship plates and 4*l.* 15s. for angles less 2½ per cent. The rolling mills are working very irregularly. Hematite pig iron is dull on the basis of 44s. per ton for Nos. 1, 2, and 3, f.o.b. west coast ports.

Wages Questions.—Dr. Robert Spence Watson, of Newcastle, has consented to officiate as arbitrator in the iron-workers' wages question, and he will decide whether the employers in the North of England are entitled to reduce the wages 5 per cent or whether the men should have an advance of 5 per cent. It will be for the Board to accept the award whatever it may be, and both employers and operatives should loyally abide by the decision. The accountants' certificates showing the realised prices of pig iron during the quarter ending September 30, for the regulation of the Cleveland ironstone miners and the blast-furnacemens' wages, have been issued, and they give the price of No. 3 36s. 5.93d. per ton. This figure entitles the miner to a slight advance, but the blast furnacemens' wages remain unaltered.

Ironmasters and the Chemical Trade.—Messrs. Bell Brothers, of the Clarence Iron Works, Middlesbrough, the pioneers of the salt trade, are now raising upwards of 600 tons of salt per week, and they have erected splendid chemical works adjoining their evaporating pans, and are now manufacturing soda. Messrs. Bolckow, Vaughan, and Co., of the Cleveland Iron Works, are still boring for salt at Middlesbrough. They have commenced a second bore hole at South Bank, near their great steel works. A new company are boring at Huverton Hill, and it is the intention of Messrs. Sadler, Forbes, Abbot, and Co., one of the largest chemical makers in the kingdom, whose headquarters are now at Middlesbrough, to put down a bore hole shortly. There is no doubt that Middlesbrough will soon be as well known for her chemical products as she has been for making pig iron and rails.

The Coal and Coke Trades.—Coal is firm but coke is rather easier.

MR. EUGENE BOURDON.—It is with regret that we announce the death of Mr. Eugene Bourdon, an engineer whose reputation is as widely extended as the use of steam power. He died at the age of 77 from the results of an accident which occurred to him while making some experiments on the Orleans Railway with an anemometer based upon the same principle as his well known pressure gauge. He was a most prolific and indefatigable inventor, and it has been stated that he took out no less than thirty-seven patents. He had the good practical sense to know how to turn his inventive skill to account commercially, and amassed a handsome fortune. In private life he displayed the most genial manners, and was always ready to join with ardour in the amusements of his family and friends.

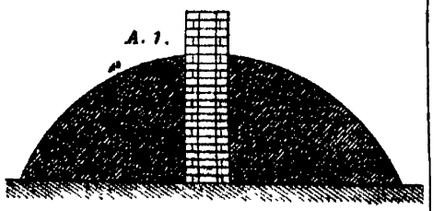
THE BYE-PRODUCTS OF COAL.

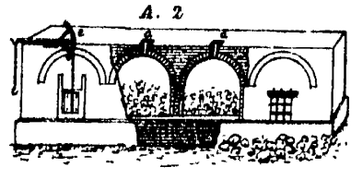
*The Recovery of Bye-Products from Coal, with Special Reference to the Coke and Iron Industries.**

By Watson Smith, F.C.S., F.I.C.

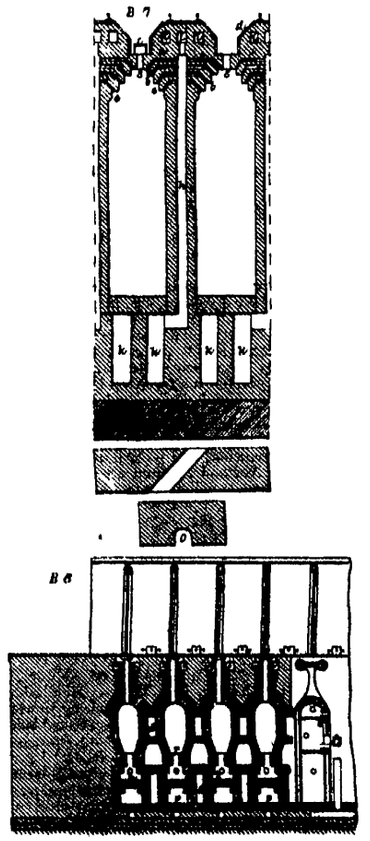
(*Continued from page 306.*)

I.—*Developments of the Beehive Form of Coke Oven, and of the Meiler or Mound.*—The most remarkable case is that of the beehive oven, first modified (see Table,† page 306 *ante*, column E), by Pernolet (E_5) as a close oven [illegible] described in "Muspratt's Dictionary" (art. "Fuel"), then





Coke Ovens Types A_1 and A_2.



Coke Ovens. Types B_7 and B_8.

by Aitken (C_2), and later by Jameson (C_3), in whose modifications a step backwards towards the root form was taken, for air is admitted into the coking space. A remarkable parallel case of development had already taken place from the meiler or mound, as root form, by Jones and by Blackwell (see Table, C_1), whose mounds were erected on a prepared brickwork foundation,

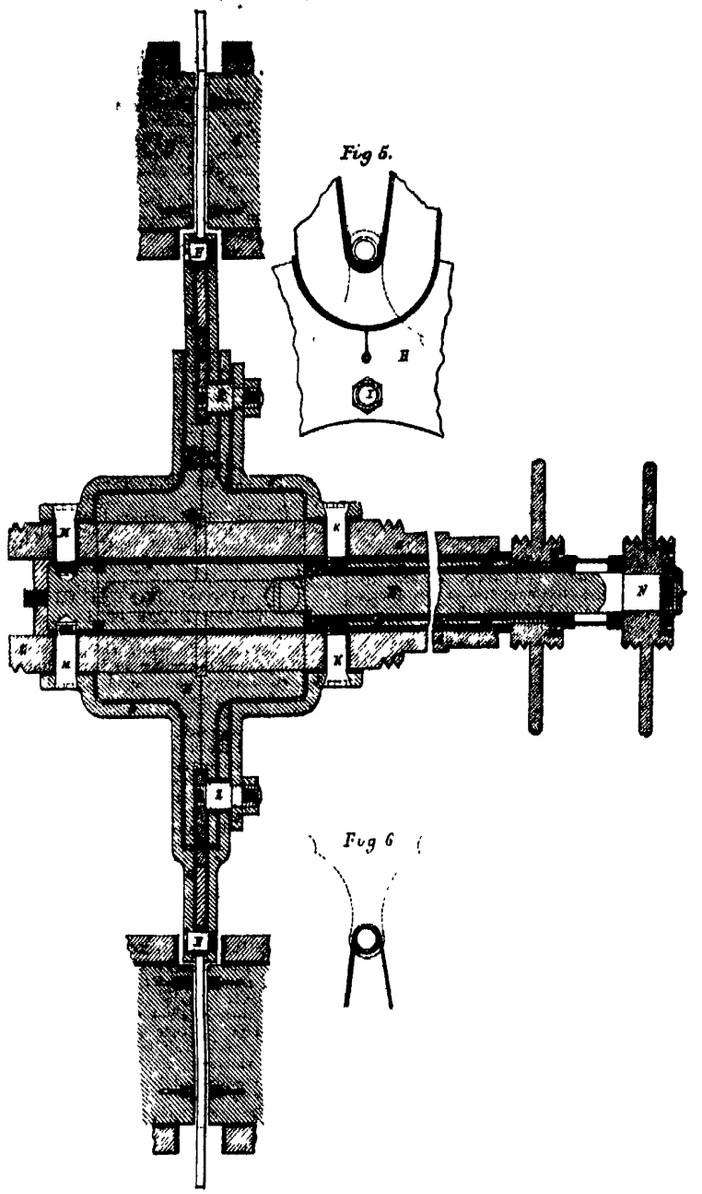
* Paper read at the Chester meeting of the Iron and Steel Institute.

† We commence this week on the present and opposite pages the publication of the diagrams illustrating Professor Watson Smith's valuable analytical table. The great number of these diagrams prevents us from publishing them all in one issue. The following are the references to the illustrations now published:

A_1.	Meiler or mound oven.	B_4.	Sachse oven.
A_2.	Beehive oven.	B_5.	Hiltawski oven.
E_4.	Jones' oven.	B_6.	Franzen ,,
E_5.	Appolt ,,	B_7.	Müller ,,
E_6.	Coppée ,,	B_8.	R. Wintzek's oven.

ARMATURE OF FERRANTI DYNAMO.

(*For Description, see Page 333.*)

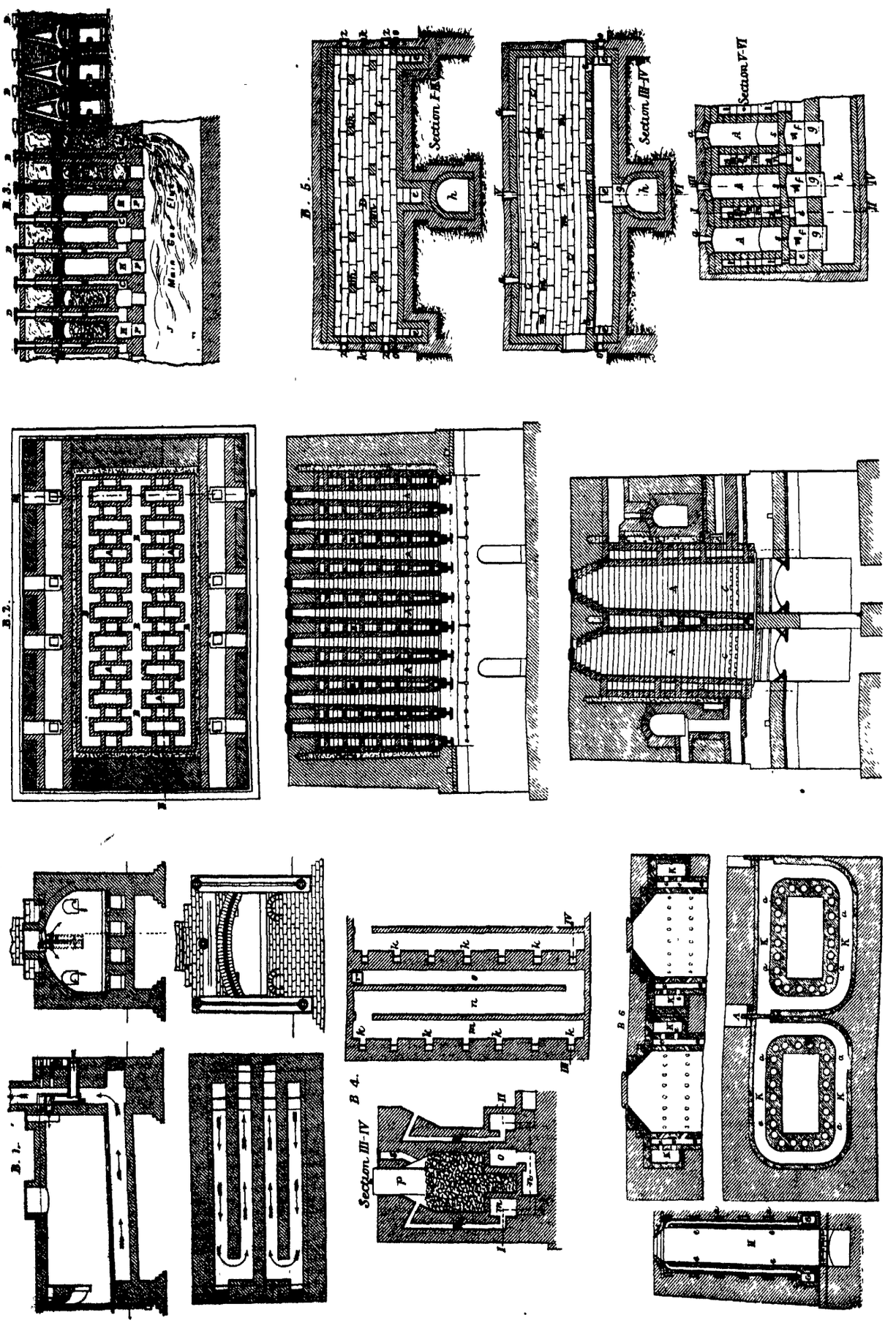


and around a kind of short square chimney shaft perforated in its sides, where these would be covered by the coking fuel. The projecting part of the chimney (not perforated) was capped at the top by a damper. The lower end of the chimney communicated underground by means of a covered channel or pipe with a well or old boiler sunk in the ground with a tap at the bottom, and containing coke. It acted as a tar and ammonia well. For the exhauster, a chimney draught served, and a pipe passed from the old boiler-well, sloping upwards to the foot of the chimney, into which it entered. Thus the gases were lost. Here is a development analogous to those of Aitken's and Jameson's ovens from the beehive. Aitken's oven bears much resemblance to Jameson's modification, and the tar from Aitken's oven resembles that from Jameson's, and is not valuable for dyes and colours. Aitken blows air into his oven above the coke, and with the air return gas from the condensing and scrubbing apparatus, and he exhausts the gases and vapours, drawing them through the bottom of the oven, i.e., downwards, the bottom of the oven having three perforated flues through which the gases and products pass, uniting into one main, proceeding to the condensing apparatus. Klönne's coke oven (German Patent 25,673), Dingler's Journal 232 [6], 256, resembles a Pernolet's adapted beehive, and certainly has the beehive form. However, Klönne draws off his products from above, and heats strongly, as Pernolet did, the bottom or sole of his oven by the return gases, after condensation. This first stage of the process continues until so far as possible all the tar and ammonia are driven off, when it ends. The second stage begins by raising the damper of another opening set on the side of the central top charging hole, opposite to that containing the exit for the tar and ammonia vapours, to the hydraulic main. Moreover, during this final stage of the coking process a damper is raised, previously closing air-holes in front of the lower part of the oven, thus admitting air into the coking mass. The process in this second stage resembles Jameson's, only the half-burnt gases now find their way upwards, and into an opening and passage into a vertical side flue now uncovered by its damper. The pipe of the other passage for tar and ammonia being luted in the hydraulic main, the half-burnt gases are in no danger of preferring that direction. These gases later on mix in suitable flues below the oven with air previously heated, and the mixture is completely burnt by being passed through the same passages still hot, through which the stronger gases of the first stage of the process had been passed and burnt with hot air. I should much like to examine a sample of tar from this new oven. There are evidences of higher temperatures than can be attained by Aitken and Jameson, and perhaps somewhat higher than Pernolet could obtain; but the thick dense layer of fuel in an oven of this kind and the absence of more heated side flues makes me very doubtful as to the character of this tar. Moreover, the admission of air in the second stage as described, will certainly mean some reduction of the coke, and of ammonia obtained as a bye-product.

Jameson has proposed, for the production of hard coke, with simultaneous recovery of bye-products, that in addition to the drawing-off or exhausting pipe with tap, placed below the sole of his oven, two other smaller pipes shall also be inserted, through which he proposes at suitable intervals to return the gases and vapours. The oven is filled as usual, and as soon as ignition has taken place above, the wider suction pipe is caused to act gently, effecting a slow exhaustion of the bye-products and gases. Since this process diminishes the coke and makes it softer, Jameson returns through the other pipes a portion or the whole of the gas drawn off, and a portion or the whole of the tar vapours, to a similar oven, but one which has attained a further stage of combustion and ignition, in

TYPES OF COKE OVENS.

(See Column B of Professor Watson Smith's Table, Page 306 ante.)



order that the carbon of the gases and vapours may become deposited in the pores of the coke thus treated, whilst the hydrogen burns at the surface of the mass or escapes. He claims various other possible modes of action and treatment of gas and bye-products.

Jameson further proposes to treat carbonaceous or coaly matters, shales, &c., difficult to coke and not possible to coke, also on the partial combustion principle in an oven, *which partakes of the nature of a reverberatory furnace.* It is, in short, as if Jameson had attached a fireplace with the usual reverberatory furnace fire bridge, to his modified beehive oven, so that flames from the furnace can play over the thick coking mass on the deep lying bed and then pass on to the chimney flue, whilst the suction process for gases and bye-products is set up in the space below the perforated bed on which the coking mass lies. It is proposed to adapt this process also for the roasting of ores in order to recover bye-products, and for the recovery of the fairly pure carbonic acid of limestone, or in sublimations. When necessary for the sake of increasing the heat, the ores or other matters to be roasted may be mixed with different proportions of coal.

H. Hutchinson (Eng. Pat. 2843, June 7, 1883) patents a process, which he states will yield hard coke and a tar rich in benzol, demanding a rapid rise in the temperature of ignition, or a soft coke and a tar rich in paraffin, demanding a slow coking. He proposes to do this by passing previously heated air through numerous channels or small flues, into the ordinary coke ovens in order to hasten the coking and raise the temperature of ignition, *the bye-products, as gases, being drawn off by flues in* the upper parts of the ovens.

In his oven for producing heating gas or illuminating gas, he passes, besides air, superheated steam through a perforated middle tube, rising perpendicularly from the bottom of the oven, amongst the fuel. As regards the first part of the process, whatever the coke may be, I have great fears about the "tar, rich in benzol."

(*To be continued.*)

TRIAL TRIPS AND LAUNCHES.

On Tuesday, September 9, 1884, Messrs. Edward Withy and Co. launched from Middleton Shipyard, West Hartlepool, a vessel named the Longnewton, the first of two iron screw steamers to the order of the Marquis of Londonderry. The principal dimensions are: Length between perpendiculars, 275 ft.; beam extreme, 38 ft.; depth moulded, 19 ft. 9 in., with a carrying capacity of about 2550 tons. The vessel will be fitted with triple expansion engines of 170 nominal horse-power by Messrs. T. Richardson and Sons, Hartlepool. The second vessel, which will be launched in the latter part of this month, is intended to trade between Seaham Harbour and Nine Elms Wharf, London, and is of novel and peculiar construction, all the masts, davits, funnel, &c., being made to hinge down to enable the vessel to go under London Bridge.

On Saturday, September 20, the s.s. Danehill, which was built by Messrs. Campbell, Mackintosh, and Bowhead, at Scotswood, for Messrs. Hay, Adam, and Co., of Liverpool, went on her trial trip. Her length is 228 ft.; breadth, 35 ft., and her depth from top of floors to underside of main deck is 13 ft. 9 in., and to the underside of poop 20 ft. 9 in. Her engines, which are 125 nominal horse power, and work up to 625 indicated, are built by the Wallsend Shipway and Engineering Company Limited), and have Lloyd's machinery certificate. The cylinders are 26 in. and 52 in. in diameter, with a stroke of 30 in. She has one double-ended steam boiler working to a pressure of 80 lb. on the square inch. The hull and engines were built from designs by Messrs. Ashlin and Ashbridge, consulting engineers and naval architects of 81 Rumford-place, Liverpool, and under their superintendence. On a two hours' trial a speed of 9¾ knots was maintained.

On the same day the double-ended quadruplex propeller steamship Snowdrop was launched from the yard of Messrs. Allsup and Sons, at Preston. This vessel is the second of two sister ferry boats building to the order of the Wallasey Local Board from the designs of their engineers, Messrs. Flannery and Fawcus, of Liverpool. The draught of water being limited, it is not possible to obtain the immersion of sufficiently large screw propellers of an ordinary type, and therefore four screw propellers, viz., two at the bow and two at the stern, have been used. The vessels are 130 ft. long and 35 ft. wide, and present an extremely large deck surface, for the accommodation of passengers. They are each capable of carrying about 2000 passengers, and are expected to steam 12½ miles per hour.

On Sept. 23, a steel twin-screw salvage tug was launched from the shipyard of Messrs. E. Finch and Co. (Limited), Chepstow, built to the order of the Bristol Docks Committee. On leaving the ways she was christened the Bullog. Her principal dimensions are 92 ft. length over all, 20 ft. breadth, 10 ft. depth moulded. She is fitted for salvage purposes, being supplied with a 5-ton swing crane placed amidships, a steam driven-capstan and winch combined forward, an 18-in. centrifugal pump placed just aft amidship, and strong towing gear at the end of the boiler casing. A complete chequered iron deck runs fore and aft, and Barlow iron bulting entirely around the hull. Two steel boilers designed for 120 lb. working pressure, and two pairs of compound surface condensing engines of 30 nominal horse power each, will be fitted by the builders. The boat and her machinery throughout has been built from the designs of Mr. J. W. Girdlestone, engineer to the Bristol Docks.

Messrs. Burrell and Sons, Dumbarton, on Saturday, the 20th ult., launched an iron screw steamer named the Bisagno, a vessel measuring 320 ft. by 37 ft. by 27 ft. 6 in. She is a sister-ship to the Bormida, lately built by Messrs. Burrell, and has been built to the order of the Societa Italiana di Trasporti Marittimi, Raggio and Co., Genoa; she is being engined by Messrs. Duncan Stewart and Co., Glasgow.

On Monday, 22nd September, Messrs. Barclay, Curle, and Co., Whiteinch, Glasgow, launched the St. Cuthbert, an iron barque of about 1000 tons register, and measuring 202 ft. by 33 ft. 9 in. by 20 ft. Specially designed for carrying a large cargo, and built to the highest class at Lloyd's, she is to be fitted out in a very complete manner alike for taking in and discharging cargo and for safety and comfort at sea. She is owned by Mr. Alexander Rae, Liverpool, and is to be engaged in the trade with the west coast of South America.

Messrs. William Denny and Brothers, Dumbarton, on the same day, launched a steel-built screw steamer named the Oban, a vessel of 765 tons gross register, for the Union Steamship Company of New Zealand. She measures 200 ft. by 32 ft. by 16 ft. 3 in., is classed 100 A 1 at Lloyd's, is double-bottomed except in the machinery space, and is being fitted with refrigerating chambers for conveying fresh meat from port to port in New Zealand. Messrs. Denny and Co. are supplying the Oban with engines of 600 horse-power indicated. A duplicate ship for the same owners is in a forward stage of progress in the same yard.

With the same tide Messrs. Russell and Co. Port-Glasgow, launched an iron barque of 1055 tons, measuring 210 ft. 6 in. by 34 ft. 10 in. by 23 ft., and named the Anchenges. She has carrying capacity for 1650 tons.

Messrs. Charles Connell and Co., Whiteinch, Glasgow, also with the same tide, launched a four-masted sailing ship named the Wendur, a vessel of 2000 tons register, and measuring 295 ft by 42 ft. by 24 ft She is fitted with water ballast between floors in three compartments capable of holding 200 tons, thereby insuring stiffness and the means of trimming the vessel with light cargoes. This is the first ship built on this principle on the Clyde. The vessel is considerably in excess of Lloyd's requirements. She is owned by Messrs. A. Mackay and Co., Glasgow, and is intended for the East Indian trade.

A screw steam trawler built of wood, and named the Juliette Marie, a vessel of 102 tons, and measuring 103 ft by 20 ft by 9 ft 6 in., was launched by Messrs. D. Allan and Co., Granton, on the 24th of September. She is owned by M A Sevestre, of Dunkirk, and is to be employed in trawling off the French coast; she is being fitted with engines of 50 horse power by Messrs Walker, Hunderson, and Co, Glasgow.

On the same day, Messrs. A. M'Millan and Son, Dumbarton, launched two screw steam cruisers, named the Eurotus and the Penous, vessels of 420 tons each, and measuring 137 ft. by 25 ft. by 14 ft. They are to be armed with Krupp guns, the carriages for the same to be supplied by Sir William Armstrong, Mitchell, and Co. Messrs. Scott and Co, Greenock, are supplying the engines, in each case of 400 horse power. The vessels are for the Greek Government.

The steel twin-screw steamer Gairloch, built and engined by Messrs. Blackwood and Gordon, Port-Glasgow, to the order of the Northern Steamship Company, of Auckland, New Zealand, ran her official speed trials on the Firth of Clyde on Thursday, the 25th of September A vessel of 400 tons gross, measuring 147 ft. by 23 ft. by 9 ft., and built to the highest class in Lloyd's Register, she is propelled by two pairs of compound engines of 85 horse-power combined, the cylinders being 17 in. and 31 in. in diameter respectively, with piston stroke of 21 in., the steam pressure being 90 lb. per square inch. The vessel is intended to develop the passenger and cattle trade of the northern ports of the colony Her passenger accommodation and her mechanical appliances are exceedingly complete. The mean speed attained on the measured mile was 11 knots, which, taking the unfavourable character of the weather into account, was considered highly satisfactory.

Messrs. Russell and Co., Greenock, on the same day launched an iron sailing ship named the Clackmannanshire, a vessel of 1500 tons register, and measuring 240 ft. by 36 ft. by 23 ft. A sister ship to the Kirkcudbrightshire launched by the same firm in the preceding month, she is the ninth sailing vessel built by Messrs. Russell and Co. for the "Shire" Line owned by Messrs. Thomas Law and Son, Glasgow. An 1800-ton ship is being laid down on the vacated berth.

Also on the same day, Messrs. Murray and Co., Port-Glasgow, launched the Jessie Darling, an iron screw steamer of about 320 tons, and measuring 125 ft. by 23 ft. by 10 ft. 6 in. She is fitted with water ballast in the fore and aft peaks, and she will have all the most approved appliances for the rapid loading and discharging of cargo. The engines are being supplied by Messrs. Kincaid and Co., Greenock. Messrs. John Darling and Son, Adelaide, South Australia, are the owners.

With the same tide Messrs. Murray Brothers, Dumbarton, launched an iron screw steamer, of 450 tons, named the Dalmarjia. She has been built considerably in excess of Lloyd's highest class, and specially constructed to carry a large cargo on a light draught of water. She has been ordered by Austrian owners for trading on the River Plate. Messrs. Muir and Houston, Glasgow, are supplying the engines.

On the following day two sailing schooners named the Dona Anna and the Dona Maria, were launched by Messrs. Blackwood and Gordon, Port-Glasgow. They measure 100 ft. by 20 ft. by 6 ft., and have been built to the order of the Amazon Steam Navigation Company (Limited), for trading on the River Amazon.

On Saturday, the 27th ultimo, the steel paddle-wheel steamer San Martin, built by Messrs. Napier, Shanks, and Bell, Yoker, and engined by Mr. David Rowan, Glasgow, went down the Clyde for her official speed trials. A vessel of 1250 tons, she measures 240 ft. by 34 ft. by 11 ft. to main deck, and is the finest vessel in the extensive fleet of the Lloyd Argentino Company, of Buenos Ayres, now *consisting of seven paddle steamers, eight screw steamers,* and eleven sailing vessels. She is intended for the route from Monte Video and Buenos Ayres up the River Plate and its tributaries to Assumption, calling at fourteen ports, the length of the route being 1250 miles. Her passenger accommodation is very extensive, and is fitted out in a most elaborate and comfortable manner. The fittings of the vessel include an installation of the electric light. The engines are of the compound type, with fixed diagonal cylinders, with a piston stroke of 5 ft. 6 in. Steam of 95 lb. working pressure is supplied by two steel boilers. Over the long course from the Cloch to the Cumbrae Light a mean speed of 13.3 knots was attained.

On October 7, the s.s. Longnewton, built by Messrs. Edward Withy and Co., West Hartlepool, for the Marquis of Londonderry, left Hartlepool on her trial trip. The vessel is so built that she will carry a very large cargo, 2600 tons deadweight, on a low net register tonnage of 1205 tons. The engines are by Messrs. Thomas Richardson and Sons, on their triple expansion principle, and are arranged to develop 850 indicated horse-power, with a working pressure of 140 lb. per square inch. This is the sixth set of engines made on this principle by this firm. In this vessel a novelty has been introduced in marking on the side the amount of surplus buoyancy and the length of the maximum righting lever that she will have when loaded with homogeneous cargo down to her Plimsoll marks, and in all future vessels that Messrs. Edward Withy and Co. build, they intend to give this information. It is thought this will lessen the risk of vessels being delayed through supposed overloading, besides giving useful information to the outside public which hitherto in many cases has only been known to the builders.

NOTES FROM THE SOUTH-WEST.

Rhymney Iron Works.—The directors of the Rhymney Iron Company (Limited), have reinstated Mr. D. Evans as manager of the works.

The Mumbles.—The system of telegraphic and telephonic communication with the Mumbles is being improved by the laying of special wires connecting that headland with Swansea, Cardiff, and Newport. This will enable subscribers to the Exchange to communicate direct to their offices at those ports.

Bristol Docks.—A meeting of the Bristol Town Council was held on Tuesday. The docks committee presented the following report. "Your committee have been much engaged in carrying out, in pursuance of the resolutions passed by the council at its meetings on the 12th and 22nd of August last, the arrangements consequent upon the *transfers to the corporation of the undertakings so transferred* by virtue of the Bristol Dock Act, 1884. Your committee have had registered in the stock register, in the names of the persons to whom they have been directed by the companies to issue the same, 625,000*l* Bristol Corporation Stock, the amount of the first instalments of stock issuable to the companies, and probably before this report is presented to the council the stock certificates, numbering upwards of 1100, will have to be handed over to the companies for distribution. Your committee have appointed their secretary, Mr. F. B. Girdlestone, who has acted as manager of the city docks for upwards of nine years, to be general manager of the dock undertakings of the co-operation." At a dinner to be given to the Mayor of Bristol in the course of the present month, in connection with the dock amalgamation, a piece of plate appropriate to the occasion will be presented to his worship. It will assume the form of a handsomely chased punchbowl, with what may be called a naval rim representing various kinds of vessels under full sail and steam. On one side of the bowl is to be an engraving of the Avonmouth Dock, and on the other side that of Portishead, both purchased for the city through the mayor's assiduous exertions.

Bristol Industrial Exhibition.—An industrial and fine art exhibition is now being held at Bristol. A department set aside for machinery in motion proves highly interesting to many of the visitors. Messrs. Kerr and Co. show the mode of winding cotton thread on reels by means of their spooling machine; Messrs. Lindrea and Co. have at work their new kind of treadle for sewing machines, termed the "pendulum or swinging treadle," and a "vertical feed" machine, for which is claimed that it stitches a larger range of thicknesses of material than any other machine. Messrs. Bradbury and Co., and the Singer Manufacturing Company have numerous sewing machines at work; Messrs. Marsh and Co. exhibit the process of hat making; and Messrs. Frost and Reed their system of picture framing and gilding. Messrs A. Lee and Brothers illustrate the manufacture of various articles in slate; and Messrs. Laverton and Co. have in motion a moulding machine, a continuous band saw, fret-cutting machine, turning

lathes, also a large Brussels carpet loom, weaving high-class Brussels carpets. Messrs. Hutchings and May show machines for making boots. Messrs. Parsons and Co. have at work a new standard screw wire machine for sewing the soles of boots instead of rivetting. Mr. Arrowsmith's double royal Wharfedale letter-press printing machine is printing Arrowsmith's Christmas annual for 1884. The boys of the Clifton-road Industrial School are daily busily engaged in manufacturing brushes. The Bristol Wagon Works Company has a spoke-turning machine in operation at certain periods each day. Messrs. Seargeant and Bennett, of Redcliffe and Nicholas-streets, are turning out on their improved bag machine 160 bags per minute. Messrs. Robinson show a patent satchel machine which executes 140 square-bottomed bags per minute.

Newport.—There is not much change in the steam coal trade. A fair demand exists, but more particularly for the better classes of coal. The house coal market is firmer, a more cheerful tone being perceptible. The manufactured iron trade continues in a depressed condition. Last week's coal clearances were 53,784 tons. The total quantity of coal cleared was 2873 tons, forwarded to the following destinations: Rio Grande, 232 tons; Passages, 73 tons; La Guayra, 100 tons; Oran, 140 tons; and to Halifax, 2328 tons. From Bilbao there arrived 7210 tons of iron ore, and 1450 tons came to hand from other sources.

The Glamorgan and Aberdare Canals.—A number of influential freighters are endeavouring to negotiate for the acquisition of the Glamorgan and Aberdare Canals, for the purpose of forming a railway from Merthyr and Aberdare to Cardiff.

Taff Vale Railway.—Notwithstanding that an agreement between the Taff Vale Railway Company and the Powell Duffryn Company has for some months past come into force, owing to the want of siding accommodation, the arrangements to take away the whole of the Powell Duffryn traffic over the Taff Vale Railway have not yet been completed. The coal for Cardiff, Penarth, and Newport from the company's collieries at Aberaman and Cwmaman, is handed to the Taff Vale Company at Treaman, that from Middle Duffryn is still conveyed by the Great Western Railway, as a siding there is not yet connected with the Taff system. A new signal-box with sidings is, however, in course of construction and, when completed, this colliery will also be served by the Taff Vale Company.

Cardiff.—The best qualities of steam coal have been in fair demand, but trade generally has been quiet. Patent fuel merchants continue busy. In some instances it has been found impossible to avoid demurrage. In the house coal market a firmer tone prevails. The iron ore market remains inactive. Last week's clearances comprised 117,017 tons of coal, 1686 tons of iron, 4858 tons of fuel, 20 tons of copper, and 643 tons of coke. From Bilbao, there arrived 5784 tons of iron ore, and 182 tons came to hand from other sources.

Gloucester Wagon Company (Limited).—A recent strike at this company's works has terminated. Mr Slater, the general manager, addressing the men, said if they chose to apply for employment they could do so, but he would only take back those whom he required. When he told that he had letters that morning applying for work from over 200 men they would understand that he had no difficulty in filling their places. He had had to cancel a large contract in consequence of this wretched strike. The men had been employed for many years and had become like spoilt children. Many times the company had taken work at something like cost price, in order to keep the men employed, and this was the way the men treated the company. Of 369 men who went out on strike 262 have been allowed to resume work.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The warrant market was again firm last Thursday, and there was a further recovery of ½d. per ton. Business was done on forenoon 'Change at 41s. 7½d. to 41s. 8½d. cash, also at 41s. 9½d. to 41s. 10d. one month, the close being buyers at 41s 8d. cash and 41s. 9½d. one month, with sellers asking ½d. per ton higher. In the afternoon there were transactions at 41s. 8½d. cash, also at 41s. 10½d. and 41s. 10d. one month, the market closing with buyers offering 41s. 8d. cash and 41s. 10d. one month, and sellers wanting ½d. more per ton. A continuance of the firmness was shown in the market on Friday, and prices improved 1d. per ton, the gain on the week being 1½d. per ton. Transactions took place in the forenoon market at 41s. 9d., 41s. 9½d., and back to 41s. 8½d. cash, also at 41s. 10½d. one month, the close being sellers at 41s. 8½d. and 41s. 10½d. cash and one month, respectively, and buyers offering ½d. per ton lower. Business was reported in the afternoon at 41s. 9d. and 41s. 9½d. cash, also at 41s. 10½d. and 41s. 11d. one month, with sellers at the close wanting the top prices, and buyers at ½d. per ton under. The market was dull and depressed on Monday, and prices declined 2d. per ton, being fully last week's recovery. During the forenoon market there were transactions at 41s. 9d. down to 41s. 8d. cash, also at 41s. 11d. down to 41s. 10d. one month, and sellers at the close were asking the lower rates, and buyers offering ½d. per ton lower. Business was done in the afternoon at 41s. 8d. and 41s. 7½d. cash, also at 41s. 9½d. and 41s. 9d. one month; and the market closed with sellers at 41s. 7½d. cash, and 41s. 9½d. one month, with buyers at ½d. less per ton. Yesterday's market was much depressed, and prices showed a further decline of 1d. per ton. There were transactions during the forenoon at 41s. 7½d. down to 41s. 6½d. cash, also at 41s. 9d. and 41s. 8½d. one month, the lower rates being offered at the close by buyers, with sellers at ½d. per ton higher. The afternoon quotations were 41s. 6½d. and 41s. 6d. cash, and 41s. 8½d. and 41s. 8d. one month, with sellers at the close wanting the higher rates, and buyers offering ½d. less per ton. Business was transacted this forenoon at 41s. 7d. and 41s. 7½d. cash, also at 41s. 9d and 41s 9½d. one month, with sellers at the close wanting the higher quotations, and buyers offering ½d. per ton less. There was a slight improvement in the afternoon, sellers wanting 41s. 8d. cash and 41s. 10d. one month at the close, with buyers at ½d. less per ton. The market has become almost entirely featureless, the feeling being very dull, while there are absolutely no prospects of an early improvement. Only a very moderate amount of business is doing from day to day, and even that is nearly all confined to members of the trade, there being practically no speculation showing itself, the revival of which, however, would doubtless be the signal for a decided improvement. Buyers are acting with rather more confidence, whilst sellers are not so pressing. Shipping brands are scarcely if at all changed, a few of them, however, are still firm in price owing to their scarcity, but the majority are easy, and on the whole there is not so much pressure for delivery. Production is still diminishing, and unless prices improve the prospects are that it will be still further reduced. The Shotts Iron Company have blown out the only blast furnace that they had going at their Castlehill Works, so that the number of furnaces now in blast is reduced to 92, as compared with 109 at this time last year, Last month's make of pig iron was about 16,500 tons less than the make in September, 1883, and prices on the average were about 4s. 9d. per ton under that of September last year The shipments of pig iron from all Scottish ports last month amounted to 9655 tons, as against 9242 tons in the preceding week, and 12,023 tons in the corresponding week of 1883. They included 1150 tons to the United States, 880 tons to Canada, 100 tons to Australia, &c, 105 tons to France, 759 tons to Italy, 1680 tons to Germany, 430 tons to Holland, 100 tons to Belgium, 360 tons to Spain and Portugal, 300 tons to China and Japan, and lesser quantities to other countries The stock of pig iron in Messrs Connal and Co's public warrant stores stood at 582,662 tons yesterday afternoon, as compared with 583,597 tons yesterday week, showing a decrease for the week of 935 tons.

Burntisland Harbour Commission —At a meeting of this Board held yesterday, the annual abstract of accounts was submitted, from which it was shown that the revenue for the year ending September 30, after making the necessary deductions, was 23,552*l*, and the expenditure was 23,228*l*. A sum of 6000*l* was expended on new works during the year—partly out of revenue The quantity of coal shipped during the year was 722,427 tons, as against 470,636 tons in the year 1878-79, and 166,599 tons in the year 1874-75

The Shipbuilding Trade at Dundee —This branch of trade continues to be exceedingly dull. In three of the yards there is at present no work going on, and in the fourth there is a whaling vessel on the stocks. It is expected that the keel of a large tug steamer for the River Hooghly will be laid down within the next few days in Mr. W. B. Thompson's shipyard.

Adoption of Steam for the Dundee Tramways.—Arrangements have been made by the Dundee Tramway Company to work their lines by steam engines. The first of the requisite number of engines are expected to arrive within a couple of months, and they will be employed in the first instance upon the Lochee line. The first delivery will consist of three engines, made by Messrs. Green and Co., Leeds, and they will be sufficiently powerful to draw two large bogie carriages, capable of containing 62 passengers each. The consent of the Police Commissioners to work the tramways by steam engines was obtained by the company last week, and it is expected that the Board of Trade sanction for the same purpose will be obtained in a day or two.

Kirkcudbright Harbour.—A few days ago the Kirkcudbright Town Council resolved to consult an eminent engineer as to the best mode of improving the harbour of that port.

Cost of the New Tay Bridge Works.—At present the sum of 16,000*l*. per month is being paid by the North British Railway Company on account of the works of the new Tay Bridge, and it is estimated that after the end of the present year about 340,000*l*. will be required for the completion of the works.

Suspension in the Iron Trade.—Messrs. John Aiton and Co., of the Milnwood Malleable Iron Works, near Holytown, have found it to be impossible, on account of financial difficulties, to carry on their works without coming to an arrangement with their creditors. The trade liabilities are stated at 7000*l*, but there are heritable debts to a large amount besides. Their workmen were all discharged last Saturday.

The Forth Bridge.—On Monday afternoon, the third caisson required for the Forth Bridge was launched at South Queensferry, the ceremony being performed by the Countess of Rosebery. The caisson is 70 ft. in diameter, and when completed it will be 72 ft. in height. It is made entirely of steel, and will be sunk on a solid foundation with 11,000 tons of concrete. The weather was excellent, and the proceedings passed off very successfully.

Concrete v. Granite for Graving Dock Bottom and Altars. —At their last monthly meeting held yesterday, the Clyde Navigation Trustees resolved on using concrete instead of granite for the bottom and altars of the new graving dock which they have at present in course of construction in connection with Glasgow Harbour In the opinion of Mr. Deas, the engineer, it is perfectly possible to construct a water-tight, good, sound dock of concrete.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Advance in Coal.—In Sheffield the coalowners followed the example of the Lancashire colliery proprietors and advanced the price of coal on Wednesday. In Lancashire the advance is from 1s. to 1s. 6d per ton, and in Yorkshire from 10d to 1s. In several districts the miners have announced that they will demand an increase of wages.

New Municipal Offices for Bradford.—At a special meeting of the Finance and General Purposes Committee of the Bradford Town Council the plans of the new municipal offices, which it is intended to erect in Chapel lane, immediately in the rear of the Town Hall, and which have been prepared by Messrs. W and R. Mawson, architects, were approved The building will be erected on the site of the old buildings at the back of the Town Hall in a triangular form, so as to permit of a new street being constructed from Chapel lane to the new Lancashire and Yorkshire goods station, and both Chapel lane and Nelson-street will be widened. This new street will afford an outlet for the whole of the traffic which at present converges in front of the Town Hall and through Chapel lane from Manchester-road, Thornton-road, and other streets. The new street will be 60 ft wide, and there will be an open space of 30 yards at the end of the new building. The area of the flooring in the new hall will be 2889 yards, of which two-thirds will be devoted to municipal and one-third to school board purposes The cost is estimated at 30,000*l*

Sheffield Gas Company.—The fifty-ninth ordinary meeting of shareholders of the Sheffield United Gaslight Company was held on Wednesday at the Cutler's Hall There was only a moderate attendance, Mr F. T Mappin, chairman of the company, presided, and said that Sheffield gas was as good as the company was called upon to supply—as good as that of any town that had not an unlimited supply of cannel coal The company had done all they could to mitigate the alleged nuisance at their Brightside chemical works. The report (which was adopted) showed a surplus of 1489*l*. after paying dividends

Charles Cammell and Company, Limited —At a meeting of the directors it has been decided to pay an interim dividend after the rate of 5 per cent per annum on all the shares of the company, payable on the 3rd inst, this being at the same rate as was paid at the corresponding period of last year.

The Lighting of Public Clocks —Mr John Dolby, the Local Government Board auditor, has surcharged the Buxton Local Board with the cost of lighting the public clock on the Devonshire Hospital in that town Mr. Dolby has also made a similar surcharge on the New Mills Local Board, for lighting with gas the clock on the Public Hall The auditor gives as his reason for so doing that the clocks are not the property of the ratepayers

FOREIGN AND COLONIAL NOTES.

Encouraging Colonial Industry —The South Australian Marine Board having accepted an English tender for boilers required for a steam launch only slightly in advance of local tenders, the matter has been referred back to the Board, and it is probable that a local tender will be ultimately accepted.

The Caspian and the Persian Gulf —A group of Parisian capitalists headed by M. de Freycinet, will, it is stated, join with Russian concessionnaires in constructing a railway from the Caspian Sea to Bussorah, on the Persian Gulf. The Czar and the Shah will support the scheme. A nephew of the Russian minister of finance is one of the concessionnaires. It is intended by this means to create a through route between England and India which can be passed over in a fortnight. It is expected that the work will be completed in three years, but a good many hitches may yet arise.

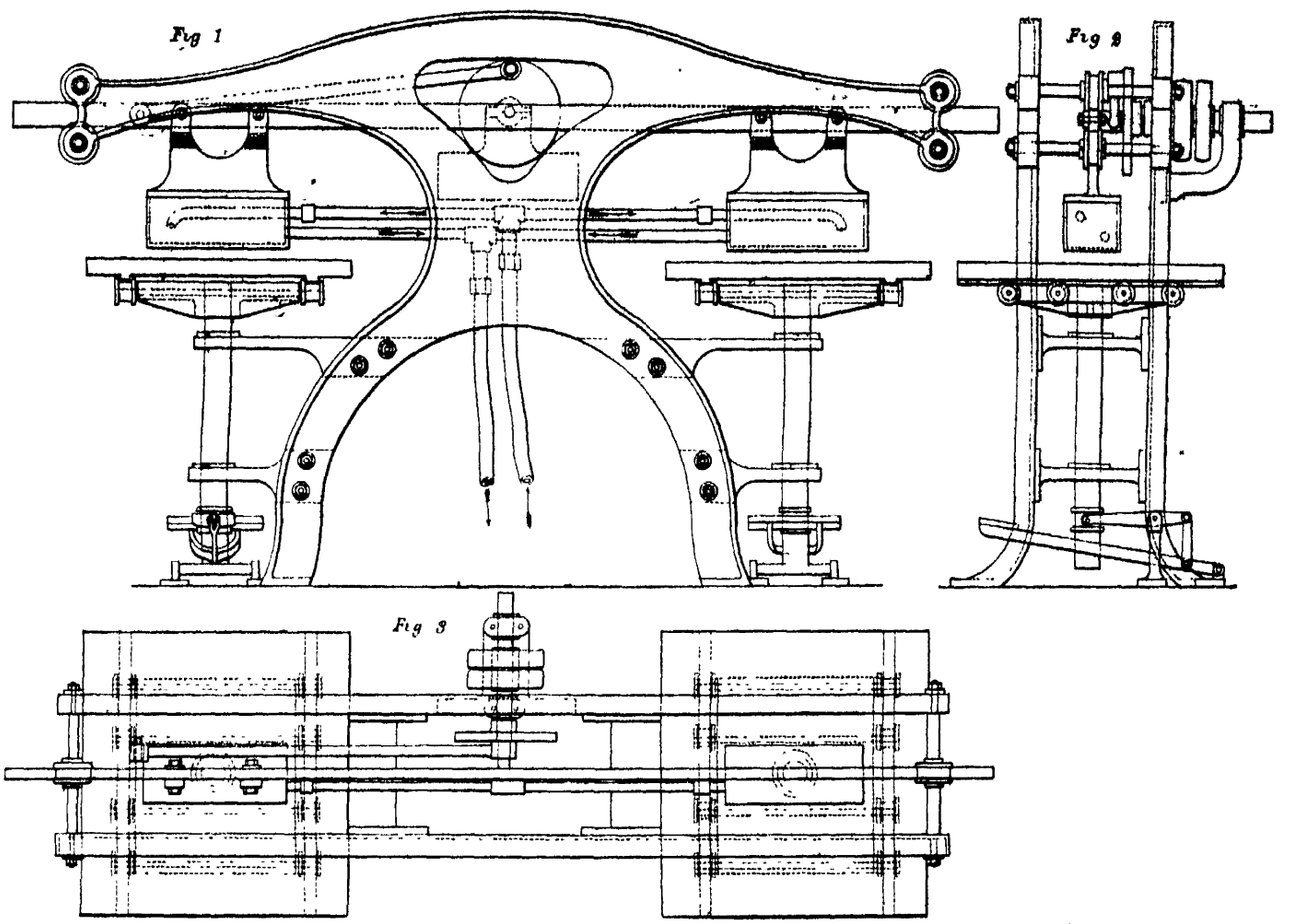
Lang's Bay —Mr Hardy has brought before the South Australian Legislature the question of providing accommodation for ocean-going steamers at Largs Bay. The discussion has been adjourned in order to ascertain whether a local Ocean Dock Company intend to avail themselves of the provisions of their Act.

Too Many Cooks.—At a recent sitting of the South Australian Railway Commission, Mr Maw, engineer-in-chief, stated that an order for rolling stock was sent to England without consulting Mr. Thou, the locomotive superintendent, and it was done by the authority of the Commissioner for Public Works, Mr. Ramsay. In letters read before the Commissioner, Mr. Thou made a strong point of the friction between his department and that of the engineer-in chief being detrimental to the interests of the public service.

Trucks for Panama.—We learn that the Panama Canal Company has just divided orders for 800 trucks among four Belgian firms. The contract prices range between 71*l*. and 85*l* 12s. per truck.

Great Northern Telegraph Company.—The number of messages forwarded by this company in the first eight months of this year was 797,897, as compared with 802,690 in the corresponding period of 1883. The revenue collected in the first eight months of this year was 182,680*l*., as compared with 168,386*l*. in the corresponding period of 1883.

IRONING MACHINERY AT THE HEALTH EXHIBITION.



We illustrate this week two forms of ironing machines which are now being exhibited in the Machinery in Motion Department at the Health Exhibition.

The first machine is shown by Messrs. H. Podger and Sons, of Bromley, Kent, and is illustrated by Figs. 1, 2, and 3, above. This apparatus is principally designed for ironing shirt fronts, collars, cuffs, and such articles. Referring to the engravings, Fig. 1 is a side elevation, Fig. 2 an end elevation, and Fig. 3 a plan. The machine here illustrated is a double one, but a single machine is also exhibited. The tables are adjusted vertically, being worked by means of a foot lever plainly shown in Fig. 2. The irons reciprocate on the sliding bar on which they are hung, being actuated by the disc crank shown, which works the connecting rod attached to the sliding bar, the latter being guided by the four rollers shown. The irons are heated by steam supplied through flexible pipes.

The "Inviota," machine, which is exhibited by Messrs. Davey and Fabian, of Dashwood House, New Broad-street, is shown in Fig. 4. The long horizontal cylinder, which is covered with cloth or other suitable material, revolves slowly and takes the place of the ordinary ironing table, at the same time the iron, which is made hollow in order to receive steam for heating, has given to it a reciprocating movement in a line with the axis of the roller. The necessary motion of the iron is obtained by means of an eccentric worked by gearing, the action of which is plainly shown in the engraving; the small roller guides running on a guide-bar are also clearly illustrated. In order to convey steam into the moving iron, either a short flexible tube or a metallic swivelling joint is used. When required to be worked the machine is put in gear, and the piece to be ironed is passed under a projecting lip on the iron. The roller then carries it through, and it gets smoother by the pressure of the reciprocating iron. The machine is simple, and no doubt very effective. It is made in sizes weighing from 15 cwt. to 25 cwt., and with a length of roller from 3 ft. 3 in. up to 7 ft. 8 in. A treadle is provided for lifting the iron from the roller if required, but this is not necessary in ordinary work. The iron can also be heated by gas if preferable.

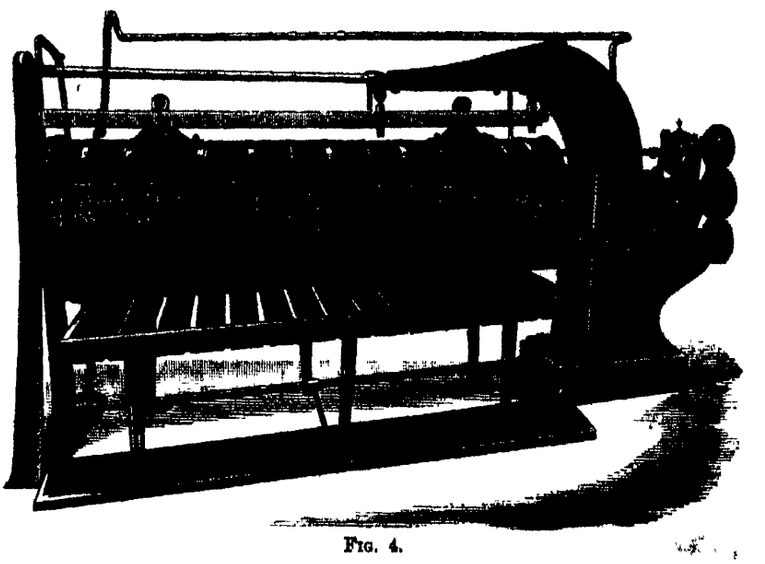


Fig. 4.

The Flint Chemical Works.—We have been asked to state that the designers of the causticizer made by Messrs. R. Daglish and Co., for the Flint Chemical Works, and described by us on page 299 *ante*, are Messrs. Parnall and Simpson, of Liverpool and Widnes.

American Locomotive Building.—The Cooke Locomotive Works at Paterson, New Jersey, have completed an order for seven mogul freight engines for the Elmira, Cortland, and Northern Railroad. Messrs. M. M. Buck and Co. are building a small locomotive for a railway in Algeria. They are also turning out a handsome locomotive, to be carried in a trades procession in the autumn.

Canadian Railways.—The Guelph Junction Railway, which is intended to connect with the Ontario section of the Canadian Pacific, at or near Schaw Station on the main line, has at last assumed a definite shape. A number of Montreal people are interested in the new line, one of them being Mr. Shanley, of the Canadian Pacific Railway, who has gone over the proposed route. A survey of the St. Catherine's and Niagara Railway has been completed. It is to pass through the best and most productive sections of the Niagara peninsula, approaches within a few miles of Hamilton, with which it is to be connected by a branch, and passes on by way of Burlington Beach to Toronto. A survey of a proposed railway between Kingsville and Windsor, is being steadily pushed forward. The line has been located as far as Maidstone, and will cross the Canada Southern Railway track two miles west of Essex Centre. A contract for 100 miles of the eastern end of the line has been let.

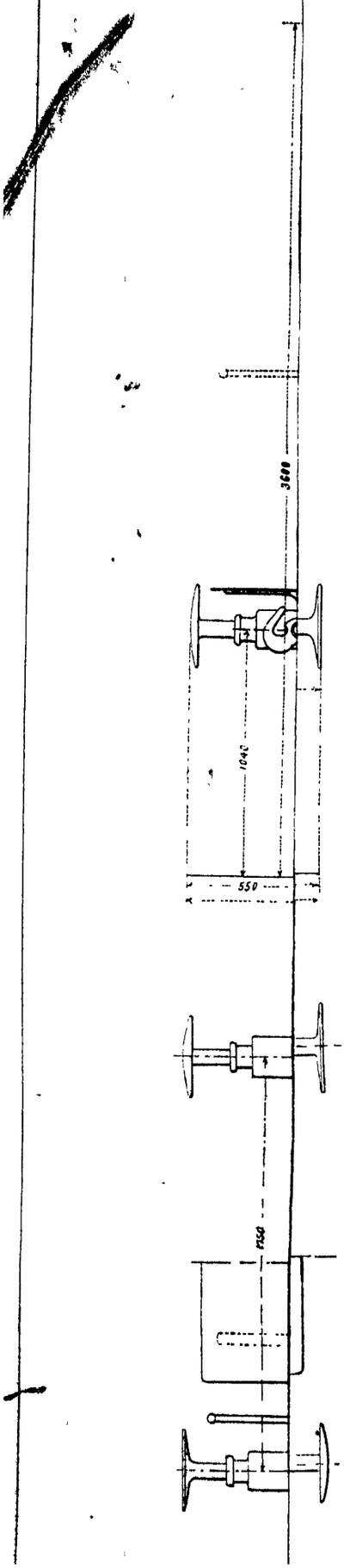

3600
1040
550
1250

Fig. 3.

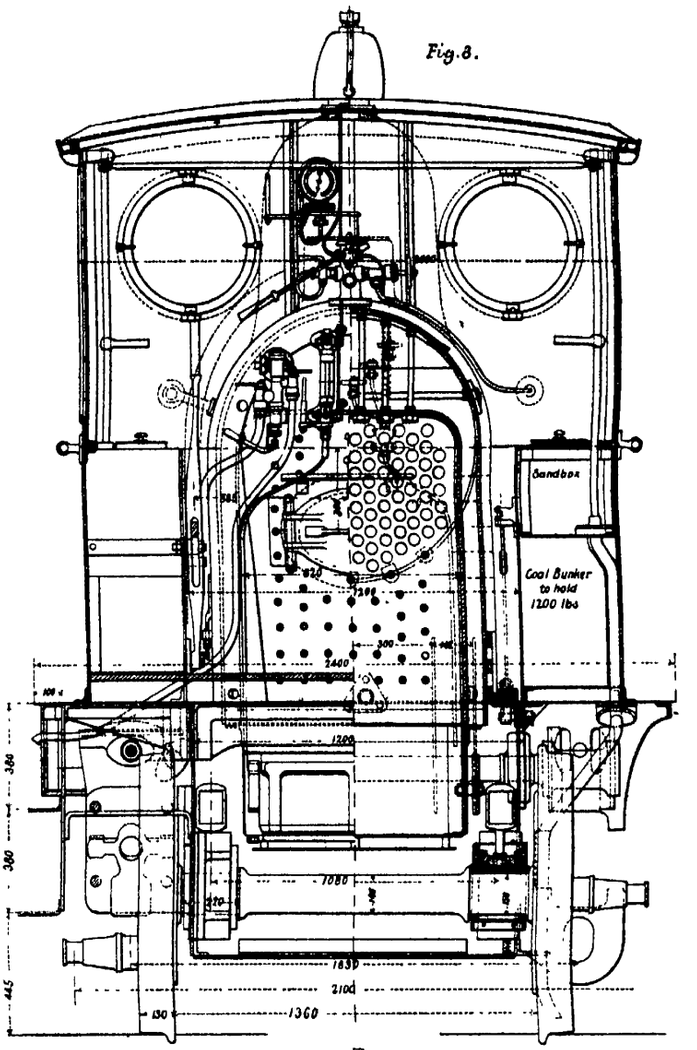
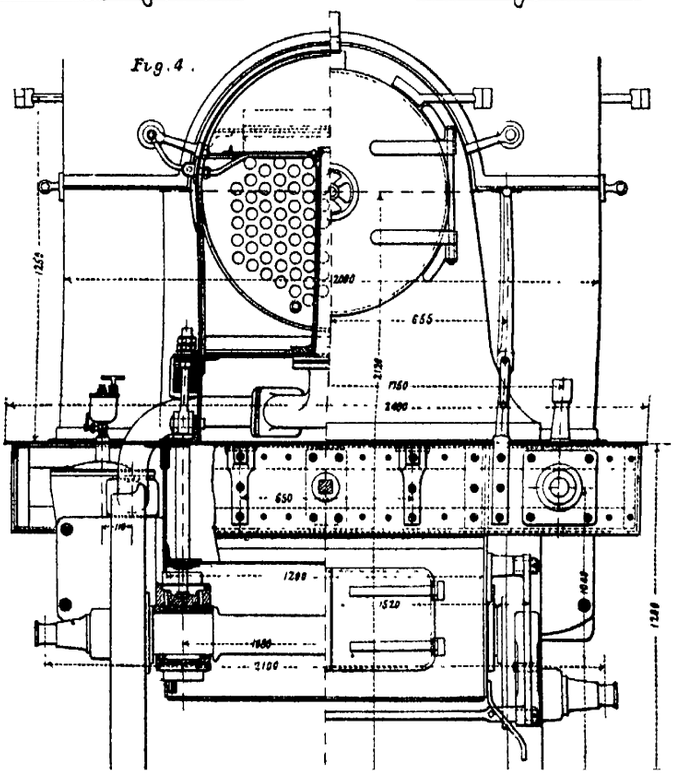

Sandbox
Coal Bunker to hold 1200 lbs
2400
1200
1080
1830
2100
1360
380
380
445

Fig. 4.


1250
2000
655
1750
2400
650
1200
1520
1080
2100
1200

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BOMBAY: Messrs. A. Asher and Co., 5, Unter den Linden.
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EGYPT: John Menzies and Co., 12, Hanover-street.
FRANCE: Veuve J. Boyveau, Libraire Etrangère, 22, Rue de la Banque, Paris; 26, Rue Turquem, 15, Boulevard St. Martin, Paris.
GLASGOW: W[illegible] Love.
LEIPSIC: A[illegible] Dürr.
J. A. Boc[illegible]
LIVERPOOL: Mrs. Taylor, Landing Stage.
MANCHESTER: John Heywood, 143, Deansgate.
OSTEND: Strickland and Cope.
ROTTERDAM: H. A. Kramers and Son.
UNITED STATES: John Wiley's Sons, 15, Astor Place, New York.
VIENNA: Lehmann and Wentzel, Kärntnerstrasse.

Advertisements intended for insertion in the current week's issue must be delivered not later than 6 P.M. on Thursday. The charge for advertisements is three shillings for the first four lines or under, and eightpence for each additional line. The line averages seven words. Payment must accompany all orders for single advertisements, otherwise their insertion cannot be guaranteed. Terms for displayed advertisements on the wrapper and on the inside pages may be obtained on application. Serial advertisements will be inserted with all practical regularity, but absolute regularity cannot be guaranteed.

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The publisher begs to state that since January 1, 1883, the ordinary copies of ENGINEERING sent abroad are printed on thin paper. The illustrations being, however, so much less effective on thin paper, foreign subscribers are strongly recommended to order thick paper copies, which they can have by paying the difference in postage as indicated below.

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Foreign subscribers, especially when renewing their subscriptions, are particularly requested to advise the Publisher of the transmission of the Post Office Order, and the exact amount for which it is made payable. If this precaution is omitted, some difficulty is very likely to occur in obtaining the name of the sender.

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We beg to announce that we have appointed the firm of John Wiley's Sons, 15, Astor Place, New York, the sole agents for ENGINEERING in the United States, and all subscriptions for the United States will in future be payable to them. They will also be prepared to receive advertisements for ENGINEERING, and will afford full information as to terms, &c., on application.

The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

ENGINEERING.

FRIDAY, OCTOBER 10, 1884.

THE STATE OF THE NAVY.

OUR able and enterprising contemporary, the *Pall Mall Gazette*, has succeeded, by presenting indisputable, but hitherto neglected facts, forcibly and persistently, in awakening public attention to the state of the Navy, and in creating a widespread interest and well-founded alarm that will not readily be quieted. It has been known for a long while past that the present state and future prospects of the Navy of this country are alike bad, and that the latter are only more deplorable than the former. We have frequently called attention in detail to certain of the main faults of our naval administration, and have shown in what respects it has failed to satisfy the requirements of this great empire, and of the vast interests that are committed to its charge. But our voice has been like that of one crying in the wilderness, and has apparently been disregarded. Certainly it has not been able to penetrate that triple armour of apathy, prejudice, and pedantry which appears to encase all who are charged with the administration of the Navy.

Many circumstances now combine to insure a fair and patient hearing for those who have anything to say about the state of the Navy, and the manner in which this has been brought about is a striking illustration of the power that can be exercised by the daily press. Temperate, accurate, and well-timed statements alone are not sufficient—these had already been repeated *ad nauseam* by ourselves and others—but it has been by the striking device of devoting one-half of the columns of a newspaper which usually contains short articles and notes to a recapitulation of much that has been, and can always be, said upon the subject of the Navy. The portentous length of the article which succeeded in arresting the attention of the public, "a length which, although fully warranted by the importance of the subject, is entirely without precedent in the history" of the journal which published it, was yet insufficient to contain all the charges that can be only too clearly brought against those responsible for the present state of things.

Although the means by which public interest has thus been aroused to the state of our first line of defence denote a chronic indifference and neglect to the matter, which is strangely inconsistent with our absolute dependence upon it for prosperity, and even existence as a nation; and although it is discreditable to those whose duty it is to maintain the Navy in the requisite state of efficiency, that the *Pall Mall Gazette* should have been justified in raising a cry from one end of the country to the other in order to excite in them a proper sense of duty, still it is a matter for congratulation that the public ear has at length been reached. It is high time that something was done to put the Navy upon the footing which is demanded by all the circumstances of the day, and to have it maintained in the condition which is necessary, not only for protection at home, but also to meet the rapidly growing requirements of our trade and possessions abroad.

One of the most striking, and, at first sight, strangest, characteristics of the present discussion upon the state of the Navy, is the unanimous and hearty support given to outside critics by all branches of the naval service, both executive and civil. Naval officers of all ranks have written supporting the views that [are expressed, and only complaining that they do not go far enough; while others, together with some of the professional employés at the Admiralty, are scarcely restrained by the service regulations from giving public expressions of sympathy. The officers of the dockyards, and of the constructive department of the Admiralty, are jubilant over the prospects that are opening up of now getting that attention paid by the Treasury to the growing wants of the Navy which their own official representations have failed to command. If the secret history of the present agitation were to be written, it would be found that Government officials sometimes use, anonymously, that power of the press which, at other times, they so much dread and denounce, in order to advance views for which they cannot otherwise obtain an adequate hearing

This peculiar phenomenon of sympathy with, and active support of, a movement which to all appearances commenced outside of the Navy, by nearly all classes of the naval service, is probably caused, not so much by the facts which have been brought forward as by the main inference which has been drawn from them. The increasingly retrograde condition into which our Navy is falling as compared with that of foreign powers, the growing requirements of our over-sea trade, and the long list of clauses which are contained in the whole indictment against those responsible for the state of the Navy, have been used mainly for the purpose of enforcing a demand, which of all others is certain to be popular throughout the entire naval service, viz., increase of expenditure. A mere demand for increase of expenditure is always sufficient to gain the support of every admiral and captain in the fleet, and the whole of the constructors at the Admiralty and dockyards. We quite agree that an increase of expenditure is at the present time desirable, and that we cannot recover lost ground, still less make the further progress which is demanded by the constantly increasing requirements of the country, without considerably adding to the normal amount of our naval expenditure.

The point that appears to have been missed in the discussion is, that our present unsatisfactory position is due not merely to deficient expenditure, but very largely to the manner in which the current expenditure has been made. The most serious and pressing question is, not so much the finding of money for strengthening the Navy—money can always be got, and in as large a quantity as may be necessary in Great Britain for a supreme purpose of this kind—but it is the economical and profitable application of such expenditure as may be decided upon. The sums of money that have been voted by Parliament of late years for the construction of ships for the Navy have been enormous, considering the results that have been obtained from them. We have had ships like the Ajax and Agamemnon which have been more than eight years in building, and have cost enormous sums of money, sums vastly greater than the original estimates provided for, and yet they are not in a satisfactory condition for performing the services expected of them. The Polyphemus, for which the cost was voted by Parliament in the early part of 1877, is still incomplete, after having had nearly twice the money spent upon her that was originally estimated and voted; and, after all, it appears unlikely that she will ever prove of any substantial value to the Navy.

The building of ships for the Navy is conducted upon principles which cause great waste of expenditure, slowness of production, and inefficiency of results. There is no institution in this country which receives such small value for its money as the Admiralty does for its expenditure upon ship construction. Although it is only a truism to say that this country possesses vast shipbuilding resources, yet the public is deprived of the benefit of them by the antiquated and extravagant system upon which it has always built, and is apparently content to go on building, its ships. A Committee, presided over by Lord Ravensworth, has been inquiring, during the present year, into the manner in which contracts are made by the Government with private shipbuilders, for building and repairing ships of the Royal Navy The building of ships in the dockyards is such a costly and wasteful process that it is becoming more and more desirable to build as many as possible of the ships of the Navy with the aid of private skill and enterprise; and it is reported that Lord Ravensworth's Committee has recommended that in future all Her Majesty's ships shall be built, as far as possible, by contract For some strange reason, however, the publication of the report has been delayed by the department, and no copy of it is yet procurable. The Committee has, however, made a step in the right direction, and we trust that the stereotyped official objections that are sure to be raised against any extension of the system of building ships by contract will be brushed on one side, and that the constructive department will be instructed to carry out the recommendations of the Committee.

The expenditure upon the Navy will be much more economically and profitably employed, by building ships in private shipbuilding yards instead of in the public dockyards This is the course that has always been adopted in the construction of boilers and marine engines for Her Majesty's Navy. The public generally have no idea that, notwithstanding the importance that is attached to building ships in the dockyards, the construction of boilers and engines has never become established there; and these are always made by private engineers. Why the same system which contributes to the Navy one section of a fighting ship, and that not the least important one, cannot also be trusted to produce the whole, we are unable to conceive.

It is true that giving ships out to build by competition among private shipbuilding firms in the same way as is already done with marine engines would greatly economise the expenditure upon the Navy; but in order to obtain anything like the whole benefit of the economy that might thus be made, a radical alteration is necessary in the system upon which vessels and their fittings are now designed, and interfered with down to the smallest detail, by the Admiralty constructors. We pointed out on the 30th of May last, that great defects are to be found in Admiralty specifications, and in the official supervision of work building by contract. We showed that all the specifications which are sent out from the Admiralty for builders to tender upon, profess to contain complete and definite descriptions of the various parts of the vessels to

which they relate, while they are in reality documents of the most vague and indeterminate character. They generally contain several hundreds of items, the greater number of which are simply required to be done "as directed," or "to the approval of the overseer." These specifications appear to be framed with the intention of leaving everything as open as possible for subsequent alterations, and for additions, that the Admiralty constructors may feel inclined to ask for as the work proceeds; and the shipbuilder who has tendered to such a specification is thus left entirely in the hands of the Admiralty officials, with no really definite guidance as to the ultimate cost of the work. The building contractor has no specific or solid ground to stand upon under his contract, and what little might be furnished by a fairly drawn arbitration clause, is cut away from him, by the circumstance that he is allowed no appeal, in the event of a dispute, to any authority except the Controller of the Navy. We also pointed out at the same time, that the system of inspection, which is adopted at the Admiralty, is of an entirely different character from that found best by our largest mercantile shipowners, and leads, through various causes, to a great increase in the cost of work, and to an enormous waste of time.

We can only just refer, at present, to these points, for the purpose of indicating one or two directions in which the state of the Navy might be made much more efficient, without any increase of expenditure. The wise and economical administration of naval expenditure is, however, a very great question, and one which we confess we are almost hopeless of seeing properly grappled with. Admiralty officials will eagerly support any movement for spending more money, as they are now doing; but they will resist, with all the powerful means of obstruction they possess, any attempt to examine exhaustively the details of expenditure, or to make it more profitable. They not only oppose at all times attempts to promote economy, with a determination that almost indicates a failure to comprehend the necessity for it, but anything like speed of production is also strenuously resisted by them.

The Admiralty constructors are believed to sympathise warmly with the present outside effort to obtain an increase of expenditure upon the Navy, but the only one who has raised his voice publicly upon the subject is Mr. Barnaby, the Director of Naval Construction. It is instructive to note, by what he has said, the direction in which Mr. Barnaby's mind is working. His only object appears to be to prepare the public for a continuation of the old dilatoriness and sloth in the completion of ships. It has been stated that a recent Brazilian ironclad, of a very powerful type, was completed in two years, and this fact was brought forward as a proof of the possibility of greatly shortening the time occupied in completing ships for the British Navy, some of which have taken no less than seven or eight years in construction. Mr. Barnaby writes to the papers, however, saying that "It is dangerous to assume that modern armoured ships can be built rapidly even under the best conditions, as this ship has been;" and that uncertainties upon naval points, and gunnery trials, occupied three years before even the ship in question was completed, although as far as hull and machinery were concerned she was finished in a little over two years. Why it is "dangerous" to assume that ships can be built rapidly, we cannot, after much reflection upon the point, imagine; and Mr. Barnaby does not condescend to explain. As the whole point of his letter turns upon this element of danger, we have not obtained much benefit by studying it, and we venture to think that the public have not been greatly enlightened by it. We do not know why it should be even incorrect to assume that modern war-ships may be constructed as rapidly as this Brazilian vessel was; but why it should be "dangerous" to assume it, we are completely at a loss to conceive. We hold that such an assumption is not only free from danger but that it is a correct and reasonable one, and that it should be the aim of our naval constructors to devise some means by which our ships of war could be built in something like the same time as is employed in building ships for foreign navies. Mr. Barnaby cannot prove that the shipbuilding resources of this country are unequal to the performance of what he considers to be such a feat; on the contrary, he is compelled to admit that they actually do it for other nations. There are firms who would undertake to do the same for our Navy as has been done for that of Brazil, and we feel sure that the results would be equally as successful as those which have been obtained by the Admiralty with vessels that have enormously exceeded their originally estimated cost and taken an unexpected number of years to complete. It is a bad sign for the future that the Director of Naval Construction—who should be informing his mind, expanding his ideas, and looking abroad to ascertain what can be done by the combined enterprise and mechanical resources of this country, and how to utilise them for the public service—should appear to have his attention mainly occupied by the fear that the present slowness of production and barrenness of results achieved by the Admiralty, may be publicly noticed and blamed. He is content and desirous that his department should have more money entrusted to it by Parliament to spend, but he does not wish that the present unnecessary and unprofitable mode of expenditure should be noticed or interfered with.

THE BRAKE QUESTION.

On another page we publish a long letter from Mr. Martin, the chairman of the Vacuum Brake Company; but not only has a greater part of this letter already appeared as an advertisement in many of the provincial papers, but it also contains matter some of which is entirely irrelevant to the brake question proper, and more which is either incorrect or very misleading, or which has repeatedly been answered before. We are unwilling not to give Mr. Martin a full hearing, but as there is scarcely any statement in the letter with which we can agree, we cannot pretend to take up here all the points on which the latter is open to reply, and it is the less necessary to do so since, as we have said, many of them have been already dealt with in our columns.

Mr. Martin's protest consists mainly of unmeasured abuse of the Westinghouse brake. He tells us nothing new that is true, and he is most hasty in his conclusions, and in his desire to accept as facts, what are only the longings, and it may be the opinions of discontented partisans. Like many others similarly placed, Mr. Martin is not consistent. We have already shown in our issue of the 26th ultimo, the change which he has undergone with regard to what, in his letter to the *Times* in August, 1881, was called the "ill-judged action" of the Board of Trade; and more important still that after years of uncompromising opposition to the Board of Trade requirements, Mr. Martin now announces that his company have come to the conclusion that an "automatic brake is desirable." In the present letter, too, it will be noticed that the paragraph which appeared in the letter to the *Times* of the 18th ult. relating to the working of the Westinghouse brake on inclines, and which we refuted in our last article, is withdrawn, and that referring to Sir Henry Tyler and the Board of Trade inspecting officers considerably modified. It is certainly amusing to read the published correspondence between Sir Henry Tyler and Mr. Martin, and then to learn from Mr. Martin's letter that "many insinuations have been made against Sir Henry Tyler by injudicious advocates of the vacuum brake," when he himself was the offender. It was asserted also in the previous letters as a positive fact that it was "well known that the majority of the four responsible advisers of the Board of Trade are prepared to recommend a brake for universal adoption, if asked to do so, and that that brake is not the Westinghouse automatic." This statement has attracted some attention from its bold assurance, but it now turns out to be only an opinion, for in his letter to us he is more cautious, and says, "I think I may assert with confidence," &c. There is, of course, no foundation for making any such statement in regard to the Board of Trade officers, and the wish was clearly father to the thought. The cause must indeed be desperate which requires such tactics, and it is scarcely seemly for the proprietors of the brake in use, or rather out of use, at Penistone and many other places, to indulge in vague statements, such as "some of the employers of the Westinghouse automatic have suffered heavily." Mr. Martin pronounces many eulogies on his own system, and many charges are made against the Westinghouse brake, but no facts or figures are given in support of these statements, which can, therefore, only be looked upon as Mr. Martin's fancies, belied as they are by our own knowledge of the subject. Of what possible use can it be to refer to the well-worn subject of the Euston conference? Is it not notorious that this was simply a packed meeting, and that no one was invited except those who were known to be favourable to the vacuum system? Is it not also equally well known that although nine out of the twelve present voted in favour of non-automatic brakes (a fact not of much assistance to Mr. Martin now, in view of his recent conversion), nevertheless twelve out of the sixteen of the principal railways in Great Britain are in favour of automatic brakes? The simple truth is that of these principal lines, only four, namely, the London and North-Western, the Great Northern, the South Eastern, and the Manchester, Sheffield, and Lincolnshire, have been directly and practically obstructing the progress of automatic brakes.

The great point, however, upon which the Euston meeting was unanimous, was the adoption of the Clayton coupling for use with vacuum brakes, and Mr. Martin informs us that this coupling is used on the three trunk lines to the north. This is another fiction. The fact is that the Great Northern Company use quite a different coupling, and the only coupling which is common to the joint stock trains on these three routes, is the Westinghouse. The Clayton coupling, as Mr. Martin says, "is not adapted to the Westinghouse system, which is therefore now one of the great impediments, if not the chief impediment, to the adoption throughout the country of one system of continuous brakes." If we are to believe Mr. Martin when he states that their "simplicity has recommended vacuum brakes to all practical engineers, and is fast bringing about their universal adoption," and if the four responsible advisers of the Board of Trade are really prepared to recommend the adoption of his automatic vacuum brake, it is difficult to understand why it should be necessary to issue such questionable manifestoes, or how the Westinghouse brake should form such an impediment to its progress.

The Westinghouse brake has no doubt always been, and will continue to be, an impediment to the progress of the vacuum system, but what are the facts? We find from the Board of Trade returns that there are now five kinds of vacuum brakes in use, so that Mr. Martin's friends are by no means inclined to agree amongst themselves, and we are not told which of these is the "one system" referred to. The Vacuum Brake Company have, however, announced that they have come to the conclusion that an automatic brake is desirable, and we may assume that they would prefer their own system, as used on the Lancashire and Yorkshire and London and South-Western Railways, to be the universal brake. This apparatus, however, according to the returns was only in use upon 1800 vehicles in this country, whereas the Westinghouse was fitted on nearly 13,000 vehicles. It is, to say the least, amusing to blame the latter for being "an impediment to the introduction of one system of continuous brakes." It is much as though the members composing the the fourth party in the House of Commons were to blame the rest of the House for being an impediment to their accession to office. The whole of the Westinghouse brakes are identical and interchangeable, while none of the vacuum systems will work together harmoniously. It is true that four of them use the same coupling, but we need hardly point out that lives are not saved by a coupling only, any more than a coupling can save a brake from condemnation. The carriages must clearly be equipped with the same brake if the Board of Trade are to be satisfied, and not with several different forms having the same coupling, a fact indeed which is not at all unlikely to become a trap, and to result in accidents. There is therefore no question as to where the impediment lies to the introduction of any one system.

Mr. Martin says, he prefers to rest his case on the returns of brake failures to the Board of Trade, and to draw his conclusions from them; that is, we suppose, when they are arranged in the way so familiar to the readers of the Vacuum Company's circulars. We have frequently shown how erroneous such a system of treatment is, and that these returns can only be made of service as a test of delays, when comparing two brakes of exactly the same principle, and only then, provided they are made rigidly upon the same basis. As to the positive merits of brakes, the returns form no guide. Mr. Martin says, "there is no doubt that the chief cause of the failures of the Westinghouse brake is the complication of its various parts," and "to those familiar with this

brake it is quite unnecessary to dilate upon the enormous complication of the apparatus as now employed, and particularly upon the dangers incident to the employment of the triple and other valves." Those familiar with the facts, as well as the brake, know that nothing could be further from the truth than the above statements, as well as the further one that "to meet the many defects of his apparatus, Mr. Westinghouse is constantly devising and patenting new and complicated valves and other apparatus, every one of which increases the danger." Mr. Martin, of course, refers to no data, but this need not prevent our doing so for him. The truth is that the Westinghouse brake is practically what it has been for years, with certain improvements, and in reality fewer parts. If certain new valves have been patented, it does not follow that they have been used, and if used they are certainly not put on in addition to others, but to replace them. Again, the reports against the Westinghouse brake are by no means of the kind stated by Mr. Martin; the interesting thing is—and Mr. Martin could have found it out for himself—that the vital parts peculiar to the Westinghouse brake, viz., the pump, triple valve, coupling, and driver's valve, very rarely fail indeed. The returns show that it is to men and material the trifling delays are mainly due; for instance, over two-thirds of the reports for the half-year ending June 30 are the result of burst coupling hose alone. Only 11 pumps out of about 1500 and 15 triple valves out of nearly 13,000 are mentioned as causing delay once in running 15½ million miles in six months! Moreover, 13 of the triple valves are returned by the Midland Company alone in running only 375,000 miles (a fact which probably requires no explanation); so that over 15,000,000 miles have been run with only two cases of a triple valve being suggested as a cause of delay! These are very interesting and remarkable facts, and they completely upset Mr. Martin's gratuitous nonsense as to the dangers arising from the use of triple valves and other complications. It is worth while pointing out also that simple as Mr. Martin's automatic vacuum brake is claimed to be, there are 71 failures of this brake on the Lancashire and Yorkshire Railway alone in the six months, and it has only run 21,000 miles per failure; whereas the Westinghouse has run nearly twice as many. Mr. Martin tells us he prefers to accept the official returns, and to draw his own conclusions. To what conclusion do these facts lead him may we ask? It is too much to hope for consistency from the Vacuum Brake Company, but the logic of their own system of reasoning points to only one conclusion, and that is, the inferiority of their own automatic brake.

This, however, is not a question of delays. It cannot be too often repeated that the question of efficient or inefficient brakes is a question of life or death to railway travellers and railway servants. So many are the inventions now brought forward, and for such multifarious purposes, that people appear to have had a way of regarding a brake much as they would a new form of steam engine, sewing machine, or bicycle, appearing to ignore the fact that the peculiar and essential function of a brake is to save life, and that, as we have said before, in its power to do this in the greatest number and variety of situations, constitutes the first point in considering the relative merits of the various systems. It may, of course, be possible to overload an invention, and by introducing refinements which serve little or no useful purpose, render the apparatus impracticable for ordinary work; but this has not been the case with any system of continuous brake which has come under our notice. On the contrary the endeavour has rather been in most cases to aim at an amount of so-called simplicity in the manufacture, quite inconsistent with the efficiency required under circumstances so varied as those to be met with in many of our worst accidents. The question is not one of simplicity, but of efficiency; but while the advocates of the Westinghouse brake are willing to make this the test, their opponents appeal to the simplicity of their apparatus and its obedience to the laws of nature, and when it fails they naturally call on Providence, and are ready to suggest that a miracle should have been performed for their benefit.

Until two brakes are before the public, both fulfilling the same functions, under as many conditions and with equal efficiency, there is really no choice. We quite fail to understand, for instance, why, when riding in a carriage forming part of a slip portion, Mr. Martin is not to be under the same protection as we who are in the front part of the same train; yet, as we have pointed out, no vacuum brake can be worked on the slip portions of trains, or carry a store of power independent of the engine. Why, too, are those who are compelled to travel in long trains to be deprived of the same amount of protection as is enjoyed by those in one of half the length? There may be more parts in the Westinghouse brake, but we have satisfied ourselves that there is not one but what effects a useful purpose, or which, if absent, would not lessen its efficiency, in much the same proportion as that of a vacuum brake would be increased, if they were introduced into that system.

ELECTRICAL TRANSMISSION OF POWER.

The important experiments on the transmission of power by electricity, which have been for a long time in preparation, between Paris and Creil, will enter shortly upon a practical phase. It will be remembered that a powerful syndicate was formed some time since, to realise on a large scale, the theories of M. Marcel Deprez, upon the electrical transmission of force, which theories received a practical development at the Palais de l'Industrie in 1881, at Munich, on the Northern Railway of France, and at Grenoble. This syndicate, composed among others, of the Paris house of Rothschild, the Creuzôt and Fives-Lille Companies, and the Société Industrielle et Commerciale des Metaux, subscribed a capital of half a million francs. The new series of experiments will be conducted between Paris and Creil. The programme has been prepared by a commission consisting of M. Marcel Deprez, M. Sartiaux, director of the Northern Railway of France, M. Aron, engineer to MM. de Rothschild, M. Cael, director at the Ministry of Posts and Telegraphs, and several other distinguished engineers. The late M Ch. Bontemps was also a member of the commission According to this programme it is intended to furnish at the Creil Railway Station, an initial motive power furnished by two locomotives, each of 130 horse-power. These two engines will together drive the generating dynamo through four totalising dynamometers, of a new type, by which it will be easy to read continuously the work transferred to the dynamo.*

The generating dynamo will give a current of 20 ampères with an electromotive force of 7500 volts, corresponding to about 200 horse-power absorbed. This energy will be transmitted to two smaller dynamos placed at the La Chapelle station in Paris, and which it is expected will develop 50 per cent of the initial energy, one giving 60 and the other 40 horse-power, which will be employed to drive a number of machines for mechanical purposes, and for electric lighting. The dynamos were constructed by the Fives-Lille Company, and some idea of their dimensions may be given by the fact that 17,600 lb. of copper wire has been used in winding the armature and field magnets. The transmission line, which is more than 70 miles long, and includes a complete circuit, will be laid overhead, and will consist of a cable with seven strands of silicious bronze made by M. Lazare Weiler, of Angoulême. These strands have a diameter of 1·9 millimetres, and together correspond to a single wire of 5 millimetres in diameter. The weight of the line will be from 2 to 2½ tons, and its total electric resistance is less than 100 ohms. Its breaking strength exceeds 1900 lb. From the initiation of the experiments the question of employing an insulated or non-insulated cable was warmly discussed. The necessity of insulation appeared at first to be of the greatest importance on account of the high tension of the current, and which it was intended to raise to 10,000 volts. Under these conditions the engineers of the commission representing the State wished to inclose the cable in a protective insulation, to prevent loss of current, especially during rain, and to avoid accidents. After a number of experiments it was decided to abandon continuous insulation, which would have the twofold inconvenience of great expense and imperfect protection. It was considered that accidents were little to be feared, since it would be a complete circuit fixed on high posts above the reach of ordinary interference, and a mixed system was decided on, which involved the insulation of about 47 miles of the line. This insulation, which was executed by the Société Générale des Telephones, is on the Berthoud-Borel system, by which the wires are inclosed in a lead envelope. Experiments with this arrangement have given quite satisfactory results, though it was found that with a current of 2500 volts the cable thus covered acted like a Leyden jar, the envelope giving off static sparks during a considerable period. The inconvenience from this would be easily overcome by connecting the lead to earth. Or by breaking the lead envelope at intervals, and especially at the junctions, 500 yards apart, and making good the joints with hard rubber, the total surface of the condenser would be reduced, and the effects entirely prevented.

It is expected that all the preliminaries of the trials will be completed in a month or two, and that they will be carried out at the end of the year.

* This dynamometer, which was devised by M. Deprez, was described in *La Lumière Electrique*, September 27, 1884.

THE PHILADELPHIA ELECTRICAL EXHIBITION.—No. II.

By Mr. C. J. B. Woodbury, Boston.

Telephones.

The exhibit of telephones is perhaps more complete than it could be in any other city in the United States, for the reason that three of the rivals of the American Bell Telephone Company for telephonic business, were organised in this vicinity, and two of them are doing an "exchange" business here, which allows the trial of their instruments over lines constructed for commercial business and subject to the same obstructions as those of the Bell Company, thus affording unusual facilities for the comparative merits of the relative instruments in actual practice. The Bell Company, as being by far the largest association of its kind in this country, has the most comprehensive exhibit, and has grouped together instruments of all periods of telephonic history excepting those of Philip Reis, which perhaps can hardly be considered as more than the preliminary steps towards the electrical transmission of sound. The exhibit occupies a central position in the new building, and has among its attractions a miniature central office connecting with different rooms and parts of the building and with the main central station of the Bell Company in Philadelphia, so that one may talk directly from the building to any of the subscribers to the system in Philadelphia and surrounding towns. In the centre of its exhibit is a small room with a table for writing and chairs for visitors to occupy, while the various parts of the system are explained by the courteous gentlemen in charge. As decorations to this room are exhibited a full-length oil painting of Professor Bell and a portrait of Mr. T A. Edison. In the cases which surround the sides of the exhibit may be seen telephones of every size, shape, and age. Some of the original instruments used by Professor Bell may be seen, containing magnets 5 in to 6 in. in length, and weighing 2 lb. or 3 lb., and it is specially worthy of note that the first instruments are all electro-magnets Here are seen the earlier forms of Edison's work in telephonic research, and the various shapes of magnets used by him and Mr. Phelps in their system. In another set of cases may be seen the early forms of the battery transmitter or microphone, especially the instruments used by Mr. Blake in the experiments which resulted in the instruments now known as the Blake transmitter, and in general use throughout the United States, wherever the Bell instruments have been introduced. Some of the earlier forms of adjustment of the pressure between the carbon and platinum points, show the care exercised to have this adjustment an exact one, for in one instrument the carbon is on the end of a balanced lever which is controlled by a screw of low pitch, whose head is attached to an arm travelling over a graduated circle. In this instrument a movement of the carbon for a distance of one one-thousandth of an inch would be readily observed, and the experimenter could determine with great exactness the pressure which gave the best results under different conditions. In the adjoining case may be seen the several forms of carbon transmitter devised by Messrs Edison, Berliner, and Gilliland, and the various means used by them to obtain the proper adjustment of the carbon and platinum contacts. There are also a set of instruments consisting of a receiver and carbon transmitter manufactured by Messrs. Siemens and Halske, of Berlin These instruments are of large size, and the workmanship

TELEPHONES AT THE PHILADELPHIA ELECTRICAL EXHIBITION.

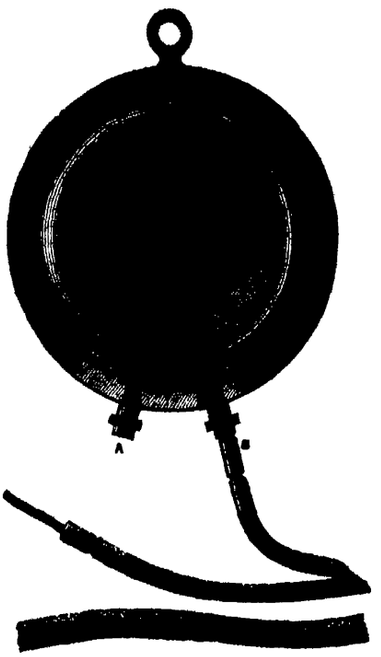


Fig. 1.

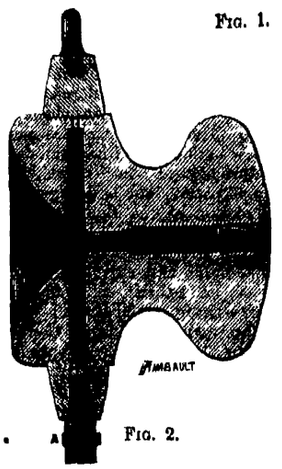
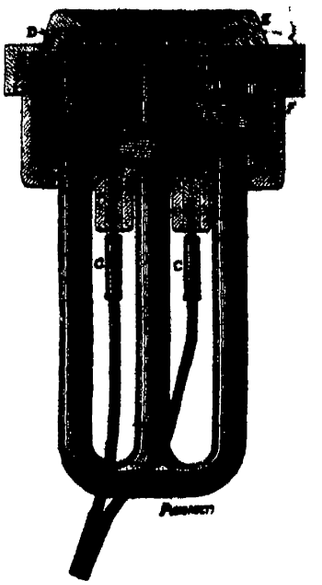


Fig. 2.



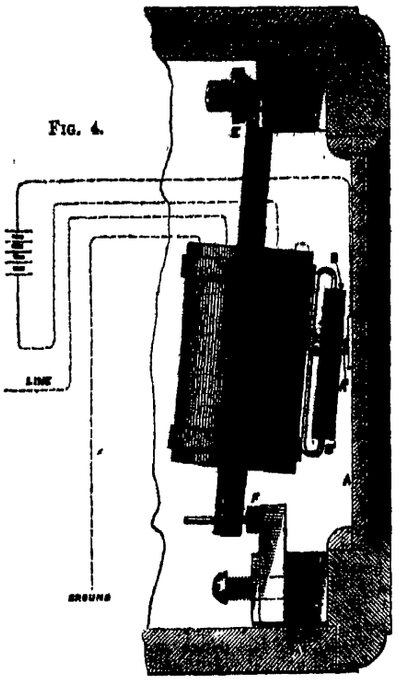


Fig. 4.

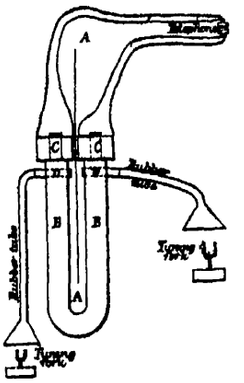
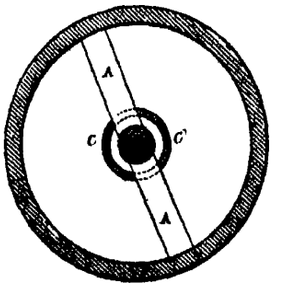


Fig. 7.



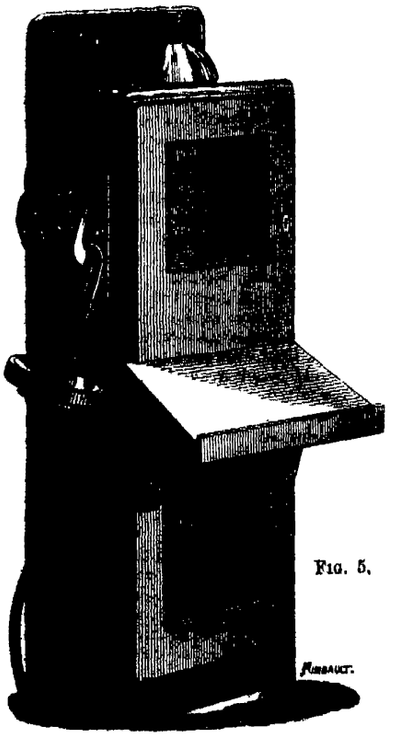


Fig. 5.

has rather a coarse appearance to the American eye. Here, too, are a set of instruments consisting of transmitter, receiver, and call-bell combined in a small desk, which holds the transmitter battery, and manufactured by Roosevelt, of Paris. In another case are various forms of calling devices used in former years, such as battery "tap bells," and magnet calls operated by suddenly withdrawing an armature from a powerful permanent magnet on the poles of which coils of fine wire are wound. These latter instruments have now gone out of use in this country, as it was found that the magnets rapidly degenerated, presumably from the stress produced by the repeated sudden withdrawals of the armature. In this case are also seen the earlier forms of transmitter used before the microphonic transmitter was developed to its commercial types. These consist of compound horseshoe magnets, over the poles of which the iron diaphragm was suspended and to which the voice was conducted by a speaking tube. The writer remembers well the difficulty with which any complicated message was sent by these instruments, and wonders at times that people persevered in using them. Here, too, [illegible] motophone, or chemical telephone, in which the pressure of a platinum point against a chalk cylinder, moistened with dilute sulphuric acid, was varied by the amount of current passing through the point. The changes were mechanically transmitted to a metal diaphragm, and thus reconverted into waves of sound. Beside this instrument is a receiver exhibited at the United States Centennial Exhibition in 1876, in which the diaphragm is made of parchment and the vibrations are given to it by a piece of iron ($\frac{3}{4}$ in. by $\frac{1}{2}$ in. by $\frac{1}{16}$ in.) fastened to its centre. The Dolbear exhibit comes next in interest as being on an entirely different plan. Most of our readers fully understand that in the Bell instruments the vibration of the dia- [illegible] the change in magnetic attraction of a permanent bar magnet, and that the remainder of the apparatus is merely means for producing such change in [illegible] produced by the voice. Professor Dolbear discovered that it was unnecessary to employ a magnet to reproduce these vibrations; in fact, that they were reproduced in the wire itself by the change in the amount of static charge from the secondary coil in a Blake transmitter for instance. In other words, the particles of electric conductors close together, exert an attraction upon each other, corresponding in some degree to the electromotive force of the current passing in them, since each element of surface may be supposed to be charged with an opposite polarity from its subsequent one, and in such state exerts a corresponding attraction upon it. In practice, Professor Dolbear's receiver consists of two sheets of thin metal, preferably tin-type plates; one of them is connected to the line and the other to the ground, or if a metallic circuit is used, one is attached to each line. These plates are separated by a very small air space (see Figs. 1 and 2), one being secured rigidly by the edges and centre, while the other is held only at the edges, thus leaving the centre free to vibrate; when the varying charge in the rear plate excites an opposite and corresponding charge in the front one, the attraction consequent thereon also varies, and the front plate reproduces the sound waves which originally produced the variation in static charge [illegible] means of the transmitter. For a transmitter, Dolbear employs an instrument quite

similar to the original transmitter of Philip Reis, except that the coils which produce the secondary or static charge are wound to produce higher static charges, as the efficiency of the instrument depends largely upon this. Of course the passage of this high tension current over the wire would tend to increase the amount of leak on the line, and so decrease the efficiency of service; it is, therefore, usual to place the coil at the receiver, and transmit to it the variations in the low tension current from the receiver, thus avoiding the necessity of high insulation except within the instrument itself. The call-bell is also operated by the static charge generated by the same battery and coil used for the transmission of speech, the vibrations in current being produced by an ordinary toothed wheel contact breaker turned by a hand-crank, and the variation in the current so produced also induces the opposing charges of electricity in the plates of the receiving telephone and renders it still more sensitive to subsequent variations in the current. There is about as much difference between a receiver thus sensitised, and one not thus acted upon, as between two Bell receivers, in one of which a permanent magnet is used, and in the other an electro-magnet charged by the current from the transmitter. It will be readily seen that the instruments of Bell and Dolbear have no points in common except that they both use varying currents of electricity to reproduce articulate speech, and the decision which the American Bell Telephone Company obtained against the Dolbear Company in the Circuit Court of Massachusetts has received severe criticism. It is, however, said that the decision of the judge was largely influenced by the testimony of one of the experts in the case, to the effect that the static charge used in the Dolbear telephone was the mechanical equivalent of the force of the magnet in the Bell instrument.

Besides these instruments, there is on exhibition, some of the apparatus used by Professor Dolbear in his experiments in magneto-telephony, and an instrument used by him in October, 1876, is believed to have been the first telephone with a permanent magnet. There are also several transmitters of a pattern somewhat similar to those of Reis. Two of them have four contact points all acting simultaneously to the primary coil. This part of his experimenting was not concluded, as the Bell patents hindered any monetary advantage in this direction.

The Dolbear Company claims for its instruments on the static principle, several advantages over all magneto-telephonic systems, especially freedom from noise in the receiver caused by inductive currents from other lines, and by earth currents, and it would seem likely that this should be the case. It therefore seems probable that the instruments would operate satisfactorily on long lines where the Bell instruments have up to the present time been unable to succeed, from the fact that these noises in the receiver drown out ordinary conversation on lines over 100 miles. Whether these claims are justified by facts, we had no opportunity of judging, as the line attached to the instruments did not extend far enough.

The exhibit of Mr. Elisha Gray, which is next to that of Professor Dolbear, presents merely an historical aspect, as Mr. Gray never proceeded further than his original patent, and assigned it to the Western Union Telegraph Company, who have turned over all their telephone rights to the American Bell Telephone Company. Mr. Gray was experimenting to produce a harmonic telegraph system by which a number of messages might be sent simultaneously over one wire, when he discovered that the instruments he was using would transmit speech as well as musical notes, and filed his caveat, it is said, only two hours after Mr. Bell filed his application for a patent for a speaking telephone. His instruments, mostly magnets with sounding boards and contact breakers, are exhibited, as also his final results in harmonic telegraphy, there being a complete set of six instruments, three at each of the lines working in unison with vibrations of tuning-forks, each sounder responding only to interruptions in its own note. One of Mr. Gray's early experiments consisted in attaching one end of the secondary wire of a Ruumkorff coil to the side of a tin-lined bath tub, and rubbing the dry side with a smooth piece of metal attached to the other end of its secondary wire. He found that he could produce a low note of the same pitch as that given by the circuit breaker at the end of the coil. This experiment is interesting as pointing in the same direction as Professor Dolbear's work.

The exhibit of the Clay Commercial Telephone Company, of Philadelphia, consists of a miniature central station with lines running to different parts of the exhibit, and a connection with the main office of the company in the city of Philadelphia. There is a switchboard for connecting the different lines, and opportunity is given to use the instruments to different parts of the city, if desired. The instruments used by this company differ in several particulars from any others now employed, and it is on the basis of their superiority to the systems of other companies that the Clay Company anticipates a large share of business. The receiver has a tripolar magnet as seen in the cut, and the wire is wound around each pole in a continuous circuit instead of having a separate coil for each pole or a single coil inclosing all the poles as is the case in most multipolar receivers. The claim of the company is that this method of forming the magnets and winding the coil obviate all trouble from inductive currents, and in fact that the inductive current, instead of opposing the useful current, acts in union with it and increases the efficiency of the receiver. In Fig. 3 the poles marked B are of one polarity, and the central one of the opposite polarity.

In the receiver, Fig. 4, A A, is a diaphragm of wood, against which rests a carbon cylinder C, on each side of which is a contact point of platinum. D is the induction coil, which is used to press the carbon cylinder and platinum points together. At F is a U-shaped piece to prevent transverse motion of the rod. The induction coil may be moved along this rod, thus giving a greater or less pressure as is desired on the contact points; at E there is a metal spring which also aids in this adjustment. The two instruments with a magneto call-bell and automatic switch for cutting the telephone out of the circuit are combined as seen in Fig. 5. The company also has a central office switchboard in which the subscriber, by hanging up his telephone, disconnects his line automatically from the other line over which he has been talking. This is done by having the connection strips held in place by a catch on the armature of an electro-magnet; when the subscriber hangs up his receiver the hook pulls down a switch and passes a current of electricity through the electro-magnet releasing the catch, the connection strip then is returned to its former position by a spring and the subscriber's line is in connection with the central office only. While we do not wish to go into detailed criticism of this apparatus, it seems as if there were several objections to the system which would prevent its general adoption. The company has about 250 subscribers in their central station in Philadelphia, to whom it is said to give very great satisfaction.

The Overland Telephone Company owning the patents of Dr. Myron Baxter and also those of Graham, Eaton, and Dr. Van der Weyde, forms the next exhibit. Dr. Baxter's telephonic receiver is a bipolar instrument. His transmitter has a large number of contact points and it is claimed that more cells of battery can be used on this instrument than any other telephonic transmitter now invented, thus enabling its use with unusual efficiency on lines of great length. The Eaton receiver differs from the Bell instrument chiefly in having the magnet made of a number of small bars of steel, forming a bundle about ¾ in. in diameter. Mr. Eaton claims that this method of forming the magnet enables it to respond to variations in current more readily than the form adopted by Professor Bell. The fact that this form of instrument was carefully tested four years ago in Boston by the Bell Company and rejected by them as not an improvement, would seem to throw some doubt on this claim. The instrument known as the Graham receiver (Fig. 6) transmits the vibrations to the diaphragm by means of a small coil of wire C C closely surrounding the pole of the magnet B. This coil is suspended by a spring lying across the end of the magnet, and pressing on its upper surface upon the diaphragm, and any movement produced in the coil by varying attraction in the magnet is thus directly communicated to the diaphragm. The company claim that the construction of their transmitter is such that the circuit is made and broken at each pulsation produced by the voice, but a careful test failed to show any evidence of this fact. They have used the instruments through 800 miles of wire, but as they do not state when this test was made, it may be that it was done at a time when there was very little electrical disturbance from telegraphing or otherwise, in which case the same facts might be stated to be true of instruments owned by the Bell Company.

The Drawbaugh Telephone Company has a space over which their sign is displayed, and in which they have have a show case carefully covered with a white cloth. On this cloth is an announcement that the instruments in the case will be displayed as soon as the suit between them and the American Bell Telephone Company, now in the courts, reaches a decision. It is, therefore, impossible to judge at all concerning the merits of these instruments.

In the loan collection from the United States Patent Office is the model of a telephone invented by Professor John Trowbridge, of Harvard University, for the comparison of different sounds and various forms of coils used on the magnet poles.

A diaphragm of thin iron extends between the poles of a horseshoe magnet, B B, Fig 7. Short tubes D D are inserted in holes bored near the poles of the magnet, and long rubber pipes are affixed to these tubes. Tuning-forks are vibrated near the extremities of these rubber tubes, the columns of air transmitting the vibrations of the tuning-forks to the opposite sides of the diaphragm. Upon each pole of the magnet are placed adjustable spools, whose terminals are connected to receiving telephones. Professor Trowbridge considered that the diaphragm being in equilibrium between the poles of the magnet, it would be more sensitive to slight changes in current, but subsequent investigation did not indicate any method of adopting this principle to the commercial use of telephones, although an opportunity for the intelligent investigation of overtones seems to offer itself through this instrument.

At the present time the question of the rights in the electrical transmission of speech in the United States is clouded by an endless series of litigation. The decisions of the lower courts, as far as rendered, have conceded to Professor Alexander Graham Bell the full title to this principle, and if the subsequent decisions from the appellant courts should permit the use of other forms of telephone, it seems as if the Bell Company would still remain masters of the situation, except as regards isolated lines, because that company is protected by numerous patents covering each element of the central station system, which enables intercommunication between any two subscribers to the system.

This is no place for a discussion whether such a juncture of affairs tends to repress individual investigations upon the problems of electrical transmission of speech, but it is an assured fact that the uniformity of organisation essential to the administration of an enterprise of the magnitude of the Bell Telephone Company also assures to the subscribers a similar efficiency of service.

THE BRITISH ASSOCIATION.

In a former issue (see *ante*, page 275), we have reported a part of the proceedings of the recent meeting of the British Association at Montreal, and we now, though somewhat tardily, propose to give a general notice of the business done, at this meeting, which possessed quite an exceptional interest from its having been held so far from home. The arrangements for the reception of the British Association at Montreal were sufficiently comprehensive and satisfactory to please the oldest or most fastidious of the members, and the exceptionally good opportunities afforded by the various affiliated colleges round M'Gill University enabled all the sections, excepting perhaps E and F, to be conveniently reached from the central offices in the M'Gill College. The main buildings of the M'Gill University are pleasantly situated in ornamental grounds tastefully laid out at the foot of Montreal Mountain, unpretending in their external appearance, but substantially built of the native limestone on which the city stands. The original building has been successively added to and enlarged without any general plan being adhered to, and besides these extensions several distinct buildings have been put up in the grounds and adjoining to them, which are generally the property of different religious bodies affiliated with M'Gill University, which itself has no Theological Faculty, but offers advantageous terms to any denominations whose students may have the benefits of its classes and degrees These different colleges came in admirably for the business of the Association, sufficiently near for all

purposes of convenience, and affording ample room for the working of each of the sections. In the main building of M'Gill were the general committee and reception rooms, writing and reading rooms, post office telegraph, and other necessary offices, whilst Section B was appropriately domiciled in the chemical class room of the college. The Medical Faculty occupies a distinct building at the north-east corner of the grounds, and here Section D conducted their meetings, whilst Section C occupied the theatre and other rooms underneath the Redpath Museum, a handsome structure in front of the west wing of the main college building. Section A had the Morrice Hall, a wing of the Presbyterian College. Section G met in the Congregational College just across M'Tavish-street from the Presbyterian College, and the new Section H inaugurated for the first time at this meeting of the Association held their deliberations in the Wesleyan College, the extreme eastern building within the area devoted to the M'Gill Institution, and approached either through the grounds or from University-street, the eastern boundary of the property. A quarter of a mile down this street, Section E met in the gymnasium, and Section F in the Synod Hall in connection with the English Cathedral.

The proceedings commenced on Wednesday, August 27, when the committees of the different sections met in their respective quarters to arrange the business to be attended to, and the papers to be discussed. In the evening a general meeting was held in the Queen's Hall, the chair being taken by Sir William Thomson. His Excellency the Governor-General, the Marquis of Lansdowne, made the opening speech welcoming the numerous visitors from Great Britain and the United States, and after remarking that this was the first meeting in over a half a century that the Association met outside of the British Isles, explained that this was not inconsistant with the objects of the Institution, or the designs of its founders. Expressing the hope that this meeting would be fraught with far-reaching advantages both to the hosts and the guests, he gracefully referred to the large number of members of the corresponding American Institution then present, whose approaching meeting at Philadelphia had been postponed for a week or two beyond its usual time so as to provide the members of each Association an opportunity of taking a part in the deliberations of the other, and concluded by the announcement of the knighthood which was intended to be shortly conferred upon Sir William Dawson, the able and popular head of the M'Gill University, the official intimation of which was received with the most cordial enthusiasm. Sir William Thomson then acting for Professor Cayley, who was unavoidably absent, resigned in his name the presidency of the Association, and introduced Lord Rayleigh, the President elect, under whose chairmanship the proceedings of the present—fifty-fourth—meeting of the Association would be conducted.

The President's address, after recalling that for over fifty years the Association had held their autumn meetings in various towns of the United Kingdom, within whose limits there were probably few places of importance which they had not visited, stated that now, not satisfied with past successes, they were seeking new worlds to conquer, and that whatever objections might have been at first raised against this departure from their established usage, they were soon outweighed by the consideration of the magnificent opportunities it would afford of extending the sphere of their influence, and of becoming acquainted with a part of Her Majesty's Dominion, which, associated with splendid memories of the past, is advancing daily by leaps and bounds to a position of importance such as not long ago, was scarcely dreamed of. Englishmen ought to know more of matters relating to the colonies, and anything which tends to bring the various parts of the empire into closer contact can hardly be overvalued. The address then entered into an able and exhaustive explanation of the progress, position, and prospects of physical science, reviewing generally the salient points of recent experimental investigation, the admirable discourse being listened to with the greatest attention by a large and appreciative audience.

The Hon. de Chauveau, in an eloquent speech in French, proposed a vote of thanks to Lord Rayleigh, and pointed out that the reunion to-day was significant in this sense, that whilst in the political world the question of a federation of the whole British Empire was being raised, the British Association by its present action had taken the initiate in its sphere by laying the foundation of a scientific federation.

The following morning, Thursday, the sections all got fairly to work, the inaugural addresses being given in the various places assigned to them, and a large amount of business was got through, the meetings in every case being well attended. Passing over the proceedings of Sections A and B, Mathematics and Chemistry, which, belonging to pure science, have a more general scope, and cannot be localised to bear upon the Canadian place of gathering, a number of the papers in the other sections were upon topics evidently suggested by the locality of the meeting, and consequently possessed features of novelty to the older members of the Association. In Section C, Geology, eight of the nine papers were on Canadian geology, and the last, by Professor Claypole, of the Geological Survey of Pennsylvania, was on an allied topic "Pennsylvania before and after the Elevation of the Appalachian Mountains." The first paper was by Mr. Gilpin, Inspector of Mines in Nova Scotia, on the past experience in gold mining in Nova Scotia, giving an account of the origin and development of this industry, and the geology of the different districts in which gold has been or is now worked. This was followed by an equally important paper by Mr. Budden upon the coals of Canada, which it was explained were widely distributed over the Dominion, from the extreme eastern point on the Atlantic to the western shores of the Pacific. The principal coalfields are five in number. The Cape Breton district bounded on the west by the outcrop of the seams about thirty-one miles in length, and dipping under the Atlantic Ocean to the east, comprising numerous valuable seams of bituminous coal. The Pictou County coal, field came next, widely known from the immense thickness, over 30 ft., of its principal seam. The Cumberland coalfield further west followed, only recently developed on a large scale. On the shores of the Bay of Fundy the exposure of three seams showed an immense thickness, estimated at 14,000 ft. vertically of coal-bearing rocks and shales. The 97th parallel separated pretty exactly the coal-bearing formations of America into two classes. To the east they are carboniferous, in the west they are found as coals and lignites at various horizons in the secondary and tertiary rocks. Their commercial development has only recently commenced; but when it was considered that outcrops of valuable seams were found eastward of the Rocky Mountains, and north of the United States boundary for hundreds of miles, no anxiety need be felt as to their extent. In British Columbia but little exploration has been done on the mainland, but in Vancouver's Island the coal is now well opened, and is being mined on a large scale, with the best modern appliances. Another important paper was read by Mr. Brown on "The Apatite Deposits of the Province of Quebec." These are all in the county of Ottawa, where mining operations commenced in 1875, and from whence between 60,000 and 70,000 tons have been shipped, the greater part within the last three years. More than three-quarters of this contained from 75 to 82 per cent. of phosphate of lime, the balance from 70 to 75 per cent. Mining has extended to a depth of 130 ft., but by far the larger quantity has been taken from surface workings open to daylight.

In Section D., Biology, the President, Professor Moseley, of the University of Oxford, in his inaugural address, took up the subject principally of deep sea life, a strong argument in favour of selecting this branch of investigation being their proximity to the United States, to which science was indebted for so many important discoveries in deep-sea matters. After referring to the experiments made on H.M.S. Challenger as to the composition of deep-sea water, he went on to speak of the food supply of deep-sea animals, which he thought was mostly in the form of dead matter slowly descending from above The address was deeply interesting, and elicited considerable discussion. Other papers were read by Messrs. Herbert, Carpenter, Spence, Bate, and Honeyman.

In Section E, Geography, under the presidency of Sir Henry Lefroy, unusual interest was excited by the presence of Lieut. Greely, who was warmly welcomed by the President, and who, in doing so, said that he, as well as all the scientific men of Great Britain and Europe, had followed with the greatest interest the efforts made to effect the release of his party, and hailed with the greatest delight their ultimate rescue. The opening address was delivered at one o'clock by the President, who alluded at the outset to his early life in Canada, and his association with some of its scientific societies. There were in Canada two spots of great physical interest, not surpassed by any other on the globe: one was the pole of magnetic attraction; the other, the focus of greatest magnetic force, often, but incorrectly, described as a pole. The discovery of the former was described by the President; the other had, so far, never been visited at all, although Dr. Bell, in his exploration of Lake Nepigon, was within 200 miles of it. Of objects more exclusively geographical, to which he hoped this meeting might give a stimulus, was the exploration of the immense tract of seventy or eighty thousand square miles lying east of the Athabasca River, which was still all but a blank upon our maps. The President then referred to numerous explorations and discoveries recently effected in Central Africa and Asia, and wound up by paying a compliment to Mr. Sanford Fleming for his perseverance and enthusiasm with regard to the introduction on this continent of standard time, by referring local time to a succession of meridians 15 degrees or exactly an hour apart. A number of highly interesting papers followed this address, devoted principally to Central and Eastern Africa.

No section has maintained a stronger interest during the whole of the meeting of the Association than Section F, on Economical Science, under the presidency of Sir Richard Temple. The subject chosen for the address was "The General Statistics of the British Empire." With an area of 8,650,000 square miles, only 120,000 square miles are in the United Kingdom, whilst 1½ millions of square miles are in India, and 7 millions belong to the colonies. Including, however, regions, which though not belonging to the empire have fallen under its political control, more or less, such as Egypt, Zululand, or Afghanistan, the total area, directly or indirectly under the control of the British Empire, may be taken at nearly 10 millions of square miles, or about one-fifth of the 50 millions of square miles composing the habitable globe. Of this grand total not less than 2½ millions have been topographically surveyed, and most of this minutely field by field. The coast line of the empire is about 28,500 miles with forty-eight large harbours, and its whole length has been surveyed. Of the whole one-sixth is within the tropics, one-third in the antipodes, one-third in North America, and the remaining one sixth in the temperate zone of Europe or Asia. Out of the 10 millions of square miles hardly one-fifth can be said to be either cultivated or occupied. An enormous area, not less than two millions of square miles, principally in Canada and Australia still remains of good land not at present brought into use, sufficient at the lowest estimate to sustain a population of 200 millions of people. The total population amounts to 305 millions of souls in those regions included directly in the empire, to which ten millions may be added for the districts referred to as under political control. Of this 315 millions 45 millions are of the Jew or Caucasian races, 39 millions being Anglo-Saxons. Then there are 3½ millions Celtic, 1½ French Canadians, and half a million of Dutch in South Africa, besides a number of different European nationalities, but few of these are of the Latin race from the south of Europe, and hardly any are from Russia. Ethnically 45 millions are Caucasian, 254 Aryan, and five millions Mongolian, the rest being principally aboriginal races. In religion scarcely 46 millions, or one-seventh of the whole, profess Christianity, whilst 188 millions are Hindus, the whole Hindu race being subject to the British Crown, and forming more than half of its subjects. Then there are 60 million Mohammedans, comprising half of the Mohammedan world, with 7 million Bhuddists, and about 7 millions of pagans. The average population is only 38 to the square mile against 184 to the mile in India and 485 in England, the only portion that is really densely peopled throughout, this average being about the same as Belgium, the most densely peopled country of Europe. The paper went on to review the revenue of this immense empire, the number of men trained to arms, its shipping, its commerce, which is one-third of the whole trade of the world, its manufactures, its steam power, the average earnings per head, its public and municipal debts, its public works, education, and other statistical facts, being altogether one of the most elaborate papers produced at this meeting. Another excellent paper followed, by Mr. Westgarth, an Australian, and

President of the Melbourne Chamber of Commerce, on "The British Empire in North America and Australasia."

(To be continued.)

NOTES.

Position of the Poles of Magnets.

Messrs. W. Hallock and F. Kohlrausch have made a number of experiments on ordinary long bar magnets in order to determine with exactitude the true position of the poles in the length of the bars. Fourteen magnets were used, some of various conditions of hardness, and in general they were in the form of steel cylinders magnetised in the direction of their axes. Their results, taken in connection with those of Schneebeli and Helmholtz, agree in showing that the effective poles of a magnet are about one-twelfth of the distance of the length from the ends. This result is, according to the observers, in all probability correct to within five per cent.

Light and the Electric Resistance of Metals.

Mr. Arthur E. Bostwick has made an elaborate series of experiments on the supposed influence of light in altering the resistance of metals. Since the diminution of resistance of selenium, when a ray of light falls upon it, was discovered by Messrs. May and Willoughby Smith, Dr. Richard Börnstein has attempted to show that not only selenium and tellurium possess the property in question, but other metals such as gold, silver, platinum, also possess it. This effect was not verified by Siemens and Hausemann, of Berlin, and now Mr. Bostwick's researches have not established the fact asserted. His conclusion is that "if light causes any diminution in the electrical resistance of metals, it probably does not exceed a few thousandths of one per cent."

A Tell-Tale Electric Bell.

In order that the person ringing an electric bell may be able to tell whether, on making contact, the bell actually rings, Mr. Douglas Mackenzie has devised the following arrangement. Besides the press-button, and let into the wall, is a simple telephone receiver of the Elisha Gray or Bell model, and consisting of an electro-magnet with a soft iron plate armature free to vibrate over one of its poles The sounding or "clicking" core of Page may also be employed instead of the diaphragm armature. This electro-magnet is formed up in circuit with the bell and battery, so that when the bell is in action, with its contact interrupting the current, the telephone or electro-magnet will emit a musical note or hum, which, when heard by the person ringing the bell, informs him that the bell is ringing, always supposing that the current is strong enough.

A New Caoutchouc.

It is reported that the attention of the Indian Government has been drawn to a tree in Southern India, from which large supplies of caoutchouc can be drawn. This is the "Tuchmig" of the Chinese, or *Prameria glandulifera* of botanists. Unlike the South American tree, from which the caoutchouc is tapped by piercing the bark, the gum is obtained from the new source by breaking the boughs and drawing it out in filaments. If the new caoutchouc is at all equal to the old in insulating properties it will form a timely discovery, for the introduction of electric lighting has created an increased demand for india-rubber coated wires. Indeed several inventors have lately been engaged in trying to manufacture a substitute for gutta-percha and india-rubber out of oxidised oils, that is to say, oils treated with chloride of sulphur, mixed with asphalte, ozokerit, and other insulating substances.

Toughening Gold.

Dr. J. C. Booth, of the United States Mint, has discovered a general method of toughening gold and silver which he recently described to the American Chemical Society. Some time ago, Mr. Booth found that a quantity of brittle gold accidentally melted with some tough gold in a crucible had rendered the whole mass very brittle, crystalline in fracture, and therefore useless for coining. The whole = 5154 lb. av., was toughened by him in one and a half day at a trifling cost by the new process. The 75,000 oz. of gold were divided into 14 "melts" of 5400 oz. each, and each melt separately toughened. The ingots, which could be broken into pieces by striking them on the edge of a wooden box, were put into the crucible with soda ash and anhydrous fused borax, in the ratio of one or two ounces to a melt, until the crucible was nearly full. It then appeared as a quiet mass of metal covered with a viscid slag, disposed to swell and puff. A few crystals of saltpetre, say one or two ounces, were then dropped into the centre of the metallic surface, and as they melted, their spreading out over the whole surface was aided by the concentric motion of the bottom of a small crucible. The moment the visible oxidising action began to slacken, the melter skimmed off, by a small blacklead dipping crucible, the fluxed matter as rapidly as was consistent with the care necessary to avoid taking up metal. The remainder in the melting pot was the toughened metal.

The Monument to Fresnel.

Among the many statues recently erected in France to commemorate the fame of her citizens, one of the most interesting is that of Augustin Fresnel, which was unveiled before a deputation from the French Academy of Sciences, at Broglie, his native place. Fresnel was born at Broglie on May 10, 1788. His father was an architect, who subsequently removed to Mathieu, near Caen, and at thirteen years of age Fresnel, who was a delicate and backward child, was sent to the Ecole Centrale, at Caen, where he showed a decided bias for the study of mathematics and mechanics. From there he entered the Ecole Polytechnique and left it an Ingenieur des Ponts et Chaussées. During eight or nine years that he subsequently passed at Vendée in the Drôme he showed no signs of the remarkable genius he was afterwards found to possess. One day, however, his thoughts turned towards the nature of heat and light, and the existing theories on the subject. When Napoleon returned from Elba he joined the royal army as a volunteer, but soon tired of it and retreated to Mathieu, where he gave himself up to study. A memoir on diffraction which he sent to Arago began the scientific connection which lasted till his premature death on July 14, 1827. On the request of Poinsot and Ampère, Fresnel was authorised in 1816 to come to Paris and finish his researches, and in 1818 he was appointed engineer to the Canal de l'Ourq. From this time he commenced the discoveries in light and lenses which have distinguished his name. In an eloquent discourse at the unveiling of his monument, M. Jamin pronounced him the French Newton.

Estimating Manganese in Cast Iron.

Mr. Charles Bloxam, the well-known chemist, has recently given the following test for manganese in cast iron, which is much simpler and easier than those generally employed. The metal is dissolved in HCl in a small beaker, the solution evaporated to dryness in the beaker, the residue dissolved in water with a little HCl, filtered from graphite and silica, the filtrate peroxidised by adding a few crystals of $KClO_3$, and heating, diluted, with a convenient quantity of water, NH_3 added until the first formed precipitate dissolves reluctantly on stirring, NH_3 mixed with excess of acetic acid (added in sufficient quantity to convert all the iron into acetate), and an excess of sodium phosphate. The cream-coloured precipitate of ferric phosphate is filtered off, the precipitate re-dissolved (without washing) in HCl, the solution again nearly neutralised with NH_3, and precipitated with the mixture of NH_3 with excess of acetic acid. The two filtrates are mixed, an excess of NH_3 added, and boiled, when the manganese is precipitated as the crystalline, very insoluble, ammonia phosphate, which is filtered off and washed. As soon as the washings leave no residue or evaporation, the wet filter, with the precipitate, is placed in a platinum crucible, which is then covered and quickly heated to redness by a Bunsen burner. After ignition the precipitate is $Mn_2P_2O_7$. It is well, if possible, to keep the ammoniacal solution near its boiling point for an hour, and to set it aside for the night, though the greater part of the manganese is precipitated at once on ebullition. The ignited precipitate should be redissolved in HCl, and the solution mixed with ammonium acetate to detect any ferric phosphate, which, if worthy of notice may be ignited, weighed, and deducted.

New Zealand Coal.

The existence of coal on the hills lying behind the township of Kaitangata has long been known to the residents in the district, and to others who have taken any interest at all in coal mining. But it is only within the past month or two that any idea of the extent and quality of the seams has been arrived at. A gentleman from the north having heard of the existence of coal on the property owned by Mr. Fraser, resolved upon a visit to the land. He was so pleased with the result of his exploration that he at once decided to have a thorough survey of the field made by practical men. The result of this survey being also satisfactory, he entered into partnership with a well-known member of the House of Representatives, having obtained a lease of the land from Mr. Fraser, at a peppercorn rent, and with a provision for a reasonable royalty. The land, which is situated in Block 8, Kaitangata district, and lies within easy distance of the township of that name, comprises in all about 1500 acres. Of this area, 1000 acres has been proved to be coal land containing several seams. Of these the so-called A has been proved to be 9 ft. in thickness, and judging from appearances, the coal is suitable for either household purposes or steam-producing. A little further on—about 15 chains to the south of the A seam—is the B outcrop. Its exact thickness has not been ascertained, but so far as proved it is over 14 ft. Mr. Twinning, mining engineer, in a report which he recently made on this field, considers all these outcrops to be one and the same field, particularly owing to their being as nearly as possible in a straight line north and south. There are, however, he adds, several outcrops to the east of this line, which proves clearly that the coal extended in that direction to the boundary of the lease, a distance of about 30 chains.

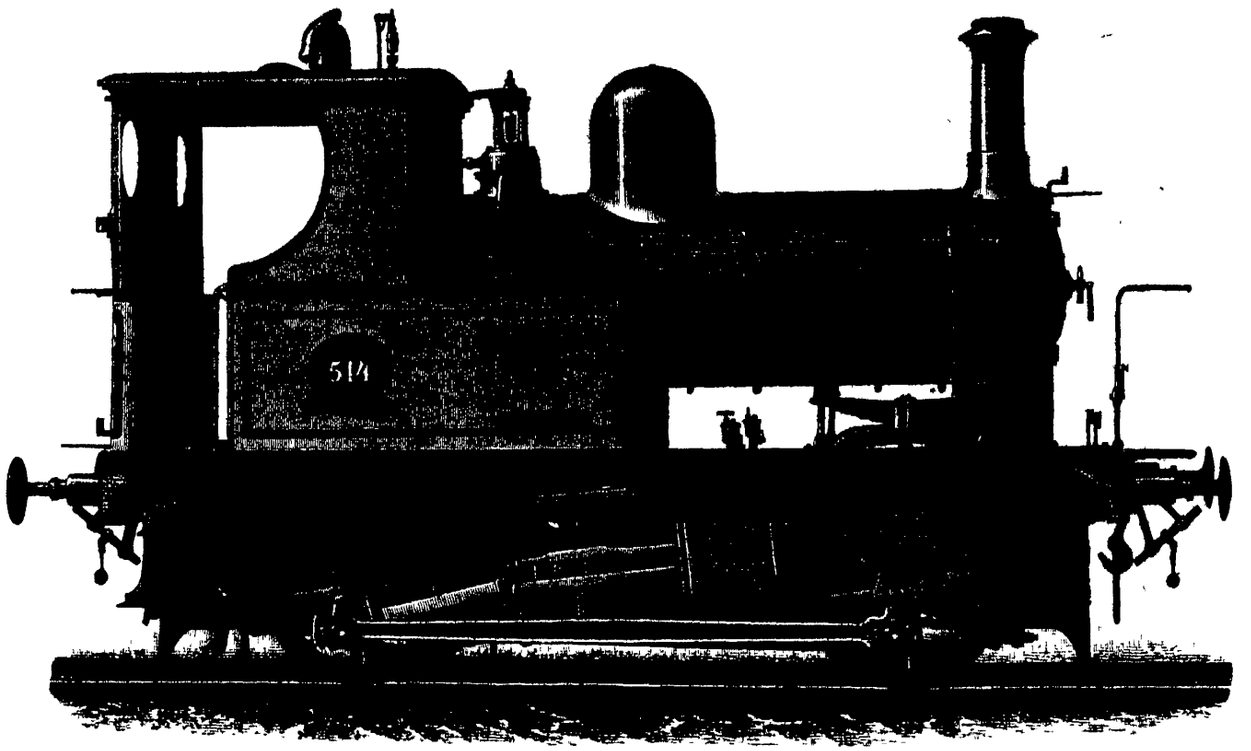
Water Supply of Nottingham

Mr. Tarbotton reports that the amount of water supplied for consumption in Nottingham, during the year ending March 25, 1884, was nearly 1,600,000,000 gallons, being an increase of 100,000,000 gallons, as compared with the year ending March 25, 1883. The supply for domestic purposes was nearly 1,000,000,000 gallons, and the population supplied with water at the present time may be taken to be from 236,000 to 240,000 The Sion Hill Works are in about the same condition as last year Not quite so much water has been pumped at the works during the past year as in previous years, in consequence of the newly acquired supplies having been brought into action The Basford Works are now in excellent condition. Several improvements have been made during the past year, especially in connection with the pumping arrangements to the high-level reservoirs on Mapperley Plains On the completion of the new reservoir it will be necessary to raise much more water at Basford to the high level. This service is increasing rapidly, and when the Carlton district is supplied the two smaller engines at Basford will be fully occupied on the upper zone The Bestwood Works have been almost duplicated in general power, and the capital outlay has ceased The new adits or drifts have been completed, and the engines are now capable of being worked together, the supply of water being abundant There has been nothing to indicate reduction in volume, the springs are constant, but the excessively dry weather of the present year may have an influence on the yield of these, and, in fact, of all the wells, in the course of a few months. Nothing more can now be done at Bestwood to increase the supply beyond extending the adits to an indefinite length, but for some time to come no operations of this kind will be needed. The water is of excellent quality, the engines are in first-class condition, and the station is now being worked with regularity and economy. The Papplewick Works are now drawing towards completion Great progress has been made during the past year, during which, and especially during the summer months, large quantities of water have been pumped from the temporary well and supplied to Nottingham *vid* the Papplewick and Red Hill reservoirs. By next spring it is hoped this station will be completed. It is impossible to estimate at present the daily amount of water which may be obtained from Papplewick, for the permanent well is only partially sunk, but judging from the yield of the pilot well and the appearance of local strata, there is every reason to expect these works will be the most prolific. The Papplewick Works have cost up to the present time about 37,500*l*., and a probable additional sum of 13,500*l*. will have to be laid out to finish them.

Northern Pacific Railroad.—The work of ballasting the Portland and Kalama branch of the Northern Pacific Railroad is almost completed. A new mammoth ferry-boat, the Tacoma, which will be used in transferring passengers and freight across the Columbia, between Kalama and the west side has been completed.

TANK LOCOMOTIVE FOR THE DUTCH STATE RAILWAYS.

CONSTRUCTED AT THE HOHENZOLLERN LOCOMOTIVE AND ENGINE WORKS, DÜSSELDORF.



We give this week a two page engraving, in addition to a perspective view on the present page, illustrating a tank locomotive of a type of which a number have been supplied to the Dutch State Railways by the Hohenzollern Locomotive and Engine Works, Dusseldorf-Grafenberg, of which works Mr. G. Lentz is the managing director. We shall in an early number give further illustrations of these engines and shall then fully describe them and their performance.

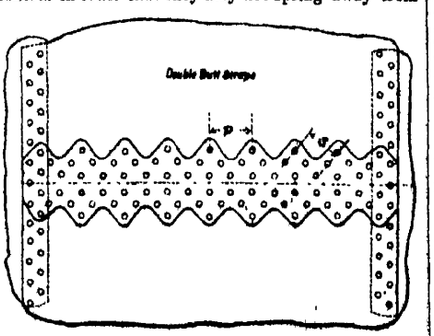
NOTES FROM THE UNITED STATES.

PHILADELPHIA, September 26, 1884.

The week just closed has been one of considerable disappointment to the American iron trade. For several weeks there have been evidences of a coming improvement, and an active movement was looked for in all kinds of iron and steel, but business has dropped off, for some unexplained reason, and everything is again dull and lifeless, and it is now useless to hope for any improvement until after the presidential election. Political excitement increases as this event draws nearer, and business of all kinds will probably feel the unfavourable effects. The production of pig iron is being steadily reduced, and this late decline in activity will probably result in several companies making further reductions in output. There are no stocks anywhere, and for that reason good irons are steady in price. Consumers are buying barely enough to keep them going, and are paying 19 dols. to 21 dols. for No. 1 foundry, 17.50 dols. to 19 dols. for No. 2, and 16.50 dols. to 18 dols. for grey forge. The demand for the latter is not very active, as the mills throughout the country are, with comparatively few exceptions, running less than full time, and many are entirely idle. The bridge works have a good many orders on hand, but are taking very few new ones. Prices for all kinds of manufactured iron are very low, and it will be a difficult matter to advance them, until demand assumes very large proportions. The nail trade is in very bad condition, owing to the heavy production, the lowness of prices, and the competition of the steel nail, which is gaining favour rapidly, and is to be had at a very little over the price paid for iron nails. The latter are selling at 2 dols. to 2 20 dols., and carload lots of steel nails are offering at 2.20 dols. It will be a comparatively short time before the iron nail is laid aside for the steel nail, though the nailmakers are trying to persuade themselves and the public that this is not probable. Reductions of wages continue to be announced. The mills of the Susquehanna and Schuylkill regions have just reduced wages of puddlers to 3.50 dols. per ton, and all other labour 12 per cent. There is very little interest shown in foreign material. Prices have declined, and sales of 20 per cent. spiegeleisen have been frequent during the past few days, at 26.50 dols. to 27 dols. Foreign Bessemer has been almost entirely superseded by the domestic article. Quotations are nominally 19 dols. to 19.50 dols., but only very trifling sales have been made. Small lots of steel blooms sell at 36.50 dols. to 37.50 dols. at tide. Steel wire rods are very dull, and are quoted at 46 dols. Business in steel rails continues fair, as far as the mills in this State are concerned, and a great many moderate-sized orders for winter and spring delivery have been booked at 27 dols. to 27.50 dols.; but outside mills, being unable to compete at this price, have secured very little business. There are rumours to-day, that there has been a combination of steel rail interests effected, and that hereafter prices will be not less than 29 dols. to 30 dols. per ton, but at present writing it is impossible to give details.

THOM'S IMPROVED BOILER JOINT.

We illustrate below a new form of boiler joint invented by Mr. John Thom, of 8, Storey-square, Barrow-in Furness The engraving shows the arrangement so clearly that very few words of explanation will suffice. The lines of rivets form zig-zags or vandykes, and the edges of the covering strip are cut to a corresponding contour in order that they may not spring away from



the plate when caulked. This disposition of the rivets permits of the minimum of reduction of the cross-section of the plate, the number of rivet holes in the outer row, where the plate encounters the maximum strain, being only one-half of that of the inner rows. The joint has a strength equal to about 90 per cent. of that of the solid plate, and by its use a saving of 15 per cent. of the weight of plates can be obtained with equal strength. It has been passed by the Board of Trade for some boilers now building. The following are the formulæ by which the strength is computed:

Let t=Thickness of plate,
S=Pitch diagonally,
p=Pitch of rivets (greatest),
d=Diameter of rivets,
a=Sectional area (one rivet),
n=Number of rivets in p=5,
1.75=For rivets in double shear,
$\frac{4}{5}$=For steel plates and steel rivets.

Percentage of plate to solid plate $=\frac{p-d}{p}\times 100$.

" rivets " " $=\frac{n\times a\times 1.75}{p\times t}\times 100\times\frac{4}{5}$

$S=\frac{1}{4}p+\frac{1}{4}d+d$.

Lap joints can be made in a similar manner.

The Launch of the "Rodney."—On Wednesday, the Rodney, the second of a new class of armoured vessels to be named after famous admirals, was launched at Chatham, the christening ceremony being performed by the Duchess of Edinburgh. The dimensions of the ship are: length between perpendiculars, 325 ft.; extreme breadth, 68 ft.; depth in hold, 26 ft. 5 in.; draught forward, 26 ft. 3 in.; aft, 27 ft. 3 in.; mean, 26 ft. 9 in. The proportion of beam to length is 1 ft. to 4.7 ft. run, and gives the vessel great stability for fighting purposes. The displacement is 9740 tons, and the power at forced draught, is contracted to be 9500 indicated horse-power. The engines are being made by Messrs. Humphrys, Tennant, and Co., and each set will have one 52-in. high-pressure cylinder, and two 74-in. low-pressure cylinders, all with a stroke of 3 ft. 9 in. The crankshafts and propeller shafts are made of Whitworth's hollow steel, and are carried in Whitworth steel frames built into the vessel and forming part of it. The general design of the engines resembles that adopted in the Collingwood and the Brazilian ironclad the Riachuelo. The boilers, twelve in number, are of Siemens-Martin steel, and are placed in four independent stokeholds. The coal carrying-capacity is 900 tons. The armament of the Rodney consists of four 63-ton guns mounted in two barbette towers, one forward and one aft of the central citadel, which will contain six 6-in. guns on the broadside. She is also to have twelve 6-pounder quick-firing shell guns, eight Nordenfelts, and two Gardner machine guns. Her complement will also include twelve Whitehead torpedoes, which can be launched from four different parts of the vessel. The hull is armoured above and below the water line with steel-faced plates; the citadel is protected by 18 in. armour along the sides, and 16 in. at the ends, while the two polygonal barbettes have armour from 10 in. to 11½ in. thick set at a slope. Below the load line is an armoured deck which before and abaft the citadel, is 3½ in. thick. The main deck is formed of three thicknesses of 1 in. steel plates. Over the citadel is a decked space, all round which the skin plating rises to the height of a man. The estimated speed is 16 knots. We are indebted to the *Times* for the above particulars of the vessel's equipment.

CRUCIBLE CAST STEEL.

*On the Manufacture of Crucible Cast Steel.** By Mr. Henry Seebohm.

(*Concluded from page* 305.)

A chemical change in the composition of the bars has taken place. They were originally pure iron or nearly so, containing perhaps one-quarter per cent. of carbon or less, were fibrous in their structure, and would bend double without breaking. After the process of conversion they have become a carburet or carbide of iron or steel, containing from half to one and a half per cent. of carbon, according to the length of time they have been in the furnace, and the degree of heat to which they have been subjected. They are now more or less crystalline in their structure, and can be broken by a slight blow of a hammer.

The converting furnaces in use in Sheffield vary in size, some holding as much as 30 tons of iron, and others not more than 15 tons. The iron gains slightly in weight by being converted into steel. The process occupies about three weeks, and a pair of pots may be used from 20 to 40 times before they are worn out and have to be replaced by new ones.

As in every other process connected with the manufacture of steel, in the process of conversion it has to run the gauntlet of many perils. Sometimes the pots crack; air is admitted to the furnace; the charcoal is burnt, and in bad cases even the iron is oxidised. Bars which have thus missed conversion are technically said to be "alred;" and even when very slightly affected, may easily be discovered, in consequence of their having almost lost the tendency to become rusty. If the furnace be raised to too high a heat the surface of the bars will melt, and when they are drawn it will appear "glazed." There are even instances handed down by tradition in Sheffield of unskilful converters, who had heated the furnace under their care to such a degree that the whole mass of iron and charcoal had become fused together, and the end of the furnace had to be taken out to remove the contents.

During the process of conversion the outside of the bar of iron is turned into steel the first, and in a spring heat the centre of the bar remains iron, though when the bar is broken the crystals of iron have lost their brilliancy; in technical language, the bar is said to be full of "sap," though the sap is "killed" and no longer looks "raw" or "stares."

In a country heat the sap is still more killed, and the crystals of steel on the edges have become more distinct.

In a single-shear heat the fracture shows more steel on the outside and less iron in the centre, until in a double-shear heat the fracture shows about equal proportions of iron and steel. It is important that the transition from one to the other should be as gradual as possible. When the line of demarcation is violent or sudden, the process of conversion has been carried on too rapidly, and bars of blister steel so converted are said to be "flushed."

In a steel-through heat, as its name implies, all trace of iron in the fracture has been lost sight of, but the crystals of steel are small.

A short time longer in the furnace will make the steel a melting heat; the crystals will be large, and in exceptional cases their facets will reach across the bar.

The melting furnace consists of a row of oval melting holes large enough to contain two melting pots, one in front of the other, and deep enough to allow of sufficient coke to cover the lids. From each melting hole a flue leads in old-fashioned furnaces into a flat stack, each hole having a separate flue in the stack, but many furnaces are now made with short flues from each hole leading into a main flue, which ends in a single square chimney. The application of gas to the melting of steel has been successful, but for the highest qualities coke is principally used, as the control which the melter has over the temperature of each pot, which sometimes requires "keeping back" and some times "hurrying on," is supposed to be more absolute. There can be little doubt, however, that the adoption of gas melting furnaces is only a question of time.

The furnace floor is on a level with the top of the melting holes; and the grate bars, as well as a flue leading into the chimney by which the draught may be controlled, are accessible from the cellar.

The pots in which the steel is melted are generally made in a room adjoining the melting furnace. They are composed of a mixture of Burton and Stannington clay, to which is sometimes added a proportion of Stourbridge clay, and if the pots are required to stand a great heat, of china clay from Devonshire. A small quantity of ground coke as well as of old pots ground is also added. Great care is taken that the clay be absolutely disintegrated and perfectly mixed together. This is accomplished by treading it in a trough, the pot-maker and his assistant kneading it with their bare feet. The pots are moulded in an iron "flask" by means of a wooden "plug," and are slowly dried at the back of the stack; and the night before they are used gradually heated to a dull red-heat, a process called annealing. Pot-making is a very important part of the manufacture of best cast steel. It is absolutely impossible to make good cast steel if the pots are defective. Each pot lasts a single day, and is used three times, containing severally about 50 lb., 44 lb., and 36 lb. of steel each round. The object of lessening the weight of each successive charge is to bring the surface of the molten metal to a different place in the pot, because the "flux" or scum which accumulates on the surface, has a chemical action on the silica of the pot, which is consequently decomposed for some depth just at that point, and the pot is reduced in thickness.

The bar steel is first carefully selected of the exact temper required, all flushed or alred bars are rejected, and after it has been broken up into small pieces and carefully weighed, it is conveyed to the pot, which has already been placed in the melting hole through an iron funnel called a charger. The lid is carefully adjusted, and the melting hole filled with coke.

The degree of heat to which the furnace is allowed to go is carefully regulated by the "puller-out," who is technically said to "work" the holes, and who has perfect control over them by means of the two flues, into either of which he can insert a firebrick if required; a brick in the melting hole flue lessens the heat by lessening the draught; one in the cellar flue increases the heat by increasing the draught. The head melter periodically inspects the pots, and gives the final instructions to the puller-out, and decides the precise moment when the steel is dead melted, and the holes sufficiently burnt down to allow of its being "teemed" or poured into the mould with a fair chance of producing a sound ingot. When the "puller-out" has put on his "clothes," by which is meant a series of sacking wraps which envelop the arms and legs, and are soaked with water to protect him from the heat, he raises the pot with a pair of "pulling-out" tongs," and lifts it from the hole to the floor of the furnace.

The lid is instantly taken off with a pair of lid tongs, and the scum and flux is removed by a skimmer from the surface of the molten steel, which is then poured into a cast-iron mould formed of two halves tightly ringed and wedged together. The interior of the mould has been previously "reeked" or covered with a coat of coal-tar soot, to prevent the ingot from adhering to it.

The melting of the higher qualities of steel is a process requiring the greatest skill, and one of the principal reasons why the trade has become to such a remarkable extent localised in Sheffield, is the importance to this branch of the trade of being able to select, from a large class of more or less experienced workmen, the few exceptional men in whom sound judgment, technical skill, and steady habits are combined. The chances of accident in the melting of steel are many and various. Not only badly made pots, but badly annealed or badly worked pots, are sure to "run," and the steel to be deposited amongst the ashes, where it imbibes so much sulphur as to be practically of no value. Should a piece of coke accidentally find its way into the pot, the ingot will show a bright sparkling fracture; technically speaking it will be said to "stare," and under the hammer will prove "hot short" and crumble to pieces. If the steel be not long enough in the fire, it will teem fiery and produce a honeycombed ingot, and the same result will follow if it be too hot when it is poured. If it remain too long in the fire it will teem "dead," "the fracture of the ingot will look scorched," and though exceptionally sound, it will be brittle if hard, and wanting in tensile strength if mild. If the molten steel be chilled before it is poured into the mould, which may be detected by the stream skimming over as it is teemed, the fracture of the ingot will appear dull in colour, and full of small holes or honeycombs.

All ingots having a proportion of one per cent. or more of carbon, if properly melted will pipe, that is to say, the steel in the centre of the ingot will settle down as it cools, leaving a hollow space in the middle at the top of the ingot to the depth of from 3 in. to 5 in. When the ingot has become cold it must be topped, that is to say, the hollow part must be broken off, until the ingot shows a sound fracture, and before this fracture has had time to rust, the ingots must be carefully examined; the ingots which are not properly melted must be rejected, and the exact percentage of carbon which each ingot contains must be marked upon it. An experienced eye can judge of the percentage of carbon contained in an ingot to a wonderful nicety by the appearance of the fracture. Between 1 per cent of carbon and 1¼ per cent. every tenth per cent. is well marked, and an experienced hand will detect a difference between, for example, 1.3 and 1.35 per cent.

In order to reduce the ingot of cast steel to the size and shape required by the consumer, it must be re-heated and when hot enough, hammered or rolled to the dimensions ordered. Great care must be exercised in this process not to burn or overheat the steel; and to prevent this the half "cogged" bar must be continually turned round in the fire, and ground fireclay or sand and borax sprinkled upon it. In many cases it is necessary to give the surface of the bar, after it has been once drawn down under the hammer, a welding or "wash" heat, to close the small honeycombs which are scattered here and there on the surface of the ingot. It is a matter of great importance, especially with large ingots, that they should not be hammered until they are thoroughly heated or "soaked" through, and it is of equal importance to all ingots that they should not lie too long "soaking" in the fire, especially in a dry fire, that is, one without blaze. The effect of hammering steel is to make it crystallise in very small crystals, a result which greatly improves its quality, but at the same time exposes it to the risk of various accidents in the process. The forging, tilting, and rolling of cast steel all require very experienced workmen, and a considerable outlay of expensive machinery. It is seldom that a workman attains exceptional skill in many departments, and great loss is sustained by too often changing faces or rolls, so that these processes cannot be satisfactorily or cheaply carried on upon a small scale, and this is one of the chief reasons why the crucible cast steel trade has to such a large extent become localised in a single town.

It might be supposed that when the best quality of iron had been selected, and the greatest care used in all the processes of manufacture—the converting, the melting, and the forging—the result must of necessity be good steel, and the troubles of the steel manufacturer would be over. But this is not the case by any means. So far from being over, the greatest difficulty has yet to be faced. The result may be good steel, but good steel only for certain purposes. There was a time, in the golden age of steel manufacturing, when steel was steel, and if it did not answer the purpose for which it was required, it was taken for granted that the fault lay with the workman. In some cases the manufacturer altered the percentage of carbon, but the "temper" of the steel was kept a profound secret from the consumer, in most cases, no doubt, because the manufacturer had very vague ideas on the subject himself. Chemical analysis was unknown in the trade; the despotic sway of the rule of thumb reigned supreme. Now it is customary for the manufacturer to take the consumer into his confidence, and not only to inform him of the percentage of carbon which the steel contains, but also to give him the benefit of his opinion as to the purposes for which it is, or is not, suitable. Formerly if the consumer discovered that chisel steel contained less carbon than tool steel, he owed his discovery entirely to his own wit.

There can be no doubt that for many purposes a considerable latitude may be permitted, if the steel has the good fortune to fall into the hands of a clever workman who understands how to "humour" it; but next to quality—by which is meant percentage of phosphorus, sulphur, &c., combined with some other obscure points of crystallisation—the most important thing is temper, or percentage of carbon For some purposes, indeed, temper is of more importance that quality. Nothing is more common than for steel to be rejected as bad in quality, because it has been used for a purpose for which the temper was unsuitable. We may divide consumers of steel into three classes. First, those who use their own judgment of what percentage of carbon they require, and instruct the manufacturer to send them steel of a specified temper, second, those who leave the selection of the temper to the judgment of the manufacturer, and instruct him to send them steel for a specified purpose; and third, those who simply order steel of a specified size, leaving the manufacturer to guess for what purpose it is required. Fortunately, the size and shape generally furnish some clue to the purpose for which it is likely to be used. For example, oval steel is almost sure to be used for chisels, and small squares for turning tools, but 1½ square may be used for a turning tool or a cold sett, or 1½ round for a drill or a boiler cup, and the manufacturer has to puzzle his brain to discover whether the chances are in favour of its being used in the lathe room or in the blacksmith's shop. It cannot too often be reiterated of how much importance it is, when ordering steel, to state the purpose for which it is going to be used.

Of course the number of tempers of steel is infinite, but the following is a list of the most useful.

Razor Temper (1½ per cent. carbon).—This steel is so easily burnt by being over heated that it can only be placed in the hands of a very skilful workman. When properly heated, it will do twice the work of ordinary tool steel for turning chilled rolls, &c.

Sawfile Temper (1¾ per cent. carbon).—This steel requires careful treatment; and although it will stand more fire than razor steel, should not be heated above a cherry-red.

Tool Temper (1¼ per cent. carbon)—The most useful temper for turning tools, drills, and planing machine tools in the hands of ordinary workmen. It is possible to weld cast steel of this temper, but only with the greatest care and skill.

Spindle Temper (1¼ per cent. carbon).—A very useful temper for circular cutters, very large turning tools, taps, screwing dies, &c. This temper requires considerable care in welding.

Chisel Temper (1 per cent carbon).—An extremely useful temper, combining as it does great toughness in the unhardened state, with the capacity of hardening at a low heat. It is consequently well adapted for tools when the unhardened part is required to stand the blow of a hammer without snipping, but where a hard cutting edge is required, such as cold chisels, hot setts, &c.

Sett Temper (¾ per cent. carbon).—This temper is adapted for tools where the chief punishment is on the unhardened part, such as cold setts, which have to stand the blows of a very heavy hammer.

Die Temper (⅝ per cent. carbon).—The most suitable temper for tools where the surface only is required to be hard, and where the capacity to withstand great pressure is of importance, such as stamping or pressing dies, boiler cups, &c. Both the two last tempers may be easily welded by a mechanic accustomed to weld cast steel.

It is a somewhat remarkable fact that although steel is intermediate in chemical composition between wrought iron and cast iron, containing more carbon than the one and less than the other, its properties are quite different from either of them. It may be made to resemble either of them alternately, but it is principally used in a third condition, in its capacity to assume which the great value of steel consists. Annealed steel has nearly all the properties of lead, being very soft and malleable. Hardened steel has nearly all the properties of glass, being very hard and brittle. Tempered steel has most of the properties of whalebone, being hard but at the same time elastic. The chemical change which takes place during these processes has not yet been discovered. We might evolve a very pretty theory to account for it, by assuming that in the process of annealing some of the combined carbon was liberated, and existed in the steel in the form of free or uncombined carbon; but such a theory only explains part of the facts, and is not, I am afraid, borne out by the results of chemical analysis, so that we must fall back upon the mysterious and unknown laws of crystallisation. The effect cannot be due simply to the increased density of the hardened steel caused by the contraction of the steel by sudden cooling. It is a remarkable fact that the specific gravity of hardened steel is less than that of unhardened steel. Steel of course expands with heat, and when it is allowed to cool slowly regains its original size; but if it be cooled suddenly—

* Paper read at the Chester meeting of the Iron and Steel Institute.

the only known way in which it can be hardened—although it contracts very much, it does not quite reach the small size of the unhardened state.

However complicated the details of the manufacture of cast steel may be, the complications involved in its subsequent use are still greater. It would be impossible to lay down exact rules for each of the thousand and one tools in which steel is used. The treatment of each tool in each process which it undergoes is an art that can only be learnt by practice, and can no more be taught in a book than the arts of skating, riding, or swimming. The utmost that can be done is to lay down certain general rules, which may explain to some extent, if they fail to teach, the most important details of manipulation. All steel may be regarded as involving a question of compromise. Each tool requires a certain degree of hardness; the problem is how to secure the maximum amount of toughness that is compatible with it. To secure this the first step that must be taken in bringing the steel into the shape required is to heat the steel as little as may be before it is forged, and in the process of forging to hammer it as much as possible. The worst fault that can be committed is to heat the steel more than is necessary. When steel is heated it becomes cross grained; its silky texture is lost, and can only be restored by hammering or sudden cooling. If the temperature be raised above a certain point the steel becomes what is technically called "burnt," and the amount of hammering which it would require to restore its fine grain would reduce it to a size too small for the required tool, and the steel must be condemned as spoilt. Overheating in the fire is also the primary cause of cracking in the water. One of the principal reasons why a high quality of steel is required for certain purposes is that it will suffer less injury by being heated to a greater degree or by being heated and reheated a greater number of times than inferior qualities of steel. In heating steel the happy medium must be attained between heating it too much or too little, and between letting it lie too long "soaking" in the fire, and not "soaking" it through. Both the degree of temperature and the duration of the heat must be carefully watched.

Some tools, such as circular cutters, files, &c., after they are forged into the shape required, must have teeth cut into them. Before this can be successfully accomplished a preliminary process has to be gone through. The process of hammering, or forging the steel into the shape required, has hardened it to such an extent as to make the cutting of teeth into it impossible or difficult, and it must consequently be annealed. This process consists in reheating the steel as carefully as before, and afterwards allowing it to cool as slowly as possible. Many tools are only required to be hardened on a small part of their surface, and it is important that the unhardened parts should possess the maximum amount of toughness, the minimum amount of brittleness, that can be attained. The process of annealing, or slow cooling, leaves the steel coarse-grained, gives it its maximum of ductility, and causes it, in fact, to approach in its properties those of lead.

The last process in the manufacture of articles made of steel, where the invaluable property which distinguishes steel from wrought iron or cast metal is revealed, is the double process of hardening and tempering, by which we suddenly change the steel from lead into glass, and afterwards gently change the glass into whalebone. In these, as in all other processes which steel has to undergo, it has again to run the gauntlet of fire. It does so, however, at much greater risk than heretofore. The forging of the tool is finished; it has taken the final shape to which it was destined; and any injury which may be done to it by overheating is irrevocable, and can no longer be cured or mitigated by the hammer. It is necessary, therefore, to double and redouble the care bestowed upon the heating of the steel, lest the temperature be raised beyond the point necessary to secure the required hardness. The part of the steel required to be hardened must be heated through and heated evenly, but must on no account be overheated. The tool must be finished at one blow, the blow caused by the sudden contraction of the steel produced by its sudden cooling in the water, and if this blow be not sufficient to give to the steel a fine grain and a silky texture, if after the blow is given the fracture (were the tool broken in the hardened part) would show a coarse grain and dull colour, instead of a fine grain and glossy lustre, the tool is spoiled, the labour bestowed upon it is thrown away, and it must be consigned to the limbo of "wasters." The special dangers to be avoided in hardening each kind of tool must be learned by experience. Some tools will warp, or "skeller" as we say in Yorkshire, if they are not plunged into the water in a certain way. Tools of one shape must cut the water like a knife, those of another shape must stab it like a dagger. Some tools must be hardened in a saturated solution of salt, the older the better; whilst others are best hardened under a stream of running water. Most tools have a tendency to water-crack if taken out of the water before they are absolutely cold. Where the edge of a tool only is hardened, care should be taken to move it up and down in the water, so as continually to change the water level lest the tool should crack at the water level. Steel contracts in hardening, and contracts differently where it is cooled suddenly from the places where it is cooled slowly. If the hardened part joins the unhardened part too suddenly, the steel at the junction will be in a dangerous condition of tension, which predisposes it to crack, and it is wise to lessen the amount of tension by distributing it over as great an area as possible. In some tools, where the shape necessitates a great difference in the rapidity of the cooling of the various parts, it is often wise to drill holes in the thicker parts, where they will not interfere with the use of the tool—holes which are made neither for use nor ornament, but solely with a view of equalising the rapidity of the cooling of the various parts, so as to distribute the area of tension, and thus lessen the risk of cracking in hardening. So many causes may produce water cracks that it is often difficult to point out the precise cause in any given case. The most common cause is the overheating of the steel in one or other of the various processes through which it has to pass. A second cause may be found in the over-melting or too long boiling of the steel, causing it to part with too much of its occluded carbonic acid, a fault which may be attributed to the anxiety of the manufacturer to escape honeycombs in the ingot. A third cause may sometimes be discovered in the addition of too much manganese, added with the same motive. A fourth cause may, curiously enough, prove to be a deficiency of carbon, one of the most common causes of water-cracking in files; whilst in some cases too much carbon will produce the same effect. A fifth cause may be one which, as a steel manufacturer, I ought to mention in a whisper—the presence of phosphorus in the steel; but, after all, this may not be the fault of a too greedy manufacturer, who wants to make too much profit; it may possibly be the fault of a too stingy consumer, who will not pay a price sufficient to admit of a good quality of iron being used. There is nothing so dear as cheap steel. It must be more economical to put five shillings worth of labour upon steel that costs a shilling, to produce a tool that will last a week, than to put the same value of labour upon steel that costs only ninepence, to produce a tool that will only last a day. The system adopted by some large consumers of buying best tool steel by tender, is one which in too many cases defeats the object for which it was instituted, and by lessening the price, and consequently deteriorating the quality, causes the steel bill to be apparently lessened at the cost of the labour bill, so that extravagance instead of economy is the result. In fact, it is an illustration of the proverb about being "penny wise and pound foolish." Scores of firms in the steel trade habitually offer best cast steel at prices varying from 40*l.* to 45*l.* a ton. The statement that the steel supplied is the best that can be made, may be accurately described as an ugly little word of three letters, and the firms which make it are liable to be suspected of "voluntary inaccuracy."

The culminating point in the manufacture of tools made from steel, the final process which gives to them their most valuable properties—properties possessed by no other metallic substance—is that of tempering. The steel was originally lead; the process of hardening has turned it into glass; but we do not want glass—it is too brittle; we want whalebone. An unhardened knife would bend like wrought iron; a knife hardened only would break like cast metal. We want the elasticity of the whalebone. Our knife must spring like—like what?—like steel. To attain this quality it must be tempered.

If a piece of hardened steel be heated slightly and then allowed to cool it becomes tempered. It suddenly changes from glass to whalebone, and in the process of changing its nature it fortunately changes its colour, so that the workman can judge by the colour which it has assumed the extent of the elasticity which it has acquired, and can then give to each tool the particular degree of temper which is most adapted to its special purpose. The various colours through which tempered steel successively passes are as follows: straw, gold, chocolate, purple, violet, and blue. Of course in passing from one colour to another, the steel passes through the intermediate colours. It really passes through an infinite series of colours, of which the six above mentioned are arbitrarily selected as convenient stages.

It must be borne in mind that the elasticity of tempered steel is acquired at the expense of its hardness. It is supposed that the maximum of elasticity and hardness combined is obtained by tempering down to a straw colour. In tempering steel, regard must be had to the quality most essential in the special tool to be tempered; for example, a turning tool is required to be very hard, and is generally taken hot enough out of the water to temper itself down to a degree so slight that no perceptible colour is apparent; whilst a spring is required to be very elastic, and may be tempered down to a blue.

Hardening in oil is a mode of treating steel which is of special value for certain tools, and appears to a certain extent to attain by one process the change from lead into whalebone without the passage through the intermediate glass stage. It is unfortunately not yet possible to give any scientific explanation of the change which takes place in the hardening and tempering of steel. All that chemists yet can do is to mystify their readers by writing unintelligibly about molecular rearrangement and crystalline transformation.

In speaking of the various foreign substances which are found in cast steel, I have confined myself for the most part to those which are supposed to be injurious to its quality; but, before I close my paper, a word or two must be said upon the various materials which are added to cast steel with the intention of improving it. If the steel manufacturers of Sheffield are not doctors of chemistry, they most of them practise as quacks. It has ever been a darling dream of the Sheffield steel-melter to discover some substance—some philosopher's stone—which will transmute common cast steel into best cast steel. The various substances used in the melting of cast steel, and supposed to have a chemical effect upon the material melted, are known by the technical name of "physic."

The most universally used of these is peroxide of manganese, mixed with a little ground charcoal.

Common salt, rock salt, salammoniac, chromate of potash, prussiate of potash, and even ground fluor spar and broken glass, form ingredients of the physic used by some steel-melters.

Manganese, either in the form of spiegeleisen or of ferro-manganese, is also largely used, and has a definite effect upon the steel. It prevents to a large extent the formation of honeycombs in the ingot, and increases the welding capacity of the steel; it gives the steel greater tenacity when hot, so that it may be heated to a greater heat without cracking under the blow of the hammer or the tension of the rolls; but it must be very cautiously used, as it undoubtedly increases the brittleness of the steel, and its tendency to water-crack, if it be added in the melting pot instead of being previously suffused through the iron.

Silicon is even more dangerous; it causes the steel to crystallise in smaller crystals; it materially assists its capacity to receive a high polish; it increases its soundness, but makes it more brittle.

Wolfram or tungsten, added in the form of a metallic alloy, is used to a considerable extent in the manufacture of a special steel, sometimes called Mushet steel, which is frequently made so hard that it does not require to be hardened. It is used principally for turning tools, which, in consequence of the temper of the steel not being liable to injury by heat, can be driven at a higher speed than usual. Special steel of this kind is the finest-grained that can be produced, but is so brittle that it can only be used by exceptionally skilled workmen.

Chromium is sometimes used instead of wolfram; and it is said that titanium is also employed, but I am not aware that any of the latter metal has yet been detected in steel by chemical analysis.

A special steel for taps, called mild centred cast steel, is made by converting a cogged ingot of mild cast steel so that the additional carbon only penetrates a short distance. These bars are afterwards hammered or rolled down to the size required, and have the advantage of possessing a hard surface without losing the toughness of the mild centre.

It is much to be regretted that no easy method of testing cast steel has been invented. The amount of breaking strain, and the extent of the contractions of the area of fracture, give valuable information respecting iron or steel which is not hardened, and is not required to be used in a hardened state, but for hardened and tempered steel they are practically useless. It is very difficult to harden and temper two pieces of steel to exactly the same degree. A single test is of comparatively small value, as a second-rate quality of steel may stand very well the first time that it is hardened, but deteriorates much more rapidly every time it is rehardened than is the case with steel of a high quality. Nor is the breaking strain a fair test of the quality of cast steel. For many tools the capacity to withstand a high amount of breaking strain, slowly applied, is not so much required as its capacity to withstand a sudden shock. The appearance of the fracture of cast steel is also very illusory. The fineness of the grain, and the silkiness of the gloss, are very captivating to the eye, but can be produced by hammering the bar until it is almost cold. The consumer of steel may be enraptured, if he be of a poetical turn of mind, by the superb fracture of a bar of steel, reminding him of a picture by Ruskin of the aiguille structure of the higher Alps. But, after all, this is only a dodge, depending upon the inclination of the axis of the revolving hammer to the plane of the anvil. The practical consumer of steel must descend from the heights of art and science, and take refuge in the commonplace of the rule of thumb, and buy the steel which he finds by experience to be full of "nature and body."

If I have been successful in my attempt to explain the art and mystery of crucible cast steelmaking, you will have understood that the converting, melting, and forging of steel are three arts, each of which requires as much dexterity as the arts of skating, riding, or swimming. To arrive at perfection in these arts is difficult to those who do not inherit from skilled ancestors the facility to learn them; hence the trade has become localised in a few centres, of which Sheffield is the oldest and by far the most important. The arts of forging, hardening, and tempering which are necessary for the further manipulation of the steel after it leaves the hands of the manufacturer in Sheffield, require equal dexterity, so that the art of steelmaking, if not mysterious, is very complicated. The real mystery lies in the chemical explanation of the effects produced, and when chemists have explained the phenomena of hardening and tempering steel, they may possibly discover why cast steel made from Dannemora iron is superior to the imitations of it. At present I presume that the candid chemist must admit that there are more things in the best crucible cast steel than are dreamt of in his philosophy.

Gas at Melbourne.—At the half-yearly meeting of the Melbourne Gas Company, a dividend of 6½ per cent. was declared, and 7500*l.* was carried to the reserve fund.

Illawarra Railway.—Tenders have been opened at the New South Wales Department of Public Works for the construction of section No. 2 of the Illawarra Railway, which includes about twelve miles of Messrs. C. and E. Miller's abandoned contract. Ten tenders were received, the lowest being that of Messrs. Rowe and Smith, 440,218*l.* 15*s.* The second section of the railway commences from about George's River, and ends near Coal Cliff. Its length is 20½ miles, and by reason of the extensive nature of the tunnels and earthworks which will have to be carried out, the contract is one of the heaviest ever entered into in New South Wales. Nearly 1,000,000 yards of excavation will have to be made in cuttings, and no fewer than seven tunnels will have to be constructed. No. 1 tunnel, at a point 24¾ miles from Sydney will be 242 yards in length; No. 2, at 26½ miles, will be 418 yards; No. 3, at 27¼ miles, will be 26 yards; No. 4, at 27½ miles, will be 582 yards; No. 5, at 28½ miles, will be 89 yards; No. 6, at 29½ miles, will be 286 yards; and No. 7, at 31 miles, will be 1694 yards, or nearly a mile long. The 31st of July, 1885, has been fixed as the time for the completion of the work so far as the twenty-fourth mile peg, which is the easiest portion of the contract; and for the completion of the remaining part of the section, the date named is the 31st of December, 1887.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

Compiled by W. LLOYD WISE.

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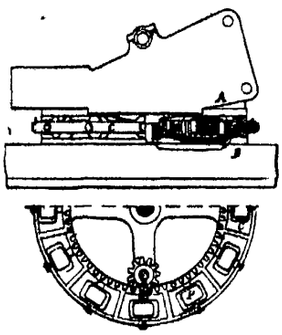
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Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

CRANES.

5282. M. J. Coles, London. Improvements in the Method of Revolving or Slewing Cranes. [4d. 2 *Figs.*] January 29, 1884.—This invention relates to that type of crane in which an upper bed has a rotary motion relatively to a lower non-rotating bed, and consists in placing between the upper and lower beds a live ring having attached to it a circular rack into which the slewing pinion of the crane gears. As shown in the figures, A is the upper or revolving bed, B the lower and non-revolving bed, C the live ring, D the slewing pinion, and E the teeth of the rack, F F being the rollers of the live ring. In Fig 1 part of the live ring is cut away to show the teeth of



the rack E and the slewing pinion D gearing into them. The live ring is formed as a frame and fitted with rollers resting on the lower bed of the crane, while the upper revolving bed rests on top of the rollers. Thus when the live ring is rotated the rollers in it also rotate by the friction of their underside on the lower bed, and at the same time the upper bed is caused to revolve by the friction between it and the upper surface of the rollers, and by the attachment of the rack to the live ring instead of to any immobile part of the crane the live ring and its rack are free to skid on the lower bed of the crane and so prevent any shock that might be caused by too suddenly stopping or starting the movement of the crane. (*Sealed May* 9, 1884).

6006. L. Richards, Dowlais. Improvements in Hydraulic Cranes. [6d. 3 *Figs.*] April 21, 1884.—The ram is fixed and the cylinder with its jib slides up and down as well as turning about the ram. The water passes into the cylinder through the body of the ram which has its lower and upper portions of different diameters so as to balance a portion of the weight of the cylinder, jib, and appendages, other rams arranged by the side of the main ram doing the work of lifting the crane and its load. The crane, through its centre piece, rotates on top of the cylinders of the secondary rams which are formed so as to carry suitable circular paths at their top and bottom ends which serve for two rings of rollers with a corresponding circular race provided upon the jib centre piece. (*Accepted September* 5, 1884).

DIFFERENTIAL PULLEYS.

2194. W. P. Thompson, Liverpool. (*G. Smith, New York, U.S.A.*) **Improvements in Differential Pulleys or Pulley Blocks.** [6d. 6 *Figs.*] February 12, 1884.—Suitable side plates sustain the axles of an upper and lower sheave, and are connected with any ordinary suspending device. The upper and lower sheaves are each provided with grooves to accommodate the rope, and each have two sections, one of larger diameter than the other, and both sections move together. The relative size of the two sheaves (each considered as a whole) may vary to any desired extent, but the diameters of the two sections of the two sheaves must bear the same relative proportions one to the other. There is one more groove in each of the sections of the upper sheave than in the corresponding sections of the lower sheave, and the rope, a continuous one, is supplied with a fall block and hook of any convenient description. (*Sealed May* 20, 1884).

ROCK DRILLS.

2852. T. W. Acquith and R. H. Crosby, Seaton Delaval, Northumberland. Improvements in Apparatus for Drilling Holes in Coal and other Minerals. [6d. 6 *Figs.*] January 29, 1884.—The standard consists of a pair of tubular telescopic legs which are connected together and adjusted in position by clamping screws; the ends are braced together by crossbars, at the top and bottom, provided with means for fixing them firmly to the floor and roof. The gear for transmitting motion to the screwed drill spindle is mounted in a chest formed of a pair of cheek plates adapted to embrace the telescopic legs and be movable upon them. The screw box or nut is made in two parts jointed together and placed upon two studs or pins projecting from the front side of the chest. The box when opened allows the screw to be drawn quickly back, so avoiding the necessity of unscrewing. The drill consists of a relatively short and small advancing spiral and two following cutters each having a forward part oblique to the axis of the drill and a following part parallel thereto. These are followed by a twist portion and the usual square tang. (*Sealed June* 27, 1884).

5038. W. J. Allison, London. (*F. A. Halsey, New York, U.S.A.*) **Improvements in Steam Rock Drills.** [8d. 11 *Figs.*] March 11, 1884.—The objects are to prevent the introduction of steam, and consequent forward cushioning of the piston when the drill is working at its longest stroke, to use the steam expansively, and to confine in the upper end of the cylinder a certain amount of residual steam, after the exhaust has taken place, which serves to cushion the piston on its instroke, and by its re-expansion assists in propelling it in its working stroke. The cushioning of the piston in its forward stroke is obviated by making the steam passage, by means of which the valve is shifted, to admit steam to the cylinder to effect the return stroke of the piston, of small area. Combined with the restricted steam passage is the inlet port, governed by the piston, and so located that the steam is cut off by the piston before it reaches the limits of its downward or working stroke; similarly the exhaust port of the upper end of the cylinder is so located and arranged that it is closed by the return stroke of the piston soon after its commencement, the steam being thus confined until the piston makes both its upward and downward strokes, and again opens the exhaust port. (*Sealed June* 20, 1884.)

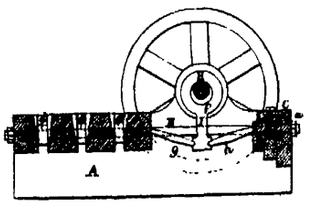
EXCAVATORS.

4619. J. E. McKee, San Francisco, U.S.A. Improvements in Excavating Apparatus. [6d. 4 *Figs.*] March 13, 1884.—The excavator consists of a series of ploughs supported and arranged so as to be driven in a circular path by means of a vertical shaft operating at the front of the dredge boat. The material turned up by the ploughs is thrown inward towards the centre, from which point it is taken out by means of a suction pipe connected with a rotary pump, and is discharged by the latter into an inclined pipe by which it is conveyed to the point of deposit. (*Sealed June* 20, 1884).

STONE BREAKERS.

5066. W. H. Baxter, Leeds. Improvements in Stone Breaking and Ore-Crushing Machines. [6d 4 *Figs.*] March 17, 1884.—The machine comprises a suitable framework on which is mounted a shaft provided with an eccentric to which is fitted an arm carrying the crushing jaw. In front of the jaw and between the framework is mounted a grooved or fluted roller which is caused to revolve whilst the eccentric on the shaft actuates the arm carrying the jaw. The toggle is of the ordinary form and the material is fed through a hopper between the jaw and roller. (*Sealed June* 24, 1884)

5662. W. R. Lake, London. (*T. A. Blake, New Haven, Conn., U.S.A.*) **Improvements in Machines for Breaking or Crushing Stone, Ore, and Similar Materials.** [6d. 4 *Figs.*] March 18, 1884.—The invention consists in arranging a series of jaws on guides so as to move in a horizontal plane, the spaces between the faces of the adjacent jaws forming a mouth to receive the material to be crushed. The illustration is a sectional side view showing the machine provided with one fixed jaw to produce the resistance. The bed of the machine A has running longitudinally above it from end to end two parallel rods B B. Outside the rear end C a nut *a* is applied to each of the rods, which at their other ends run through the fixed jaw D, a like nut *b* being on these ends of the rods. The sliding jaws E, F, and G slide freely on the rods as guides, and have the adjacent faces of



their end portions parallel and so arranged as to leave a small space between these faces. Springs, preferably india-rubber collars *d*, are placed between the faces to force the jaws rearward to their normal position. The central portions of the adjacent faces of the jaws are reduced so as to form suitably prepared converging cutting faces *e*. Power is applied to the rearmost jaw G by an eccentric *f* on the driving shaft H operating a two-bar toggle *g h*, the forward end of the bar *g* taking its bearing on the back of the jaw G, the rear end of the bar *h* taking its bearing on a stationary seat *i*; the adjacent ends of the two bars take their seat on opposite sides of the toggle block *l*, from which a connecting rod I extends to the eccentric, which latter imparts a reciprocating motion to the toggle block. Instead of producing the resistance by a fixed jaw, power may be applied at both ends of the series of jaws by duplicating the toggle arrangement. (*Sealed September* 16, 1884).

7560. C. Dalton, Leeds. Improvements in Machines for Crushing Stones, Ores, and other Hard and Brittle Substances. [8d. 4 *Figs.*] May 10, 1884.—The fixed jaw faces are made in three parts, each arranged to slope forward from the top to the bottom, so that the bottom of one overlaps the top of the next. Motion is imparted to the two toggle pieces by a head or boss toothed on its front and back faces so as to represent the segments of a spurwheel, and the toggle ends are toothed to correspond with these segments, and the parts are so set as to give a knapping motion to the movable jaws. (*Sealed September* 16, 1884).

SLOTTING MACHINES.

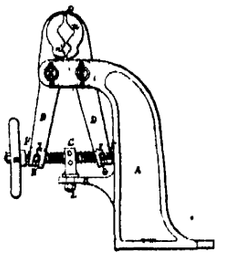
5671. E. P. Alexander, London. (*C Weitmann, Stuttgart*). **Improvements in Slotting and Shaping Machines.** [6d. 4 *Figs.*] March 20, 1884.—The machine is a portable one, and so arranged that the piece of work to be operated upon can be chucked or fixed upon the outside of a face-plate by a forked holder or clamp passing through the interior of the bore to be slotted, hence the diameter of the wheel, or other such-like article, does not affect the applicability of the machine. The tool consists of a combination of a slide bed adjustable to any required inclination, a rack device driven by gearing, a slide having a pivotted tool carrier, and a longitudinally reciprocating inclined or wedge-piece adjustably connected with the rack. The clamping device consists of a forked holder passing through the bore of the work to be operated upon, and carrying a tightening screw for pressing a thrust or stirrup piece against the outer face of the work to be operated upon. (*Sealed August* 29, 1884).

SCREWING MACHINES.

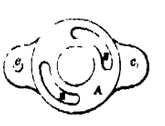
6987. W. Jenkins, Wednesbury, Staffs. Improvements in Screwing Machines. [6d. 6 *Figs.*] March 10, 1884.—The machine is designed for simultaneously cutting three screw threads in tube fittings or other similar articles, and is provided with guide screws by which the taps are forced into the fittings. The spindles carrying the taps are adjustable by means of handwheels and nuts to suit the different lengths of taps and size of fittings to be operated upon. An adjustable bolt permits of the depth of the thread being regulated, and a catch, in combination with this bolt, automatically stops the machine when the depth of thread for which it has been set is reached. Reversing is effected by a disc and wormwheel in combination with a weighted lever and a belt striking shaft. (*Sealed June* 20, 1884).

VICES.

610. W Devoll, Birmingham. Improvements in Tube Vices. [6d. 5 *Figs.*] January 4, 1884.—To obtain a quick and powerful motion, the inventor constructs his vice as shown in the illustration. A suitable frame A carries two levers D D pivoted about the bolts E E, and having at their lower ends jaws F F, in each of which is fitted a nut G having on it two projections H H, which fit into and are free to slide in the slot holes I of the levers. A screw J fitted with a handwheel *m* has on one part of



its length a right hand, and on the other part a left hand thread, and passes through the nuts G G which are correspondingly threaded. This screw is held at its centre by two small pins which pass through the bearing C, and a groove turned in the screw. The bearing is supported by a bracket K to which it is secured by a nut L. The levers are provided at their upper portions with suitable angular toothed jaws *n* and *n*¹, and surmounting these with parallel toothed vice jaws *o*. In a later Specification (6276 of April 12, 1884 4d 3 *Figs*) the same inventor shows a method of swivelling the above vices by means of the radial plate illustrated herewith. The radial plate A is formed with suitable slots B B



through which pass two bolts serving to secure the suitably modified frame A (shown in the previous figure) to the radial plate. Holding down bolts pass through the holes C C. (*The former patent was sealed April* 29, 1884, *and the latter accepted September* 2, 1884).

EXPANDING MANDREL.

9440. J. Timmins, Barrow-in-Furness. An Improved Expanding Mandrel. [4d. 14 *Figs.*] January 31, 1884.—The mandrel consists of four tapered steel sliding wedges, traversing on a steel spindle having four suitable taper grooves to carry the wedges. The wedges are retained in position by a steel sliding sleeve having four slot holes, through which part of the wedges project. The sleeve and wedges are actuated by two steel box nuts traversing the screwed parts of the spindle which is threaded at both ends. (*Sealed July* 11, 1884).

GASFITTER'S TOOL.

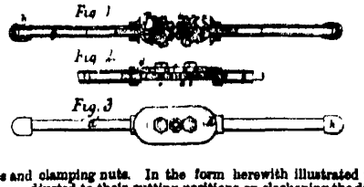
2132. G. Plumpton, Warrington. A New or Improved Combination Tool for Use by Gasfitters and others. [6d. 9 *Figs.*] January 25, 1884.—The gas and cutting pliers are by additions made applicable as screwdrivers, pipe openers, screwing plate, rhymers, and screw tap. A solid screw die is inserted between the handles, and as near the point as possible, by widening out the handles, and forming a square hole in each of them, into which take two corresponding projections formed on the sides of the die. On removing the die a rhymer having suitable square shanks, can be inserted between the handles. Adjustable dies may be used by suitably forming the inner sides of the handles and placing the ends of a crossbar, provided with a central setting screw, in the square holes. (*Accepted September* 9, 1884).

METAL WORKER'S TOOL.

9432. E. M. Eckardt, Dresden. A Universal Machine Tool for Coppersmiths, Metal Workers, and others. [6d. 12 *Figs.*] June 26, 1884.—The machine is applicable for the purposes of bending, boring, pressing, forming, cutting, grinding, or polishing bars, rods, staves, or plates of metal. The machine consists of a bedplate having suitable devices for securing or shaping the work, and provided with a spindle to which certain tools can be attached. (*Accepted September* 2, 1884).

STOCKS AND DIES.

5661. J. C. Bauer, London. Improvements in Stocks and Dies. [6d. 9 *Figs.*] March 17, 1884.—The object is to combine in one tool an entire set of stocks and dies with a simple means of adjusting them. In its simplest form two discs are employed turning on pivots, one of which is eccentric, in another form both discs turn on concentric pivots, in each of these the discs after being adjusted are clamped in place by suita le side



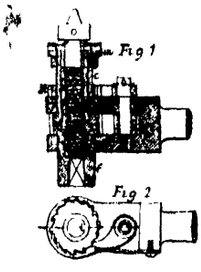
plates and clamping nuts. In the form herewith illustrated the dies are adjusted to their cutting positions on slackening the discs *a a*¹, by turning the screw *e*, and the nut of the screw *e*¹, the required pair of dies *c* are then brought into position by turning the discs *a a*¹, which are then again clamped after the dies have been brought up to their cutting position by the crutch-shaped ends of the rods *g g*. These rods slide within the handles *d*¹ *d*¹ and are

operated by the screw caps A A, the holes in the plate d, in which the pivots b and b' have their bearing, are elongated to allow of the lateral movement of the discs a and a^1. The pipe or other article to be threaded passes through holes f in the plates d d. (*Accepted September* 2, 1884).

RATCHET BRACES.

9014. E. Godfrey and E. Garratt, Sheffield. Improvements in Ratchet Braces. [*4d.* 5 *Figs.*]—The body of the brace is made with an opening to receive and inclose the ratchet wheel. This opening is made somewhat larger than the ratchet wheel and has cut on its inside surface, at a part diametrically opposite the handle, one or more (preferably four) teeth, corresponding with those on the ratchet wheel, and into which they are drawn and withdrawn by the action of the handle when the reciprocating motion is imparted to it by the operator. In a modification a spring slide, bearing on the ratchet wheel, is used to keep the teeth in gear, or the teeth may be formed upon a separate piece of metal and let into a recess formed in the body, and which piece may be either stationary or movable by means of a spring (*Sealed August* 26, 1884).

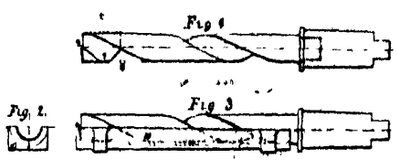
10,151. C. Schumacher, Cologne. Improvements in Ratchet Braces. [*4d.* 6 *Figs.*] July 15, 1884.—The object is to render the feed motion of the drill more minutely variable. The figures show respectively an axial section and a plan of the drill, which comprises a lever d, an internally screw threaded drill-holder f, a screw spindle g, a feed motion sleeve c, and two ratchet wheels, one of which has a tooth more than the other. A third ratchet wheel k may be keyed on the upper part of the sleeve c, this wheel having one or more teeth less than the wheels on the lower part of the sleeve, and the inventor states that "the feed motion obtained by means of these different wheels is invariable within the limits determined by the difference in the number of the teeth of the wheels, and the pitch of the



screw thread of the screw spindle g" The feed motion sleeve is divided into two parts A and c coupled by a third part m in such a manner that any excessive feed motion or turning of the sleeve c causes a sliding between the two coupled parts. The sleeve c is split lengthwise, and coupled with the sleeve A, which carries a feather piece for turning the spindle g, by means of a conically threaded screw cap n. The sleeve h thus turns the spindle g, provided that the nut m is sufficiently screwed down to produce the necessary pressure between the sleeve A and the sleeve c by the compression of the split part of the sleeve c. To reduce the feed motion the nut m is slackened, and the screw spindle g will then only be set in motion when the resistance of the drill is no longer sufficient to overcome the friction between the sleeves c and h (*Accepted August* 15, 1884).

DRILLS.

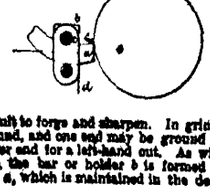
7867. A. Soderstrom, Stockholm. Improvements in Twist Drills. [*4d.* 7 *Figs.*] May 6, 1884.—The drills are provided, as shown in the illustration, Fig. 1, with only one single twist 1, which is made deep and wide so as to have a large section for the passage of the borings, and the cutting edges 2 of which radiate from the centre. The cutting edge at the bottom of the drill does not extend to the centre, hence it leaves at 3 a small central core unattacked by the drill, and which core corresponds with the depth of the hole bored. To prevent its being easily broken off, and also with a view of making a cleaner cut the point



4 of the cutting edge is rounded off. To insure the proper action of the drill, and also to prevent its being "forced" or sticking fast in the hole, the diameter is reduced from a certain point (6) at the bottom upwards, an untouched portion of the drill is left to serve as a guide, and a still further portion is made slightly tapering. In making large drills the stem, of an inferior quality of steel, has mounted on it an independent cutter 8 made of the best steel, and provided with a projection to maintain its rigidity whilst cutting. A cast-iron shell 10 (Figs. 2 and 3) is used in sharpening the drills. This corresponds exactly with the external form of the drill, and by smearing the surface with a colouring material it shows, by deficient contact when the drill is laid in it, the places to be rectified. (*Sealed August* 12, 1884).

CUTTING TOOL.

10,749. C. Mather, Manchester. An Improved Tool for Cutting Metal. [*4d.* 3 *Figs.*]—The tool is made of a semi-circular form, the inside or smaller circumference forming the cutting angle, which angle varies according to the distance of the cutting edge from the tool holder. This form of tool is preferred when the tool has to be made from any of the self-hardening steels



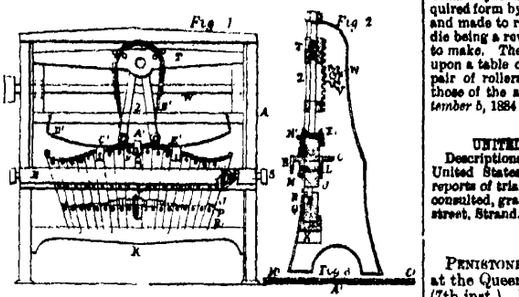
which are difficult to forge and sharpen. In grinding the tool the heel only is ground, and one end may be ground for a right-hand cut and the other end for a left-hand cut. As will be seen from the illustration the bar or holder b is formed with a groove to receive the tool a, which is maintained in the desired position by a plate c screwed to the holder b; d is the rest and e the shaft or other article being turned. (*Accepted September* 2, 1884).

SHEARS.

11,622. W. E. Godge, London. (*W. F. Wickenden, San Luis, Obispo, Cal., U.S.A.*) **Improvements in Shears.** [*4d.* 2 *Figs.*] August 7, 1884.—The shears are of the ordinary pattern having blades whose shanks are united by a spring, and are provided with a brace which holds the blades wide enough open to permit of their being conveniently ground. The brace consists of a pivotted rod sufficiently strong and of such a length that when extended transversely between the shanks it will hold the blades open by its conical head taking into a pocket in the opposite shank. (*Accepted September* 9, 1884).

SPRING FORMING MACHINE.

10,733. G. Norwood, Bridgeport, Conn., U.S.A. Improvements in Spring Bending and Forming Machines. [6*d.* 4 *Figs.*] July 29, 1884.—In this machine the former bars are readily adjustable to the desired contour of the spring, and are so arranged that any pressure on their upper extremities tends to bind them more closely together. In the illustrations the machine is shown by Fig. 1 in front elevation, of which Fig 2 is a central vertical section taken at the line a a. The platforms B C secured to the frame A, or cast integral therewith, are provided with elongated perforations to allow the free passage of the water used in cooling. The former bars J, arranged between the platforms B C with their lower extremities resting upon a crossbar K, are so constructed that the centre one only is in a plane at right angles to the crossbars, while the others have a regular progressive pitch, the sides of the bars being so arranged that adjacent bars are contiguous throughout their whole length, hence the centre bar becomes, as it were, the key, and to prevent its movement except in a vertical plane, the central bar is slotted longitudinally as at L, and a pin M, driven through the lower portions of the platforms B C, extends through the slot and maintains the bar in a vertical position. To facilitate adjustment in the direction of their length, the former bars are made in two sections, an upper and a lower one, the upper extremities of the former being adapted to conform to the contour of the spring.



These upper portions have a pin projection which fits into a recess in the lower section, and therein abuts against a coiled spring Q, the set screws R serve to maintain the upper portions in any desired position. Clamping screws S hold all the bars firmly together as against any lateral displacement. The inside upper portion of the frame A receives a sliding carrier T, racked at its inner side. Motion is imparted to the carrier in a vertical plane by pinions V, arranged on the driving shaft W, and engaging with the rack U, the shaft is also provided at one extremity with a driving pulley X which is connected to any suitable reversing mechanism by belt or otherwise. The presser bars Z, within the lower extremities of which are journalled rolls A^1, are pivotted to the upper part of the carrier, and are held together by springs B^1. The strip D of thin metal connected at its extremities to the carrier frame by coiled springs D^1, serves to prevent any track or mark being left on the surface of the spring. This strip also serves by means of perforations M^1 and channel N^1 to convey the water for cooling the springs during the process of manufacture. The jaws E are adapted to be attached to the extreme ends of the former bars by a bolt F^1. A rubber washer G is placed over the bolt and next to one of the jaws, which are clamped against the former bars by a nut H^1. The set screws I^1 extend through the lower extremities of the jaws and bear against the bars. By these means the jaws are allowed to yield in order to accommodate springs of only slightly varying widths. Clips J^1, formed with forked projections K^1 L^1, the former adapted to be inserted within the bars and the latter of a spring nature, exerting a downward pressure against the spring proper, are placed at the extreme ends of the spring in order to hold it securely at those points while being bent and formed. (*Accepted August* 2, 1884).

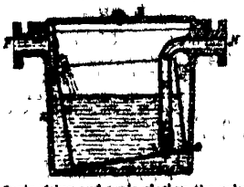
OIL CANS.

1469. J. Hesselwood, Leeds. Improvements in the Construction of Oil Cans. [*4d.* 2 *Figs.*] January 15, 1884.—In vertical oil cans feeding holes are provided, so constructed as to allow of the oil being seen some time before the can is filled to overflowing, and having covers so arranged as to allow any drops of oil that may run down the spout to enter the feeding cup, and thus save the oil and keep the body of the can clean. The feed hole is formed as a concave opening or cup having a boss projecting inwards, into which is screwed a tube forming part of the cover. The latter has a flange which fits on top of the cup, thus forming a double joint with the cup between. The cover is perforated to convey any waste oil into the cup. (*Sealed April* 23, 1884).

8729. J. and H. Lucas, Birmingham. An Improved Oil Can. [*4d.* 1 *Fig.*] February 22, 1884.—A spiral spring is placed within oil cans of the type commonly known as "flop" oil cans, so as to distend the sides to their normal or bulging condition after the removal of the pressure necessary to eject the liquid. (*Sealed June* 13, 1884).

STEAM TRAPS.

3627. G. G. Pidding and W. Hopkins, London. Improvements in Steam Traps. [*6d.* 3 *Figs.*] February 6, 1884.—The object is to increase the certainty of action by arranging a float inside the chamber to work on a fulcrum and so gain extra power by the leverage to open or close the discharge pipe against any pressure of steam. In the illustration the outer box or chamber A has bolted on to it a lid B, and has placed within it a float C, free to move about the fulcrum by trunnions D, which fit into recesses in the outer box. The discharge pipe E is attached at its upper end to the outer box. The water entering at F fills the outer space G until it runs over into the float C and causes it to sink; this uncovers the end of the pipe E by drawing down the valve I, and the pressure of steam then acting on the surface of the water contained in the float forces the water up the pipe E and through the outlet H, until sufficient water is blown out to



permit of the float rising and again closing the valve. (*Accepted August* 5, 1884).

SOCKETS FOR SHAFTS OF TOOLS.

1365. T. Brown, Sheffield. Improvements in and Connected with the Construction and Manufacture of Sockets or Hoops for Pick Shafts and other Similar Tools. [*4d.* 9 *Figs.*] January 11, 1884.—The hoops or sockets are made from strips of steel so constructed that the parts subjected to the greatest strain are made thicker than the other parts. This is accomplished by making the sockets from double tapered strips from which blanks of special form, having four projections, are punched. The blanks are folded over end to end to form the body of the socket, and the projections are folded one over the other to form two eyes or slots in which the blade is secured. The part of the blank between the projections, or the projections and that part of the blank inclosed between them is thicker than the remaining parts. (*Sealed April* 12, 1884).

FORMING MACHINE.

10,477. J. Maxfield, Sheffield. Improvements in the Moulding or Shaping of Seamless Wrought-Metal Knobs, Cups, Cans, Vases, and similar Articles. [*4d.* 7 *Figs.*] July 23, 1884.—The cups made in the usual way from a sufficiently ductile metal are brought to the required form by means of a roller fixed on the end of a lathe spindle, and made to rotate in close proximity to a non-rotating die, such die being a reverse section of the form of the article it is intended to make. The die is fixed immediately under the rotating roller upon a table capable of vertical and horizontal adjustment. Or a pair of rollers may be used whose outlines are the reverse of those of the article they are intended to form. (*Accepted September* 5, 1884

UNITED STATES PATENTS AND PATENT PRACTICE.

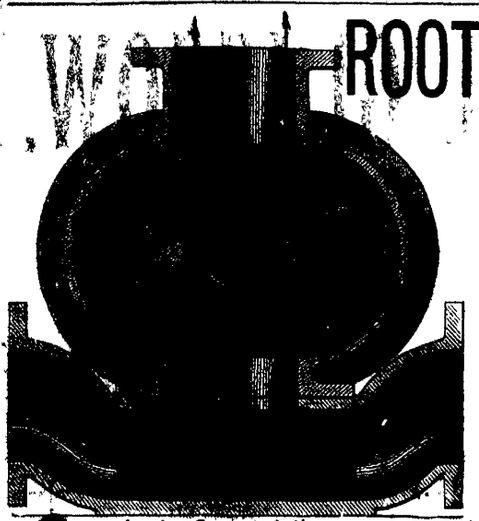
Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

PENISTONE ACCIDENT.—The friends and sufferers met at the Queen's Hotel, Manchester, on Tuesday morning (7th inst.). It was resolved that a test action be tried, the amount for legal costs being nearly raised in the room.

THE BLOCK SYSTEM.—On Sunday last (5th inst.) the new universal or clearing-house block system, came into operation on the North-Western, Midland, and other railways. The change of regulations is necessarily inconvenient and requires extra care on the part of the signalmen. The universal code is the result of the Canonbury Tunnel accident.

COAL IN THE PAS-DE-CALAIS.—The quantity of coal raised in the Pas de-Calais in 1883 was 6,150,801 tons, as compared with 5,706,390 tons in 1882, and 5,326,390 tons in 1881. The stocks of coal on hand in the department at the close of 1882 were 43,169 tons; at the close of 1883 they had increased to 62,614 tons. As regards the sales of coal effected last year 1,202,208 tons were disposed of in the Pas-de Calais itself, 1,746,813 tons went into the department of the Nord, and 2,644,423 tons into other French departments, while 51,019 tons went abroad.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.—The ordinary monthly meeting was held at the Cannon-street Hotel on Saturday. Mr. Rea and Mr. Thorburn respectively filled the chair and deputy chair, and there was a fair attendance of members and friends. It was announced, after the reading of minutes, &c., that two only of the associated foremen were unemployed, namely, one of boiler-makers and one of pattern-makers. Mr. Meredith Jones—late treasurer—next claimed to be placed on the superannuation fund for the benefit of aged and necessitous members, and the application was agreed to *nem. con.* Other matters of business were transacted, and then Mr. John Lewthwaite read a paper on his "Improved, or 'Regis' Method of Manufacturing Iron and Steel." The author disclaimed any great scientific attainments, and after some preliminary remarks as to "what formed the basic process," proceeded to describe his own. He said that he selected iron of one, two, or more brands and melted it in a common puddling or reverberatory furnace, taking care that the melting was complete. He then threw upon the molten metal, as gradually and equally as possible, certain mineral ores in a finely disintegrated condition, as in the case of the New Zealand titanic sand, and in such proportions as he had determined by a long course of experiments to be the most efficacious. The effect was an electro-chemical combination by which the molten metal became much more fluid, its impurities were thrown off, and its quality and strength vastly improved. Mr. Lewthwaite exhibited a number of specimens of metal resulting from his process, and these, handed round, were regarded with critical interest by the practical gentlemen present. A discussion followed, and this was joined in by Messrs. Barth, Comrie, Rea, J. Newton, and others. Finally, a vote of thanks was unanimously passed to the reader of the paper.



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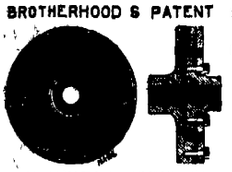
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BROTHERHOOD'S PATENT

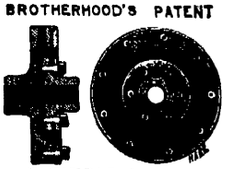


FLEXIBLE COUPLING

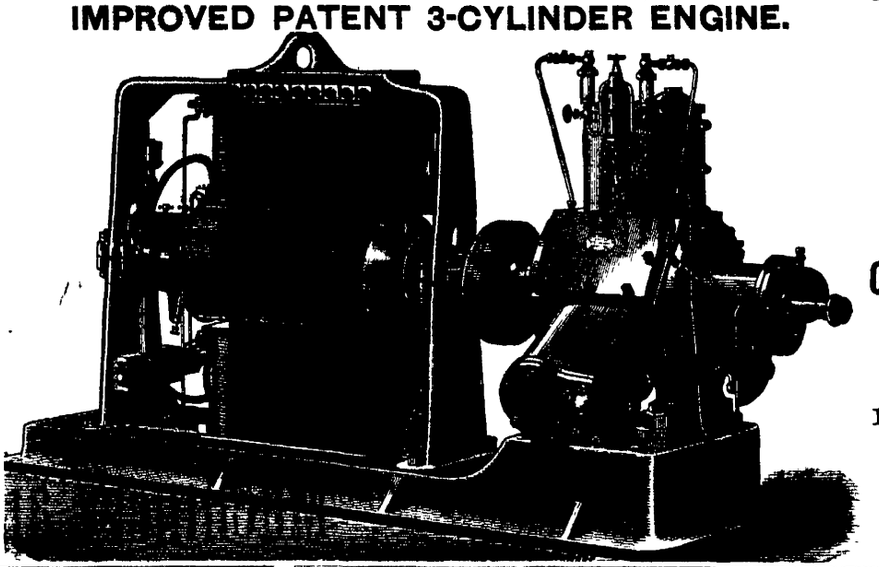
PETER BROTHERHOOD,

MECHANICAL ENGINEER,
BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.
IMPROVED PATENT 3-CYLINDER ENGINE.

BROTHERHOOD'S PATENT



FLEXIBLE COUPLING



THE MOST
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AND
EFFECTIVE
FOR
SHIP LIGHTING
As in General Use in the British, French, Italian, Danish, &c., &c., Navies.

FOR DRIVING
FANS,
CENTRIFUGAL PUMPS,
AND OTHER
HIGH-SPEED
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AS APPLIED FOR GRAVING DOCKS.





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LIGHT DRAUGHT STEAMERS
AND
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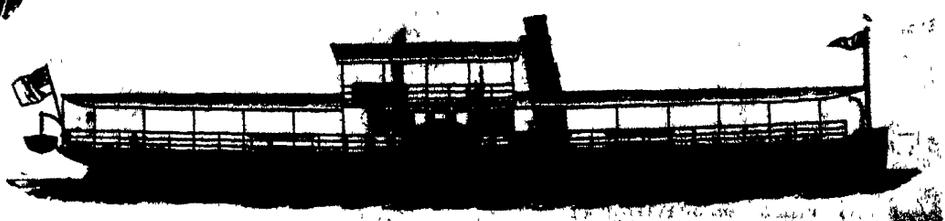
Tug Steamer, 80 ft. by 11 ft. by 6 ft. 6 in. 80 I. HP. Constructed 1884.

WE SEND ESTIMATES ON RECEIPT OF PARTICULARS AS TO SERVICE, DRAUGHT, SPEED, PASSENGER AND CARGO CAPACITY.

SPECIALLY CONSTRUCTED
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TANGYES' HYDRAULIC PRESS

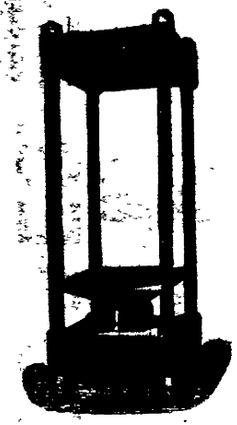


Fig. A.

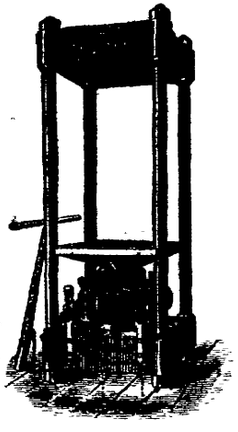
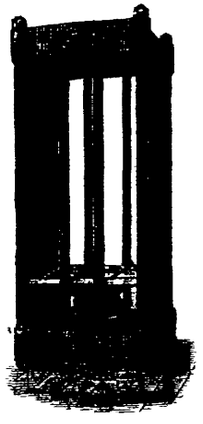


Fig. B.

Fig. A for Detached Hand or Steam Pumps
„ B has self-contained Cistern and Hand Power Pumps. 162

TANGYES' HYDRAULIC PRESS

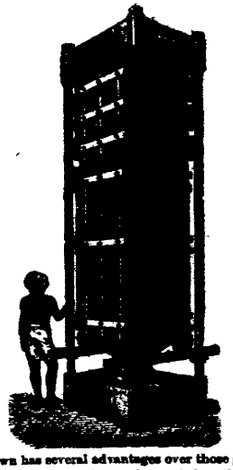
With Tee Iron Bars and Side Lining.



This Press is for Baling Wool, Hay, Grass, Hides, &c., &c. It can be made with Cistern in Base and pair of Hand Power Pumps, as shown Fig B., page 162. 164

TANGYES' HYDRAULIC PRESS

With Improved Portable Box.



The oak packing box shown has several advantages over those generally used:—

The three sides are firmly secured together, and one of them forms the back of top box. It can be run out clear of the Press even when doors are open. The hoops are arranged horizontally, and the fastenings are disengaged simultaneously by a single lever fig. back box. A spare bottom is supplied to each so that the box can be re-filled while the box is being hooped, thus saving time.

The Press can be made with Cistern in base and pair of Hand Power Pumps as shown, Fig. B., page 162. 166

TANGYES' HYDRAULIC PRESS

With or Without Pumps.

As illustrated on page 162.

No.	Diam. Ram	Rise Ram	Power	Distance between Table & Top when down	Distance between Pillars	Size of Table.	Price without Pumps	Price with Cistern in base and Pair Pumps
	Ins.	Ins.	Tons	Ins.	Ins.	Ins.	Fig. A.	Fig. B.
1	6	15	50	42	30 × 30	46 × 30	£46	£71
2	6	24	50	54	„ „	30 × 24	48	73
3	6	42	40	72	45½ × 37½	49½ × 41½	65	80
4	6	54	40	84	„ „	45 × 36	70	85
5	6	48	30	72	40½ × 40½	43½ × 43	60	85
6	7	15	80	42	30½ × 30½	46 × 30	56	91
7	7	36	70	60	36 × 27½	39½ × 30½	65	90
8	7	30	80	60	34 × 34	37½ × 34	60	85
9	7	48	70	72	66 × 30	70½ × 34	105	130
10	7	60	70	84	39 × 27	39 × 27	90	115
11	7	60	70	84	45½ × 30½	46 × 30	98	123
12	7	36	80	60	24½ × 22½	32½ × 30½	70	95
13	8	42	80	84	45 × 37	45 × 36	85	110
14	8	48	150	72	66 × 30	66 × 30	170	195
15	8	48	100	72	36 × 24	36 × 24	90	115
16	8	48	100	72	39 × 33	39 × 39	95	120
17	8	12	100	24	„ „	48 × 24	85	110
18	8	15	100	21	„ „	24 × 21	75	100
19	8	12	100	24	„ „	33 × 33	75	100
20	10	18	200	36	36 × 24	38 × 26	90	115
21	10	18	200	50	„ „	„ „	95	120
22	10	24	200	72	„ „	„ „	98	123
23	10	18	150	48	45½ × 30	49½ × 33½	95	120
24	10	66	175	84	„ „	„ „	130	155
25	10	120	150	123	„ „	41 × 17	180	205
26	10	20	200	64	43½ × 42½	48 × 42	130	155
27	10	108	200	125	„ „	41 × 17	230	255
28	10	36	200	72	„ „	50 × 42	160	185
29	10	36	200	72	„ „	64 × 42	165	190
30	10	54	150	72	72½ × 45½	96 × 48	205	230
31	10	48	200	72	56½ × 44½	61 × 49	155	180
32	10	84	150	108	66 × 30	66 × 30	205	230
33	12	54	200	84	84 × 50	89½ × 54½	245	270

163

TANGYES' HYDRAULIC PRESS

With Tee Iron Bars and Side Lining

As illustrated on page 164

No	Diam. Ram	Rise Ram	Power Tons	Distance between Table and top when down	Distance between Pillars	Size of Table	Price with Tee Iron Bars on all sides	Price with Cistern in Base and pair Pumps	If also with Plate Iron Lining on two sides. Extra
50	6 ins	36 ins	50	54 ins.	30 × 30 ins.	29 × 24 ins.	£60	£85	£5
51	6 „	42 „	50	60 „	36 × 24 „	35 × 24 „	70	95	7
52	6 „	48 „	40	72 „	45½ × 37½ „	44 × 30 „	78	103	9
53	7 „	54 „	80	72 „	30½ × 30½ „	29 × 24 „	90	115	8
54	7 „	54 „	70	72 „	36 × 27½ „	35 × 24 „	85	110	8
55	7 „	54 „	70	72 „	39 × 27 „	38 × 27 „	100	125	10
56	7 „	54 „	70	72 „	45½ × 30½ „	44 × 30 „	110	135	10
57	7 „	54 „	70	72 „	66 × 30 „	65 × 30 „	130	155	10
58	8 „	66 „	100	84 „	36 × 24 „	35 × 24 „	110	135	10
59	8 „	66 „	100	84 „	39 × 33 „	38 × 27 „	120	145	12
60	8 „	66 „	100	84 „	45 × 37 „	44 × 30 „	110	135	12
61	8 „	66 „	150	84 „	66 × 30 „	65 × 30 „	200	225	12
62	10 „	78 „	200	96 „	36 × 24 „	35 × 24 „	150	175	13
63	10 „	72 „	150	96 „	45½ × 30 „	44 × 30 „	155	180	16
64	10 „	84 „	200	108 „	56½ × 44½ „	54 × 36 „	200	225	15
65	10 „	84 „	150	108 „	66 × 30 „	65 × 30 „	230	255	

The Rise of Ram and the distance between Table and Head can be varied to meet special requirements. 165

TANGYES' HYDRAULIC PRESS

With Improved Portable Box

As illustrated on page 166.

No	Diam Ram	Rise Ram	Power	Distance between Table and Top when down	Distance between Pillars	Size of Table	Price Press minus pump	Price with cistern in base and pair pumps	Price box extra
			Tons						
80	6 ins.	48 ins.	50	72 ins.	30 × 30 ins.	30 × 18 ins.	£55	£70	£20
81	6 „	48 „	50	72 „	30 × 30 „	36 × 18 „	58	73	25
82	7 „	54 „	80	72 „	30½ × 30½ „	30 × 18 „	65	90	20
83	7 „	48 „	70	72 „	36 × 27½ „	36 × 24 „	67	82	25
84	7 „	66 „	80	84 „	30½ × 30½ „	36 × 18 „	70	98	27
85	7 „	60 „	70	84 „	36 × 27½ „	36 × 24 „	73	98	26
86	8 „	66 „	100	84 „	36 × 24 „	30 × 18 „	95	120	30
87	8 „	60 „	100	84 „	39 × 33 „	30 × 24 „	100	125	27
88	8 „	72 „	100	96 „	36 × 24 „	36 × 18 „	100	125	25
89	8 „	72 „	100	96 „	39 × 33 „	36 × 24 „	110	135	45
90	8 „	72 „	100	96 „	36 × 24 „	42 × 18 „	105	130	40
91	8 „	72 „	100	96 „	39 × 33 „	42 × 24 „	112	137	50
92	8 „	96 „	100	108 „	36 × 24 „	48 × 18 „	110	135	50
93	8 „	84 „	100	108 „	39 × 33 „	48 × 24 „	120	145	65
94	10 „	96 „	200	108 „	36 × 24 „	36 × 18 „	145	170	40
95	10 „	84 „	150	108 „	45½ × 30 „	36 × 24 „	135	160	50
96	10 „	120 „	200	138 „	36 × 24 „	41 × 17 „	165	190	60
97	10 „	102 „	200	120 „	36 × 24 „	42 × 18 „	150	175	50
98	10 „	84 „	150	108 „	45½ × 30 „	42 × 24 „	140	165	60
99	10 „	108 „	200	126 „	36 × 24 „	48 × 18 „	155	180	60
100	10 „	102 „	150	126 „	45½ × 30 „	48 × 24 „	155	180	75
101	10 „	102 „	150	126 „	45½ × 30 „	54 × 24 „	165	190	85
102	10 „	102 „	150	126 „	45½ × 30 „	60 × 30 „	170	195	110

The rise of Ram and distance between Table and Head can be varied to meet special requirements.

The Press can be made with Cistern in base and pair of Hand Power Pumps. 167

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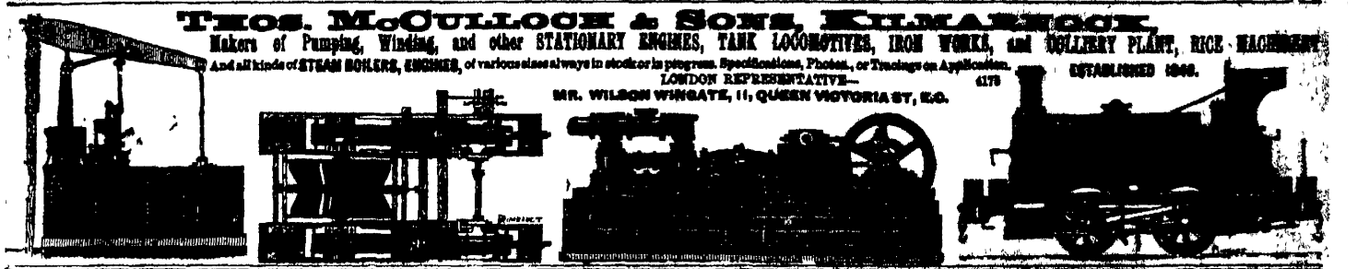
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Makers of Pumping, Winding, and other STATIONARY ENGINES, TANK LOCOMOTIVES, IRON WORKS, and COLLIERY PLANT, RICE MACHINERY

And all kinds of STEAM BOILERS, ENGINES, of various sizes always in stock or in progress. Specifications, Photos., or Tracings on Application. 4178

ESTABLISHED 1868.

LONDON REPRESENTATIVE—
MR. WILSON WINGATE, 11, QUEEN VICTORIA ST, E.C.



JOHN I. THORNYCROFT & CO.,

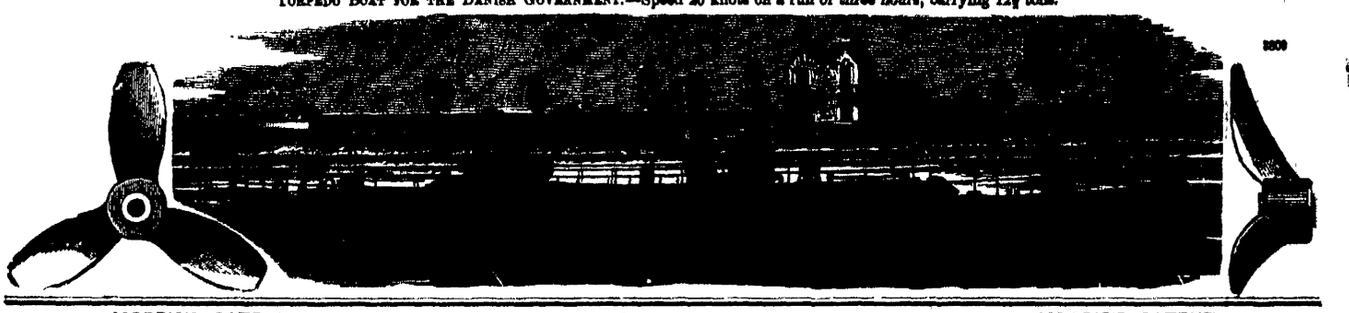
STEAM YACHT AND LAUNCH BUILDERS,

CHURCH WHARF, CHISWICK, LONDON, W.

YACHTS AND LAUNCHES FOR SEA OR RIVER SERVICE, from 25 to 100 feet in length, and Speeds from 10 to 25 Miles per Hour

Thornycroft's Patent Screw Propellers made for all sizes of Vessels. Efficiency superior to any hitherto brought out.

TORPEDO BOAT FOR THE DANISH GOVERNMENT.—Speed 20 knots on a run of three hours, carrying 12¼ tons.



MORRIS'S PATENT

INSTANTANEOUS HOSE COUPLING.



SIMPLEST AND QUICKEST IN THE WORLD.

Used by all the leading Fire Brigades in Europe

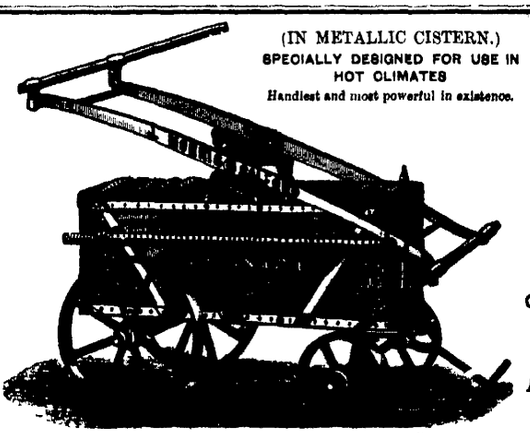
OVER 60,000 SUPPLIED.

HAND POWER FIRE ENGINES of all kinds and sizes, suitable for every climate.

(IN METALLIC CISTERN.)

SPECIALLY DESIGNED FOR USE IN HOT CLIMATES

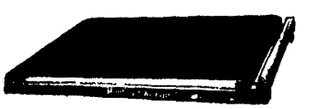
Handiest and most powerful in existence.



MORRIS'S PATENT

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SPRING MATTRESS.



TO FIX ON ANY KIND OF BEDSTEAD.



FOLDED FOR EXPORT.

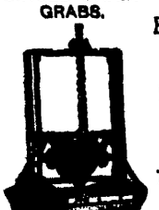
Only Spring Mattress with a Smooth Surface.

NEVER GETS OUT OF ORDER.
NEVER NEEDS REPAIR.
NEVER LOSES ITS SHAPE.

HOSE PIPES of Copper-Riveted Leather, India Rubber, Canvas and Rubber-Lined Canvas.

JOHN MORRIS, Fire & Hydraulic Engineer, REGENT WORKS, SALFORD, MANCHESTER.

SINGLE CHAIN GRABS.



SUPPLIED TO ORDER WHEN PREFERRED.

WORKS:
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PRIESTMAN BROTHERS.

CONTRACTORS FOR BARGES TO H.M. GOVERNMENT & THE INDIAN BOARD.

LONDON OFFICE:
52, QUEEN VICTORIA STREET.

DOUBLE CHAIN GRABS.



PARTICULARS, TESTIMONIALS, GREAT ADVANTAGES, &c. ON APPLICATION.

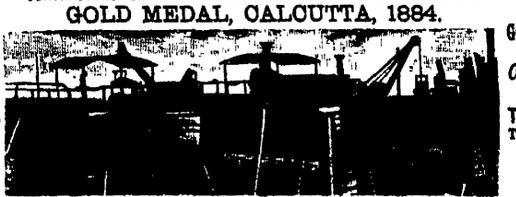
AWARDS

DIPLOMA of HONOUR AMSTERDAM, Paris, Melbourne, Adelaide.

Contractors for Dredgers to

THE ENGLISH GOVERNMENT
THE CROWN AGENTS FOR THE COLONIES
The German Government
" French Government
" Italian Government
" Cape Government
" Danish Government
" Chinese Government
" Chilian Government

GOLD MEDAL, CALCUTTA, 1884.



THE PATENT DREDGER EXCAVATOR & ELEVATOR.

AWARDS

GOLD MEDAL FISHERIES LONDON, Sydney, New Zealand, Tynemouth.

Contractors for Dredgers to

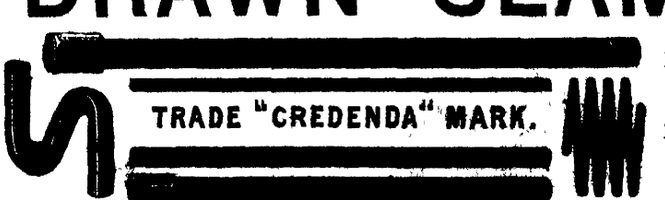
THE INDIAN BOARD
THE MERSEY DOCK & HARBOUR BOARD
The South Australian Government
" New Zealand Government
" Spanish Government
" Victorian Government
" New South Wales Government
" Dutch Government
" Queensland Government

—:PATENT:—

COLD-DRAWN SEAMLESS

THE CREDENDA COLD-DRAWN SEAMLESS STEEL TUBE COMPANY, BIRMINGHAM.

FOR BOILERS AND STAYS, HYDRAULIC PRESSES, AIR RESERVOIRS.



STEEL TUBES.

BIRMINGHAM WORKS & OFFICES:
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LONDON OFFICE:
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BORING RODS, COUPLINGS, BUSHES, SPINDLES, COLLARS, BICYCLES & OTHER USES.

CLASS A.



LOCO. PATTERN, SINGLE LEVER.

THE HANCOCK

INSPIRATOR

ONLY GOLD MEDAL Paris, 1878. FIRST AWARD, Sydney, 1879.

60,000 IN USE.

THE DONKEY PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND RELIABLY.

No Adjustment.

Draws Water at 140°.

All Sizes lift water 25 ft.

Delivers to Boiler up to 212°.

ESTIMATES FOR FIXING COMPLETE with Guarantee to start in good working order, and all information on application to—



Feeds through Heaters.

Can be used as a Pump only.

No Valves or Wearing Parts.

Can be examined instantly.

THE HANCOCK INSPIRATOR CO., 108, Upper Thames St., London, E.C.

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STATIONARY PATTERN. 5115

Henry Bessemer and Co., Limited,

Manufacturers of Cast Steel,

SHEFFIELD.

FORGINGS

In Steel of any size.—Quotations given either for uses or finished complete.

STEEL CASTINGS

Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0.30 per cent. carbon, and to bear a tensile strain of 34 tons to the square inch.

TYRES AND AXLES.



SOFT CAST STEEL

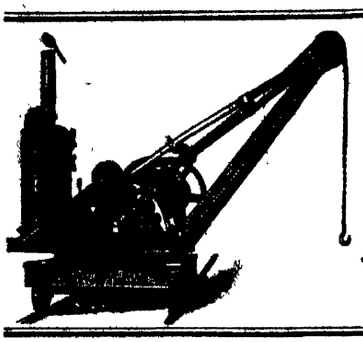
In bars and rods, for general use in Engineering Works.

BLOOMS, BILLETS, & SLABS

Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,

Of superior quality. 1137



EXORS. OF WM. BALMFORTH,

RODLEY, NEAR LEEDS,

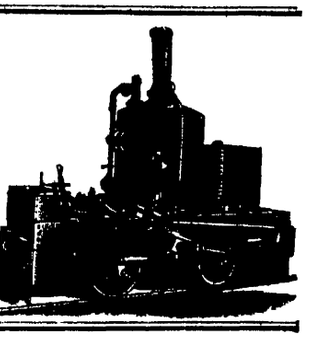
MANUFACTURERS OF

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TRAVELLERS, HOISTS,

AND ALL KINDS OF LIFTING MACHINERY.

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes. 4097





THE COALBROOKDALE COMPANY, LIMITED

MAKERS OF

STEAM ENGINES,

HORIZONTAL AND VERTICAL,

AND

OTHER MACHINERY.

MAKERS OF

STEAM PUMPS.

PARKER & WESTON'S PATENT

PUMPING ENGINES for Mines, Sewage and Water Works.

BOILER FEEDERS and SLIP PUMPS.

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MANCHESTER, 29, PRINCESS STREET. 5138

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DICK, KERR & CO., Engineers and Contractors. (Five Medals awarded, Calcutta International Exhibition, 1883-4.)



SOLE MANUFACTURERS OF

KERR'S PATENT

PORTABLE

RAILWAY

SUITABLE FOR MINES AND CONTRACTORS

WAGONS & LOCOMOTIVES

FOR ALL CLASSES OF WORK.

Catalogues and Prices on application. 5024



101, LEADENHALL ST., LONDON, E.C. Works: Britannia Engineering Works, KILMARNOCK.

TREATMENT OF TOWNS REFUSE.

MANLOVE, ALLIOTT, FRYER, AND CO.,

Works: NOTTINGHAM & ROUEN. London Offices: 50, QUEEN VICTORIA STREET, E.C.,

SOLE MAKERS OF

Machinery & Apparatus for treatment of Towns Refuse by Fryer's Patent Methods, "PURIFICATION by FIRE."

MINERAL MATTER.—Cinders and other rubbish are destroyed by means of the Patent DESTRUCTOR. The residue, ground with lime, is made into an excellent Mortar, and sold freely at a profit. The steam power is furnished by the waste heat from the destructor. VEGETABLE MATTER.—The Sweepings of Markets and Paved Streets, Paper, Straw, Garbage, &c., are converted by means of the Patent CARBONIZER into Charcoal, which is used for removing offensive odours from privies, drains, and infected places; it is scattered over offensive material when transported on Carts or Railway Trucks. A layer of Charcoal should be placed in every newly-opened grave ANIMAL MATTER.—"Pail contents," slaughter-house refuse, and the contents of Arrivals, are reduced by the Patent CONCRETOR and Patent DRYERS to a most valuable inodorous manure, a powder resembling guano, readily sold at from £5 to £9 per ton

These three processes may be combined or used separately. They offer the most effectual and the most profitable means known for the disposal of refuse. Every product is valuable, no nuisance is created, no stores are accumulated, no residue is left, and the spread of infectious diseases prevented

Some of the most important cities and towns have already adopted FRYER'S method to a greater or less extent. Among others may be enumerated CITY OF LONDON, LEEDS, BIRMINGHAM, MANCHESTER, ROCHDALE, STAFFORD, NOTTINGHAM, HECKMONDWIKE, DERBY, BLACKBURN, BURY, BRADFORD, WARRINGTON, BOLTON and HULL.

SOLE MAKERS OF WASHINGTON LYON'S PATENT DISINFECTOR,

Patent Carboniser, Destructor, Concretor, Firman's Dryer, Haresceugh's Dryer, Double Effect Dryer, Odour Tight Sanitary Cart, Cinder Screen, Pail-Washing Apparatus; Improved Charcoal Closets.

SEE FUTURE ADVERTISEMENTS. 5076

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FROM EVERY SECTION OF RAIL.

Portable Railways and General Railway Plant

HARTLEY & ARNOUX BROS.

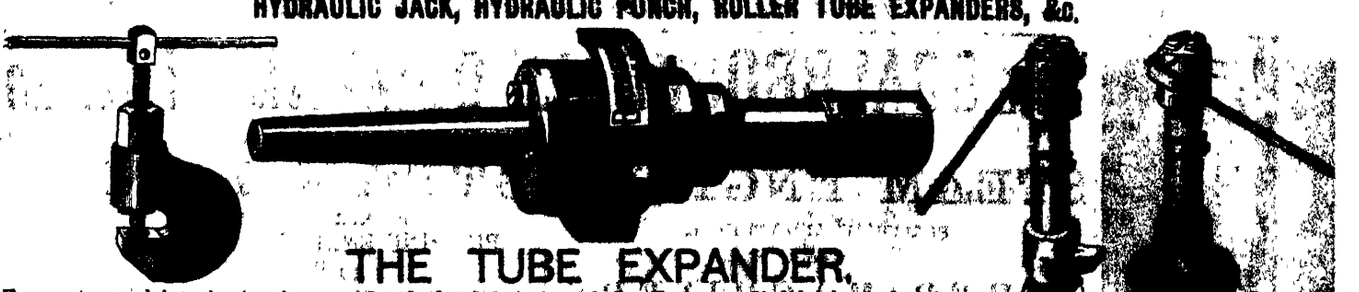
STOKE ON TRENT

RICHARD DUDGEON,

114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF HIS

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, &c.



THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "DUDGEON'S ROLLER TUBE EXPANDERS," R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only are stamped as under:—

R. DUDGEON, N.Y., Patd. Feb. 5th, 1867, on the Guide-ring of each Tool, WITHOUT WHICH NONE ARE GENUINE.

These can always be obtained at R. Dudgeon's English Depôt, 114, Fenchurch Street. If more confidence to get them through Manufacturers should be taken in saying "*Dudgeon's own make*" on the Order, but as R. Dudgeon observes with regret that imitations bearing his stamp counterfeited are being sold as his he would respectfully recommend their Customers and Users requiring Expanders of his make to apply direct. In urging this he merely seeks to ensure the identity of what is made by himself, by which he is content to stand or fall.

R. Dudgeon takes this opportunity of returning thanks for past favors, either by orders or recommendation, and it being his intention entirely to undertake the Quality and Workmanship in manufacture such a Tool as the Expander is, he solicits a continuance of the favors of the Trade.

ILLUSTRATED PRICE LISTS ON APPLICATION TO R. DUDGEON, 114, FENCHURCH STREET, LONDON, E.C.

15 PRIZE MEDALS.] THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED, [15 PRIZE MEDALS.
4, WEST REGENT STREET, GLASGOW.
SANTIAGO, 1875, 2. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1883, 1.



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 4796

100 to 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

Crossley's Patent TWIN-ENGINES. Impulse every revolution. The steadiest running Gas Engine yet made.

THE "OTTO." GOLD MEDAL at Crystal Palace, & HIGHEST AWARD at Paris Electrical Exhibitions.



New Patent SELF-STARTER. Best, Safest, and Simplest made, may now be applied.

CROSSLEY'S NEW VERTICAL ENGINE. Requiring little floor space

½ TO 100 HP. IND. MANY IMPROVEMENTS. OVER 15,000 IN USE.

LONDON: 24, POULTRY, E.C. GAS ENGINE GLASGOW: 58, UNION STREET 4775

CHEAP GAS FOR MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·5 lb. per ind. H. P. per hour.

The DOWSON ECONOMIC GAS COMPANY, Ltd., 3, Great [illegible] W. 4888

PULLEYS, FOR TRANSMISSION OF POWER BY BELTS, CAST OF SELECTED IRON, FROM CAREFULLY DESIGNED PATTERNS, EITHER PLAIN OR TURNED AND BALANCED.

TURNED SHAFTING. SHAFT-FITTINGS, PATENT, ADJUSTABLE, SELF-ADJUSTING, SELF-LUBRICATING, PEDESTALS, HANGERS, WALL-BOXES.

TAYLOR & CHALLEN

ENGINEERS • MACHINISTS • DERWENT FOUNDERY • FOUNDERS • SMITHS • CONSTITUTION HILL



BIRMINGHAM

SOLE MAKERS OF WITHINSHAW'S NEW PATENT FEED-WATER HEATER AND Purifier



Great Saving in BOILERS AND COAL.

MAKERS OF Winding, Forge Mill, Pumping Engines.

Price Lists on application.

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ELECTRIC LIGHT ENGINEERS AND CONTRACTORS,

76, LITTLE BRITAIN, LONDON. Steam Factory: POWNALL ROAD, DALSTON.

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ESTIMATES FOR INSTALLATIONS FREE OF CHARGE. EXPERIENCED MEN SENT TO ALL PARTS OF THE COUNTRY.

Licensees of the "Clarke and Bowman" Arc Lamp, and of Faure's Storage Batteries.

PATERSON & COOPER'S DIRECT CURRENT "PHŒNIX" DYNAMOS.

No. 1.—	For 16	20 candle-power Lamps, or	2	Small Arcs, or 1	Large Arc £36
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4696

Awarded a First-Class CERTIFICATE OF MERIT at Manchester, and a First-Class DIPLOMA OF MERIT at Tynemouth.

PATENT DIAGONAL ROCKING FIRE-BARS

—(Can be Fixed in a Few Hours.)— ARE ECONOMICAL, DURABLE, SMOKE-CONSUMING. —(No Attachment to Boiler necessary.)—

Numerous Official Tests show an average economy of over 10 per cent. These Patent Bars last Years where ordinary Bars last only Months.

Recently supplied to the order of the eminent builders of the engines and boilers of the most powerful Ironclad afloat for use in the whole of the furnaces, to work with "Forced Draught," MAKING THE THIRD Ironclad fitted. Used by the most eminent Engine and Boilermakers (Marine and Land), Railways, Home and Foreign Governments, &c. 5119

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Strongest and Most Durable Metal for Bearings and Bushes of every Description; Hydraulic Pumps, Pinions, Valves, &c. &c. Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c.

SOLE MANUFACTURERS UNDER SEVERAL PATENTS— 1475

The PHOSPHOR BRONZE COMPANY Limited, Sumner & Emerson Streets, Southwark, London, S.E.

Calcutta, 1884.—HIGHEST AWARD.



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(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

Baker's Patent Rotary Pressure Blower and Gas Exhauster.

BAKER'S PATENT ROTARY PUMP.

HALL'S PATENT STONE BREAKER.

CRUCIBLE STEEL CASTINGS.

General Machinery of Every Description.

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CHARLES CHURCHILL & CO.,

AMERICAN MACHINERY AND TOOL IMPORTERS

21, CROSS STREET, FINSBURY, LONDON, E.C.

ESTABLISHED IN 1862.



C. C. & Co. have just removed to much larger premises with ample show rooms and warehouse, and will carry a greatly increased stock of all the best American tools.

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THE ONLY GENUINE AMERICAN MORSE TWIST DRILL,

WITH CENTRE GRINDING LINE, STOCKS AND DIES, REAMERS AND MILLING CUTTERS,

Stephens' Patent Vices, Horton Chucks, Cushman Chucks, Westcott Chucks, Sweetland Chucks, Stanley Rule & Level Co.'s Planes, &c., &c., Gould's Manufacturing Co.'s Pumps, and a great variety of New American Tools.

New Catalogue for 1883 just issued, 215 pages Quarto, sent on receipt of One Shilling in Stamps.

(THE LARGEST CATALOGUE OF AMERICAN TOOLS EVER PUBLISHED IN GREAT BRITAIN.) 4134

W. NEILL & SON,

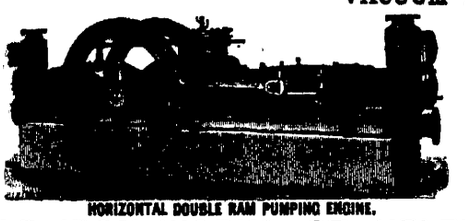
ENGINEERS, IRON & BRASS FOUNDERS, BOILER MAKERS, &c.

MANUFACTURERS OF

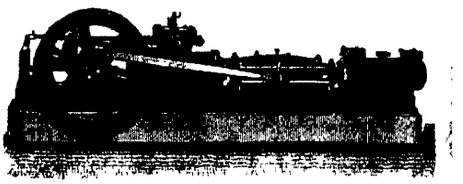
PUMPING ENGINES, BLOWING ENGINES, STEAM ENGINES, AIR COMPRESSORS, and VACUUM PUMPS.



DOUBLE RAM PILLAR PUMPING ENGINE.



HORIZONTAL DOUBLE RAM PUMPING ENGINE.



BLOWING ENGINE AND AIR COMPRESSOR. 4258

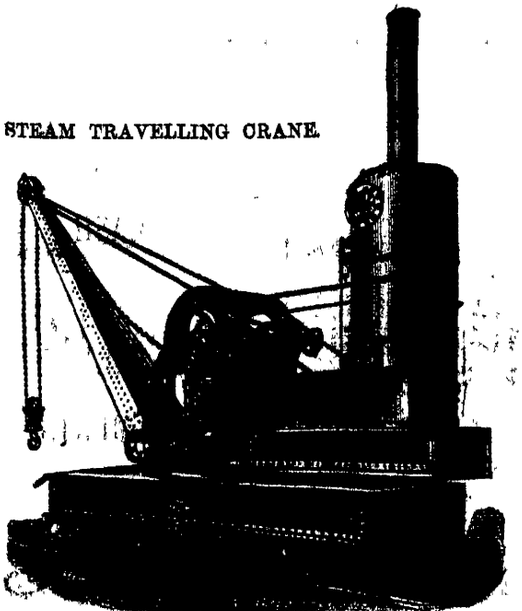
BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.

COWANS, SHELDON & CO., LTD.,

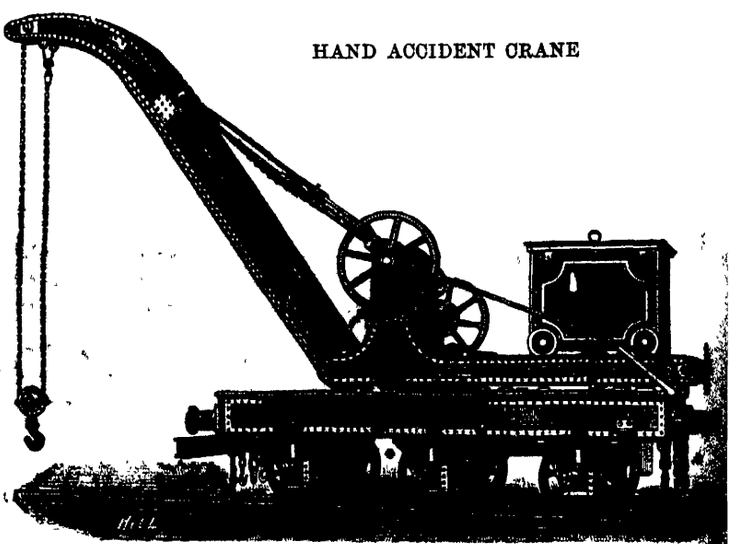
ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.

STEAM TRAVELLING CRANE.

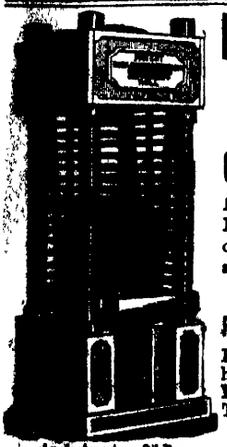


HAND ACCIDENT CRANE



TURNTABLES, CRANES, MASTING SHEERS, AND TRAVERSERS OF EVERY DESCRIPTION B

STEAM, HAND, OR HYDRAULIC POWER.



Anglo-American Oil Press for 15 to 18 Tons Cakes.

ROSE, DOWNS & THOMPSON,

Established 1777.

OLD FOUNDRY, HULL.

Makers of the ANGLO-AMERICAN

OIL-MILL MACHINERY,

For crushing Linseed, Cotton Seed, Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent. in labour and power, and 2 to 4 per cent. in Oil. (See *Engineer*, May 6, 1881, and Nov. 23, 1883.)

PRESSES FOR ALL KINDS of OIL SEEDS.

Elevators and Creepers for Grain Warehouses, Accumulators and Hydraulic Dock Machinery, Stationary Engines, Boilers, Trawling Engines, and Capstans for Fishing Boats.

SOLE MAKERS OF

HODGES & THOMPSON'S PATENT

KINGSTON EXCAVATOR.

Grabs and Buckets for Mud, Sand, Shingle, Silt, Clay, Rock, Debris, Boulders, Coke, Ore, &c., supplied on Pontoons for Harbour and Dock Dredging.

NO HEAVY BALANCE WEIGHTS.

NO SPECIAL CHAINS.

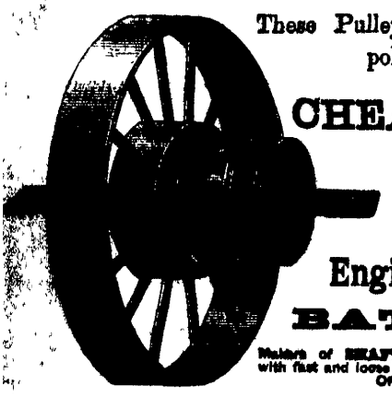
PERFECT AND RAPID WORK.



Kingston Dredger with Mud Bucket. 5197

London Office (Dredging Machinery): 28, KING WILLIAM STREET, E.C.

TURNED WROUGHT IRON PULLEYS.



These Pulleys are **TURNED IN A LATHE,** and not polished on a Grindstone like those generally sold.

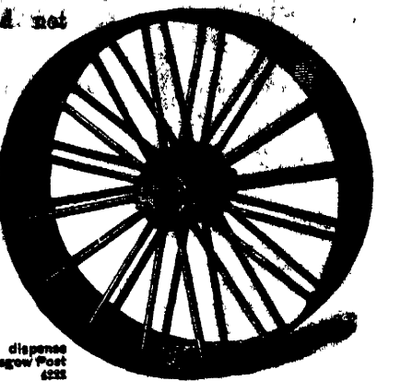
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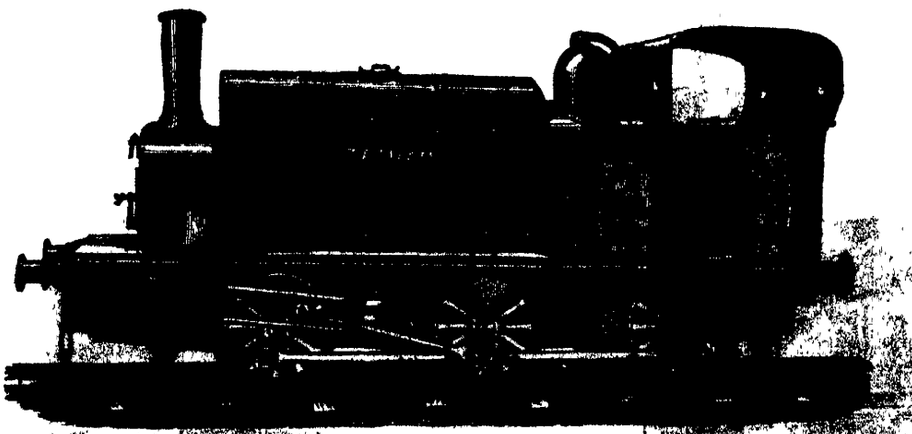
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SEE HALF-PAGE ADVERTISEMENT SEPT. 19th, Page 33.

RAILWAY PLANT!!

SEE HALF-PAGE ADVERTISEMENT OCT. 3rd, Page 33.

RANSOMES & RAPIER, 1, Westminster Chambers, LONDON, S.W., and Waterside Ironworks, IPSWICH.

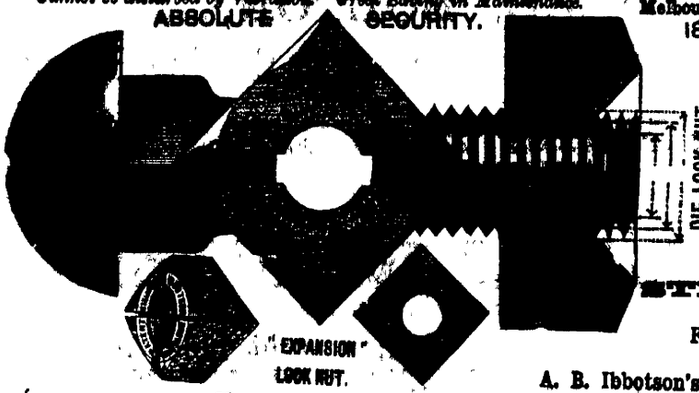
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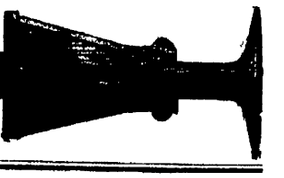
A. B. Ibbotson's Patent Steel Die and Expansion Lock Nuts, and Steel Bolts, Railway Fastenings, &c., &c.



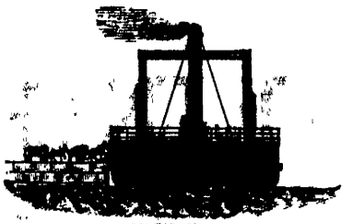
GEORGE TURTON'S PATENT WROUGHT IRON BUFFERS,

AND PATENT COMPOUND CAST STEEL SPRINGS. { 4130 8613

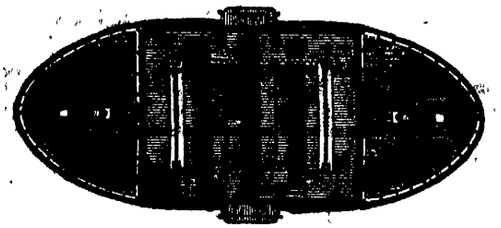
LONDON OFFICE: 4, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W.



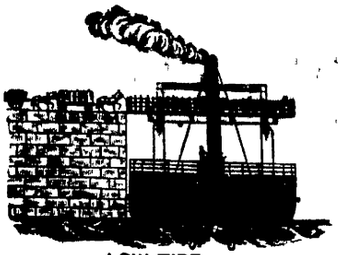
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HIGH TIE.

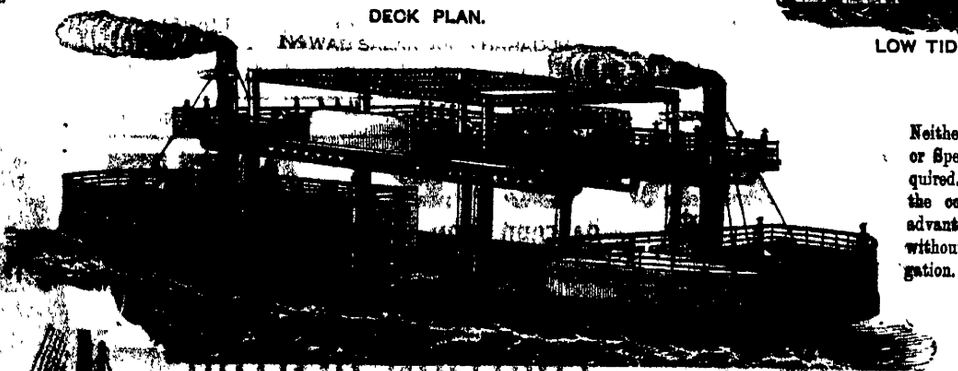


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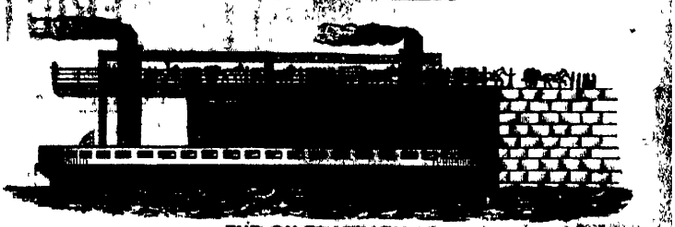
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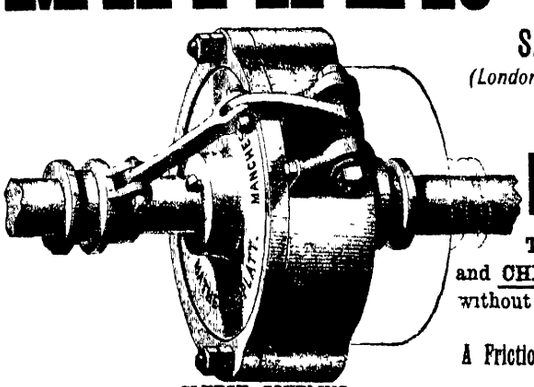
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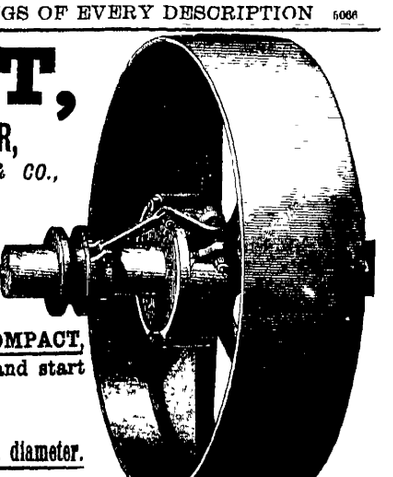
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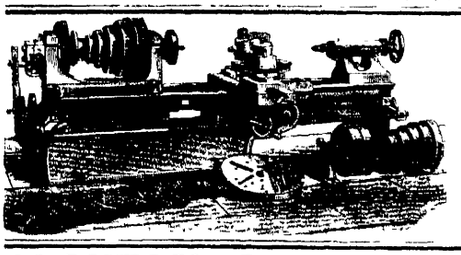


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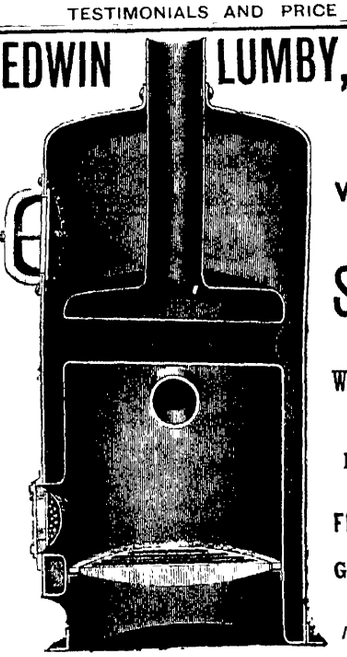


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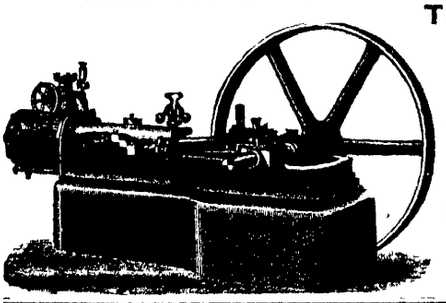
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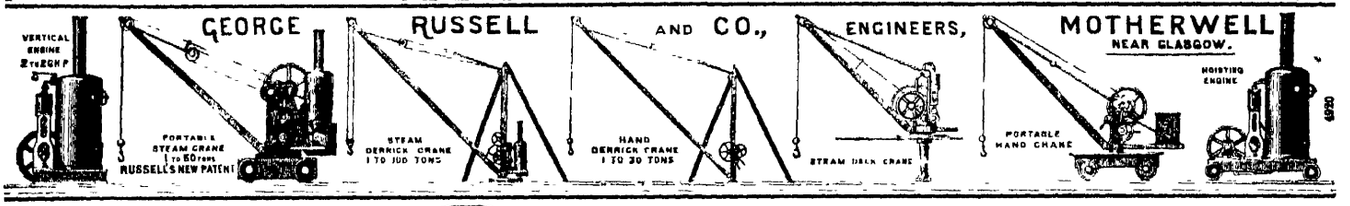
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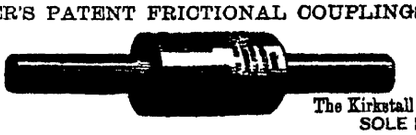
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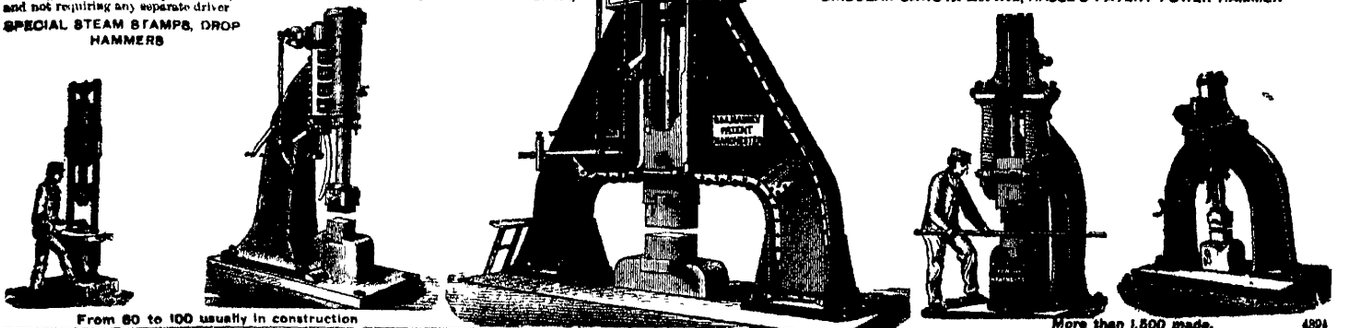
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[Registered at the General Post Office as a Newspaper

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An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.

VOL. XXXVIII.—No 981] *LONDON FRIDAY, OCTOBER 17, 1884* [PRICE 6d By Post 6½d

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STEAM LAUNCH MACHINERY 4955

Boiler Tubes, Iron, Steel, and HOMOGENOUS EDWIN LEWIS AND SONS, Wolverhampton 4863

Tubes MARINE, LOCO', STEAM, BORING, COLLIERY LARGE TUBES LAP WELDED TO 12in DIAM

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James Russell and Sons, LIMITED, CROWN TUBE WORKS, WEDNESBURY

London Warehouse 108, Southwark Street, S E
Leeds Warehouse 6, Mark Lane, Briggate
Price Lists on application 5001

Wrought Iron Tubes and FITTINGS LLOYD AND LLOYD, ALBION TUBE WORKS, BIRMINGHAM WAREHOUSES 99, Cannon Street, E C Liverpool 61 Paradise Street Manchester 7, Blackfriars Street 5231

STEEL CASTINGS STEEL CASTINGS

Hadfield's Steel Foundry Co, SHEFFIELD GOLD Medals, Paris and Melbourne '78 & '80 For Engineers, Railways, Tramways, Mines, Hydraulic Work, Dredgers, &c, &c Specially sound, dense, and of unequalled strength, toughness and durability Our Unhammered Steel Castings as recently tested by H M Govt, stand 40 to 65 tons per sq inch (varying according to the hardness and purpose required) and up to 20 per cent elongation Can be thoroughly relied upon for regularity and uniformity of temper See Advertisement page 32 4594

AWARDS TO

John M'Dowall & Sons, JOHNSTONE, NEAR GLASGOW,

FOR WOOD WORKING MACHINERY

INTERNATIONAL EXHIBITION SYDNEY, 1879 80	INTERNATIONAL FORESTRY EXHIBITION, EDINBURGH, 1884
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Okes,

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Atkinson's Patent Gas Engines.

5054

89, QUEEN VICTORIA STREET, LONDON, E C

Field's Patent Boilers and TUBES LEWIS OLRICK & CO, London 5046

See Illustrated Advertisement, page 26

George Russell & Co., ENGINEERS and BOILERMAKERS, ALPHA STEAM CRANE and ENGINE WORKS, MOTHERWELL, near GLASGOW SILVER MEDAL, PARIS, 1867 4921

Steam Hammers.—

Massey's Patent Hammers
RECEIVED THE ONLY PRIZE MEDAL PARIS 1878
More than 1600 made
Drop Hammers Hasse's Patent Power Hammer
B & S MASSEY, MANCHESTER. 4896

The "Differential" Pumping ENGINE —DAVEY'S PATENT for Draining Mines, Water Supply of Towns, Irrigation; Supplying Docks, Pumping Sewage, and General Pumping Purposes

HATHORN, DAVEY, & CO, LEEDS

H, D, & Co have Patterns of "Differential" Engines of all sizes from 5 to 600-horse power, and have facilities for supplying very powerful Engines and Pumps at a short notice 5356

Locomotive Tank Engines designed and constructed by MANNING, WARDLE, AND COMPANY, Boyne Engine Works, Leeds 2487

See their Illustrated Advertisement, page 40

Locomotive Tank Engines, TRAMWAY ENGINES AND CARS Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough 5206

See Illustrated Advertisement page 11

The Patent Corliss Engine And PATENT CORLISS GEAR ENGINE, with special Improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N B These engines are made Horizontal or Beam, Condensing, Non Condensing, and Compound Also makers of Rice Mills, and Paper Mills, and General Engineers Machinery shipped or trucked direct from the premises 2590

John Cochrane, Engineer, BARRHEAD, N B,

Advertises his STEAM ENGINES, STEAM HAMMERS STEAM PUMPS, &c, in this Paper every Fortnight Catalogues &c, on application 5320

Steel Hydraulic Cylinders.— HENRY BESSEMER & CO, Limited, SHEFFIELD

See Advertisement last week, page 31 3627

Tweddell's Hydraulic Rivetting Machines

14, DELAHAY STREET, WESTMINSTER, LONDON, S W 4897

See Illustrated Advertisement last week, page 47

L. Sterne & Co., Limited. ENGINEERS,

Sole Makers of

Clerk's Patent Self-Starting Gas Engine.

HIGHEST AWARD,

BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881

GOLD MEDAL,

CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifiers,

WITH

STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels, Emery Machines, Spiral Springs.

The Crown Iron Works, GLASGOW

The Crown Iron Works (Hollinwood), MANCHESTER

10, Victoria Chambers, WESTMINSTER.

City Office and Show Rooms, 40, CANNON STREET, E.C.

10, Rue Lafitte, PARIS. 2583

International Inventions

EXHIBITION, London, 1885.

DIVISION I., INVENTIONS. DIVISION II., MUSIC.

Patron:
HER MAJESTY THE QUEEN.
President:
H.R.H. THE PRINCE OF WALES, K.G.

Applications to Exhibit must be made on Printed Forms, which will be supplied on application to the SECRETARY, International Inventions Exhibition, South Kensington, S.W. These must be filled up and returned on or before the 1st November, 1884. G 935

TENDERS.

INDIA OFFICE,
16th October, 1884.

BY ORDER OF THE SECRETARY OF STATE FOR INDIA IN COUNCIL.

INDIAN STATE RAILWAYS.

The Director General of Stores for India is prepared to receive

Tenders from such Persons as may be willing to SUPPLY—
STEEL RAILS, 41½ lbs., 7161 tons.
STEEL FISHPLATES, 307 tons.
SPIKES, 212 tons.
WHEELS AND AXLES, 800 pairs.

The Conditions of Contract may be obtained on application to the Director General of Stores, India Office, Westminster, S.W., and Tenders are to be left at his Office at any time before Two o'clock p.m. on Tuesday, the 28th October, 1884, after which no Tender will be received

A. ABERCROMBIE JOPP, J 61
Director General of Stores.

TO CONTRACTORS.

CARDIFF CORPORATION WATERWORKS.
LLANISHEN SECTION, CONTRACT No. 5.

The Waterworks Committee of the Corporation of Cardiff are prepared to receive

Tenders for the Construction of FILTERS and SERVICE RESERVOIR, Boundary Walls, Fencing, Pipe Laying, Roads, and other works connected therewith, situate near the Heath, about two miles from Cardiff

Plans and Drawings may be seen after Monday, the 13th instant, at the Offices of the Waterworks Engineer, Mr J. A. B WILLIAMS, Queen's Chambers, Cardiff, and printed copies of the Specification, Form of Tender, and Bill of Quantities may be obtained on payment of Five Guineas, which will be returned after the receipt of a bonâ fide tender.

Tenders must be enclosed in a sealed envelope, endorsed "Tender for Filters and Service Reservoir," and must be addressed to and left with me, the undersigned, before Ten o'clock of the morning of Friday, the 24th day of October

The Corporation do not bind themselves to accept the lowest or any Tender

J. L. WHEATLEY, Town Clerk
Town Hall, Cardiff, 4th October, 1884. G 956

THE SOUTHERN MAHRATTA RAILWAY COMPANY, LIMITED.

The Board of Directors of the Southern Mahratta Railway Company, Limited, is prepared to receive

Tenders for the Supply of
IRON UNDER-FRAMES and IRONWORK, &c., for Low-sided Goods Wagons, Timber Trucks, and Covered Goods Wagons
WHEELS and AXLES.
AXLE BOXES
LAMINATED and VOLUTE SPRINGS
INDIA-RUBBER ATTOCK'S BLOCKS, &c
LAMPS, and
PORTABLE FORGES, &c.

As per Specifications and Drawings, to be seen at this Office.

Tenders are to be delivered in sealed envelopes, addressed to the Secretary, marked "Tender for Under-frames," &c., or as the case may be, not later than Twelve o'clock at noon on Wednesday, the 29th October, 1884

The Company is not bound to accept the lowest or any Tender. By order of the Board,
(Signed) EDW Z. THORNTON,
Secretary's Office, 31, Lombard Street, E.C. Secretary
2nd October, 1884. G 955

VENTNOR LOCAL BOARD.

TO CIVIL ENGINEERS.

Competitive Designs are invited for the CONSTRUCTION of an IRON PROMENADE PIER and LANDING STAGE to be ERECTED at Ventnor.

A Lithographed Plan of the Site with instructions and particulars of competition may be obtained on application to Mr. R. S. SCOTT, C.E., Surveyor to the Board, Local Board Offices, Ventnor, I W

The author of the design, which in the opinion of the Local Board is the best suited for the place and which complies with the instructions furnished, will be appointed at the usual commission to carry out the works.

Plans, &c., are to be sent in to the undersigned on or before the 8th day of December next.

By order, A HOUSTON,
Town Clerks Office, Ventnor, I.W., Clerk to the Board
7th October, 1884. G 962

APPOINTMENTS OPEN.

Wanted, for a Foreign Arsenal, a SUPERINTENDENT of the GUN FACTORY. Must be a man of experience, and competent to take the sole charge of the Manufacture of Modern Breech-loading Cannon.—Address, stating age, and full particulars of past experience, and enclosing copies of testimonials, to JULIUS ALLMANN AND CO., 2, Victoria Street, Manchester. G 950

Wanted, for a Large Engineering Works, near Manchester, a First-class FOREMAN, accustomed to large and small high-class engines and mill gearing; liberal salary to really good man.—Address, G 977, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 977

Wanted, thoroughly Competent FOREMAN BOILERMAKER, for Marine Engine Works; young man preferred.—State experience, age, and salary required, to G 1000, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 1000

Wanted, a First-class Tool DRAUGHTSMAN.—Apply, BEYER, PEACOCK & CO., Limited, Gorton Foundry, Manchester. J 62

Wanted, an Experienced Town TRAVELLER, on salary and commission, by a Firm manufacturing an engineering speciality.—Apply, X., Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. G 989

Agents Wanted, to Sell Fine DURABLE COMPOUND MACHINERY OILS, amongst mills, mines, and other steam power users Liberal commission.—Address, J. B. TYLOR, 24, Finch Street, Whitechapel, London. G 992

Agents Wanted, to push First-class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool. 5233

Lists of Berths Vacant or WANTED. See "ENGINEERING REVIEW," weekly 1d — E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5278

SITUATIONS WANTED.

An Engineer, age 31, Student of the Vienna Polytechnical School, with ten years' experience in Corliss Engines, Boilers, Pumps, Waterworks, and general Mechanical Engineering (lately established abroad), seeks an APPOINTMENT as Draughtsman to a large Engineering firm. Speaks four languages, and will accept any salary to commence with —Address, J 54, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. J 54

Foreman Moulder (Non-Unionist), long experience in Pipes and general work; is well up in moulding by machine; also arranging plate and plaster work; desires SITUATION, either day or piece work.—Address J 63, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W C J 63

Parliamentary Work. — To Civil Engineers and Borough Surveyors.—A Land and Engineering SURVEYOR, who has had large experience in getting up the Surveys, Sections, and Deposit Plans, is open to an ENGAGEMENT, terms moderate —Address, J 51, Offices of ENGINEERING J 51

Sydney, N.S.W.—M. Inst. C.E., proceeding on 24th inst., would undertake COMMISSIONS —Address at once, making town appointment, J 53, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C J 53

A Lady is desirous of Placing a well educated and intelligent YOUTH (16), where he would be likely to obtain a good practical knowledge of engineering, state premium required, &c.—Address, N, MAY'S Advertising Offices, 159, Piccadilly G 996

Wanted, to Apprentice a YOUTH (age 16) to Mechanical Engineering. —Address, stating terms, to F H, 16, Coventry Street, London, W. G 965

Agency for Germany Wanted by an energetic and experienced Engineer First-class references.
Address, M M ROTTEN, 97, Königgratzerstrasse, Berlin G 959

PARTNERSHIPS.

To Civil Engineers in practice. —The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright.
WHEATLEY KIRK, PRICE AND GOULTY, 52, Queen Victoria Street, London, E.C 5271

WANTED, &c.

Wanted, New or Second-hand SHAPING MACHINE, about 5 ft. bed, 12 in. stroke —Send full particulars to R. A. LISTER and CO., Engineers, Dursley. G 988

Wanted, a High-Pressure CONDENSING or COMPOUND ENGINE, to indicate 150 HP. at a speed of 80 revolutions with 40 lbs. steam; also a FLY-WHEEL, in halves, 16 to 18 ft. diameter, 10 tons.—Address, F. A. CLARK & SON, Lead Mills, Hammersmith, London, W. J 52

Wanted, a Powerful Dredger, capable of digging out 8 metres (25 ft.) in depth, in stiff clay with stones. Would be bought or taken on hire for a series of years.—Address, B. H., 7822, care of AUG. I. WOLFF & CO., Advertising Agents, Copenhagen, K. Denmark. G 924

Wanted, 12 in. Level, 5 in. or 6 in. Theodolite, in good condition.—Apply, F. T. HOPKINSON, 1, Delahay Street, Westminster, S.W. G 998

Lists of Machinery Wanted or on SALE. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5262

FOR SALE.

For Sale, One Pair of Compound Surface Condensing MARINE ENGINES AND BOILER, 120 HP. Nominal. 5280
J. GILMOUR & CO., Engineers, Glasgow.

For Sale, The Universal Pulveriser. Will grind all kinds of Refractory Materials, Ores, Stones, &c. Weight 4 tons. New.—Apply, C. E. HALL, Standard Iron Works, Washford Road, Sheffield. 5244

For Sale.—To Public Libraries. "ENGINEERING," 20 bound Vols., 7 to 20, in good condition, 3s. 6d. per volume.—Address, HOUSEKEEPER, 30, Walbrook, London. G 996

For Sale, a Bargain, New 5 HP. HORIZONTAL ENGINE, 7 in. cylinder, 14 in. stroke, with governors and boiler feed pump complete, highly finished. Price £30.—A. G. MUMFORD, Culver Street Ironworks, Colchester. G 990

For Sale, Largest Stock in England, Engineers' Machine Tools, Steam Hammers, Steam Engines, Wood-working Machinery, all sizes, best materials and workmanship, low prices; send for stock list.—SCOTT BROTHERS, Halifax.

For Sale, being superseded by engines of higher power, a pair of High Pressure Condensing STEAM ENGINES. Cylinders, 26 in. diam., 5 ft. 6 in. stroke, with cold water pump for same.—Can be seen at work at the Manufactory of the LONDON PORTLAND CEMENT CO., Ltd., Northfleet, Kent, to whom enquiries may be addressed G 534

For Sale, by the Mortgagees, the NORTHFIELD IRON WORKS, Rotherham, Yorkshire (Freehold). 22 puddling furnaces, 18 in. forge-train, 14 in. bar mill, guide and hoop mills. "Colliers" tyre mill Railway and canal to works.—Apply to Messrs. MACREDIE & EVANS, Chartered Accountants, Sheffield. G 838

For Sale, Steam Launch, 24½ ft. long, with mahogany and glass cabin, nicely fitted, placed aft; first class engine, 6 in. by 6 in., and boiler in good repair, just undergone thorough overhaul and repainted; well suited for wild fowl shooting; fitted with gear for swivel gun and silent exhaust to engine, can be viewed and tried by appointment —A. G MUMFORD, Culver Street Iron Works, Colchester G 991

For Sale, Steel Launch, Twin SCREW (in progress and nearly finished), 55 ft. long by 13 ft. beam, 6 ft. 6 in. deep, draught 3 ft. 6 in., engines 10 in. and 15 in by 14 in. strokes. No wood work fitted, can be shipped in three sections; designed for high speed and light draught.—For Specification and price, apply to LOUDON BROTHERS, 111, Bothwell Street, Glasgow, and 156, Upper Thames Street, London. G 960

For Sale, at low prices for CASH, a BAND SAW, by Powis, James & Co., with Compensating Spring and Canting Table; a DEAL FRAME, by Powis, James & Co., with rack feed; a LOG and PLITCH FRAME, to take 30 in. log, with 56 ft. track; a pair of 8 in. DEEP WELL PUMPS, 2 ft. stroke, powerful driving gear, girders, &c., complete; a GIFFARD'S INJECTOR for 16 HP. boiler.—For further particulars, apply to MAXWELL WILLIAMS, 35, Queen Victoria St., London, E.C. G 997

TO CONTRACTORS, HARBOUR BOARDS, &c.

For Sale, at Wicklow Harbour Works, 10-ton Cameron Self-Propelling Steam Derrick Crane, with 72 ft. jib; Priestman Steam Travelling Crane, for "B" size grab; one specially strong Priestman Grab; Chaplins' Locomotive; several tons 6 in. by 6 in. Angle and Tee-Iron; 40 tons Steel Rails; large quantity sound sawn Pitch Pine; three good Barges; one specially good rectangular Barge, on which Priestman Crane works.—Apply to JOHN JACKSON, Harbour Works, Wicklow, Ireland; or 9, Victoria Chambers, Westminster. 5122

For Immediate Sale, at low prices for cash.
SECOND-HAND.
AIR COMPRESSOR, on air receiver, 2 steam cylinders, 6 in diam. each, air cylinder, 9½ in. diam.
LANCASHIRE BOILER, 18 ft 3 in. by 7 ft. diameter.
Twenty HORIZONTAL and VERTICAL ENGINES, cylinders from 3 to 20 in dia.; second-hand and new.
10 in. TANK LOCOMOTIVE, by Fletcher, Jennings, and Co., 4 wheels coupled.
HORIZONTAL ENGINE, 9½ in. by 18 in., with reversing gear and winding drum, 3 ft. 10 in. by 3 ft. 10 in.
10-ton SELF-CONTAINED WEIGHING MACHINE.
20-ton ditto ditto.
ECLIPSE ROCK DRILL, on tripod and weights, and about 60 lbs. Steel Tools.
A New 9 HP. CHAPLINS' LOCOMOTIVE.
For prices and full particulars apply to "PHILLIPS' MONTHLY MACHINERY REGISTER," Newport, Mon. 4984

Modern Engineering Works to be LET or SOLD, situate in Midland County on canal bank, and within collecting area of two important railway stations; about 4½ acres of land (which can be increased if desired); excellent buildings, with steam power, suitable for any engineering manufacturing purposes.—Apply to WHEATLEY, KIRK, PRICE & GOULTY, Albert Square, Manchester, or 52, Queen Victoria Street, London, E.C. G 997

For Sale, Planing Machines, 14 in. long by 6 ft. square and 13 ft. by 5 ft., both with three tool-boxes; Lathe, 16 in. centre, 20 ft. gap bed, screw-cutting and surfacing; Steam Hammer, 1½ cwt., 240; 3 cwt., 276 (Massey pattern), by J. Brown & Son, complete with anvil blocks, self-acting and hand gear.—Address, JOHN MOORE AND CO., 32, Victoria Street, Manchester G 966

Quarry for Sale.—Bonâ Fide Bargain.—TO BE SOLD by private treaty, a Blue Pennant PAVING and BLOCK STONE QUARRY, now in active operation. The Paving is in great demand, and situated near one of the most thriving towns in South Wales, having railway sidings connecting it with the main line, giving easy access to several important towns.—For particulars apply to Messrs. COZENS, HEMMERDE, & CO., Accountants, 5, Clare Street, Bristol, and Albert Chambers, Cardiff. G 994

On Sale, One Pair Vertical ENGINES, indicating 520 horse-power.—Can be seen working at the LANCASHIRE COTTON SPINNING CO., Ltd., Heyside, near Oldham. G 497

Hornbeam Plank, all thicknesses, dry; warranted English growth; very large stock; cops cut to any pattern at moderate prices.—J. KREN, 264, Waterloo Bridge Road, London, S.E. 5151

Engineers' Plant for Sale.—Lathes, 6 in. to 20 in., Planing Machines, 2 ft. to 6 ft.; Shaping, Slotting, Boring, Drilling Machines, &c.; all by first-class makers, and in good order.—Send for List to BOWES, SCOTT & READ, Broadway Chambers, Westminster. G 948

Machine Tools, ready for Delivery; various sizes of Lathes, Shaping, Planing, and Drilling Machines; inspection invited; illustrations, full particulars, &c.—G. F. SMITH, Machine Tool Maker, South Parade, Halifax. G 985

Engines, Boilers, Steam and Electric Launches (Wood or Steel) supplied quickly; prices moderate.—HENRY TIPPING & CO., Greenwich, London, Steam Ship Contractors, &c. G 986

Dry Dock on the Thames, with complete Engineering Plant, TO BE LET OR SOLD.—For full particulars apply to Mr BRAD SHAW BROWN, Auctioneer, &c., 59, Fenchurch Street, E.C., and Mill Wall, E. G 978

16 HP. Portable Steam ENGINE, high class, new, with or without link motion reversing gear, FOR SALE on advantageous terms. 8 HP. PORTABLE STEAM ENGINE, high class, new, FOR SALE, cheap for the quality, with a 6 ft. pan Mortar Mill and a 5 ft. by 2 ft. 6 in Saw Table complete.—For price, or to view, apply to BARROWS and STEWART, Engineers, Bunbury, Cheshire. 503

New Tank Locomotive in stock, four wheels coupled, cylinders 12 in. diameter, 20 in. stroke. New Locos. always in progress.

Three Second-hand Tank Locomotives, four and six wheels coupled; cylinders 12 in. diameter, 18 in. stroke, for Sale or Hire.

40 HP Nominal Semi-Portable Engine and Boiler combined; cylinders 14 in. diameter, 20 in. stroke, with reversing motion, pump, and injector; working pressure 120 lbs.; new, in stock.—Photographs and specifications on application to THOMAS PECKETT (late Fox, Walker & Co.), Atlas Engine Works, Bristol. J 50

Tank Locomotives, 4 or 6 wheels coupled. Specification and workmanship equal to Main Line Engines.—Apply to R. & W. HAWTHORN, Engineers, Newcastle-on-Tyne.
See Advertisement, page 40. 4984

Locomotive Tank Engines always in stock or progress.—RUDDWELL, CLARKE and CO., Railway Foundry, Leeds, Sole Makers of RODGERS' PATENT WROUGHT IRON PULLEYS. See Illustrated Advertisement, page 36.

Locomotive Tank Engines for Main Line Traffic, Short Line, Collieries, Contractors, Iron Works, Manufactories, &c., from a superior specification, equal to their first-class Railway Engines, and specially adapted to sharp curves and heavy gradients, may always be had at short notice from Messrs. BLACK, HAWTHORN, and Co, Locomotive, Marine, and Stationary Engine Works, Gateshead-on-Tyne 1584

Compound Surface Condensing MARINE ENGINES FOR SALE; cylinders 10 in. and 20 in diameter by 12 in. stroke, fitted with Payton and Wilson's patent circular balanced and double-ported slide valves, and link motion reversing gear.—Address ALEX. WILSON & CO., Vauxhall Iron Works, Wandsworth Road, London, S.W. 4968

Bradford's Machinery Oils.—The best and cheapest in the market; successfully used and most highly spoken of by thousands of leading firms. Users of steam power, before purchasing elsewhere, are invited to apply for post-free samples, circulars, and hundreds of Second Sale testimonials, to JOHN BRADFORD & SONS, Liverpool. 5284

Brass & Copper Boiler Tubes, —MUNTZ'S METAL COMPANY, LIMITED, French Walls, near Birmingham.—Manufacturers of Solid Drawn Brass and Copper Boiler Tubes, Condenser Plate and Tubes, Pump Rods, Screw Bolts, &c. London Agents, CHARLES MORE & CO., 32, Abbey Lane, London, E.C. 4985

Boilers! Boilers!! Boilers!!! The Largest Stock in London of Portable or Vertical Boilers for Sale or Hire from 2 to 30 horse power.—F. BONE, South London Boiler Works, Long Lane, Borough. Boilers repaired by practical men only 2242

Three Double-Rivetted BOILERS, by Daniel Adamson & Co., 30 ft. long, 8 ft. diameter, two flues, with Bowling expanding mouths, stiffs and plates, first-class fittings.
One third class BOILER, 30 ft. by 7 ft., two flues and fittings, by Pollitt, guaranteed for 90 lbs. £160.
One BOILER, 27 ft. by 7 ft., two flues and fittings, Stafford's patent. £80.
G. H. BERRISFORD, 12, Bank Street, Cross Street, Manchester. G 974

Ready for Delivery :—
One Radial Drilling Machine, 6 ft. arm.
One 14 in. stroke Shaping Machine, 6 ft. bed.
One 18 in. ditto ditto ditto.
One 14 in. centre Sliding, Surfacing, and Screw-cutting Lathe, 14 ft. gap bed.
One 10 in. ditto ditto ditto, 16 ft. gap bed.
One 8 in. centre, risen to 10 in. centre, Sliding, Surfacing, and Screw-cutting Lathe, 12 ft. gap bed.
One 10 in. stroke Slotting Machine.
One ¾ in. by ¾ in. Punching, Shearing, and Angle-iron Cutting Machine, 18 in. gape, to cut 4 in. by 4 in. by ½ in. angles.
One 36 in. Pillar Drilling Machine.
GEORGE BOOTH & CO., Engineers' Tool Makers, Halifax. 5235

AUCTION SALES.

BY ORDER OF THE MORTGAGEES CANAL WHARF.

TO TIMBER MERCHANTS AND OTHERS.

Mr. Bradshaw Brown will SELL BY PUBLIC AUCTION, at the Mart, Tokenhouse Yard, E.C., on WEDNESDAY, 22nd OCTOBER, 1884, at One for Two o'clock precisely, the Valuable Beneficial LEASE of Important Canal Premises, having a frontage of 408 ft. to the Peckham Basin of the Surrey Canal, with Engine and Boiler House, Saw Mills, Timber Shed, Stables and Offices.—For Plan, Particulars and Conditions of Sale, apply to Messrs. CLARKE, RAWLINS & Co., 66, Gresham House, E.C.; Messrs. WILD, BROWNE AND WILD, 10½, Ironmonger Lane, E.C.; or of the AUCTIONEER, 59, Fenchurch Street, and Estate Office, Mill Wall, E. G 979

GROVE ENGINE WORKS, HULL.

Wheatley Kirk, Price and GOULTY will SELL BY PUBLIC AUCTION, on OCTOBER 21st, 22nd and 23rd, the following HIGH-CLASS ENGINEERING TOOLS, PLANT, and MACHINERY :—
One powerful 24in. Self-acting SLOTTING MACHINE, quick return, elliptic gearing, 5 ft. circular table.
One 5ft. treble geared FACE LATHE, with two rests.
Two Horizontal and Vertical SIDE PLANING MACHINES, to plane 14 ft. by 14 ft. and 14 ft. by 12 ft.
One 40 ton Rope Driven OVERHEAD TRAVELLING CRANE, 33 ft. span, with wrought-iron box girders, and Five other Power and Hand OVERHEAD TRAVELLING CRANES, 33 ft. to 39 ft. span, to lift 10, 20, 25 and 40 tons.
One Tweddell's Patent Fixed HYDRAULIC RIVETTER with double pumps and accumulator.
One Set of Vertical PLATE BENDING ROLLS for plates 7 ft. wide, with Steam Engine attached.
PLANING MACHINES, 16 ft. by 7 ft. by 7 ft., 8 ft. by 4 ft. by 4 ft., and 8 ft. by 2 ft. 6 in. by 2 ft. 6 in. with three, two, and one tool boxes respectively.
One Vertical CYLINDER BORING MACHINE, 11 ft. wide, with 16 ft boring bar and 11 ft. 6 in. travel of head, with Steam Engine attached; two Horizontal BORING MACHINES, with 8 in. and 5¼ in. bars.
One Universal Radial DRILLING MACHINE, to drill up to 14 ft. radius and up to 15 ft. high above base plate, nine other Radial DRILLING MACHINES, 4½ ft. to 7½ ft. arms, some self contained, others to be attached to walls.
Seventeen Sliding, Surfacing, and Screw-cutting LATHES, from 7½ in. to 28in. centres, on beds up to 26ft. long. Screwing and Tapping Machines, 2 in. and 3½ in., five Shaping, four Drilling, one 16 in Slotting, one 16 ft. plate edge Planing, one Cameron Punching and Shearing, one 6 spindle plate Drilling, and sundry other Valuable Machines.
One 24 ft. by 6½ ft. LANCASHIRE BOILER and Fittings.
One 5½ cwt. STEAM HAMMER, two Root's Blowers, Sawbench, and Band Saw.
Pair of nearly new and completely overhauled High-Pressure and Surface Condensing COMPOUND MARINE ENGINES, 120 N HP., with Screw Shafting, and Propeller, ex "Trenegless."
A large quantity of loose Tools and Appliances, New Stores, Belting, Chains, Ropes, Blocks and other Effects.
N.B.—The Tools are by Scriven, Holdsworth, Shanks, Hulse, Cameron, Fielding & Platt, Ellis, and other well known makers, and many of them have scarcely been used while some are perfectly new. Admission by Catalogue only, price 6d each, to be obtained from the AUCTIONEERS, Albert Square, Manchester, or 53, Queen Victoria Street, London, E.C. G 976

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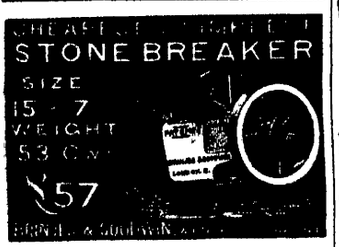
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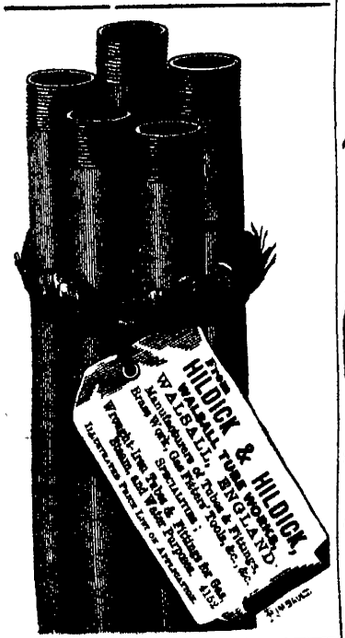
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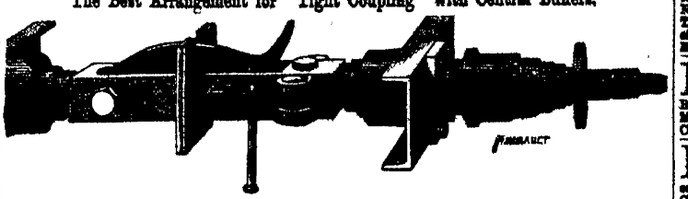
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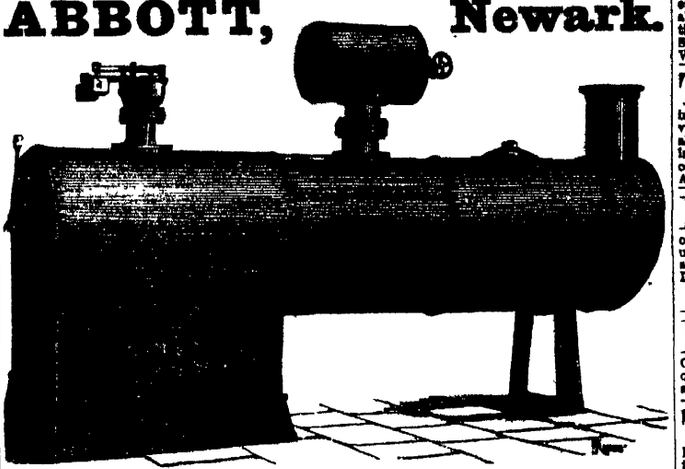
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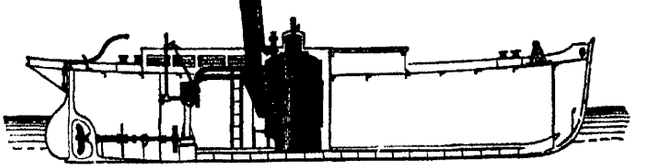


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Engelbert & Co	50
Evans, Jas. & Co	8
Fairburn & Hall	6
Falcon Engine & Car Works Ltd	1 & 11
Farnley Iron Co Ltd	21
Fernihough, John, & Sons	22
Fielding & Platt	1
Firth, Geo H	3
Fleming, A. B, & Co, Ltd	11
Forrestt & Son	1
Forsyth, Miller, & Co	10
Fowler, J, & Co	41
Francis & Co	1
Galloway, W & J, & Sons	45
Gandy Maurice	26
Gibbins R C, & Co	45
Gilmer, W F, & Co	21
Glasgow Hydraulic Forge Co	49
Glenboig Union Fire Clay Co	46
Glover & Hobson	17
Goodfellow & Matthews	38
Goodwin, James, & Co	45
Greaves, Bull, & Lakin	19
Green, Edward, & Son	43
Gresham & Craven	30
Haacke, A, & Co	10
Hadfield's Steel Foundry Co	1
Ditto ditto	32
Hannan & Buchanan	4
Hanson, W	12
Hardingham, G G M	39
Harris and Mills	4
Harvey, R, & Co.	47
Hastie, J & Co	3
Hathorn, Davey & Co	18
Ditto ditto	34
Hawthorn, R & W	2 & 40
Hayes, Edward	11
Hayes, J	17
Heenan & Froude	22
Hepburn & Gale, Ltd	19
Hett, T L.	38
Hick, Hargreaves & Co	31
Hilldick & Hilldick	4
Hill & Smith .	8
Hind & Son	40
Hodgkinson & Co, Ltd	17
Hodgkinson & Co	48
Hollorow & Co	12
Holden & Brooke	47
Hodgson & Stead	26
Horn & Son	4
Hornsby R., & Sons, Ltd	40
Hoult, J & W	24
Hudswell, Clarke & Co	2 & 36
Hunslet Engine Company	21
Hunter & English	1
India Rubber Gutta Percha, & Telegraph Works Co, Ltd	18
Inventors' Patent Right Association	4
Iron Foundry & Engineering Co	1
Jamieson & Patent Coking Co	23
Jessop Joseph, & Son	48
Jessop W, & Sons	35
Johnson & Phillips	1 & 13
Jones —	4
Jordan, T B, Son, & Cwmmanis	26
Kaye, Joseph, & Co	31
Keen J	2
Keenan, M.	18
Kell, Thos, & Son	1
Kendall & Gent	5
Kerr Stuart & Co	5
Kershaw & Pole	17
Kirk W, Price & Gemlty	3
Kirkstall Forge Company	14
Klein Schanzlin & Becker	7
Kirting Bros	17
Lancashire Patent Belting and Hose Co	1
Landale Jas	14
Landore Siemens-Steel Co	5
Leroy, F, & Co	10
Lewis, E, & Sons . .	1 & 44
Lindsay, R. B., & Co.	18
Lloyd & Lloyd	1
London Bros	42
Lowcock, Arthur	34
Lynn, J, & Co	21
Lyneghit, John, Ltd	30
Machinery and Purchase Hire Co	24
Mackie, J & J, & Co	15
Madan, C R.	17
Manchester Water Meter Co, Ltd	49
Manning, Wardle, & Co	1
Ditto ditto	40
Marshall, Sons, & Co, Ltd	50
Martin, G	48
Martin, W A, & Co.	21
Massey, B & S	1
Mather & Platt	38
Mather, G R	48
Mirrlees, Watson, & Yaryan Co, Ltd	4
Mirrlees, Watson, & Yaryan Co, Ltd	5
Mirrlees, Watson, & Yaryan Co, Ltd	6
Mirrlees, Watson, & Yaryan Co, Ltd	7
Mirrlees, Watson, & Yaryan Co, Ltd	8
Mirrlees, Watson, & Yaryan Co, Ltd	9
Mirrlees, Watson, & Yaryan Co, Ltd	10
Mirrlees, Watson, & Yaryan Co, Ltd	11
Mirrlees, Watson, & Yaryan Co, Ltd	12
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Mirrlees, Watson, & Yaryan Co, Ltd	98
Mirrlees, Watson, & Yaryan Co, Ltd	99
Mirrlees, Watson, & Yaryan Co, Ltd	100
Miller & Tapp	8
Monch, C	19
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Moreland R, & Son	7
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Smith Bros & Co	29
Smith & Wilshaw	14
Smith H Ford	24
Smith, Parfrey, & Hitchings	11
Smith Thos	26
Spencer & Co	16
Spencer, J K & S	4
Spencer John, & Sons	1
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Stanley W F	8
Stanman J	1 & 24
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Sterne, L, & Co, Ltd	1
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Stothart & Pitt Ltd	9
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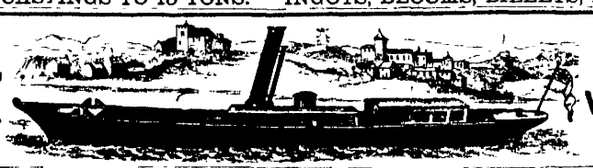
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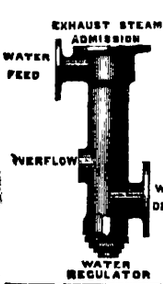
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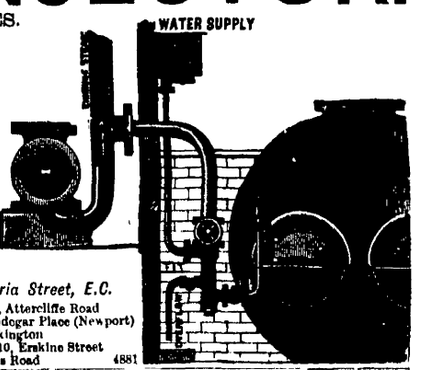
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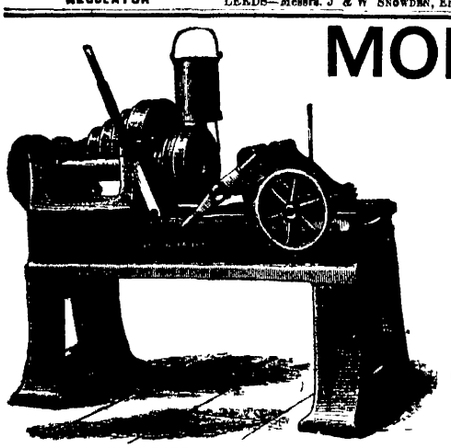
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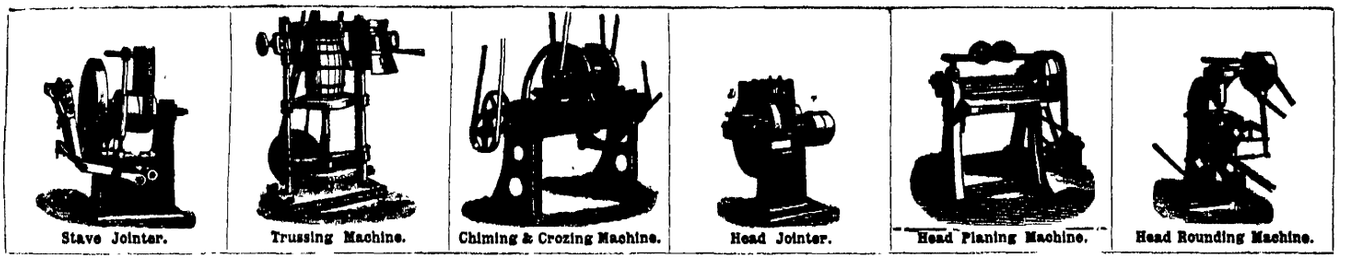
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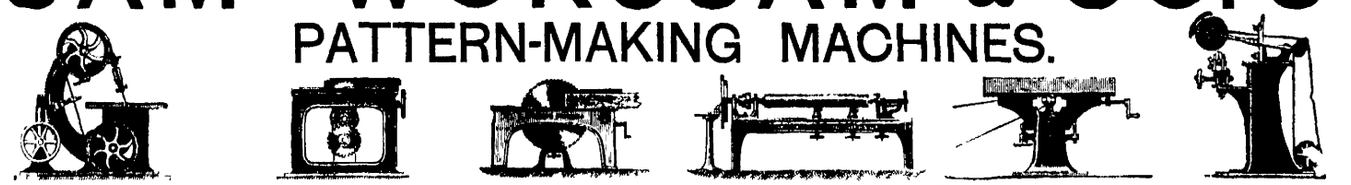
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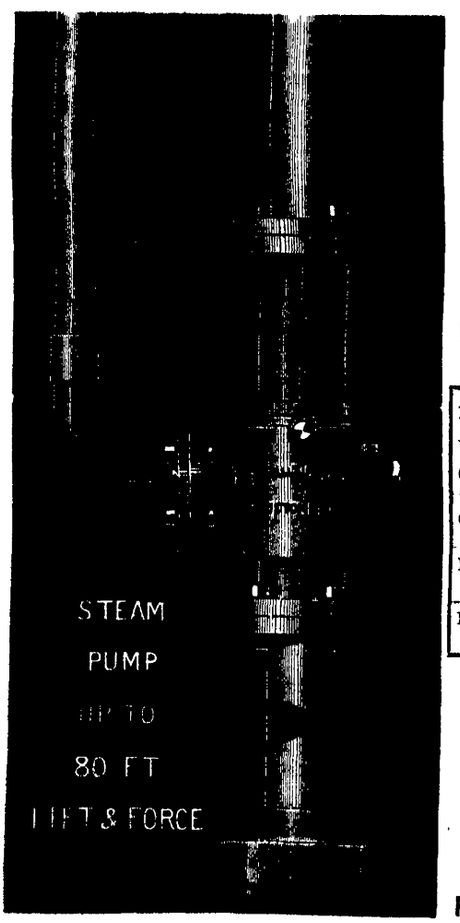
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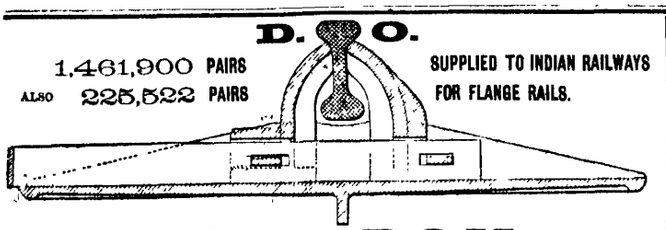
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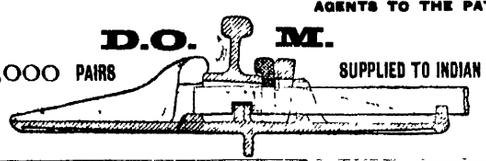
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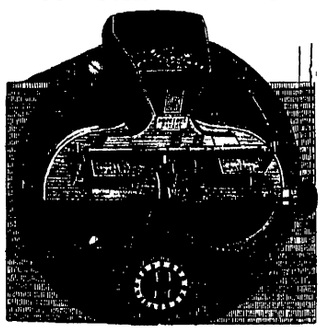
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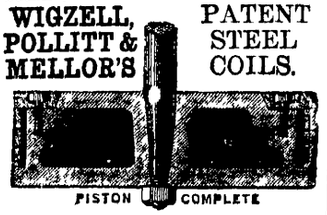
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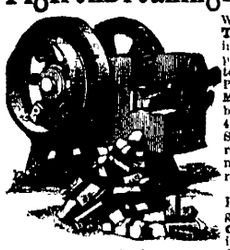
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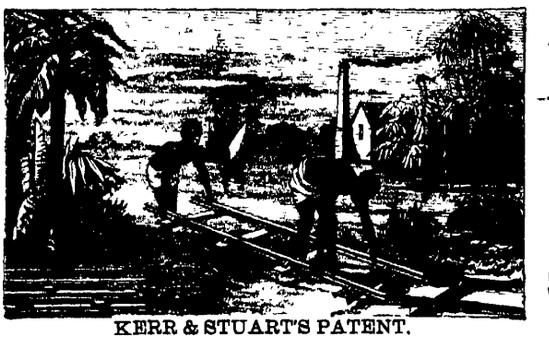
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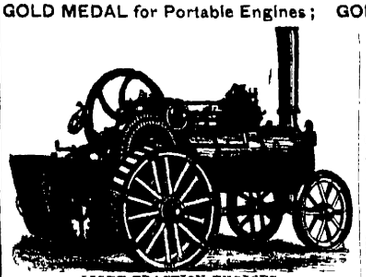
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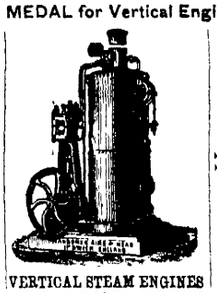
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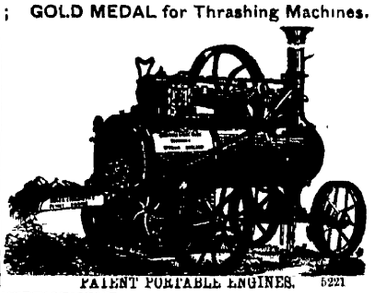
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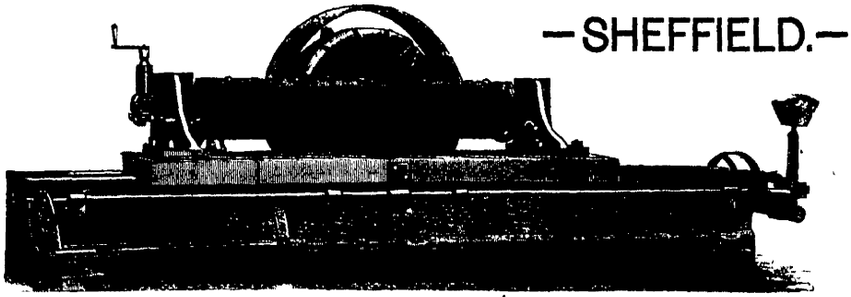


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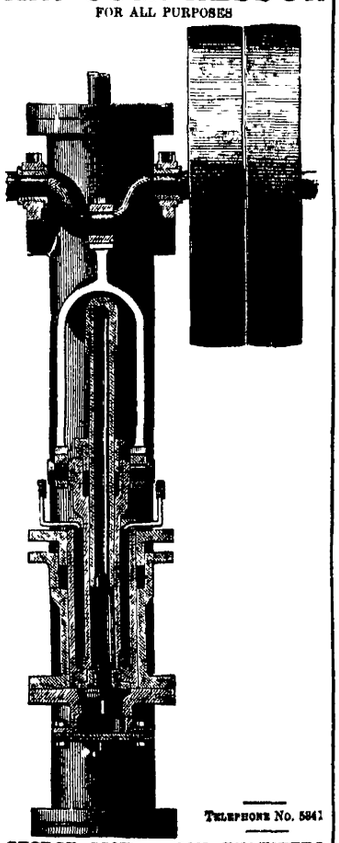
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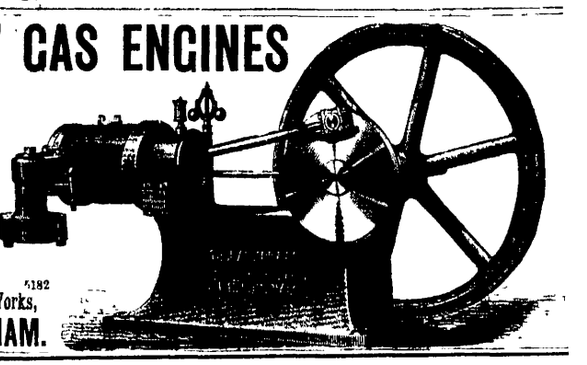
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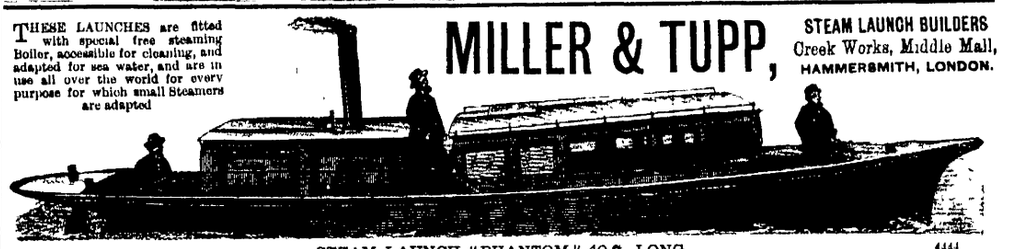
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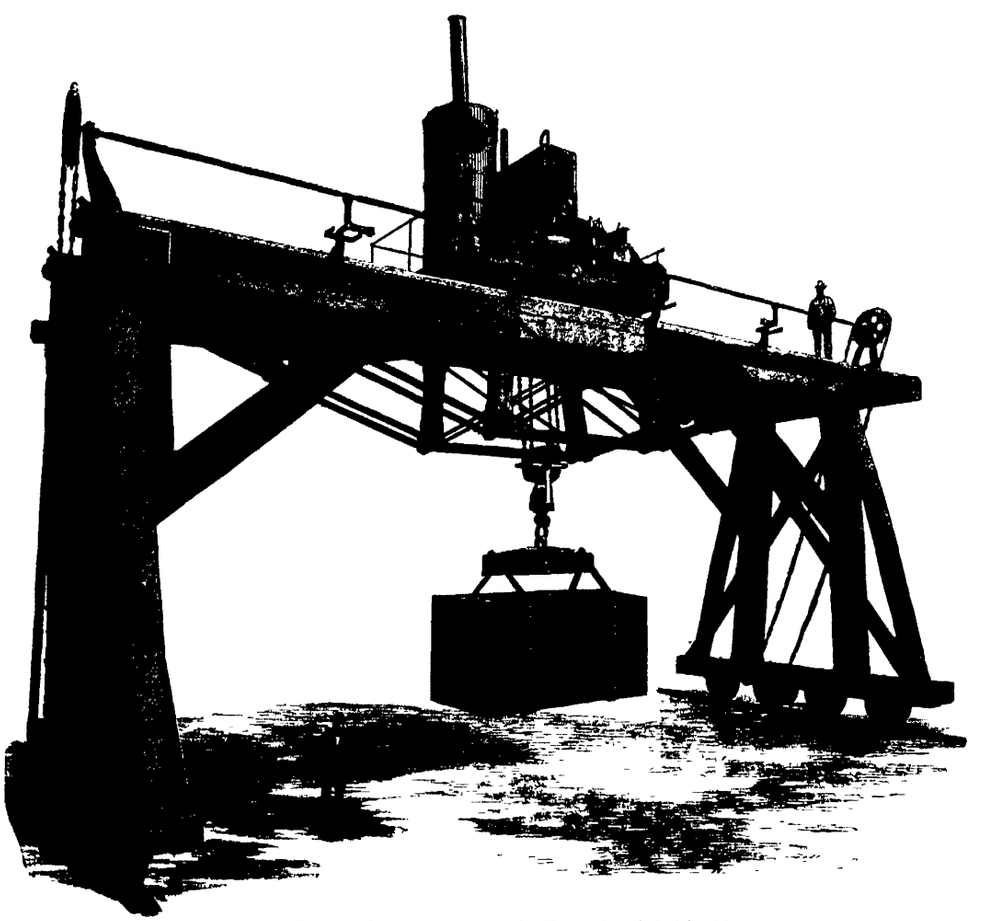


Fig. 133.—Engraved from a Photograph of a Steam Goliath to lift 40 tons.

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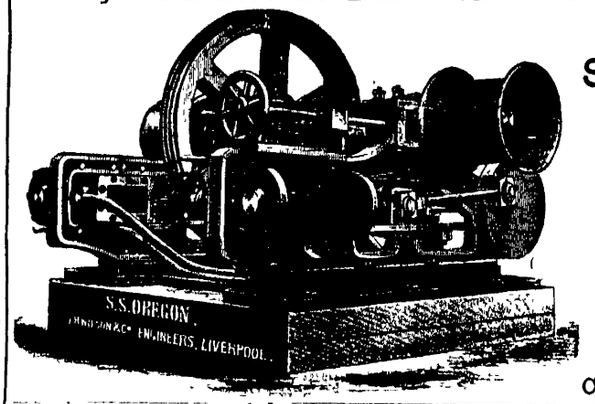
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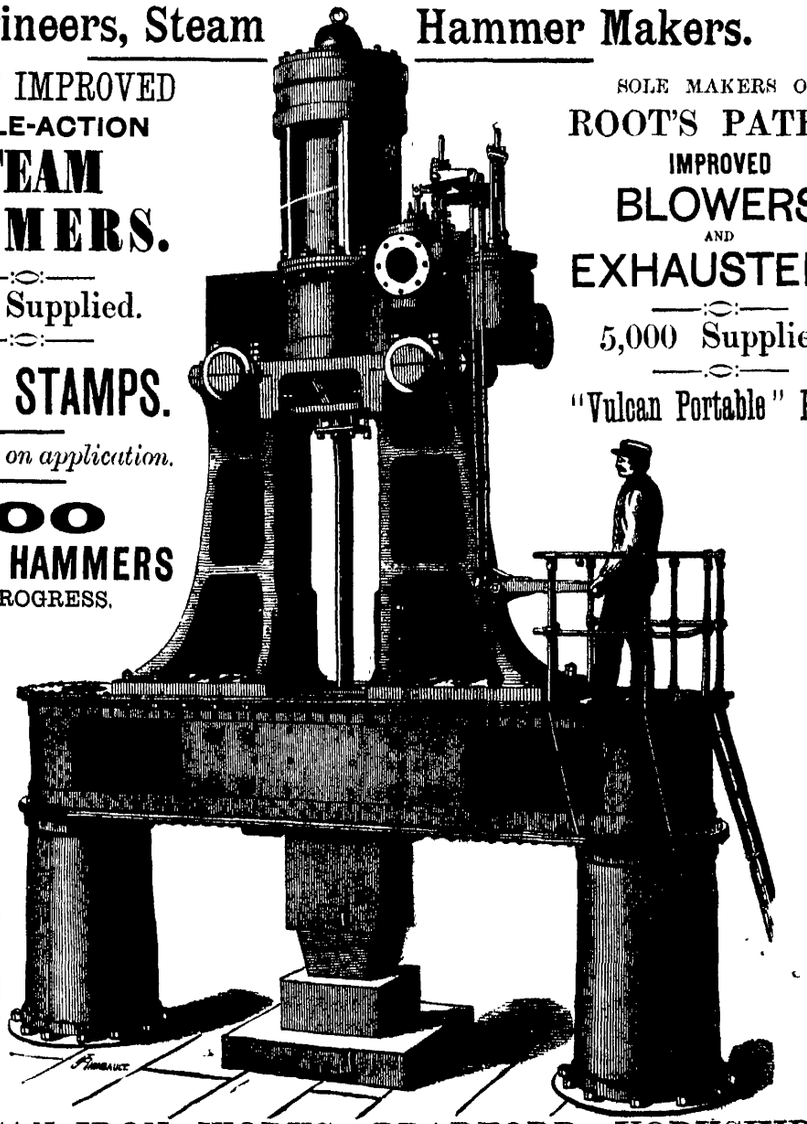
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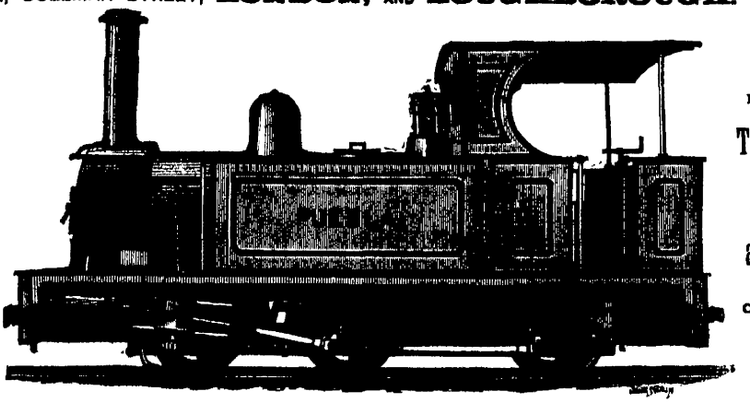
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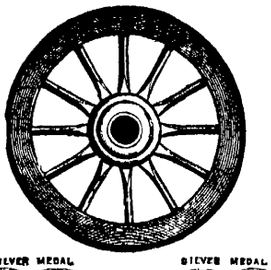
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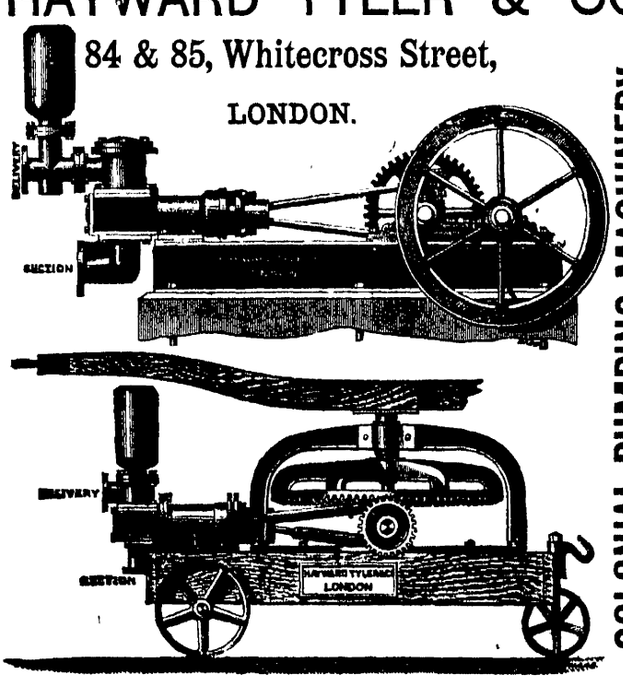
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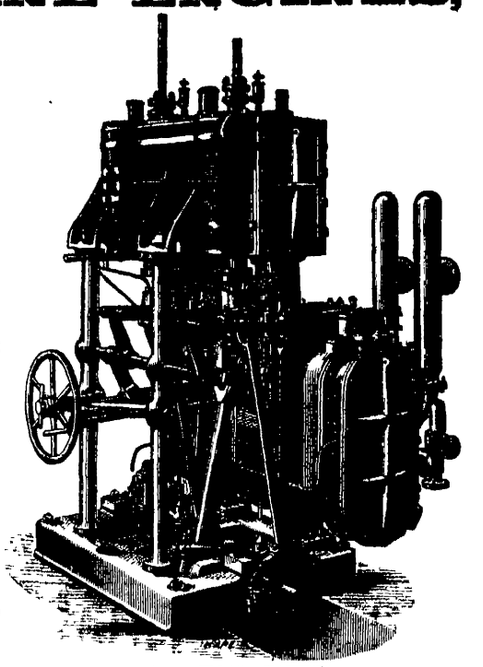
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Acorn and Midland Works, Darlaston, 3rd June.—"Dear Sirs,—In reply to yours of the 29th, the Capell 20 in. Fan we had of you is working satisfactorily, and is doing quite as much work as the 30 in. it replaced, and *taking less power* to drive it.—Yours truly, J. Simpson & Sons."

From S. Northwood & Son, Viaduct Foundry, Birmingham.—"We have much pleasure in testifying to the excellent manner in which the Capell Fan works which you supplied to us some time ago. Although a larger Fan than we had previously in use, it takes *considerably less power* to drive, while at the same time we get a better and more uniform blast, and Fan we do not drive up to speed." 5251

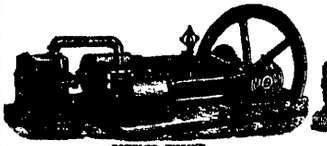
Agents for London and District:

Messrs. HOPKINSON & PRINCE, 15, Walbrook, London, E.C.

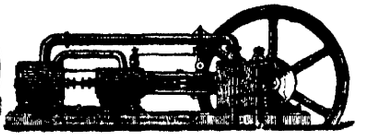
HOLBOROW & CO., Dudbridge Iron Works, Stroud,

MANUFACTURERS OF IMPROVED

Condensing & Non-Condensing Compound & High-Pressure Expansive Engines.



COUPLED ENGINE.



TANDEM ENGINE.

The **Coupled Engine** is fitted with HOLBOROW & Co.'s invention of Disengaging Valves, enabling either half to work independently should it be necessary through accident or repair, thus virtually making two Engines.

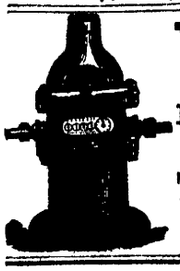
The **Tandem Engine** is designed so that pistons can be withdrawn altogether for repairs by simply removing covers; it has no more working joints than ordinary engine, occupies no more space, nor requires more expensive foundations.

A vacuum of 14 lbs. below atmosphere is readily maintained by new Single Acting Air Pump and Condenser, while consumption of fuel, as proved by exhaustive trial, does not exceed 2 lbs. per HP. per hour, and piping is above floor.

THEIR SIMPLICITY ENABLES VERY LOW PRICES TO BE QUOTED.

"An excellent action of the valves and an unusually good and well maintained vacuum. Exceptionally high vacuum—very great economy—exceptionally good results in economy."—*See Engineering*, Nov 19th, 1875, May 17th, 1878, and July 9th, 1881.

STEAM USERS, PLEASE SEND FOR PRICE LISTS. 5301



WATER METERS.

H. FROST'S PATENT.

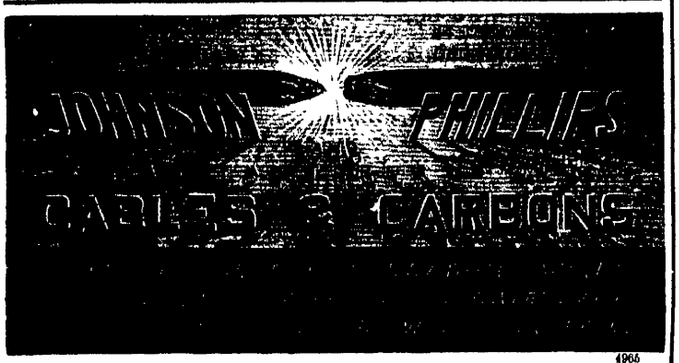
POSITIVE! RELIABLE! DURABLE!

Many Thousands in use both at Home and Abroad.

THE MANCHESTER WATER METER CO., Ltd.

TIPPING STREET, ARDWICK, MANCHESTER.

ESTABLISHED 1860 4433

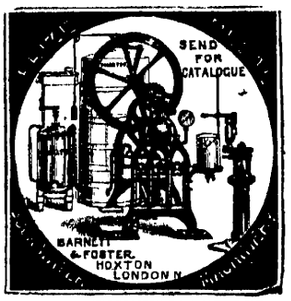


4965

Soda Water Machinery,

For the Manufacture of all kinds of Aerated Drinks in the highest state of perfection,

— BY —



BARNETT & FOSTER,

"NIAGARA WORKS,"

26º, EAGLE WHARF ROAD,

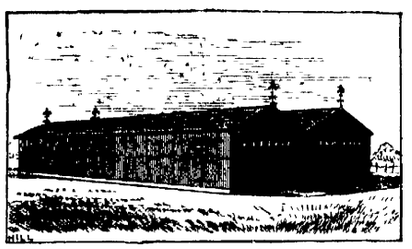
LONDON, N.

A COMPLETE SODA WATER MACHINE, including Bottling Apparatus, is supplied for £40 per set for producing 100 doz Lemonade, Ginger Ale, &c., per day

No technical knowledge is required, as all information is given to purchasers of Machines 4910

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IRON ROOFS & FIRE-PROOF BUILDINGS.



TANKS & CISTERNS.

Galvanizing Baths.

DAVIES BROS & Co CONTRACTORS FOR IRON ROOFS BUILDINGS BRIDGES &c CROWN IRON WORKS WOLVERHAMPTON

Galvanized and Painted Corrugated Sheets.

IRON ROOFS, IRON BUILDINGS,

ENGINE SHEDS, STORES.

Constructional Iron Work and Smiths' Work of every description. 5027

DAVIES BROS. & CO., Crown Ironworks, Wolverhampton.

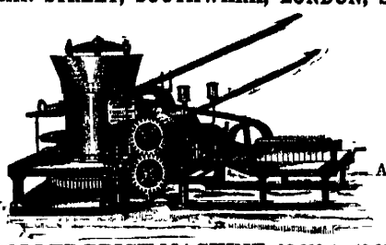
MURRAY'S PATENT BRICKMAKING MACHINERY.

Sole Manufacturers, THOMAS MIDDLETON & Co., Engineers,

LOMAN STREET, SOUTHWARK, LONDON, S.E.

Patent Steam Driven Cutting Tables.

Patent Lubricating Solid Die, for all sorts of Clay.



Patent Plunger Brick Press, for Bricks or Tiles.

Patent Brick Shaping Apparatus, for all kinds of Fancy Bricks.

IMPROVED ROLLER BRICK MACHINE, 12,000 to 40,000 Bricks per day, for Clamp and Kiln Burnt Bricks. 5164

Sole Manufacturers of all kinds of Clay Crushing Rolls, Mixing Mills, Steam Engines & Hydraulic Machinery.

S. OWENS & Co.,

WHITEFRIARS ST., LONDON, E.C.

HYDRAULIC ENGINEERS,

SOLE MANUFACTURERS OF

Blake's Patent Steam Pumps.

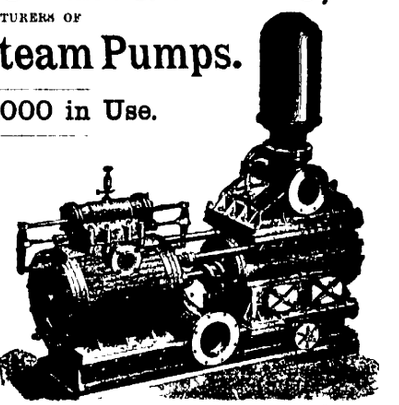
More than 16,000 in Use.

FOR PUMPING

TAR WATER,

OR

Ammoniacal Liquor.



5094

Price Lists and full Particulars furnished on application.

BILLINGTON & NEWTON,

SOLE MANUFACTURERS

OF



CROWN PHOSPHOR-TIN,

PHOSPHOR BRONZE,

PATENT FERRO MANGANESE BRONZE,

BABBITT'S & KINGSTON'S PATENT ANTIFRICTION METALS

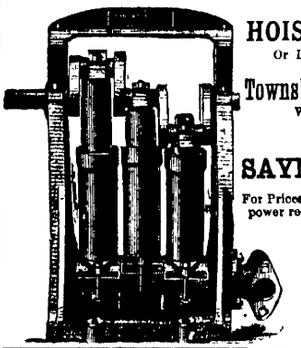
PLASTIC METAL AND WHITE BRONZE.

LONGPORT, STAFFORDSHIRE. 5159

Agents—London HAUGHTON & CO., 110, Cannon Street, E.C.
North of Europe A. SINGTON & CO., St. Peter's Square, Manchester
Scotland P. & W. MACLELLAN, Trongate, Glasgow.

JOHN RAMSBOTTOM'S

PATENT WATER ENGINES & STEAM PUMPS



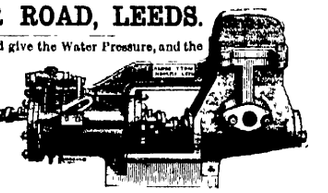
Are for HOISTING USES, Or Driving all kinds of Machines by Towns' Water Pressure Where sufficient

This Pump is UNSURPASSED Either for SIMPLICITY, PRICE, Or for General Efficiency

ADDRESS— 4986

SAYNOR ROAD, LEEDS.

For Prices, should give the Water Pressure, and the power required

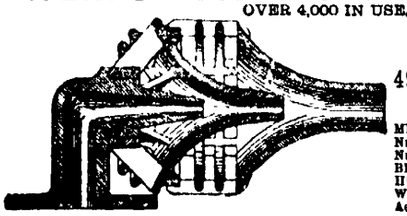


HIGH PRESSURE MARINE BOILERS.

Best and Cheapest Means of Preventing Unequal Expansion.

"WEIR'S" PATENT HYDROKINETER.

OVER 4,000 IN USE.

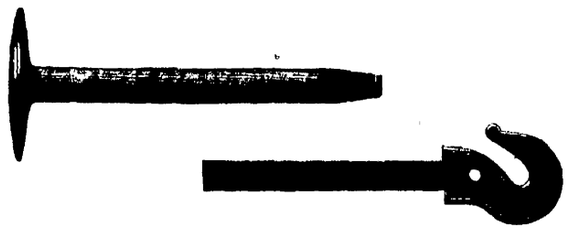


G. & J. WEIR,

49, JAMAICA STREET

GLASGOW.

MENZIES & BLAGBURN, King Street Newcastle-on-Tyne WM. REID & CO., 5 New London Street, London, E.C. A. & R. BROWN, Waterloo Road, Liverpool. R. HUGHES & CO., Fulton Street, ditto W. S. VON ESSEN, Engineer, Hamburg Agent for Scandinavia & Germany 528



Apply—THE KIRKSTALL FORGE CO, near Leeds 4686

"STANDARD" STEAM BOILING NOZZLE

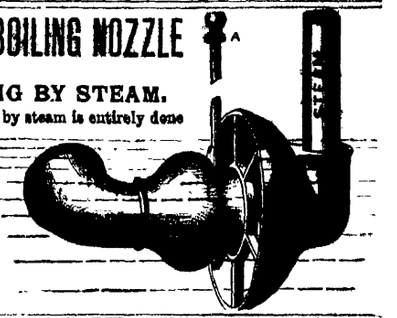
FOR

HEATING OR BOILING BY STEAM.

The objectionable noise when boiling by steam is entirely done away with, and the liquor Heated or Boiled QUICKLY, ECONOMICALLY, and SILENTLY.

¼	⅜	½	1	1½	2	3	4 in pipe
50/-	60/-	65/-	100/-	130/-	175/-	260/-	

NUMEROUS TESTIMONIALS. 4991



PICKING, HOPKINS & CO.

BOW, LONDON, E.

THE BOWLING HOOP OF EVERY DESCRIPTION IN IRON OR STEEL

STEEL CASTINGS

THE BOWLING IRON Co LTD

BRADFORD YORKS

ORIGINAL PATENTEES AND SOLE MAKERS

4567

—: MAKER OF :—

SUGAR, RICE AND FLOUR MILLS,

STEAM ENGINES,

Boilers,

LINOLEUM MACHINERY.

SUGAR MACHINERY

JAMES LANDALE,

Engineer, KIRKCALDY, N.B. 4945

East Ferry Road Engineering Works Co., Limited,

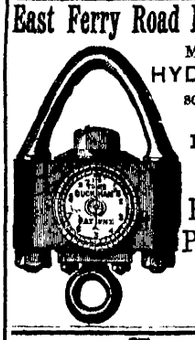
MILLWALL, LONDON, E.

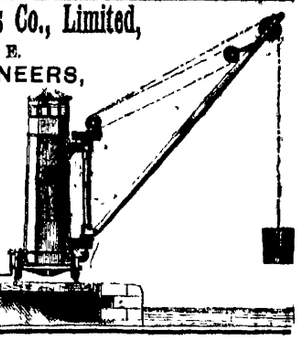
HYDRAULIC ENGINEERS,

SOLE MANUFACTURERS OF

Parkes's Patent Portable Hydraulic Cranes, Lifts, and Hoists.

F. E. Duckham's Patent Suspended Weighing Machines. 6123





Ships' Engine and Steering Telegraphs.

Over 3000 Vessels have been fitted with CHADBURN & SON'S Patent Telegraphs, including all the noted Steamers in the World, also 200 Vessels for English and Foreign Navies

EXHIBITION AWARDS } LONDON, PARIS, N E COAST, AMSTERDAM, FISHERIES.



CHADBURN & SON'S NEW PATENT DUPLEX GONG 1883.

ENGINE AND STEERING REPLY TELEGRAPHS.



ORDERS INDICATED BY SOUND & SIGHT.

A DEEP GONG from Astern to Ahead

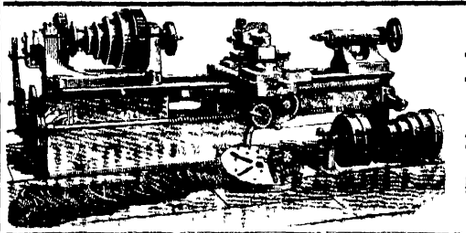
A SHRILL GONG from Ahead to Astern.



TELEGRAPH WORKS WATERLOO ROAD,

GLASGOW 69, ANDERSTON QUAY LIVERPOOL. LONDON—96, FENCHURCH ST.

6040



SPECIALITY IN LATHES

SMITH & WILSHAW,

HALIFAX, ENGLAND

Makers of all kinds of

Improved Self-Acting, Sliding, and Screw Cutting Lathes,

For Foot or Power 5220

"CLIMAX" Patent PARALLEL VICES.

Steel Jaws and Wrought Iron Sliding Bars,

INSTANTANEOUS in action,

SIMPLE in construction, ECONOMICAL in use

Width of jaw	Opens.	Size of Bar	Price
3 in ..	6 in..	1¼ by 1 in	32s.
4 in.	8 in ..	2 by 1½ in	40s
5 in	10 in.	2½ by 1½ in.	50s.
6 in.	12 in	3 by 1½ in...	70s.
7 in	14 in	3½ by 1½ in	100s



Easily and quickly adjusted without using the screw, saving time; secure grip obtained by screw and lever, the best combination for the purpose, screw is never exposed and only used for tightening the grip, opens double the width of the jaws, few and simple in its parts not liable to get out of order, there being no cams, toggles, hooks and clutches, strong and durable, working parts wrought iron and steel.

PATENTEES AND MANUFACTURERS: 5352

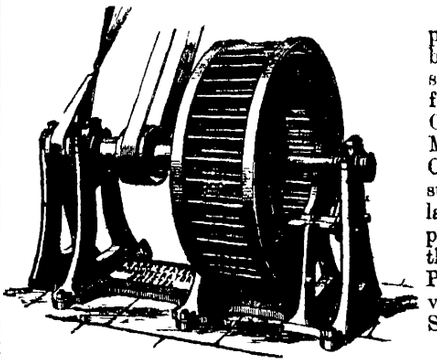
CRAMPTON BROS., 25, West Bar Green, SHEFFIELD.

"CARR'S DISINTEGRATOR,"

Registered Trade Mark, No. 6380.

AWARDED BRONZE MEDAL, PARIS UNIVERSAL EXHIBITION, 1878.

CARR'S PATENT DISINTEGRATOR.



This Machine effectually pulverizes by the combined influences of percussion and of centrifugal force, Iron, Zinc, and other Ores; Asphalte, Artificial Manures, Phosphates, Fire Clay, and many other substances. It is also largely in use for the pulverization of Coal for the manufacture of Coke, Patent Fuel, &c.; and is very effective for mixing Sugar.

These Machines are capable of reducing to a fine granular powder from 50 to 200 tons per day (according to size) of any unfibrous material. Machines made to order from 18 inches diameter, to suit special requirements of purchasers; these small machines being specially adapted to the requirements of Chemical Manufacturers for Mixing and other purposes.

No Agents. All Machines will in future bear the Registered Trade Mark ("Carr's Disintegrator") in three places—viz: on Bedplate, and on outside Face of each Cage.

A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee, 2528

PHILIP TRIGGS, Albion Chambers, BRISTOL.

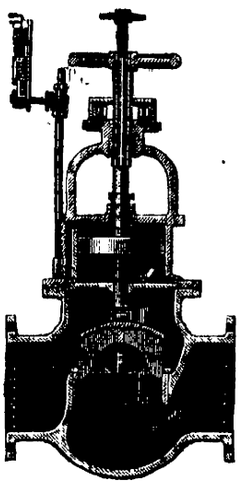
TATE'S PATENT

Electric Valve-Closing Apparatus

FOR STEAM ENGINES.

Medals Awarded AT THE INDUSTRIAL EXHIBITION, BRADFORD, 1882.

INTERNATIONAL FISHERIES EXHIBITION, LONDON, 1883.



THIS *APPARATUS* IS LARGELY USED ON STATIONARY ENGINES WITH THE GREATEST SUCCESS.

DUNCAN BROS.,

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AND
79, COMMERCIAL STREET, DUNDEE.

TELEGRAPHIC ADDRESS—"DOUCINE, LONDON."

Monthly List of New Machinery in Stock, POST FREE. 4190

GEO. BOOTH & CO.,

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MAKERS OF

LATHES

PLANING, SLOTTING, SHAPING, BORING, DRILLING, AND SCREWING MACHINES.
SPECIALITY.
Punching & Shearing,
PLATE BENDING,
PLATE PLANING,
ANGLE-IRON BENDING,
And all Classes of Shipbuilders' and Boilermakers' Tools.

ALSO SELF-ACTING STEAM HAMMERS.
Contractors to the British and Foreign Governments. 4748

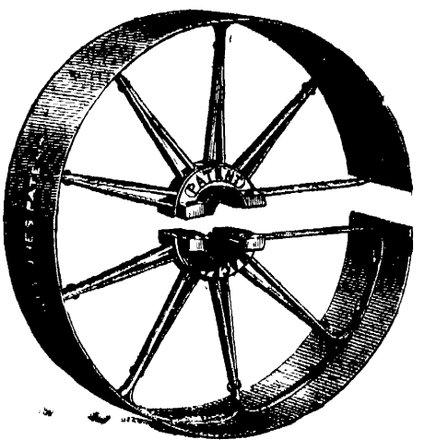


MACKIE'S

PATENT WROUGHT IRON SPRING PULLEYS,

Adopted by the Lords of the Admiralty, the War Department, the leading Engineers, &c.

L'EXPOSITION INTERNATIONALE D'ELECTRICITÉ, PARIS, SEPTEMBER, 1881.



INTERNATIONAL ELECTRIC EXHIBITION, LONDON, December, 1881.

ELECTRIC DESIGN.

Specially recommended for export on account of their Lightness & Strength

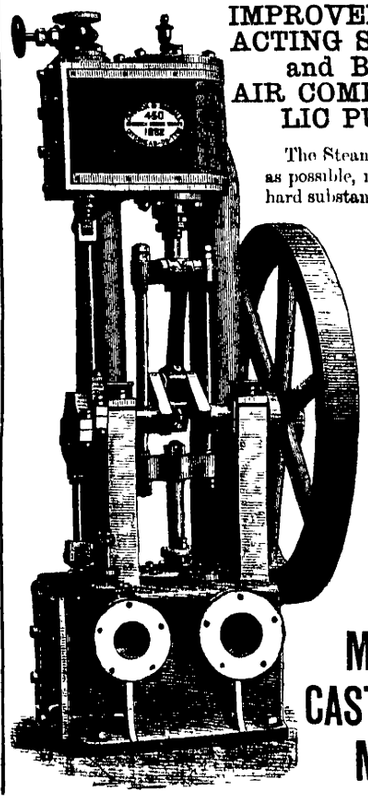
SOLE MANUFACTURERS:

J. & J. MACKIE & CO.

BERKS IRON WORKS,
READING. 4104

CARRICK & WARDALE,

Redheugh Engine Works, GATESHEAD.



IMPROVED SINGLE & DOUBLE ACTING STEAM FEED, BILGE and BALLAST PUMPS, AIR COMPRESSORS, HYDRAULIC PUMPS & PRESSES.

The Steam Pumps as illustrated are, as nearly as possible, incapable of being choked, save with hard substances, and in working it has been found that shavings, waste, corn, small coals, &c., pass easily through, which renders them eminently suitable for ballast pumps for ships.

They are largely used in Chemical Works, Breweries, &c, where ordinary lifting valve pumps are readily choked, and by Railway Companies for supplying water at watering stations.

MAKERS OF EVERY DESCRIPTION OF CHEMICAL WORKS MACHINERY AND CASTINGS, HYDRAULIC MACHINERY, &c. 5134

THE STEEL COMPY. OF SCOTLAND,

LIMITED.

(SIEMENS PROCESS).

150, HOPE STREET, GLASGOW.

MANUFACTURERS OF

Steel Rails, Plates, Angles, Beams, Bars, Hoops, Forgings, Steel Castings, Blooms, &c. 1091

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CONTRACTORS TO THE ADMIRALTY AND FOREIGN AND COLONIAL GOVERNMENTS.

MANUFACTURERS OF

STEEL PLATES, SHEETS AND BARS

(Siemen's Process) and

IRON SHEETS, PLATES AND BARS

FOR SHIPS, BOILERS, BRIDGES, &c.

	Ship	Boiler	Special	Extra Fine
Brands	P S	P SS	P SB	P SB
	Steel	Steel	Steel	Steel

FOR COMBUSTION CHAMBERS

Boiler End & Furnace Plates, Flanged & Welded. Special Steel for Anti-Collapse Rings & Welded Tubes.

IRON AND STEEL FORGINGS OF ANY DIMENSIONS FOR MARINE ENGINES AND OTHER PURPOSES.

IRON AND STEEL CRANK SHAFTS OF SPECIAL MANUFACTURE.

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Belfast, 67, Donegall Street | H. H. BUTLER | Rotterdam, Willemskade No 9 | Post van der BURG & Co

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FORSYTH, MILLER, AND CO.,

BROAD STREET, MILE END, GLASGOW.

IMPROVED

Malleable Iron (or Steel) Castings.

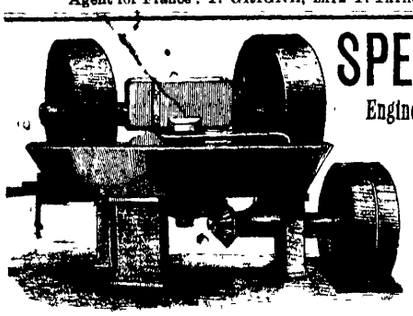
Hydraulic Cylinders,

Spur Wheels and Pinions for Rolling Mills, and other Heavy Castings up to 6 Tons.

London Office: Crown Wharf, 5, Upper Thames St., E.C.—GEORGE HATCH, Agent.

To which Small Patterns may be sent.

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Agent for France: T. GRIGNE, late T. Tatin, 12, Rue de Malte, Paris. 4911



SPENCER & CO.,

Engineers, Millwrights, & Founders,

MELKSHAM, WILTS.

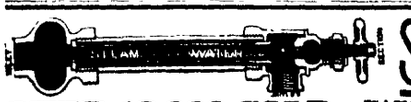
GRINDING MILLS

FOR

LOAM, COAL, OR BLACKING.

3½ ft. pan, 5 cwt. Rollers £217
4½ ft. „ 10 cwt. „ £227

— LARGER SIZES FOR MORTAR, LIME, ORE, &c., ON APPLICATION. — 5162



STEAM TRAPS

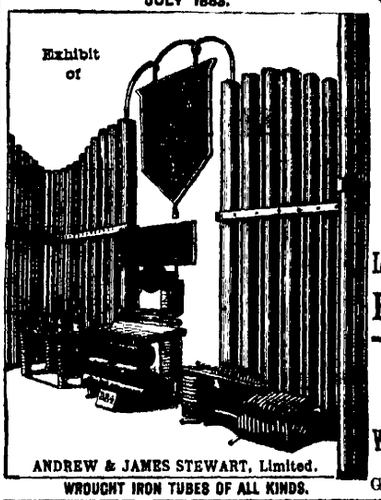
OVER 13,000 SOLD. VAUGHAN'S PATENT WATER
SILVER MEDAL AWARDED. EJECTOR OR STEAM TRAP.
POSITIVELY THE ONLY RELIABLE APPARATUS EVER MADE

	CAN BE APPLIED TO	
Satisfaction Guaranteed.	Steam Engine Piping	Steam Hammer Pipes and Cylinders
Simple. Cheap.	„ „ Cylinders	Heating Pipes.
Saves broken joints, broken cylinders, broken pipes.	„ „ „ Jackets	Heating apparatuses of all kinds.
Absolutely reliable.	„ „ Valve Casings	&c., &c., &c 4856
Unvarying.		

VAUGHAN & SON, Royal Ironworks, WEST GORTON,
Contractors to H.M Government, **MANCHESTER.**

London Agent: JAS. KEITH, 67, Holborn Viaduct. Belfast: Messrs. PATTERSON & SONS.

ENGINEERING & METAL TRADES' EXHIBITION, LONDON, JULY 1883.



ANDREW & JAMES STEWART, Limited.
WROUGHT IRON TUBES OF ALL KINDS.

ANDREW & JAMES STEWART, LTD.

Clyde Tube Works,
GLASGOW
AND
COATBRIDGE.

Address
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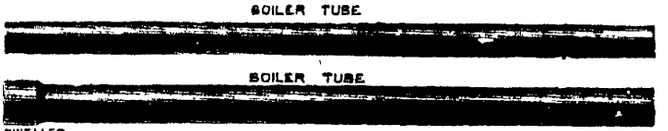
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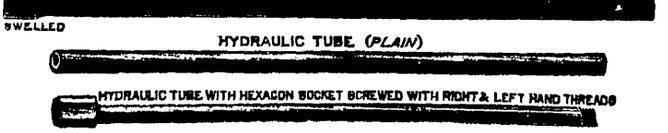
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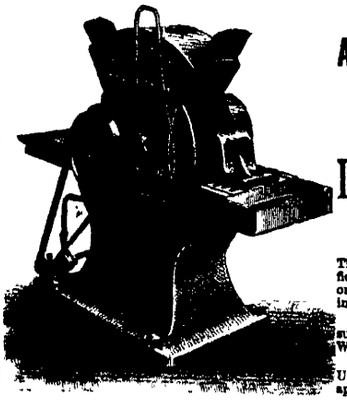
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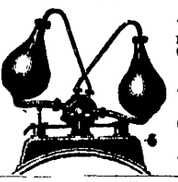
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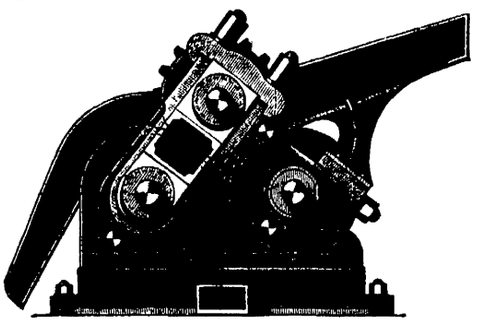
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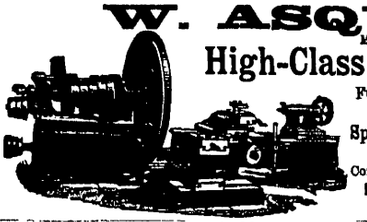
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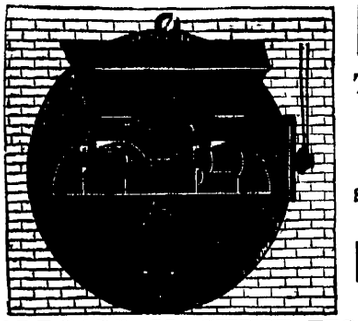
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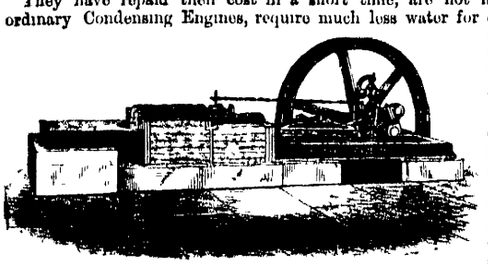
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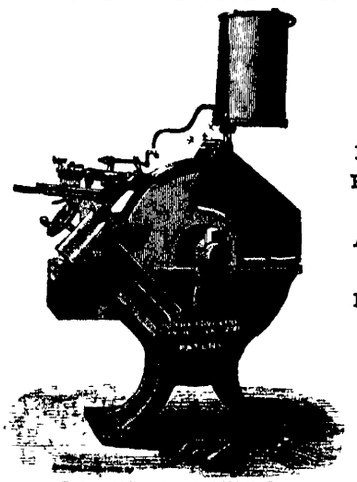
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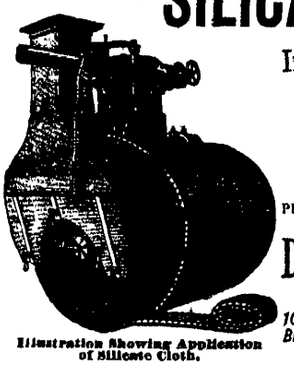


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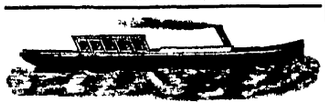
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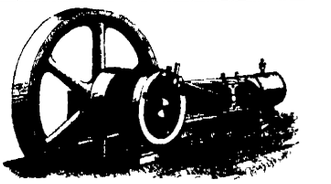
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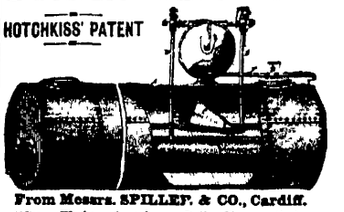
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MECHANICAL BOILER CLEANER.
HOTCHKISS' PATENT

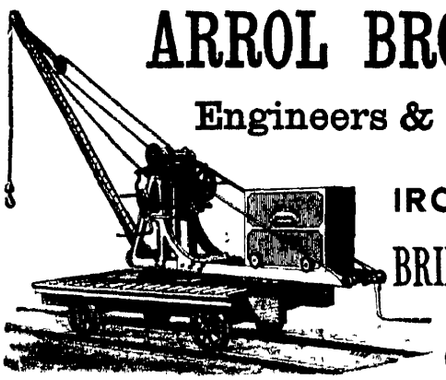


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These Bridges, in Steel, can be erected by ordinary workmen, easily taken to pieces and removed in one hour, and combine lightness with great strength.

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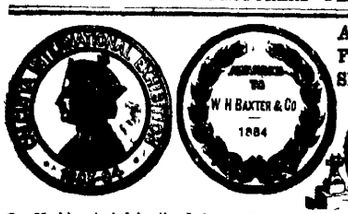
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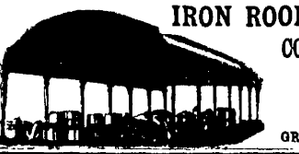
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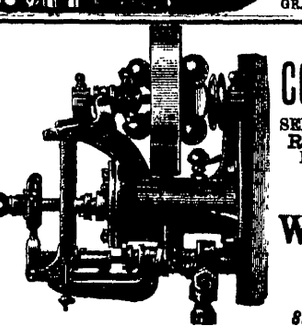
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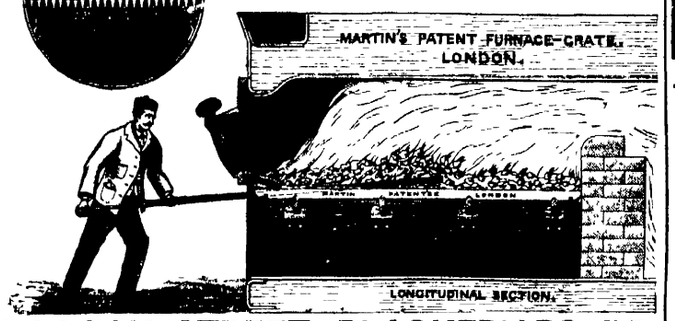
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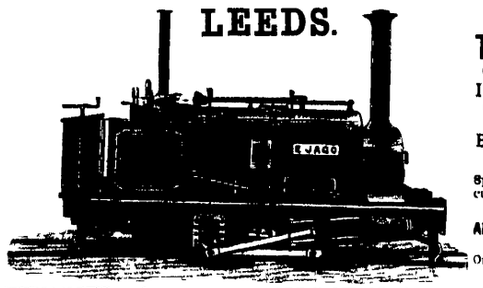
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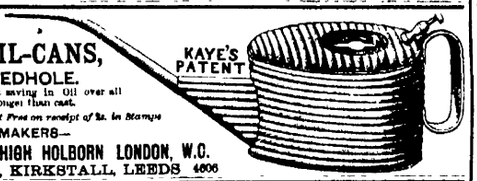
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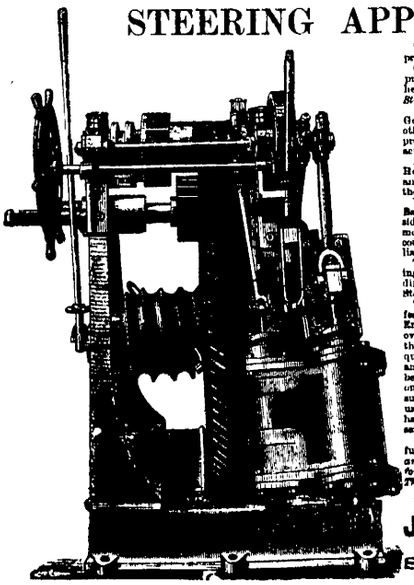
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The Gear is perfectly automatic, the Engine responding to the action of the Steersman instantly in either direction, so that as good a course can be steered by Steam as by Hand power

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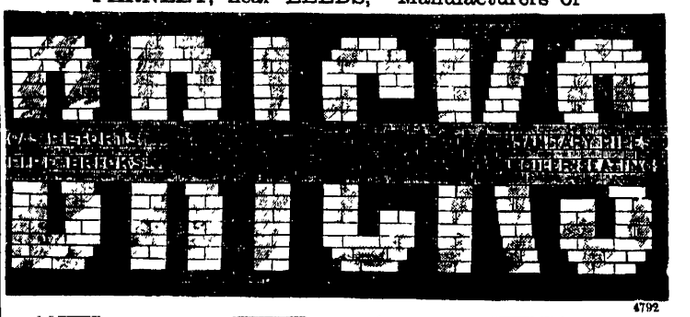
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Gas produced without fire or heat For Lighting all places where Coal Gas is unobtainable

Sizes, 12 to 500 Lights and above

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Machine Muller à faire le gaz (dite Alpha)

Elle produit le gaz sans feu et sans chaleur Elle sert à éclairer tous les endroits où l'on ne peut se procurer du gaz de charbon

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For power in all places where Coal Gas cannot be had

The Engine makes the Gas by which it is driven

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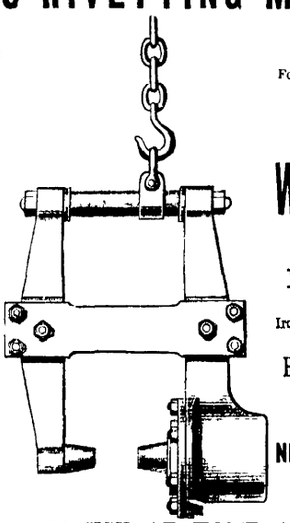
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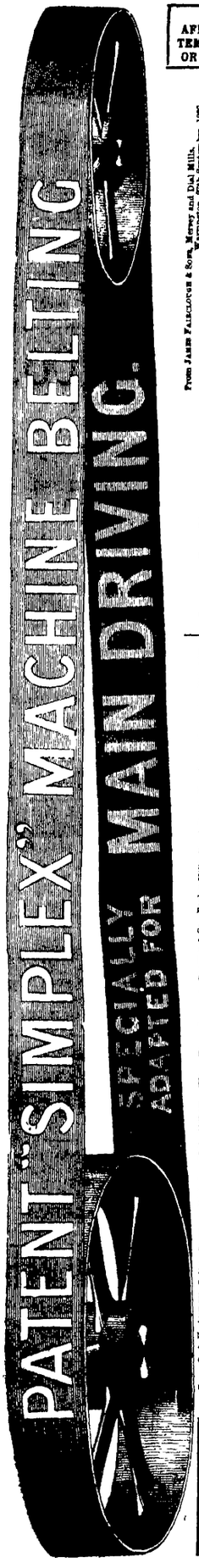
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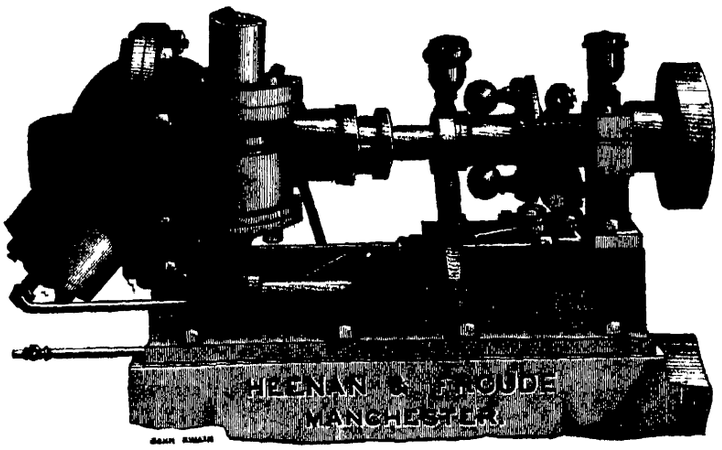
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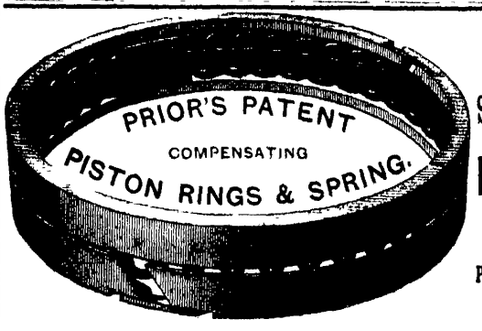
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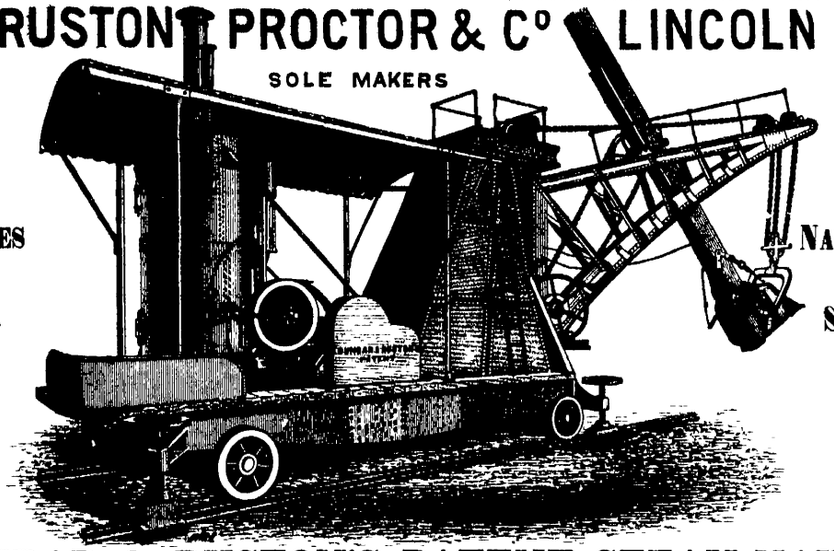
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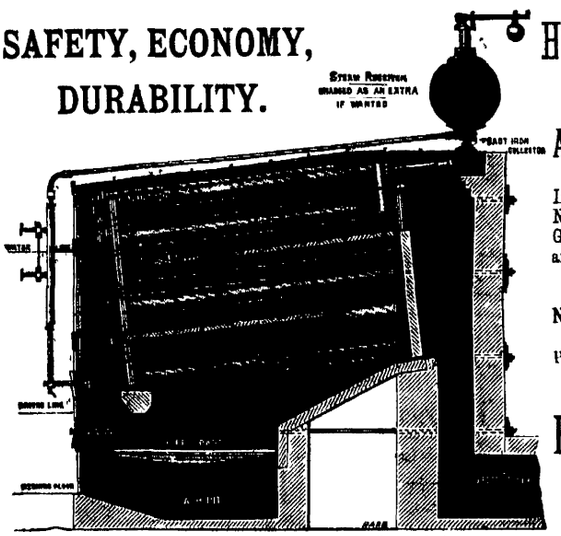
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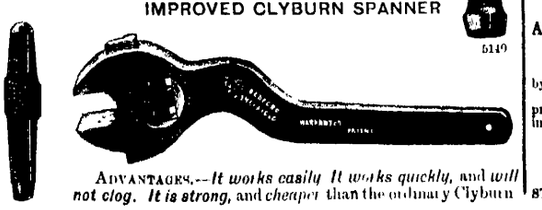
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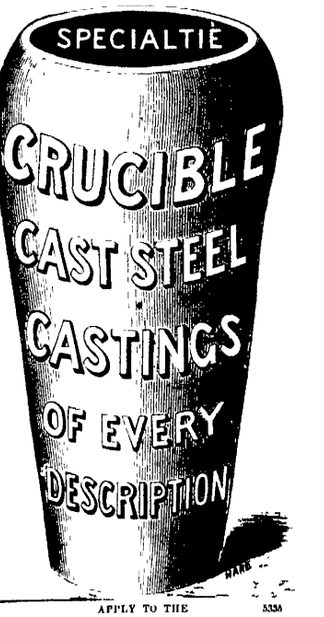
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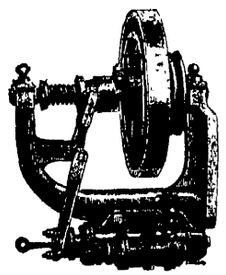
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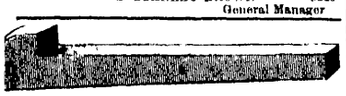
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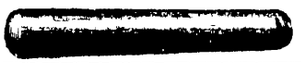
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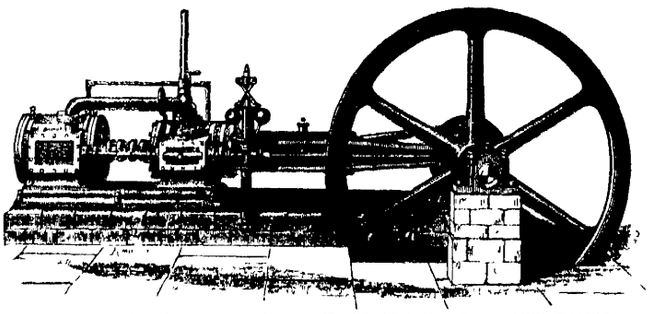
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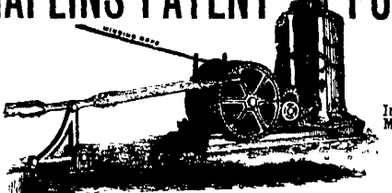
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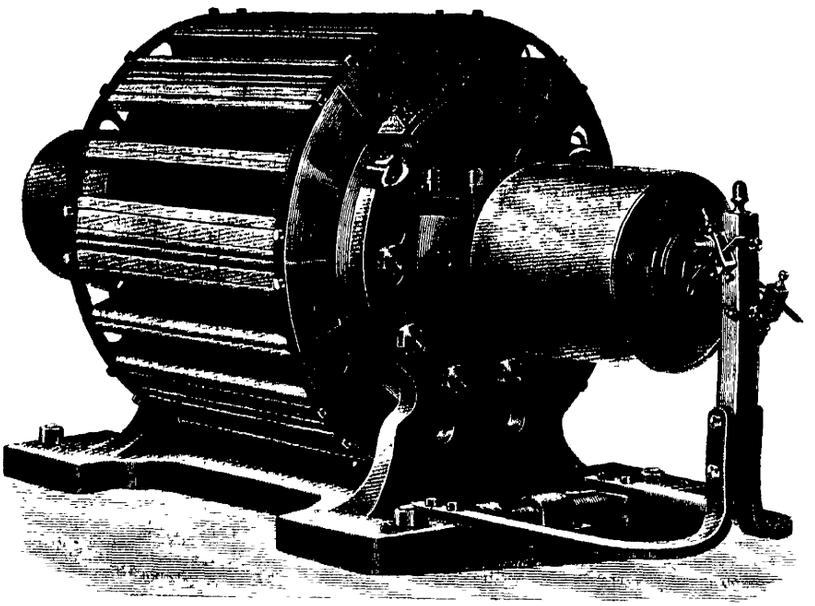
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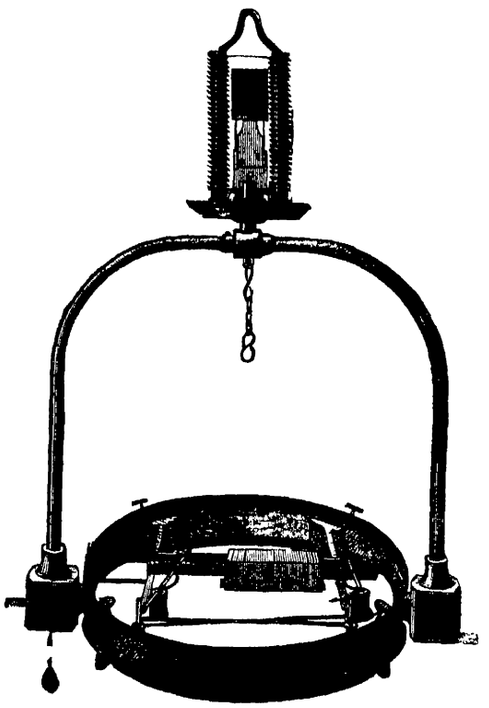
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ELECTRIC LIGHTING AT THE INTERNATIONAL HEALTH EXHIBITION.

No. IX

THE cascades at the ends of the two ponds which run down each side of the grounds, the Pavilion and grounds of the Water Companies' exhibit, and the Duke of Westminster's iron column, are illuminated by the Electric Sun Lamp and Power Company of 6, Ridinghouse-street, Regent-street Since the date of our former notice* the sun lamp, or as it was then called the "lampe soleil," has undergone considerable simplification, and the complicated block in which the carbons were burned has been reduced in size and cost. The principle, however, remains the same The light-giving power of the voltaic arc is entirely subordinated to its heating capacity, the carbons being practically hidden from view within a block of Carrara marble, through which the arc plays, raising it to a high pitch of incandescence The glowing stone gives off rays of a warm and golden tint which differs very much in their character from those of an ordinary arc lamp, being quite free from the usual moonlight character, and very steady The light depends upon the temperature of the marble, and consequently does not readily respond to variation in the structure and composition of the carbons, or to oscillations in the speed of the engine The block acts as a reservoir of heat, and likewise forms a guide for the arc, which cannot travel round and round the carbons, casting a brilliant light to one side and little or none to the other, as it is very apt to do when left to its own regulation The effect obtained at the Health Exhibition is very pleasing, particularly at the cascades, and by its ruddy glow catches the eye immediately, being distinct from the appearance of both arc and incandescence lamps of the ordinary type There are twenty-two lamps in all—five in the Water Companies' Pavilion, five on the Duke of Westminster's standard, four on the cascades, four in the engine sheds, and four in the store room

The annexed engraving shows diagrammatically the essential part of a sun lamp Two carbons, each about 6 in long, are pressed by springs into two recesses in a block of marble One of the carbons is tubular and carries within it a second



carbon pencil, which can be pushed forward when desired, through a passage joining the two recesses, until it meets the other—that is, the solid carbon The object of this is to enable the arc to be established when the lamp is started or when it becomes accidentally extinguished Formerly, when the two carbons met at an angle, instead, as now, of being in the same straight line, they were joined by a wick of carbon, as in the Jablochkoff candles, but this did not permit of them being readily relighted, and has been abandoned in favour of the present arrangement Below the line of the recesses into which the carbons abut, and centrally between them, is an inverted crater, from which the light is emitted A section of this crater taken in the centre line of the carbons is conoidal, while a section at right angles to this resembles an inverted gutter The whole of the under surface becomes incandescent, and throws its light downwards in diverging directions covering an elliptical area of floor space This is a great improvement on the original form of the marble block, which emitted a cone of light which at moderate elevations did not cover a large area For most indoor purposes, and also for street lighting, a greater length of illumination is required in one direction than another and a lamp which gives an equal effect all round wastes much of its power on the walls and other surroundings

The marble block is mounted in a cast iron box, from the opposite sides of which there emerge two tubes to carry the carbons These are constantly

* See ENGINEERING, vol. xxxii., page 454.

pressed towards each other by arms attached to the ends of coiled springs, as shown in the lower figure on the preceding page, which illustrates a sun lamp with the globe removed The inner carbon which establishes the arc, is either operated by hand or automatically, according to the construction of the lamp In the former case a cord, depending from the lamp, is attached to a rod which abuts against the pencil, and when the cord is pulled the rod is pressed forward and then recedes as the cord is released When the action is automatic there is mounted on the frame a high resistance solenoid in a derived circuit When the circuit is established the current raises the core of the solenoid. This is coupled by a lever and a pawl and ratchet wheel to a drum, around which there passes a weighted cord connected to a lever attached to the carbon pencil When the core rises the pencil is pushed forward, and as soon as it touches the opposite carbon a fresh circuit is opened to the current across the arc The solenoid is cut out of circuit by the safety switch described below, immediately loses its power, and its core falls, rotating the drum and drawing back the pencil to establish the arc.

All the lamps are arranged in series, and therefore need to be supplemented by self-acting switches to prevent the extinction of one breaking the circuit to all the rest. A switch is mounted above each lamp, and comprises a solenoid with two mercury contacts When the circuit is intact the solenoid is in series with the arc, and as long as the lamp is alight the current flows through it, keeping the core raised, and holding one of the contact pieces it carries out of the mercury cup which is situated below it When the arc is broken the core descends and a fresh path is opened for the current It enters the lamp at the positive terminal and passes into the first cup, from thence it goes by a contact wire carried on the core into a second cup, and through a resistance coil to the negative terminal This apparatus is shown on the top of the lamp in Fig 2, the resistance being made in two parts, one at each side of the solenoid The solenoid core is counterweighted in a very ingenious manner. One of the mercury cups below it is made larger than is necessary for the transmission of the current and receives a pear-shaped float depending from the core By adding or removing a few drops of the fluid the equilibrium of the core can be regulated as desired In the automatic lamps metal contacts are substituted for the mercury cups as they remain in action only a moment, and the resistance coil is wound on a hollow bobbin to form the solenoid mentioned above

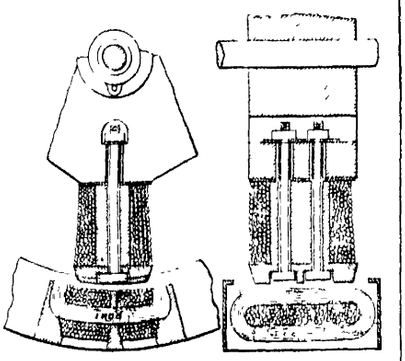
The Sun Company states that the marble lasts twenty-five to thirty hours, and costs sixpence The carbon pencils each waste at the rate of ½ in per hour, and cost one shilling per foot, or one farthing per hour for the two There is no waste, as a new one can be inserted behind a short piece of the preceding one, and can feed it up to the last fragment The current, which may be either direct or alternating, varies from 5 to 25 ampères according to the power of the lamp, while the electromotive force necessary to maintain the arc diminishes with the increase of the current, the larger lamps having the smaller resistance The following Table gives the particulars of the requirements and performances of the lamps

Ampères	Volts	Watts	Horse Power	Total Candle Power	Candle Power per Horse Power
8	110	880	1·2	900	750
10	95	950	1·3	1000	850
12	90	1080	1·5	1500	1000
16	75	1200	1·6	2000	1250
25	60	1500	2·0	3800	1800

It is to be noticed the horse-powers are electrical, not indicated Sir Samuel Canning and Mr Robert Sabine made some tests of these lamps in 1882, and reported that they gave nearly 1000 candle-power per indicated horse power with the photometer in the best position, at an angle of 40 deg the illumination was about two-thirds of this

The lamps at the Health Exhibition are fed by an alternate current machine which we illustrate on the preceding page It is the invention of Messrs. Clerc and Bureau, who also brought out the sun lamp, and bears a general resemblance to the Gramme alternate current machine Upon a central spindle there is mounted a twelve-sided boss to which twelve magnet cores, of the cross section shown below, and of a length dependent on the length of the machine, are bolted The bolts are not screwed directly into the cast iron, but are secured by nuts let into grooves in the boss. The magnet cores are wound with wire so arranged that the poles are alternately north and south, and they are excited by a current from a Siemens D_2 dynamo This current enters and leaves by brushes bearing against collector rings at the end of the spindle, and passes through internal conductors to the magnet.

The induced current is generated in fixed coils. This arrangement gives great facilities for varying the electromotive force and the intensity of the current, as the coils can be readily grouped either in series, or in parallel, or in compound parallel, according to the purpose for which it is intended Or the coils may be divided into independent groups, and some connected to arc lamps, some to incandescence



lamps, and some to sun lamps, without any fear of the one affecting the other. For installations where works and offices are to be lighted from the same generator this is a great recommendation The outer bobbins together form a kind of stationary Gramme ring. Each is wound on an iron core of a form shown in the cross section The form of this core is claimed by the inventors as a special feature of their design It is not, as in the Gramme ring, entirely hidden within the wire in which the current is induced, but is bent round at the edges and brought out, so that it is subjected to the direct inductive influence of the revolving magnets. Each core is fitted with two wooden side pieces, which constitute the cheeks or flanges of the coil, and a wooden central rib which divides the coil into two parts These pieces of wood project beyond the ends of the coil, and are attached to brass segmental end pieces, which together form a circle, which is carried by the standards of the machine. The ends of the conductors are brought out to a grouping table provided with binding posts which can be coupled together in any desired order

The machine shown in the illustration revolves at 600 revolutions per minute, and at that speed gives a current of 12 ampères, with an electromotive force of 1200 volts. It is designed to feed twelve lamps of 2500 candle-power

To regulate the electromotive force according to the number of lamps in action, the exciting current is led through an adjustable resistance consisting of a vertical zig-zag of wire arranged over a channel filled with mercury The lengths of the arms of the zig-zags gradually increase, so that their lower ends form an inclined line The whole is mounted in such a way that it is raised or depressed by a solenoid in the main circuit, as the intensity of the current increases or diminishes The current from the exciting machine enters the mercury trough, and if the resistance be at its highest point, it rises up the longest leg of the zig-zag, which is the only one which touches the fluid. It then traverses all the zig-zags in succession and flows away to the field magnets of the alternate current generator Should more lamps be lighted the main current will be temporarily checked and the solenoid core will descend until the second, third, fourth, or some still shorter zig-zag touches the mercury, when all the preceding will be short-circuited and the resistance offered by them to the exciting current will be eliminated. The magnetic intensity of the field will be increased and the main current will be maintained almost at its former level, the total range of the current between the greatest and smallest number of lamps being less than 7 per cent

The system of the Sun Company is unique, and coming between the arc and incandescence methods of illumination, it combines many of the advantages of both, and avoids most of their defects It is extremely steady, and may be used for all the ordinary purposes of life, such as reading, writing, and the like Of course it cannot be applied to very small apartments, which only require the light of a couple of gas jets, but for halls, libraries, places of entertainment, and workshops, it is eminently adapted. It requires more power than ordinary arc lighting, and this has often been urged against it, but it would be much fairer to compare it with Swan lamps, and then the balance is decidedly in its favour. It is to be seen to great advantage in the South Kensington Museum, where it is used to light the picture galleries, a purpose for which it is well suited, and one which experience has shown to be quite beyond the capacity of arc lamps to fulfil satisfactorily.

CABLE TRAMWAYS.

By J Bucknall-Smith.

About twenty-five years have passed away since Mr G. F Train first introduced the modern system of street tramways into this country, and although his enterprise was summarily arrested by opposition created by prejudice and by the shortcomings which attend all new schemes, the system was afterwards successfully revived in 1868, when the first Act of Parliament was obtained for a system of horse tramways in Liverpool. The subsequent rapid development of horse tramways in the United Kingdom, and also in Europe and other parts of the civilised world, is familiar to most of our readers, but five years of practical operation scarcely had elapsed ere many engineers, impressed with the unsuitability of animal traction, were busily engaged in designing special steam locomotives and other motors for tramway purposes. The marked tardiness with which horses have been and are being superseded by mechanical power for the arduous purpose of hauling our street tramcars, is more the result of certain inefficiences in the various motors offered in the market than from any inherent unsuitability in the employment of mechanical power itself It is however fair to admit that in some cases the want of efficiency is not so much attributable to the engines as to the character of the permanent way, which may be quite unfit for such class of vehicles However, there are now many lines where locomotives are being used on appropriate roads with favourable results On the other hand, whilst thus duly recognising in certain suitable instances the superiority of such motors over animal power, it is nevertheless incontrovertibly clear that there are many streets in densely populated districts, in which the passage of steam engines will never be permitted

Of course it should not be lost sight of, that there are now other tramway engines in the market than those actuated by steam, as for example, compressed air and electric motors, which are free from many of the substantially founded objections to the use of steam, but as yet these have proved in practice to be expensive or unreliable Later on in these articles some analytical and comparative statements will be given and considered, for the purpose of forming a comparative estimate of the value of the special features of the various systems used or proposed for the propulsion or haulage of street tramcars But for the present we must confine ourselves to directing attention to a comparatively new method of mechanically working street and other tramways by what is known as the 'Cable system of traction," which is now being practically demonstrated by the Highgate Hill tramway.

The mere idea of a "cable tramway," or in other words a tramway on which the cars are drawn or hauled by means of a cable or rope receiving its motion from a stationary and distant source of power, contains in itself no remarkable novelty as many must be aware, as cable traction has been successfully employed upon certain railways and in mines for many years past But the specific adaptation of the broad principle to street tramways has involved much ingenuity and ability of both foreign and English inventors and engineers for some time past.

It will doubtless be remembered by some of our readers that this system of tramway working was first placed before the British public in a tangible form in October, 1882, or immediately after the

necessary Parliamentary powers had been obtained for the construction of the first cable line in England, viz., that at Highgate Hill, which was to extend from the Archway Tavern, Upper Holloway, to Southwood Lane, Hornsey, a distance of rather less than a mile

The practical introduction of this valuable system into Europe must mainly be attributed to the ability and incessant labours of Captain H. F. Mills, R.A., although Messrs. Parish and Eppelsheimer some years previously had unquestionably devoted considerable time and energy in endeavouring to introduce it into Liverpool, Edinburgh, and Bristol. The above gentlemen are still actively identified with the scheme which now promises to produce a popular, efficient, and remunerative system of public locomotion

There can be, however, little doubt in the minds of those acquainted with the subject that the successful conversion (in January, 1882) of the State-street horse tramway, Chicago, U.S.A., to the "cable system" of traction—at a cost of about 400,000*l.*—afforded in a great measure the requisite impetus for the introduction of the system into this country. The prior Californian cable roads had the unquestionable advantage of an excellent and uniform climate, whereas the Chicago installation was subject to most variable weather and extreme temperatures, thus placing it under the most trying and crucial conditions, somewhat similar to the possible requirements it might be called upon to withstand in the erratic meteorological variations of a British climate. At the present stage it will suffice to add that the Chicago cable lines are an unqualified success, and the same brief remark may be equally well applied to the "Highgate Hill cable line," London, which was opened to the public on the 29th of May last, and which has been in satisfactory operation ever since, both mechanically and financially. There is incontestably one peculiar practical advantage of the system in question over others at present before the public, viz., its capability of economically working steep grades without adding anything to the weight that has to be hauled for the sake of obtaining the requisite adhesion. In fact, the only system that could possibly aspire to anything like reasonable competition in such cases would be the old and cumbersome rack-and-pinion roads. From the capabilities of the "cable system," it will now be quite practicably feasible to effect tramway communication in the most hilly districts which hitherto have been considered as almost inaccessible. At the same time the system is thoroughly applicable to the economical working of tramways constructed on level ground, as most completely exemplified in Chicago.

In the following respects the "Cable system" offers important advantages:

1. In avoiding the great wear and tear of the permanent way occasioned by the horses usually employed for drawing tramcars.

2. In the freedom from noise arising from the beating of the horse's feet upon the road, or from the disturbance created by the moving parts of travelling motors, or from the exhaust and the evolution of fire, sparks, or smoke, all of which are more or less common to steam and other engines.

3. In the greater cleanliness of the roads, by the withdrawal of horses.

4. In the facilities for satisfactorily and economically dealing with periodic fluctuations of traffic, as at certain hours of the day, or on holidays or fêtes.

5. Finally, but not least in the opinions of many humanitarians, in the obviation of cruelty to the horses which have hitherto been most unsuitably employed.

The benefit set forth in the last clause, has secured for the system the warm approval and support of the "Royal Society for the Prevention of Cruelty to Animals," but, of course, under many circumstances other successful mechanical systems of traction could boast of the same benevolent result.

However, we do not propose to consider any ethical recommendations which may constitute valuable ornaments to a prospectus, but rather to confine ourselves as closely as possible to purely technical matters, for in practice we may rest assured that the public and companies, however professedly humane, will still continue to use animal power so long as it suits their convenience or their pockets. Therefore before the plea for consideration for the horses can receive much practical attention, it rests with the ingenuity of engineers to devise and establish a mechanical system of locomotion that will afford the travelling public the same, if not better, comfort and accommodation than heretofore, and an equal degree of control or safety in transit at the same rate of fares. At the same time the proposed scheme must show a distinct remunerative advantage to the shareholders, and be reasonably free from the numerous objections commonly raised by municipal or local authorities, and the anti-tramway world. Then we may reasonably expect to find the employment of horse-power to be speedily recognised as an element of barbarism. Now the cable system when and where judiciously applied, *i.e.*, under befitting circumstances with regard to traffic and the route, certainly appears to be a marked step in the above direction, although it would not be for one moment believed that a system which is claimed to possess so many paramount advantages, could be absolutely free from alleged defects or objections, especially when one appreciates the great variance of opinion that must exist upon such subjects, combined with the prejudices of vested interests. However, later on, the applications, construction, and operation of the system in question, will be sufficiently described and illustrated, as to afford a fair basis for technical investigations and criticism, but before proceeding to consider the cable tramway systems of to-day, a brief retrospective glance at their history and development will be instructive.

For carrying out this object we purpose classifying or subdividing our subject into the six following sections:

1. Preliminary remarks upon early cable schemes which have technical bearing.

2. The history and development of street cable tramways proper, including descriptions of the principal features of the construction and operation of the Clay-street line, Sutter street line; California-street line, Geary street line, Union and Presidio line, Market street line, all within the city of San Francisco.

3. The conversion of the Chicago horse lines to the cable system, the Rent Park and Columbia Avenue trial section, Philadelphia, the introduction of the system into the State of New York, the Brooklyn Bridge cable line, the introduction and development of the cable system in the colony of New Zealand.

4. Descriptions and illustrations explaining the construction and operation of the first cable line in Europe, viz., Highgate Hill tramway, London.

5. Technical examinations and analyses of the various elements of the system with costs and details of construction.

6. Financial analyses of the working of the system, with general comparisons and notes respecting this and other systems of tramway working at present in use, and other concluding remarks relative to the cable system and its latest applications.

From the foregoing syllabus it will be understood, that if all the technical matters relating to cable tramways were to be thoroughly considered, it would involve a very voluminous production, so that it will be necessary to treat the matter at issue with as much brevity as practically consistent with the magnitude and importance of the subject, and at the same time avoid repetition as far as possible.

In engaging with the first portion of the subject before us, it is proposed to briefly consider some of the earliest applications of cable traction or hauling, more especially as exemplified in the mining industries of this country. At first sight the direct applications of wire cables for hauling purposes may appear to many to be of a very limited character but their value for such purposes was appreciated in this and other countries long before the locomotive was invented, and as a matter of fact has been more extensively taken advantage of for surmounting steep gradients than any other system.

On the 14th of May, 1875, ENGINEERING described the wire-rope haulage system as applied to street tramways in San Francisco, and remarked that it was "especially adapted to localities where the gradients are such as to render it impossible to employ horses, and where interference with the existing traffic cannot be permitted." It then gave a detailed account with illustrations of the whole installation, explaining the manner in which the rope was driven, the method of attaching the cars to it, and all the precautions taken to insure safety to the passengers. Since then by actual experience at San Francisco the system has been found to work tramway traffic so cheaply that it earns from 14 to 30 per cent. on the capital expended.

The mention of cable traction will naturally recall to the minds of many the numerous ingenious devices and improvements made in cable haulage for colliery purposes, and which were in a great measure promoted and stimulated by the unparalleled depression experienced in the coal trade some years ago.

Ropes, metallic cables, and chains have been used for years past in a variety of ways, with most satisfactory results, and in many cases the lines thus worked have been of considerable length and subject to trying grades and curves, whilst the traffic in some instances was very heavy. Latterly, in collieries, the tractive agents chiefly employed have been cables, constructed of iron or steel wires, and the great improvement made of recent years in their manufacture has done much towards developing the uses of cable traction and telo-dynamic transmission of power.

It will be recognised, that the functions and conditions of these primitive cable lines, were and are, in many cases, analogous, if not identical, with those of the street cable tramways of to-day, and therefore by briefly examining some of the performances of the former, it will serve as an appropriate introduction to the considerations and study of the later system.

(To be continued.)

THE ELECTRICAL CONFERENCE AT PHILADELPHIA

(Concluded from page 321).

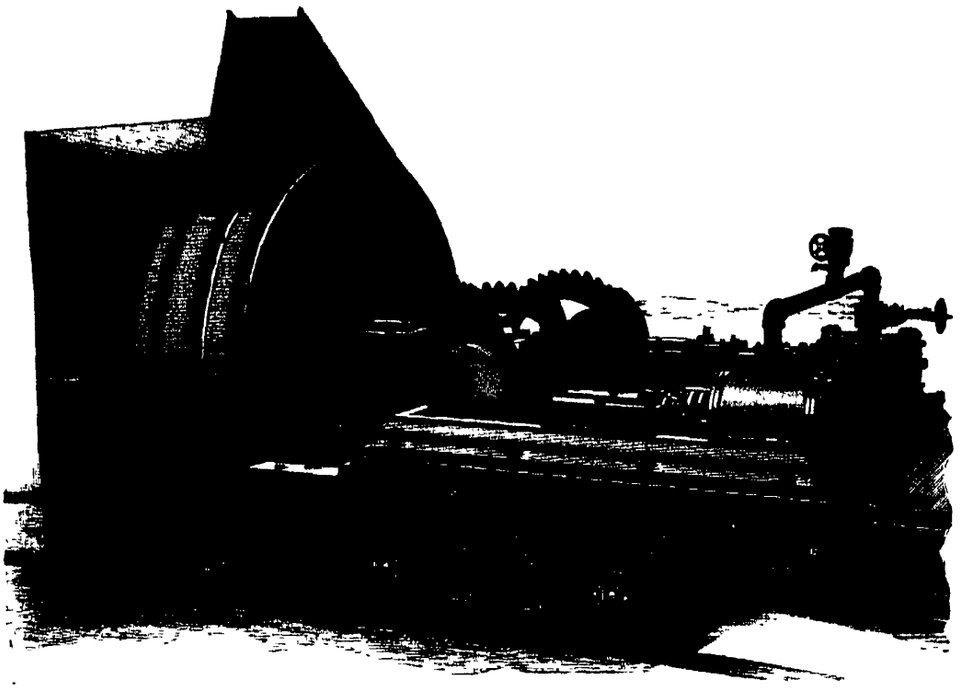
ON Thursday the light standard once more came before the conference. Referring in high terms to the investigations of Captain Abney, Mr. Preece, who, together with Professor Forbes, up to the last day, when Professor Silvanus Thompson had left, represented the British visitors most vigorously and successfully described his unit of illumination of a surface as being the illumination thrown by an English standard candle on a screen at 12·7 in. distance. The distance is chosen to render the standard more acceptable to the French, the equivalent being the illumination of a screen at one metre distance by a bec-carcel. The standard is only a secondary one, but is, by the incandescence of a carbon filament by means of a uniform current, most easily reproduced, and is very constant, as Abney and Preece have proved, the measurement of light, moreover, is at the same time a measurement of work. Mr. Preece intends to submit his views fully before the Light Standard Committee.

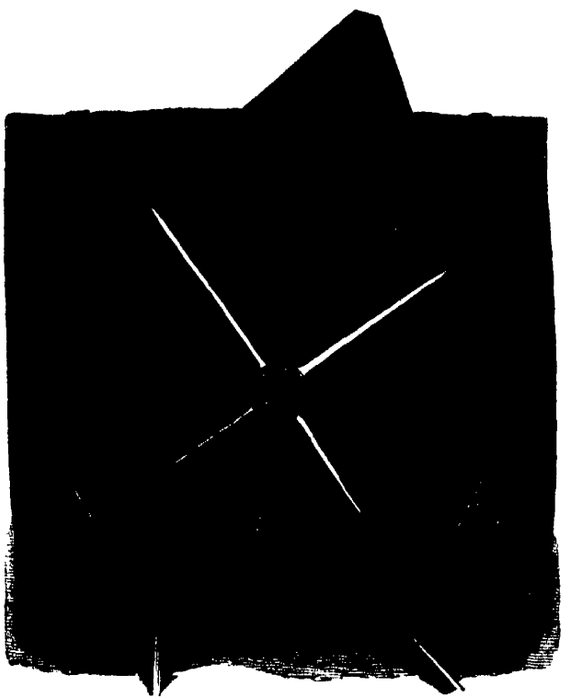
We have little more to add about the routine business of the conference. The main part of the morning and afternoon sittings was taken up by a discussion on "The Theory of the Dynamo," introduced by Professor Rowland, who abbreviated his extensive paper. Professor Rowland approaches the problem merely as theorist, being convinced that practice must confirm theory. He dealt with losses of efficiency arising from friction, Foucault currents and other disturbances, and from the energy required in maintaining the magnetic field. It is difficult to summarise an abstract, and all the more so when a profound mathematician, like Professor Rowland, is the speaker. We do not imply by describing the professor as a mathematician, that his paper abounded in formulæ. On the contrary, he expressed his views in very plain and clear language, sketching a few dynamo types as exhibited at Philadelphia on the blackboard, yet it is a difficult task to summarise what diagrams alone can clearly convey. Professor Rowland prefers round to oval or square magnetic cores, one circle of lines of force to several such circuits in the case of several electro-magnets, pole-pieces may be elongated, but may then further lose lines of force through the air, which conducts them about 5000 times more than iron, iron bars encircling pole-pieces should be avoided as they lead to a short circuiting of the lines of force, attachment of the pole-pieces to iron plates, even if a brass plate interposed, is injurious, long iron cores are, within uncertain limits, cheaper and better. As to armatures, both the Gramme and the Siemens armatures contain dead wire, the former more than one-half of the whole length. The question of losses from self-induction in the armature was afterwards discussed by Professor Fitzgerald. Professor Rowland concluded by proving that in two dynamos exactly alike but of different size, with a constant magnetic field, and an equal speed in the large one only, the electromotive force will remain constant,

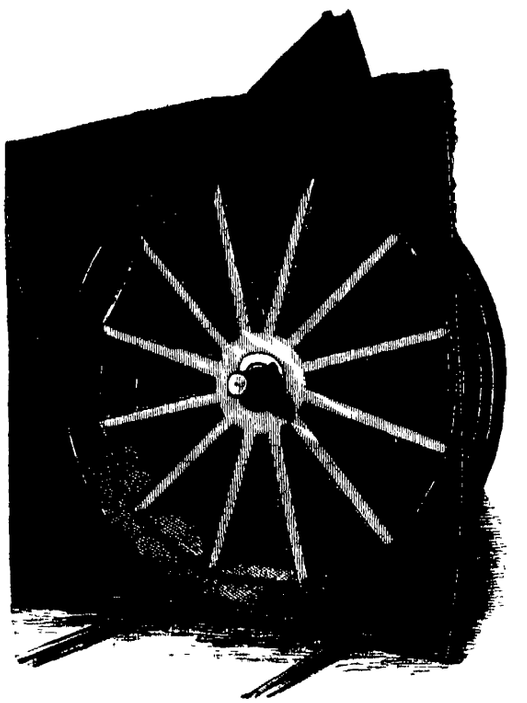
ROTARY STEAM SNOW SHOVEL.

CONSTRUCTED BY THE ROTARY STEAM SNOW SHOVEL COMPANY, PATERSON, NEW JERSEY, U.S.A.

(*For Description, see Page* 359.)







the current and resistance must vary as the linear dimensions, the work done also as the linear dimensions, whilst the weight of course increases with the cube, and that further, the efficiency again must be a constant. Professor Elihu Thomson, the joint inventor of the Thomson-Houston dynamo, disagreed with Professor Rowland on most points. The armature, he argued, becomes an opposing magnet, loss of lines of force from elongated pole-pieces is hence not to be feared; two magnetic circuits may have their advantages, and iron bars near the pole-pieces, although capable of short-circuiting magnetic lines, strengthen the total field. The question of long and short electromagnets depends upon the dimensions of the armature and its distance from the field magnets. Professor Thomson further denied the existence of dead wire in the armatures, and the usual statements about the armature resistance. When working, the coils are occasionally in multiple arc, but do not receive equal currents, as the adjustment of the brushes is never perfect, and hence the heat evolved not a constant. To the discussion on the dynamo theory, Professor Silvanus Thompson offered of course a weighty contribution. We must, however, refrain here from entering into his ingenious arguments and equations, and cannot do better than refer our readers to the speaker's new volume on dynamo machines, proof sheets of which he held in his hand whilst addressing the attentive conference. Professor Rowland strongly dissented from Professor Thompson in his statement that a thick iron core would show layers of opposing polarity, which opinion Professor Rowland characterised as revolutionary. Professor Forbes also took part in the discussion.

In the afternoon the President inquired the wishes of the conference concerning the final adjournment. His own proposal to close on Friday was rejected, and Mr. Keith's motion for adjournment on Saturday carried. The sense of this motion was evidently for a final adjournment, but we shall see that ultimately an adjournment subject to a future call of the President was agreed upon.

ENGINES OF THE U.S. FISH COMMISSION STEAMER "ALBATROSS."

CONSTRUCTED BY THE PUSEY AND JONES COMPANY, WILMINGTON, U.S.A.

(For Description, see Page 358.)

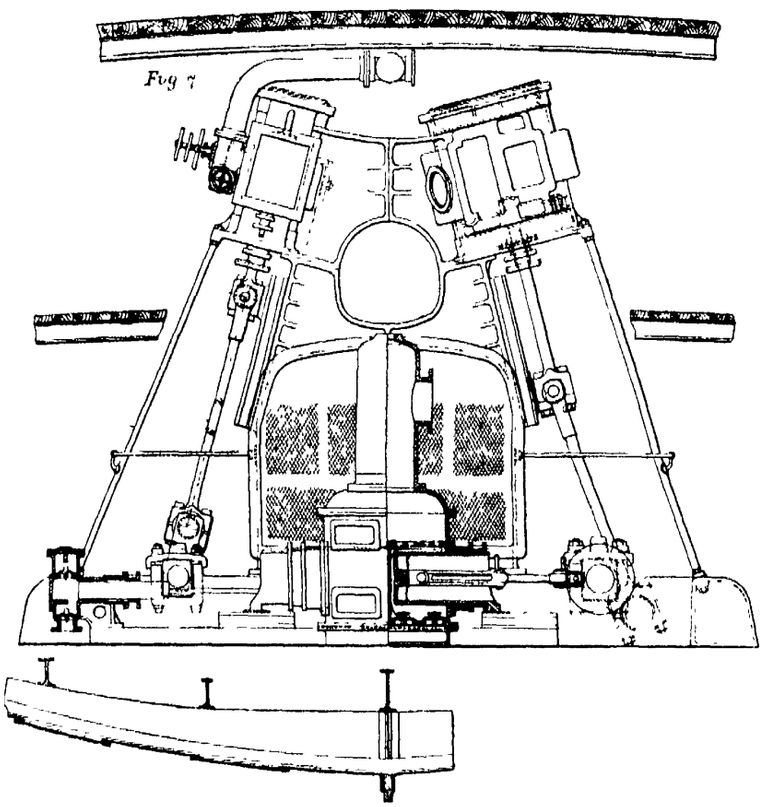


Fig 7.

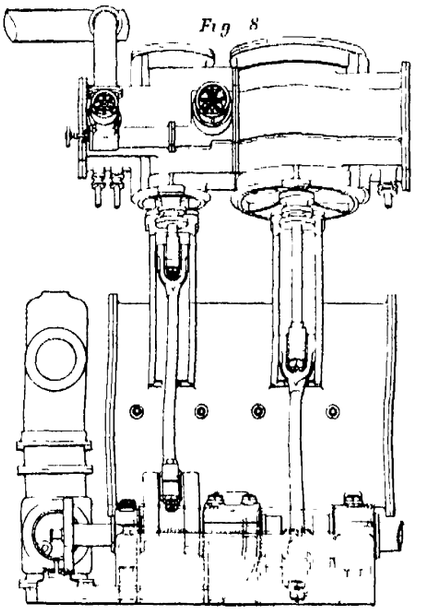
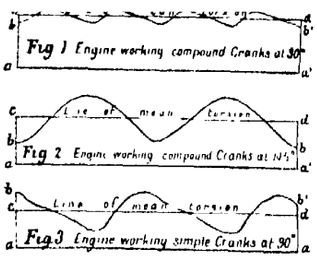


Fig 8.

Professor Nipher, of St. Louis, approached the next subject, the "Electrical Transmission of Power," in an entirely novel and most ingenious way. He plots out speed-curves which, by his method, always appear as straight lines, starting at lower or higher points according to the load put on the motor. We assent, however, fully to what Professor Forbes said, that it was impossible to grasp the full bearing of this suggestive method without careful study. Mr. Sprague, well known in England, demonstrated the necessity of high potential circuits for electric railways. No one else rose afterwards, but Mr. Houston, to continue this discussion, which did not evolve any novel practical features. The "Storage Batteries" were ably and warmly defended by Mr. W. H. Preece. For the storage battery companies Mr. Preece had, of course, not much commendation, but he testified to the very good work which secondary batteries, as he prefers to call them, charged by a dynamo, have done at the General Post Office for telegraphic purposes. He has found them so reliable and so well adapted for the English telegraphic system, which does not permit the direct use of dynamos, after the manner employed in America, that one of the first things he will enforce after his return is the replacement of the greater part of the 22,000 cells by secondary batteries. Of the three types experimented with—the Faure, the Tribe, and the Planté—he preferred the old Planté, the advantages of which other speakers also acknowledged. Mr. Preece further gave a description of the degenerating luxury, as Professor Forbes termed it, of the electric light in the house obtained by gas engine, dynamo, and secondary batteries. Mr. Keith referred to his early experiments with subacetate of lead batteries, and Professor Koyle recommended carbon plates, which he prepares by boiling tar in a vessel with many narrow brass partitions, each compartment giving a carbon plate rendered porous by the evolution of gas during the heating. Professor Forbes dwelt upon the equations regulating the currents in a circuit comprising dynamo, secondary batteries, and lamps, and Professor Van Dyck described an alkaline zinc-copper battery of low but very constant force. The amalgamated zinc is placed at the bottom of the cell, the copper spiral above, the cell works well, but requires a low potential current for charging.



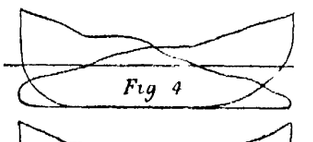


Fig 4.

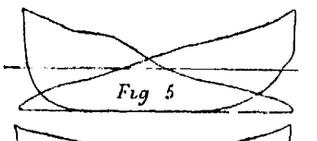


Fig 5.

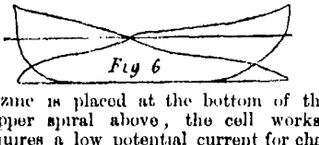


Fig 6.

Professor Dewar, when called upon to address the conference upon the chemistry of the secondary batteries, hoped that the heavy and cumbrous lead plates would one day be abolished, and that we should find effective material in chlorates, iodates, chromates, and peroxide of hydrogen, bodies the thermo-chemical properties of which promise as much electromotive force as lead peroxide.

Mr. Lockwood, of the American Bell Telephone Company, had prepared a long paper on "Induction in Telephone Wires, Long Distance Telephoning, and Underground Wires." Want of time, however, did not permit it being read *in extenso*. Mr. Lockwood does not attach much importance to induction. Long lines are always noisier, but one end of a line may be troublesome, whilst the other is perfectly quiet. In America generally the lines running north and south give most trouble, some lines from Boston to the west, however, form a remarkable exception to that rule. Sea coast lines work better, probably on account of the humidity of the ground. In the whole a certain leakage seems to stop the noises, and not too well insulated lines therefore may answer better than those of more perfect insulation. Whatever, however, the insulation may be, every pole forms an earth contact, although of a high resistance. Screaming noises become particularly audible both at midday and at midnight, lines on higher plateaus appear subject to periodical storms at certain hours. Improvements of receivers cannot remedy the evil, as such improvements intensify all sounds transmitted along or induced in the line. As regards the connection of single local lines to long complete metallic circuits, Mr. Lockwood mentioned a device which Mr. Preece called very interesting. If we have a complete circuit between New York and Philadelphia, and local lines emerging from each of the termini, a wire is carried round one way at New York, and round the other way at Philadelphia. Mr. Preece, commenting upon Mr. Lockwood's paper, described this method preferable to the one used in England, which avails itself of a primary induction coil in the single line acting upon a secondary coil in the double metallic circuit. Mr. Preece further related his experience in long-distance telephoning.

We have already mentioned that Mr. Preece, as member of the Committee upon Units, proposed that the new unit of power should be the modified watt, which he had first publicly advocated at the Montreal meeting of the British Association. Sir William Siemens, Mr. Preece, and others had exerted themselves at Paris to introduce a new unit of power instead of the compound unit volt-ampère, but the German scientists objected because there were already too many English names in the system, and the French could not assent to the watt as the French language contains no W. Watt originally settled the horse power as equal to 22,000 foot-pounds, but thinking this too low he raised the horse-

power value himself by 50 per cent. to 33,000 foot-pounds Since that time, the horse-power has retained its value, in England at any rate The equivalent of the horse-power in the C G S system is 746 watts To get rid now of this inconvenient divisor, to bring the unit of power properly into the category of the C G S measurements, and finally to avoid the uncertainty arising from the existence of two horse-powers, the English and the French-German, Mr Preece proposed to engineers and electricians to drop the old horse-power of 746 watts, and to create a new horse-power of 1000 watts which would cause no trouble in calculation This new horse-power would, by 34 per cent., be greater than the old, and we have, therefore, for reductions, to multiply by either 1 34 or 0.736 At Montreal, Sir William Thomson spoke warmly in favour of the modified watt, and as many practical men and scientists, whose opinions Mr Preece has consulted, agree with him that the modification is desirable, there appeared good hope, that the American committee, to which the motion was referred would carry its adoption When, however, the question came up again on Saturday, Mr Preece himself reading the report, several objections were raised, although the report confined itself to the recommendation of accepting the watt, reserving the new or metric horse power for future consideration When it had been settled whether this preliminary report was to be received without discussion, or to be adopted after reception and discussion, Captain Michaelis, of the United States Ordnance, rose to propose as an American citizen, that the term "the Henry" should be applied to what was recommended as the watt Professor Koyle thought the term kilowatt sufficiently explicit Lieutenant Fiske expresses himself satisfied with the erg only He has probably no objection to majestic rows of ciphers, the watt alone requires seven Professor Rowland was against any final settlement before the value of the ohm had been definitely determined, and he desired to adhere to his 10$6\frac{1}{2}$ centimetres Professor Willard Gibbs recommended that no unit should be adopted unless universally used and universally understood As the watt, in his opinion, was merely an English term, not being used by the Continental nations, and, moreover, not strictly speaking a unit of the C G S system, but merely one added on to the electrical system of units with which the name of the engineer Watt had only an indirect connection, he desired to keep passive Professor Rowland argued for international units, but the debate was again losing itself when Mr Preece reminded the meeting that his preliminary report did not call for any definite decision.

The report from the Committee on Light Standards could not be read, as the chairman, Professor Trowbridge, had suddenly been called away The President, Professor Rowland, hinted that some are light manufacturers appeared to measure their intensities in four directions and to palm off the sum of the intensities as the candle-power

The next subject on the list, "The Electrical Investigation of the Physical Qualities of Structural Metals" was introduced by Captain O E Michaelis, who apologised for having nothing but suggestions to bring before the conference, and the subject seemed to have dropped, until the end of the meeting, when, the adjournment having already been voted, Professor Koyle moved for a committee with the object of obtaining State support, for the electrical and magnetic examination of the fatigue of metals and alloys Professor Koyle submitted that brass and other alloys suffer most from this fatigue, brass so strongly that an ordinary spiral spring exposed to sunlight for several days may altogether lose its elasticity. He ascribes the phenomenon to a difference of potential between the copper and zinc, leading to a decomposition of the moist air in the pores, and finds a support of his view in the fact that less porous brass has greater tensile strength and less electrical resistance The debate on the "Measurement of Large Currents," in which Mr Keith, Professor Forbes, and Professor Rowland participated, brought nothing new. As regards the "Application of Electricity to Military and Mining Engineering," General Abbot recommended compound-wound dynamos supplying 60 volt currents and not absorbing more than 25 or 30 horse-power for the search lights, or better for one strong search light of 20,000 candles, and another dynamo for the incandescence lamps for internal service, which is of no less importance He concluded by saying that if the United States Navy is to be maintained they will want more ships, and all lighted up by electricity. Nothing was said about the electric light in mines, and no discussion followed

The last subject, "Lightning Protection," was introduced by the President, Professor Rowland, with injunctions to be brief, as the time for ajournment was approaching. Professor Rowland gave an abstract of Maxwell's idea, to cover our houses by metal cages or network, and not to neglect to run iron bars along the bottom of the house Powder and petroleum magazines might thus effectually be protected, if all minor sparking was obviated A few paradoxes in lightning conductors were mentioned One company makes U shaped rods, the lightning to pass down one arm and to disperse harmlessly up the other, and has taken legal action against a scientist, who described the system as a dangerous humbug.

The real business terminated with this discussion, and after the usual votes of thanks, including one to the foreign visitors, to which Mr Preece in the absence of the vice-president, Sir William Thomson, replied, the adjournment *sine die* was carried Several persons, however, desired to fix another meeting, and relying upon the urgent recommendation of such conferences by Mr. Preece and others, they proposed that they should adjourn subject to the future call of its chairman The motion thus avoided any allusion to the commission and a possible collision with the Act of Congress, which had incorporated the commission for a certain period The various committees were arranged to meet again in the first days of October at Baltimore, as we have already mentioned. When and where, or if at all, this final meeting of the conferees, decided upon at the last moment, will take place, is uncertain.

THE UNITED STATES FISH COMMISSION STEAMER "ALBATROSS"

In our issue of September 7, 1883, we gave a double-page illustration of the Albatross, together with a short description of the vessel and the work she was intended to perform. Since our former notice was written the Albatross has made one or two voyages during which her performance has been carefully noted by the engineer in charge, Mr G W. Baird, U S N The following details of the working of machinery and speed of the vessel are taken from Mr Baird's official report Although no especially novel features can be claimed for the data obtained and the results set forth, we quote them at some length as records of steamship performance, when carefully taken by disinterested and capable observers must always be of value The Albatross, too, is a new vessel, built and engined by one of the best-known firms in the United States, the Pusey and Jones Company, of Wilmington, Delaware The vessel itself has been already described, but we may here repeat a few of the leading dimensions before proceeding to quote from Mr Baird's report We give two views of the engines on page 357, and annex the leading details of construction.

Twin-Screw Steamer Albatross, built of Iron for the United States Fish Commission by the Pusey and Jones Company, of Wilmington, Delaware, U.S.A

Dimensions of Hull.

	ft.	in
Length from rabbet to rabbet on 12 ft. water line	200	0
Depth top of floors to top of deck beams	16	9
Breadth of beam moulded	27	6

Engines

The two pairs of engines are of the inverted compound surface condensing type, fitted on one bedplate and with a surface condenser, common to both pairs, placed between them and forming a part of their framing The upper parts of the engines incline towards each other, the two shafts being 10 ft 8 in apart There are two overhead return-flue boilers

	in.
Diameter high pressure cylinders	18
,, low ,, ,,	34
Stroke	30
Steam ports of large cylinders	3 by 20
,, small ,,	1¾ ,, 13½
Exhaust ports of large ,,	4½ ,, 20
,, ,, small ,,	3½ ,, 13

Slide Valves.

Ordinary D form, worked by Stephenson link motion.

Cut off Valves

Gridiron type, three openings, $\frac{7}{8}$ in by 12½ in.

Condenser.

Water in tubes Yellow metal turned in and out $\frac{5}{8}$ in. diameter. Cooling surface, 2150 square feet. Tubes in three nests

Air Pumps.

One to each engine of trunk plunger type, worked horizontally by a crank on forward end of main shaft, 15½ in. in diameter by 15 in. stroke.

Circulating Pump.

Works independently; 16 in in diameter by 15 in. stroke.

Feed Pump.

One to each engine. Worked by air pump motion, 4¼ in. in diameter by 15 in.

Propellers.

Four bladed, 9 ft. in diameter by 14 ft. 10 in mean pitch, by 26 in. long. Periphery of blades thrown, 4 in. aft.

Boilers.

Diameter of waist, 8 ft. 6 in and 8 ft 6 in. front by 21 ft 6 in length, with water-leg furnaces Two furnaces 6 ft 6 in long Main flues, three of 11 in diameter, one of 12 in. diameter, and one of 15 in diameter for each furnace, 16 return flues in each tier One steam chimney made in halves and common to both boilers, shell 7 ft 4 in in diameter, and flue 4 ft. 4 in in diameter, with a height above the shell of 14 ft. Chimney 54 in in diameter by 28 ft high.

Appendix to Quarterly Report of Passed Assistant Engineer G W. Baird.

The following results must not therefore be considered as for the maximum performance of the vessel, but for the conditions of ordinary cruising This however, does not impair the deductions for scientific purposes The coal used was the anthracite supplied to the Navy, and it contained a considerable quantity of ash, clinker, and slate

Duration of voyage	42 h. 9 m.
Total distance in geographical miles of 6080 ft	423
Mean number of geographical miles per hour	10 04
Mean number of revolutions per minute, starboard engine	79 05
Mean number of revolutions per minute, port engine	79 06
Slip of the starboard screw	14 74
,, port screw	14 75
Steam pressure in boilers	60 lb
Pressure in starboard receiver above zero	25 53 ,,
,, port receiver above zero	23 78 ,,
Vacuum in condenser	24 46 in.
Height of barometer	30 09 ,,
Mean point of cutting off in starboard high pressure cylinder	20 33 ,,
Mean point of cutting off in starboard low pressure cylinder	14 03 ,,
Mean point of cutting off in port high-pressure cylinder	19 78 ,,
Mean point of cutting off in port low pressure cylinder	17 83 ,,
Total number of pounds of anthracite coal consumed	42,865
Total number of pounds of ashes, clinker, &c	8,353
Total number of pounds of combustible	34,512
Mean number of pounds of coal per hour	1016 97
Percentage of refuse in coal	19 40
Mean number of pounds of coal per hour per square foot of grate surface	10.667
Mean number of pounds of coal consumed per hour per square foot of heating surface	0.41
Mean number of strokes per minute of circulating pump	80
Temperature of the air on deck	73 73
,, ,, injection water	65 73
,, ,, discharge water	93 78
,, ,, feed water	76.39
Horse Power.	
Indicated horse-power developed in the starboard high-pressure cylinder	93 46
Indicated horse-power developed in the starboard low pressure cylinder	122 24
Indicated horse power developed in the port high-pressure cylinder	110.22
Indicated horse power developed in the port low-pressure cylinder	131 60
Aggregate indicated horse power developed in the starboard engine	215 70
Aggregate indicated horse-power developed in the port engine	241.82
Horse power required to work the starboard engine	22.11
Horse-power required to work the port engine	22 11
Net horse power applied to the starboard shaft	193 58
Net horse power applied to the port shaft	219.70
Horse-power absorbed in friction of the load on the starboard engine	14 518
Horse power absorbed in friction of the load on the port engine	16.478
Horse-power expended in the ship of the starboard screw	23.27
Horse-power expended in the ship of the port screw	26.83
Horse-power expended in friction of the starboard screw blades and shaft on the water	21.27
Horse-power expended in friction of the port screw blades and shaft on the water	21.27
Net horse-power applied to the propulsion of the hull	280.64

Distribution of the Power

Percentage of the net power applied to the shaft absorbed in friction of the load	7 50
Percentage of the net power applied to the shaft absorbed in friction of the screw on the water	10.29
Percentage of the net power applied to the shaft absorbed in the slip of the screws	12.122
Percentage of the net power applied to the shaft utilised in the propulsion of the hull	70.081

Economic Results

Pounds of coal consumed per indicated horse-power per hour	2 222
Pounds of coal consumed per net horse-power per hour	3 246
Pounds of combustible consumed per indicated horse power per hour	1 789
Pounds of combustible consumed per net horse power per hour	2 613
Pounds of coal consumed per mile	101 336
,, combustible consumed per mile	81 588

Thrust of the Screws

The net power applied to the propulsion of the hull by the two propellers being 289 64 horses, is equal to $(289.642 \times 33,000) = 9,558,186$ foot pounds of work per minute, and the speed being 10 03 knots per hour is equal to $\left(\frac{10\ 03 \times 6086}{60}\right) = 1017\ 376$ ft per minute, therefore the resistance of the hull, and the equivalent thrust of the screws, at that speed was $\left(\frac{9558186}{1017\ 376}\right) = 9395$ lb

The thrust per indicated horse-power at that speed was $\left(\frac{9395}{457.526}\right) = 20\ 31$ lb, and per pound of coal per hour it was $\left(\frac{9395}{1016\ 97}\right) = 9\ 23$ lb.

The Change in the Crank Angle.—The cranks, as originally arranged, at 145 deg, diminished, to a small extent, the friction on the centre main bearings, by the almost opposite position and almost opposite crank effort The indicator diagrams taken from the high-pressure cylinders bear a very near resemblance to each other, with the cranks at either angle, but in the low pressure diagrams the difference is marked Fig 6 (page 357) is from the starboard low pressure cylinder, with the cranks at 145 deg Fig 5 is from the same cylinder, with the cranks at 90 deg, but with the receiver enlarged from $1\frac{1}{2}$ to $2\frac{1}{2}$ of the volume swept by the high-pressure piston Fig 4 is a diagram from the same cylinder with the cranks at 90 deg but with the original volume of receiver, namely, $1\frac{1}{2}$ the volume swept by the high pressure piston

The relative contours of those diagrams and their variance from the hypothetically perfect diagram is marked, and if an engineer is willing to accept them as final, he will doubtless decide in favour of that produced by the engines as originally arranged, namely, at 145 deg crank angle

The indicator, however, only records the action of the steam in the cylinder, and gives no indication of the work, either utilised or wasted, beyond the steam cylinder

It is manifest that a crank, turned by a uniform moment, is revolved with less labour and less injury to its journals than if turned by an intermittent force —by blows, for example Uniformity of torsion on the shaft is one of the great objects sought This torsion may be demonstrated, graphically, by constructing diagrams whose abscissa is referred to the length of the path of the turning force, and the ordinates to the moments of torsion In Figs 1, 2, and 3 the ordinates are calculated for the combined moments of the two cranks, and the same units being used for each. The lines *c d* in these figures refer to the path described by the combined effort of the two cranks, and the ordinates, commencing with *a b* and ending with a^1 b^1, represent the moments of torsion The curved lines represent the variation in the torsion, and the superiority of these torsion curves is in their nearer approach to the straight line *c d*.

In changing the crank angle from 145 deg to 60 deg the eccentrics were not disturbed The cushioning, lead, and release are the same in both cases The same boiler pressure and mean back pressures are maintained, and the same number of expansions are employed; consequently there can be no physical advantage in the original over the present crank angle. The mechanical saving in the minute amount of friction eliminated in a single journal of each engine is much more than compensated for by the saving of friction on the screw blades alone by their more uniform velocity.

The Kazenstein packing on the piston rods has worked so well that I feel it merits a special mention I respectfully recommend it be placed on the high-pressure valve stems The Baird distilling apparatus has produced 5883 gallons of water during the quarter, steam being used from the main boilers, the ship being at sea under steam, and cylinder oil (a compound of petroleum) being used in the cylinder The water was good.

The receivers were ordered to be enlarged, by the engineer who designed the ship, when the crank angle was changed from 145 deg to 90 deg This was effected by placing a large convex bonnet on each low pressure valve chest This increased the receivers from $1\frac{6}{10}$ to $2\frac{6}{10}$ times the volume swept by the horse power pistons Seeing an excellent opportunity for a valuable experiment I took the responsibility of putting only one of the new bonnets on, and selected the starboard engine for that purpose, so that for all the steaming recorded in this log book, the port engine had the small receiver and the starboard engine the large receiver. The results show no essential difference in the performance; what little difference does appear is in favour of the engine with the small receiver. I therefore reduced the starboard receiver by restoring the original valve chest bonnet

A ROTARY STEAM SNOW SHOVEL

Few winters pass without some railroads in the north and western States being for some part of the season blocked with snow, and when a severe winter comes round many roads are often obstructed for months In the latter case the whole earnings of some roads are expended in the effort to keep the road open, so that traffic can be carried on even in an irregular way The cost of keeping roads open in such cases is simply enormous Although ingeniously contrived apparatus has been brought forth to aid human labour in the most difficult operations, the invention of machinery to aid railroad companies to clear away snow obstructions has proved singularly unsuccessful All snow ploughs in use follow one idea, they ram into the drifts, and their efficiency in throwing the snow clear of the rails depends upon the speed of the engines that are pushing them A less primitive or more dangerous way of performing a difficult mechanical operation could hardly be conceived By extravagant expenditure of force such ploughs are made to open out light drifts, but heavy snow requires to be cleared by an army of shovellers, and ploughs of this kind can never be safely sent to operate on snow without being accompanied by numerous shovellers to dig them out when they get stuck fast in snow banks

It is believed the machine illustrated in perspective on page 356, will effect a revolution in the methods of dealing with railroad snow blockades The idea followed in designing this rotary steam snow shovel was to apply steam moved machinery to performing the operation done on a small scale by the shovel in the hands of a workman It is really a screw constructed like a huge post-hole cutter and operated in a similar way, and is mounted on a strong steel plate frame that is pushed into the snow bank The screw cuts into the snow, slicing away the drift with great velocity, and throwing it into a revolving fan, which projects it through a shoot on the top of the drum where the fan revolves, delivering it in a stream beyond the railway fence if needed to do so The appearance of the screw as it does its work can be perceived by an examination of the left hand figure, the construction of the drum holding the fan and of the machinery that operates both will be understood by inspecting the one on the right

Power to operate this snow-working machinery is supplied by a double cylinder engine which, with boiler, water tank, and coal bunkers, is carried on a heavy double truck car The cutting screw and the carrying fan are each fastened to a separate shaft, one of the shafts forming a hollow tube, through which the other shaft passes

The necessity for two shafts arises from the cutting screw and the carrying fan turning in opposite directions. The screw, in taking hold of the snow, puts it in motion in a direction opposite to that in which the screw is revolving By arranging the fan to move so as to keep the snow going in the direction it has started, the high speed necessary for carrying the snow away clear of the track is easily obtained.

The duplex shafts are operated by a system of bevel gears driven by the engine, and the pull on the screw shaft is withstood by a long bearing with thrust collars resembling those used on steamers One of these machines that was made early this year, and was tried successfully on a Canadian railway, has a cutting screw 9 ft in diameter, and the engines were able to turn it between 200 and 300 revolutions a minute Other steam snow shovels to be made before winter will be constructed as wide as possible to pass bridges and platforms, and the engines will be made powerful enough to operate the screw at the high speed required to throw the snow clear of the track Flanges, which are not shown in the cut, are secured in front of the machine, and they throw the snow up to the screw so that the rails are left perfectly clean for the wheels of the engine that is pushing the machine The front of the frame carrying the screw inclines outward at a sharp angle which will force the border of snow not cut by the screw into the centre, so that it will pass into the fan The whole of the machinery, including boiler and coal bunker, will be placed under cover

We know of no mechanical want that has been so severely felt for years as that which this rotary steam shovel is intended to fill, and there is a great future open for the machine if it fills the expectation of most practical railroad men who have examined it. The inventor was Orange Jull, a Canadian machinist, who worked for seven years before he got the idea brought to a practical conclusion. Officials of the Canadian railway where the first machine was tried, speak very favourably of its performance It is intended to give a public test of the rotary steam snow shovel as early as possible this winter somewhere convenient to Chicago The machine will be made and the patents controlled by the Rotary Steam Snow Shovel Manufacturing Company, Paterson, N J, J S Leslie, president, George Cox, secretary Adaptations of this machine on a smaller scale have been designed for cleaning streets from snow, and machines similar to lawn mowers will be made for cleaning sidewalks and such work Those meant for this purpose will be light, and easily handled by one man.—*American Machinist*

THE BYE-PRODUCTS OF COAL

The Recovery of the Products from Coal, with Special Reference to the Coke and Iron Industries *

By WATSON SMITH, F.C.S., F.I.C

(*Continued from page* 338)

II *Developments of the Coppée Form of Coke Oven* — In the Coppée oven the gaseous products of the destructive distillations find their way through openings in the upper part of the vaulted walls of the oven into vertical side flues, into which, from the outside air, is admitted In these flues combustion takes place, and the flames passing down the side flues, enter a bottom flue, along which they pass to a lower bottom flue, and from this into a large main flue below both, which, running at right angles to the length of the ovens, passes to the chimney (See "Muspratt's Dictionary," vol iv, p 963, or W Smith, Brit Assoc Report, Sect B, for 1883) The ovens of Sachse, Hiltawski, Franzen, Muller, and Wintzek (see Table, B 4, 5, 6, 7, 8), are all more or less modifications of the Coppée form, with various improved methods and appliances for economising, distributing, and regulating the heat of combustion, but attached to none of them are appliances for recovering bye products (See Ger Pats 22,111, 1882, No 21,455, 1882, No 24,279, 1883, No 20,582, 1882, and No 26,131, 1883) Franzen's oven is, perhaps, in shape the greatest departure from the Coppée form, being much wider proportionately Besides the vertical flues heating the outer walls of the oven, there is also a further outer flue where mixture with the air takes place, this being also in communication with the vertical inner flues by means of perforations The outer mixing flue of one oven is connected with that surrounding a neighbouring oven by a passage closed by a damper The arrangement is such that when one oven is too cool, the damper can be raised and the flames of a hotter neighbouring oven be caused to pass into the mixing channel of the cooler oven, and so aid in raising its temperature again Franzen has also constructed a deep narrow shaft oven (see Table of Diagrams)

Sachse constructs the roof of his oven with an interrupted slit, into which heavy slabs are introduced, so as to press upon the charge of coking fuel and cause the production of a dense coke Comparative weights are given, proving that a denser coke can thus be obtained

We pass on now to consider those forms derived from the Coppée which are arranged for the recovery of bye products Not the least remarkable amongst these is the

Larmann's Oven (Ger Pat Suppl 17,203, 1881), which is variously modified Firstly, it may be used like a beehive oven, air being admitted into the coking mass (see Table A 3 and Table of Diagrams, C 3) by an opening or slit in the floor of the oven But although so used, it is shaped and heated like a Coppée, for the half burnt gases pass into the side flues, where they mix with more air The half burnt gases pass besides through new openings lower down in the walls of the ovens, so that the points of intense combustion, where the mixture with air in the side flues takes place, are brought closer to the coking mass (see Table C 3) But this air slit admitting air into the coking mass can be closed, and only opened at the later stage of the process of coking (Table D 3) Though the recovery of bye products is spoken of with this oven, I confess I have as yet seen no details or description of any plan proposed for the purpose, and without some radical alteration in construction I have little confidence in either the quality or quantity of these bye products

Modified Coppée Oven —In this form, arranged by Otto for the conversion of Coppée ovens already built, apertures are arranged in the top arches of the ovens, through which the vapours and gases are drawn, the openings to the vertical side flues being filled up (Table E 9) The gases after condensation are returned to the ovens, and are injected by one or several blowers into the channel or flue directly below the oven beds, combustion takes place here, and the fire ascends through the side flues, and descends the other neighbouring side flues into a lower bottom flue just below the one in which the gases and air are first blown, from this the fire passes to the main flue (running at right angles to the length of each oven) and to the chimney I fear the attempt to convert ovens that have already sustained so high a temperature, letting them cool, and stopping the side flues, rearranging these and the lower flues, would be a more difficult piece of work than appears at first sight

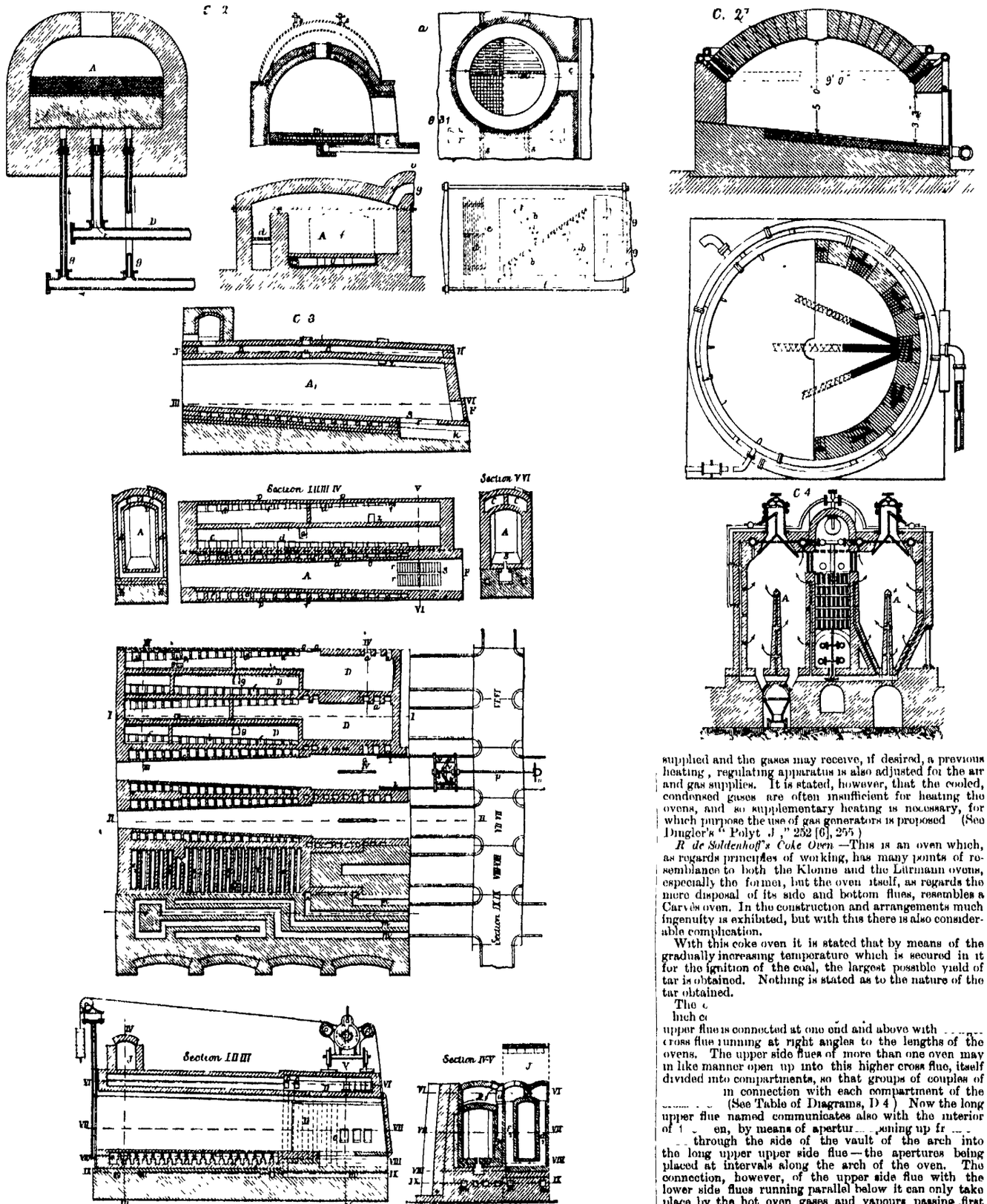
Otto's Coke Oven is an adapted Coppée, arranged either for no recovery of bye products, for recovery during a part of the coking period, or during the entire period (Table E 13) On reading the account of this oven in Fischer's "Jahresbericht," I could not avoid the thought that in the process for recovering the tar products during the first twenty-four hours of the total forty-eight required to work off an oven, the temperature must be too low for the satisfactory formation of aromatic hydrocarbons, and I see Otto and Herberz have proposed the use of auxiliary heating arrangements, such as gas generators

I consider that Otto has shown the greatest ingenuity and skill in the various arrangements he has engrafted on to the oven which bears his name, but I am forced to the conclusion that the arrangements have grown somewhat complicated, and involve many minutiæ I cannot but think that plant subjected to such tempera

* Paper read at the Chester meeting of the Iron and Steel Institute.

TYPES OF COKE OVENS.

(See Column B of Professor Watson Smith's Table, Page 306 ante.)



tures as coke ovens are, in order to save serious expense in first costs of erection, and most of all in repairs, the difficulty of which is increased by complexities, should be as simple as possible, and that each oven should be as independent of its neighbours as possible. Now these are the very points in Otto's coke ovens where I fear difficulty, but perhaps Dr. Otto will be able to enlighten me on the subject.

Herberz' Coke Oven (Ger. Pat. 25,526, June 26, 1883) appears to me less complex than Otto's arrangement. Herberz (E 14) draws off the gases and vapours from the centre of the arch of his oven (a close one, unconnected with the vertical side flues), condenses them to separate tar and ammonia, and carries the gases back to the ovens by pipes, and passes these gases into the vertical flues of the modified Coppée ovens from above; air is also passed in similarly from pipes similarly arranged, and running along with the gas pipes. The arrangements are such that the air supplied and the gases may receive, if desired, a previous heating, regulating apparatus is also adjusted for the air and gas supplies. It is stated, however, that the cooled, condensed gases are often insufficient for heating the ovens, and so supplementary heating is necessary, for which purpose the use of gas generators is proposed (See Dingler's "Polyt. J.," 252 [6], 255.)

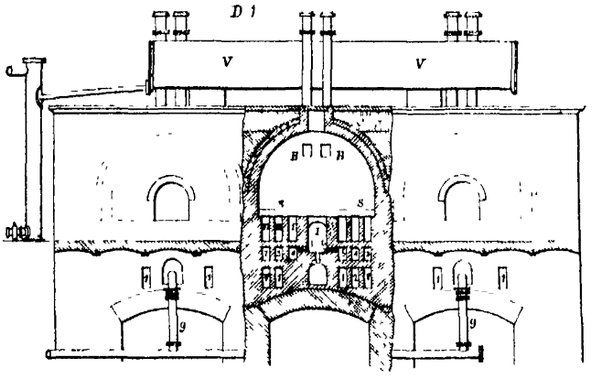
R. de Soldenhoff's Coke Oven.—This is an oven which, as regards principles of working, has many points of resemblance to both the Klonne and the Lürmann ovens, especially the former, but the oven itself, as regards the mere disposal of its side and bottom flues, resembles a Carvès oven. In the construction and arrangements much ingenuity is exhibited, but with this there is also considerable complication.

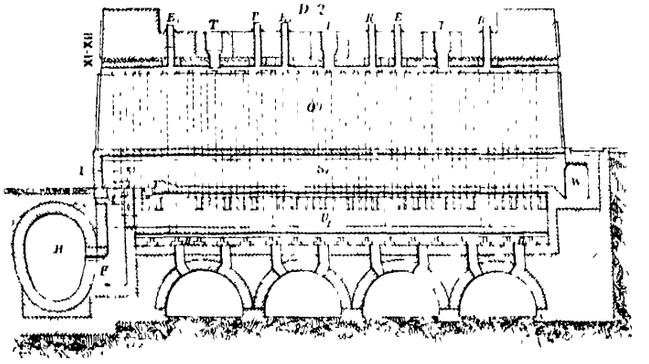
With this coke oven it is stated that by means of the gradually increasing temperature which is secured in it for the ignition of the coal, the largest possible yield of tar is obtained. Nothing is stated as to the nature of the tar obtained.

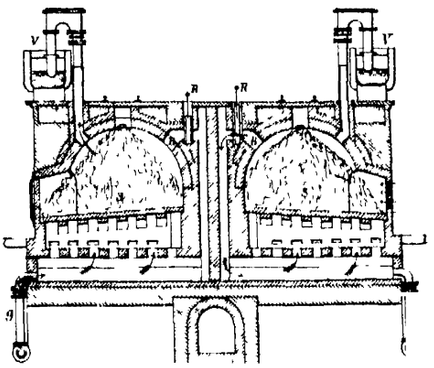
The c
hich c
upper flue is connected at one end and above with
cross flue running at right angles to the lengths of the ovens. The upper side flues of more than one oven may in like manner open up into this higher cross flue, itself divided into compartments, so that groups of couples of
in connection with each compartment of the
(See Table of Diagrams, D 4.) Now the long upper flue named communicates also with the interior of
en, by means of apertur
through the side of the vault of the arch into the long upper upper side flue—the apertures being placed at intervals along the arch of the oven. The connection, however, of the upper side flue with the lower side flues running parallel below it can only take place by the hot oven gases and vapours passing first into the cross flue compartment, and from this compartment (common to a neighbouring oven also) down a short vertical branch flue into the next horizontal long side flue below. Now, connection of the long upper side flue with the cross flue or compartment can be cut off at will by a damper, which also cuts off connection of the cross flue with the next lower flue. The horizontal wall or midfeather separating the second long side flue from the bottom one of the three, contains also a long, narrow flue opening to the outside of the oven and to the air, but

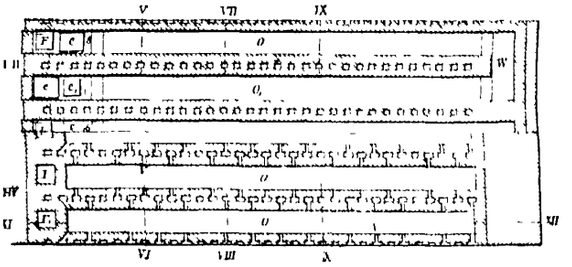
TYPES OF COKE OVENS.

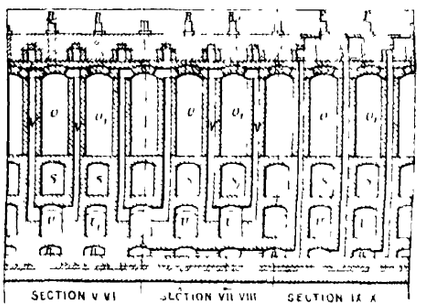
(*See Column B of Professor Watson Smith's Table, Page 306 ante.*)

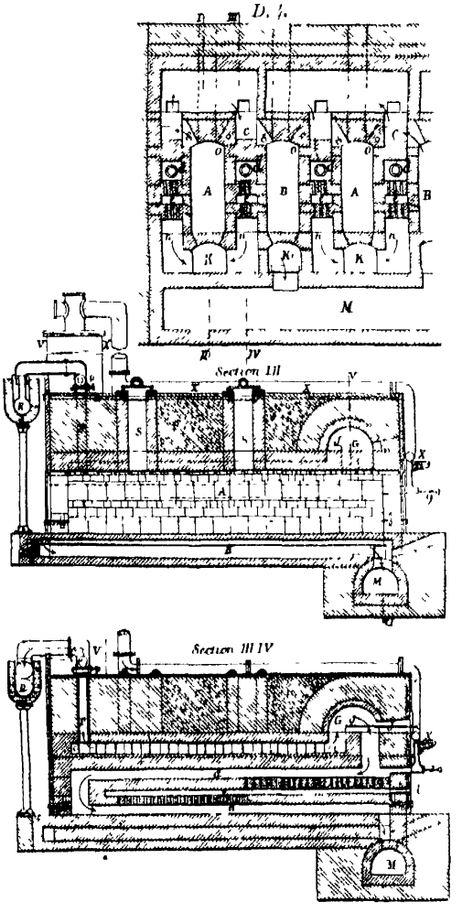












closed at the end of the mid feather wall, so that an coming from the opening to the outside of the oven, can only gain access to the second and third long side flues through perforations in the lower and upper walls of the two flues respectively, for which purpose the said mid feather wall is built of perforated firebricks. The air opening mentioned can be stopped or regulated at will. Thus, it will be seen that if the first flue mentioned, the upper side

of the oven, parallel with ... ments run), then the ... to Coppée oven, through the ... flue, and then descending into a cross bottom flue, escape to the chimney, circulation from the oven interior through all the heating flues is established. Let the damper, cutting off the connection of the upper side flue with the cross flue (acting also as a reservoir for the gases of two ovens) ... d its cooling can ... be expedited by o... midfeather flue, and through its perforated walls into the second and third side flues, of which it forms the common mid feather wall. But now, another connection not yet referred to—may be established with the upper side flue ... hydraulic main running along the back of the ovens, and sunk in a vessel containing water. When the damper to the cross flue is closed, the oven gases have no choice, on entering the upper side flue, but to continue upwards to the hydraulic main, where the tar and some of the ammonia water condense, the gases with still some ammonia and other vapours escape at the end of the main into a scrubbing arrangement supplied with cold water. The gas from this is conducted across the top of the ... z the front of the ... taps) into the seco... of the oven takes place from above, the coal falling down two shafts in each oven. From the description of the arrangement of these ovens, it will now be evident (see Diagrams D 1), that the process is conducted in two stages, and somewhat as follows. 1st stage, when the ovens at first, very hot from the completion of the last charges, are now cooling down, though still hot enough to work the freshly charged coal through its first stage, in which the tar products have to be condensed. 2nd stage, when the ovens, now grown comparatively cool, are placed out of connection with the hydraulic main by opening the damper to the cross flue, and so to the other and lower side flues, the oven gases then passing, just as in the Coppée and Appolt systems, admission of air at the close of the ... at the outside of the ovens,

air thus being drawn into the interiors of the ovens from the outer atmosphere In this respect the process resembles Lürmann's, only that the admission of air takes place above the mass of fuel and not below it, as in Lürmann's oven The working is so arranged that the oven or ovens in connection with each compartment of the upper cross flue, is, or are, either cooling or hot, *i e*, either in the first or second stage ; in other words, the ovens are worked alternately, either singly or in pairs It is stated that the dampers to the cross flues are never quite closed, so that during the first stage some circulation of hot oven vapours through the side flues takes place, which means consequently loss of tar and ammonia A sort of valve-arrangement near the tops of the upright pipes to the hydraulic main sets each oven in communication with that main.—(Dingler's "Polyt ," J 252 [7], 283, 284.

From the fact that so much recourse is had to cold air and cooling, like that of the rich gases first evolved —some are burnt, and that in the second stage air is admitted into the coking mass, I don't see any evidence to guide me to the belief in increased quantity of tar and ammonia, and indeed my doubts are considerably in favour of a probable decrease of quantity of both bye products, and as regards the quality of the tar, the temperature of the oven may possibly be high enough to secure its goodness, what there is of it ; but with respect to this temperature, supposing that the heat of the second side flue, where the chief combustion of the gases takes place, to be anything like that of gas retorts, or of the bottom flue of the Simon Carvès oven, then I think the perforations of the fire bricks admitting the air to those side flues must gradually, but soon, get fused up Let this doubly *perforated* midfeather wall once get out of order and need repairing, part of the oven must come down, and then the upper cross flue, common to more than one oven, is interfered with, for more or less cold air will then probably get access to it from the oven in repair The oven is a most ingenious contrivance, but at all events the first impressions are adverse to it, on account of its minutiæ and complications, to say nothing of the quality and quantity of the tar and ammonia

III *Developments of the Knab and of the Pauwels Dubochet Ovens* — Perhaps this series of developments is the most interesting of all, especially for the reason that, beyond the shadow of a doubt, real coal tar, or rather coal tar valuable for dyes and colours, is produced by ovens not greatly differing from the original models, and the coke is as firm and solid as could be wished for blast furnace use It is stated by Gurlt, in his work, "The Bereitung der Steinkohlen briquettes," that "the oldest coke oven employed for recovering tar products is that of C Knab, of St Denis, near Paris" Originally Knab worked only with bottom flues, according to Hussener (Fischer's "Jahresb." 1883, page 1213), and at the coke ovens of Lebrun at Commentry (Dingler's "Polyt J." 154, 97), Carvès, under whose management at St Etienne eighty eight Knab ovens were erected, first introduced the heating of the ovens with side flues in addition to that with the bottom flues. After the improvements of Carvès, there were gradually introduced at Besseges fifty three coke ovens in the years 1866 to 1873 ; and in the year 1879 at Terre Noire, near St Etienne, a hundred ovens. According to Dr F Fischer (Fischer's "Jahresb," 1883 1214), there were already, in the year 1854, fifty coke ovens known as Pauwels Dubochet ovens at work near Saarbrucken, which makes these ovens of somewhat earlier date than those of Knab and Carvès (Dingl "Polyt J," 142, 414, and 160, 394) However, although the form of the oven was similar in some respects to that of the Knab improved by Carvès, or otherwise Carvès ovens, still there is evidence to show that in other respects it differed*, and the coking temperatures were very different, as will shortly appear In the beginning of the year 1870, when coke rose in price immensely, the chief director of the Paris Gas Company, W Oechelhaüser, caused the introduction at the stations Ivry and La Villette of two sets of Pauwels Dubochet ovens, for the purpose of producing from caking coals metallurgical coke and illuminating gas for the city of Paris, one-half of which was supplied by the latter It was said to have less illuminating power than good retort gas, for which reason it was mixed in the gasometers with retort gas The coke was said to be the best imaginable, and commanded a high price for use on locomotives and for metallurgical and other purposes The dimensions of the fireplace of one of these ovens as given in Gurlt's work (page 30) are—length, 7 20 meters, breadth 2 meters, and height of vault 1 meter Dr Fischer, however, gives for Carves ovens, as erected at Besseges ("Jahresb," 1883, 1214) the following particulars "These ovens were (according to many measurements) only built 0 6 metres wide," and Gurlt adds as to the Pauwels Dubochet oven, "The working of this oven is generally the same as the Knab oven (Carvès oven), only the coking of the charge of six tons takes place at a very much lower temperature and lasts for three days, whereby one ton of coal yields 7500 cubic feet of gas" But these differences, however slight they may appear, are fully sufficient to make a complete difference in the tars obtained, and Gurlt further on remarks, as he might be anticipated to do, "The tar is much lighter (*i.e.*, has a much lower specific gravity) than gas retort tar of a specific gravity of 1 2, also it contains less naphthalene and carbolic acid" I feel no doubt myself that the narrower-built Carvès oven would have yielded a better illuminating gas than did the Pauwels Dubochet oven, but the coke would have been harder I consider from all the evidence obtained, that to M Carves belongs the full credit of being the first to construct and work a coke oven capable of yielding good metallurgical coke, coal gas, and valuable coal-tar, which, with astonishingly little modification, continues to the present time the simplest and best oven for the purposes named, according to my opinion

The earlier Carves oven was furnished with a fireplace and grate, the uncondensable gases being brought round to the fireplace by pipes, and burnt there Otherwise the flue arrangement was much the same as now The recent Carves oven is fired exclusively by the gases escaping condensation, these entering the lower flue at the place where the hearth or fire used to be, air being forced in through an annular pipe In the Simon Carves oven, or recuperator oven, the air introduced receives a previous heating to some 500 deg to 600 deg Cent (900 deg to 1000 deg Fahr) by the flues being brought in contact with the hot flues conveying away the spent fire gases from the ovens The question may be asked, "But if by the use of recuperation you have plenty of heat for the lower flues and side flues, do you not get so intense a heat where the first combustion of gas and air takes place that no material will stand such firing, in other words, do not the lower flues get soon burnt out?" The reply is, since recuperating, the two lower or bottom flues have been thrown into one, this simplifies matters, and there is less material to burn Then at the part of the bottom flue where the greatest heat is sustained, the walls are lined with the best silica bricks, *i e*, bricks formed of compressed fine white sand and a binding material. Moreover, the heated air admitted into the bottom flue is purposely insufficient for complete combustion of the gas introduced there, the further supply of hot air being admitted into the side flues of the oven The arrangements for thus admitting the air are completely under control by means of dampers The silica bricks are made in France, and I believe in Yorkshire, and should contain about 97 per cent pure silica, and will stand practically any needful temperature Thus ample heat is obtained for the process, and a tar is produced richer than any as yet known in anthracene and naphthalene It also contains benzene, toluene, xylene, and carbolic acid I have recently prepared a pint of pure coal tar xylene from the solvent naphtha of Simon Carvès tar, kindly supplied to me by Mr S A Sadler, of Middlesbrough Mr Sadler most kindly worked off a 12 ton tar still, charged alone with the tar from the coke ovens of Messrs Pease, of Crook, by Darlington, and he sampled the various products, and sent me one gallon specimens of them. These samples I am putting through a close examination and analysis, and I hope to read my full report in November or December next before the Manchester Section of the Society of Chemical Industry

Pernolet's coke oven differs very little from the Carvès oven with the old fireplace and grate, but in an improvement in the year 1870, carried out because Pernolet found that whilst the fireplace of the Carvès oven was burnt away by the heat the oven walls were not hot enough, he carried the gas into the upper horizontal side flue alone and fired the bottom flue from solid fuel In this we have increased complication of matters in comparison with Carvès oven (See Fischer's "Jahresb," 1883, pp 1215, 1216)

Hussener has slightly modified the Carvès oven, using a recuperating process considerably like the Simon-Carvès improvement He passes air through the lower cooling channels in the lower part of the oven, and so heats it to 300 deg, when it is driven into the fireplace (where now no hand-firing is necessary) along with the gas, and also higher up and simultaneously into the upper side flue Finally, he passes gas into the upper side flue at the other end of the oven. He thus claims to heat the oven with its own gas entirely, an end attained in the Simon-Carvès oven without such additional piping and regulating arrangements. Were silica bricks not known, doubtless some such distribution of the intense heat of the bottom flues of the Simon-Carvès oven would be needed ; but by using one bottom flue and silica bricks, simplicity is secured, material saved, repairs rendered easier, and the chances of breakdowns diminished by avoidance of multiplied adjustments, flues, pipes, and other complications

Ruppert, of Gelsenkirchen, introduces tubular or flue arrangements into and through the oven, through which, from the outside, air can enter and become heated, when it then enters with the stream of gas into the combustion flue, also cold air can be allowed to enter this tube, and hence either heating or cooling can be effected Several other similar flues are also arranged, the object being to place the temperatures of different parts of the oven under better regulation and control, and also to be able to admit air at various points into the combustion flues. (See Dingler's "Polyt. J ," 252 [6], 255)

Semet and Solway also admit air, to burn with the gases which have escaped condensation, which air has received a previous heating after much the same plan as that adopted by Hussener, only that the air warmed in the lower exit flues is, in addition, first drawn down through vertical passages arranged in the walls supporting the vaulting Thus, further heating of the air is secured. However, Semet and Solway employ fireplaces and grates. The flames of the solid fuel pass along a single bottom flue, which divides at the end of the fireplace into two parts, up which the fire passes and traverses the side flues, composed of rows of thin stone shells, forming the horizontal parallel flues The gas and hot air can be admitted both into the fireplace and into the upper side flue Mr Mond, of the firm of Messrs Brunner, Mond, and Co, informs me he is erecting fifteen of these ovens, and expects to have them at work about the end of this year This oven of Semet and Solway is, as already stated, merely a somewhat more complicated, and therefore probably more expensive, form of the Simon-Carves oven, and I should very much doubt if there is any improvement as regards the process

Seibel draws off gases and vapours as usual, and returns the gas after condensing, to be entered into the upper side flue with air, whence it passes downwards through the lower side flues to the main exit The bottom flue is heated apparently with hand firing, and altogether the arrangement is much the same as with Semet and Solway.

The regenerative coke oven of the Silesian Coal and Coke Works in Gottesberg, is simply a Simon-Carvès oven with slightly modified side flues. At first (Ger Pat 25,825, May 6, 1883) an alternative regenerative or superheating system was proposed, by means of which the hot burnt gases could alternately pass down either one pigeon-holed regenerator situated below the oven to the main exit, or down the other adjacent one of a double set, according to the position of a suitable damper, whilst the cool condensed gases and air passed upwards through the other regenerator The one of these is the exact counterpart of the other, and each is divided by a mid feather wall, so that the gas may travel up one part, the air up the other, so as not to mix before entering the combustion space in the oven Suppose the hot gases have been caused by the clapper valve damper to escape down the one divided regenerator to the exit, thus using it with its two compartments now simply as an escape flue, and that it has become thus highly heated, on reversing the action, the cool gas and air now rise upwards, being drawn through their respective compartments of this now highly heated regenerator, and are respectively heated before uniting in the combustion space of the lower oven flue, whilst the hot exit gases find their way down the other system, which now in its turn becomes highly heated Thus no fireplace and grate are needed

According to a more recent patent (Ger. Pat 26,421, May 7, 1883), it is found more advisable only to subject the air to a previous heating, whilst the gas enters the combustion space without previous heating (See Dingler's "Polyt. J ," 252 [6], 254, and 255)

Hussener and K Moller in Gelsenkirchen experimented for some time with the Carves oven, and their results led to the formation of a coal-distillation company working fifty of these ovens, built on a somewhat improved plan It will be seen from the data in the Table above that, as regards the coal tar, the results are no better than those

RESULTS OF COKE OVEN WORKING AT GELSENKIRCHEN, CROOK, AND MIDDLESBROUGH.

At Gelsenkirchen, by Hussener and Möller

Output	Per cent
Large coke	75 0
Small "	0 8
Dust	1 2
Tar	2 77
Ammonium sulphate	1 10

The tar yielded on distillation 8 8 per cent of volatile liquids, and 39 5 per cent of pitch The further treatment of the distillate gave

	On the Tar per cent
Benzol (b p 80 deg to 100 deg)	0 59
Benzols (b p 100 deg to 140 deg	0 49
Naphthalene	0 89
Phenol*	1 39
Anthracene	0 95

At Crook, by Darlington

Output.	Per cent
Good coke	77 03
Tar (sp gr 1 106)	2.60
Gas liquor at 6 deg to 7 deg T	†10 40 =1 09 per cent ammonium sulphate

(Robert Dixon)

Messrs S A. Sadler and Watson Smith

The tar yielded on distillation 4 5 per cent by volume of light oils available for phenol, benzenes, and solvent naphtha, 20 4 per cent by volume of creosote oils with much naphthalene, and 34 2 per cent of thick anthracene oils

Further treatment of the distillate gave (S. A. Sadler)

		Per cent on Tar
Water	10 00	
Benzol 50-90 per cent,	0 50	1.10
Solvent naphtha (90 per cent at 160 deg C)	0 60	
Heavy naphthas	0 40	
Crude carbolic acid	0 05	
Creosote oils	46 50	
Anthracene	0 74	
Pitch and loss	41 21	
	100 00	

* There is probably some mistake here With so much anthracene and so little benzenes, the phenol (if pure crude carbolic acid be meant) should be lower in quantity, and the naphthalene higher

† When these numbers were obtained the condensation was quite insufficient, and so doubtless both tar and ammonia were lost

* Dr Ad Gurlt informs me (October 10th) that "the Pauwels Dubochet coke ovens were certainly in use in 1854 at the coke works of De Wendel, near Saarbrücken, but they never produced tar, for all the gases and products of distillation were burnt around the coking chamber to heat the same. The walls of the coking chamber inclined at an angle of 45 deg, and the oven had an auxiliary fireplace near its lower opening, through which opening the coke charged could glide down into a cooling chamber.

obtained by Mr. Robert Dixon, Messrs. Pease's manager at Crook, and by Mr Sadler at Middlesbrough, who works the tar and extracts the constituents. Mr. Sadler kindly furnished me with the data given under his name

Appolt's Oven —I know of no adaptation of the Appolt oven for the recovery of bye-products I can conceive one possible, and the advantage of removing the coke from below by simple removal of the trap door arrangement would have seemed to present temptations to a trial.

(To be continued.)

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

The Yorkshire Coal Trade.—During the month of September, the total quantity of coal sent to Hull from the Yorkshire collieries reached 133,808 tons as against 118,064 tons forwarded during the corresponding month of last year, this being an increase of 15,744 tons For several months past the Hull coal trade has been drooping, and for the first nine months of the present year the returns show only 968,352 tons, as compared with 1,003,932 tons from January to September, both inclusive, of last year, or a falling off of not less than 35,580 tons.

The Water Supply of Bradford —The reduced state of Bradford water supply is causing much anxiety on the part of the responsible authorities Last week there were something over 10,000,000 gallons of water in the high level reservoirs of the corporation, which is said to be hardly equal to five days' supply, and in the low level reservoirs the quantity of water is about equal only to a fortnight's consumption. A more restricted supply for public use is inevitable. The reservoirs have been inspected by the Water Works Committee, who were accompanied by the town clerk and Mr Binnie, the engineer It is stated there will be shortly forthcoming a scheme for providing an additional supply

Extension of the Rawson-place Market at Bradford,—The Markets and Fairs Committee of the Bradford Corporation have come to the resolution to recommend the council to sanction a scheme for extending the Rawson place Market The scheme includes the absorption of the shop property in John street and Rawson place The estimated cost of the property required for the extension is something more than 20,000*l*

Proposed Street Improvements in Bradford —The Street Improvement Committee of the Bradford Corporation, at their weekly meeting on Thursday, decided to recommend the council to carry out certain street improvements in order to complete several schemes of street improvement, including that of the widening of Westgate The most important of these is the widening of Little Horton lane, so as to avoid the bend in that thoroughfare near Trinity Chapel; the proposal to construct a straight street from the junction of Darfield street and Lumb lane into John street, the long delayed improvement of Beckside road, and the widening of Cemetery-road and Alberton road, that an extension of the tram lines may be made.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES

MIDDLESBROUGH, Wednesday

The Cleveland Iron Trade —Yesterday the market remained dull and prices were rather easier for prompt delivery No 3 Cleveland pig changed hands in small lots at 36s. 4½d per ton Higher prices are asked for special brands, and as much as 37s is paid for No 3 in exceptional cases Shipments of pig iron from this port continue good, notwithstanding the recent storms Up to date this month there have been exported 30,700 tons against 39,500 tons last month and 40,000 tons during the corresponding time last year. The manufactured iron is dull at 5*l.* per ton for ship plates and 4*l* 15*s* for angles, less 2½ per cent. at works Hematite pig iron is unchanged at 44s. for Nos. 1, 2, and 3, f o b. west coast ports.

The Cleveland Pig Iron Makers and Trade Prospects.—Last week we pointed out that in view of the dull prospects over the winter months, the combination pig makers were anticipating difficulty in maintaining prices unless they resorted to a further curtailment of the production, and that such a step was surrounded with difficulties and complications On Monday it was reported that the combination had been broken up In the afternoon a special meeting of the Cleveland Ironmasters' Association was held in their offices at Middlesbrough and was largely attended. The condition and prospects of the iron trade were fully discussed and it was resolved that the proceedings should be kept strictly private. At the conclusion of the meeting the merchants were anxious to ascertain what had transpired, and all sorts of reports were in circulation In some quarters it was stated that the advisability of blowing out a further number of blast furnaces, in order to reduce the make within remunerative limits during the ensuing winter, had been fully talked over and that a committee had been appointed to obtain information on the subject and report to the Association. The appointment of an official salesman for the district had also been suggested. In other quarters there was a settled opinion that the combination for systematic restriction and the regulation of prices has ended, and that each pig iron maker would have to rely on his own individual responsibility in conducting his business, and would either continue his furnaces in blast or blow them out according as he might interpret the natural law of supply and demand. It is beyond doubt that certain firms cannot afford to put iron into stock any longer, while others are in a position to keep their plant, in which enormous sums are invested, fully occupied and dispose of their stock when prices improve The combination attempt to bolster up prices has failed, and if each individual maker is to be left to carry on his business operations in his own way there will be a change which will benefit the consumer

The Coal and Coke Trades —Coal is still hardening in price, and coke is easier

Shipbuilding and Engineering —These two great industries are still depressed, and prospects for the winter months are no brighter. On the Tyne, Wear, and Tees there is great distress amongst the working classes, and special organisations have been formed to deal with the poverty and suffering

NOTES FROM THE NORTH

GLASGOW, Wednesday

Glasgow Pig Iron Market – Last Thursday's warrant market was steady, with transactions reported on forenoon 'Change at 41s 7½d to 41s. 8½ cash, also at 41s 9d to 41s 10d one month, the close being buyers at 41s 8d cash and 41s 9d one month, with sellers near Business was done in the afternoon at 41s 8½d down to 41s 7½d cash, also at 41s 10d. down to 41s 9d one month, and sellers at the close were wanting 41s 7½d cash and 41s 9½d, one month, with buyers offering ½d less per ton The market was quiet but steady on the following day at Thursday's closing prices; over the week, however, there was a decline of 2d per ton During the forenoon business took place at 41s 7½d. cash and 41s 9½d one month, and there were buyers at the close at those prices, with sellers asking ½d per ton higher, the same prices prevailed in the afternoon, but buyers at the close were offering ½d per ton less Monday's market was quiet during the forenoon, but as the shipping returns for last week showed a better result than was expected, the tone of the market became firmer in the afternoon, and prices rose 1d per ton Transactions took place in the forenoon market at 41s 7½d cash and 41s 9d one month, and the close was sellers at 41s 7½d cash and 41s 9½d one month, and buyers at ½d per ton lower In the afternoon business was reported at 41s. 7½d to 41s 8½d cash, also at 41s 9½d and 41s 10d one month, and sellers at the close were asking 41s 8½d and 41s. 10½d cash and one month, respectively, with buyers at ½d per ton less Business was done yesterday forenoon at 41s 7½d up to 41s 9d cash, also at 44s 9½d up to 41s 11d one month, with buyers at the close offering the top prices, and sellers wanting ½d more per ton. The afternoon rates at which business was transacted were 41s 9d cash, and 41s 10½d one month, and at the close of the market there were sellers at those quotations, with buyers at ½d per ton under Somewhat higher prices were reached to-day, but there was a decline by the close in the afternoon The forenoon prices reached from 41s 8d to 41s 10d cash, and from 41s 10d to 41s 11½d one month, the closing rates for buyers being 41s 9½d cash, and 41s 11½d one month, with sellers at ½d per ton higher In the afternoon transactions were reported at 41s 9½d and 41s 9d cash, also at 41s 11d and 41s 10½d one month, with sellers at the close asking the lower rates, and buyers offering ½d. per ton less The market continues to be exceedingly flat and featureless, and only a very limited amount of business is being done speculatively in warrants, and most of the movement taking place from day to day is still the result of operations within the trade, but such speculation as has been showing itself is credited with the advance that has taken place in prices during the past week There is no change to report in the aspect of the home trade, and there is a very general feeling that no material improvement need be expected for some months to come Several of the superior shipping brands are still scarce, but on the whole there is now rather less demand for them One blast furnace has been re-lighted at Summerlee Iron Works, and another at Dalmellington Iron Works, so that there are ninety four furnaces in actual operation, being exactly the same number as at this time last year The shipments are still keeping low For the past three quarters of this year the aggregate turns out to have been the lowest since 1880, being only about 5000 tons above that for the same period of 1879, while the stock in store is 252,000 tons more than it then was, being an increase of about 75 per cent Last week's shipments amounted to 11,661 tons, as compared with 9635 tons in the preceding week, and 11,787 tons in the corresponding week of 1883 Up till last Saturday the shipments for the year amounted to 441,197 tons, as against 504,989 tons for the same period last year, showing a decrease of 63,792 tons The shipments reported last week were specially notable on account of the large quantity of pig iron despatched to Russian ports—in all, 2310 tons There were also despatched 1465 tons to the United States, 675 tons to Canada, 480 tons to South America, 430 tons to Australia, &c, 320 tons to Italy, 790 tons to Germany, 795 tons to Holland, 140 tons to Spain and Portugal, and lesser quantities to other countries The hematite pig iron market remains very prostrate, the current quotation being 43s 6d per ton for the usual proportions of Nos 1, 2, and 3 brands f o b at Cumberland ports. The stock of pig iron in Messrs Connal and Co's public warrant stores stood yesterday afternoon at 582,162 tons, as against 582,662 tons yesterday week, showing a decrease for the week of 500 tons

Forth Bridge —On the part of the Forth Bridge Railway Company, it has been found necessary to issue a notice this week in the following terms In consequence of the interruption to the works from the large number of visitors, the directors find it necessary to give notice that in future visitors will only be admitted to the works on Saturdays, from 2 to 4 o'clock P M., when a steamer and conductors will be provided, and a charge of 5*s* made for each person, and which charge will be credited to the Forth Bridge Sick and Accident Fund

The Glasgow Chamber of Commerce and the International Inventions Exhibition At last Monday's meeting of the Glasgow Chamber of Commerce, the secretary submitted an official communication regarding the International Inventions Exhibition, which it is intended to hold at South Kensington next year Two leading members of the Chamber spoke on the subject Mr James King said that it was expected to be a very extensive and interesting Exhibition, and notice was prominently given that inventions should be exhibited without the liability of inventors forfeiting their rights by the publicity which they obtained Mr David Guthrie said it might not be out of place to add a word of warning to gentlemen who meant to exhibit as to the danger of submitting their patents to the eyes of the world We had to fight in this country against foreign competition and hostile tariffs, and the principal weapon against these was the ingenuity of our inventors We had seen lately, in regard to the International Patents Convention, that neither the United States nor Germany had joined that convention Whether they had joined it or not, he did not think the danger of piracy would have been removed They knew that the law with regard to the enforcement of patents was not a satisfactory one The difficulty in enforing patent rights was enormous, and were they on the continent the difficulty would be tenfold He thought that those men who proposed to exhibit should carefully consider whether their inventions might not be liable to be pirated by foreign countries It was ultimately agreed to remit the matter to the home committee for consideration

Professor Elgar on the Navy and Clyde Shipbuilding — The annual dinner of the Glasgow Trades House took place last week, and on that occasion a toast was proposed for the purpose of enabling Professor F Elgar, who was one of the guests, to make a sort of semi public appearance The toast was "Naval Architecture, Marine Engineering, and other Industrial Interests of the Country," and in responding, the "John Elder" Professor of Naval Architecture said that so far as naval architecture and marine engineering were concerned, those industries demanded their sympathies, as they were in a very low state Shipbuilding was worse at present than it had been for a great many years, and they would soon see the effect of that in Glasgow A large number of highly skilled artizans were out of employment, and they were likely to remain so for some time to come On the other hand, they heard a great deal about the present state of the Navy At the present time it was stated, and he believed it was correctly stated, that the Navy of this country would not compare favourably with the navies of other countries If we did not build more war ships, France would very soon succeed in out-building us in ships, and would be able to put a more powerful navy in the waters than we possess That was not a satisfactory position for this country The present state of the shipbuilding trade was one which was exceptionally favourable towards altering that state of things It seemed that the only thing that the Admiralty had to do was to make up its mind that more ships were necessary This was a very good opportunity for the Admiralty in placing the Navy on a proper footing, for they could build on the Clyde district alone within the next two or three years a sufficient number of vessels The two questions, it seemed to him, could be made to neutralise each other, and it rested with the authorities of the country to avail themselves of the immense resources that they possessed

The Coal Trade - There is very little appearance of activity in the coal trade of Lanarkshire and the west of Scotland generally, and in most cases it takes hard pushing to get orders Buyers in most instances have the ball at their own feet, and, as a matter of course, they do not hesitate to kick it At many of the collieries in Lanarkshire there is much broken time in consequence of the paucity of orders, and many of the railway sidings being heavily blocked with coal laden wagons Ayrshire has been favoured this week with a number of orders, as the westerly winds have allowed vessels to get into ports The result has been that some of the sellers in that county have been able to refuse orders this week, but they look on that state of things as being only temporary Prices are very low, indeed, it is hardly possible to quote correctly at present, as lower prices will be taken according to circumstances The f o b rates at Glasgow are—Main coal, 5s 3d to 5s per ton, ell coal, 6s to 7s, splint coal, 6s 3d. to 6s 9d

A CANDID CONFESSION —Last week's issue of *Vanity Fair* contains a somewhat remarkable avowal Our contemporary states that having been led to take an interest in railway brakes, and having formed an unfavourable opinion of the Westinghouse brake they had submitted the whole question to an expert on whom they could place complete reliance The result is, says our contemporary with a candour which is highly creditable, that "we feel bound to publish the expert's report, to acknowledge that we, in our ignorance, took a wrong bias, and to say that for the future we shall believe in the superiority of the Westinghouse brake over all others at present in use" The report is conclusively in favour of the Westinghouse automatic brake, as such must always be, when the matter is investigated by an impartial and unprejudiced mind We have called this confession remarkable, for it would seem as though it were almost impossible for people who, like *Vanity Fair*, have formed a wrong opinion on the brake question, to acknowledge their error, even in the face of a catastrophe like that at Penistone It must be allowed that there is decidedly more fairness than vanity in our contemporary's composition What an easy solution of this vexed question if the advisers of certain companies were animated by the same spirit, and by making a candid confession of their error become forthwith public benefactors.

WILLIAMS'S SYSTEM OF TORPEDO ATTACK AND DEFENCE.

(*For Description, see Page 369.*)

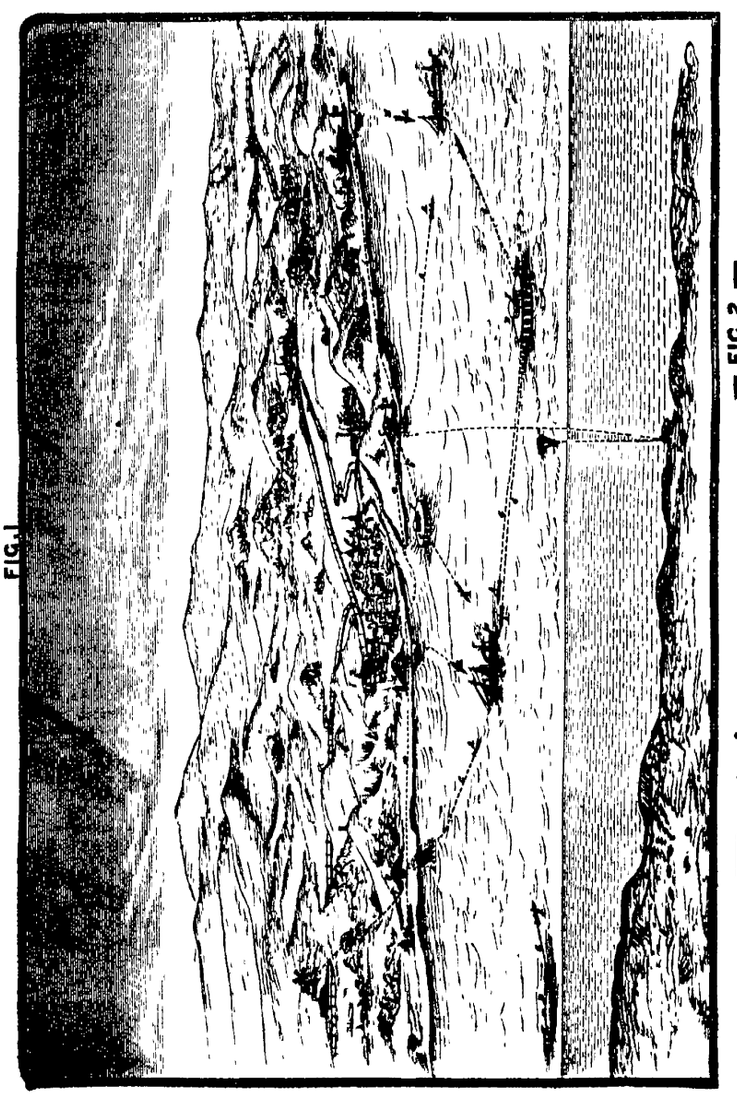


FIG. 1.



— FIG. 2 —

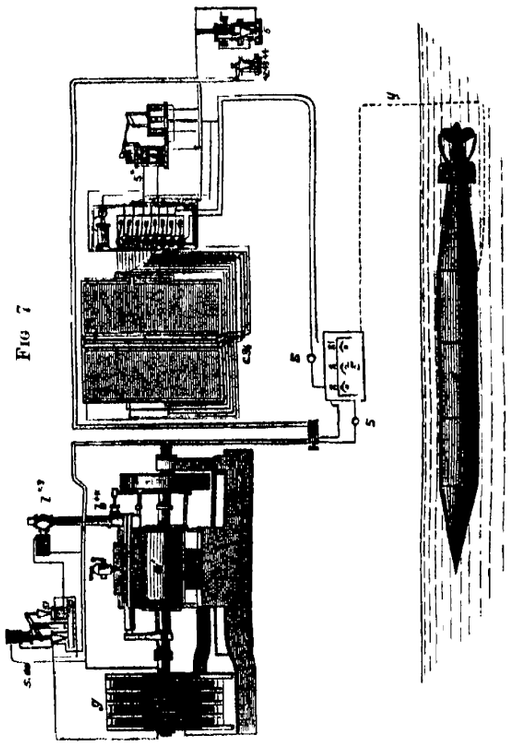


FIG 7

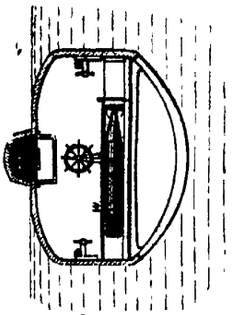
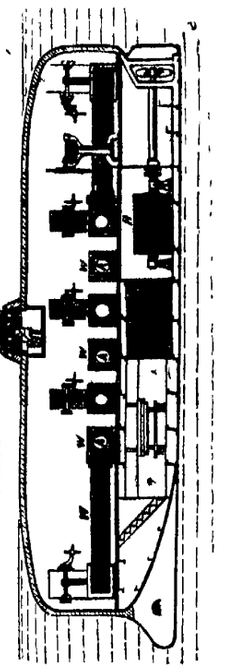
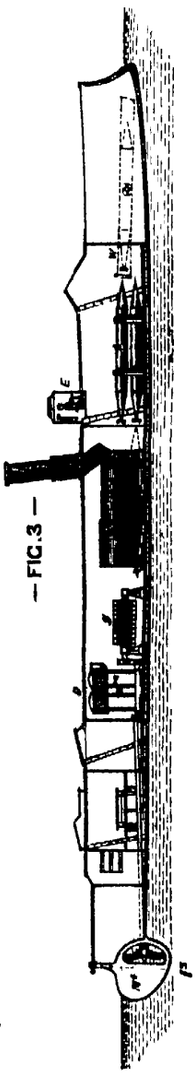


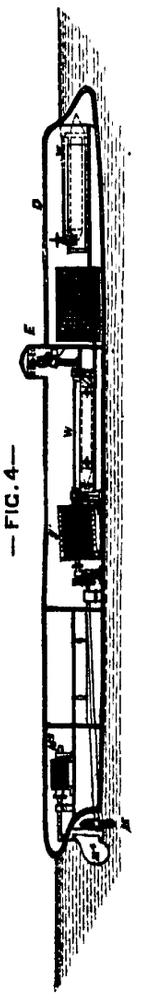
FIG. 6.



— FIG. 5 —



— FIG. 3 —



— FIG. 4 —

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The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant*

ENGINEERING.

FRIDAY, OCTOBER 17, 1884.

THE STATE OF THE NAVY.

IN our article of last week upon this subject we pointed out that deficient expenditure is not by any means the only cause of the discreditable and alarming condition into which the British Navy has been allowed to lapse. The antiquated and unbusiness-like system under which the Admiralty builds its ships is greatly to be blamed, as it inevitably leads to extravagant expenditure, slowness of production, and poverty of results In proof of this we instanced the cases of the Ajax and Agamemnon, which have been more than eight years in building, and have vastly exceeded the estimates of cost that were placed before Parliament. We also referred to the Polyphemus, which has been nearly eight years under construction, and has already cost nearly twice the amount that was originally estimated and voted for her. It may be instructive to call attention, in greater detail, to these cases, as they afford fair illustrations of the working of the present system of building ships for the Navy.

Preparations for commencing the Agamemnon were in progress in Chatham Dockyard in January, 1876, and the Ajax was laid down in Pembroke Dockyard in March of the same year. They belong, as is well known, to the Inflexible type of central citadel armour-clad turret ships. The estimated cost of each vessel was 350,000*l.* for the hull, and 91,000*l.* for the machinery; and it was stated by the First Lord of the Admiralty, when they were ordered, that they would be completed in four years. The Agamemnon was launched in 1879, and the Ajax on the 10th of March, 1880 The Agamemnon was the first ironclad laid down in the Royal Dockyards after the Inflexible was commenced; and from 1874 till 1879, the Agamemnon and Ajax represent the whole amount of new ironclad construction which was entrusted to the dockyards. The *Times* of the 13th of September, 1879, in describing the launch of the Agamemnon, says, "For five years it was found sufficient to commence and complete one ironclad, and to commence and partially build two; not, be it remembered, with starved estimates or stinted labour, but with a vigorous application of both" The same authority goes on to state, that "As the constructive department at Portsmouth lived on the Inflexible, for an unspeakable length of time, so the constructors at Chatham contrived to live on the Agamemnon, while they revelled in dreams of the monsters promised them" This is strong language from an organ which, upon critical occasions, often plays the part of apologist for the Admiralty; and we, therefore, prefer quoting from it, to expressing the same opinions in our own words

Is it to be wondered at that our Navy is fast dropping behind, relatively to the navies of other countries, and that we are getting out-built by France and other powers, when we find money spent upon vessels in large amounts, and so little that is tangible forthcoming in the shape of ships? The money has been spent, not so much in achieving practical results in the form of useful and much-needed additions to the Navy, but in continual alterations and transformations of the vessels in progress, and in thereby developing through the progress of construction somewhat different ships from what were originally contemplated The Ajax and Agamemnon have been undergoing this process for nearly nine years, and still they are not in a state to add to the effective strength of the Navy. In the language of the *Times*, the dockyards and the constructive department have been "living upon" these ships for an unconscionable length of time

It cannot be urged in excuse of this enormous delay with the Ajax and Agamemnon, that it is due to their being of novel type, and because the original conceptions upon which their design was based could only be worked out in detail cautiously and tentatively. This was not at all the case with these two ships The authority above quoted stated at the time of the launch of the Agamemnon, in 1879, that "she is a copy—in some respects a servile copy—of the Inflexible, and it is difficult, with ships as with pictures, however good in themselves, to excite enthusiasm about replicas or copies." It appears to be as difficult to get the "copies" executed as to excite enthusiasm about them. The Inflexible, again, was originally delayed till experience had been gained of the sea-going qualities of the Devastation. When Mr Goschen, who was then the First Lord of the Admiralty, first referred to the building of the Inflexible in Parliament, he said that the results of the experiments upon the Devastation would be waited for, before proceeding further with her. In the construction of the Inflexible, the Admiralty were guided, therefore, by actual sea-going experience with the Devastation; and in afterwards proceeding with the Ajax and Agamemnon, they had only to deal over again with the same points as had arisen and been settled, in connection with the design of the Inflexible.

We now come to the case of the Polyphemus The question of building the Polyphemus was first brought before Parliament by Mr. Ward Hunt in 1877 She is a vessel of peculiar form and construction, and has frequently been described in our columns, and it is sufficient now to remind our readers that she is only plated with the thinnest of armour, carries only a few guns of the very lightest description, and mainly depends for offensive power upon the use of the ram and torpedo. She was launched in June, 1881, and is still in a very incomplete state She was originally fitted with high-pressure boilers of the locomotive type, and these proved, upon trial, to be so great a failure that they had to be taken out of the vessel, and new ones of ordinary construction substituted for them. The *Times* published, upon the occasion of the failure of the boilers of the Polyphemus, a stereotype form of apology for it It stated, upon the 7th of February, 1883, that it was found that the new type of boiler could not keep steam, and the vessel fell far short of the estimated speed of 17 knots. "This was, no doubt, a sad disappointment; because, in a ship which has discarded the gun, and has concentrated her power of attack upon the ram and torpedo, it is evident that speed must be an important factor of efficiency" The latter part of this sentence contains a platitude which is well worthy of the occasion, and has a fine official flavour about it. The *Times* goes on to assure its readers, that "the defective speed of the Polyphemus, however, is not radical, and can be easily rectified"

It will be well to read, in the full light of this confident, and apparently authoritative, statement, the latest utterance of the *Times* upon what really had to be done in order to rectify the mistakes that had been made with the boilers of this vessel. In a report of the visit of the Lords of the Admiralty to Portsmouth, in the *Times* of Monday last, we read the following "When the Polyphemus torpedo ram came round from Chatham to Portsmouth, she was generally regarded so much as a gigantic failure that she was nicknamed the Poly(in)phemus" The two chief points in which she failed, viz, in her torpedo-firing apparatus and in her boilers, are described; and the report goes on to say, "the second defect has been removed by substituting for the experimental boilers a set of the ordinary return tubular pattern. The result is that the Polyphemus has attained more than her estimated speed, and has in a great measure retrieved her character Comparatively simple as these alterations may appear at first sight, they involved the dislocation of almost the entire ship, and have employed a staff of shipwrights from November of last year until the present time In order to get the old boilers out it was necessary to clear away the funnel hatch and the divisional fore and aft athwartship water-tight bulkheads It was also necessary to remove and rebuild the boiler bearers, the fore and aft water tight bulkheads at the middle line, and one of the athwart bulkheads, and the water-tight flats over boilers in the steering engine and dynamo flats New coal bunkers were constructed to suit the forms of the boilers, water-tight doors fitted, and means devised for working the coal. . The other work included the relagging of the bunker bulkheads, flats, &c, the strengthening of the bulkheads in the wake of new fan engines, the fitting of bearers for stokehold plates, the altering of the arrangements for carrying water into the main drain, and the installation of electric, incandescent, and search lights by Messrs. Siemens Brothers In addition, however, to the new work and necessary readjustments, a comprehensive list of defects had to be taken in hand, ranging from automati drain valves, to life rafts and mess tables."

The above facts in the history of the construction of the Ajax, Agamemnon, and Polyphemus, are, in themselves, a proof of the correctness of our statement, that the present system of building ships for the Navy is wasteful, dilatory, and unbusiness-like. Further comment upon this is surely needless.

We have referred above to the *Times*, as sometimes playing the part of apologist for the Admiralty when failures occur, or public attention is called to official blunders or neglect. The report already noticed of the visit of the Lords of the Admiralty to Portsmouth, furnishes a striking instance of this. It says that Lord Northbrook has "pointed out that a ship of war could scarcely be built under five years;" and his statement is, apparently, accepted by the *Times* as perfectly correct and indisputable. Sir Thomas Brassey, we are told, has "lifted the subject out of the heat and temptations of party politics," and has succeeded in showing, that "without strain and without excitement, the naval supremacy of the country is being annually strengthened by an accession of war vessels of

improved types" The *Times* assures us that the French broadside ironclad Amiral Duperré is much inferior in fighting power to what is supposed by some of the most competent judges; and is "liable to become crippled easily in an action, either by having her guns silenced, or by having her engines disabled by shell." It is said to be a fatal defect in her construction that, in order to protect the hull of the water-line, the broadside guns and crew have been left exposed to the fire of an enemy. We may note, in passing, that this is precisely what Mr. Barnaby stated at South Kensington, in 1876, constituted his ideal of a fighting ship He considered that the Nelson and Northampton, which have this very arrangement of sacrificing the protection of the gun deck, and carrying thick armour, in the form of a belt at the water-line, were preferable to the Inflexible or the Téméraire, in which the guns and the crews are protected by armour. The *Times* pronounces the Amiral Duperré to be defective, for the identical reason that she approaches, in some degree, to what Mr. Barnaby calls his ideal of a fighting ship. It goes on to state, in a somewhat oracular manner, that "upon a balance of advantages, the gain must remain with the ship which can continue fighting to the last" This is another fine platitude; but the point of it is lost, because the *Times* does not explain whether it is the Amiral Duperré or the English ships which are to continue fighting till the last.

The *Times* report, includes what may be termed an essay upon the advantages of *not* completing our ships of war. It says. "Naval critics may complain that much time is apparently wasted in the completion of certain ships. It should, however, be remembered that these ships are representative, and that the time which is spent upon the fittings of one, will enable the others, of which it is a sample, to be equipped with all the greater expedition" We have already pointed out that the same authority informed us in 1879, that the Agamemnon and Ajax were copies—in some respects servile copies—of the Inflexible. How does this apology, or excuse, therefore, apply to the case of these vessels We are constantly being told that future ships are to benefit by the experience of former ones; but one of our chief grounds of complaint is, that we never see this excellent principle reduced to practice The *Times* goes on to say that the Colossus, which was laid down early in 1879, and launched in March, 1882, has made "much steady progress" since their lordships' previous visit, but several months will probably elapse before she will be out of the dockyard hands." This will make six years for the present estimated time for building the Colossus, a vessel which is styled an improved Agamemnon, and this estimate may, and probably will, be greatly exceeded. We are further told that, "although, as a rule, the delays arising from alterations while slips are in progress are to be deprecated as seriously retarding their completion and adding materially to their first cost, the wisdom of proceeding cautiously in the instance of the Colossus is obvious" The *Times* informs us that another armour-clad, the Camperdown, which was laid down in December, 1882, or nearly two years ago, has made such progress that she may be regarded as one-fourth completed at the present time.

The particulars given above, which are mainly extracted from the *Times* reports, are sufficient to show what building ships in the dockyards means, and to account in no small degree for the backward state of the Navy. In describing the cause of this unsatisfactory condition of things, we are content to adopt the language of a speech made by Sir Thomas Brassey (then Mr. T. Brassey) in the House of Commons on March 12, 1878. It is needless to say that when this speech was delivered Sir T Brassey was not a member of the Board of Admiralty, and had not been converted to the belief that the Admiralty is the best of all possible departments, and that everything done by it is the best possible of its kind. Sir Thomas Brassey was greatly alarmed in 1878 about the state of the Navy. He thought "that we were conspicuously deficient in ships adapted for attacks on forts and batteries. We had been warned of our shortcomings in this respect by Sir Thomas Symonds and other eminent officers, but we had neglected their advice. . . . Again, it might be questioned whether the increase in fighting power was proportionate to the increase in the cost of the later ships. . . . The waste of public money through repeated modifications of a design during construction, was denounced with his usual force by Mr. Cobden, in his well-known pamphlet on the 'Three Panics.' Those remonstrances were equally needed at the present time. . . . The Constructive Department of the Admiralty was overtasked, and ought to be strengthened. The administrative, consultative, and scientific functions should not be combined in one hand, the same individuals ought not to propose designs, and afterwards pass them in review. It was suggested by the Royal Commission on Scientific Instruction that a Council of Advice should be appointed by the Government. The evidence collected with reference to the Controller's Department of the Admiralty clearly showed that the present staff were too much absorbed in their administrative duties to be able to give a due proportion of time and thought to original investigation. The recommendations of the Royal Commission on Scientific Instruction were based on the evidence of such men as Mr. Froude, Sir William Thomson, Mr. Anderson, the superintendent of machinery at Woolwich, and the hon. member for Pembroke. Mr. Froude told the Committee that if such a Council had existed enormous sums would have been saved, which had been expended in the construction of ships on a scale of 12 in to the foot The incompleteness of the preliminary investigations had led, not only to defective designs, but to wasteful expenditure and long delay."

The opinions thus expressed by Sir Thomas Brassey in 1878, and which hold as good now as they did then, fully confirm all our statements respecting the changes and transformations which take place in the design of a ship during the progress of construction, and the great waste of public money and loss of time that is caused by our present system of building ships for the Navy. It also confirms our statement that the Navy is not administered in a profitable or business-like manner; and that what is wanted, is not so much a mere increase of expenditure upon the Navy, as a radical administrative reform, such as will lead to the affairs of the Admiralty being economically, energetically, and ably conducted. There are other facts which we intend to bring forward in illustration of this point. The exigencies of space prevent us from attempting more in the present article than to draw attention to the results of some of the attempts to build ships for the Navy in the Royal Dockyards, and what has formerly been said about such attempts by the present apologists for the Admiralty.

The article published by the *Times* upon Tuesday last upon "The State of the Navy," from a correspondent, makes the only suggestion which is reasonable for dealing with the somewhat distant future of the question; and that is to appoint a committee that shall inquire into the whole of the subject embraced in the naval defences of the empire. This is a necessary course to take; but the work of the committee will inevitably be long and laborious; and in the mean time more ships are urgently required. Immediate steps are necessary in order that lost ground may be recovered, and that the country may not be left for a considerable period without adequate protection. The value of the *Times* article is largely discounted by the circumstance that it is based upon the erroneous assumption, that everything possible has been done for the Navy with the money allotted to it, and that our Navy administration has, in the main, "been wisely conducted within the comparatively narrow limits fixed by the Estimates." The *Times* thinks that all that is wanted is to increase the naval expenditure. We demur altogether to this position, and are of opinion that we have shown good grounds for a more searching and business-like treatment of the matter.

NORTHERN CRUDE IRON PRODUCTION.

The possibility of a further reduction of the output of crude iron in the north-eastern district, imparts interest to that industry. There has been a twofold fluctuation in the extent of the production, as within the five last years there has been first a large increase in the extent of the output, and this has been followed by a reduction of the local iron made, in accordance with the decision of the combination of the ironmasters for that purpose. It will be interesting to glance at that fluctuation, and as the circumstances of the trade five years ago were in many respects similar to those of to-day, we may best devote attention most to the statistics of the trade during that period. The first Table that we give may be prefaced with the remark that in the year 1877 the maximum production of pig iron in what is called the "Cleveland" district was reached—2,138,378 tons being made in that year. The quantity made, fell off in 1878, and still more in the year 1879, when the lowest production since 1870 was reached. Hence the quantity produced rose by bounds, and only in 1882 was there a check to that increase; but as we shall see, the class of iron embraced in that production was changed. The following is the total for the north-eastern or "Cleveland" district of the

Pig Iron Production.

Year.	Tons.
1879	1,781,443
1880	2,510,853
1881	2,670,339
1882	2,668,650
1883	2,760,740

Here it is clear that with the exception of a check in 1882, when a fall of less than 2000 tons took place in the amount, there has been, despite combination and low prices, an increase in the total production. But as we shall now show, there has been a check to the increase of the production of iron from the local ores, as the following Table will indicate by a contrast of the classes of iron made:

Quality of Iron Made.

Year.	Cleveland Iron.	Hematite, &c.
1879	1,506,454	274,989
1880	1,991,032	519,821
1881	1,998,824	671,515
1882	1,772,239	916,411
1883	1,855,508	905,232

Thus in the five years there has been an addition to the minimum of about twenty per cent. of the amount of Cleveland iron made, whilst the quantity of the hematite, spiegel, &c., has been more than trebled. Let us now take the returns for the past month, and we find that the production of Cleveland pig iron was at the rate of 143,755 tons, or 1,725,050 tons annually less than that of any year since 1879, whilst the production of the hematite, &c, iron was 52,551 tons, or at the rate of 630,612 tons yearly. It is evident, then, that for the present year we shall find that there will be a considerable reduction in the amount of the production of one or both classes of iron. It must, however, be added that the iron described as "hematite, &c," includes "basic iron," and that during the time when the basic converters have not been at work this is added to the "Cleveland iron," so that the fall this year in the production of the "hematite, &c," is more apparent than real

The yield of iron from the furnaces has a tendency to increase from year to year. It may emphasise this if we give the average production of each furnace for the first and the two last years. Each furnace—regardless of the class of iron made by it—produced in round numbers 18,600 tons in the year 1879, by the year 1882 the average production had risen to 22,000 tons, and for the year 1883 it had further advanced to 23,600 tons. It seems, on the whole, doubtful whether the high average production of the past year will be retained during the current year. At the present time the crude iron trade of the north-east seems on the point of change. During the whole of this year the price of Cleveland iron has been maintained, but it has been maintained by a considerable reduction from the maximum production. Recently, there has been on the one hand greater firmness in the price of that crude iron; but there has been a very serious falling off in the local consumption, and up to the present time there is no sign of any large recovery in that local use. In this particular the condition of the trade is similar to the year 1879, when the demand for iron for export suddenly rose, the increase in the local demand showing itself most fully in the following year. Prices of crude iron have been maintained this year at fully 6s. per ton below the minimum of five years ago, and if there should arise either increased demand or diminished production, it is probable that the higher price of this year—higher than that of 1879 but still very low—will be at least maintained. But with the smaller local use, and with no great probability of any rapid recovery in the extent of that use, it would seem that it is to the consumption of pig iron outside the Cleveland area that that district has to look for the causes that will determine the amount of the production of iron within its bounds.

THE STABILITY OF SHIPS.

A PAPER by Professor F. Elgar upon "The Variation of Stability with Draught of Water in Ships," was read before the Royal Society on the 13th of March last, and has just been published *in extenso* in the current volume of the Society's Transactions. The paper is an interesting but very lengthy one, and space only admits of our calling attention to some of its most striking features.

One of the main points contained in the paper is the demonstration and development of a proposition enunciated by the author in a letter to the *Times*, which appeared on September 1, 1883. This is described by him as follows :

If any homogeneous body, which is symmetrical about the three principal axes at its centre of gravity, be of such density as to float with its lowest point at a depth x below the water ; then, if the density be altered so as to make it float with its highest point at a height x above the water, the righting moments will be the same in both cases at equal angles of inclination, and consequently the range of stability and complete curve of righting moments will be the same. This proposition can be made still more general, as was shown by Mr William John, in a letter to the *Times* of the 5th September ; as it applies to all homogeneous floating bodies of irregular form revolving about a horizontal axis fixed only in direction In this general form, the condition of turning the body through an angle of 180 deg., or upside down, must, however, be included, because the immersed volume in the one case must be of the same form as the immersed volume in the other, and this can only be obtained with irregularly-shaped figures by turning them through an angle of 180 deg For this reason the author chose symmetrical figures for the purpose of giving a popular illustration of the analogous effects of low freeboard and light draught upon the stability of ships, and avoided introducing the condition of turning through 180 deg. in order to get similar volumes above and below water in each case The general proof of the proposition laid down is that the line joining the centre of gravity of the immersed volume with that of the volume above water must pass through the centre of gravity of the whole body, and the distances of the centres of gravity of the two sections from that of the whole body are inversely proportional to their volumes; so that the moment of stability, which is proportional to the immersed volume multiplied by the distance of the centre of gravity from that of the whole body, will be the same in both cases.

In order to illustrate this proposition, cross curves of stability, *i.e.*, curves showing the variation of righting moment with draught of water, the angles of inclination, being constant, are given for two homogeneous floating bodies of prismatic form and of the same breadth and depth, one being rectangular and the other elliptical in cross-section. The whole of these curves are symmetrical with respect to the line representing the righting moment at one-half the depth of total immersion. A further series of cross curves are given for a homogeneous prismatic body, the upper half of whose section is rectangular and the lower half elliptical, this being an illustration of the kind of departure from symmetry of form which exists in ships.

The righting moments at fixed angles of inclination are less in the latter body, when it is deeply immersed than when it is floating at light draughts with equal volumes below water to those which are above in the other case. This is a very important point, and helps to show the importance of considering how stability is affected in floating bodies generally by light draught of water. In this instance Professor Elgar's proposition, above stated, respecting the equality of the stability at light and deep draughts requires modifying in a sense unfavourable to the light draughts.

Professor Elgar goes on to give similar cross curves for a steamer 400 ft. in length, 44 ft in breadth, and 32 ft. 6 in. in moulded depth. We are thus enabled to compare the stability of homogeneous symmetrical forms of floating bodies at all draughts of water with that of a ship and also with that of a body intermediate in character between the two. It is shown that in ships of the type taken the stability at light draughts with various positions of centres of gravity is less than at deep draughts.

When there are equal volumes above and below water in this vessel, the righting moments at the light draughts are generally much less than at the deep draughts, except when the centre of gravity is raised excessively, and, for this class of ship, unusually high.

The author says that :

The analogy that exists between light draught and deep draught stability in floating bodies of approximately symmetrical forms, and particularly the point of resemblance afforded by the fact that what is a wedge of immersion in one case is that of emersion in the other, and *vice versâ*, cannot fail to have struck some who have had to calculate the stability of bodies floating at light draughts, but attention has never been prominently called to it. It is desirable, however, that the connection between the two cases should be fully realised, and the dangers peculiar to very light draught of water appreciated as thoroughly as are those which attach to low freeboard. Just as was said in 1871, in a passage already quoted, that metacentric height was formerly, by general consent, taken as a sufficiently good standard of comparison in judging of the stability a ship would have, on account of "the vague impression that the angle would be very large at which the ship became unstable," so, since the introduction of curves of stability, the dangers attaching to light draught have been frequently lost sight of, because of the equally vague impression that, so long as a vessel has a high side out of water, and any metacentric height, she will have large righting moments at great inclinations and a large range of stability.

The considerations set forth in this paper show the necessity for taking a more comprehensive view of the problem of stability than has formerly prevailed, by investigating the cross curves of stability of ships, and thus ascertaining how the righting moments at fixed angles of inclination vary with draught of water They also show how the stability at fixed inclinations does vary in some ships with draught of water, and becomes comparatively small at light draughts. "In designing ships and other structures which are required to float safely at very light draughts of water, such calculations are necessary if accidents are to be prevented. In some cases the necessity is as great, or even greater, than for vessels of low freeboard."

In constructing cross curves of stability, and judging by them of how stability varies in a ship with draught of water, Professor Elgar lays great stress upon the necessity for representing the variation of righting moment, instead of that of righting arm, as is commonly done He says that

In dealing with cross curves of stability, and thus considering the variation of stability with draught of water, the curves of righting moments require to be constructed, and not merely curves of G Z, or lengths of righting arm. The ordinary curve of stability usually has for its ordinates the lengths of G Z at the various angles of inclination This is right enough for the condition under which such curves are constructed, because the displacement is then constant, and the curves represent either lengths of righting arm or righting moments, according to the scale upon which the ordinates are measured. In the cross curves of stability, however, draught is one of the variable elements, and the displacement changes with it A cross curve whose ordinates represent the lengths of righting arm at various draughts of water is therefore quite different in character from a cross curve of righting moments, whose ordinates are length of righting arm × displacement It is necessary, in order to judge accurately of the variation of stability with draught of water, to use curves of righting moments, and not merely curves of G Z, such as are usually considered sufficient when the draught of water is fixed.

The above are some of the chief points contained in the paper, and it is a very important one to all interested in the subject of the stability of ships It is the first attempt to deal in a comprehensive and practical manner with the problem of variation of stability with draught of water, and to lay down some of the broad principles upon which it depends. There are other parts of the paper which are very interesting and should be instructive to some who are ready to take a hasty and extreme view of the manner in which the safety of a ship depends upon mere metacentric height, and other elements which are easily calculated. Professor Elgar emphatically condemns the idea frequently entertained that the metacentric of a height of a ship is a satisfactory standard by which to judge of the safety in respect of stability. He says that :

Such instability as may be due to deficiency, or absence, of metacentric height is not necessarily dangerous, and may not be sufficient to cause a complete capsize It will, of course, cause the vessel to incline away from the upright, but a position of stable equilibrium may soon be reached ; and the righting moments at greater inclinations, and the range of stability, beyond that point may be so large as to put all danger of upsetting out of the question if there are no openings through which water may find its way inboard, and no large weights free to shift. Many ships are in this condition when *light*, and some approach it when laden. On the other hand, there are vessels which in which small metacentric height involves a serious *risk of capsizing*.

No fixed distance of centre of gravity below metacentre, or metacentric height, as it is commonly termed, can be adopted as a standard for application to all ships, because such a measure of stability is very imperfect and insufficient, and may by itself be misleading This is chiefly due to the reasons that the form and proportions of the above-water part of the ship are not taken into consideration in the metacentric calculations, and the under-water form not completely so ; and that the value, as a general measure of stability, of a given metacentric height is largely affected by the absolute heights in a ship of the centre of gravity and metacentre. The initial stability is, of course, constant for a given metacentric height whatever may be the absolute positions of the metacentre and centre of gravity, but the righting moments at moderate and large angles of inclination, and the angle at which such righting moments vanish, or change into upsetting moments, are largely dependent upon the absolute position of the latter point Speaking generally, it may be said that, keeping the same distance between the metacentre and centre of gravity, the righting moments at successive angles of inclination, and the range of stability, are increased by lowering these points and reduced by raising them.

Experience proves that some classes of vessels are as safe and seaworthy in respect of stability with 1 ft, or even less, of metacentric height, as others are with 3 ft. or 4 ft ; while some of an exceptional character require much greater stability than even the latter figures would give Examples of this class are to be found among ironclad monitors of very low freeboard and with heavy upper works, including armoured turrets and guns on deck ; and also among paddle steamers of extremely light draught, with extensive tiers of houses above them These are cases in which the metacentre and centre of gravity are both comparatively high in the ship."

These views appear to be quite sound and practical, and to be consistent with the otherwise inexplicable fact that numerous mercantile steamers are worked in perfect safety with very small metacentric heights, and often when approaching the light condition, and being loaded or discharged, in dock or river, with none, or a small negative metacentric height. It is obvious that many vessels are quite safe in such conditions if properly watched and cared for.

Professor Elgar draws attention to another very important point, and one which doubtless seriously affects some vessels, and may account for some of the so-called mysterious losses at sea He says :

Many mercantile vessels employed in the carrying trade are laden with cargoes which, together with the coals that are required for consumption upon a voyage, weigh twice their own total weight In such cases the position of the centre of gravity of the laden ship is largely dependent upon stowage, and the stability may be entirely dependent upon it The consumption of coal at sea introduces a cause of variation in position of centre of gravity, and metacentric height, which operates during a voyage, so that the stability may be materially altered after a steamer has left port, by reason of the consumption of coal. Such alteration frequently has the effect of diminishing the stability; and there are cases of steamers whose gross weight when fully laden is reduced at sea from this cause by over 25 per cent, and some in which the metacentric height is reduced by 1½ ft These large changes in the amount and distribution of a ship's weights—some of which take place at sea—sometimes make the problem of regulating the stability of a ship, so as to prevent its ever becoming deficient or excessive during her voyages, a very difficult and extremely delicate one

This paper shows what a large field there is for scientific research in the various branches of naval architecture, and also illustrates the practical use of such research in drawing attention to sources of danger to ships that might otherwise be overlooked, and how they may be counteracted. Sound practical lessons, drawn from scientific truths, which all having to do with ships can understand, are a great and pressing want, and Professor Elgar's paper constitutes a valuable contribution both to the science and practical teachings of the subject.

THE HEALTH EXHIBITION.

EDUCATIONAL EXHIBITS.—No. VII.

THE educational section shows that vigorous efforts are being made to render teaching, especially of elementary science, demonstrable and practical. This is the only rational way of teaching subjects founded upon observation and experiment, it affords, moreover, the only means of obtaining from such subjects the valuable educational advantages which they are capable of yielding Even in quite recent times much stress has been laid upon bookwork It is incontestably necessary, but must go hand-in-hand with experimental illustration The facts of chemistry, the principles of mechanics, the electrical behaviour of bodies, are never adequately realised by youthful minds until exhibited, demonstrated, and explained round the lecture table Men like Faraday were able to make *the simplest means subserve their purposes* This, too, should be the aim of the science teacher, the simpler his apparatus, the more commonplace his illustrations, the better. Yet in every school in which elementary science is taught, there ought to be a collection of instrumental appliances sufficient to illustrate the subjects which form part of the regular course. Even with these there will always be abundant room for personal initiative and ingenuity One must also bear in mind that ours are days of high-pressure work when school authorities —forgetful of all sound principles—are ever clamouring for *multa* instead of the wholesome *multum* of former times. Such an unphilosophical and wretched system leaves the teacher but little

leisure for devising, making, and fitting up the apparatus necessary for science courses.

In some sections of the Exhibition, lecture-charts may be seen showing experimental arrangements, machines, and explanatory diagrams. These charts are not without some value; but, after all, they are only poor substitutes for the appliances themselves. Like the pictures of many treatises on experimental physics, they convey inadequate, sometimes unreal, and often inapplicable notions of things. A good working model of any apparatus is of far greater and of more realistic value than any diagrammatic chart, however well drawn and coloured. A class will derive more correct and thorough knowledge from one lesson, say on electrical induction, given with an insulated conductor, a proof plane, and electroscope, than from half a dozen given with the aid of some of the best science charts. Wherever possible apparatus should be used in preference to mere diagrams.

It is pleasing then to notice, among the educational exhibits, the appliances which are made in order to help towards the proper equipment of elementary science schools. An interesting and varied collection is shown in Room 14 by Mr. James Rigg. This gentleman has devoted his practical engineering knowledge and skill to the construction of models in theoretical and applied mechanics, in kinematics, machine construction and drawing, and in steam.

Most of the appliances for mechanics were prepared from models made under the direction of the late Professor Willis. Those illustrating theoretical mechanics include good working models of the mechanical powers. The construction of various scales and the use of the vernier are also appropriately shown.

The collection for applied mechanics contains illustrations of such familiar things as a pump, a gas meter, a turbine, the hammer of a pianoforte, &c. The kinematical models are very interesting, and refer chiefly to wheel and link-work. Those for heat are especially numerous, including some fine sectional models of a locomotive, a compound steam engine, a condensing beam engine, parallel motion, and Bourdon's pressure gauge.

These are all of good size, so that the motion of the parts and the consequences of that motion may be easily and distinctly seen by a whole class at a time. It is evident that with such means the study of machinery is rendered clear and fruitful.

Close to this collection may be seen a catalogue which contains lists of many other pieces of educational apparatus made by Mr. Rigg.

In the large corridor near Room 10, Professor Alexander B. Kennedy exhibits twelve photographic views of the engineering laboratory of University College, London. The present highly efficient state of this laboratory is entirely due to the initiative and energy of Professor Kennedy, and these views bear evidence to the completeness with which he has carried out his work.

THE PHILADELPHIA ELECTRICAL EXHIBITION.—No. III.

By Mr C. J. B. Woodbury, Boston.

One of the salient features in the policy of the Franklin Institute in this Exhibition, as in all work of this Society, is to disseminate information upon the subject of the Exhibition. Reference has already been made to the character of the public lectures, and to the prizes offered to the public school children for the best accounts of the Exhibition, which are the only prizes in connection with the affair.

Professor Edwin J. Houston has rendered an actual service to the popularisation of electrical science by preparing a series of tracts upon various electrical topics, each of them treating of some one subject, in four duodecimo pages, such as arc lights, incandescence lights, dynamo machines, voltaic batteries, &c., in which the general principles are given in a clear manner and entirely free from inaccuracies of statement generally prevalent in attempts at popularisation of science.

Still more concise statements upon these subjects are printed upon large cards about 2 ft. high, and 1½ ft. in width, hung in suitable places in the Exhibition.

The "wax-figgers" in the mythical show of Artemus Ward were unlabelled, and inquiring patrons were told to "pay their money and take their choice"; but such latitude of imagination is discouraged at Philadelphia by the huge placards upon some of the more prominent articles, as, "This is a Dynamo Machine;" "This is an Arc Light;" "This is a Secondary Battery," sometimes in error called a "storage battery."

These assistants are of real service for the object for which they are designed; even though exuberant Young America sometimes avails himself of an opportunity to affix one of these placards to any person who falls asleep while resting upon any of the seats at the Exhibition.

A more technical feature of the Exhibition is the series of tests to be undertaken by Boards of Examiners chosen from among some of the most efficient specialists in electrical science and engineering. The work of this Board is divided into the following sections, to each of which certain members are assigned.

I.—Dynamo-electric machines for lighting.
II.—Dynamo-electric machines for plating.
III.—Dynamo-electric machines for miscellaneous purposes.
IV.—Dynamo-electric motors and transmission of energy.
V.—Arc lamps.
VI.—Carbons for arc lamps.
VII.—Incandescence lamps.
VIII.—Photometrical measurements
IX.—Dynamometrical measurements.
X.—Boilers.
XI.—Steam engines.
XII.—Gas engines and other prime motors.
XIII.—Apparatus for high electromotive force: 1. Lightning protection. 2. Electrostatic induction machines and induction coils. 3. Igniters.
XIV.—Voltaic electric apparatus. 1 Voltaic batteries and accessories 2. Polarisation and storage batteries.
XV.—Electro metallurgy.
XVI.—Thermo and magneto electric apparatus.
XVII.—Electric conductors. 1. Telegraph and telephone wires and cables. 2. Electric light and power circuits. 3. Submarine cables.
XVIII.—Underground conduits.
XIX.—Electric telegraphs 1. Morse systems. 2 Printing telegraphs. 3. Duplex, quadruplex, multiplex, and harmonic systems.
XX.—Telephones, microphones, and radiophones.
XXI.—Fire and burglar alarms and annunciators
XXII.—Electric signal and registering apparatus.
XXIII.—Electro-therapeutic apparatus.
XXIV.—Electro dental apparatus.
XXV.—Applications of electricity to musical apparatus.
XXVI.—Applications of electricity to artistic effects and art productions.
XXVII.—Applications of electricity to warfare.
XXVIII.—Instruments of precision.
XXIX.—Educational apparatus.

Owners of physical apparatus and instruments of precision, whether exhibitors or not, have generally aided the administration by loans of such appliances as may be of use to the Board of Examiners It is expected that the members of the Board of Examiners will avail themselves of every facility in the use of apparatus and accurate methods of procedure to render these tests of the highest value as an exact record of facts. The feature of the omission of prizes or graded awards does not serve to lessen their responsibility; neither does it diminish the emulation among the exhibitors of rival machines. The following is the code of quantitative tests proposed for dynamo-electric machines:

Exhibitors of dynamo electric machines, who desire quantitative tests to be made of their machines, are requested to make formal application for such tests before September 3, 1884 Exhibitors desiring tests of their dynamo-electric machines can have them made by making formal application for the same, and by subscribing to and fulfilling the conditions of the following code: These tests will be of a quantitative character, and when once begun will not, except by special agreement with the examiners, be abridged. The right is reserved to limit the number of dynamos tested, and taking into consideration the order of application, to elect which dynamos shall be tested, if time does not permit of complete tests for all dynamos entered for the tests. Competitive tests will not be made except on the joint application of the two or more parties desiring them, and who must, prior to the test, agree upon the points to be placed in competition. These latter may relate to any class of work for which dynamo-electric machinery is intended.

Section I.—*General Condition of the Test.*

Article 1. Terminals.—The terminals of all the various circuits of the machine must be so arranged that independent connections can be conveniently made.

Article 2. Current.—The current strength of the machine under normal conditions must be definitely stated.

Article 3. Difference of Potential.—The difference of potential on the poles of the machine, when running under normal conditions, must be definitely stated.

Article 4. Horse-Power.—The horse-power required by the machine, when running under the normal conditions, must be stated.

Article 5. Speed.—The normal and the maximum rate at which the machine is to be run must be definitely indicated.

Article 6. External Resistance.—The external resistance on which the machine is intended to be run under normal conditions should be stated.

Article 7. Number of Lamps.—If the machine is intended for lighting, the number of arc lamps or of incandescent lamps intended to be supplied should be stated.

Article 8. Frame.—State whether the frame of the machine forms part of the circuit.

Article 9. Weight of the Machine.—The total weight of the machine should be given.

Article 10. Specifications.—Each exhibitor shall communicate to the sections on dynamo electric machines such descriptions and drawings of the dynamo as may facilitate the labours of the sections. He may also indicate in writing his claims as to the meritorious points of his exhibit.

Article 11. Field Magnets.—The exhibitor is requested to state the following points concerning field magnets. 1. The shape and size of the core indicated by means of drawing. 2. The nature of the iron of the core. 3. The weight of the core. 4. The character of the winding of the field magnets. 5. The diameter or gauge of the wires, naked and covered, with the length and weight of the same. 6. If the field magnets have separate windings the foregoing particulars are to be specified for each winding. 7. The total weight of field magnets, including the core and windings. 8. The material, size, shape, and weight of the pole-pieces. 9. If the particulars concerning the pole-pieces cannot be separately indicated, they may be included with the core of the field magnets, in which case it should be indicated. 10. The total weight of the field magnets, including pole-piece and wires.

Article 12. Armatures and Commutators, or Collectors. The exhibitor is requested to state the following points concerning the armature and collector 1. The nature and material of the core. 2. The shape and size of the core, indicated by means of a drawing 3. The weight of the core. 4 The diameter or gauge of the wire employed, and the weight and length of same. 5. The method of winding the wire upon the core, indicated by means of a drawing. 6. The total weight of the armature. 7. A drawing of the collector and brushes with wire connections, showing manner of collecting the currents. 8 If the brushes are automatically adjusted for lead, or the lead is sensibly constant, state particulars of the devices by which these points are effected, together with detailed drawings of the same.

Article 13. Special Devices used in operating Machines and Circuits.—The exhibitor is requested to state the following concerning special devices and circuits: 1. Any peculiarities of machine as to prevention of sparking and of short circuiting. 2. The devices for regularity of speed, constancy of current, or constancy of difference of potential. 3. Methods of coupling the machines in feeding circuits. 4. Any peculiarities in arrangement of circuits. 5. Means for cutting out lamps, motors, &c. 6. Other special devices used in operating the plant safely, economically, and efficiently.

Section II.—*Measurements.*

Article 1. Co-operation of Sections.—The several sections will co-operate in the measurements so as to simultaneously determine the mechanical energy applied to the machine, and the electrical energy given out by it. The sections on lamps will measure the efficiency of the lamps in candles per electric horse-power in the lamp. As far as possible measurements of the lamps and of the machines will also be made together under the normal conditions.

Article 2. Dynamometrical Measurements.—The amount of mechanical energy absorbed will be measured by means of dynamometer, or otherwise.

Article 3. Measurement of Speed.—The speed at which the dynamo is run will be read simultaneously with the other measurements.

Article 4. Measurements of Resistance and Temperature.—The resistances and temperature of the machine will be measured both before the beginning of the test, and immediately upon its conclusion.

Article 5. Unit of Resistance.—All resistances will be reduced to the value of the legal ohm.

Article 6. Measurement of External Resistance.—Provision will, as far as possible, be made for running machines on an external resistance of wire, all lamps, motors, &c., being excluded from the circuit, and the resistance of this exterior circuit will be determined accurately by measurements of difference of potential at terminals and of current strength It will also be measured directly as far as practicable.

Article 7. Measurements of Current.—It is proposed to make the measurements of current by either one of the following methods, or by two or more simultaneously: A. By means of a shunted galvanometer, with adjustable resistances in galvanometer circuit. Its calibration will be made by means of a voltameter. B. By means of the tangent galvanometer, the calibration to be made by means of voltameter, or by calculation of the constant, with measured value of the horizontal intensity of the earth's magnetism. C. By means of a voltameter. D. By means of a calorimeter. E. By means of an electro-dynamometer.

The relative weight to be given the determinations of current by the various methods will be determined by the sections.

Article 8. Measurement of Difference of Potential.—It is proposed to measure the difference of potential by one or more of the following methods: A. By means of a galvanometer in a derived circuit of high resistance, connected directly to the points between which the difference of potential is to be determined. The calibration to be made with a known current strength and re-

sistance, or with a cell of known electromotive force. B. By means of a condenser and standard cell. C. By means of a calorimeter. D. By means of an electrometer.

Article 9. Computations.—The computations on the data furnished by the tests will give the efficiency of the machine as a means of converting mechanical energy into electrical energy, and also (combined with the results of the sections on lamps) the efficiency of the system as measured by the light produced per mechanical horse-power.

Article 10. Records.—The records of the observations and computations will, under proper restrictions, be accessible to the exhibitors.

General Note to Exhibitors.—The exhibitors are respectfully requested to offer any suggestions or criticisms in regard to these proposed tests, and to state any precautions deemed necessary to perfect fairness.

The tests of steam engines are of especial importance, as the engines are all of the type known as high speed engines, a class of machines which has been widely developed in later years in response to a demand on the part of electric lighting interests for engines occupying limited space, suitable for furnishing power to dynamo machines at such flywheel velocity that little intermediate belting would be necessary, and possessing above all other features, an accurate system of governing. As in other uses of steam as a motive power, economy is a matter of importance, especially as electric lighting plants are rarely in situations where an ample supply of water for condensation is obtainable.

The result of these engine trials ought to add some desired information upon the problem of the class of engines most suitable for electric lighting purposes. It is frequently claimed on behalf of a certain engine in this Exhibition that a rapid change from a light to a heavy load, or the reverse, will only cause a variation of one revolution per minute when the speed of the engine is about 250 revolutions per minute. In another instance, the governor of an engine has been tested by withdrawing and replacing one of the conductors at the binding posts of a dynamo in full operation, and the governor proved equal to the work of controlling the engine during these fluctuations between maximum and minimum load.

The record of these official tests will be given as soon as completed for publication They will be conducted in accordance with the following code of quantitative tests proposed for steam engines.

Special Notice.

Exhibitors of engines, desiring quantitative tests made of their exhibits, must make formal application for such tests before July 15, 1884 Engines can be exhibited, but will not be tested unless formal application and agreement to the following code are completed within the specified time. Parties desiring tests made of their engines, can have them made by making formal application therefor, and by subscribing to, and fulfilling the conditions of the code. All tests will be quantitative, and will, once begun, not be abridged, save by special agreement with the judges Tests of regularity of speed, however, will be made independently of other measurements. The committee reserves the right to limit the number of engines tested and to elect which engines shall be tested, if time will not permit complete tests for all making formal application.

Section I.—*Conditions of Exhibition and Test.*

Article 1 Cylinders.- The cylinders of the engines entered may be of any capacity and proportion of stroke to diameter.

Article 2. Indicator Connections.—Each cylinder shall be drilled and tapped by the builder, for indicator connections, by means of ½ in pipe in the usual manner, and to the satisfaction of the judges. Pet dramage cocks must be on the cylinder. The crosshead or some other point must be drilled for the indicator cord attachment.

Article 3 Clearance.—Each cylinder shall be drilled and plugged at both ends, *so as* to admit of being completely filled with water and emptied by means of ½ in. pipe, in order to determine the clearance and the piston displacement of one stroke at each end. These data will be obtained both hot and cold

Article 4. Valves.—The steam and exhaust valves will be tested under full steam pressure, 90 lb. per square inch by the gauge, unless some other pressure has been agreed upon for the test.

Article 5. Piston Packing.—The tightness of the piston will be determined by *removing the back cylinder* head and subjecting the piston head to full boiler pressure on each centre.

Article 6. Flywheel.—Each maker is requested to use such diameter of band flywheel or of pulley as shall give a belt speed of 4000 ft. per minute. Should he require a different belt speed he will specially note the same, in communicting with the Exhibition Committee.

Article 7. Steam Pipes.—Each exhibitor will be required to furnish his own connections with the main steam pipe, the main injection pipe, and the main overflow pipe or tanks.

Article 8. Space.—Each exhibitor will be furnished with space at the regular rates established for the exhibition, in which space he must build his foundations at his own cost, and subject to the approval of the superintendent.

Article 9. Specifications.—Each exhibitor will communicate to the chairman of the Committee of Judges on steam engines, such a description and drawings of the engine exhibited as will facilitate the labours of that committee, together with his claims as to meritorious points for his exhibit.

Each exhibitor must file the following data before the tests, viz.: Diameter of the steam cylinder to the nearest hundredth of an inch. Diameter of the piston rod to the nearest hundredth of an inch. Diameter of the steam pipe to the nearest hundredth of an inch. Diameter of the exhaust pipe to the nearest hundredth of an inch. Diameter of the flywheel to the nearest hundredth of an inch. Width of the face of the flywheel to the nearest hundredth of an inch. Weight of the flywheel in pounds. Area of the steam ports, each to the nearest hundredth of an inch. Area of the exhaust ports each to the nearest hundredth of an inch. Stroke of the engine. Indicated horse-power of the engine when believed to be working most economically. Revolutions of the crank per minute. Weight of the whole engine, exclusive only of the flywheel. When a condenser is used and driven by the engine, the following additional data will be required, viz.: Diameter of the air pumps to the nearest one hundredth of an inch. Diameter of the injection pipe to the nearest one hundredeh of an inch. Diameter of the overflow pipe to the nearest one-hundredth of an inch. Stroke of the air-pump piston to the nearest one-hundredth of an inch. And if an independent condenser is used, that is not driven by the engine, give diameter of the injection pipe to the nearest one hundredth of an inch. Diameter of the overflow pipe to the nearest one-hundredth of an inch. Drawings of the condenser used, any other data peculiar to it, and a full description.

Section II.—*Preparations for the Tests.*

Article 10. Steam.—The steam for the tests will be furnished by the Exhibition boilers and will come from boilers specially set apart for the purpose of the tests. It will be charged for at regular rates of 3 cents per indicated horse-power per hour. Steam will be furnished to exhibitors one week before the tests are made, if desired. No charge will be made for the services of attendants or experts, or the use of apparatus, unless in some extraordinary case, when the cost will be fixed by the superintendent of the Exhibition. No charge will be made for steam when power is ordered by the superintendent for the general purposes of the Exhibition.

Article 11. Pressure —The steam pressure used will be subject to the wish of the exhibitor, but shall not exceed 90 lb. per square inch by the gauge. A special standard gauge will be used during the tests, and subjected to careful tests before, and after use.

Article 12. Safety Valve.—The safety valve will be set to blow off at 10 lb above the pressure fixed upon

Article 13 Quality of the Steam —The thermal value, the temperature, and the pressure will be taken by means of scale calorimeters, thermometers, and standard gauges at the boiler, at the steam chest, and at the exhaust, if the engine is non condensing The thermometers, calorimeters, &c, will be furnished by the Exhibition, but the exhibitor must do such mechanical work, must furnish such piping, tools and materials, as are necessary to make the required attachments, at his own cost, and subject to the orders of the Committee of Judges.

Article 14 Temperature —The temperatures of injection and of hot well will be taken with standard thermometers, in the case of condensing engines

Article 15 Water.—The water used will be taken from the city mains The feed water for the boilers will be weighed by means of scales and a large tank, and will be run into a smaller supplemental tank, from which it will be pumped into the test boilers by means of a feed pump actuated by steam from other boilers. The condensing water used will, in the case of condensing engines, be measured after leaving the hot well in two carefully gauged tanks, alternately filled and emptied, the temperature also being taken. The known weight of steam used will be subtracted from the overflow. The injection water will be weighed in large tanks, and its temperature taken. The injection water will not be delivered under pressure

Article 16. Speed of Engine —The number of revolutions of the engines will be taken by a continuous counter attached to the crankshaft. The variations in speed for one minute will be taken at each twenty minutes by means of an electric chronograph, connected with a standard clock, beating seconds. The variations in speed during one stroke will be taken by an acoustic chronograph at twenty minutes intervals Special tests of speed alone, under varying loads, will be made if desired, and close attention will be had to this point in all cases.

Article 17. Barometric Measurements.—A standard barometer and thermometer will be read at fifteen minute intervals during the trial.

Article 18. Vacuum.—The vacuum of condensing engines will be read by a gauge, carefully compared before and after the trials.

Article 19. Testing of Gauges, Indicators, &c.—All of the gauges, indicators, and thermometers used shall be carefully tested before and after the trials, and the party whose engine is tested shall have the right to be present in person or by agent at these tests

Article 20. Diagrams.—The indicator diagrams will be taken at fifteen minute intervals, and will be read for initial pressure, pressure at cut-off, terminal pressure, counter pressure at mid-stroke, maximum compression pressure, mean effective pressure, point of cut-off, release of steam, and exhaust closure From the diagrams will be computed the indicated steam at the point of cut-off and at release, as also the actual steam from boilers per horse-power per hour,

Article 21. Load of the Engine —The Committee of Judges will test the engine at the load desired by the exhibitor of it, unless circumstances shall render it impossible to meet his wishes. If the load does not exceed 75 indicated horse power, the net load will be measured by Tatham's transmitting dynamometer.

Article 22 Friction Diagrams —At the close of the regular trial the engine will have its belt taken off, and be run for one hour for friction diagrams

Article 23. Duration of the Trials —Unless otherwise arranged the trials will last ten hours.

Article 24. Economy and Efficiency of the Engine — No account will be taken of the coal burned, but the economy of the engine will be deduced from the actual steam used and water weighed to the boiler. The trial will begin with the established pressure. The level of the water in the boiler and the pressure of the steam will be kept as nearly constant as possible during the whole of the trial. The whole weight of the water fed to the boiler, subject to proper deductions for waste, and to corrections for variation of level in the boiler, will be multiplied by its thermal value as steam at the steam chest, and divided by the product of the indicated horse power of the engine and the number of hours of the test. The resulting quotient will be used to divide 2557 69* British thermal units, giving the efficiency of the engine as compared with the mechanical equivalent of the heat furnished to it, and therefore its efficiency, as a means of converting heat into work. The net horse power of the engine will be used for computation similarly to the indicated horse-power, and the result will be taken as the measure of the efficiency of the engine, both as a means of converting heat into work, and as a machine for the transmission of power. This latter shall be considered the true measure of the efficiency of the engine

The boiler tests are wisely kept distinct from the engine tests Although much of the steam is furnished from boilers of locomotives, yet other types of stationary boilers are represented, and the results furnished by these later forms of boilers will be of interest

The nature of the work did not call for the preparation of a code of procedure with such detail as in the case of the trials of dynamos and of engines, yet the arrangements are well organised for the objects of the tests

The records of duplicate inventions indicate the parallelism of the human mind No invention of moment can be developed to a position of any importance, but that some one will make declaration of earlier scheme possessing its salient points. The honours and the acquisitions borne upon Professor Alex. Graham Bell stimulated to a phenomenal degree the memories of the inventors of abandoned, still-born telephones

It is refreshing in times effused with such charlatanism to observe the evidence of the independent conception of the leading principle in an important invention Among the models of early electrical inventions is a Gramme ring made by Professor H A. Roland at the Rensselaer Polytechnic Institute in Troy, New York, in 1867, three years before M. Z T Gramme patented the armature which bears his name

Unfortunately, the armature of Professor Roland is only a portion of an uncompleted dynamo For some cause the construction was stopped after the armature had been wound, and a portion of the castings of the frame and magnets finished. A similar interest attaches to the exhibit of the various Wallace-Farmer dynamo machines which were exhibited at the United States Centennial Exhibition in 1876, and some of them made two years earlier One of them has its armature at the top of two electromagnets, and in its general outline, without making any comparison of construction, may be compared to a small Edison dynamo inverted upon its pedestal. The dynamos used to sustain the arc lights upon the tower of the Machinery Hall at the Centennial are represented by one of them number, which is still in good order

Another instrument which was built as a dynamo and used as a motor, carries the ponderous name of the magneto electric telemachon This machine is worthy of note as containing an armature built upon plates of soft iron insulated from each other These old dynamos, with their lamps sustaining arcs between broad carbon plates, should be credited in no small measure with the development of electric lighting interests in the United States.

TORPEDOES FOR DEFENCE AND ATTACK.

The activity displayed by the various governments of the world in torpedo warfare declares plainly that the importance of the torpedo as a weapon of offence and defence is now fully recognised.

The amount of actual destruction effected by its use has not, however, since its introduction, been extensive, and therefore the present position which this

* Joule's equivalent 774.1 foot pounds.

weapon holds in the estimation of those who are competent to deal with it, is an evidence both to its power of destruction, which induces great care in guarding against attacks, and to the moral effect produced by its employment in preventing operations of attack being undertaken where the presence of torpedoes is expected. It is obvious that as the efficiency, speed, and range of the powers of the torpedo are increased the advantages arising from its employment will accrue in greater measure to those powers which are fully equipped with such an arm

We illustrate on page 364 some improvements in torpedoes and the methods of using them, which are an advance in the direction which it seems to us that improvement is sure to take. These improvements are in connection with the class of torpedoes known as "movable" or "locomotive" torpedoes, which are distinct from the fixed submarine or submerged mines, formerly the only known form of marine torpedoes. But the improved torpedo is also distinct from the "Whitehead" and "Fish" torpedoes (these being prominent examples of the movable or locomotive class), because it has the added feature expressed by the term "controllable." That is to say the torpedo is not only propelled through the water, without being accompanied by a single man, but it is also controlled in all its movements during its entire course, which may extend to a distance of two miles The importance of this feature in such appliances has been recognised by experts for a number of years. The first to propose a crude method of carrying out the idea was, we believe, Captain Ballard, an English officer stationed in India, who suggested a method of working the rudder electrically through an electrical cable connected with the shore, about the year 1869 In the experiments made with his plan only an ordinary ship's launch was used, as the experiments took place before the introduction of even the modern torpedo launch, and although at that time no means were known by which a torpedo could be made to run under water, yet it was recognised that the full value of the system of controlling marine projectiles of the torpedo class, could only be realised when such a torpedo was invented.

A considerable step towards the realisation of these conditions was made by Colonel Lay, an American pioneer in the introduction and use of torpedoes in naval warfare, who invented and introduced the submerged torpedo which bears his name, with electrical appliances for controlling the rudder and the other mechanism of the projectile through an electrical cable, the motive power being an engine driven by compressed carbonic acid, the valves of which were also manipulated by electro magnetic means. The use of such an agent for developing motive power necessarily restricted the use of this torpedo and prevented its employment on a large scale in the equipment of men-of-war or at stations along any extent of coast, as it required special apparatus for manufacturing and compressing the carbonic acid, which could not conveniently be carried or worked on board ship or without considerable difficulty elsewhere The weight of the engine on this plan was also equal per horse-power developed to that of steam engines, and this necessarily imposed a restriction upon the power, and therefore on the speed obtained in torpedoes of ordinary dimensions, and there were also difficulties to contend with, arising—as in the case also of torpedoes propelled by compressed air engines—from the cold produced by the expansion of the gas Colonel Lay, however, demonstrated the absolute precision with which this class of torpedoes can be directed in spite of adverse conditions sufficient to render uncontrolled torpedoes quite inoperative

In the plans of Mr J. S Williams, which we illustrate, electricity is employed both for the motive power and for all the appliances by which the various movements of the apparatus and of the torpedo itself are controlled. The advantages arising from the employment of such an agent, are numerous as regards the manipulation of the torpedo itself, and it is possible, as the plans indicate, to apply the system of working on an extended scale, so that the defence of harbours and coast lines can be carried out with great completeness and without involving large outlays of money.

In Fig 2 we illustrate a sectional elevation of the torpedo which shows the magazine V in the bow of the vessel. Arrangements can be employed as shown for detaching it from the body of the torpedo on contact with the object attacked, allowing it to drop to a predetermined distance under the ship, and for firing the charge electrically

Immediately behind this is the electrical apparatus P for raising and lowering two or more sight rods which carry hooded incandescent lamps (working either in the circuit of the accumulator on board or in that of the cable) for indicating to the operator at the discharging station, the direction of the torpedo's course to enable him to steer it directly to the object attacked, in spite of the effects of adverse currents, or of any change of position in the enemy's vessel.

Fixed sight rods may be used, or other means for indicating the position of the torpedo, as its speed is such that even although observed, it can scarcely be guarded against. The succeeding compartment contains the electrical cable G in a coil which allows the cable to pay out itself as the torpedo advances, and thus prevent any drag on the motion of that vessel.

The accumulator or secondary battery is placed next, and this appliance has been so much improved by Mr. Williams that on his plan it is possible to store in the small space at command an amount of energy representing the power necessary for a speed of twenty-five miles an hour, and with a very small dead weight.

Interposed between the accumulator and the motor in the electrical circuit of the cable are variable resistances and other governing devices by which the current passing to the motor is regulated automatically in accordance with the speed of the motor or with the electric pressure in the circuit from the accumulator. These devices are connected by the cable with a variable resistance at the switch-board and are operated thereby, and thus the supply to the motor can be regulated, controlled, or stopped at the will of the manipulator at the switch-board placed at the point whence the torpedo is despatched

The motor which adjoins is composed of a number of disc-shaped armatures fastened on a central shaft, the field magnets being also of disc form and so arranged that the armatures revolve within a distance of about $\frac{1}{24}$ in. from the pole surfaces. This enables an exceedingly high efficiency and great power to be realised from a small weight of motor

It is obvious that such a construction is specially suitable for equipping torpedoes and launches, and permits of increase in the power of the motor in either of two directions, *i.e.*, either by increasing the number of discs of a given diameter upon the shaft or by increasing the diameter of the discs, both of these methods giving increased power in direct ratio to the increase of size.

The mechanism for controlling the rudder is also worked electrically, and the force is regulated by at least one variable resistance, worked automatically or by hand, interposed in the electrical circuit of the cable and the keyboard. Through the medium of a circuit reverser and variable resistance, the direction of the current through the cable is controlled in such a manner as to move the rudder either to port or starboard, and if desired, maintain it at any angle by simply varying the force of the current passing through the cable. The rudder mechanism can be worked by the energy stored up in the accumulator on board the torpedo, and in such case it is included in a circuit from the accumulator upon which circuit a variable resistance and circuit closer operate, these devices being worked by the current passed through the paying-out cable. This current is regulated by a pressure regulator and controlled by a circuit reverser and variable resistance upon the keyboard

Means are also employed for indicating the position in which the rudder is placed at any moment, and such position will correspond to some defined resistance introduced at any given moment in the circuit This mechanism for operating the rudder may consist of an arrangement of compound solenoids, the armatures of which are connected to a lever on the rudder head, or a small electro-motor can be employed for operating worm gearing on or combined with the rudder head; the rudder being brought back to the midship or normal position by springs or counter balance weights.

Such electrical appliances are also applicable in the equipment and working of torpedo launches, and we illustrate in Fig. 4 a launch so fitted, and carrying a number of torpedoes in compartments from which they are discharged and subsequently propelled towards and directed with precision against the object of attack.

Where torpedoes are not equipped with an accumulator the motor can be driven direct from a dynamo machine through the electrical cable provided with pressure regulating appliances and a key board, or from accumulators carried on board a launch or man-of-war, or stationed at any number of fixed points along a shore, or on board of floating batteries. Fig. 7 shows diagrammatically a torpedo so propelled, and in Fig. 3 a steam torpedo launch is shown having both a dynamo machine and accumulators on board as well as a number of torpedoes. Figs. 5 and 6 illustrate a floating fort or battery carrying a considerable number of torpedoes and electrical apparatus for developing electrical force or for charging accumulators for working the torpedoes or propelling the battery itself when desired. Such forts can be anchored in suitable positions for the defence of harbours or coasts, or propelled from place to place to within torpedo range of a fleet which it is intended to attack, or to a suitable position for supplying torpedo launches or torpedoes with electric power or for supplying torpedoes. A general plan illustrating the application of these appliances to the defence of coasts and harbours is given in Fig 1. Electricity of high force is developed at a convenient generating station shown at *a*, and can be distributed or transmitted with high force along the coast through a light cable *a* to various stations B, where accumulators are placed (for storing the energy) which, when fully charged, are disconnected from the circuit automatically or by hand. At such stations a number of electrical torpedoes are held in reserve for supplying launches or for being discharged therefrom and directed as occasion requires. At F is shown a floating torpedo battery, and also a branch cable *b* for supplying electric power to launches or vessels equipped with electric accumulators, and at D F is a floating battery under way.

A branch from the supply cable is shown carried out some distance from the shore and buoyed so that the floating batteries or torpedo launches shown at C D may have their accumulators recharged without requiring the vessels to go into harbour.

Torpedoes are represented at A as being discharged from the shore stations, floating batteries, and from the torpedo launch against two hostile ironclads, which are shown approaching the coast or harbour, and the paying-out electrical cables by which the movements of the torpedoes are controlled, are represented by dotted lines G.

In presence of such a system of defence it would obviously be practically impossible for a hostile fleet to damage ports or harbours, or even to land troops upon a coast so protected, and the adoption of such a system by this country would increase the effective power of the Navy by relieving for naval purposes the large number of ironclads employed at present for guarding ports and harbours at home and abroad. Into the economical aspect of this subject we do not here enter at length, but it is very clear that for a given sum expended in appliances for defence and attack a much more effective and rapid return can be obtained from such a system than where the money is spent for the building of either ironclads or fortifications.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, October 3, 1884.

The American iron trade has passed through another week of extreme dulness, but some sanguine iron men believe that a favourable change is near at hand Production has been so rigidly restricted, stocks are so low in first as well as second hands, and prices so evidently at the lowest possible limits, that a slight improvement in demand, which seems inevitable at an early day, will surely start prices in the right direction, and once started, consumers of all kinds of material will rush into market, and an active movement with better prices will result. But every one is waiting for some one else to start the movement. The production of pig iron in Pennsylvania has not been so light for several years as it is at present, and some furnace companies will probably restrict further, should the expected improvement be much longer delayed. A few companies making special grades of pig iron, are well sold up, but most of the trade are anxiously seeking purchasers for their production during the remainder of the autumn. Prices for good qualities of pig iron cannot decline further, having about reached cost limits, and there is a steadiness which is giving rise to more hopefulness; No 1 foundry irons sell at 19 50 dols. to 21 dols. for best makes, while inferior qualities sell at as much as 1 dol. less than the inside figure quoted. The foundries throughout this section are doing less work than usual, and the demand is consequently very light, as no one is willing to carry stocks. The mills of Pennsylvania are, as a general thing, working to about two-thirds capacity. During the past week there has been an increase in the activity in some sections; several mills in Pittsburgh which have been idle for some time, have started up, and others have changed from single to double turn. But on the other hand, wages have still further declined, and reductions have been announced in a large number of industrial establishments during the past four or five days In most cases, these reductions are quietly accepted, as the workmen feel that a strike would be worse than useless, owing to the large amount of unemployed labour in all manufacturing centres. The bridge works are very busy, but bar and plate mills have less work ahead than usual. Competition for the little new business that is offering, is extremely sharp, and prices are down to limits which leave but little profit to manufacturers. But many millowners are glad to take contracts at bare cost, in order to avoid the necessity of shutting down. Bar iron ranges from 1.50 cents to 2 cents per pound, according to quality and also to location of mill. Plate iron, 2.10 cents; angle iron, 2.1 cents; beam and channel iron, 3.25 cents to 3.50 cents. Pennsylvania steel railmakers, having sold their production for some months ahead, are asking still better prices. The business of the past week has been done at about 27.50 dols. at mill, and to-day the Pennsylvania Steel Company refuse to book orders at less than 28 dols. at mill, while some makers are reported to have named 29 dols. at mill as their inside figure. No very large orders have been placed, but small orders for urgent requirements are coming in steadily, and there are still some large orders to be placed before winter, so that the steel rail interests of this State at last may be said to be in

very fair condition. The mills in the west are less favourably situated, and have taken very few orders lately, not being able to compete with Pennsylvania mills at present prices. The demand for foreign irons is showing less and less activity month by month. The starting of a large furnace in this section, on Bessemer pig, will still further lessen our reliance on foreign supplies. The foreign article is quoted at 19 dols. to 19.50 dols., while American, of equal quality, can be had at a little less than 18 dols. at furnace. A few sales of 20 per cent. spiegeleisen have been reported through the week, at 26.50 dols. to 27 dols., and there is some inquiry still being made; other kinds are offered at very low prices, but consumers are not in need of stocks just now. Steel wire rods are also in very little request, and are quoted as low as 45 dols. at tide water. There is some talk in iron trade circles here of a movement to obtain the removal of the 75 cents per ton duty on foreign ores, but it may amount to nothing more than talk.

ELECTRIC LIGHTING NOTES.

THE Edison and Swan United Electric Light Company have recently completed another very successful electric lighting installation on a Clyde-built vessel the ship in question being the paddle-steamer San Martin, built by Messrs. Napier, Shanks, and Bell, Yoker, near Glasgow, for the Lloyd Argentino Company, of Buenos Ayres, under the inspection of Senor Brugo, the president of the company. Current is obtained from a 200-light Edison-Hopkinson dynamo made by Messrs Mather and Platt, Manchester. This machine is specially designed for withstanding the malinfluence of the moisture, dirt, and oil which are inseparable attendants of machinery on board steamships. It is actuated by a Tangye vertical engine of 10 horse-power. The conducting wires are led from the dynamo to all parts of the ship and are protected behind mouldings which are suitably combined with the general decorations of the vessel in the public rooms, but they are so arranged as to be everywhere accessible. There are in all 157 electric lights in the vessel. Each state room has a light wholly for itself, and a switch is provided for each lamp, so as to give the passenger absolute control over it. On each side of the drawing room saloons there are plain but substantial plated brackets, while the dining saloon is fitted with eight handsome two-light pendants supplied by Messrs. M'Geoch and Co., Glasgow. In order to provide against any accident from short circuits the lamps are arranged in about twenty sections, each of which is protected by a lead safety fuse which can be renewed in an instant on the removal of a water-tight case with which each is fitted. In the alley ways, and throughout the several decks and engine-room, specially strong and water-tight fittings have been used.

During the past week the Lords of the Admiralty have been making their annual inspection at Portsmouth, and among other matters the electric lighting of the ships of the Navy occupied their attention, as great extensions have been made in this department during the last twelve months. The Edison system is now at work in four of the Indian troopships, and will be soon fitted to the Euphrates. The torpedo ram Polyphemus has been furnished with two Siemens dynamos and Swan lamps, the conductors being arranged on the single-wire system which utilises the metal of the ship for the return lead. The introduction of this system into the Navy is a novelty, but it has been universally employed by Messrs Siemens Brothers in the merchant marine, and presents many valuable advantages over the double-wire system, being exceedingly simple to understand and remarkably free from danger. In the engine and boiler rooms the leads are carried in iron pipes to defend them from wet and grease. The complete installation consists of two arc search lights, 220 incandescence lamps for internal lighting, and a yard-arm reflector fitted with eight 50-candle power incandescence lamps. Each dynamo, and the engine by which it is driven, is capable of feeding a search light of 25,000 candles, or 150 incandescence lamps, and can be applied to either purpose at will. The Bacchante and the Triumph have been fitted with D Gramme machines for search-light purposes, but it is not probable that more of this type will be employed, as they cannot stand continuous working without becoming dangerously hot. The Volage has the Wilde improved machine. The chief interest, however, was excited by the Colossus, in which the electric lighting has been carried out most extensively, every department of the ship having its own lamps and switches. The general arrangement comprises a day and night circuit for the mess, decks, citadel, passages, and working parts of the ship, while the stores and other smaller compartments have their own lights and switches. The night circuit includes sufficient lamps to enable the ship to be patrolled without lanterns. The whole of the lamps are fixed in spring holders, as described in our notice of the Brush system at the Health Exhibition, to prevent the filaments being broken by the concussion of the heavy guns. The switch-board in the dynamo room has six main circuits, two leading to the projectors, a third to the forward part of the ship, and supplying ninety 10-candle lamps and fifty 20-candle lamps, a fourth to the after portion, where there are fifty-five 10-candle power and forty-six 20-candle power lamps. The others light the citadel where there are thirty-one 10-candle power and thirteen 20-candle power lamps, and the engine-room, which has sixty-eight of smaller and fourteen of the large lamps There are three Victoria dynamos, each driven by a Brotherhood engine, either of which can light the whole ship. The other two are available for the search lights. The installation includes two yardarm reflectors, each containing eight 40-candle power lamps, capable of being affixed to any part of the rigging for coaling and the like. The whole of the installation has been carried out by the Brush Company, who employ their slow-speed machines in all their ship work, and have given the greatest satisfaction to the naval authorities by the excellent manner in which they have carried out their contract. The following Table, which we take from the *Times*, together with some of the above particulars, shows the size of the various floating installations at Portsmouth

Ship's Name	Dynamos	Engine	Lamps		Candle-Power
			Half	Whole	
Crocodile	Edison Hopkinson	Brotherhood	288	90	10 and 16
Malabar	Edison	Ditto	204	115	16 ,, 8
Serapis	,,	Gwynne	299	101	16 ,, 10
Polyphemus	Siemens compound	Brotherhood		220	20
Colossus	Victoria	Ditto	250	230	20 and 10

OCEAN STEAMSHIP NAVIGATION

TO THE EDITOR OF ENGINEERING.

SIR,—A paragraph in the address of Sir Frederick Bramwell, at Montreal, revives the interest felt among engineers as to what opinion was expressed in 1836, at Dublin, and again in 1837, at Bristol, by Dr Dionysius Lardner, on the subject of ocean steam navigation His remarks before Section G at Bristol, August 25, 1837, were specially reported for the London *Times*, and published in that journal August 27, 1837

His views, as expressed at Dublin in 1836, are, I presume, only to be found, if preserved at all, in the volume of Transactions of the B A.A.S for 1836 He *did*, in his work on the steam engine, published in 1835 express an opinion that practical steam voyages of greater length than 2000 miles, would be found impossible, "allowing for surplus fuel" Later, in the edition of Lardner's "Popular Essays on Scientific Subjects"—London Longman, Brown, Green, and Longman's, 1852 (but in the text brought down only to 1851, p. 234, " . now, 1851,") the question is stated as a commercial question—as to the probability of *profitable* ocean steam navigation, and a letter from John Bourne in a note on pp 291, 292, 293, confirms this view Presuming that the copy of the *Times* for August 27, 1837, and also the Transactions of the B.A.A.S. for 1836 and 1837, are accessible to you, will you kindly throw some light on the matter in controversy *in re* "Scientific Precision *v* Practical Retrospection," or refer me to some compendious statements of the facts of the case.

Yours truly,

J. C. HOADLEY.

28, State street, Room 28, Boston, Mass., U.S.A.
October 6, 1884.

DOUBLE BUTT STRAP JOINT

TO THE EDITOR OF ENGINEERING

SIR,—On page 348 of last week's ENGINEERING you illustrate and describe a novel rivetted joint for boilers, and state that it was invented by Mr John Thom, of 8, Storey-square, Barrow-in-Furness. Now I do not wish to deprive Mr. Thom of any credit that may be due to him, but in justice to myself I must draw your attention to the fact that the joint in question was invented and patented by me between four and five years ago, as will be seen by the specification of my patent, No 1740 of 1880, inclosed herewith.

By giving due publicity to this letter you will oblige,

Yours faithfully, PETER SAMSON.

Meadow Croft Villas, Sutton, Surrey.
October 14, 1884.

TO THE EDITOR OF ENGINEERING

SIR,—I inclose herewith copy of a paper "On the Strength of Cylindrical Boiler Shell," read nearly ten years since, and published in vol xviii of Transactions of the Institution of Engineers and Shipbuilders in Scotland. An examination of Fig 9, plate 7, will show that it is scarcely correct to describe the joint illustrated in ENGINEERING of the 10th inst. as "a new form of boiler joint invented by Mr. John Thom;" for that figure shows the precise distribution of rivets now claimed by Mr. Thom as his invention It is possible, however, that Mr Thom's claim is only for "scolloping" the edges of butt straps, but this "scolloping" was such an obvious answer to the objection to wide pitches, that it was suggested at the time by the writer of the paper.

There are some minor inaccuracies in the article which it may not be out of place to point out. It is obviously incorrect to say that "this disposition of rivets permits of the minimum of reduction of the cross section of the plate;" for a moderate exercise of intelligence would enable any average draughtsman to arrange a distribution of rivets leaving a much higher proportion of plate than 90 per cent. It is equally incorrect to say that "by its use a saving of 15 per cent. of the weight of plates can be obtained with equal strength;" this would be the saving as compared with joints having about 75 per cent section, but not with those of higher percentage Thus the formulæ quoted are not by any means those "by which the strength is computed"

Yours faithfully,

H. MACCOLL.

Victoria Engine Works, Liverpool, October 13, 1884.

RAILWAY BRAKES

TO THE EDITOR OF ENGINEERING

SIR,—Mr Martin and I have evidently received somewhat different impressions from our reading of "Express Driver's" letter, for I cannot see therein where "he proceeds to condemn every form of continuous brake" except the Westinghouse automatic. In my humble opinion he simply gives the result of his *practical experience* with four different brakes, and as a result of this experience the Westinghouse certainly comes out best Nor do I see the illogical part of the letter, for I am quite with "Express Driver" in thinking that the mere fact of being able to apply a brake with "one turn of his wrist" is decidedly an argument in favour of the brake.

Will Mr Martin still further and more closely investigate the Board of Trade returns, and then kindly *inform your readers* what percentage of the 3900 so called *failures* (occurring between the years 1880 and 1883) were absolute failures to act when required? And if he does so I think we shall see that a very large proportion of these 3900 failures (?) speak highly in favour of the Westinghouse system as a silent monitor, ever watchful over the safety of the travelling public

It would also be interesting to know, if Mr Martin could kindly inform us how many (if any) of the 1074 failures tell in favour of the different vacuum brakes To any but Mr Martin, "Express Driver's" reasons for not disclosing his name are sufficiently obvious

I, and I think most of your readers will be with me, fully agree with the "Saturday Reviewer," that the preponderance of evidence is very decidedly against Mr. Martin, and I challenge the latter gentleman to describe in "thrilling" or any other terms, 5 per cent of the 3900 failures (if so he will persist in calling them) which could be *bond fide* put as against the general efficiency of the Westinghouse system

As to misquoting the Board of Trade returns, these returns to any unprejudiced observer, show very clearly that they "tell fatally in particular instances," and in a very emphatic manner, against the 1074 failures of the vacuum brakes, and decidedly in favour (as to general efficiency) of the Westinghouse system

The very complete answer that is given to the eleventh paragraph by the one immediately preceding it, would almost lead us to suppose that Mr Martin had rather regretted having penned the former one First, however, let us see what the "enormous complication" said to be involved by these "28 brake patents containing 150 claims" really means; had Mr Martin known anything about these patents he would have been aware that the claims are drafted on what is known to patent agents as the American combination clause system, and under this method the absolute new matter claimed drops to a very insignificant total as compared with the number of the claims Further, from Mr. Martin's description one might imagine that there were rows of valves upon every carriage fitted with the Westinghouse brake As a matter of fact there is only one patented valve, viz, the triple valve, on every carriage There is also a self closing release valve (not patented I believe) which replaces the former release cock on the brake cylinder, and the old leakage valve has been done away with Therefore, with the exception of these improvements the Westinghouse fittings on a carriage are practically what they were eight or nine years ago, and Mr. Martin has again had recourse to his imagination for his facts I have spoken to many drivers ("Express" included) upon the subject, and though I have not yet found any one of them complain about the dangers of Mr Westinghouse's triple and other valves, I have heard numerous remarks from these men (and they are the best qualified of all men, in my estimation, to express an opinion on the subject), which were, to say the least of it, anything but complimentary to some of the vacuum brake systems.

I think that Mr Martin, who is so fond of the Board of Trade returns, might at least be consistent, and refer to these returns for information about the triple and other valves of the Westinghouse brake If he does so, he will surely find that during the past two or three years very little indeed appears to have happened to these valves, the returns merely showing a long list of failure of material or men, with which the brake, as a system, has nothing to do.

In my opinion Colonel Yolland's report on the Blackburn accident was somewhat qualified by the following minute, signed by the Right Honourable J. Chamberlain, and which accompanied Colonel Yolland's remarks "On the other hand there is evidence that the brake was in order, and had acted properly on this journey at the preceding stations at which the train had stopped." Most of your readers will remember that this particular report of Colonel Yolland's did not go far towards enhancing his fame

Had the Midland Company availed themselves of the ample provision which Mr. Westinghouse had provided, long before the date of the Blaemoor collision, for better security in regard to the brake couplings, this accident would never had been heard of, and even as it was, had

the signalman done his duty, the collision would not have occurred

Mr Martin, unwittingly no doubt, pays a high tribute to the energy and perseverance with which Mr. Westinghouse always endeavours to effect any improvement in his brake system, but I am afraid it would take many Mr. Westinghouses to bring any of the vacuum brakes up to a par with the present high state of efficiency of the Westinghouse system It would have been more discreet on Mr. Martin's part to have kept the Euston Station meeting out of the question. Where were the "chief locomotive superintendents and engineers" of the Great Eastern, North-Eastern, North British, Glasgow and South-Western, London, Brighton, and South Coast, Caledonian, &c., railways? Certainly not at the meeting, and perhaps Mr. Martin could enlighten us as to the cause of their absence.

It is certainly news to me to be told that "it is only within the last few years that the defects of the Westinghouse automatic brake have made themselves apparent in actual working," and I trust that Mr. Martin will pardon me for taking his statement *cum grano salis*; and it must indeed have required a wonderfully inventive imagination to have "discovered that the automatic vacuum brakes" supplied by Mr Martin's company, "are at least as powerful and efficient as the Westinghouse, if not more so, and far surpass it in point of certainty, simplicity, and economy" Judging from prices I have seen quoted I very much doubt the economy of Mr Martin's brake (in first cost) as compared with the Westinghouse, and as to repairs perhaps he will substantiate his statement by giving us, for, say, twelve months, the accounts of a train, fairly representative in its nature, on which his brake has been used, and I will furnish authentic accounts of a similar train on which the Westinghouse system has been in use for a like period of time, or longer if he desires it.

My pecuniary stake in the question is *nil*, for I am not even a chairman of a brake company, nor am I interested to the extent of one single penny in any system of brakes, but from a purely disinterested point of view I fully agree with Mr. Martin that Parliament should compel the railway companies to adopt some interchangeable system of continuous *automatic* brakes, and I am fully convinced that the almost criminal neglect of the safety of their passengers by some of the companies, will not be removed until the all-powerful lever of the Legislature is more thoroughly brought to bear upon them

Apologising for making such an encroachment upon your space,

I remain, Sir, yours obediently,
F. S. Snowdon.

14, Brunswick square, W.C.

To the Editor of Engineering.

Sir,—I have received from Sir Henry Tyler a complaint of the publication of my letter of September 25, on this subject in your last issue, as it contains the following paragraph:

"Many *insinuations* have been made against Sir Henry Tyler by injudicious advocates of the vacuum brake. All that can be fairly said is that all the recommendations which emanated from the Board of Trade before he became the paid vice president of Mr. Westinghouse's company, were of such a character that it was supposed (erroneously) that no brake could comply with their conditions except the Westinghouse."

Sir Henry Tyler has complained to me of the insertion of this letter, and has assured me in writing

1. That while at the Board of Trade, he never recommended the Westinghouse or any particular brake.

2 That his voice and pen at the Board of Trade were always against compulsory action of any sort on the railway companies.

3. That it was only after receiving an offer from Mr. Westinghouse to join his company that he resigned his appointment at the Board of Trade and made a thorough investigation as to the merits of the various brakes and consented to join the Westinghouse Company.

He adds, "This special investigation was obviously made after, and could not possibly have been made before, I received the offer from Mr. Westinghouse to join his company."

I accept unhesitatingly Sir Henry Tyler's assurance, and of course withdraw the statement which I made, and as Sir Henry Tyler considers that it contains some imputation upon him (a conclusion which I entirely repudiate), I apologise to him for making the statement

As Sir Henry Tyler desires that the statement contained in my letter of the 25th of September shall be withdrawn in the number of Engineering to be published on Friday next, I should feel obliged if you would insert this letter.

I am, Sir, your obedient servant,
Richard B. Martin,
Chairman, Vacumu Brake Company, Limited.
32, Queen Victoria-street, London, October 16, 1884.

To the Editor of Engineering.

Sir,—I have read with great interest the valuable details contained in your article (page 342) relating to the inefficiency of vacuum brakes. The failures which are constantly taking place must sooner or later lead to a serious disaster.

In your issue of September 10th I gave details of several failures of the "two-minute leak-off brake on the Midland;" since that date several others have occurred, two of which may be of interest to your readers. On the 12th of September the 11 55 noon from Manchester was running at full speed down Sharnbrook Bank (1 in 120) when the vacuum pipe broke; the brake being called automatic should have stopped the train. A passenger riding on the balcony of the Pullman car writes that he did feel the brake act for a few seconds, then it released its hold and the train ran on as usual without any brake power. What became of the automatic action in this case?

On Friday last, 10th inst., the second portion of the up night Scotch express was worked from Leicester to London with the "two-minute brake." One of the passengers from Glasgow informs me that approaching *Bedford* he felt the action of the brake and quite expected the train was coming to a stop, when the brake blocks ceased to grind on the wheels and the train ran the full length past the station and foul of the junction.

It has been claimed for the Midland that much attention has been given to the question of continuous brakes, but these constant dangerous failures do indeed prove that further attention should be given to the subject. In the two cases mentioned no accident resulted, but is it likely that the company will always be so fortunate?

I am, Sir, yours faithfully,
Clement E. Stretton.

Saxe-Coburg-street, Leicester, Oct. 14, 1884.

UNPATENTED INVENTIONS AT EXHIBITIONS.

To the Editor of Engineering.

Sir,—Having in the practice of my profession observed that exhibitors of unpatented inventions at international and industrial exhibitions, are not generally aware that their position is affected by certain provisions of the "Patents and Trade Marks Act, 1883," I beg to point out through the medium of your paper that the six months' protection of unpatented inventions so exhibited is no longer accorded unconditionally, such protection being *now obtainable only by compliance with the requirements* stated in Section 39 of the above mentioned Act and Rule 17, of the "Patents Rules."

Details of the mode of procedure may be obtained from the proper official sources of information, or I will supply information without charge on application.

I am, Sir, your obedient servant,
W. T. Whiteman,
Fellow of the Institute of Patent Agents.

7, Staple Inn, London, W.C., October 14, 1884.

AUTOMATIC INJECTORS.

To the Editor of Engineering.

Sir,—In Messrs. Fairburn and Hall's last letter to you we see that they decline our challenge to publicly compare their injectors with ours, while at the same time they still claim to possess all the novel features of our injectors, as set forth in your article of September 5th.

In common fairness to ourselves we must ask to be allowed to point out that the challenge now declined merely embodied the new features in question, the novelty of which had been taken exception to by Messrs Fairburn and Hall.

By still persisting in claiming these features, while at the same time remaining unwilling to prove their claims (which we again challenge) by actual trial, they leave us free to draw our own inference.

We are equally anxious with Messrs. Fairburn and Hall that there should be no misapprehension, and this must be our excuse to you, Sir, for re-opening the question.

Yours truly,
Holden and Brooke.

St. Simon-street, Salford, October 11, 1884.

MULTIPOLAR DYNAMOS WITH TWO BRUSHES.

To the Editor of Engineering.

Sir,—I shall be obliged if you will afford me space for the following note in your journal of which I am a constant reader. In your issues of September 19 and 3rd inst., you publish letters claiming a priority of the invention, in the first place attributed to Mr. Mordey, for reducing to two, the number of brushes in multipolar dynamo machines. I am the holder of a patent having the same object, and effected by the same means, and my French specification bears the date of May 10, 1882. It therefore anticipates that of Mr C. W. Vincent, which is dated May 18, 1882, and which in its turn is prior to the patent of Mr. Mordey, of January 24, 1883.

Yours obediently.
A. Cazzon,
Ingénieur des Arts et Manufactures.

Pont de Claix, Isère, France, October 6, 1884.

[A hectopolar machine with only one pair of brushes was illustrated at page 50 of vol. xxxiii. of Engineering, under the name of the Arago disc machine. The arrangement was not identical with that employed in the Victoria and Elphinstone and Vincent machines, because since there were eight coils in the armature and six magnets in the field, no two coils were, at a given moment, of equal potential, but it was suggestive of what might be done under the simpler conditions which prevail in these later multipolar dynamos. A somewhat similar arrangement was patented by Dr. Siemens in 1881.—Ed. E.]

TRIAL TRIPS AND LAUNCHES.

Messrs. John Elder and Co., Fairfield, Glasgow, on the 18th of September, launched a steel twin-screw steamer of about 2000 tons gross, and measuring 270 ft. by 40 ft. by 24 ft. 6 in. She is to be employed in repairing and keeping in order the new Mackay-Bennet Transatlantic telegraph cables. She has a double bottom on the circular system of construction, divided into four water-tight compartments for water ballast, and this extends right fore and aft. Water ballast can also be carried in the cable tank cones. There are five water-tight bulkheads, four of which extend to the upper deck. A rudder is fitted at each end of the ship, with means of locking the same from the upper deck when not required for manœuvring. There are three tanks for stowing the telegraph cables, their collective capacity being 27,000 cubic feet. All the fittings and mechanical appliances of the ship will be of a very complete and efficient character. The vessel will be fitted with two sets of compound inverted cylinder engines, each having two cylinders 25 in. and 50 in. in diameter, respectively, with piston stroke of 3 ft. The surface condensers will be placed at the back of each engine, the water being supplied to them by one of Messrs. W. H. Allen and Co.'s centrifugal pumps. Steam will be supplied by two cylindrical single-ended multitubular boilers each fitted with four of Fox's corrugated furnaces, and the working pressure of the steam will be 100 lb. per square inch. The vessel is named the Mackay-Bennet.

The Etruria, which has been built to the order of the Cunard Steamship Company, for their service between Liverpool and New York, was launched on the 20th of September from the yard of Messrs. John Elder and Co., Govan, in the presence of some thousands of spectators. She and her sister ship, the Umbria, which was launched from the same yard last June, are the two largest vessels that have yet been constructed by that firm, and are larger than any other vessels engaged in the ocean passenger and mail services. The Etruria is a five-decked ship of 8000 tons gross, and measures 520 ft. by 57 ft. 3 in. by 41 ft.; she is to be fitted with a set of three-cylinder engines of 12,500 horse-power indicated. The high-pressure cylinder is 71 in. in diameter, and the two low-pressure cylinders each measure 105 in. in diameter, the length of stroke being 6 ft. Steam will be supplied by nine circular steel boilers having in all 72 furnaces (Fox's patent) and a working pressure of 110 lb. per square inch. The accommodation will be sufficient for 720 first-class passengers, a portion of which may readily be adapted for steerage passengers or troops.

Crucible *v.* Bessemer Steel.—Referring to the discussion which took place during the recent meeting of the Iron and Steel Institute at Chester, on the reading of Mr. Seebohm's paper, a correspondent writes to the *Sheffield and Rotherham Independent* as follows: "With reference to Mr. Seebohm's paper read before the Iron and Steel Institute, and the remarks made thereon by Mr. Frank Hall, I have instituted very careful inquiries as to the number of crucible steel furnaces there are at work in Sheffield at the present day. I find that there are at least 30 if not 35 per cent. fewer at work now than there were ten or twelve years ago. As those gentlemen stated that the output of crucible steel in Sheffield was larger than ever, it would be rather interesting to know how it is made, as the productive power of each furnace is the same now as it was then. Perhaps Mr. Seebohm or Mr. Frank Hall will answer this question."

The Purchase-Hire System.—A company, called the Machinery Purchase-Hire Company, has been formed to supply plant on a system of deferred payments. The idea is, of course, by no means new and is familiar to all in its application to furniture. In addition to this the agricultural implement makers have long been in the habit of selling engines to be paid for by instalments, and a similar system has been in vogue with relation to railway wagons. The new company requires one-third of the amount with the order, and the remainder by quarterly instalments extending over a period of from six months to three years, the balance bearing interest at 5 per cent until completely wiped out. The plan of obtaining machinery on credit may prove convenient in some cases, but it carries with it all the dangers of trading with borrowed money, with some special inconveniences of its own. The address of the company is No. 147, Queen Victoria-street, E.C.

The New Cunard Steamship "Umbria."—The trial trip of the steamship Umbria has been a great triumph for her builders, Messrs. John Elder and Co., Glasgow. The vessel attained the enormous speed of 21 knots, or 24.182 statute miles an hour, on an experimental run in the Firth of Clyde on the 4th inst., and is said to be the fastest steamer afloat. With a large and distinguished company on board the went down to Ailsa Craig, and on the return trip from the Craig to the Cumbrae light her full power was exerted with the above splendid result. The speed is, we believe, considerably in excess of that which her owners, the Cunard Steamship Company, contracted for. We hope to be able on an early occasion, by the courtesy of Messrs. Elder and Co., to give a detailed and illustrated description of this noble ship and her engines, and therefore it is not necessary to do more at present than mention a few of the leading facts. She is a vessel of about 8000 tons gross, being 520 ft. in length by 57 ft. in breadth, with a depth of 40 ft. to the upper deck. Her engines, having one high-pressure and two low-pressure cylinders, developed on the trial trip 13,500 horse-power. Steam is generated by nine steel cylindrical boilers, each having eight of Fox's corrugated furnaces, or seventy-two in all, the total heating surface being 38,500 square feet. Her passenger accommodation and her mechanical appliances and other fittings throughout are on a larger and completer scale than has hitherto been known on an ocean steamer. She was contracted for in the month of July, 1883, and launched in June, 1884, or in a little more than eleven months from the time of the contract; and the trial trip took place in a little over three months from the day on which she was launched. The original intention was to have had her ready for starting on the service of the Cunard Company next spring, but the speed with which she has been built and fitted out has enabled her owners to mark her off and advertise her to start on her first outward voyage early next month.

EXPERIMENTS ON CHILLED CAST-IRON ARMOUR.

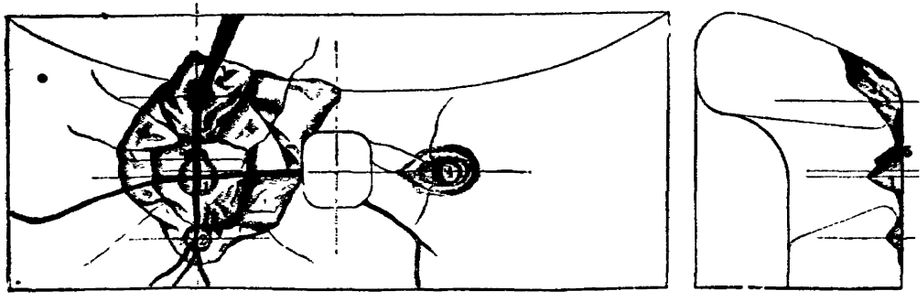


FIG. 1.



FIG. 3.

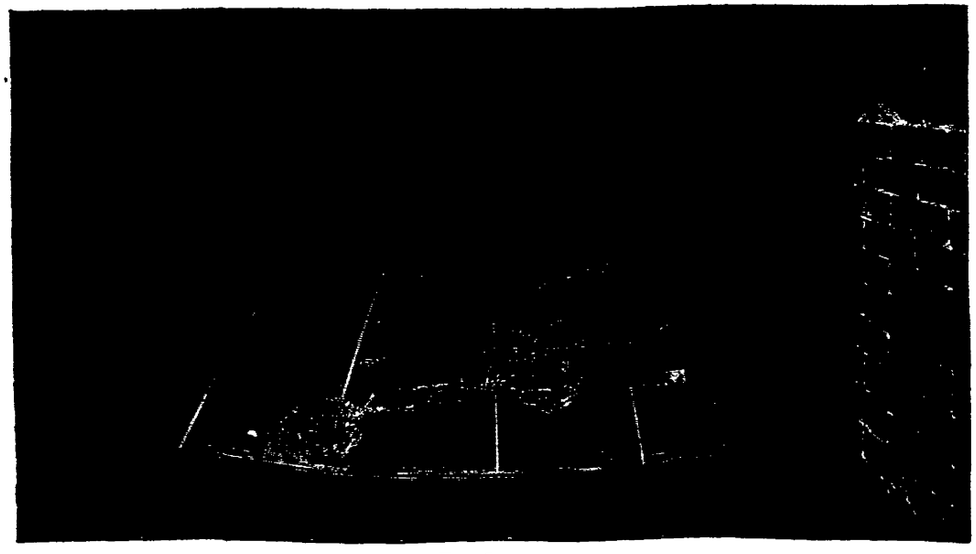


FIG 6.

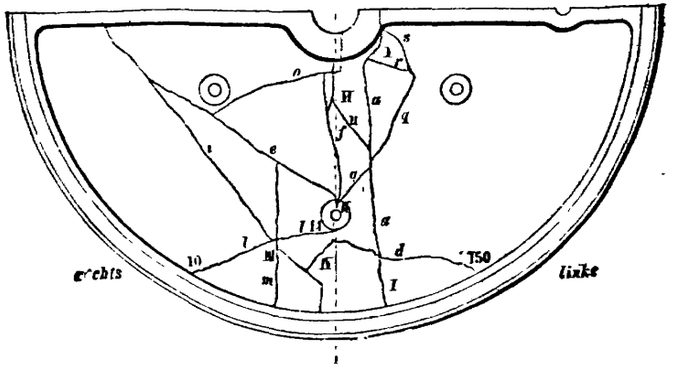


FIG. 5

FRENCH AND GERMAN EXPERIMENTS AGAINST CHILLED CAST-IRON ARMOUR.*

By JULIUS VON SCHUTZ, Engineer.

ON the 7th, 8th, and 9th of April, 1884, experiments took place at St. Chamond (France) against chilled cast-iron, compound, and wrought-iron armour, the results of which were considered by the press as a decided victory in favour of wrought-iron armour.

Although the experiments do not now permit of an entire and accurate conclusion to be drawn, because the quality of the chilled cast iron made by the Chamond Works is to the present quite unknown in Germany, still in one respect they are of great interest, as they again show what influence the vault-shaped form of the armour has upon its resisting power.

This influence seems at first to be somewhat self-evident, for, as the angle of incidence of the projectile essentially depends on the curved surface of the armour, it is evident that that armour surface is the best which offers the smallest angle of incidence.

This entirely natural conclusion is nevertheless in a surprising manner refuted by all the experiments so long as chilled cast-iron projectiles have been used; these shells, when striking nearly normally, were shivered into atoms, whilst when striking obliquely they broke up in large pieces which more or less injured the armour plate and always caused a number of hair cracks.*

Perhaps the profile of the French armour, which we shall describe later on, owes its origin to those observations, for it seems to be so calculated as to enable the guns in any position before the armour to give normal hits.

Now the experiments were not made with chilled cast-iron shells but with steel projectiles, which when fired mostly remained entire, and this completely alters the matter, as a nearly infrangible projectile, which strikes the plate with almost its total striking energy, will give better results with a normal hit than with an oblique one.

Thus, on account of the present extraordinary improvements in steel projectiles, the proper theoretical proportion between armour and projectile is only now re-established; but a mistake would be made if the component the striking energy which really has effect on the mour should be calculated in proportion with the sine the angle of impact, for the causes of the effect are ore complex.

A proper idea of the effect of the projectiles in oblique fire can only be obtained by continued firing experiments, and we shall for this reason give the description of the French experiment with normal fire in comparison to that of two German experiments with oblique fire.

I. THE EXPERIMENT AT ST. CHAMOND ON APRIL 7TH, 8TH, AND 9TH, 1884.

The targets were three armour plates, of chilled cast iron, rolled iron, and compound metal, all manufactured at the St. Chamond Works.

The chilled cast-iron armour corresponds to an embrasure plate of a casemate (see "Aide Mémoire," 1883, chapter xiii., page 18). The plate (Fig 1) had the shape of a hollow cylinder segment covered at the top, and the convex surface went in a somewhat sharp curve into the flat arching of the cover.

The profile of the surface to be fired at formed, an

* Translated from the "Neue Militarischer Blatter."

* See the "Mittheilungen des Ingenieur-Komite's," No. 22 (1877), pages 24, 25, 28, also "Neue Militarische Blatter," January, 1884, page 84.

of the plate. Three hair cracks *b*, *c*, *d*. The projectile broke up into numerous pieces, the same as in later experiments.

Round 2.—Weight of projectile, 446.5 kilos.; depression, 4 deg. 25 min.; angle of incidence, 19 deg. 35 min.; point of impact, centre line of the plate, 120 cm. from the round edge of the plate. Effect: The shot struck the middle erecting hole and caused an indent on the upper half 10 cm. deep, round this was a scaling off of 80 cm. by 54 cm. greatest extension and smallest depth.

Crack *b* prolonged itself to the right as far as the round edge of the plate. A new crack *e* proceeded from the point of impact upwards to the right 64 cm. under the straight edge of the plate. Hair crack 40 cm. long, *g* in a sharp curve crossing the crack *a*, A 32 cm. long. Back of the plate: Crack *a* showed itself as going through from one edge of the plate to the other, Fig. 5. Crack *e* which ran on the surface of the plate under the straight edge, began on the inside on the straight edge, extended to the middle hole for erecting, and ran in a zigzag to the round edge of the plate. Crack *f* extended nearly radially from the middle hole for erecting purposes to the straight edge of the plate. Length 97 cm. The direction differs considerably from those cracks on the upper side of the plate. Crack *g* visible on the inside as far as crack *a*. A radial crack, which was seen before the firing in the middle plate of the butt ring, was enlarged, and the plate had sunk 1¼ mm. Projectile shattered.

Round 3.—Weight of projectile, 444.6 kilos; depression, 4 deg. 42 min.; angle of incidence, 22 deg. 52 min.; point of impact, 72 cm. to the right of the centre line, 70 cm. from the round edge of the plate. Effect: An oblong splash. A crack *i* proceeding from the point of impact to the right and running into crack *e*. Three short cracks, *k*, *l*, *m*, the latter proceeded to the round edge of the plate. Crack *a* prolonged upwards towards the left, ran 10 cm. under the straight edge. Inside of the plate: Crack *i* visible in its entire length, crack *l* united with *d* on the inside, separated, as shown in Fig. 5, a segment of the plate. Crack *m* went through the plate, appeared to be united with *k*. Projectile shattered.

Round 4.—Weight of projectile, 445.1 kilos.; depression, 4 deg. 45 min.; angle of incidence, 23 deg. 25 min; point of impact, 28 cm. from the centre line, 45 cm. from the round edge of the plate, between hits one and three. Effect: The shell struck the segment loosened by the third round, and caused, beside a splash, a scaling off on the point of impact upwards, towards hits one and three, as shown in the engraving. New cracks *n*, *o*, *p*, in thin curves to the edge of the plate A prolonged as far as point of impact 1. The piece of the plate close to crack *b* was raised on the right hand 35 mm. An examination of the crack showed that it ran in an oblique direction inside of the plate towards the round edge, but was not visible on the back of the plate. Back of the plate. The fourth round had caused no new crack, but the piece circumscribed by the cracks *l* and *d* had sunk. The sinking on the left hand was 150 mm., in the middle 14 mm., and on the right hand 10 mm. The piece separated stuck fast in the joint. Projectile shattered.

As the plate seemed to be still entirely capable of resistance, the trial was continued on the 28th of May.

Round 5.—Projectile: Krupp's flat-head shell. Diameter of the flat part, 137 mm.; weight, 445 kilos.; depression 3 deg. 48 min.; angle of incidence, 12 deg. 18 min.; point of impact, 100 cm. to the left of the centre line, 60 cm. from the straight edge of the plate. Effect: An oblong indent 10 mm. deep without scales, three cracks, *q*, *r*, *s*. Back of the plate: The cracks, *q*, *r*, *s*, were also visible at the back. The crack in the middle of the bedplate was enlarged. The piece separated by the cracks *l* and *d* had sunk about 25 mm. deeper, but still stuck fast in the plate. Projectile shattered.

Round 6.—Projectile, Krupp's flat-head steel shell; weight, 445 kilos.; depression, 3 deg. 44 min.; angle of incidence, 13 deg. 14 min.; point of impact, centre line of the plate 94 cm. under the straight edge. Effect: An oblong depression without scales; two fine cracks *t* and *u*; crack *f* lengthened. Back of the plate: Crack *f* prolonged to the edge; cracks *o* and *u* visible on the back; the loose piece had not sunk any deeper; projectile was broken up.

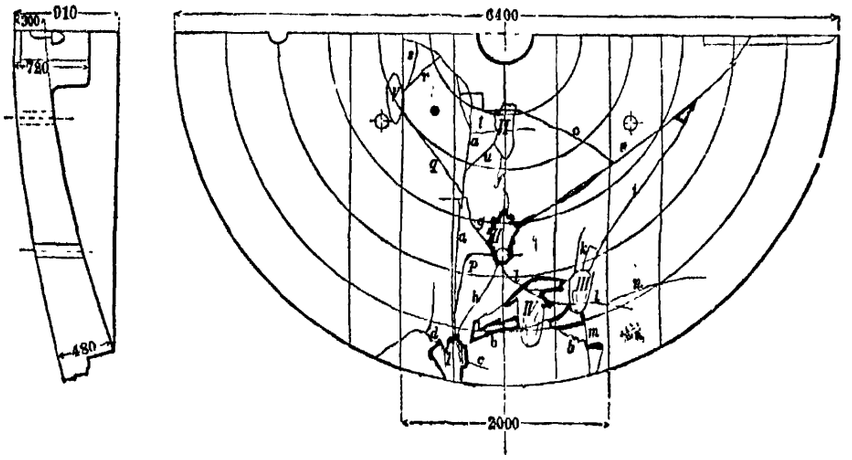


FIG. 4.

The trial had to be discontinued after the sixth round, as the earth bank for stopping the projectiles had received so much injury that it no longer afforded sufficient security for stopping them.

SUMMARY.

The armour plate had now showed more than sufficient resisting power in case of an attack, as the projectiles could never strike at such a great angle of incidence as in the last trial, and the dimensions chosen proved to be quite sufficient.

The advantages of the curved surface were rendered conspicuous; for example, the fourth shot struck a piece already separated from the plate, and could not drive it inside, notwithstanding that the resisting powers of the dome-shaped form were already reduced by the cracks in the ground plate. The sixth shot also struck a piece already separated by cracks without being able to force it inside.

The "chill cracks" proved to have no influence on the resistance of the shield, as the cracks caused by the projectiles were produced and prolonged independent of these.

It was interesting to notice the great influence the angle of incidence had upon the effect of the fire.

The effect of the shot on the base part of the plate was greater than that of rounds 5 and 6, notwithstanding the latter hit the plate when it was in a weaker state

It appears the projectiles strike with the bottom, as soon as the ogival part has touched the plate, and to this in a great extent may the effect be ascribed, and is all the more violent the greater the angle of incidence.

The greater angle of incidence caused by the slanting of the plate and the depression of the gun should in attack more than equalise the stronger charge of powder. The violent striking of the base of the projectile explains why these were all shattered, which, with the quality of Krupp's steel and the simple deflection on the ogival part would have been surprising.

If objection is made against the firing at the "front" plate, that the energy of the projectiles was 100 metre-tons less than that of the projectiles at St. Chamond (N.B. the German plate was however more than one-third weaker than the French one), this objection disappears with regard to the experiment on the cover plate, in which the energy fired against the latter was six times greater than that of the French projectiles. The plate was in its thickest part one-third, and in its weakest part one-half, thinner than that of St. Chamond

The resistance which the armour opposed to the shots fired against it proved that the latter had a considerable surplus of strength. The cracks remained in consequence of the curved construction—that is, from the pressure thereof, entirely closed, and appeared on the surface to be hair cracks, although they had gone through the entire thickness of the plate. Small separate pieces which were struck by the shots remained fixed with extraordinary firmness in the joints, so that, according to the opinion of the Trial Commissioners, the cracked part of the plate would have been capable of withstanding several shots. The right and left third part of the plate was as good as completely intact, and therefore capable of withstanding a heavy fire. This trial is in more than one respect important. As already mentioned, it was thought that glancing shots had an especial destructive effect against chilled cast armour, and the covers were always regarded with mistrust. The trials at Buckau have quite removed these objections, as the diameter of the plate, 6.4 m., was a minimum one compared to the side plate formerly fired at, and it afforded, notwithstanding, a more than sufficient power of resistance. But objection can be raised that at St. Chamond a front plate was fired at, and that the results obtained from the trials against a cover plate can have no relation whatever to the first named.

This objection is correct. In that case an armour dome with a profile where the greatest angle of incidence for the projectile is 24 deg. is not available, because inside it there would be no room for a gun. We have for this reason placed the firing against the "cover" before that of the "front" plate where an angle of incidence of 46 deg. 30 min. took place. If the effect of this shot is considered, then the conviction will be obtained that an angle of incidence of 46 deg. is the most favourable one for the armour. The effect of the five 15 cm. shells fired against the "front" plate consisted only of a few hair cracks hardly visible with the naked eye; one of the last of these hair cracks was measured by a probe and found to be 45 mm. deep. It should also not be forgotten that the upper part of the front armour was not supported, whilst a dome forms a completely closed arch.

The construction of dome-shaped armour with the greatest angle of incidence conceived of, viz., 45 deg., now offers no special difficulties. The inside of the turret is not touched at all by the alteration of the profile, and the superior results obtained in firing out of the 28 cm chilled cast iron armour turrets at Pola can thus also be referred to the armour turrets with flat profiles

When we reflect that the steeper profiled "side" plate of the 30.5 cm. turret fired at on the 22nd of October, 1883, at Buckau, was not breached until it was struck by the fourth shot hitting the Achilles' heel of this construction, that is, the bottom diminution of the profile, we arrive at very favourable conclusions of the resisting powers of chilled cast-iron armour with a flat profile; these conclusions are certainly directly opposite to those of the works at St. Chamond as normal shots to which the French plate was exposed, are impossible with the new armour. Against oblique fire chilled cast-iron armour, however, is capable of resisting in a high degree, so that the conclusion of the St. Chamond Works must in this respect be considered as wrongly drawn.

THE VAPOURS OF HEATED IRON.

*The Spectroscopic Examination of the Vapours Evolved on Heating Iron, &c., at Atmospheric Pressure.**

By Mr. JOHN PARRY, Ebbw Vale.

METALLURGISTS favoured with opportunities of observing the behaviour of metals whilst being heated or fused, are of opinion that the fumes usually seen are due to the volatilisation of the metal itself, or of some more volatile constituent.

In casting alloys of the more fusible metals, this dissociation or volatilisation is an accepted fact, and is usually considered when adjusting the proportions of the constituents. Alloys of the more infusible metals, such as iron, manganese, nickel, cobalt, &c., have not been studied; but those who have observed the behaviour of crude iron and steel whilst being fused, or otherwise manipulated at high temperatures, have noted that, in addition to the well-known evolution of gas, fumes are given off, which has led to the inference that, as before stated, some more volatile constituent is being evolved, and Professor Ledebur asserts that even iron is volatilised. The chemical composition of a metal may therefore be changed, presumably, within certain narrow limits It may be that crude iron is slowly dissociated, and certainly at the high temperature of the Bessemer process iron is volatilised, and may be seen far above the mouth of the converter, forming a red cloud, quite unlike ordinary smoke or vapour.

The spectroscopic examination of the flames issuing from blast and other furnaces shows only continuous spectra, with but few lines, very similar to the spectrum of the ordinary Bunsen flame, with the exception of the Bessemer flame, which gives the carbon spectrum, together with (according to some observers) that of manganese

I have, however, found that many of the metals are volatilised at a comparatively low temperature, but give only continuous spectra when examined in the flame. The vapour requires the intense heat of the electric spark to be passed through it to insure complete dissociation, and consequent production of the usual line spectra. (A list of metals thus tested is given on the next page.)

Spiegeleisen fused in a crucible evolved a fume in which I detected zinc, copper, manganese, calcium, and, with less certainty, magnesium.

Bessemer pig iron, similarly treated, gave copper, manganese, calcium, and either lead or arsenic, as well as gas burning with a flame resembling that of carbonic oxide.

Bessemer pig iron burnt in a stream of oxygen at a dull red heat gave copper, manganese, &c., as before, but more intensely, also a great number of lines which appear to be derived from iron. This spectrum requires careful study, and, when developed, may throw some light on the reactions occurring during the Bessemer blow.

Spanish iron ore reduced in a crucible with charcoal, at a heat sufficient to form a button of fused metal, evolved zinc, copper, and manganese.

It is therefore probable that matter may be evolved during the ordinary heating processes in the manufacture of iron and steel, as previously explained, but giving no visible indications of the fact, in consequence of the heat being sufficient only to volatilise without effecting dissociation.

With my present limited experience, I am of opinion that the actual quantity of matter evolved from iron, steel, &c., is very small, and not at all likely to affect the quality of the coarser kinds of iron and steel, although it may be otherwise when a material of even quality and great purity is required.

The germ of the foregoing is to be found in the recent work of spectroscopists, more especially of Mr. Lockyer, who, in his "Studies in Spectrum Analysis"—a volume abounding with suggestions which should, in my opinion, be carefully studied by those practically engaged in the iron manufacture—says, "Depend upon it, that as spectroscopy becomes the daily work of ironfounders and the like, it will be found to be bristling with scientific truth which may be used in these practical applications."

* Paper read at the Chester meeting of the Iron and Steel Institute.

Notes.—Spanish iron ore evaporated to dryness with hydrochloric acid. The dried chlorides were carefully and gradually heated in the blowpipe, and copper, zinc, calcium, barium, lead, silver, and manganese lines successively detected in volatilised chlorides. At the highest obtainable heat, iron lines are seen.

The impure ferric chlorides, obtained by digesting steel or iron in hydrochloric acid and evaporating to dryness, heated as above, shows—first, copper and calcium; second, manganese; next, with less certainty, chromium and magnesium. On increasing the heat, the iron spectrum is vividly seen.

Steel or iron filings, mixed with ammonium chloride, and heated also, gives the foregoing series of spectra, which last longer, and may be repeated by successive additions of the chloride.

Very fine spectra of sulphur and phosphorus may be obtained by slightly heating either, on a moderately hot plate of iron, placed just below the spark from the coil. None of the lines have been detected in the fumes evolved from iron and steel.

Notes on the Volatility of the Metals in Heated Crucibles. Fletcher's "Injector Blowpipe" Used.

Thallium ...	Very volatile. Flame and spark spectrum.
Arsenic ..	,, Spark spectrum.
Copper	,, Volatilised from most metals. Flame and spark found in most metals.
Cadmium	Easily volatilised. Spark spectrum only.
Zinc .	,, ,,
Bismuth .	Volatilised at highest red heat. Ditto
Antimony	Easily volatilised. Ditto.
Potassium. .	,, Flame and spark spectrum.
Sodium .	,, Ditto.
Tin ..	Volatilised at highest temperature of blowpipe. Spark only.
Lead ...	Volatilised at lower temperature than tin. Ditto.
Silver .	Not volatile. Copper spectrum seen. Ditto.
Gold ...	,, ,, ,,
Chromium	,, ,, ,,
Manganese	Volatilised with difficulty. Ditto.
Aluminium	Volatile.
Selenium ...	Very volatile. Spectra require further study.
Tellurium	Ditto.
Phosphorus	Easily volatilised on hot plate. Good spark spectrum.
Sulphur ..	Ditto.

Notes of Experiments on the Spark Spectra of the Chlorides of the Metals and Alkalies Volatilised at Atmospheric Pressure.

The chlorides of lithium, strontium, copper, and calcium are volatile in the flame of an ordinary alcohol lamp, showing the characteristic spectral lines in the spark about 1 in. above the flame.

Zinc, barium, copper, and magnesium chlorides are also faintly seen. Query about arsenic? Filter-paper moistened with zinc chloride and placed in the alcoholic flame gave the line W. L. 4809.

Steel filings, mixed with ammonium chloride and heated—copper and manganese first appear, next calcium (zinc?), next iron spectra; after heating thirty minutes only, one copper and two manganese lines are seen. Iron lines nearly gone; calcium seen. Further heated thirty minutes, only calcium; traces of copper flashing out.

Spiegeleisen as above; in addition, magnesium seen; brighter spectrum throughout.

Sulphur heated on plate with spirit lamp, spark above gave vivid spectrum of sulphur. Phosphorus as above.

Copper chloride mixed with ammonium chloride and heated with spirit lamp in a glass tube 20 in. long, copper distinctly seen in the spark at the top of the tube.

Impure steel chlorides, as above, heated in glass tube 4 in. long, spark at top, calcium first seen, copper, next manganese group. After heating some time, only calcium and copper were visible.

Ordinary nickel, cobalt, bismuth, tin, and antimony, show copper spectrum when heated. All metals hitherto tested evolve copper.

Query zinc in steel?

Query magnesium in spiegel? Only first line of magnesium seen on edge of nitrogen line, W. L. 5712.

Compared this line with magnesium, by clamping cross wires down on it; magnesium line distinctly seen on edge of nitrogen, W. L. 5712.

It may be inferred from the results herein given, and from those previously published in the *Journal* of the Institute, that the foreign elements present in iron may be divided into two groups:

First, alloys, solidified solutions of one metal in another, such as iron with hydrogen, carbon or combinations of iron and hydro-carbons, copper, manganese, &c. These are more or less dissociated in accordance with the temperature and time of exposure to a given heat.

Second, other combinations with iron, of which sulphur and phosphorus may be considered typical, in which dissociation is not effected at a temperature less than that of the induction coil spark and electric arc.

A third group may be imagined in which the foreign element (according to Deville) is intermolecularly dispersed throughout the metal. Carbonic oxide may thus exist in iron and steel.

I venture, therefore, to suggest that, in addition to the ordinary estimation of carbon, sulphur, phosphorus, &c., in iron and steel, the amount of iron oxide should be determined, and the hydrogen and carbonic oxide evolved on heating in vacuo (at a certain fixed temperature to be hereafter determined), should be given in volumes of the metal tested; in other words, that one cubic inch of metal evolved by cubic inches of hydrogen and carbonic oxide.

NOTES FROM THE SOUTH-WEST.

South Wales Coal and Iron.—The shipments of coal and iron from South Wales ports in September were again large. The foreign coal shipments from Cardiff were 607,220 tons; Newport, 143,397 tons; Swansea, 79,945 tons; Llanelly, 6171 tons. The shipments for September, 1883, were: Cardiff, 523,704 tons; Newport, 127,897 tons; Swansea, 87,484 tons. The coastwise shipments last month were: Cardiff, 88,930 tons; Newport, 100,643 tons; Swansea, 59,135 tons; Llanelly, 1890 tons. For September, 1883, the shipments were: Cardiff, 84,097 tons; Newport, 87,354 tons; Swansea, 58,749 tons; Llanelly, 1296 tons. The iron shipments last month were: Cardiff, 884 tons; Newport, 4526 tons; Swansea, 53 tons. From Cardiff were also shipped 6344 tons of coke and 13,068 tons of patent fuel. From Newport were also shipped last month 153 tons of coke.

New Colliery Undertaking.—On Monday a number of gentlemen assembled on the Gellyhir estate, situate to the south of Nelson, and about two miles from the Ystrad Mynach Junction of the Rhymney Railway, for the purpose of witnessing the cutting of the first sod of a proposed new colliery. Among those present were Mr. A. Mitchell, civil engineer, Hergoed; Mr. W. Harris and Mr. T. Freeman, colliery proprietors, Maesycwmmer; Mr. S. R. Baker, surveyor, Caerphilly; Mr. E. Edwards, Penwain House; Mr. Love, contractor, Maesycwmmer, &c. The undertaking is promoted by Messrs. Mitchell, Harris, and Freeman, the organisers of the Gwerna Colliery at Maesycwmmer. The taking consists of 600 acres of the celebrated Mynyddislwyn seam. The minerals have been obtained from Windsor, Mr. G. W. G. Thomas, The Heath; and Mr. W. Rees, Penwain. The output tonnage is estimated at 10,000 tons per acre, which will be worked by a level. The coal is 6 ft. 3 in. in thickness, opening to the rise. It appears that borings have been taken, which necessitate a pit of only 30 yards in depth to obtain the coal, which will be conveyed by an incline half a mile in length on to the Llancaiach branch of the Taff Vale Railway. The contract has been entrusted to Mr. Love, Maesycwmmer, and it is anticipated that coal will be obtained in a few months.

Water Supply at Cardiff.—A meeting of the Water Works Committee of the Cardiff Town Council was held on Friday. A letter was read from Messrs. Britton and Co., solicitors, Bristol, asking whether the council would be prepared to compensate Mr. A. Krauss, contractor, for not having accepted his tender for the Llanishen contract in spite of the fact that it was the lowest sent in. The town clerk was instructed to inform Messrs. Britton that the committee could not for a moment entertain the proposition.

Bristol Docks.—At the last meeting of the Bristol Town Council the Docks Committee reported that 625,000*l.* Corporation stock had been issued, and that they had appointed Mr. F. B. Girdlestone, who had acted as manager of the city docks for upwards of nine years, to be general manager of the dock undertaking of the corporation. Notice had been given to the various officers of the Portishead and Avonmouth Docks to terminate their services, with an intimation that such of them as might be required would be open to re-appointed. Mr. J. Dixon, the manager of the Avonmouth Company, however, had been given three months' notice to terminate his engagement. The committee also informed the council of certain changes which they recommended in the dues. A discussion, lasting several hours, took place with reference to the appointment of Mr. Girdlestone as secretary and manager; but in the end the council approved of the appointment by a majority of 29 to 22. They also approved of the recommendations as to dues. It was resolved that plans and tenders for new dock offices should be invited.

Cardiff.—Some steam coal shippers have remained busy, and collieries are reported to be working with fair regularity. Prices do not show much fluctuation, and those currently quoted for the best qualities are still from 10s. to 11s. per ton. The small coal market is still quiet. In the house coal trade a better tone has continued; cold weather is having the usual effect upon this branch of local commerce. Last week's shipments comprised 133,212 tons of coal, 410 tons of iron, 3750 tons of patent fuel, and 800 tons of coke. From Bilbao there arrived 4800 tons of iron ore, and 1074 tons came to hand from other sources.

The Caerleon Tin Works.—These works are being restarted.

Newport.—The steam coal trade has been fairly well sustained. Some of the collieries have not worked quite so well, but this may no doubt be attributed to some extent to unfavourable winds having retarded the arrivals both of steam and sailing tonnage. Traffic over the Pontypridd and Caerphilly Railway is increasing. The iron market continues in a depressed state. Last week's coal clearances amounted to 62,365 tons. From Bilbao there arrived 11,710 tons of iron ore, and 5150 tons came to hand from other sources.

THE FRENCH COAL TRADE.—In the centre of France, as well as in the basin of the Loire, the deliveries of coal are not very important at present. Quotations have been, however, generally well maintained.

THE PLUMBERS' CONGRESS.—Arrangements have been made for the holding of a conference in connection with the "Plumbers' Congress" at the Technical Institute, Health Exhibition, South Kensington, on the 20th inst. The mayors of forty of the principal towns in England have already accorded their co-operation to this object, and many of the leading practical plumbers in and about London are giving their assistance.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

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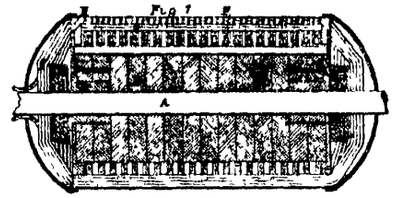
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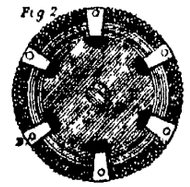
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Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

DYNAMO-ELECTRIC MACHINES.

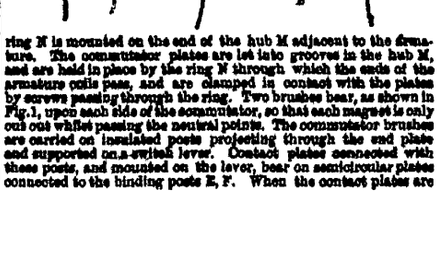
131. H. J Allison, London. (*R. N. King, Dayton, Ohio, U.S.A.*) **Electro-Dynamic Machines.** [6d. 13 *Figs.*]—January 1, 1884.—Referring to the illustration, the series of wooden discs B are secured to the shaft A by means of supporting discs and a circular series of tie-rods D. The supporting discs are secured upon the shaft by means of metallic plates E provided with inwardly projecting lubs. The core of the armature is formed of a series of wire rings F supported in U-shaped metallic loops, and pierced with holes through which the rods D pass. Air spaces are formed between each of the coils F, and between the inner periphery of the metallic loops and the wooden core B, and air conduits H connected with these latter spaces pass through the supporting discs. The ends of the armature are closed by metallic plates. The transverse longitudinal coils I are wound between the U-shaped loops, air spaces connected with the conduits H being formed between each of the coils By the above construction an efficient circulation of air is maintained. Each portion of





the commutator consists of a ring formed in two segments. These rings are connected together by bolts; two bolts pass through all the rings, and are electrically connected to the terminals of one section of the armature, and, through washers having projections bearing respectively on the two segments of the first ring, with the first commutator ring; two other bolts pass through all the rings except the first, and connect the second ring to a second section of the armature; similarly the other rings are connected to their respective sections, there being two bolts for each commutator ring. Brushes bearing upon the rings are connected together in series. In order to short-circuit the armature coils as they pass the neutral spaces, the commutator sections are made half the breadth near their neutral parts and segmental tenons, on a metallic disc fitted on but insulated from the commutator shaft, fit into the spaces so formed, but are insulated from the commutator segments. The current passes from the commutator segment by the brush to the metallic disc, and so to the other commutator segment, thus short-circuiting the armature coil. (*Sealed September* 19, 1884).

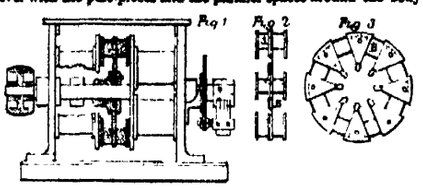
974. S. Pitt, Sutton, Surrey. (*L. W. Stockwell, Cleveland, Ohio, U.S.A.*) **Electric Motors.** [8d. 9 *Figs.*] January 8, 1884.—The field-magnet A is supported by end pieces of the casing B and has inwardly projecting poles. The two armature magnets C D have their cores arranged at right angles to the armature shaft and to each other, and their greatest width is parallel to the armature shaft. The poles of these magnets are enlarged to present the arc of a circle and revolve in close proximity to the curved pole-pieces. The magnets are each wound continuously in the ordinary way, and are connected to opposite plates of the commutator. The armature shaft has its bearings in the end pieces of the casing B, and carries near one end a vulcanite hub M upon which the commutator plates are arranged. An insulating



ring N is mounted on the end of the hub M adjacent to the armature. The commutator plates are let into grooves in the hub M, and are held in place by the ring N through which the ends of the armature coils pass, and are clamped in contact with the plates by screws passing through the ring. Two brushes bear, as shown in Fig. 1, upon each side of the commutator, so that each magnet is only cut out whilst passing the neutral points. The commutator brushes are carried on insulated posts projecting through the end plate and supported on a switch lever. Contact plates connected with these posts, and mounted on the lever, bear on semicircular plates connected to the binding posts E, F. When the contact plates are

between the semicircular plates the armature coils are short-circuited, the current passing from the post D through the field magnets to the post E, and by the semicircular plates, which are connected by the contact plate, to the post F. By turning the switch lever from this position in one or the other direction, the current may be sent through the armature so as to cause it to revolve in the required direction. The armature and field magnet poles are so shaped "that as the armature pole approaches the pole of the field magnet or moves part way across its face, a relatively larger area of the field magnet and armature will be brought into proper magnetic relation to urge the rotation of the armature with increased power until the dead point is reached," the pole-piece being wider at one part than at another. (*Sealed September* 5, 1884).

1884. J. Riley, Alfreton, Derby. Magneto or Dynamo-Electric Machines. [6*d.* 9 *Figs.*] January 17, 1884.—The armature consists of a solid piece of metal B formed with projections A, terminating in pole-plates, on each side. The projections A are first wound with insulated wire until the coils are level with the pole-pieces and the parallel spaces around the body



are then wound as in the ordinary ring armature. These two sets of coils may be joined together and connected to the usual form of commutator or be connected to separate commutators. The commutator segments are secured by screws to insulating plugs screwed into the annular metallic body of the commutator and are insulated from the body. (*Accepted September* 2, 1884).

SECONDARY ELECTRIC GENERATOR.

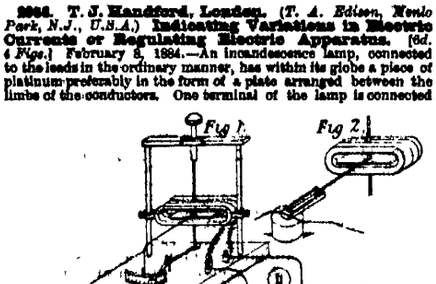
2662. C. D. Abel, London. (*C. Zipernowski and M. Deri, Buda-Pest, Austria*). **Transforming and Distributing Electric Currents.** [6*d.* 1 *Fig.*] July 9, 1884.—This consists of a motor and a generator mounted on the same base and having their shafts coupled together The field magnets of the motor and generator are combined in one system. The wires forming the armatures of the motor and generator may be wound on the same part of the construction. The current from the secondary generator is regulated by means of its speed by putting it in or out of circuit with the primary current. A time measuring apparatus may be employed to measure and record the expended electricity, or the number of revolutions of the secondary generator may be recorded. (*Accepted August* 12, 1884).

PRIMARY ELECTRIC BATTERY.

190. R. Applegarth, London. Voltaic Batteries. [*2d.*] January 1, 1884 —The negative electrode consists of a vessel of carbon, of cylindrical or other suitable shape, grooved, fluted, or corrugated inside or outside, or both. This vessel also serves to hold the exciting liquid or electrolyte. Several of these electrodes may be arranged inside one another with intermediate positive elements. (*Accepted September* 12, 1884).

ELECTRIC CURRENT REGULATOR.

2966. T. J. Handford, London. (*T. A. Edison, Menlo Park, N.J., U.S.A.*) **Indicating Variations in Electric Currents or Regulating Electric Apparatus.** [6*d.* 4 *Figs.*] February 8, 1884.—An incandescence lamp, connected to the leads in the ordinary manner, has within its globe a piece of platinum preferably in the form of a plate arranged between the limbs of the conductors. One terminal of the lamp is connected



to one terminal of a galvanometer or other indicating apparatus whose other terminal is connected to the platinum piece. The galvanometer is thus in a shunt circuit including the vacuous space and indicates the variations in the current. The galvanometer needle may be made to close circuits to electrically operated devices for regulating the generator supplying the current. The illustration shows clearly the arrangement. C is an adjustable resistance. (*Accepted September* 2, 1884).

ELECTRIC CURRENT METER.

4791. Sir D. Salomons, Tunbridge Wells, Kent. Current Meters. [6*d.* 1 *Fig.*] March 12, 1884.—This relates to meters used in charging and discharging secondary batteries. The current is measured by decomposing water in a glass tube graduated to act as a measure for the amount of current passed in any given time. Two such tubes are employed, one for charging and one for discharging, so that any difference in the quantity of gas formed shows in favour or against the accumulators. The loss in charging and discharging may be corrected by increasing the diameter of one of the tubes in a suitable proportion, or by placing a suitable resistance in the circuit. In a modification two depositing cells are employed, the plates being suspended from the opposite ends of a beam. (*Sealed September* 5, 1884).

ELECTRIC RAILWAYS.

2332. A. M. Clark, London. (*J. C. Henderson, New York, U.S.A.*) **Grips for Electric Cars.** [6*d.* 4 *Figs.*] February 14, 1884.—This comprises an adjustable clamp capable of operation from the car of the motor, and which may also serve as a current carrier. The clamp bears against a rail or rails arranged in an underground tube, and increases the friction of the motor wheels when necessary, or, in case of failure of the electric current, assists the brake by increasing the pressure of the car wheels on the track. The clamp consists of a Y-shaped bar, whose forked end passes through a slot in the tube, and carries rollers bearing on the upper and under sides of the rail in the tube, the friction or bite of the lower rollers being regulated by drawing up the clamp by means of a screw. (*Sealed October* 3, 1884).

DISTRIBUTING ELECTRIC CURRENTS.

4042. J. E. H. Gordon, London. Enabling Arc Lamps to be Used in Parallel Circuit with One Another, or with Incandescence Lamps. [6*d.* 2 *Figs.*] February 27, 1884.—The lamps are fed by alternating currents. An inductive resistance is inserted in each branch leading from the main to an arc lamp, and consists of a coil of wire with an iron core so proportioned that the true resistance is small, and that the inductive resistance is small as long as the current is of the moderate strength required for the arc lamp, but in which the apparent resistance will, owing to self induction, enormously increase if, owing to the short circuiting of the lamp or other cause, the current tries to increase above a value a little exceeding its proper amount. These inductive resistances serve as a protection against over heating of the wires and instead of fusible cut-outs. (*Sealed June* 10, 1884).

5624. J. E. H. Gordon, London. Electric Mains. [6*d.* 2 *Figs.*] March 28, 1884.—In electrically lighted districts in which the lamps are supplied from two or more centres, each in its turn supplied by a feeding main coming from the same centre, each main consists of several smaller mains which can be disconnected as required. By this means the electromotive force at the distant end can be regulated. (*Sealed July* 4, 1884).

ELECTRIC CONDUCTORS.

3639. W. R. Lake, London. (*J. W. Tringham, Windsor, Ontario, Canada.*) **Supporting and Insulating Electrical Conductors.** [4*d.* 3 *Figs.*] February 2, 1884.—The conductor is secured to the pole or other suitable support by a U-shaped block, the conductor being inclosed in a sheet of insulating material, placed between the arms of the block and the arms closed upon one another. The two sides of the block may be tapered and forced into a corresponding support which closes their ends. (*Sealed May* 13, 1884)

4365. R. S. Waring, Pittsburg, Penn., U.S.A. Lead Armoured Electric Cables and Mandrels for Manufacturing the Same. [6*d.* 23 *Figs.*] March 4, 1884.—The insulated conductors are inclosed in separate passages in a homogeneous metallic body, and are arranged in two rows, the adjacent wires of the two rows being in closer proximity than the adjacent wires in either row. The wires of one row alternate in order of position with those of the other row. The cable may be made up of a number of pairs of rows as above described The mandrel of the press for forming the cable has, at its point, a series of nipples arranged in one or more pairs of rows, and in correspondence to the conductors of the cable. The nipples may open out into a chamber or recess which determines the external form of the cable.

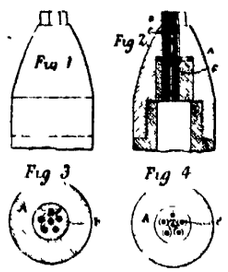
4366. [6*d.* 8 *Figs.*]—In this specification the conductors are inclosed in passages through the ductile metal, and are arranged in distinct circular groups around a central core, the central group being composed of conductors arranged in circular order around a common centre, the conductors occurring in the radial lines of the surrounding groups. The distance between adjacent wires of a group is less than the distance between the successive groups. The mandrels for producing these cables are also described, the arrangement being similar, except for the position of the nipples, to that described in the previous specification.

4367. [6*d* 6 *Figs.*]—In this cable three conductors are inclosed in the ductile metal or alloy, and have positions at equal intervals around the solid axis or core of the body, the thickness of the metal wall between the conductors being less than the thickness of covering surrounding the conductors.

4368. [6*d.* 7 *Figs.*]—In this cable a series of strengthening wires are inclosed within the soft metal body and are arranged in circular order around the conductors.

4370. [6*d.* 14 *Figs.*]—The mandrel has a tapered body and a teat or projection on its end with separate passages through both the mandrel and teat. The outside wire passages extend beyond the central wire passage. The teat has longitudinal grooves extending between the outside wire passages to the point and having channels connecting the grooves with the central recess

4371. [6*d.* 19 *Figs.*]—The tapering steel mandrel A has a screw-threaded socket for attachment to the core bar of a lead press, and above this socket is formed with another socket *b*, from which extend two or more small passages *c* through the



upper end of the mandrel A. Steel tubes *e*, provided at their inner ends with flanges, are inserted in the passages *c*, and are held in place by a perforated plug *f* As will be seen, the nipples *e* can be readily removed and replaced. Slight modifications are described and illustrated.

4969. [6*d.* 9 *Figs.*]—In order to make branch or loop connections in lead covered cables, the metal covering is removed and the conductor exposed and severed. The severed ends are connected with the exposed ends of the wires of a branching cable, and the exposed surfaces covered with insulating material, and the whole covered by a plumber's wiped joint of solder. The cables may be repaired at any point in a similar manner. This and the preceding six specifications by the same inventor were sealed June 10, 1884.

5044. S. F. Shelbourne, New York, U.S.A. Electric Cables and Lines of Electric Communication and Prevention of Induction therein. [6*d.* 14 *Figs.*] April 22, 1884.—An induction shield of metal or coating of magnetic oxide of iron surrounds the insulation of each conductor of the cable, and is inclosed in an insulating coating, by which it is separated laterally from electrical contact with each and every other like induction shield in the same cable, but connected electrically in pairs with a like shield at the ends of the cable. This outer insulated coating may be surrounded with a second induction coating also insulated, the two coatings being connected together at the ends. In Figs. 1 and 2, *e* and *e*1 are the two induction shields, which are shown connected electrically by the dotted line *f* in Fig. 1. In order to diminish the parallelism of the conductors of the cables, strands composed of three or more conductors spiralled about each are employed, the conductors in strands laterally adjacent being spiralled in opposite directions. Several layers of such strands are employed, each successive layer being spiralled about the core or centre line of the cable in a reverse direction to the spirals of the preceding inner layer.

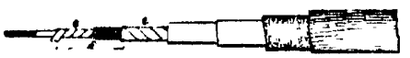


Fig. 1.

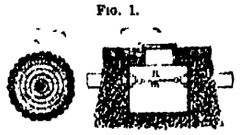


Fig 2. Fig. 3.

Fig. 3 shows in section a series of chambers or vaults sunk in the ground, in and through which the sections composing a line of underground cables are connected with each other The electrical connection of the conductors is indicated by the letter *m* and of the shields by the letter *n*. (*Sealed August* 1, 1884).

6128. M. Sugar, London. Electrical Conductors or Leads. [4*d.*] April 5, 1884 —These are formed of flat ribbons of metal insulated if necessary, and are specially applicable for house leads (*Sealed September* 30, 1884)

INSULATING MATERIAL.

923. H. J. Allison, London. (*J. Greives and J H Bleoo, Paterson, N J , U.S.A.*) **Insulating Compound for Electrical Purposes.** [2*d.*] January 8, 1884 —The carbonates, oxides, sulphates, silicates, and other insoluble salts of the alkaline earths are mixed with fused resin. Any of these earths are reduced to a powder and mixed with melted resin. Three to five per cent. of any fixed oil may be added to render the mixture plastic. (*Sealed May* 20, 1884).

1571. A. H. Huth, London. Manufacture of Compounds of India-Rubber, Gutta-Percha, &c. [4*d.*] January 16, 1884 —Gum kauri resin, amber, colophony, gum animé, copal, lac, sandrac, mastic and analogous resins are mixed together and combined, with or without earth, wax, solid paraffin or like substance, in such definite proportions that the combination shall have a melting point corresponding with the heat to which the india rubber or substance will be exposed during the process of manufacture or curing of the goods (*Sealed September* 2, 1884).

ELECTRIC BRAKE.

1469 R. Sutcliffe, Idle, Yorks. Brake for Utilising the Energy of Moving Bodies by Causing Dynamos to Charge Secondary Batteries. [6*d* 3 *Figs.*] January 15, 1884.—Friction discs or friction pulleys are employed to transmit the power from the revolving wheels of carriages or from the drum of colliery winding apparatus, with or without intervening gear to dynamo-electric generators which are employed to charge secondary batteries. This apparatus may be used alone or in conjunction with an ordinary brake (*Accepted August* 22, 1884)

PERMANENT MAGNETS.

4107. S. H. Parkes, Birmingham. Compound Magnets. [6*d* 10 *Figs*] February 23, 1884 —A steel wire, rod, or bar, is bent into a symmetrical flat zig-zag form, the bends being either angular or curved This rod is magnetised and converted into a permanent magnet by applying a powerful magnet to the adjacent angles or curves at opposite edges of the zig zag. The magnet may be used in flat form or be coiled up into a tubular form. (*Sealed July* 22, 1884).

TELEGRAPHY.

2767. W. P Thompson, Liverpool. (*T F. Taylor, New York, U S A*) **Automatic Telegraphy.** [6*d* 3 *Figs*] February 5, 1884.—This relates to the class of telegraphs in which the electric impulses are automatically transmitted upon the main line and similarly recorded at the receiving station The cylinders, upon which the messages for transmission are prepared, are placed in the circuit of an independent local conductor and are provided with the apparatus necessary to prepare and to transmit the message, thus avoiding the delay incident to transferring the cylinders, each local circuit being arranged to be placed in connection with the main conductor at the will of the managing operator of the station In order to notify to the managing operator when a message is prepared, an annunciator is placed at the central desk, and a system of local conductors traverses the several compartments containing the transmitters, each compartment being provided with a circuit closer A signalling device is also provided by which the manager is enabled to communicate with the transmitting operator In preparing the messages a local circuit is required for each cylinder, including a key and a recording pen adapted to be operated by an electro-magnet and to register upon the surface of the cylinder the operations of the key. Several instruments may be arranged to be operated by a single battery Each office is also provided with one or more receiving circuits An auxiliary battery having an electromotive force less than that of the main transmitting battery and of reverse polarity thereto, and two branch conductors containing artificial resistances extending to the earth from points in the main line near the transmitting and receiving terminals respectively, are combined with the transmitting and receiving devices. This battery acts to maintain a continuous negative current upon the line. The excessive electromotive force of the transmitting battery overpowers this current and exerts, by means of a positive current, an electro-chemical action on the paper The negative current, on the interruption of the transmitting current, neutralises the residual or inductive current tending to flow through the receiver and clears the line from electro-static charge. (*Sealed May* 20, 1884).

5662. H. J. Allison, London. (*J Abterdam, New York, U.S.A*) **Automatic Telegraphs.** [6*d.* 18 *Figs* , March 18, 1884.—The transmittor comprises a drum prepared in spiral lines of conducting and non-conducting material to control the transmitting circuit. The drum is driven by a motor controlled by a fan, the blades of which can be simultaneously adjusted and locked in position The surface of the drum is prepared by means of stencil plates, each representing arbitrary symbols, and provided with hooked ends adapting them to be joined together to form a message. At each end of the line, between the receivers and the transmitters, is placed a small battery, the two being connected to the line so as to neutralise each other. At the transmitting end a line battery is connected to line around the transmitter One end of this battery is connected to the stylus bearing on the drum and to the line, and the other end to the drum and earth To discharge surplus currents one or more connections are made from the line to the ground through large resistances. (*Sealed June* 24, 1884).

5793. J. S. Lamar, Augusta, Georgia, U.S.A. Relays or Telegraphic Receiving Instruments. [6*d.*

2 *Figs.*] June 10, 1884.—A vibrating steel magnet acts by its own attraction upon the core of an electro-magnet to break circuit, and by means of the mutual repulsion between the electro-magnet and the steel magnet to make circuit. A metallic point attached to an arm from the steel magnet makes a mercury contact, the height of the mercury being adjustable by means of a regulating screw. (*Sealed September 16, 1884*).

TELEPHONIC APPARATUS.

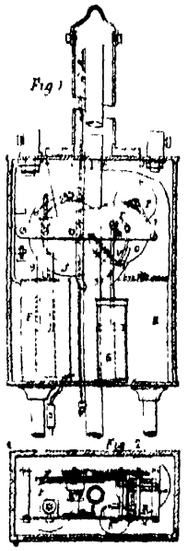
9700. W. P. Thompson, Liverpool. (*T. H. Taylor, New York, U.S.A.*) **Telephonic Receivers.** [6d. 8 *Figs.*] February 5, 1884.—The principle of this invention consists in so disposing one or more electrical conductors that different portions of the lengths of the same are brought into proximity to each other, and currents of electricity caused to traverse the same will pass and repass in approximately parallel directions, or in opposite directions through such different portions. This conductor, in one arrangement, is in the form of flat spiral coils placed in parallel planes and connected to the line. These coils mounted upon any suitable supporting material, which may or may not serve to assist in establishing acoustic vibrations. (*Sealed June 27, 1884*).

ELECTRIC SIGNALLING APPARATUS.

7773. H. A. C. Saunders and A. C. Brown, London. Electric Signal Apparatus. [6d. 4 *Figs.*] May 15, 1884.—This relates principally to the receivers such as described in Specification 2020 of 1883. Spring reeds are used instead of gravity pendulums, and the armature of the electro-magnet is separated from the mass of the flexible reed or spring, and connected therewith by a spring. The motion of the armature is controlled between fixed stops. The transmitter consists of a contact-making rod, and a spring fixed to the rod, and carrying at its free end a vibrating mass. (*Sealed August 29, 1884.*)

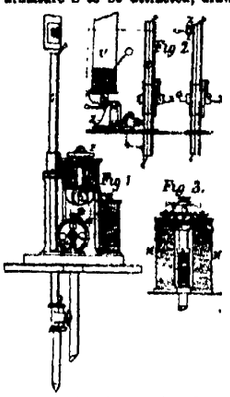
ELECTRIC ARC LAMPS.

8210. H. W. Pendred, Streatham, Surrey. Electric Arc Lamps. [6d. 5 *Figs.*] February 13, 1884.—The descent of the upper carbon-holder is controlled by gearing with a fly and brake or detent mounted in a frame supported on centres. Referring to the illustrations, the cage M is carried on pivots of the axle which supports the wheel J. The tubular axis of the brake T is mounted on a stud fixed to the cage M and has a curved tail on which is fixed a soft iron armature. The action of the lamp is as follows. When the carbons are put in, the end 1 of the cage will fall and the tail end Y of the brake T coming against a stop the brake will be released and the gearing being free to revolve, the top carbon will descend until it meets the lower carbon when the main solenoid F will attract its core b raising the end 1 of the cage, and thus the end Y from the stop; the brake is thus applied to the fly P and the whole system turns round the centre of the



wheel J the arc being struck. As the arc increases in length, the end 1 gradually descends, feeding the carbon forward until the armature on the brake comes within the attractive influence of the shunt magnet R, which raises it from the fly P, allowing the carbons to be fed. The spring S is adjusted by sliding the ring 2 along the arm V. The action of the lamp is steadied by the dash-pot b. In a modification, the brake T is applied to a wheel on the axle on which the second wheel O is mounted loosely A light spring is interposed between two studs on these wheels and a third pin on the brake wheels enters the space between the spokes of O and prevents the spring from being strained too far When the brake is taken off, the brake wheel being retarded only by the spring jumps round and lets the carbon-holder fall quickly until the two pins come in contact when its motion is opposed by the inertia of O and P, the carbon-holder falling slowly until the brake is reapplied, when the spring will continue to propel the fly P and wheel O until the pins are far enough apart. (*Sealed May 30, 1884*)

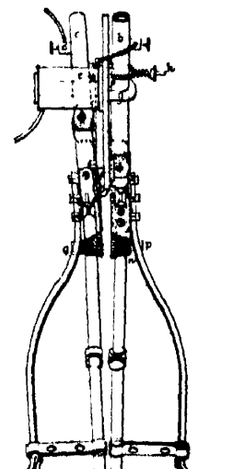
6916. R. Trott and C. F. Fenton, London. Electric Arc Lamp [6d. 5 *Figs.*] April 28, 1884.—A wrought-iron circular disc B is mounted on the fast spindle of a train of wheels N driven by the weight of the carbon-holder C and rotates within the poles of a differential magnet A of which it forms the armature. The magnet A is mounted so as to be capable of a centre swivelling motion, across the periphery of the disc B, by moving the handwheel F, thus altering its attraction at will. The core of the shunt solenoid E is attached to a pad, which on the passage of the current is raised from the periphery of the disc E. Two thin plated metallic bands are connected, the one to the top of the rod C and on to the drum D right-handed and the other to the bottom of the rod C and on to the drum D left-handed. The drum D communicates motion to the train of wheels. The spindle on which the drum D is mounted loosely carries an arm on which is mounted a pawl engaging with ratchet teeth on the drum, so that the rod C can be raised to insert fresh carbons. In order to make one set of wheelwork, regulating magnet and solenoid E govern two or more pairs of carbons, the spindle G (Fig. 2) of the wheelwork is lengthened, and the required number of drums with pawls are placed thereon. One movable lower rod (*Fig. 2*) is made to act for two lower carbons by means of a pair of stop magnets M. The armature P of the one magnet M has a brass shoe T fixed in the centre of the same and sliding on the lower rod, but resting on a bracket to the armature S of the other magnet M attached to the rod. On the passage of the current, the armature P is attracted, drawing down the rod and armature S and striking the arc. On the consumption of the first pair of carbons a switching device causes the second pair of carbons to meet, short-circuiting main current and causing the armature S to be attracted, drawing down the



rod a step lower, and leaving the armature P on the poles of its magnet, the rod sliding through the sleeve. On the consumption of a pair of carbons, pins X (Fig. 2) on the rod C make contact with pads Y and temporarily short-circuit the solenoid E, allowing the shunt current to pass through the switch magnet U which attracts its armature, drawing the spring bolt Z from the rod C, breaking the current of the magnet U, and allowing the current to return to the solenoid E, a ratchet preventing the return of the bolt Z till a pin on the bottom of the rod C frees it on the renewal of the carbons. (*Sealed August 12, 1884*).

7962. P. M. Justice, London. (*S. H. Short, Colorado, U.S.A.*) **Electric Arc Lamps.** [6d. 1 *Fig.*] May 20, 1884.—The globe or chamber for the arc is closed air-tight at the bottom and on all sides. Above the globe is a regulator connected to the globe by an air-tight tube. The carbon-holder extends loosely through the tube. By this arrangement the gases are retained in the globe, undue pressure is avoided, and free movement of the carbon secured. (*Sealed September 9, 1884*)

10,847 E. H. Gould, London. Electric Arc Lamp. [6d. 3 *Figs.*] August 1, 1884.—The carbons are inclined the one to the other, and cross or pass each other, and are made to abut against stops whereby a distance between them suitable for the arc is maintained Referring to the illustrations, a fixed frame carries on pivots near its ends the guide tubes *b* and *c*, the latter being insulated from the frame. A spring *e* holds the guide tube *c* against the regulating wedge *f*, which can be set in or withdrawn. The tube *b* has the armature *g* attached to it, and also a stem A encircled by an adjustable spiral spring. Metal tubes pass freely



down the guide tubes between rollers *n*, one of which is carried on a spring arm. The carbons pass down through the inner tubes in which they are clamped, and abut on stops *r* carried by the tubes *b c*. The stops, preferably of marble, are held in holders having square stems received in sockets, and pressed forward by springs. Wire brushes *p p* insure good electrical connection. The magnet attracting the armature *g* is preferably wound differentially. In a modification two refractory rods feed downwards towards and against the points of the carbons. A screw of steep pitch is cut in the circumference of each rod, and the point of a set screw passing through the guide tube takes into the groove. The carbons may also be caused to feed helically. (*Accepted September 2, 1884*).

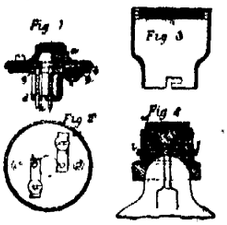
ELECTRIC INCANDESCENCE LAMPS.

9649. H. H. Lake, London. (*N. S. White, Canton, Mass., U.S.A.*) **Incandescence Electric Lamps.** [6d. 13 *Figs.*] July 1, 1884.—The fibre of silk, flax, cotton, or linen is placed in an ammoniacal solution of silver, and when saturated is stretched and dried, coated with an adhesive solution, covered with fine plumbago or gas carbon, cut into lengths and carbonised, after which it is placed in the silver solution for about three hours. The fibre may be treated with other substances in lieu of silver. In a modification, the light diffusing material is not attached to the carbon, but is placed in close relation thereto. An auxiliary burner constructed as above is arranged in any form in relation to the carbon. The filaments are connected to the platinum conductors by means of a tube formed on two ends of the conductors into which the ends of the filaments are passed, and the tubes are then flattened and their ends covered with cement. The globes are preferably slightly concave upon their undersides, and may be inclosed in wire gauze. (*Accepted September 13, 1884*).

11,215. C. D. Abel, London. (*Siemens and Halske, Berlin*). **Connecting the Carbon Filaments of Incandescence Electric Lamps to their Conducting Wires.** [2d.] August 9, 1884.—The ends of the platinum conductors are flattened and helically coiled round the ends of the filament. These coils are electrolytically coated with copper, the spheroid ends, which are in direct contact with the filament, being left uncoated (*Accepted September 9, 1884*).

INCANDESCENCE LAMP.

9668. C. Dornfeld, Cologne, Germany. Holders for Incandescent Electric Lamps. [6d. 11 *Figs.*] January 28, 1884.—The lamp holder consists of two easily separable parts which can be screwed together. The upper part is shown in Figs. 1 and 2, and comprises a metal plate *a* with a socket-shaped shoulder having a screw thread in its centre for connection to the chandelier or other support. On the other side of the plate is an insulating disc *b* having a screw thread on its periphery and carrying two Z-shaped metallic brackets *d* connected to the leads. Small metallic plates *g* projecting towards the centre are placed underneath the brackets and serve as guides for vertically arranged pins A surrounded by spiral springs resting on the metal plates and tending to press the pins downwards. The lower part of the lamp



holder is shown in *Fig.* 3 and consists of a cylindrical metallic casing having a screw thread at its upper end and angular-shaped slots at its lower end. The neck of the lamp is shown in Fig. 4 and is provided with a cylindrical-shaped insulating piece having on its circumference two opposite studs *l* which may be fixed on a ring, and on its circular surface two segmental-shaped metallic plates *m* each connected to the conductors from the lamp. In mounting the lamp, the leads are drawn through a central opening in the upper part of the holder which is then screwed on to the chandelier, the leads being connected by binding screws to the brackets *d*. The lower part of the holder is then screwed on to the thread of the disc *b*. On inserting the lamp the studs *l* pass into the angular slots, and the spring pins A are forced to rest upon the contact plates, and by slightly turning the lamp in a horizontal direction it is locked in position. Slight modifications are described and illustrated. (*Sealed May 20, 1884*).

ELECTRICAL SWITCH.

9869. J. Nutting, Dyer, Indiana, U.S.A. Circuit Closers for Telegraphic Keys. [6d. 8 *Figs.*] February 26, 1884.—An automatically closing switch, that may be readily applied to any key and that will always keep the circuit closed when the key is not in use for sending, and can be readily moved to open the circuit by the act of operating the key, is employed. The switch consists of a securing plate attached to the bedplate, a spring arm pivotted on the plate, and a contact stud carried by the arm. The thumb-piece on the spring arm is depressed by the action of operating the ordinary key (*Sealed May 30, 1884*).

9448. E. F. E. E. Lanckert, Charlton, Kent. Electric Switch. [6d. 6 *Figs.*] May 30, 1884.—The switch is provided, besides the usual metallic contact surfaces, with carbons which are pressed together by springs, and are so arranged as not to be separated until after the metallic contacts are completely broken. (*Accepted August 26, 1884*).

10351. G. Downing, London. (*W. Fitz C. M. McCarty, St. Petersburg*). **Producing and Simultaneously Transmitting a Series of Electrical Impulses or Currents.** [6d. 6 *Figs.*] July 19, 1884.—This comprises a series of vertical bars forced upwards by springs, and which can be depressed by means of a horizontal bar A switch or lever is placed between the horizontal bar and the end of each vertical bar, and when turned out of the way prevents that bar from being depressed by the horizontal bar. Each vertical bar carries a series of insulated metallic discs which make contact, when the bars are depressed, with a series of spring terminals connected to the respective circuits. (*Accepted August 19, 1884*).

CARBONS.

9781. W. Martnell, Leeds. Carbons for Electric Arc Lighting. [6d. 34 *Figs.*] June 10, 1884.—In order to utilise the ends of carbons, they are so formed that they can be joined together, or so that the end can be joined to a new length of carbon. In fitting together the ends of old carbons, a dovetail groove is cut in the end of one carbon and a corresponding projection left on the adjacent end of the next piece, these pieces being fitted together. Several forms of suitable joints are shown. New carbons are formed with special ends. (*Sealed September 12, 1884*).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

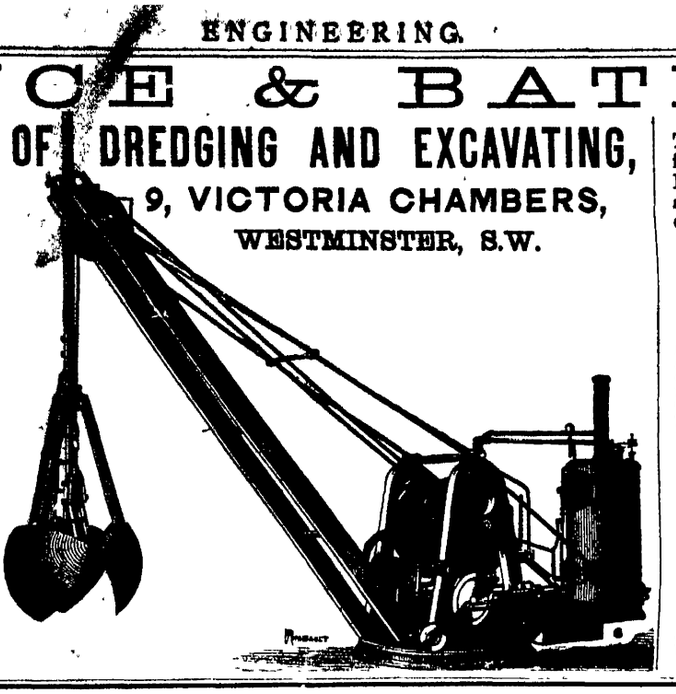
QUEENSLAND RAILWAYS.—Mr. Miles, in moving that the Queensland House of Assembly should approve the plan, section, and book of reference of the proposed extension, section two, of the Brisbane Valley Branch Railway, said that already 105,000*l.* had been voted for the purpose, and when completed the line would be within sixty miles of Nanango, a distance of 41½ miles from Ipswich. Mr. Black opposed the motion until the House had further intimation of the policy of the Government, on the ground that the country had been given to understand that no railways would be proceeded with until a Land Bill was passed. The motion was carried, however, without a division

BRUCE & BATHO'S

SYSTEM OF DREDGING AND EXCAVATING,

9, VICTORIA CHAMBERS,
WESTMINSTER, S.W.

Excavators used at
LONDON DOCKS,
WEXFORD,
CARDIFF,
HARWICH
CORK,
FRANCE,
ST. PETERSBURG,
BENARES
PARA,
MADAGASCAR,
POTI,
CALCUTTA,
SINGAPORE.



These Excavators have been largely used for sinking Wells or Cylinders for Bridge Piers, Quay Walls, &c., having worked satisfactorily in mud, sand, gravel, shingle, clay, &c. Cost of excavating by this system is cheaper than any other at present in use.

TESTIMONIALS.

WESTMINSTER, 8th April, 1880.

DEAR SIR,—I have used your Excavators for sinking over 300 cylinders, through the gravel, in the bed and at the edge of the Thames, down to the London clay, and found them very well adapted to the purpose, being able to sink cylinders 7 ft 6 in. in diameter at the rate of 2 ft. per hour, with great ease. In dredging, excavating, or unloading barges, they would be of the greatest service.—Yours truly,

(Signed) C. R. WALKER,
Contractors' Engineer.

PARKESTON, HARWICH, 28th Jan., 1882.

W. DUFF BRUCE, Esq., 9, Victoria Chambers, Westminster, S.W.

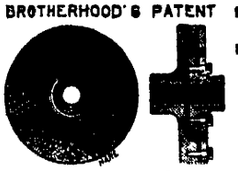
DEAR SIR,—We have much pleasure in informing you that the Excavators supplied to us by you for sinking the concrete cylinders required for the New Quay we are constructing here for the Great Eastern Railway Company, are giving us every satisfaction. With them we are able to sink the cylinders NINE FEET in diameter through the stiff silty clay forming the bed of the river, a depth of about 30 ft., in two days.

We can confidently recommend them for this class of work, or for dredging purposes, or for discharging barges.—Yours faithfully,

4742

(Signed) J. COCHRANE & SON.

BROTHERHOOD'S PATENT

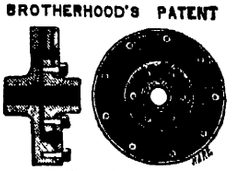


FLEXIBLE COUPLING

PETER BROTHERHOOD,

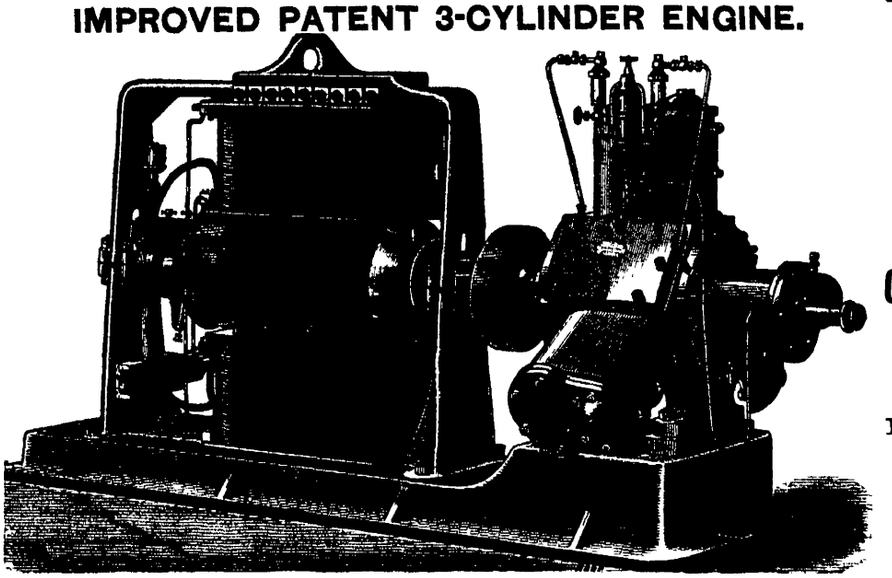
MECHANICAL ENGINEER,
BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.
IMPROVED PATENT 3-CYLINDER ENGINE.

BROTHERHOOD'S PATENT



FLEXIBLE COUPLING

THE MOST
ECONOMICAL
AND
EFFECTIVE
FOR
SHIP LIGHTING
As in General Use in the British, French, Italian, Danish, &c., &c., Navies.



FOR DRIVING
FANS,
CENTRIFUGAL
PUMPS,
AND OTHER
HIGH-SPEED
MACHINERY.

5804

International Health Exhibition.

CENTRIFUGAL PUMPING MACHINERY
FOR IRRIGATION,
Suitable for India, Egypt, and Elsewhere.

SIMPSON AND COMPANY, of Pimlico, London, have on Exhibition, close to the Water Companies' Pavilion, a CENTRIFUGAL PUMP capable of delivering 10,000 Tons of Water per Hour.

5806

TANGYES LIMITED CORNWALL WORKS, BIRMINGHAM

LONDON: 35, Queen Victoria Street. NEWCASTLE: St. Nicholas Buildings. MANCHESTER: Deansgate. GLASGOW: Argyle and Hope Streets. (D.)

TANGYES' HYDRAULIC PRESS



Fig. A.

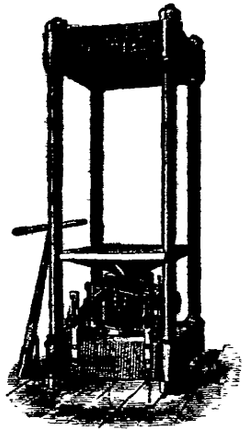


Fig. B.

Fig. A for Detached Hand or Steam Pumps
,, B has self-contained Cistern and Hand Power Pumps. 162

TANGYES' HYDRAULIC PRESS

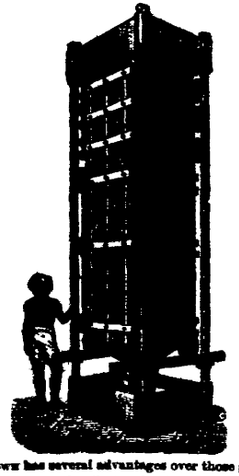
With Tee Iron Bars and Side Lining.



This Press is for Baling Wool, Hay, Grass, Hides, &c., &c. It can be made with Cistern in Base and pair of Hand Power Pumps, as shown Fig. B., page 162. 164

TANGYES' HYDRAULIC PRESS

With improved Portable Box.



The oak packing box shown has several advantages over those generally used:—

The three sides are firmly secured together, and one of them forms the lock of top-box. It can be run out clear of the Press even when doors are open. The bearers are arranged horizontally, and the fastenings are disengaged simultaneously by a single lever for each box. A spare bottom is supplied to each so that the box can be re-filled whilst the lade is being hooped, thus saving time.

The Press can be made with Cistern in base and pair of Hand Power Pumps as shown, Fig. B., page 162. 166

TANGYES' HYDRAULIC PRESS

With or Without Pumps

As illustrated on page 162.

No.	Diam. Ram Ins.	Rise Ram Ins.	Power Tons	Distance between Table & Top when down Ins.	Distance between Pillars Ins.	Size of Table. Ins.	Price without Pumps Fig A.	Price with Cistern in base and Pair Pumps Fig. B.
1	6	15	50	42	30 × 30	46 × 30	£46	£71
2	6	24	50	51	,, ,,	30 × 24	48	73
3	6	42	50	72	45½ × 27½	49½ × 27½	65	90
4	6	54	50	84	,, ,,	45 × 30	70	95
5	6	48	50	72	24½ × 43	43½ × 43	60	85
6	7	15	60	42	30½ × 30½	46 × 30	56	81
7	7	33	70	60	36 × 22½	39½ × 30½	66	90
8	7	36	70	60	24 × 24	37½ × 24	66	85
9	7	48	70	72	48 × 30	70½ × 24	105	130
10	7	15	70	42	30 × 27	39 × 27	66	115
11	7	33	70	54	46½ × 30½	46 × 30	93	122
12	7	36	70	60	24 × 24	37½ × 24½	70	95
13	8	15	80	42	45 × 27	45 × 27	85	110
14	8	33	80	60	36 × 30	46 × 30	170	195
15	8	36	80	60	36 × 24	36 × 24	90	115
16	8	42	80	72	30 × 33	39 × 30	95	120
17	8	24	100	54	,, ,,	36 × 30	85	110
18	8	15	100	42	,, ,,	24 × 24	75	100
19	8	12	100	42	,, ,,	30 × 24	75	100
20	10	24	200	54	36 × 24	32 × 30	90	115
21	10	24	200	60	,, ,,	,, ,,	95	120
22	10	24	200	72	,, ,,	,, ,,	98	123
23	10	18	150	48	45½ × 30	46½ × 30	95	120
24	10	36	175	84	,, ,,	,, ,,	130	155
25	10	120	150	138	,, ,,	41 × 17	180	205
26	10	72	200	64	46½ × 45½	46 × 46	130	155
27	10	108	200	126	,, ,,	41 × 17	230	255
28	10	24	200	72	,, ,,	46 × 46	160	185
29	10	24	200	72	,, ,,	24 × 24	160	185
30	10	72	150	72½	72½ × 45½	46 × 46	205	230
31	10	24	200	72	45½ × 44½	46 × 46	155	180
32	10	24	150	108	66 × 30	66 × 30	205	230
33	12	36	200	84	84 × 50	84 × 54½	245	270

163

TANGYES' HYDRAULIC PRESS

With Tee Iron Bars and Side Lining.

As illustrated on page 164.

No.	Diam. Ram	Rise Ram	Power Tons	Distance between Table and Top when down	Distance between Pillars	Size of Table	Price with Tee Iron Bars on all sides.	Price with Cistern in Base and pair Pumps	If also with Plate Iron Lining as five sides. Extra
50	6 ins.	36 ins.	50	54 ins.	30 × 30 ins.	29 × 24 ins.	£60	£85	£5
51	6 ,,	42 ,,	60	60 ,,	36 × 24 ,,	35 × 24 ,,	70	95	7
52	6 ,,	48 ,,	40	72 ,,	45½ × 37½ ,,	44 × 30 ,,	78	103	9
53	7 ,,	54 ,,	80	72 ,,	30½ × 30½ ,,	29 × 21 ,,	90	115	8
54	7 ,,	54 ,,	70	72 ,,	36 × 27½ ,,	35 × 24 ,,	85	110	8
55	7 ,,	54 ,,	70	72 ,,	30 × 27 ,,	38 × 27 ,,	100	125	10
56	7 ,,	54 ,,	70	72 ,,	45½ × 30½ ,,	44 × 30 ,,	110	135	10
57	7 ,,	54 ,,	70	72 ,,	66 × 30 ,,	65 × 30 ,,	130	155	10
58	8 ,,	66 ,,	100	84 ,,	36 × 24 ,,	35 × 24 ,,	110	135	10
59	8 ,,	66 ,,	100	84 ,,	30 × 33 ,,	38 × 27 ,,	120	145	12
60	8 ,,	66 ,,	100	84 ,,	45 × 37 ,,	44 × 30 ,,	110	135	12
61	8 ,,	66 ,,	150	84 ,,	66 × 30 ,,	65 × 30 ,,	200	225	12
62	10 ,,	78 ,,	200	96 ,,	36 × 24 ,,	35 × 24 ,,	150	175	12
63	10 ,,	72 ,,	150	96 ,,	45½ × 30 ,,	44 × 30 ,,	155	180	13
64	10 ,,	84 ,,	200	108 ,,	84½ × 44½ ,,	54 × 36 ,,	200	225	12
65	10 ,,	84 ,,	150	108 ,,	66 × 30 ,,	65 × 30 ,,	230	255	15

The Rise of Ram and the distance between Table and Head can be varied to meet special requirements. 165

TANGYES' HYDRAULIC PRESS

With improved Portable Box.

As illustrated on page 166.

No.	Diam. Ram	Rise Ram	Power Tons	Distance between Table and Top when down	Distance between Pillars	Size of Table	Price from below [illegible]	Price with Cistern in base and pair Hand Power Pumps	Price with Plate Iron Lining as five sides. Extra
80	6 ins.	48 ins.	50	72 ins.	30 × 30 ins.	30 × 18 ins.	£55	£80	£5
81	6 ,,	48 ,,	50	72 ,,	30 × 30 ,,	36 × 18 ,,	58	83	6
82	7 ,,	54 ,,	80	72 ,,	30 × 30½ ,,	30 × 18 ,,	65	90	7
83	7 ,,	48 ,,	70	72 ,,	36 × 27½ ,,	30 × 24 ,,	67	92	7
84	7 ,,	66 ,,	80	84 ,,	30 × 30½ ,,	36 × 18 ,,	70	95	7
85	7 ,,	60 ,,	70	84 ,,	36 × 27½ ,,	36 × 24 ,,	73	98	8
86	8 ,,	66 ,,	100	84 ,,	36 × 24 ,,	30 × 18 ,,	95	120	9
87	8 ,,	60 ,,	100	84 ,,	36 × 33 ,,	30 × 24 ,,	100	125	9
88	8 ,,	78 ,,	100	96 ,,	36 × 24 ,,	36 × 18 ,,	103	125	9
89	8 ,,	72 ,,	100	96 ,,	39 × 33 ,,	36 × 24 ,,	110	135	10
90	8 ,,	78 ,,	100	96 ,,	36 × 24 ,,	42 × 18 ,,	105	130	10
91	8 ,,	72 ,,	100	96 ,,	39 × 33 ,,	42 × 24 ,,	112	137	10
92	8 ,,	90 ,,	100	108 ,,	36 × 24 ,,	42 × 18 ,,	110	135	10
93	8 ,,	84 ,,	100	108 ,,	39 × 33 ,,	36 × 24 ,,	120	145	10
94	10 ,,	96 ,,	200	108 ,,	36 × 24 ,,	36 × 18 ,,	145	170	12
95	10 ,,	84 ,,	150	108 ,,	45½ × 30 ,,	36 × 24 ,,	125	150	12
96	10 ,,	120 ,,	200	138 ,,	36 × 24 ,,	41 × 17 ,,	165	190	12
97	10 ,,	102 ,,	200	120 ,,	36 × 24 ,,	42 × 18 ,,	150	175	50
98	10 ,,	84 ,,	150	108 ,,	45½ × 30 ,,	42 × 24 ,,	140	165	60
99	10 ,,	108 ,,	200	126 ,,	36 × 24 ,,	48 × 18 ,,	155	180	60
100	10 ,,	102 ,,	150	126 ,,	45½ × 30 ,,	48 × 24 ,,	155	180	75
101	10 ,,	102 ,,	150	126 ,,	45½ × 30 ,,	54 × 24 ,,	155	180	85
102	10 ,,	102 ,,	150	126 ,,	45½ × 30 ,,	60 × 30 ,,	170	195	110

The rise of Ram and distance between Table and Head can be varied to meet special requirements.

The Press can be made with Cistern in base and pair of Hand Power Pumps. 165

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ENGINEERING

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(Late Foremen with Messrs. Francis Berry and Sons.)

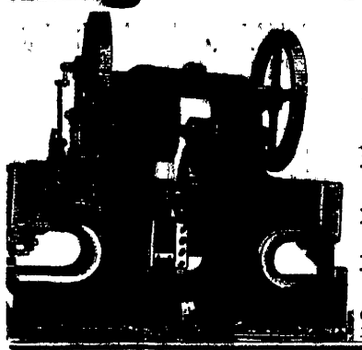
Engineers and Machine Tool Makers,

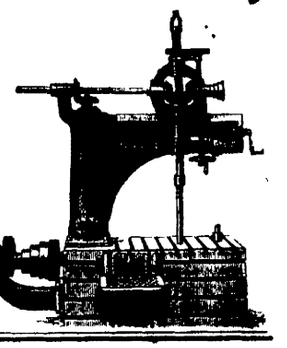
SOWERBY BRIDGE, YORKSHIRE,

MAKERS OF

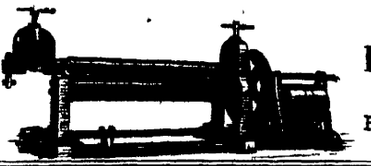
Improved Lathes, Planing, Slotting, Shaping, Drilling, Screwing, Punching and Shearing Machines,

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Special Multiple Punching & Shearing Machines for Gas Holder & Tank Makers,



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PLATE EDGE PLANING MACHINES For Boiler Makers and Ship Builders. 5163

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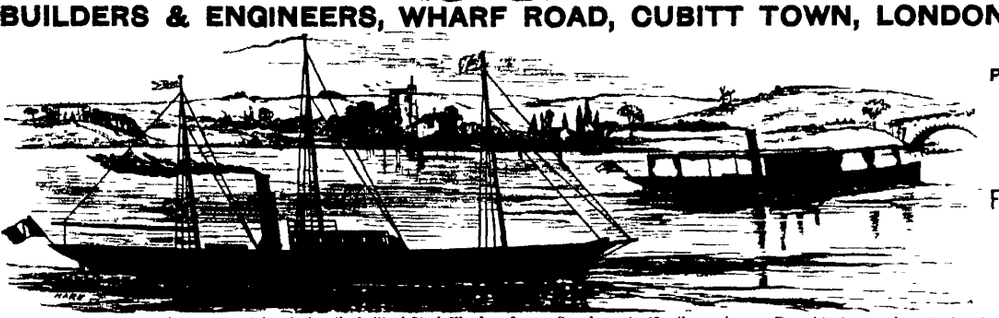
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BUILDERS Of all classes of STEAM and SAILING VESSELS, TORPEDO LAUNCHES, YACHTS, TUGS, LAUNCHES.

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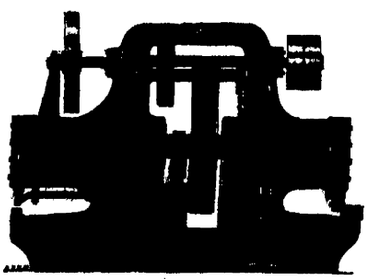
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YACHTS and LAUNCHES for Sea or River service, up to 160 feet in length, built of Steel, Wood or Iron. Speeds up to 22 miles an hour Draught of water down to 6 inches for shallow Rivers. 695

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Plate Edge Planing Machine.

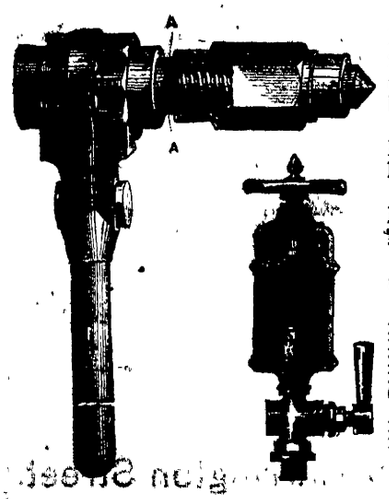
PRICES AND PARTICULARS ON APPLICATION.

Punching and Shearing Machine, with Angle Iron Cutter.

NETTLEFOLDS LIMITED, BIRMINGHAM,

SOLE MANUFACTURERS OF

WESTON'S PATENT DIFFERENTIAL RATCHET BRACE.—PATENT OPEN TOP SUET LUBRICATOR. STORER'S



These BRACES, which have been several years before the public, and are MUCH APPRECIATED by them, NETTLEFOLDS have lately CONSIDERABLY IMPROVED by enclosing the SCREW in a SLEEVE (A) which always PROTECTS it from INJURY either from DIRT or BLOWS. This SLEEVE also acts as a GUIDE for the NUT, thus keeping it steady throughout the whole of its traverse, and consequently enabling the drilling to be effected with PERFECT ACCURACY

The SUET LUBRICATOR has effected a saving of 70 per cent. in the cost of lubricating material used for Nettlefolds' Engines, and has now been fully tested in their works on 15 Cylinders working to 750 horse-power.

Messrs. HICKS, HARGREAVES & Co. write:—"We find the saving in *excess* of that stated in Messrs. Nettlefold & Chamberlain's Report—viz., 70 per cent., and the cylinders to which these Lubricators have been applied are in beautiful condition. We shall adopt them for all our engines."

By this Invention the steam is lubricated before passing to the valves, while the supply of grease is uniform and constant.

SOLD BY THE UNDERMENTIONED AGENTS:—

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LONDON	Nettlefold & Sons.	NEWCASTLE-ON-TYNE	Galloway & Co.
LIVERPOOL ..	Sharp & Carlisle, 34, James Street.	NOTTINGHAM	Manlove, Alliott, Fryer & Co.
MANCHESTER	Edmondsons & Co.	BELFAST	Patterson, R., & Sons.
GLASGOW ..	W. McGeoch & Co., Schaffer & Budenberg.	DERBY	Handyside & Co.
EDINBURGH .	Redpath, Brown & Co., Thos. Scott.	RUSSIA	Sumner, John M. & Co., Manchester.
BRISTOL .. .	Weston, J. D., & Son.	AUSTRIA	Simon, Henry, Manchester. 788
		GERMANY	Schaffer & Budenberg, Manchester.

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JOHN LYSAGHT, Limited,

TRADE MARK. TRADE MARK.

IRON ROOFS & BUILDINGS,

DESIGNS AND ESTIMATES UPON APPLICATION.

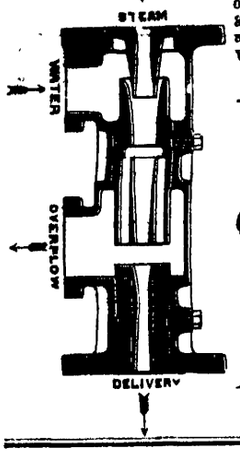
GALVANIZED CORRUGATED AND PLAIN SHEETS.
GALVANIZED STEEL SHEETS FOR WORKING UP.
GALVANIZED WIRE, WIRE NETTING, TANKS, &c.
WROUGHT AND CAST IRON GIRDERS, COLUMNS, &c.

BRISTOL: ST. VINCENT'S GALVANIZED IRON WORKS.
WOLVERHAMPTON: SWAN GARDEN MILLS.
LONDON: 28, GRACECHURCH STREET, E. C. 4682

GRESHAM'S PATENT IMPROVED SELF-ACTING INJECTOR

For Supplying Stationary, Locomotive, Agricultural, or Marine Steam Boilers with Water.

Fig. 1.



The Self-acting Injector possesses the following **great advantages over all other** Injectors:—It is **perfectly** Automatic, and **cannot fail** to work. It will lift its water supply 15 ft.; and can, when specially ordered, be made for **greater lifts.** It will work with **more ease** and **certainty** with **hot water** than **any** other Injector. If it ceases working from **any cause** (for instance, shortness of water, and consequent admission of air), it will **re-start Automatically** immediately the cause is removed. It will work **equally well at any pressure** from 10 lb. to 200 lb. It may be fixed in **any position** above or below the water supply.

The combining and receiving Cones of Fig. 2 can be taken out and cleaned without breaking any pipe joints.

The above and every other class of Injector, Ejector, and Elevator in stock and in progress; also Brass Fittings for Locomotive and other Boilers.

Upwards of **100,000** *of Gresham's Patent Injectors are now in use.*

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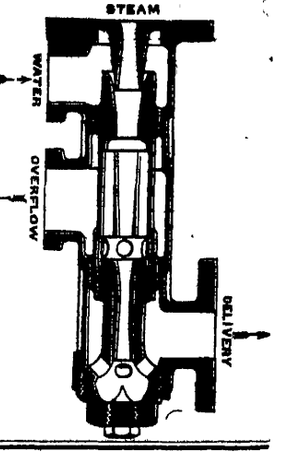
Craven Ironworks, South Hall Street, Ordsal Lane, Manchester.

LONDON OFFICE:

A. L. SACRE, 60, QUEEN VICTORIA STREET, E.C.

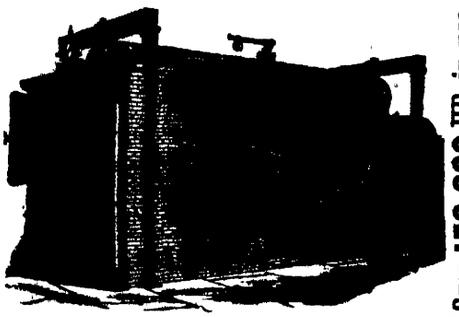
AGENTS—Glasgow: WILLIAM LESTER, 58, Renfield Street. Newcastle-on-Tyne: TANGYE BROS., St. Nicholas Buildings. Birmingham: TANGYES LIMITED, Soho 5089

Fig. 2.



THE BABCOCK AND WILCOX CO.

(NEW YORK & GLASGOW)



Over 150,000 HP. in use.

PATENT

WATER-TUBE STEAM BOILER.

Safe, Economical (as to space and fuel), and Durable; Having Perfect Water Circulation, and Spacious Steam-room; Easy of Transportation, and perfectly Accessible for Cleaning external and internally.

For Illustrated Circular and full particulars apply to our European Offices,

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40, CANNON STREET, LONDON, E.C.; and
3, VICTORIA BUILDINGS, DEANSGATE, MANCHESTER.

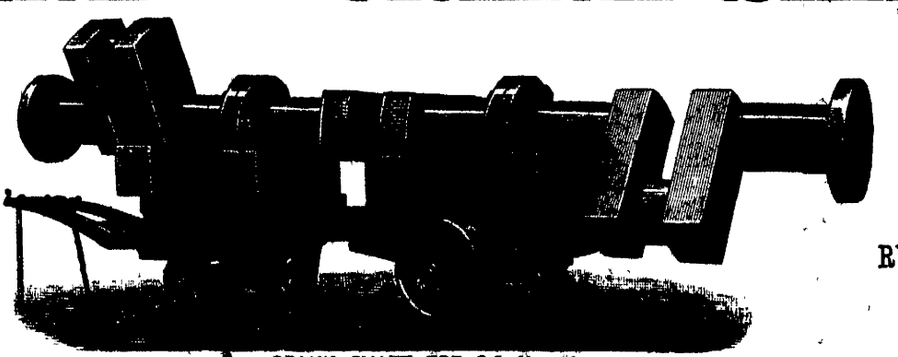
For the Colonies and New Zealand, apply at No. 8, Spring Street, Sydney, N.S.W. 4776

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FORGINGS OF ALL KINDS IN IRON & STEEL.



CRANK SHAFT FOR S.S. No. 98.
FORGED WEIGHT, 48 Tons. FINISHED WEIGHT, 41 Tons 9 Cwt.

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Armour Plate and Forging Presses.

STEAM HAMMERS.

Hydraulic Cranes and Capstans. 5903

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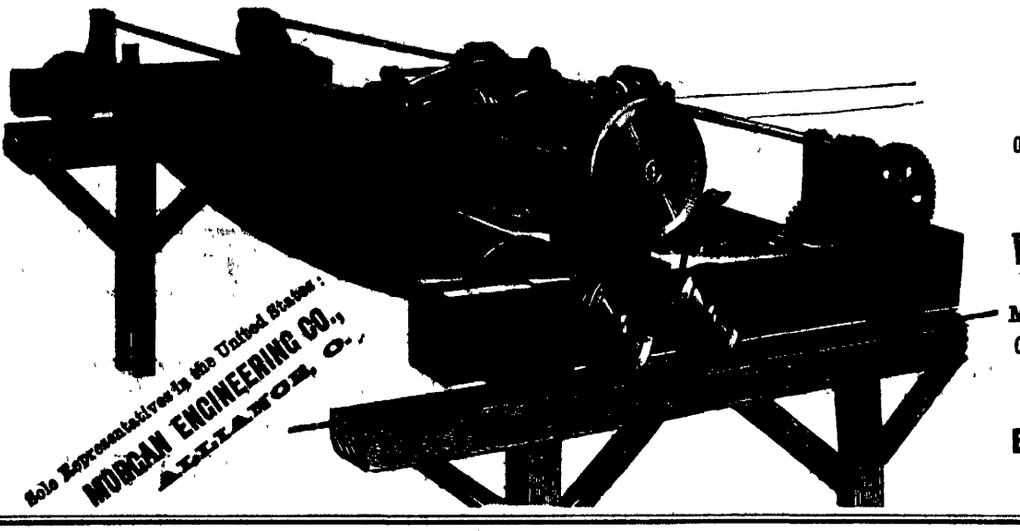
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CITY OFFICE: 89, CANNON ST., LONDON, E.C.

Cranes, STEAM, HAND, AND HYDRAULIC, FIXED, PORTABLE OR LOCO.

OVERHEAD TRAVELLERS And Lifting Machinery of all descriptions.

Boilers. All types of Land and Marine, and in all sizes.



STEAM ENGINES Of all types and powers for Mills, Mines, Water Works, &c.

Winding Gear, PUMPING MACHINERY, Combined or separate.

IRON BRIDGES, Iron Roofs and Girder Work of all kinds. 4944

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New Patent Barring Engine.

AUTOMATIC MOTION FOR MOVING INTO GEAR, AND FALLS OUT OF GEAR AUTOMATICALLY WHEN MAIN ENGINE STARTS.

The SIMPLEST, SAFEST and BEST, and also the CHEAPEST Automatic Safety Apparatus for Turning Main Engines.

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BRIDGE FOUNDATION CYLINDERS.

THE STOCKTON FORGE CO., STOCKTON-ON-TEES.

Make a Speciality of this work, turning out over 200 tons per week; also large quantities of Railway Chairs. 6000

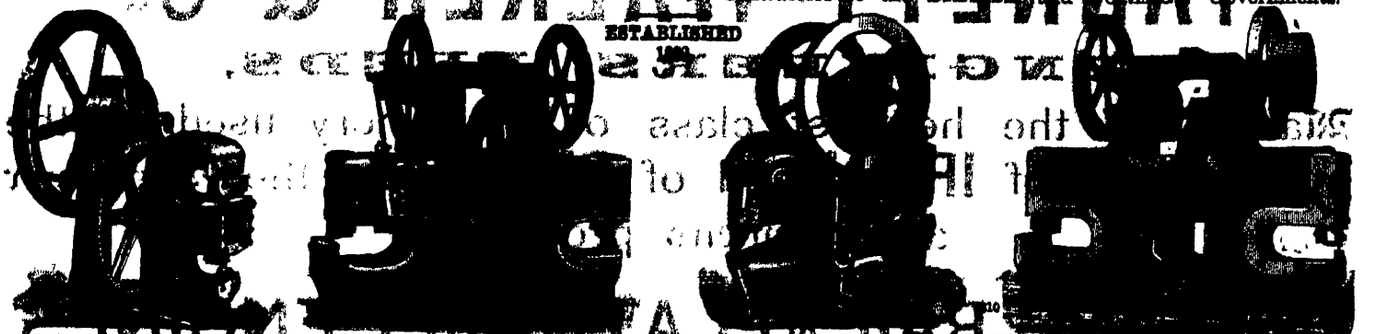
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ESTABLISHED



PUNCHING & SHEARING MACHINES.

The only GOLD Medal at Paris Exhibition, 1878, for Best Cast Steel Castings; also the only GOLD Medal for Best Cast Steel Castings, Melbourne, 1881. Three SPECIAL Diplomas, Sydney and Melbourne, 1880-81. Awarded SPECIAL DIPLOMA at Sydney Exhibition, N.S.W., for Best Cast Steel Castings. GOLD MEDAL, Madrid, 1883.

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Home, Foreign, & Colonial Railways, Admiralty, War Department, &c.

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OF UNSURPASSED QUALITY.

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FROM 4 LBS. TO 5000 LBS. EACH.

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One of our departments is specially adapted for the production of our Patent Steel Wheels and Axles for Collieries, Tramways, Ironstone Mines, Slate Quarries, Iron Works, Coal Mines, &c., and we are now manufacturing about 2,000 per week. Owing to our system of fixing the Wheels and Axles, which is simple and effective, we are enabled to describe orders with promptitude, and undertake to supply all work entrusted to us in a first-class manner.

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Our Wheels possess extra toughness, durability of welding, and lightness. 4502

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WALKERS' PATENT

AIR-COMPRESSING ENGINES

For COLLIERIES, STEEL WORKS, &c., and as supplied to HER MAJESTY'S GOVERNMENT for INDIA

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HORIZONTAL AND VERTICAL, STATIONARY, AND LOCOMOTIVE BOILERS.

Iron and Steel Forgings. Horizontal and Vertical Engines, Condensing and Non-Condensing. Roofs, Girders, Bridges, Pit Gears, &c., and all kinds of Iron and Steel Work.

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" CHARLES CAMMELL and CO., Cyclops Works, Sheffield.

" The DARLINGTON IRON and STEEL CO., Darlington.

" The WEARDALE IRON and STEEL CO., near Durham.

" The NORTH-EASTERN STEEL CO., Middlesbro'.

And to nearly 200 other Engines for a variety of purposes throughout the country.

The advantages afforded by the application of the Patented Valves to Bessemer Engines, are a greater endurance than has yet been attained to Valves worked automatically (eccentrics, &c., for the valves not being required), and an almost perfect expulsion of the whole of the compressed air from the cylinders.

RANSOMES AND RAPIER,

5, WESTMINSTER CHAMBERS,

LONDON,

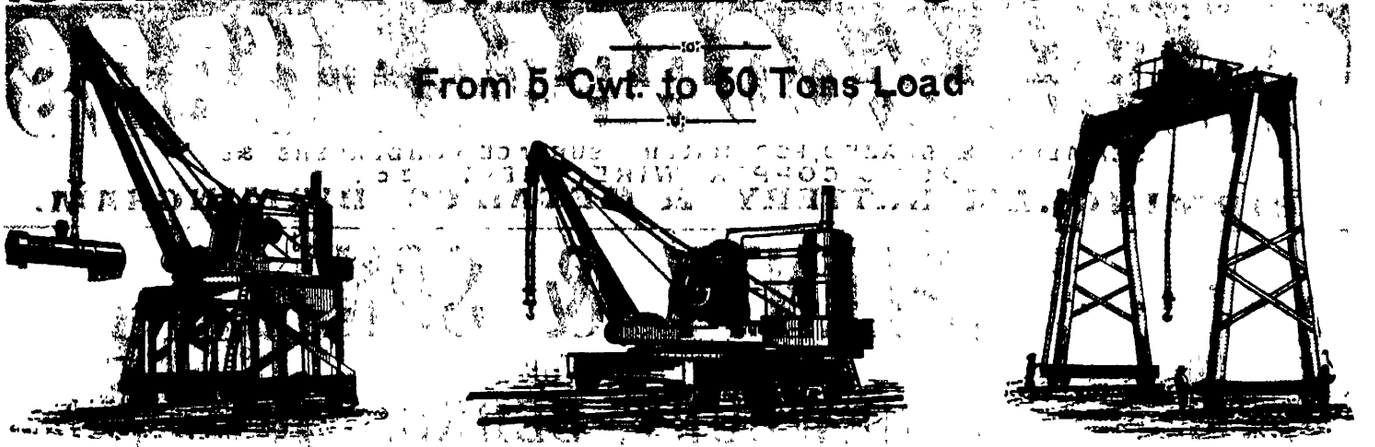
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STEAM & HAND CRANES

FOR

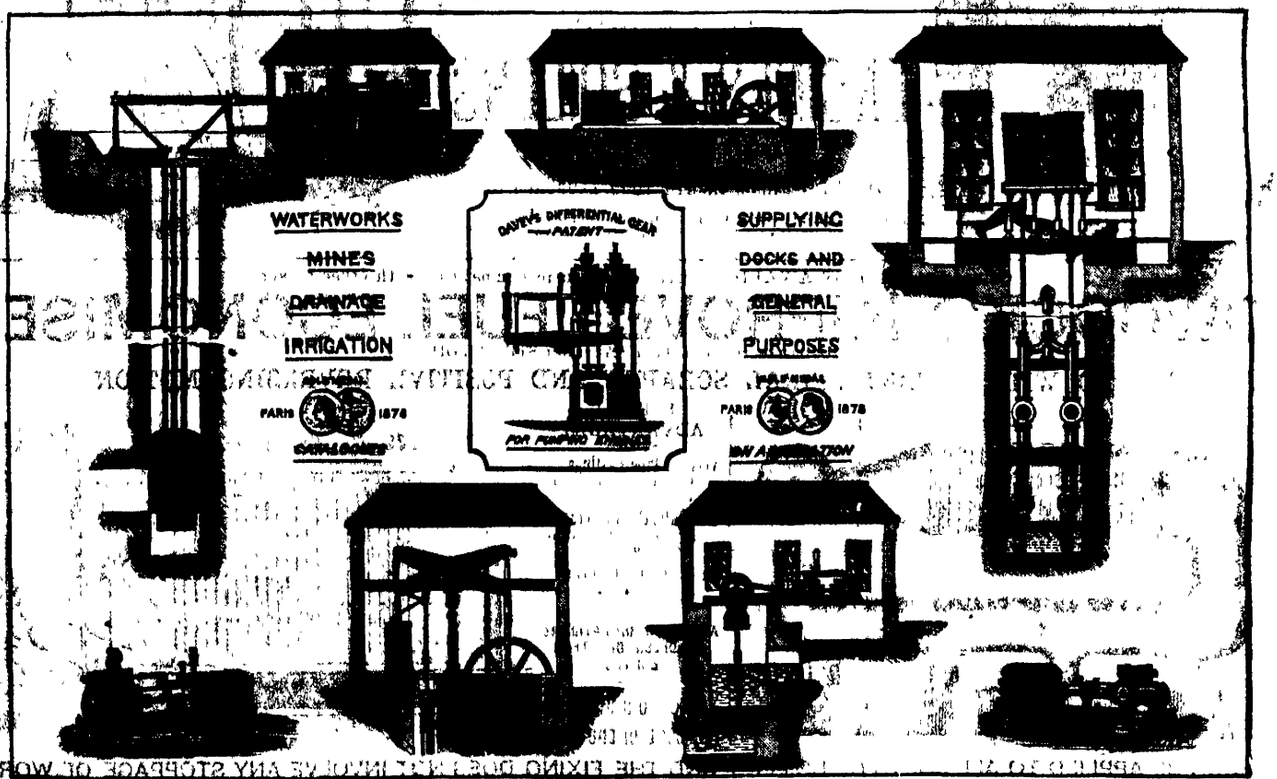
From 5 Cwt. to 50 Tons Load



FOR PRICES AND ILLUSTRATIONS APPLY TO

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PUMPING MACHINERY.



HATHORN, DAVEY & CO., LEEDS.

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breeze, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the class and power of these Boilers, showing the small amount of space they occupy—

9ft. long,	5ft. 6in.	diameter,	20-horse power.
10ft.	"	5ft. 6in.	"	25	"
12ft.	"	6ft. 0in.	"	40	"
13ft.	"	6ft. 6in.	"	50	"
14ft.	"	7ft. 0in.	"	60	"
15ft.	"	7ft. 6in.	"	70	"
16ft.	"	8ft. 0in.	"	80	"
17ft.	"	8ft. 0in.	"	90	"
18ft.	"	8ft. 0in.	"	100	"

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

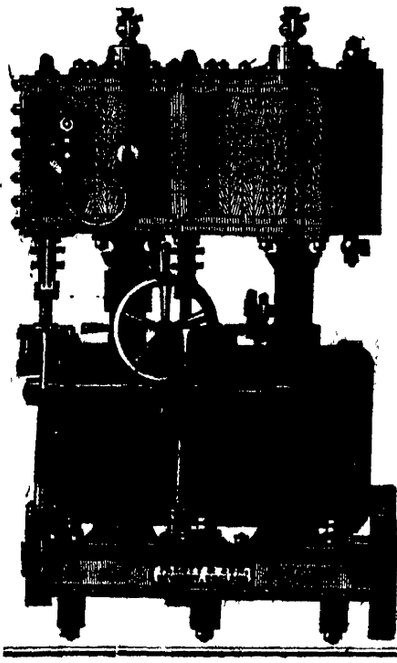
A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS.

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EAGLE IRONWORKS,

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MANUFACTURERS TO THE ADMIRALTY.

First Prize, Royal Yacht Club, Cowes.

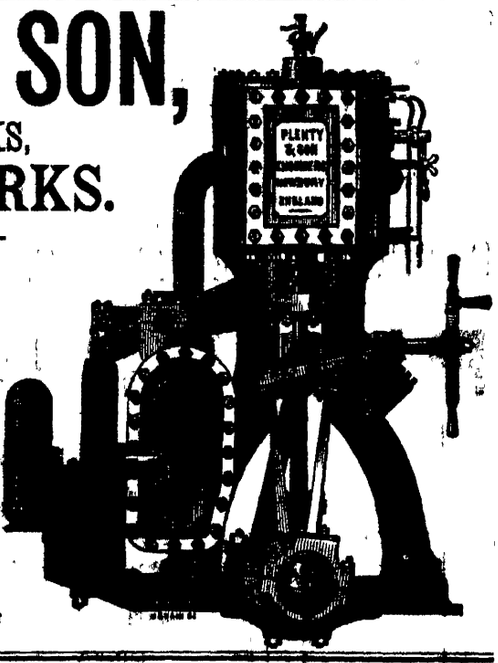
PATENT

ENGINES & BOILERS

FOR

SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &c.

Simple, High-Pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works. 4027

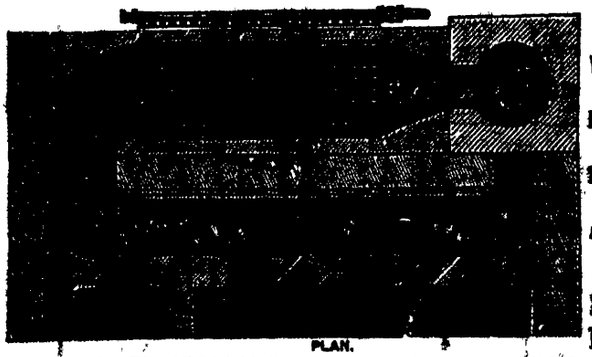


Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(For Utilising the WASTE HEAT from STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION



PLAN.

SPECIAL ADVANTAGES.

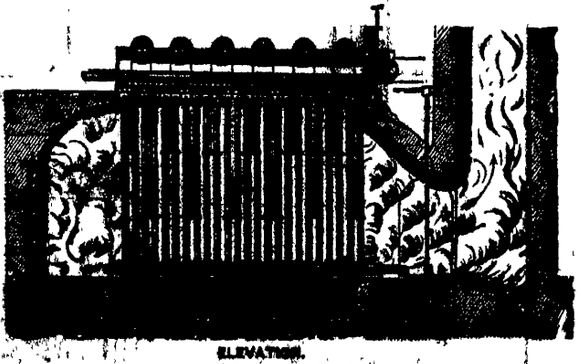
Vertical Pipe Castings. Guaranteed sound and perfectly true.

New Patent Spiral Scrapers The most effectual removers of soot.

Patent Reversing Gear. Never sticks or gets out of order.

ALREADY IN OPERATION TO NUMBERS OF STEAM BOILERS.

Saves from 20 to 25 per cent. of the fuel.



ELEVATION.

N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and abroad.

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IN IRON AND STEEL.

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WOODFORD IRONWORKS,
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LONDON OFFICES—158, LEADENHALL STREET, E.C.

CORRUGATED AND GALVANISED SHEETS,
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Manufacturers of every description of Roofs and Buildings in Iron and STEEL for Forges, Rolling Mills, Railway Stations, Goods Sheds, Yards, Docks, Stores, and General Purposes.
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Files of First Quality.—Steel Lagging Plates for Cylinders.—Steel Boiler & Ship Plates & Forgings of all kinds.

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LONDON OFFICE: MESSRS. CORNES, CALVERT & CO., 30, WALBROOK, E.C. 5157

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From 1 Cwt. to 50 Tons, for every kind of work,

Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.

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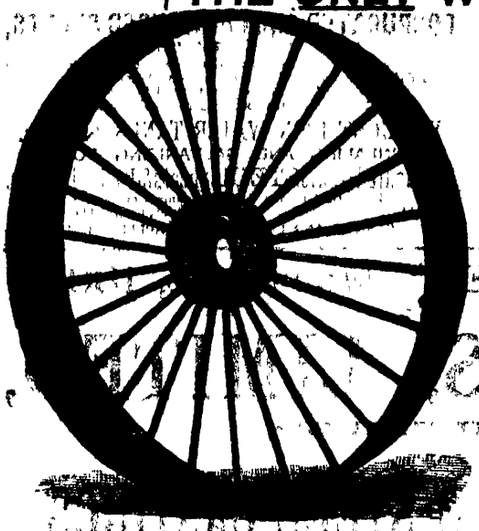
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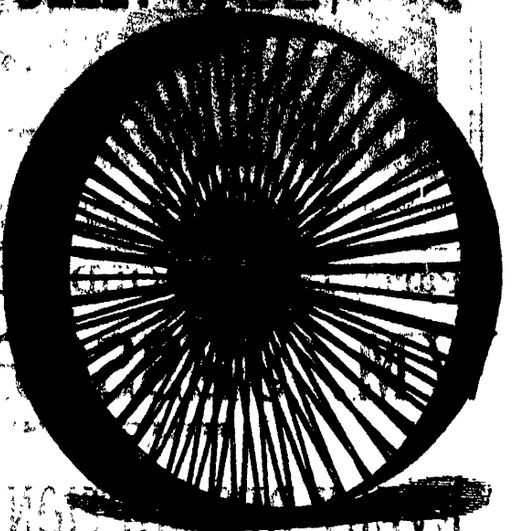
WROUGHT IRON THROUGHOUT—RIM, ARMS, AND BOSS.

Telegraphic Address, "PULLEY, LEEDS." THE ONLY WROUGHT IRON PULLEY MADE. Telegraphic Address, "RODGERS, LEEDS."

SPLIT or SOLID.

All Sizes up to 24 feet Diameter.





40,000
IN USE.

The Best Pulley in the World

USED SOLELY FOR DRIVING THE ELECTRIC LIGHT AT THE HEALTH EXHIBITION, SOUTH KENSINGTON.

Messrs. Marshall, Sons and Co., Limited, keep a Stock of our Pulleys at their Depôt, Marshalls' Buildings, 79, Farringdon Road, London, E.C.

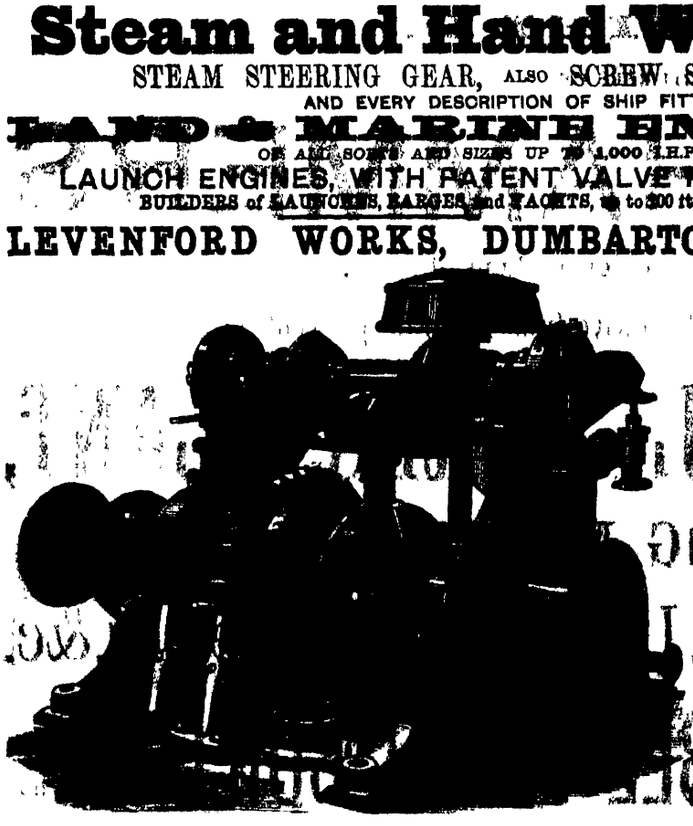
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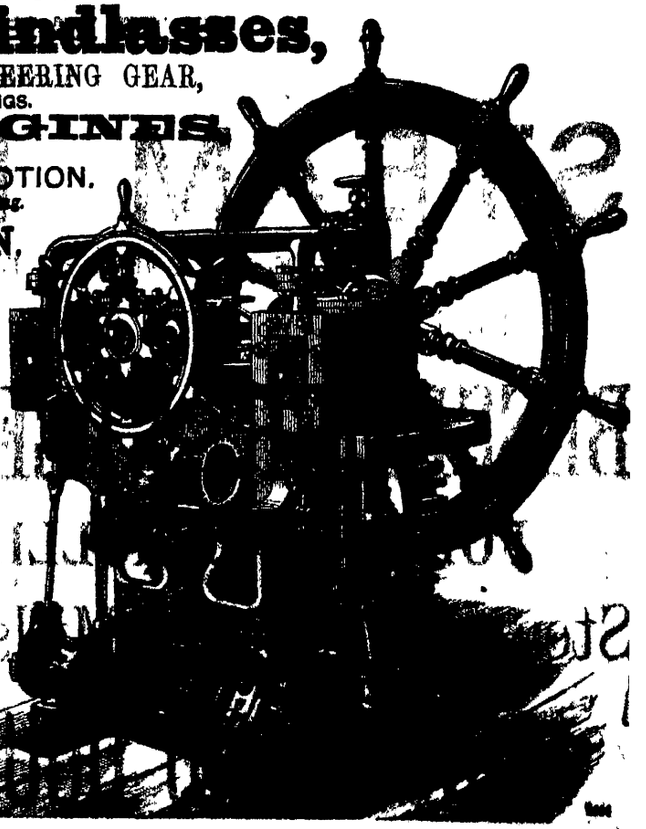
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France—O. BORISSOW, Rue a Fiens, Ster, Lille.
Russia—S. G. MARTIN, Galerny No. 12, Quartier 8, St. Petersburg.
Austria—J. EGLI, 1, Bezr Freiung 7, Vienna
Saxony—W. W. DERHAM, Leipsic.
Belgium—D. GRANDY, Rue de l'Abattoir 80, Gand.
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MATTHEW PAUL & CO.,
MAKERS OF
Steam and Hand Windlasses,
STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,
AND EVERY DESCRIPTION OF SHIP FITTINGS.
LAND & MARINE ENGINES,
OF ALL SORTS AND SIZES UP TO 1,000 I.H.P.
LAUNCH ENGINES WITH PATENT VALVE MOTION.
BUILDERS of LAUNCHES, BARGES, and YACHTS, up to 200 ft. long.
LEVENFORD WORKS, DUMBARTON.





LEATHER | INDIA-RUBBER | GUTTA-PERCHA

FOR MINING, ENGINEERING AND GENERAL MECHANICAL PURPOSES

RED. ANGUS & Co. NEWCASTLE-ON-TYNE 18, BILLITER STREET, LONDON. LIVERPOOL. And BUTE DOCKS, CARDIFF.

BORLAND'S PATENT INJECTORS

START PROMPTLY WHEN THEY ARE HOT.

No Moving Parts. No Joints to make. Continuous Action. Cheap and Economical. Small and Neat. Cleaned in a few seconds. Of best Gun-Metal only.

SPECIALITY IN INJECTORS FOR TRAMWAY, TRACTION, & LIGHT LOCOMOTIVE ENGINES.

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CHAS. S. MADAN,

21, MANSFIELD CHAMBERS, ST. ANN'S SQUARE, MANCHESTER,

WHO TESTS ALL INJECTORS PERSONALLY.

SPECIALITY IN INJECTOR AND GENERAL BOILER FITTINGS, GUARANTEED TO BE OF HIGHEST UTILITY AND EXCELLENCE.

ALL OF BEST GUN-METAL ONLY. A LARGE STOCK KEPT.

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PRICES, TESTIMONIALS, INSTRUCTIONS, &c., ON APPLICATION. LIBERAL TERMS TO THE TRADE.

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to [illegible]

Bell's Asbestos Works, Southwark.

Gentlemen,—I beg to state that your [illegible] Block Packing was used in the high-pressure cylinder of the ship with the following remarkable results:—

14,000 knots ... Vacuum ..... 26 inches.

Steam Pressure .....

My experience does not showing [illegible] any other packing

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, using the [illegible] from New Zealand coal only.

D. HENDERSON, Chief Engineer, S.S. "Rangoon"

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 10th, 1884

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable through preserving an even surface, the piston pinkings have perished, owing to high temperature, but the [illegible] remained quite smooth, and I have also used it with complete success when a steel has lasted with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained with it for our [illegible] engines to have been [illegible] Yours truly,

G. R. CLARKE, Chief Engineer.

Mr. J. Bell.

Dear Sir,—I have to inform you that [illegible] for Bell's Rolled Cloth Asbestos Packing to [illegible] satisfactorily.

Yours truly,

To Mr. Foster Bell. JOHN COLLIER, Chief Colliery Contractor.

The Patent Block Packing, as [illegible] Fig. 1, and Fig. 2 and 3 represent the Round Block Packing with metal and hollow rubber core, and Fig. 3 trimpost core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and packing makers to substitute [illegible] at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This valuable substance by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also [illegible] incrustation so immediately as to prevent its adhering to the plates.

Not only is the most economical method adopted by keeping boilers clean, but the risk of having the plates burned is entirely obviated.

It has been computed that 1 in. thick of incrustation causes a waste of 15 per cent. of coal; $\frac{1}{2}$ in., 20 per cent.; $\frac{1}{4}$ in., 125 per cent.

Thus the Preservative, [illegible] are inseparable from sealed plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the hot tank or boiler, as may be most convenient.

Sold in drums of 56 lb., 28 lb., 14 lb., and 7 lb.

BELL'S ASBESTOS [illegible] PACKING, with Metal Eyelets.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To Bell's Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the [illegible] engines at the above Colliery, and during that period we have [illegible] Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery [illegible]



The Trade Mark. [illegible] genuine only when [illegible] no other [illegible] to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depôts and not through agents or factors.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION, for coating every class of steam pipes and boilers, non-combustible and [illegible] steam up; adheres to metal, and [illegible] them from [illegible] It is [illegible] and [illegible] than any other [illegible] and is absolutely [illegible] Being supplied to the trade ready mixed with water, it [illegible] long, [illegible] the [illegible] Asbestos Boiler.

Temperature on Plates ..... 156 deg.
Covering ..... 90 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov 26th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly, "W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited, Gunnislake, Tavistock, 8th April, 1884.

Mr. John Bell, Southwark, S.E.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has given the most [illegible] results. When it has been in use we have saved fully half our coals, and [illegible] a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as yet [illegible] since been used. I can most strongly recommend the material. I am, Sir, yours faithfully,

W. J. CRAIK, Assoc. M. Inst. C.E., Engineer and Manager

BELL'S ASBESTOS & INDIA-RUBBER [illegible] TAPE AND [illegible]

for making every class of Steam and Water Joints. It can be beat by hand to the [illegible] required without pasketing, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from $\frac{1}{2}$ in. to 3 in. wide, and any thickness from 1 16th in. upwards. Manhole covers can be fitted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at any price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

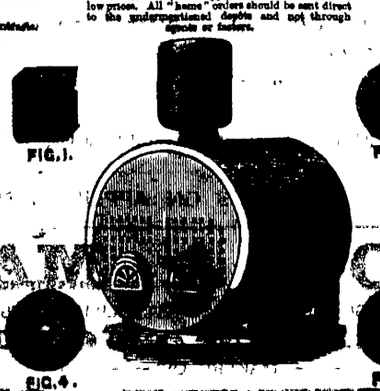


FIG. 1.

FIG. 2

FIG. 4.

FIG. 3.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD.

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regarding of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and $\frac{1}{2}$ millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above —

[illegible] Contracts.

[illegible] May, 1884.

Sir,—I have to inform you that the tender for Asbestos Millboard has been [illegible]

Director of Navy Contracts

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

* * This Sheeting is another combination of Asbestos with India-rubber, giving to the steam [illegible] advantages of both materials.

The [illegible] Wire is [illegible] from the action of heat and grease by an outer [illegible] of Tinned Asbestos Cloth, this protecting an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by all

BELL'S ASBESTOS LUBRICANT

REGD.

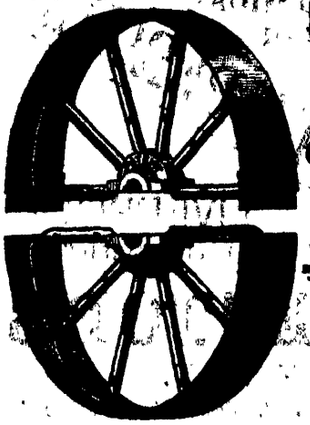
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SOLE MAKERS. **READING IRONWORKS, LTD.** READING, ENGLAND.



THE PULLEY FOR THE WORLD.

THE PATENT WROUGHT IRON

"UNIVERSAL,"

Supplied to HER MAJESTY'S DOCKYARDS and Leading Engineers throughout the Kingdom, the Continent of Europe, the Colonies, &c., &c.

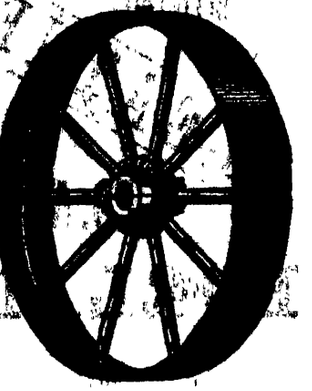
TENS OF THOUSANDS IN USE.

SILVER MEDALS

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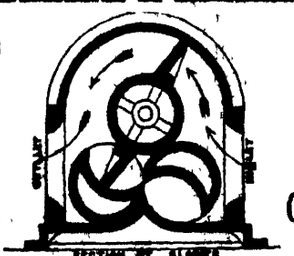
THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

Baker's Patent Rotary Pressure Blower and Gas Exhauster.

BAKER'S PATENT ROTARY PUMP.

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

HALL'S PATENT STONE BREAKER.

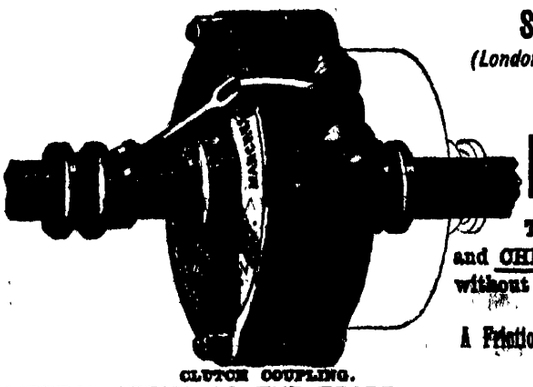
General Machinery of Every Description.

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 6731

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SALFORD IRON WORKS, MANCHESTER,

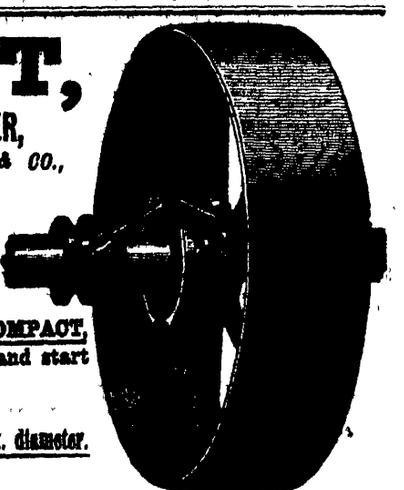
(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.)



CLUTCH COUPLING.

— PATENT —

FRICTION CLUTCH.



These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.

LIBERAL TERMS TO THE TRADE. PRICES ON APPLICATION. CLUTCH AND PULLEY 5200

GOODFELLOW & MATTHEWS,

(LATE S. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS.

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 5000

Silver Medal Paris 1881.

ELECTRIC LIGHT.

Gold Medal Crystal Palace, 1882.

WORKSHOPS, MILLS, DWELLING HOUSES, OUT-DOOR CONTRACTS.

R. E. CROMPTON & CO., Electric Light Engineers,

MANSION HOUSE BUILDINGS, LONDON, and ARC WORKS, CHELMSFORD,

Contractors to H.M. Board of Works, General Post Office, Principal Railway Companies, &c.,

ARE PREPARED TO SUPPLY SETS OF MACHINERY FOR

ELECTRIC LIGHTING EITHER BY ARC OR INCANDESCENT SYSTEM,

AS UNDER.

ARC LIGHTING.

		£	s.	d.
10-light set	(including Burgin Dynamo machine, Ten 16-hour, 2,000 candle-power lamps, cable, switch, &c.) packed and delivered free to any railway station in England	330	0	0
6-light set	do. do. do. ...	195	0	0
3-light set	do. do. do. ...	120	0	0

INCANDESCENT LIGHTING.

		£	s.	d.
30-light set	(including self-regulating Burgin Dynamo machine, Thirty Swan 20 candle-power lamps, 30 holders, cable, branch wire, cut-outs, plain wall brackets or pendants) packed and delivered free to any railway station in England	100	0	0
75-light set	do. do. do. ...	195	0	0
150-light set	do. do. do. ...	300	0	0

OTHER PRICES AND LIST ON APPLICATION.

Extract from a Letter from the Manager of the South Wales Tin Plate Works (who have since increased their installation by the addition of both Arc and Incandescent Lamps), with reference to an Installation by R. E. CROMPTON & CO.

"Six months' experience is too short a time to enable me to give anything but an estimate of the cost of Electric Lighting, as some parts of the machines only require renewing once in every two or three years. In fact, as yet the cost of renewals has been almost nothing, except in lamps. I, however, estimate that over a series of years this item of expense will not exceed £80 per annum for 100 lights, exclusive of lamps, and this is confirmed by the reports of others, who say that 10 per cent. upon the cost of the plant will quite cover repairs, and £60 is a great deal in excess of 10 per cent. upon the cost of our plant. Taking this sum as the expenditure on repairs, the cost of the Electric Light will be as follows in cases similar to our own, where there is spare steam at night:—

Wages	£62	0	0
Lamps	90	0	0
Repairs, &c. .. .	60	0	0
Oil and Stores	13	0	0
	225	0	0
Less work done by Engineer .	41	6	8
	£183	13	4

I deduct the above amount for the work done by the engineer. He has nothing to do except to oil the bearings once or twice during the night, and can turn rolls, screws for the mills, &c., in a lathe driven by the same engine as the Dynamos; in fact, it is an advantage in more ways than one to give him this work to do, as it prevents him from going to sleep and so neglecting oiling the machinery, as well as the saving in wages.

"This cost is for 100 lamps of 17 candle power for a year, using them on an average five nights a week for 14 hours in the winter six months, and nine hours in the summer six months; this gives a total of 2,990 hours, during the whole of which we have 1,700 candle power of light for the sum of £183 13s. 4d.

"What would an equal light cost in Gas at 3s. 9d. a 1,000 cubic feet? We cannot calculate on burning less than one cubic foot of Gas per hour for every three candles' power; so to get 1,700 candles power for 2,990 hours, we should burn 1,694,300 cubic feet of Gas costing £317 14s. 7d. against £183 13s. 4d. for the same light if supplied by the Incandescence Electric system.'

4813

For Price, &c., apply **SMEDLEY BROTHERS,**

PORTABLE ENGINES. MORTAR MILLS. "SPECIAL CLAY MILLS."

STEAM BOILERS

(CORNISH, LANCASHIRE, AND VERTICAL.)

TESTIMONIAL from Messrs. J. & R. Bowden. Marple, near Stockport, Jan 7, 1874.

GENTLEMEN,—We have now had one of your Portable Engines and 7 feet pan Mortar Mills, in constant work for the last twenty months, and have great pleasure in stating that they have given us every satisfaction, and for construction, strength, and workmanship are the best we have seen.—Yours respectfully,

Messrs. SMEDLEY BROS. J. & R. BOWDEN (Builders)

EAGLE IRONWORKS, BELPER.

VERTICAL Combined Engines and Boilers.

HORIZONTAL ENGINES.

5109

HARDINGHAM's Patent Sectional STEAM BOILER

ANNULAR WATER-TUBE SYSTEM.

—:—

FOR

FULL PARTICULARS,

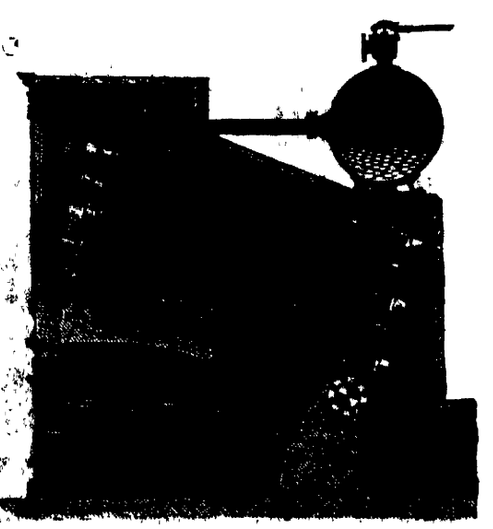
Apply to

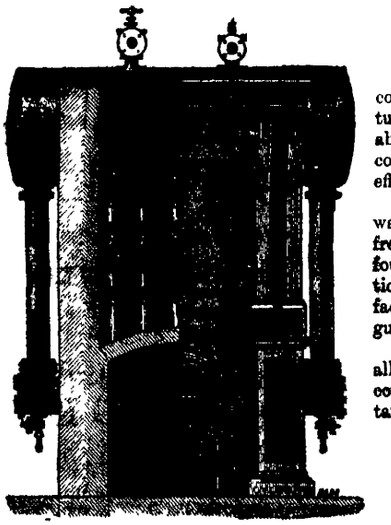
G. C. M. Hardingham

Engineer,

101, Fleet Street,

LONDON, E.C.





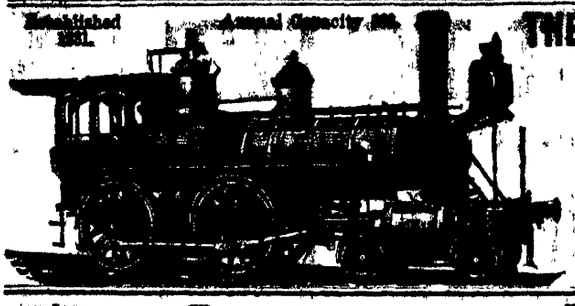
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By this improved construction of Water-tube Boiler, considerable economy in first cost and in working is effected.

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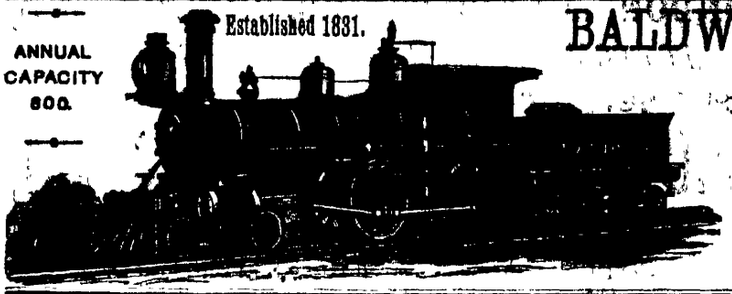
BUILDERS OF LOCOMOTIVE ENGINES OF ALL CLASSES

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OF EVERY DESCRIPTION.

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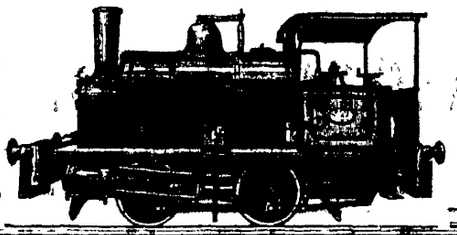
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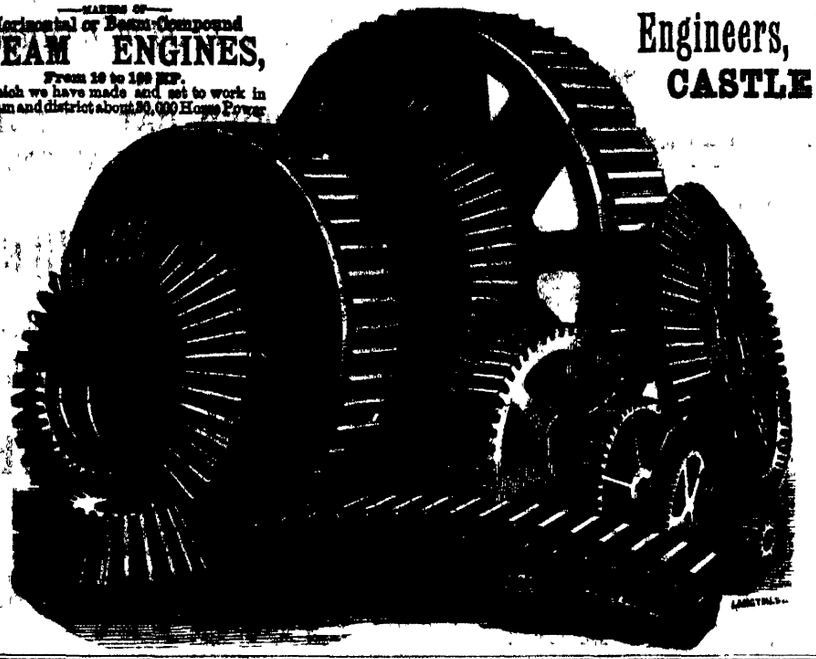


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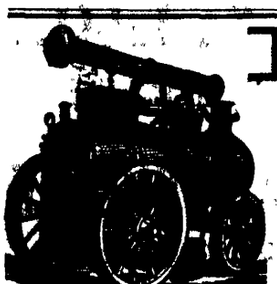


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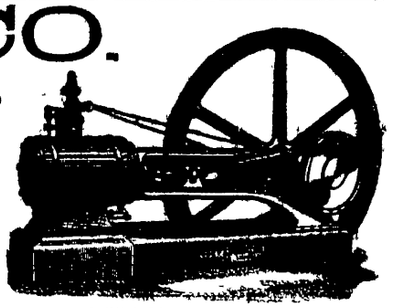
CALCUTTA EXHIBITION, 1884, FIVE FIRST PRIZES.
Budapest Agricultural Meeting, 1882—Two Gold Medals and other Awards.
Vienna Agricultural Meeting, 1882—Special Diploma for excellency of work.
Sydney Exhibition, 1880—Three First Prizes. 3051
Hanover Agricultural Meeting, 1881—Gold Medal and Diploma of Merit. [Prizes.
Paris Exhibition, 1878—Grand Prix, Gold Medal, and other

ROBEY & CO.

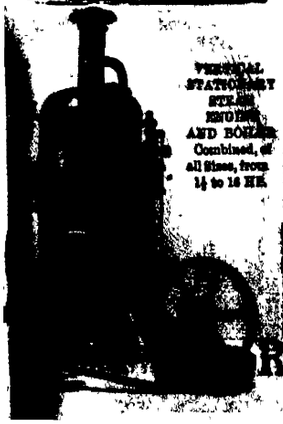


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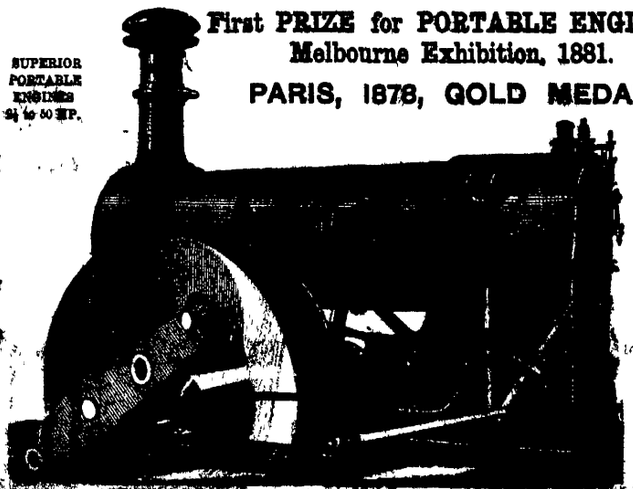
First PRIZE for PORTABLE ENGINES,
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HORIZONTAL FIXED ENGINE, 4 to 60 HP.
☞ References can be given to upwards of 9,000 Engines now at work.



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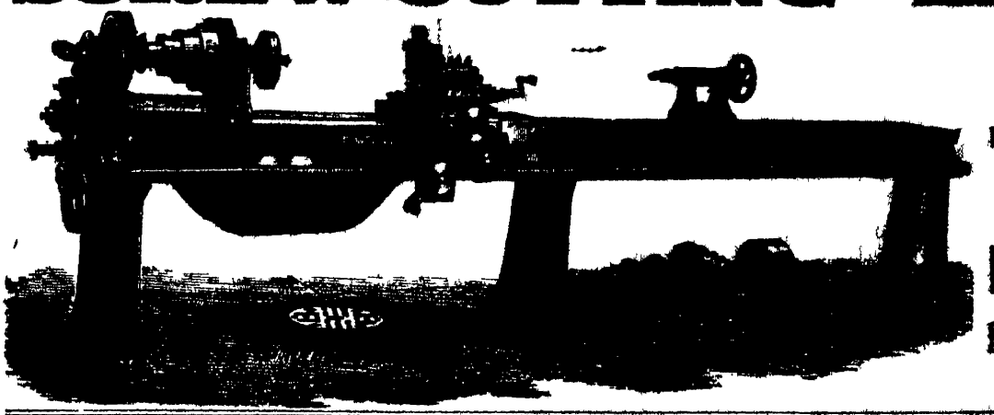
Illustrated Catalogues of the Machinery here Illustrated on application to the Manufacturers:



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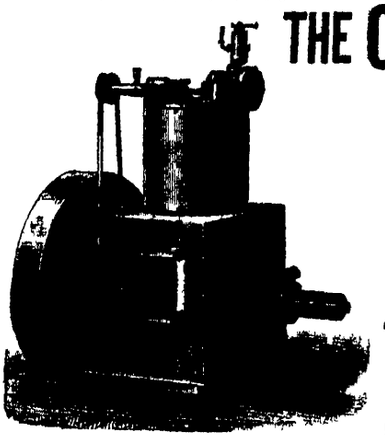


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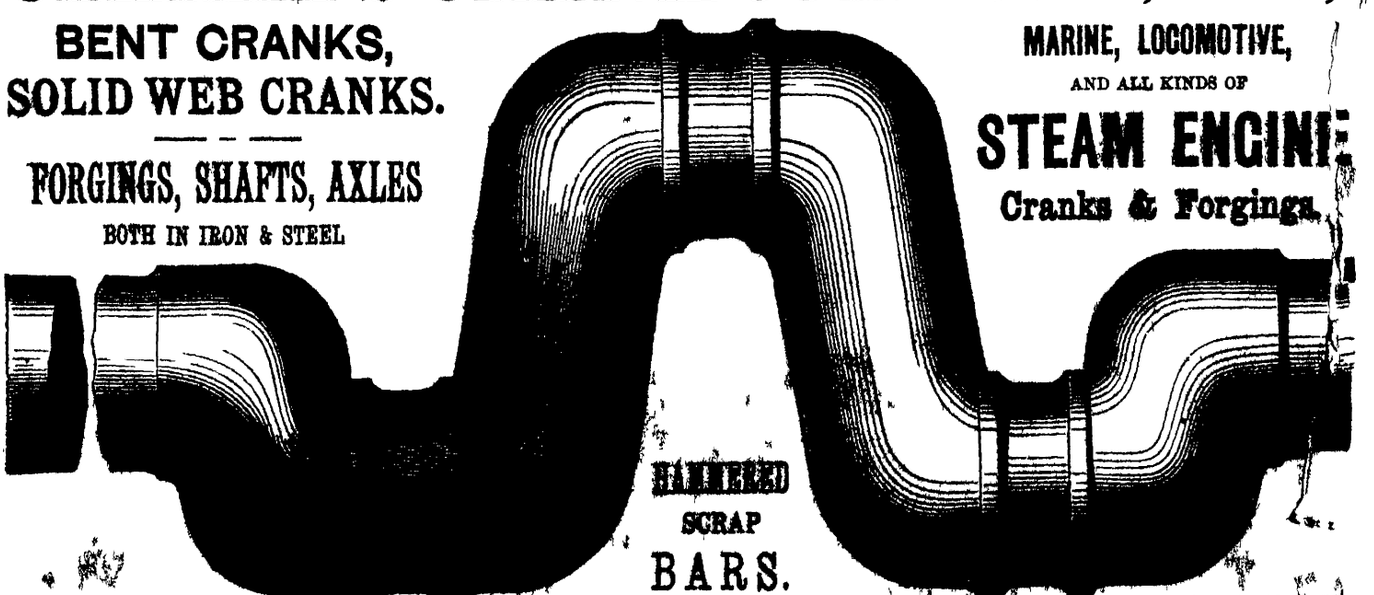
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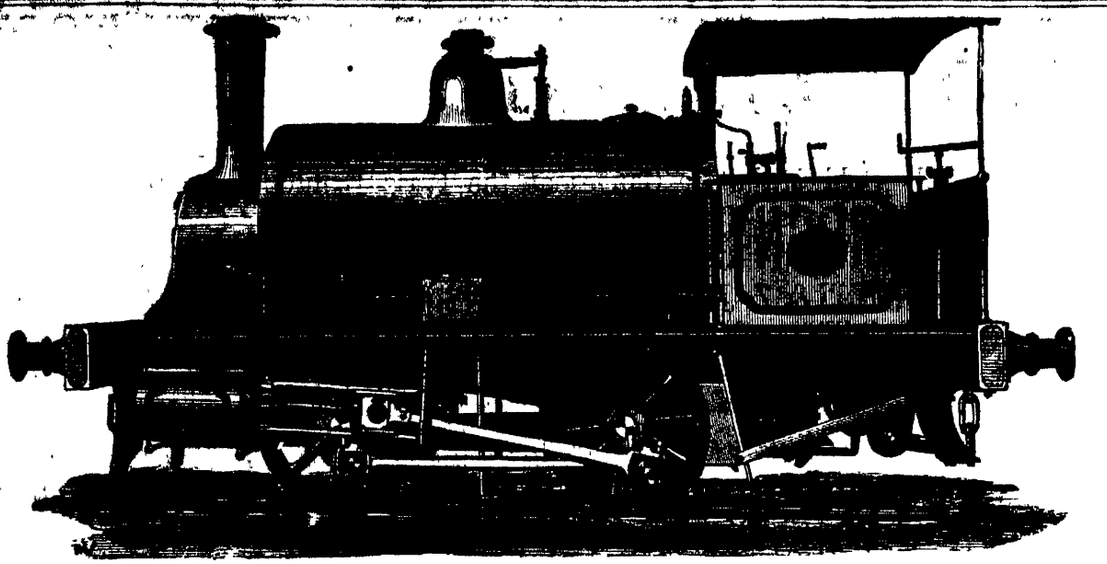
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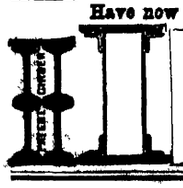
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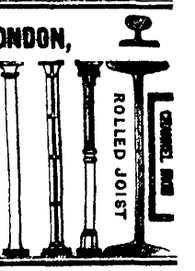
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6 × 6	5 × 3	8 × 1½ = 5 ,,	8 × 4½ = 32 ,,	7 × 3½ = 20 ,,	9½ × 4½ = 32 ,,	12 × 6 = 56 ,,	9½ × 3½
6 × 3½	5 × 2½	4 × 1½ = 7 ,,	6½ × 3 = 11 ,,	8 × 4 = 23 ,,	10 × 4½ = 33 ,,	14 × 6 = 60 ,,	9½ × 2½
6 × 3½	4½ × 3½	4 × 3 = 12 ,,	6½ × 3½ = 16 ,,	8 × 5 = 29 ,,	10 × 5 = 36 ,,	16 × 6 = 62 ,,	8 × 3½
5 × 3½	3 × 3	6½ × 1½ = 8 ,,	6 × 5 = 29 ,,	8 × 6 = 34 ,,	10 × 6 = 56 ,,	17½ × 6½ = 82 ,,	8 × 2½
4 × 3½	1½ × 1½					19½ × 7½ = 100 ,,	6½ × 2½
4 × 4	1 × 1						3½ × 1½

Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 12". Length, 12 to 30 ft. Thickness, ¼" to 2". 5126

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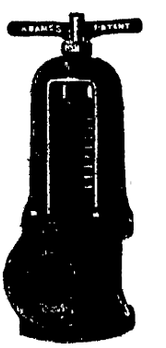
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ADAMS' VALVE TRIUMPHANT!

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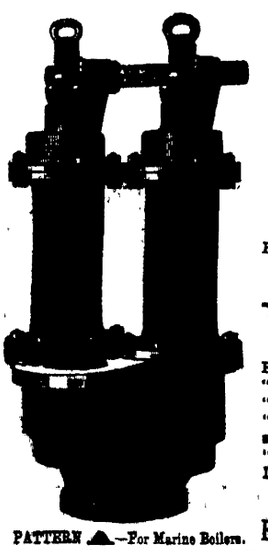
Two Special Prizes & Two Gold Medals



Pattern B—For Stationary Boilers.



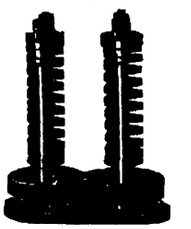
Pattern C—For Stationary Boilers.



PATTERN A—For Marine Boilers.



Pattern D—For Portable Engines.



Pattern E—For Locomotives.

Patterns D and E are made entirely of Gun Metal.

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BUTTWELDED GAS, STEAM, and WATER TUBES.

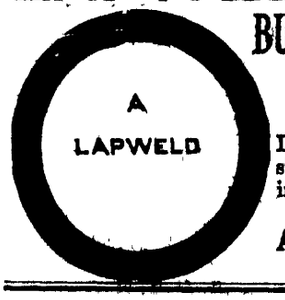
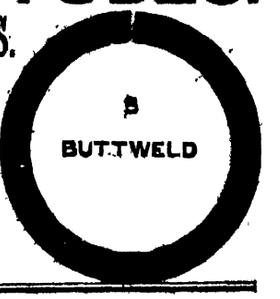


DIAGRAM SHOWING LAP AND BUTT WELDS.

These two Engravings, representing sections of Lapwelded Wrought Iron Tube (at A) and Buttwelded (at B) show conclusively the superior strength of Lapweld, which has nearly four times the surface in contact in the Weld over that given in Buttweld.

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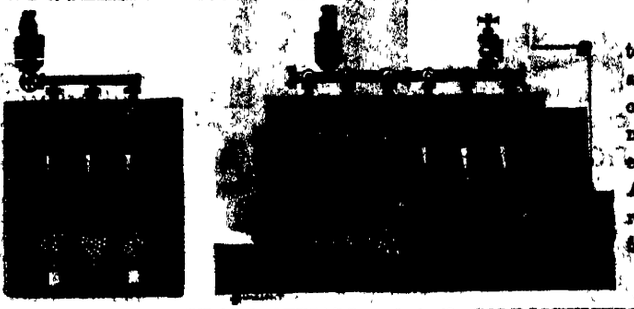
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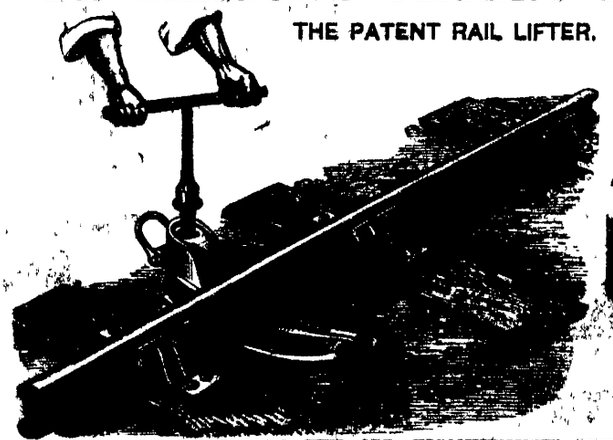
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1 & 2, TUDOR STREET, LONDON, E.C., furnishes the necessary Plant

The PORTER-CLARK PROCESS

Removes Lime, Magnesia, and Iron from **Hard Waters**, and thus, the **causes of Incrustation in Boilers and Pipes** This Process is in use in Paper Mills, Breweries, Sugar Works, India rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c One Railway Company employs it for feed water to the extent of **1,000,000 gallons** daily, and one of the London Water Companies at two of its Pumping Stations It is also in use in County Asylums, Public and other Schools, and Private Mansions The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich are rendered soft and clear 5226

DESCRIPTIVE CIRCULAR ON APPLICATION.

15 PRIZE MEDALS. THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED, 15 PRIZE MEDALS.
4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 3. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 3. GLASGOW, 1880, 2. LONDON, 1882, 1

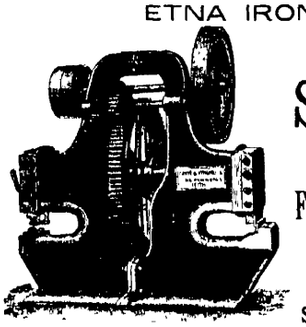


ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD 4794

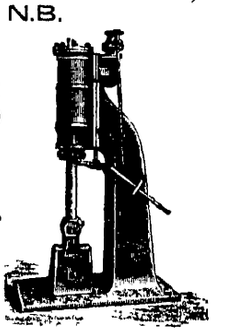
JAMES GOODWIN AND COMPANY,
Ironfounders, Engineers, and Bridge Builders
CONTRACTORS for RAILWAY PLANT, viz Cast Iron Chairs, Sleepers, Tanks, Water Cranes, Axle Boxes, Screw Piles for Bridges, Piers and Wharfs, Blast Furnace Castings, Ingot Moulds, and every description of Plant for Collieries, Iron Works, &c Also all kinds of Castings for Engineers and Tool Makers Manufacturers of Iron and Steel Bridges, Iron Roofing and Buildings, and General Structural Work (Bridge Works at Motherwell) 2247
Works Ardrossan, Johnstone, and Motherwell
Shipping Ports Ardrossan, Glasgow, Greenock, Leith

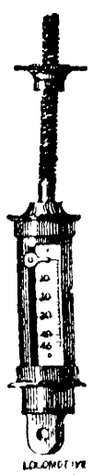
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HAND-MADE PAPERS
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The most suitable for Engineers and others. 5208
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IMPROVED DOUBLE-ACTING
STEAM HAMMERS
FOR FORGES, SMITHIES, STAMPING, &c
AWARDED THE
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Sizes from 1½ cwt to 12½ cwt usually in Stock.
PUNCHING AND SHEARING MACHINES, 4377
SHIPBUILDERS' AND BOILER MAKERS' TOOLS, &c.









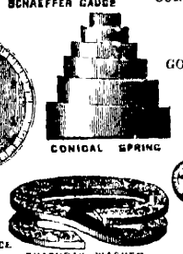
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WEST BROMWICH,
MANUFACTURERS OF
Spring Balances, Roasting Jacks,
BOURDON'S, SCHAEFFER'S, & SILVESTER'S
PRESSURE GAUGES,
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For Testing Strength of Wire, Rope, Cement, Cloth, &c.
GOODS SUPPLIED THROUGH ALL MERCHANTS AND FACTORS

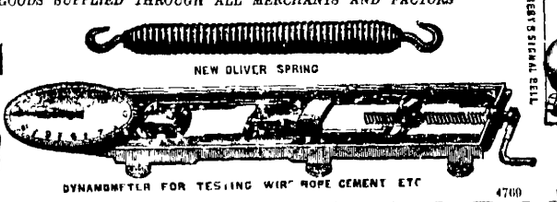












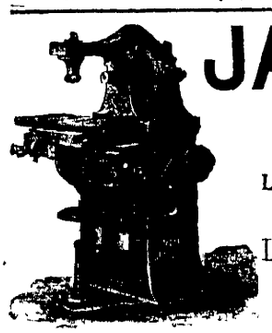


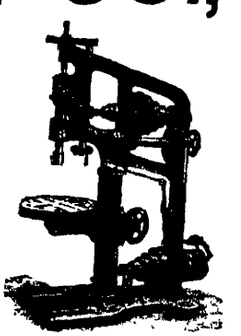


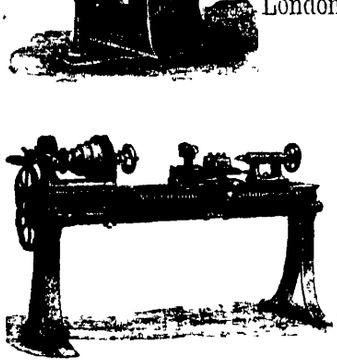


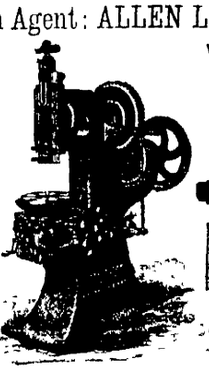
LOCOMOTIVE BALANCE
COLLIERY BALANCE UP TO 2 TONS
THACKRAY WASHER
DYNAMOMETER FOR TESTING WIRE ROPE CEMENT ETC
4760
RASTRICKS TUBE SCRAPER
LOCOMOTIVE BALANCE

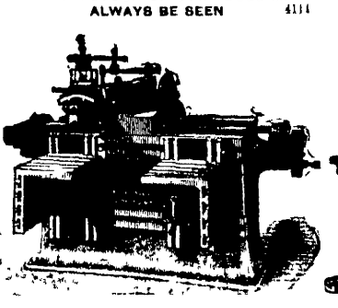
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London Agent: ALLEN LEE, Electrician, 3, Camden Cottages, Camden Rd., N.W.
WHERE A STOCK OF OUR TOOLS MAY ALWAYS BE SEEN 4114



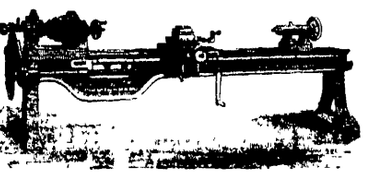




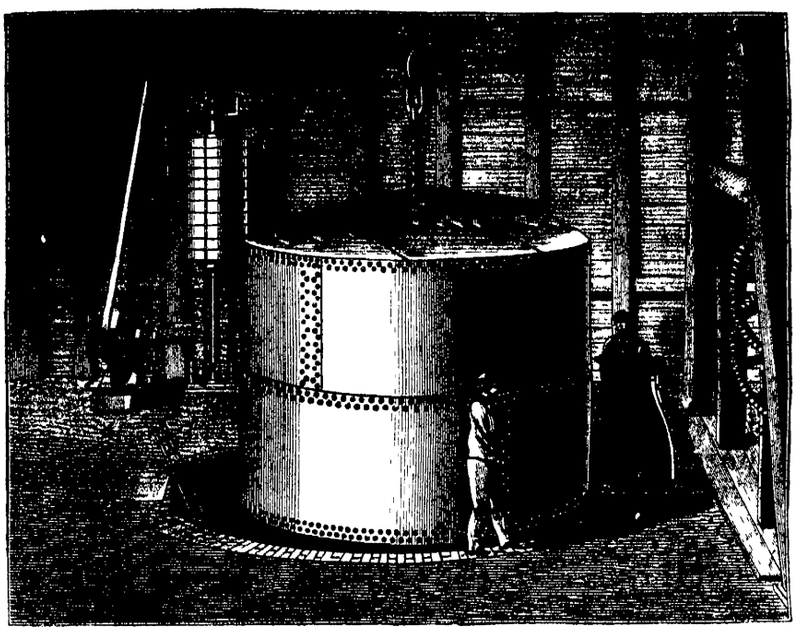








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OF THE MOST RECENT TYPES.

Punching, Shearing, Bending, Forging, Hoisting,

AND OTHER HIGH-PRESSURE

HYDRAULIC MACHINERY

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Hydraulic Labour-Saving Machine Makers,

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Contractors to the British and Foreign Governments.

RAGOSINE OIL

THE RUSSIAN NATURAL LUBRICATING OIL. Gold Medal, Paris, 1878.

Pure Hydro-carbon, free from acid. Body superior to Olive or Lard Oil | Never gums or clogs Never freezes or thickens.

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RAGOSINE & CO.,

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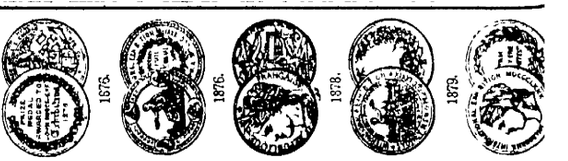
And Love Lane, Quayside, Newcastle-on-Tyne.

Works—BALACHNA and CONSTANTINOW, RUSSIA

Price Lists and full particulars on application 4779

No. VIII 2s. 0d. PER CAL.





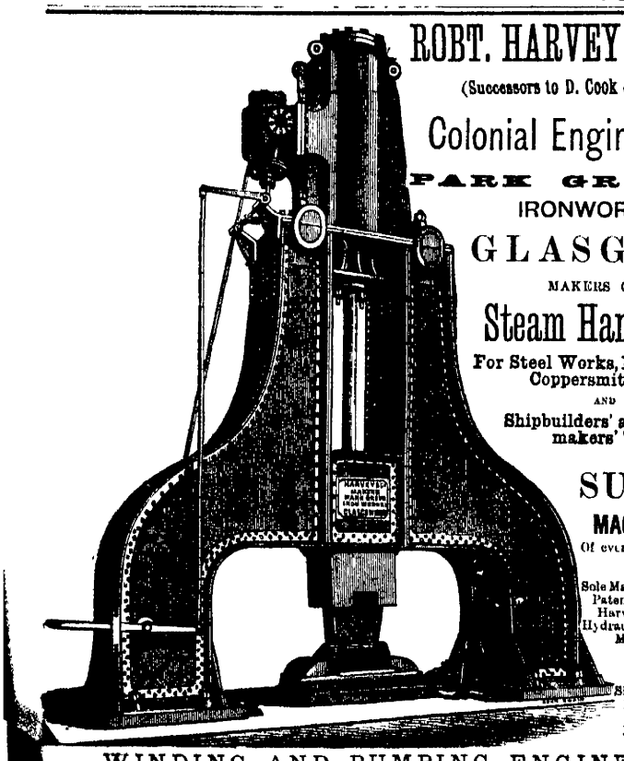
THE PERTH GAUGE GLASS,

Warranted to stand upwards of **1500 lbs.** pressure to the square inch, and bear great variation of temperature

These Medals have been awarded for the above-mentioned qualities.

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PARK GROVE IRONWORKS,

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MAKERS OF

Steam Hammers

For Steel Works, Forges and Coppersmiths,

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ALSO

SUGAR MACHINERY

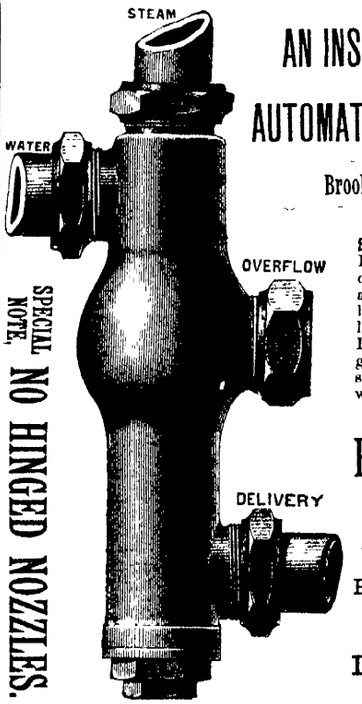
Of every description

Sole Makers of Cook's Patent Steam and Harvey's Patent Hydraulic Rivetting Machines

Punching, Shearing, Angle Iron and Bar Cutting MACHINES 5063

WINDING AND PUMPING ENGINES.

THE "INFLUX"



AN INSTANTANEOUS STARTING AND AUTOMATIC RESTARTING INJECTOR

Brooke, Holden, & White's Patent.

SPECIAL NOTE, NO HINGED NOZZLES.

The **only** Lifting Injector **devoid** of **Spindles**, Levers, Adjustable Internal Parts, or **hinged** Nozzles which lifts without manipulation and restarts automatically **Instantaneous action** on Steam being turned full on Works equally well lifting up to 12 ft., or as a "non lifter" Invaluable for Locomotives, Traction Engines, Marine, and other Boilers Can be seen working on application, or reference will be given as to their perfect reliability

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PATENT BOILER DRILL

For Drilling Boiler Shells

LICENSEES FOR THE SOUTH

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SOLE MAKERS OF
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Feed Water HEATER.



The most powerful invented.
Great Saving in Boilers, Coals, and Labour.
LARGE HEATING SURFACE
Solid Drawn Brass Tubes
Free Expansion
No Scurf adheres to the Tubes.
4837
List on application

BY ROYAL LETTERS PATENT.



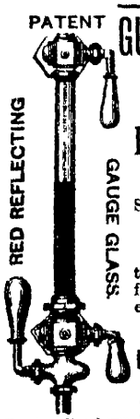
MATHER'S
Fly-Wheel Portable Engines
ARE THE BEST FOR SMALL POWER.
They have large Fly Wheels on which they travel, they are light in draught and are handy
5104
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WELLINGBOROUGH, ENGLAND.

W. R. PALMER,
LIMITED,
BACOT STREET FOUNDRY,
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Manufacturers of
MALLEABLE IRON CASTINGS.
Guaranteed true to Pattern, of best Qualities, and at Low Rates.
Castings for the Bicycle and Tricycle Trades. 4188



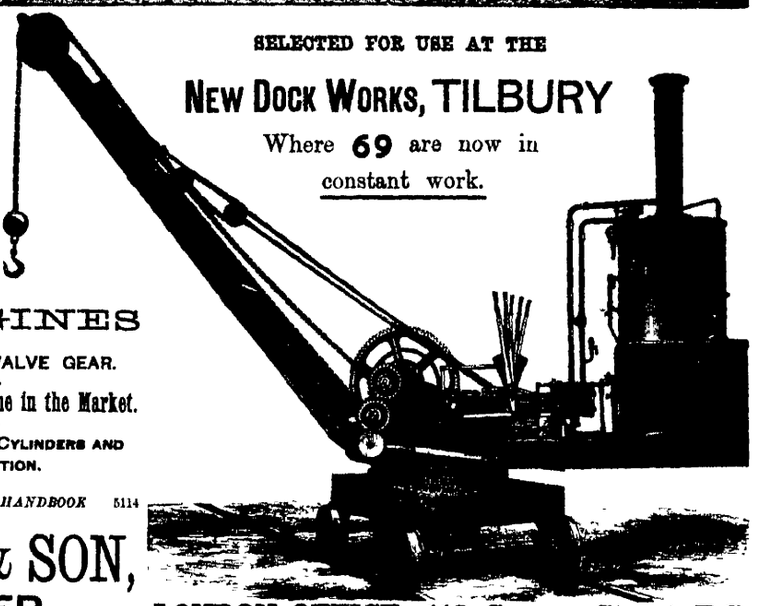
GOLD MEDAL, PARIS, 1878.

GAUGE GLASSES
AND
ENAMELS
For Iron, Cast-iron, Copper, &c.



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RED REFLECTING GAUGE GLASS,
Showing through the water a Broad Red Line.
N.B.—All Glasses are of the finest quality, and manufactured expressly to resist extreme pressure.
DEPÔT:
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LONDON, E.C.
The above line shown in black is of a rich Red. 5002
REPRESENTED BY
E. M. HAMBURGER.

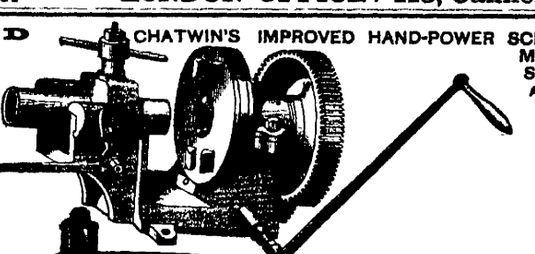
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SELECTED FOR USE AT THE
NEW DOCK WORKS, TILBURY
Where 69 are now in constant work.



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TRAVELLERS,
WINDING ENGINES,
HOISTS,
WINCHES,
—PUMPS,—
MILL ENGINES
FITTED WITH
COLLMANN'S PATENT VALVE GEAR.
Cheapest and Most Efficient Crane in the Market.
ALL OUR CRANES HAVE TWO CYLINDERS AND LINK REVERSING MOTION.
SEND FOR ILLUSTRATED HANDBOOK 5114
J. JESSOP & SON,
LEICESTER.
LONDON OFFICE: 113, Cannon Street, E.C.

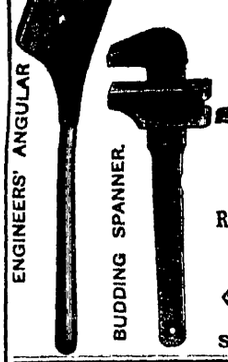
AWARDED
A
Gold & Silver Medal
AND
Two 1st Class Certificates at
Calcutta Exhibition, 1884.

CHATWIN'S IMPROVED HAND-POWER SCREWING MACHINE, SCREWING AT ONCE OVER.



PATTERN STOCKS AND DIES.

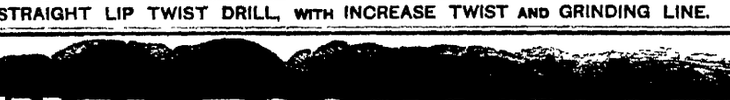








THOMAS CHATWIN,
GT. TINDAL STREET, BIRMINGHAM,
MANUFACTURER OF
STOCKS, DIES, AND TAPS,
PATENT HAND-POWER SCREWING MACHINES. TWIST DRILLS,
STANDARD CYLINDRICAL GAUGES, RIMERS,
CLYBURN, BUDDING, AND OTHER SPANNERS,
RATCHET BRACES, TUBE CUTTERS, TUBE WRENCHES, TUBE VICES,
And General Tools for Engineers, Gas Fitters, &c. 4824



STRAIGHT LIP TWIST DRILL, WITH INCREASE TWIST AND GRINDING LINE.

FUEL ECONOMISER
GREEN'S PATENT
Has been awarded the GOLD MEDAL at the CALCUTTA EXHIBITION, in addition to TWELVE MEDALS previously given at other Exhibitions. 5081
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BUTTERS BROS., Contractors' Engineers,

PERCY CRANE AND ENGINE WORKS, LAMBHILL STREET, PAISLEY ROAD,

MAKERS OF HENDERSON'S PATENT DERRICK CRANES, FROM 15 CWT. TO 30 TONS.

OFFICES: 93, HOPE STREET, GLASGOW.

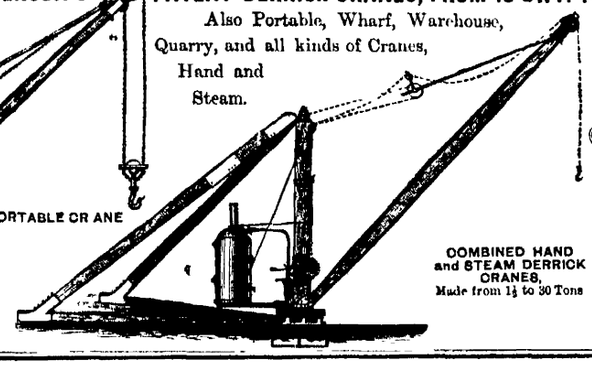
Also Portable, Wharf, Warehouse, Quarry, and all kinds of Cranes, Hand and Steam.

5068

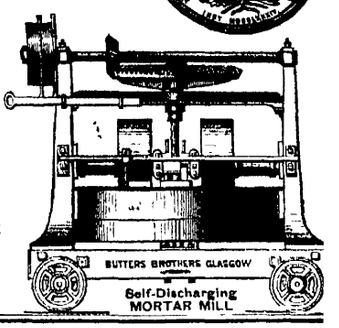
TESTIMONIALS ON APPLICATION.



Hand PORTABLE CRANE



COMBINED HAND and STEAM DERRICK CRANES, Made from 1½ to 30 Tons



Self-Discharging MORTAR MILL



Non-Compression Engine.

GAS ENGINES

FROM 1 MAN TO 100 HP.



Compression Engine.

ALL SIZES ABOVE 2 HP. SELF STARTING.

5136

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FEED-WATER HEATERS.



Feed-Water Heater.

JOHN HASTIE & CO., GREENOCK, SOLE MAKERS OF THESE HEATERS FOR SCOTLAND.

Sole Makers: BRITISH GAS ENGINE & ENGINEERING COMPANY, Limited, 11, Queen Victoria St., London, E.C

LIGHT FORGINGS.

BRAKE WORK.

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MAKERS OF IMPROVED STEAM ENGINES OF EVERY KIND, FROM 2½ TO 100 HI

PORTABLE
With Inside or Outside Cylinders

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With Inside or Outside Cylinders

—o—

VERTICAL with Cross-Tube Boilers.

—o:—

VERTICAL with Vertical Tubular Boilers.

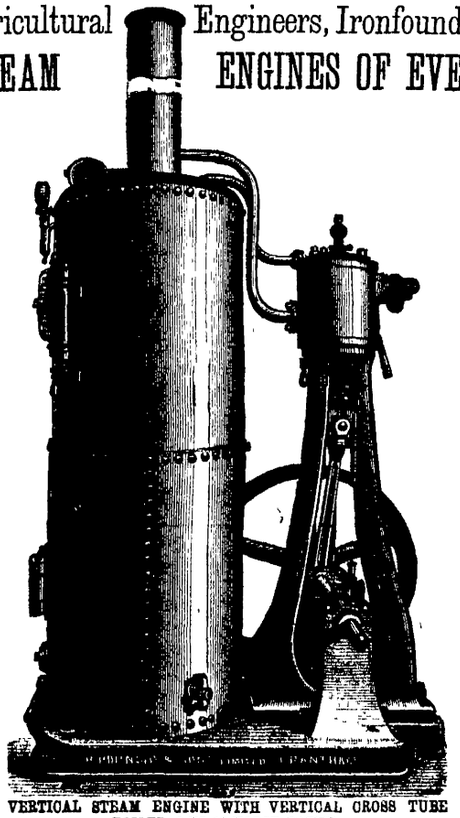
—o—

HORIZONTAL STATIONARY
Both Simple and Compound, with or without Condensers.

—.o.—

COMPOUND UNDERTYPE STATIONARY,
And with or without Condensers.

—:o:—



VERTICAL STEAM ENGINE WITH VERTICAL CROSS TUBE BOILER, 2 TO 12 HORSE POWER.

HORIZONTAL WINDING ENGINES
Both Direct acting and with Gearing

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Hornsby's Patent Automatic Expansion Gea
CAN BE FITTED TO MOST OF THEIR ENGINES

—o—

BOILERS:
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CORNISH, MULTITUBULAR,
VERTICAL, EGG-ENDED, &c. &c

The New Hornsby 1884 Twine Binder, winner of the First Prize of £100 of the R.A.S.E., and the First Prize of £100 of the Highland and Agricultural Society of Scotland (being the two largest prizes ever offered), besides other high class Awards

For Particulars of the most modern improved and successful Agricultural Machinery, including the R.A.S.L. First Prize Mowers, Reapers, Ploughs, Dressing Machines, Corn Screens, Turnip Cutters, Root Pulpers, &c., SEE ILLUSTRATED CATALOGUES in English, French, German, Spanish, Russian, &c., sent GRATIS and POST FREE on application

Plough Shares of Chilled Cast Iron, Wrought Iron Malleable Iron and Steel of Patterns to suit every Variety of Work, and made to Local Patterns if desired

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SPITTLEGATE IRON WORKS, GRANTHAM. 4965

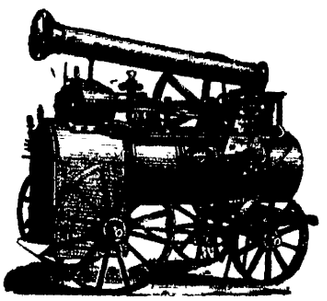
London Office: 84, LOMBARD STREET. Telephone No. 1294. South African Depot: EDINBURGH BUILDINGS, DOCK ROAD, CAPE TOWN

MARSHALL, SONS, & CO., LIMITED,

[TELEPHONE No. 6648.

BRITANNIA IRONWORKS, GAINSBOROUGH, AND MARSHALLS' BUILDINGS, 79, FARRINGDON ROAD, LONDON, E.C.

MANUFACTURERS OF PORTABLE, SEMI-PORTABLE, HORIZONTAL, FIXED, VERTICAL, AND TRACTION ENGINES, THRASHING, CORN GRINDING, SAWING AND TEA PREPARING MACHINERY.



PORTABLE ENGINES, 1½ TO 35 HORSE POWER,

Adapted for all Countries, and constructed to burn Coal, Wood, Straw, Vegetable Matter and Refuse as Fuel.

Also fitted with Patent AUTOMATIC EXPANSION VALVE GEAR, for ensuring Great Economy in Fuel and Regularity of Speed under varying loads when required.

CALCUTTA EXHIBITION, 1884—FIVE GOLD AND THREE SILVER MEDALS.
AMSTERDAM EXHIBITION, 1883 — THE DIPLOMA OF HONOUR.
ELECTRICAL EXHIBITION, CRYSTAL PALACE, 1882 — GOLD MEDAL.
MELBOURNE, 1881 — HIGHEST AWARD FOR ALL EXHIBITS; FIVE GOLD MEDALS.
SYDNEY EXHIBITION, 1880 — TWO SPECIAL AND FOUR FIRST PRIZES.
PARIS EXHIBITION, 1878—TWO GOLD MEDALS AND OTHER PRIZES.

Catalogues in English, French, German, Spanish or Russian Free on application. 3529

"ENGELBERT'S LUBRICATOR."

FOR CYLINDERS, VALVES, HEAVY BEARINGS, and SHAFTING.

Saves 40 per cent. over Tallow Lasts twice as long as Olive Oil.

A FIRST-CLASS ANTI-CORROSIVE LUBRICANT.

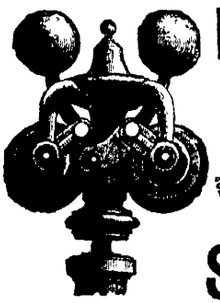
Price 3/9 per GALLON. Delivered free in United Kingdom.

ENGELBERT & Co.,

70 & 71, BISHOPSGATE STREET, LONDON.

Twelve Years in use See Testimonials.

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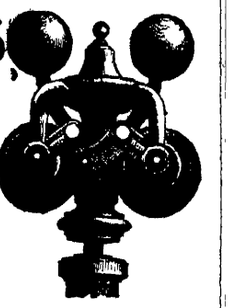
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GANDY v. REDDAWAY AND OTHERS.

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GANDY v. REDDAWAY & CO. and Others was dismissed as regards us, WITH COSTS TO BE PAID BY GANDY to

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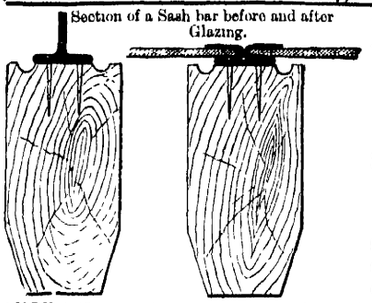
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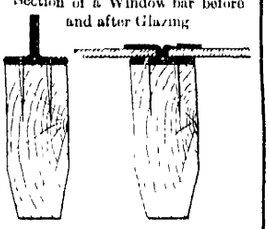


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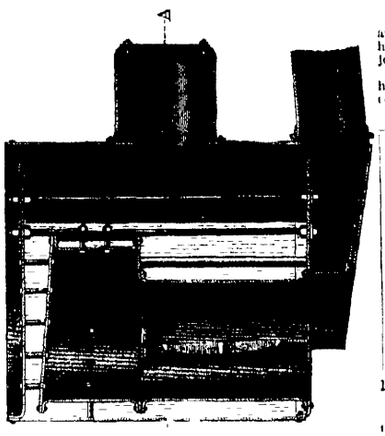
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80	5 6	7 6	3 0	2 3	225	90	£154
80	6 0	7 6	3 0	2 3	265	97	£174
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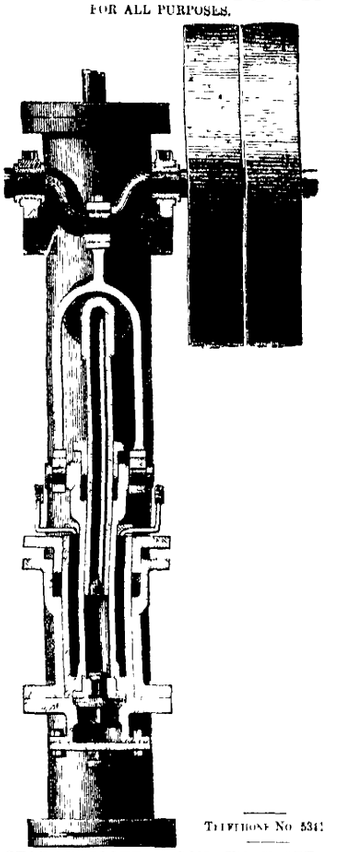
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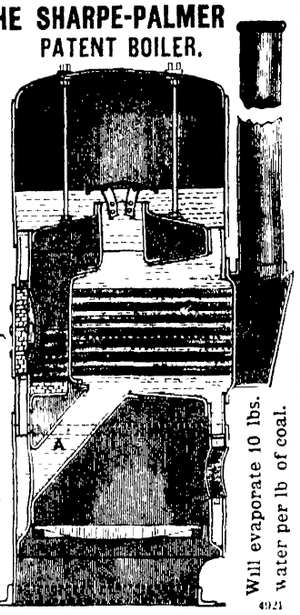
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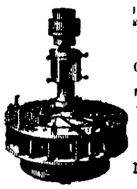
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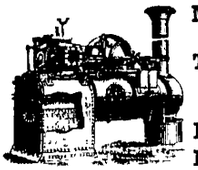
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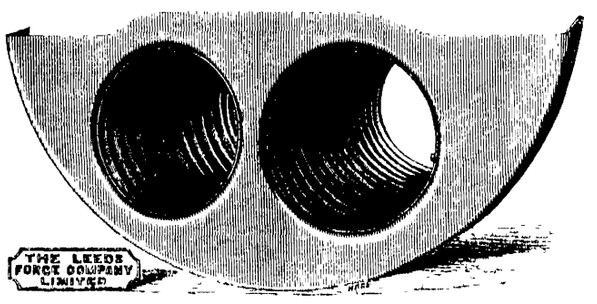
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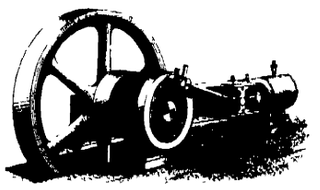
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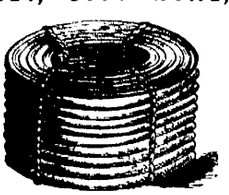
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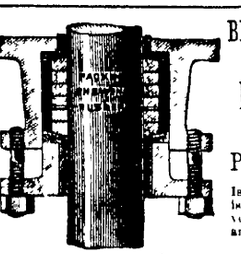


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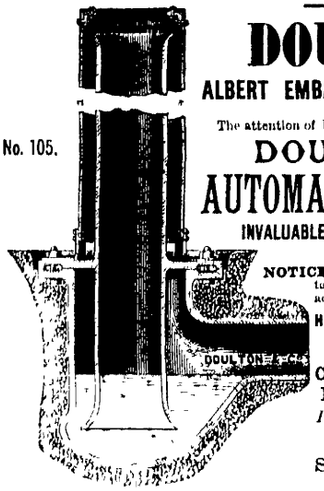
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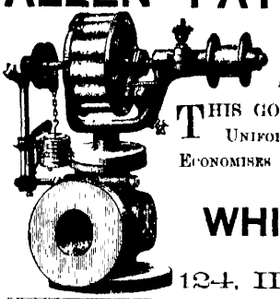
For further particulars of Appliances see List No 38, post free on application

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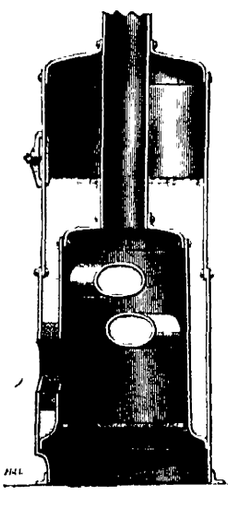
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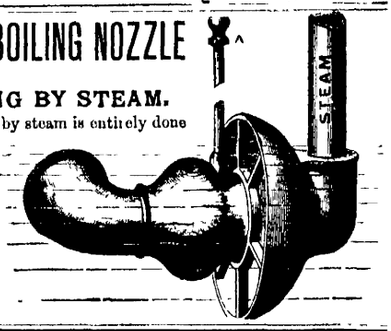
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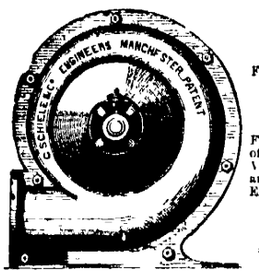
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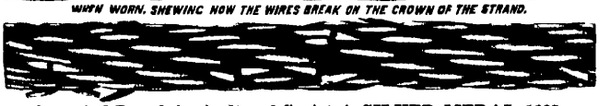


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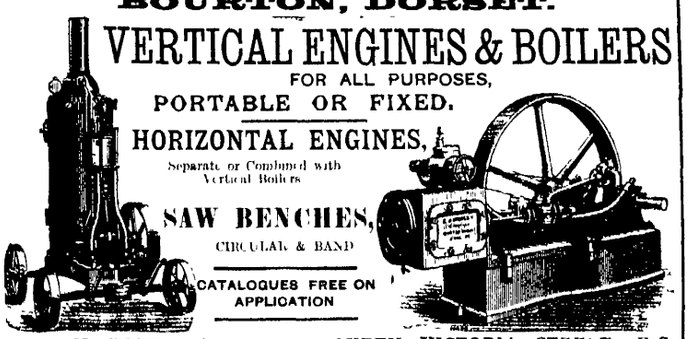
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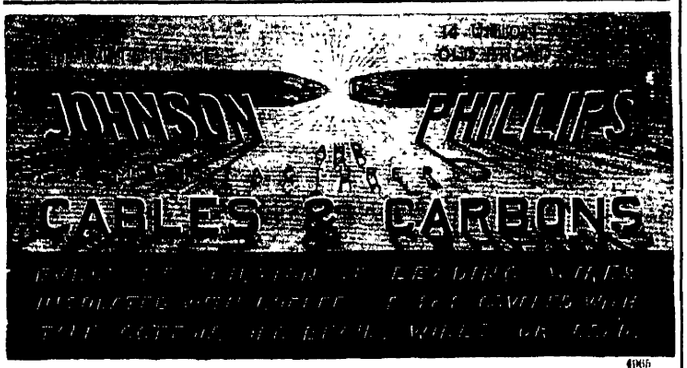
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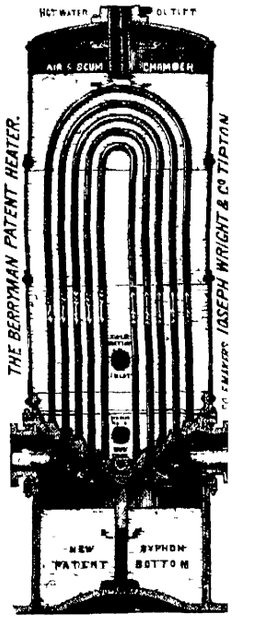
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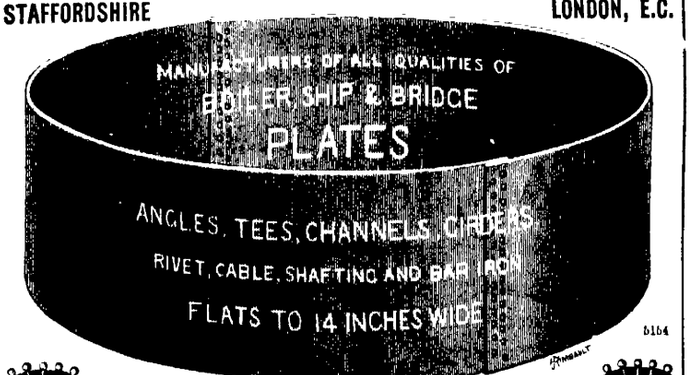
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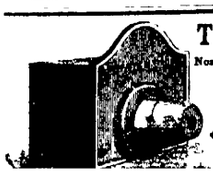
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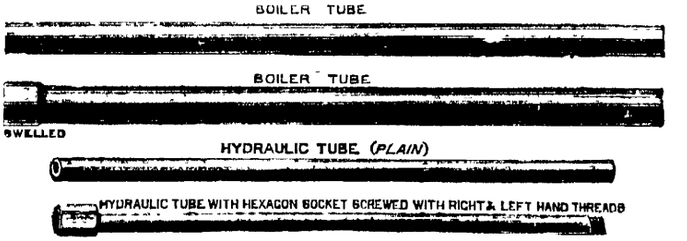
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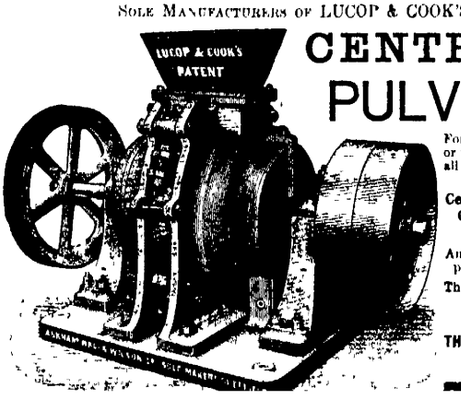
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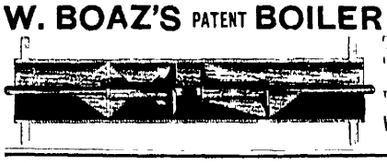
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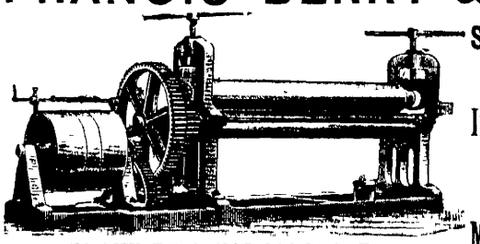


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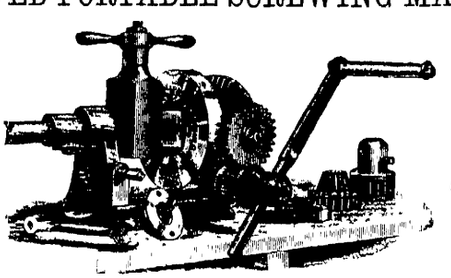
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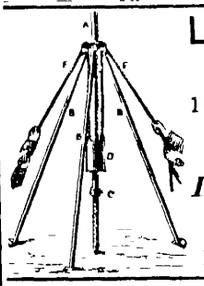
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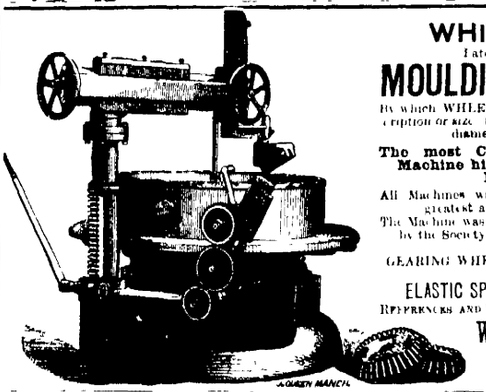
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For Bridge and Pier Building, &c., &c.



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Patent Self-contained

MOULDING MACHINE

By which WHEELS or PULLEYS of any description or size, from 2 in. to upwards of 14 ft. diameter may be made

The most Complete and Efficient Machine hitherto introduced to Engineers

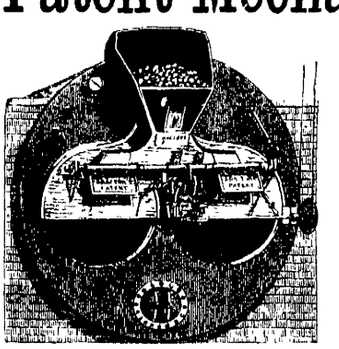
All Machines warranted to mould with the greatest accuracy and precision
The Machine was awarded the SILVER MEDAL by the Society for Promotion of Scientific Industry
GEARING WHEELS supplied to Consumers
MAKERS OF
ELASTIC SPIRAL SPRING PISTONS
REFERENCES AND TESTIMONIALS ON APPLICATION

Wm. Whittaker & Co.,
Engineers, Millwrights, Ironfounders &c. 5224
OLDHAM

Received PRIZE MEDAL at the Smoke Abatement Exhibition, South Kensington, London

PROCTOR'S

Patent Mechanical Stoker



BUFFER SPRINGS & BUFFERS ENTIRELY DISPENSED WITH.

WORKS NOISELESSLY.

Will apply the Stoker for Two Months upon approval

Over 1000 Boilers or 2000 Furnaces have been supplied with these Stokers.
Over 200 Machines now working on the Continent.

The Simplest, Cheapest, and most Efficient in the Market
Will guarantee to produce more Steam with less Coal than can be done by hand firing
No drilling of the Boiler to fix it: the bolts that hold the ordinary front are used to fix the Stoker

J. PROCTOR, PATENTEE & MAKER,
HAMMERTON IRON WORKS, BURNLEY, LANCASHIRE. 4887

The PATENT ANHYDROUS LEATHER Co., Portsmouth.

Contractors to H M Government

SOLE PATENTEES AND MANUFACTURERS OF

ANHYDROUS LEATHER AND COTTON BELTING. LEATHER HOSE, Perfectly Waterproof.

Main Driving Belts without Cross Joints, any width, and to transmit any required HP



Short Cut Strap Butts and Strapping for Home and Export.

WATERPROOF PUMP BUTTS, &C.

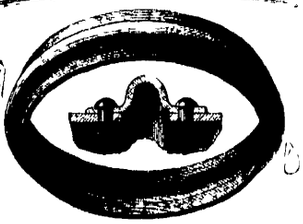
N B —All Waterproof Goods are stamped with our Registered Trade Mark, without which none are genuine

ESTABLISHED 1860

Prices and Testimonials Free 5078

ELECTRIC EXHIBITION —This Belting was at work at the Royal Aquarium, transmitting up to 130 HP.

Weldless Steel Expansion Hoops for Boiler Flues.



MANUFACTURED SOLELY BY

THE BOLTON IRON & STEEL Co LD

BOLTON, LANCASHIRE

4146

JOHN & JOSEPH HUGHES,

(Estab 1830), Dealers in Metals and Manufacturers of

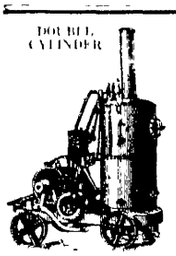


ALSO

CASTINGS IN BRASS, GUN-METAL, AND PHOSPHOR BRONZE,

Mill Brasses, Railway Wagon Brasses, &c. 4937

ALBION METAL WORKS, WOODCOCK STREET, BIRMINGHAM.



IMPROVED PORTABLE HOISTING ENGINES.

TESTIMONIAL

PORT ADELAIDE DOCK COMPANY, LIMITED, DUFFY STREET, PORT ADELAIDE, 21st September, 1881

DEAR SIR, I have much pleasure in certifying that the (5) Five No 7 Melville's Hoisting Engines which my Company bought from you some time ago are giving every satisfaction They are easily worked, and do a large amount of work at a minimum cost I can confidently recommend them for Wharf purposes

I am, yours faithfully, T A BROCK, Secretary

To W M MELVILLE, Esq Port Adelaide Dock Company, Limited

W. M. MELVILLE,

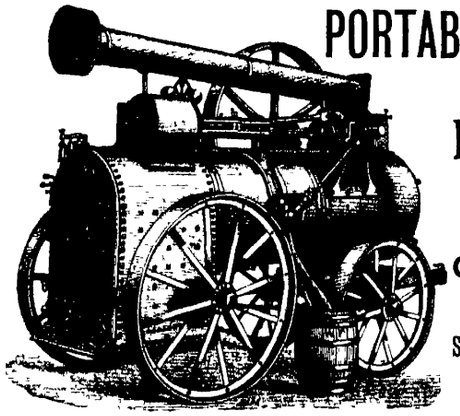
ENGINEER AND IRONFOUNDER, 4902

SINCLAIRTOWN FOUNDRY, KIRKCALDY.

WM. FOSTER AND CO.,

LIMITED,

WELLINGTON FOUNDRY, LINCOLN.



PORTABLE ENGINES,

HORIZONTAL & VERTICAL

FIXED ENGINES

Boilers of All Kinds.

THRASHING MACHINES.

CORN MILLS.

SAW BENCHES, &c.

SECOND-HAND ENGINES.

CATALOGUES & PARTICULARS ON APPLICATION 4448

CHARLES FRANCIS, SON & Co.



Bronze Medal, London, 1851
Gold Medal Havre, 1868
Highest Award Paris, 1878

CEMENT MANUFACTURERS,

WEST MEDINA MILLS, NEWPORT, ISLE OF WIGHT.

Offices:—17, Gracechurch St, London. (Established upwards of 60 years.

Portland Cement according to the Board of Works Test,

And extensively used in the construction of Spithead Forts and other large undertakings, both for the Home and nearly every Foreign Government.

Medina (or Improved Roman) Cement,

Particularly adapted for Hydraulic Purposes, more particularly where quick setting is required, such as the Breakwater at Alderney and the Digue at Cherbourg, where many thousand tons have been used

AGENTS
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CORK THOMPSON BROTHERS, 20, Winthrop Street,
BELFAST CLOTWORTHY & CO, 34, 36, and 42, Tomb Street.
SCOTLAND CURRIE & CO, 27, Wellington Street, Glasgow.
PLYMOUTH A G GILBEY, Vectis Stores, Sutton Road
PARIS W F RICHARDS, 5, Rue Santonil
BORDEAUX J L BOYSON, 87, Rue Saint-Remal 4906

THE STAR RUBBER COMPANY,

WAREHOUSES	STORES	MILLS	Telephone No "157"
106 & 108, Reade Street, NEW YORK, 157 & 159, Franklin St, BOSTON	102, West Regent Lane, GLASGOW	TRENTON, N J, U S A	Telegraphic Address "STAR," GLASGOW







THE OLDEST AND LARGEST MANUFACTURERS IN THE UNITED STATES,

BEG TO INTIMATE THAT THEY HAVE OPENED AN ESTABLISHMENT AT

131, WEST REGENT STREET,

as Headquarters for Europe and the Continent, where there will be always a Stock of Goods suitable for the different trades We beg to call your attention to the Price List, which will be forwarded on application, and should you do us the favour of comparing our Prices and quality of Goods with other Companies, we are thoroughly confident that, by giving us a small Sample Order, you will be convinced of the HIGH STANDING OF THE STAR RUBBER COMPANY, of which our guarantee in Price List speaks for itself We would call your special attention to the Medals which we obtained at the last Melbourne Exhibition for the superior qualities of our Belting and Hose 5117

GLASGOW, 1884

THE "LANCASTER"

THE Speciality of the 'Lancaster' Steam Trap consists in the LOOSE DISC VALVE at the orifice of the discharge pipe in connection with a QUICK THREAD SCREW motion worked by the float. This Valve is FRICTIONLESS in action and being loose CANNOT STICK to its seat It is very prompt in its movements for opening and closing, the discharge pipe and the working parts are VERY SIMPLE and EASILY EXAMINED It also acts as a Safety Valve as any excessive pressure is entirely against the face of the loose disc valve would by virtue of the QUICKNESS OF THE SCREW THREAD force it open Three (3) Steam Traps were employed for draining the steam pipes with which I heated Messrs A HAUKE & Co's Fossil Meal Composition at the recent Engineering and Metal Trades Exhibition at the Agricultural Hall London They acted with REGULARITY and EFFICIENCY, one of the traps being specially put to a severe test in draining the DIRTY WATER collected by the Steam Filtering apparatus attached to the steam Supply Pipes Three other Traps of the same construction were connected with SPRING GEAR in different parts of the Hall and they as well as the Steam Traps of Messrs Hacke's Stand were in motion UNINTERRUPTEDLY during the whole time of the Exhibition and gave ENTIRE SATISFACTION (Signed)

D. K. CLARKE, M.I.C.E.

LANCASTER AND TONGE, 4335

Engineers and Brassfounders. **PENDLETON**, near **MANCHESTER**, Patentees and Sole Makers

THE GENUINE AMERICAN



TWIST DRILLS.

SELIG, SONNENTHAL & Co.,

SOLE AGENTS FOR

The Genuine American "Cleveland" Twist Drills, Whiton's Lathe and Drill Chucks, "Tanite" Solid Emery Wheels and Grinders, Shaped Diamonds for truing Chilled Iron Rolls, &c, Christoffel's Patent Elliptic Boiler Tube Scrapers, Silver & Deming's celebrated Pumps, Wiley's unrivalled "Lightning" Screwing Machines, Screw Plates and Drilling Machines 5372

85, QUEEN VICTORIA STREET, and LAMBETH HILL, LONDON, E.C.

A Large Assortment of the best American and other Tools and Machinery always kept in Stock

HANSON'S SPECIALITIES

Steam Pumps, Steam Engines, Steam Winches, Steam Dryers, Steam Traps, Steam Reducing Valves, Steam Purifying Apparatus for Boilers, Water Engines and Hoists for Warehouses.

WILLIAM HANSON,

QUEBEC WORKS, BRADFORD.

LONDON OFFICE: 37, WALBROOK. 5270

(See Illustrated Advertisement October 10th, page 9)

15 PRIZE MEDALS.] **THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED,** [15 PRIZE MEDALS.

4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 3. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1882, 1



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS GLENBOIG, GLENBOIG STAR, and CUMBERNAULD 4794

100 TO 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

Crossley's Patent TWIN-ENGINES. Impulse every revolution. The steadiest running Gas Engine yet made

THE "OTTO" GOLD MEDAL at Crystal Palace & HIGHEST AWARD at Paris Electrical Exhibitions



New Patent SELF-STARTER. Best, Safest, and Simplest made may now be applied

CROSSLEY'S NEW VERTICAL ENGINE. Requiring little floor space

½ TO 100 HP. IND. MANY IMPROVEMENTS. OVER 15,000 IN USE.

LONDON: 24, POULTRY, E.C. GAS ENGINE GLASGOW: 58, UNION STREET 4776

CHEAP GAS FOR MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·3 lb. per ind. H. P. per hour.

The DOWSON ECONOMIC GAS COMPANY, Ltd., 3, Gt. Queen St., Westminster, S.W. 4883

JESSOP'S CRANES

For Particulars see last Week's "ENGINEERING," or WRITE FOR HANDBOOK.

J. JESSOP & SON, LEICESTER. 5113

Or 113, CANNON STREET, LONDON

Engineers, Machinists, **TAYLOR & CHALLEN, BIRMINGHAM,** Founders, and Smiths,

Makers of MACHINERY for the PRODUCTION of

TUBES, BOLTS AND NUTS

COINS, GUNPOWDER, SMALL ARMS, CARTRIDGES.

MAKERS OF STEAM ENGINES. *SHAFTING—Patent and other Shaft Fittings.* CAST IRON PULLEYS, &c

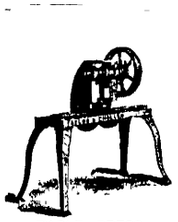
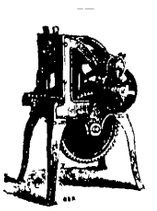


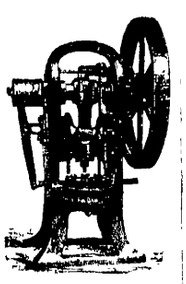
TABLE PRESS



HORIZONTAL PRESS.



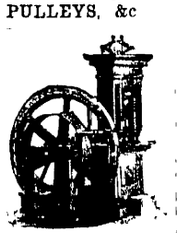
EXTENDING PRESS



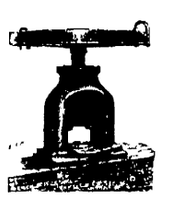
HEADING PRESS



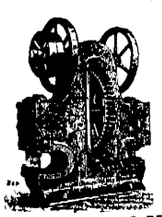
PRESS WITH TURNTABLE



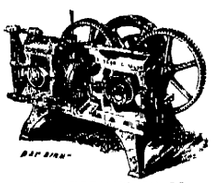
COINING PRESS



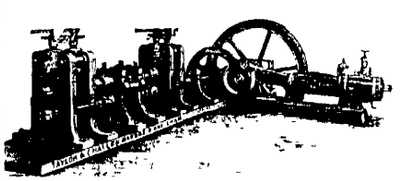
PRESS to STRIKE MEDALS and SINK DIES



PUNCHING & SHEARING PRESS



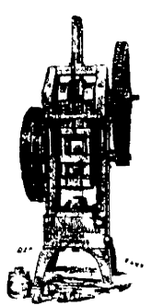
NUT FORGING PRESS

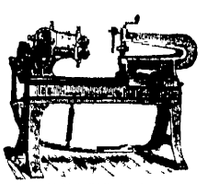


METAL ROLLING MILL AND ENGINE



DISC SHEARS.

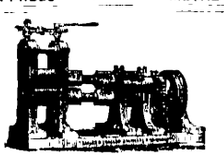




DISC SHEARS



ROLLING MILL with Wedge Adjustment.



ROLLING MILL with Screw Adjustment.



TRIMMING LATHE

4181 DRAWING PRESS

PATERSON & COOPER,

ELECTRIC LIGHT ENGINEERS AND CONTRACTORS,

76, LITTLE BRITAIN, LONDON. Steam Factory: POWNALL ROAD, DALSTON.

Complete Sets of Electric Lighting Machinery and Fittings for Lighting Hotels, Public Buildings, Factories, Mills, Ships, &c., &c.

ESTIMATES FOR INSTALLATIONS FREE OF CHARGE. EXPERIENCED MEN SENT TO ALL PARTS OF THE COUNTRY.

Licensees of the "Clarke and Bowman" Arc Lamp, and of Joel's Storage Batteries.

PATERSON & COOPER'S DIRECT CURRENT "PHŒNIX" DYNAMOS.

No 1	—For	16	20 candle-power	Lamps,	or	2	Small Arcs,	or	1	Large Arc	£36
No. 2	— „	30	„	„	„	3	„	„	2	„ „	54
No. 3.	— „	75	„	„	„	7	„	„	4	„ „	80
No. 4	— „	120	„	„	„	12	„	„	7	„ „	120
No. 5.	— „	200	„	„	„	24	„	„	14	„ „	180
No. 6.	— „	300	„	„	„			..		...	250
No. 7	— „	500	„	„	„						400

4006

Awarded a First-Class CERTIFICATE OF MERIT at Manchester, and a First-Class DIPLOMA OF MERIT at Tynemouth.

PATENT DIAGONAL ROCKING FIRE-BARS

—(Can be Fixed in a Few Hours.)— ARE ECONOMICAL, DURABLE, SMOKE-CONSUMING. —(No Attachment to Boiler necessary.)—

Numerous Official Tests show an average economy of over 10 per cent *These Patent Bars last Years where ordinary Bars last only Months.*

Recently supplied to the order of the eminent builders of the engines and boilers of the most powerful Ironclad afloat for use in the whole of the furnaces, to work with "Forced Draught," MAKING THE THIRD Ironclad fitted Used by the most eminent Engine and Boilermakers (Marine and Land), Railways, Home and Foreign Governments, &c. 5119

Agents having connections among Steam Users Required in Principal Towns. — Particulars of the Manager at the Offices, 259, Gresham House, E.C.

REGISTERED TRADE MARK

'PHOSPHOR BRONZE'

The Best and Most Durable Metal for Bearings and Bushes of every Description; Hydraulic Pumps, Pinions, Valves, &c &c Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c.

SOLE MANUFACTURERS UNDER SEVERAL PATENTS- 1475

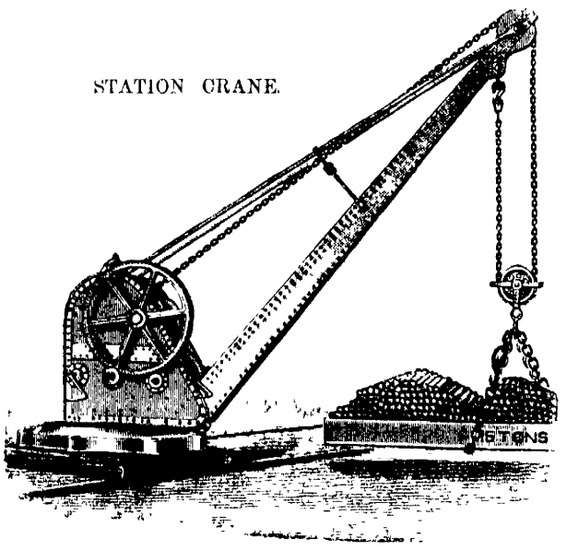
The PHOSPHOR BRONZE COMPANY, Limited, Sumner & Emerson Streets, Southwark, London, S.E.

COWANS, SHELDON & CO., LTD.,

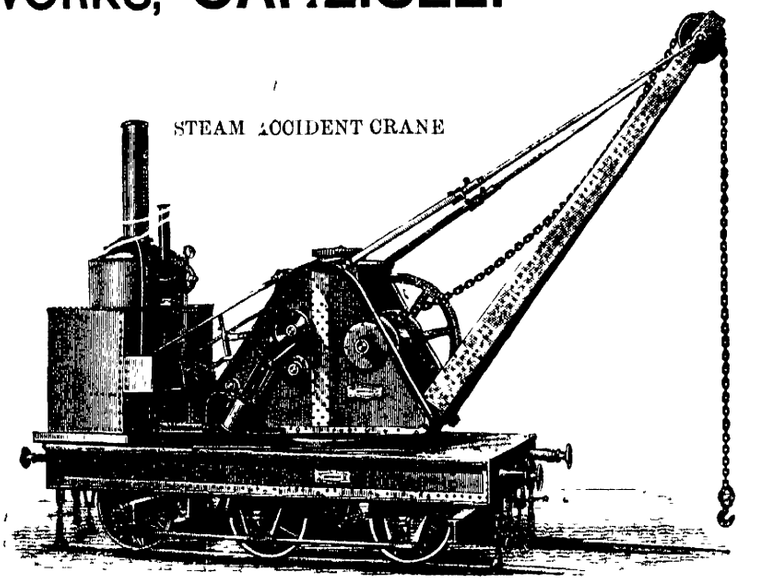
ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.

STATION CRANE.



STEAM ACCIDENT CRANE



TURNTABLES, CRANES, MASTING SHEERS, AND TRAVERSERS OF EVERY DESCRIPTION BY STEAM, HAND, OR HYDRAULIC POWER.

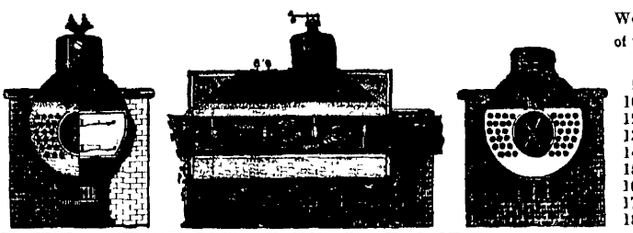
5007

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4 Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breeze, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.

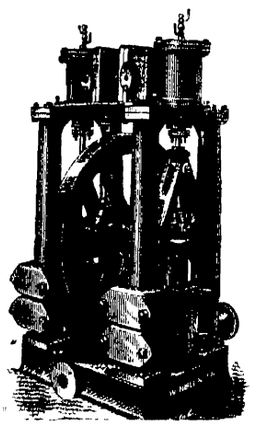


We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft.	long,	5ft. 0in.	diameter,	20	horse power.
10ft.	,,	5ft. 6in.	,,	30	,,
12ft.	,,	6ft. 0in.	,,	40	,,
13ft.	,,	6ft. 6in.	,,	50	,,
14ft.	,,	7ft. 0in.	,,	60	,,
15ft.	,,	7ft 6in.	,,	70	,,
16ft.	,,	8ft. 0in.	,,	80	,,
17ft.	,,	8ft. 0in	,,	90	,,
18ft.	,,	8ft. 0in.	,,	100	,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140



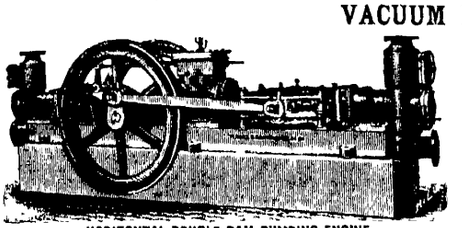
DOUBLE RAM PILLAR PUMPING ENGINE.

W. NEILL & SON,

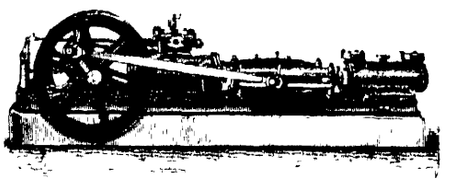
ENGINEERS, IRON & BRASS FOUNDERS, BOILER MAKERS, &c.

MANUFACTURERS OF

PUMPING ENGINES, BLOWING ENGINES, STEAM ENGINES, AIR COMPRESSORS, and VACUUM PUMPS.

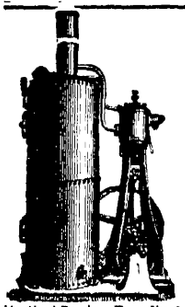


HORIZONTAL DOUBLE RAM PUMPING ENGINE.

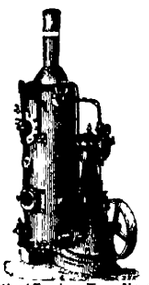


BLOWING ENGINE AND AIR COMPRESSOR. 4253

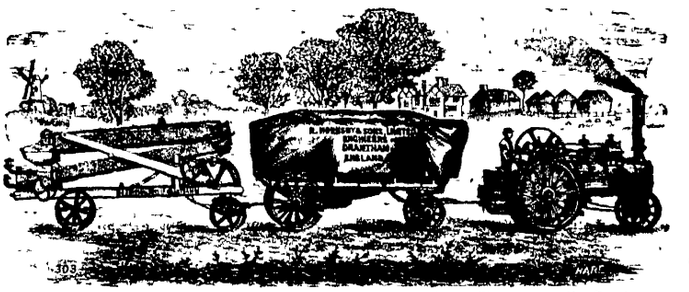
BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.



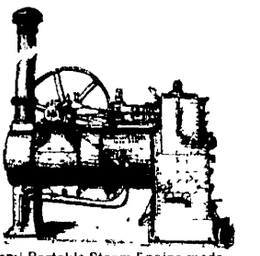
Vertical Engine, Type No 1, with Vertical Cross Tube Boiler, 2½ to 12 HP



Vertical Engine, Type No 2, with Vertical Multitubular Boiler, 1 to 3 Horse Power



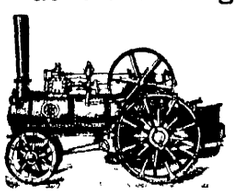
Traction Engine with Finishing Thrashing Machine and Straw Elevator on the Road



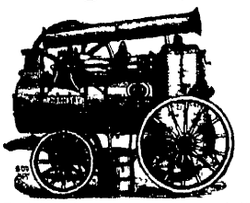
Semi Portable Steam Engine made with Single or Double Cylinders, 2½ to 35 Horse Power

R. HORNSBY & SONS, Limited,

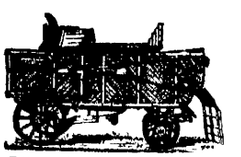
General and Agricultural Engineers, Ironfounders, Boilermakers,&c.



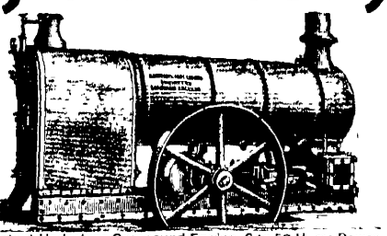
Improved Narrow Gauge Traction Engine, or Agricultural Locomotive



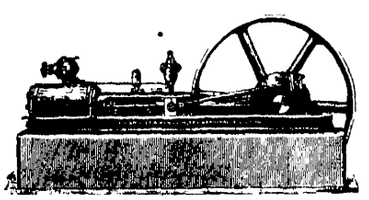
Patent Portable Steam Engine, made with Single or Double Cylinders, and from 2½ to 35-HP



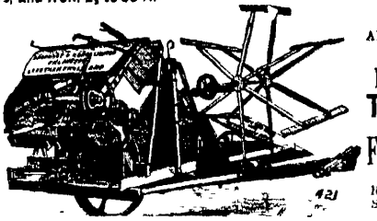
Patent Thrashing, Shaking, and Finishing Dressing Machine



Patent Undertype Compound Engine 6 to 50 H rse Power with Boiler above (as shown) or separate from the Engine, as desired



Fixed Horizontal Steam Engine, 10 to 60 Horse Power, with New Patent Automatic Expansion Gear

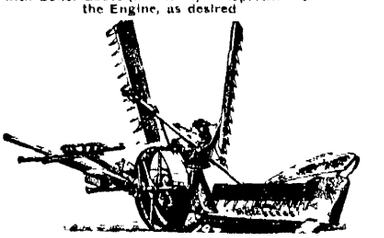


Highland Society's £100 First Prize String Sheaf-Binding Harvester

ALL PREVIOUS AWARDS ECLIPSED!!!

Hornsby's New 1884 TWINE BINDER

HAS BEEN AWARDED THE First Prize of £100 BY THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND



R A S.E First Prize Mowers and Reapers

For particulars of the most modern improved and successful Agricultural Machinery, Ploughs, Drowing Machines Corn Screens, Turnip Cutters, Root Pulpers, &c, SEE ILLUSTRATED CATALOGUES in English, French German, Spanish, Russian, &c, sent GRATIS and POST FREE on application

PLOUGH SHARES OF CAST IRON, CHILLED, WROUGHT IRON, MALLEABLE IRON AND STEEL, OF PATTERNS TO SUIT EVERY VARIETY OF WORK

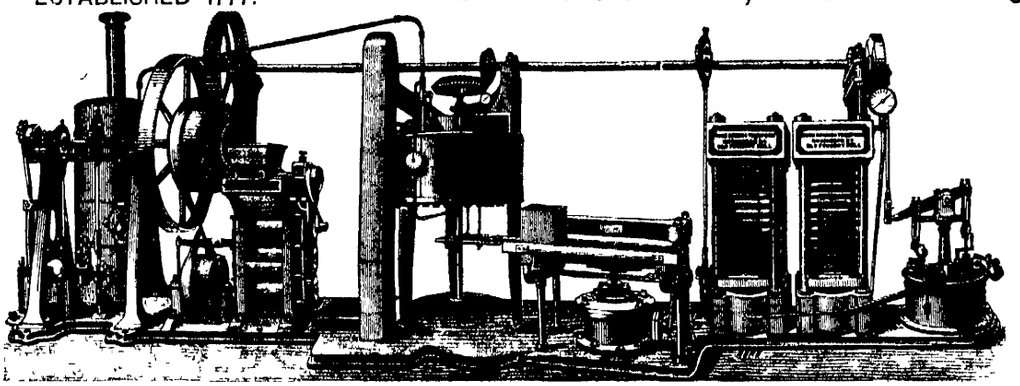
At the most important Exhibitions and trials since 1874, R. HORNSBY & SONS' Specialities have gained 565 PRIZES, including 69 Gold Medals, 126 Silver Medals, and 323 FIRST PRIZES.

SPITTLEGATE IRON WORKS, GRANTHAM. 4805

Telephone No. 1904 South African Depot: EDINBURGH BUILDINGS DOCK ROAD CAPE TOWN

ROSE, DOWNS & THOMPSON

ESTABLISHED 1777. OLD FOUNDRY, HULL. GOLD MEDAL, CALCUTTA.



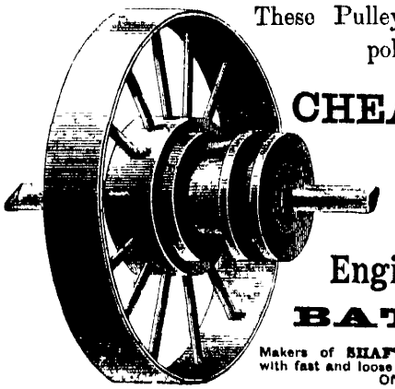
MAKERS OF THE
ANGLO-AMERICAN
OIL-MILL MACHINERY

For crushing Linseed, Cotton Seed, Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent in labour and power, and 2 to 4 per cent in Oil.
(See *Engineer*, May 6, 1881, and Nov 23, 1883.)

300,000 TONS OF OIL SEEDS,
PER ANNUM,
Are Crushed by Mills made on this system by us 5127

CATALOGUES FREE.

TURNED WROUGHT IRON PULLEYS.

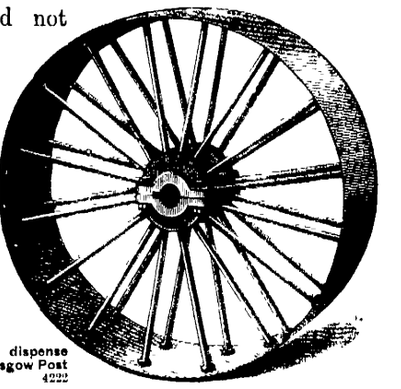


These Pulleys are **TURNED IN A LATHE,** and not polished on a Grindstone like those generally sold.

CHEAP, STRONG, AND TRUE.

Illustrated Circular Post Free.

J. BAGSHAW & SONS,
Engineers, Ironfounders & Millwrights,
BATLEY, YORKSHIRE,



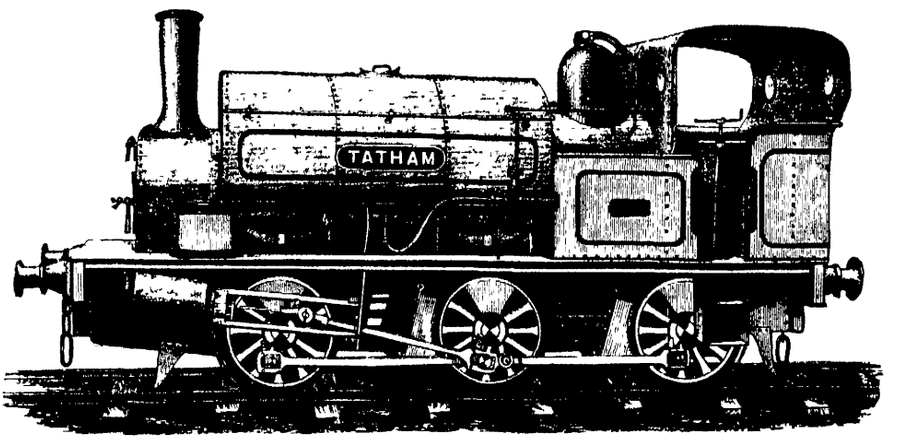
Makers of **SHAFTING** and **FRICTION PULLEYS** for Electric Lighting Machinery, which dispense with fast and loose Pulleys one Pulley answers for both In use at L & S W Railway, Nine Elms, Glasgow Post Office, King's Cross Station, and all principal Factories home and abroad 4222

ESTABLISHED 1860.

HUDSWELL, CLARKE & Co.,

RAILWAY FOUNDRY, LEEDS.

PRICES and SPECIFICATIONS on Application.



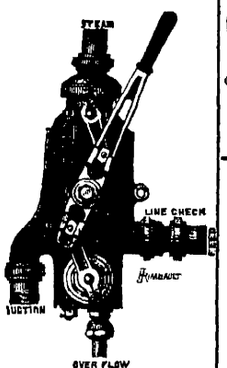
FOR CASH or DEFERRED PAYMENTS.

LOCOMOTIVE TANK ENGINES

OF ALL SIZES AND TO SUIT ANY GAUGE OF RAILWAY, 4925

For Main Line or Branch Railways, Contractors, Ironworks, Collieries, &c.

CLASS A.



LOCO. PATTERN, SINGLE LEVER.

THE HANCOCK

INSPIRATOR

ONLY GOLD MEDAL Paris, 1878

FIRST AWARD, Sydney, 1879

60,000 IN USE.

THE DONKEY PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND RELIABLY.

No Adjustment.

Draws Water at 140°.

All Sizes lift water 25 ft.

Delivers to Boiler up to 212°.

ESTIMATES FOR FIXING COMPLETE with Guarantee to start in good working order, and all information on application to—



Exhausts Air. Lifts Water 25 ft. Ejects 18 ft.

Feeds through Heaters.

Can be used as a Pump only.

No Valves or Wearing Parts.

Can be examined instantly.

THE HANCOCK INSPIRATOR CO., 108, Upper Thames St., London, E.C.

CLASS O.



STATIONARY PATTERN.

5115

Henry Bessemer and Co., Limited,

Manufacturers of Cast Steel,

SHEFFIELD.

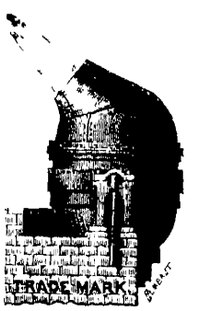
FORGINGS

In Steel of any size—Quotations given either for uses or finished complete.

STEEL CASTINGS

Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0·30 per cent carbon, and to bear a tensile strain of 34 tons to the square inch.

TYRES AND AXLES.



SOFT CAST STEEL

In bars and rods, for general use in Engineering Works.

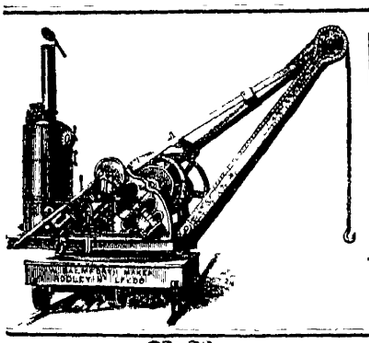
BLOOMS, BILLETS, & SLABS

Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,

Of superior quality.

2197



EXORS. OF WM. BALMFORTH,

RODLEY, NEAR LEEDS,

MANUFACTURERS OF

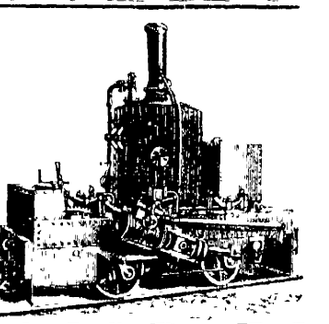
LOCO. STEAM CRANES, CONTRACTORS' LOCOS.,

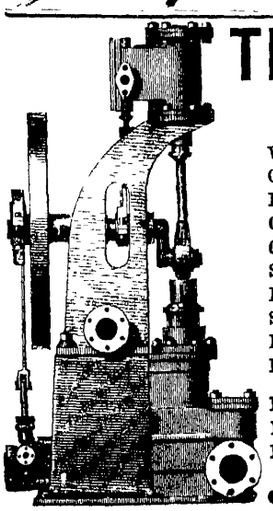
TRAVELLERS, HOISTS,

AND ALL KINDS OF LIFTING MACHINERY.

4097

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes.





THE COALBROOKDALE CO., LTD.

MAKERS OF DIRECT-ACTING AND OTHER

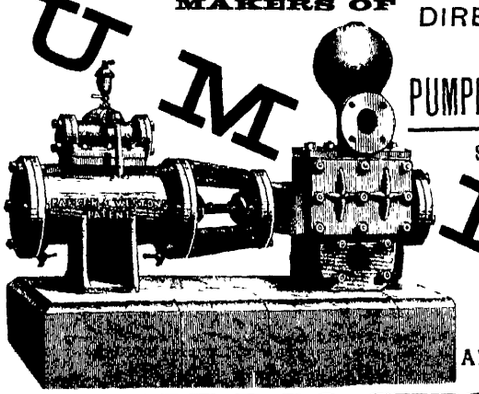
PUMPING MACHINERY

SIMPLE & COMPOUND

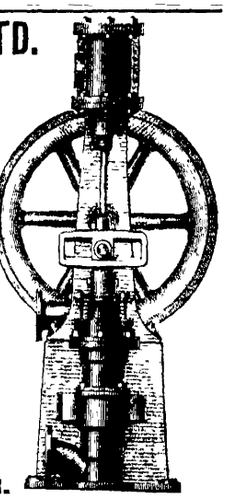
PUMPS

FOR
WATERWORKS.
COLLIERIES.
BREWERIES.
QUARRIES
CHEMICAL WORKS
SEWAGE WORKS.
POTTERIES
STEAM SHIPS.
IRRIGATIONS
DRAINAGE

BOILER FEEDERS.
FIRE ENGINES.
HYDRAULIC PUMPS



FOR ALL PURPOSES.



5130

COALBROOKDALE, R.S.O., SHROPSHIRE.

DICK, KERR & CO., Engineers and Contractors, (Five Medals awarded, Calcutta International Exhibition, 1883-4.)



SOLE MANUFACTURERS OF

KERR'S PATENT

PORTABLE

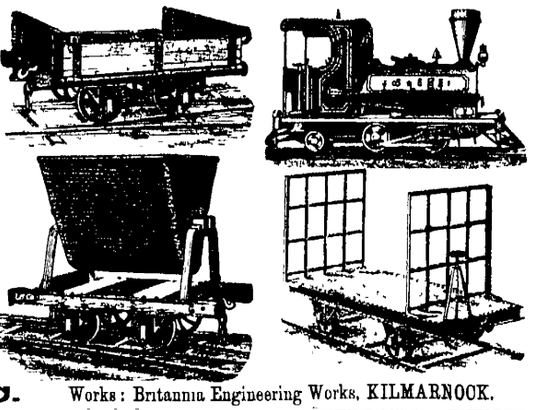
RAILWAY

SUITABLE FOR MINES AND PLANTATIONS

WAGONS & LOCOMOTIVES

FOR ALL CLASSES OF WORK

Catalogues and Prices on application 6024



101, LEADENHALL ST., LONDON, E.C. Works: Britannia Engineering Works, KILMARNOCK.

MANLOVE, ALLIOTT, FRYER & CO.,

ENGINEERS, BOILER MAKERS, IRON AND BRASS FOUNDERS, COPPERSMITHS, &c.

Works—NOTTINGHAM & ROUEN. London Offices—50, QUEEN VICTORIA STREET, E.C.

SOLE MAKERS OF

HALPIN'S Patent COMPOUND STEAM ENGINE,

(Patented by DRUITT HALPIN, C.E., 9, Victoria Chambers, Westminster, from whom information may be obtained.)

This Engine has given the most economical results yet recorded.

HIGH PRESSURE AND CONDENSING ENGINES of ordinary construction,

STEAM BOILERS—Lancashire, Cornish, Galloway, Multitubular, Compound, Vertical, &c.

Centrifugal Machines or Hydro Extractors of all Constructions for Sugar, Cloth, Wool, Chemicals, &c.

NUSSEY AND LEACHMAN'S PATENT CONTINUOUS CLOTH PRESSING MACHINE.

SUGAR MACHINERY. LAUNDRY MACHINERY.

MACHINERY AND APPARATUS FOR TREATMENT OF TOWNS REFUSE.

WATER WHEELS, SHAFTING, GEARING, AND ALL KINDS OF ENGINEERING AND MILLWRIGHT WORK

THE EXHAUST INJECTOR for feeding Steam Boilers, ensures Economy of Fuel, Economy of Water, increased Steaming Power of Boiler

SEE FUTURE ADVERTISEMENTS 5076

POINTS & CROSSINGS

FROM EVERY SECTION OF RAIL.

Portable Railways, and General Railway Plant.

HARTLEY & ARNOUX BROS.

CALIFORNIA STOKE-ON-TRENT. WORKS. MR STEPHEN HUMBLE, LONDON, S.W. 5 WESTMINSTER CHAMBERS

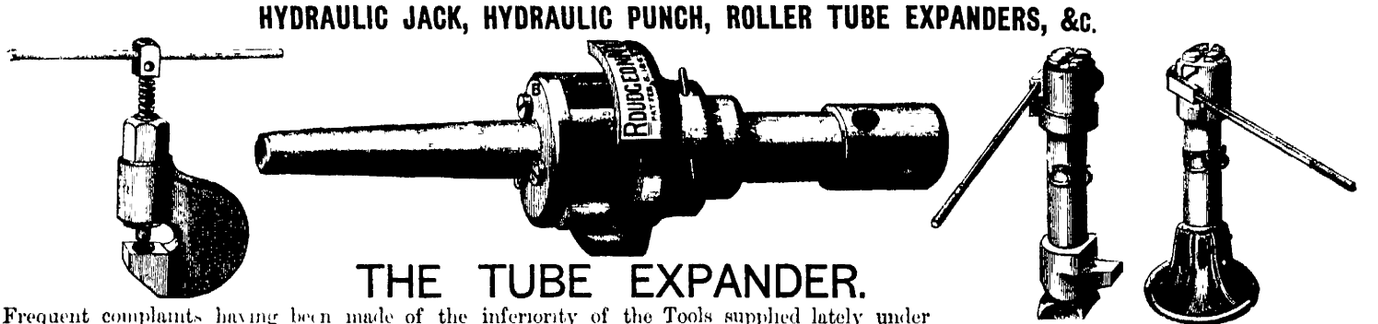
4408

RICHARD DUDGEON,

114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF HIS

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, &c.



THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "DUDGEON'S ROLLER TUBE EXPANDERS," R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only are stamped as under:—

R. DUDGEON, N.Y., Patd Feb 5th, 1867, on the Guide-ring of each Tool, WITHOUT WHICH NONE ARE GENUINE.

These can always be obtained at R. Dudgeon's English Depôt, 114, Fenchurch Street. If more convenient to get them through Merchants care should be taken to specify "*Dudgeon's own make*" *on the Order*, but as R. Dudgeon observes with regret that *imitations* bearing his *stamp counterfeited* are being sold as his, he would respectfully recommend both Merchants and Users requiring Expanders of his make to apply direct. In urging this he merely seeks to secure the identity of what is made by himself, by which he is content to stand or fall.

R. Dudgeon takes this opportunity of returning thanks for past favors, either by orders or recommendation, and it being his intention strictly to maintain the Quality and Workmanship so essential for such a Tool as the Expander, begs to solicit a continuance of the same. 3240

CATALOGUES AND PRICE LISTS ON APPLICATION TO R. DUDGEON, 114, FENCHURCH STREET, LONDON, E.C.

FIRST PRIZE MEDAL

(SILVER) AWARDED TO

BOYLE'S SYSTEM OF VENTILATION

And BOYLE'S PATENT SELF-ACTING AIR-PUMP VENTILATORS,

Art and Sanitary Exhibition, Eastbourne, October 3rd, 1884,

BEING THE ONLY AWARD GIVEN FOR VENTILATORS OR SANITARY APPLIANCES.

LATEST AWARDS

HIGHEST AND ONLY PRIZE (SILVER MEDAL) AWARDED TO VENTILATORS, INTERNATIONAL EXHIBITION, LONDON, SEPTEMBER, 1884

GOLD MEDAL (ONLY PRIZE OFFERED) OPEN VENTILATION COMPETITION, BIRKENHEAD, JUNE 1884

FIRST PRIZE (SILVER MEDAL), MINING INSTITUTE, CORNWALL, SEPTEMBER, 1883

FIRST PRIZE MEDAL, CORK INTERNATIONAL EXHIBITION, CORK, SEPTEMBER, 1883

HIGHEST AND ONLY PRIZE AWARDED TO EXHAUST VENTILATORS, HYGIENIC EXHIBITION, LONDON, JUNE, 1883

FIRST PRIZE (SILVER MEDAL), NORTH EAST COAST EXHIBITION, TYNEMOUTH, OCTOBER, 1882

GOLD MEDAL (HIGHEST PRIZE), INTERNATIONAL EXHIBITION OF MEANS AND APPLIANCES FOR THE PROTECTION AND PRESERVATION OF HUMAN LIFE, LONDON, JULY, 1882

£40 PRIZE (ONLY PRIZE OFFERED), INTERNATIONAL VENTILATION COMPETITION, LONDON, MAY, 1882

SILVER MEDAL (HIGHEST PRIZE) EASTBOURNE SANITARY EXHIBITION, AUGUST, 1881

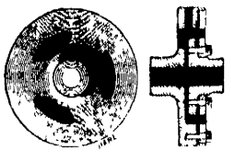
FIRST PRIZE (ONLY ONE AWARDED to ROOF VENTILATORS INTERNATIONAL MEDICAL AND SANITARY EXHIBITION, LONDON, JULY AND AUGUST, 1881

'Since these excellent Ventilators have been introduced, we have now got Perfect Method of Ventilation'—Dr. B. W. RICHARDSON, F.R.S.

ROBERT BOYLE & SON, 64, Holborn Viaduct, London,

AND 110, BOTHWELL STREET, GLASGOW.

BROTHERHOOD'S PATENT



FLEXIBLE COUPLING

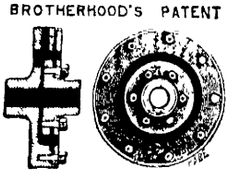
PETER BROTHERHOOD,

MECHANICAL ENGINEER,

BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.

IMPROVED PATENT 3-CYLINDER ENGINE.

BROTHERHOOD'S PATENT



FLEXIBLE COUPLING

THE MOST

ECONOMICAL

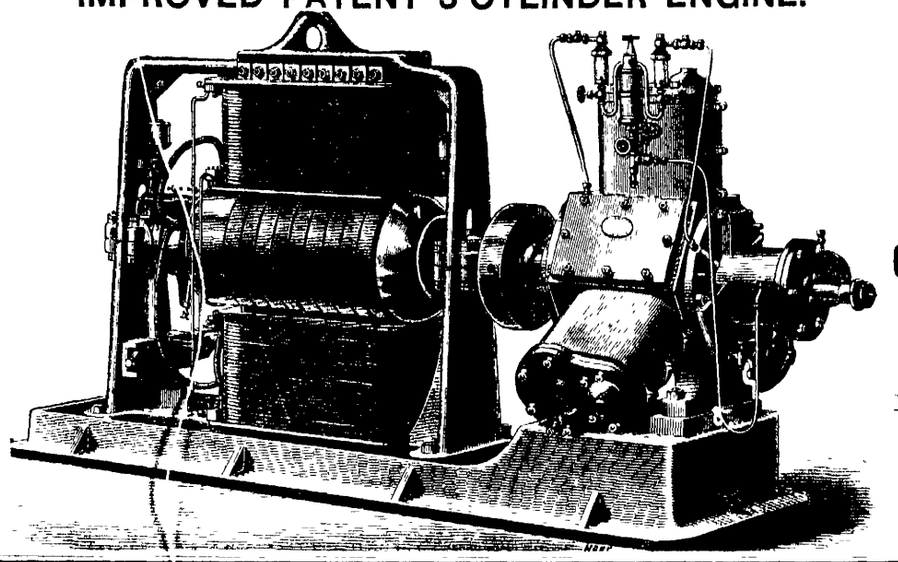
AND

EFFECTIVE

FOR

SHIP LIGHTING

As in General Use in the British, French, Italian, Danish, &c., &c., Navies.



FOR DRIVING

FANS,

CENTRIFUGAL PUMPS,

AND OTHER

HIGH-SPEED

MACHINERY.

6204

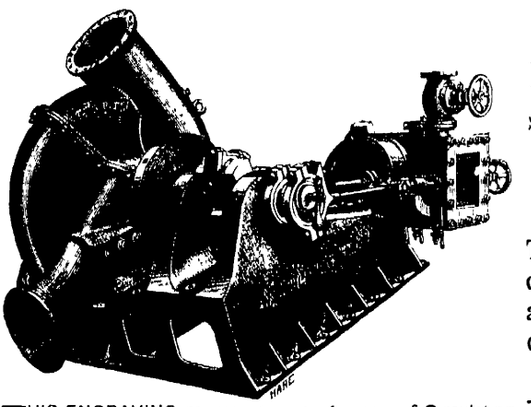
W. H. ALLEN & CO.,

MAKERS OF THE IMPROVED

CENTRIFUGAL CIRCULATING PUMPING ENGINES

600

Of these Pumps and Pumping Engines have been fitted on the Swiftest and Largest Steamers afloat, sailing in all parts of the World.



THIS ENGRAVING represents one of a pair of Circulating Engines, supplied to the Italian Government for their Ram "FRANCESO MOROSIMI," of 10,000 HP. The Pumps were entirely of Gun Metal, weighing four tons each

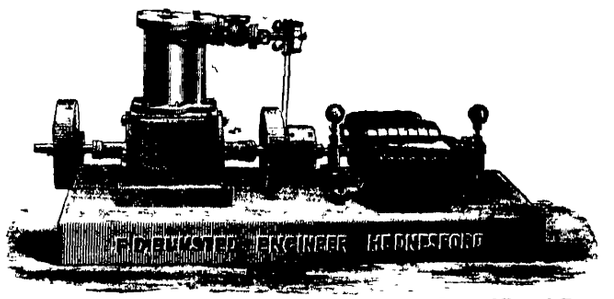
Every important Line has some of these Engines in their Steamers.

These Pumping Engines are cheaper, occupy less space, and are superior to any other form of Pumps for large or small steamers.

4805

YORK STREET WORKS, LAMBETH, LONDON, S.E.

CHANDLER'S PATENT HIGH-SPEED ENGINE



SINGLE OR DOUBLE. SILENT & STEADY.

SPECIAL TOOLS having been made for these ENGINES they are MODERATE in PRICE.

1200 REVOLUTIONS per Minute. Perfect System of Lubrication—no lubricators, no attention. Half pint of Oil is sufficient for Two Days' Supply. Forged Steel Crank and Phosphor Bronze Working Parts throughout MADE IN FOUR SIZES.

F. D. BUMSTED, Cannock Chase Foundry and Engine Works,
HEDNESFORD, STAFFS. 5280
MANUFACTURER OF PAPER BAG MAKING MACHINERY.

BRABY'S PATENT GLAZING.

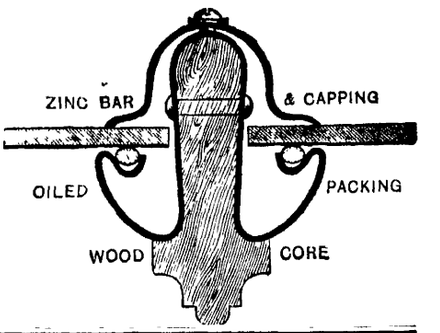
Glass set free, allowing Expansion and Contraction, and precluding Breakage.

ABSOLUTELY WATERTIGHT. PAINTING AND PUTTY SUPERSEDED.

OVER ONE MILLION FEET FIXED.

DRAWINGS AND PRICES ON APPLICATION.

MODELS AND SECTIONS ON VIEW. 5802



LONDON: 356 to 362, EUSTON ROAD. | LIVERPOOL: 6 and 8, HATTON GARDEN. | GLASGOW: 335, ARGYLE STREET.

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing —

New Zealand Shipping Co., Limited,
S.S. "Ruapehu," Royal Albert Dock, 16th May, 1884.

Bell's Asbestos Works Southwark

Gentlemen — I beg to state that your round Asbestos Block Packing was used in the high pressure pistons of this ship with the following remarkable results

14,000 miles continuous steaming without renewal.

Steam Pressure 110 lbs | Vacuum 29 inches.

My experience does not show an equal result from any other packing

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record

D. HENDERSON, Chief Engineer S.S. "Ruapehu"

Manchester, Sheffield and Lincolnshire Railway—Steamship Department
Grimsby, April 10th, 1884

Dear Sir — I have much pleasure in stating that after a trial of over nine months and comparing it with other packings I can confidently recommend your Asbestos Packing It is especially valuable when high pressures are employed as in cases where other packings have perished owing to high temperatures The packing has invariably stood well I have also used it with complete success where a gland has heated with other packings and also in cases of badly scored piston rods I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory Yours truly,

Mr J. Bell G. H. CLARKE Sup. Engineer

Department of the Director of Navy Contracts,
Admiralty, Whitehall, 20th June, 1884.

Sir — I have to inform you that your tender has been accepted for Bell's Roll'd Cloth Asbestos Packing to supply submitted

Flasht core square | Flasht core Plain

To Mr. John Bell JOHN COLLETT Director of Navy Contracts

The Patent Block Packing is square as Fig 1 and Figs 2 and 4 represent the Round Block Packing with solid and hollow rubber core and Fig 3 without core, but with rubber inlaid

As these packings are extensively imitated and as it is a common practice among dealers and agents to supply the cheaper manufactures at any list prices users are requested to see that the packing supplied to them bears the trade mark

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion It also disintegrates incrustation so immediately as to prevent its adhering to the plates

Not only is it a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated

It has been computed that 1/16 in. thick of incrustation causes a waste of 15 per cent of coal 1/8 in. 60 per cent., 1/4 in. 150 per cent

Thus the Preservative avoids the great risks which are inseparable from scaled plates lengthens the life of a boiler and covers its own cost a hundred fold by economy of fuel

It is entirely harmless and has no injurious action on metals

It can be put into the feed tank of boiler, as may be most convenient

Sold in drums and casks bearing the trade mark without which none is genuine

BELL'S ASBESTOS YARN & SOAPSTONE PACKING,

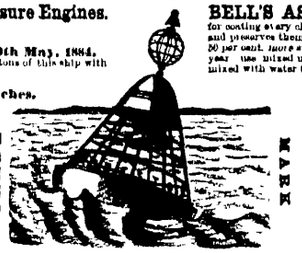
for Locomotives and all Stationary Engines running at very high speed with intense friction

Sandwell Park Colliery, Smethwick 1st February 1884.

To Bell's Asbestos Works — Dear Sirs — I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day and also for the fan pumping and hauling Engines at the above Colliery and during that period we have not used more than one third the Packing we had formerly and this I attribute to your Packing, on account of its great durability and general excellence of quality

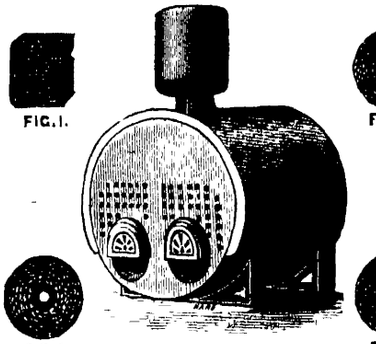
I am dear Sirs yours faithfully

THOMAS WINTER Colliery Engineer



— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices All home orders should be sent direct to the undermentioned depôts and not through agents or factors



BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-conducting felts and easily applied when steam is up; adheres to metal and preserves them from rust, prevents the unequal expansion and contraction of boilers exposed to weather covers 50 per cent. more surface than any other coating and is absolutely indestructible. It can be stripped off after many years use mixed up with 20 per cent of fresh and applied again The composition is supplied dry, and is only to be mixed with water to the consistency required for use

A Horizontal Boiler 17 ft 6 in long 15 HP gave the following results:—

Temperature on Plates 188 deg.
" " Covering 94 deg.

One ton of coal was saved per week and although the fire was raked out every evening 20 lb of steam were found in the boiler next morning

The following Testimonial refers to this Covering —

Offices of the Wimbledon Local Board Wimbledon, Nov 29th, 1883

"Dear Sir —It may interest you to know that we save exactly 40 per cent in fuel throughout using your covering —Yours truly,

W. SANTO CRIMP, C.E., F.G.S.

The Tamar and Kit Hill Granite Company Limited,
Gunnislake Tavistock 8th April 1884

Mr. JOHN BELL Southwark, S.E.

Sir —I have much pleasure in stating that the Asbestos Covering applied by you to the boilers of our travelling crane at Kit Hill has yielded most remarkable results Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam which is often a matter of great importance to us I should add that the crane runs on high gantries and is fully exposed to all weather I have formed the highest opinion of your Asbestos as used for this purpose and as you are aware have had another boiler similarly covered though it has not since been used I can most strongly recommend the material —I am Sir, yours faithfully

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints It can be bent by hand to the form required without puckering and is especially useful in making joints of manhole and mudhole doors It is kept in stock in rolls of 100 ft from 1/2 in to 3 in wide and any thickness from 1/16th in upwards Manhole covers can be lifted many times before the renewal of the jointing material is necessary

The same material is made up into sheets about 40 in square, and each sheet bears the Trade Mark without which none is genuine

It is very necessary to guard against imitations of this useful material and to secure themselves against being supplied with these inferior articles at any price users are recommended to see that every 10 ft length of the Asbestos Tape purchased by them bears the Trade Mark

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints made of the best Asbestos fibre, is well known for its toughness and purity and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material Made in sheets measuring about 40 in square, from 1-64th in to 1 in, and 1/4 millimetre to 25 millimetres thick Each sheet bears the Trade Mark

The following copy of acceptance of tender refers to above —

Department of the Director of Navy Contracts,
Admiralty, Whitehall, S.W., 17th May, 1884.

Sir —I have to inform you that your tender for Asbestos Millboard has been accepted JOHN COLLETT

Mr. John Bell Director of Navy Contracts

BELL'S ASBESTOS EXPANSION SHEETING, Patent

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials

The India rubber Washer is protected from the action of heat and grease by an outer matting of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable

This material is admirably suited to steam pipe joints and every class of valve Valves made of this material are very durable as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REG'D.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

OR THE DEPOTS— 4942

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 99, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN

[Registered at the General Post Office as a Newspaper

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.

VOL. XXXVIII.—No 983.] *LONDON FRIDAY, OCTOBER 31, 1884* [PRICE 6d BY POST 6½d

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Portland Cement,

manufactured by

Francis and Co.,

The celebrated Nine Elms Brand, established 1810
Medals London, 1851, Philadelphia, 1876, Paris, 1878
Offices Vauxhall, London. Works, Cliffe, Rochester 5338

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genuine and of the best quality, is supplied by the WOULDHAM CEMENT COMPANY for home consumption and export.—For prices, &c., address, 39, Lime Street, London, E.C. 1780

Rugby Portland Cement COMPANY

MANUFACTURERS OF

Portland Cement

Of the Greatest Strength and best Quality. Roman and Lias Cement. Blue Lias Hydraulic Lime, Ground and Unground

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WORKS NEW BILTON AND NEWBOLD 4867

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Civil & Mechanical Engineers,

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AND

110, Cannon Street, London, E.C. 3924

Over 15,000 "Otto" Engines

AT WORK,

Using 25 to 75 % less Gas per Brake HP. than

Any other Engine.

Crossley's Patent Self-Starter,

Safest, Best, and Simplest made, may now be applied 5383

Crossley's Patent Twin-Engine

Impulse every Revolution. Very Steady in Running

HIGHEST AWARD AT PARIS ELECTRICAL EXHIBITION.

Steam Launches.—Messrs.

YARROW and COMPANY, Poplar, London, are prepared to contract for—

Screw Steamers having speeds up to twenty-six miles an hour Paddle Steamers having draughts down to 6 inches of water. Machinery constructed for boats built abroad 5384

Steam Launches, fitted with

really efficient and accessible tubular boilers. For small steamers, steam lighters, salt flats, &c., these boilers will be found unrivalled.—Apply, COCHRAN and CO., Birkenhead See page 4 4749

Vosper & Co., Broad Street,

PORTSMOUTH

Have FOR SALE, New STEEL STEAM YACHT, 60 ft. by 10 ft. 4 in., New WOOD STEAM LAUNCH 40 ft. by 7 ft. 6 in., and Second hand ditto, 22 ft. by 5 ft. 6 in. 3551

Forrestt & Son, London,

SHIP AND LAUNCH BUILDERS ENGINEERS 4457

G. F. G. Des Vignes, Chertsey,

Surrey, Builder of First class High-speed Steel Yachts, Launches, & Torpedo Boats Estab. 1869 5794

Miller, Tupp, & Rouse, Steam

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OVERHEAD TRAVELLING CRANES (Hand and Power for Driving by Cotton Rope or Tumbler Shaft), DIRECT-ACTING STEAM HOISTS, AIR COMPRESSORS, HYDRAULIC PRESSES, HYDRAULIC CRANES AND LIFTS, DONKEY PUMPS

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NEWCASTLE ON TYNE

SPRINGS, BUFFERS, STEEL CASTINGS, FORGINGS, TOOL STEEL, FILES SPRING STEEL, &c SIEMENS STEEL BLOOMS AND BARS 3703
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Makers of all Machinery, &c., for the complete equipment of Telegraph Cable Factories and Steamers, Electric Leads, Cables, and Carbons, &c 5360

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Thomas Kell and Son, Lithographers, &c., execute every description of Lithography, Chromo-lithography, Engraving, and Printing, Engineering, Architectural, and Pictorial Drawing in best manner Paper Drawing, photo-lithography, &c.—40, King St., Covent Garden, W.C. 3462

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See large Advertisement alternate weeks
LANCASHIRE PATENT BELTING AND HOSE CO., "Wire Works" Mills,
STRANGEWAYS, MANCHESTER 5151

R. E. Crompton and Co.,

ELECTRIC LIGHT ENGINEERS,
MANSION HOUSE BUILDINGS, E.C. 4812
See Advertisement Oct 17, page 30

Isca Foundry and

ENGINEERING COMPANY
Railway Plant & General Engineers,

Switches, Crossings,

Turntables, Water Cranes, Girders, Bridges, Roofs, Pipes, Pumps, Wagons, Tanks, Engines, Boilers, Cranes, Works NEWPORT, MON
London Office
10, BUSH LANE, CANNON STREET, E.C. 4187

Steam Boilers, Ready for Delivery.

W. & J. GALLOWAY & SONS, Manchester, always keep a large stock of "GALLOWAY" and "TWO FLUED" Boilers ready for dispatch 5060

Willans' Patent Compound

ENGINES, for marine and general purposes Stock sizes from 6 to 150 I.H.P. Special patterns for Electric Lighting.—WILLANS & ROBINSON, Thames Ditton, Surrey 5383

Iron Roofs, Sheds, Buildings,

HOUSES Best work, reduced prices Dixon's special CURVED IRON ROOFS are the most economical for spans up

Hunter and English,

ENGINEERS AND MILLWRIGHTS,
IRON AND BRASS FOUNDERS, BOW, LONDON, E.
DREDGING MACHINERY
HYDRAULIC MACHINERY
"WILLIAMS' PAT"
LAND AND MARINE [illegible]
DISTILLERY AND BREWERY PLANT
FLOUR AND RICE MILLS
WATER AND GAS VALVES, CRANES, LOCK GATES, &c PUMPING MACHINERY
HUNTER'S PATENT FLOATING CRANE FOR DOCKS, &c.
STEAM LAUNCH MACHINERY 4955

Boiler Tubes, Iron, Steel, and

HOMOGENOUS
EDWIN LEWIS AND SONS, Wolverhampton 4868

Tubes.

MARINE, LOCO', STEAM, BORING, COLLIERY
LARGE TUBES LAP WELDED TO 12in. DIAM

Joseph Aird,

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GREAT BRIDGE, STAFFORDSHIRE
LONDON OFFICES
46, QUEEN VICTORIA STREET
MANCHESTER
QUEEN'S CHAMBERS, 5, MARKET ST.
MR. L. W. SUTCLIFFE, M.E., AGENT 5189

James Russell and Sons,

LIMITED,
CROWN TUBE WORKS, WEDNESBURY
London Warehouse 108, Southwark Street, S.E.
Leeds Warehouse 6, Mark Lane, Briggate
Price Lists on application 5001

Wrought Iron Tubes and

FITTINGS
LLOYD AND LLOYD,
ALBION TUBE WORKS BIRMINGHAM
WAREHOUSES—
90, Cannon Street, E.C.
Liverpool 67, Paradise Street
Manchester 7, Blackfriars Street 5331

Compound Surface Condensing MARINE ENGINES FOR SALE, cylinders 10 in. and 20 in. diameter by 12in. stroke, fitted with Payton and Wilson's patent circular balanced and double ported slide valves, and link motion reversing gear.—Address ALEX. WILSON & CO., Vauxhall Iron Works, Wandsworth Road, London, S.W. 4968

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Patentees and Sole Manufacturers of CHAPLIN'S PATENT STEAM CRANES, HOISTS, LOCOMOTIVES, and other Engines and Boilers.—London House 63, Queen Victoria Street, London, E.C. 2470

Stannah's Pendulum Pumps

For Prices see alternate weeks

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FOR WOOD WORKING MACHINERY

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Only FIRST Award granted to European Exhibitors	Highest Award GOLD MEDAL (1st Class)

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Okes,

LONDON AGENT FOR

Atkinson's Patent Gas Engines.

5064

39, QUEEN VICTORIA STREET, LONDON, E.C.

Field's Patent Boilers and

TUBES
LEWIS OLRICK & CO., London 5046
See Illustrated Advertisement, page 25

George Russell & Co.,

ENGINEERS and BOILERMAKERS,
ALPHA STEAM CRANE and ENGINE WORKS, MOTHERWELL, near GLASGOW
SILVER MEDAL, PARIS, 1867 4921

Steam Hammers.—

Massey's Patent Hammers
RECEIVED THE *ONLY* PRIZE MEDAL PARIS 1878
More than 1200 made
Drop Hammers Hasse's Patent Power Hammer.

Hathorn, Davey & Co.

LEEDS
PUMPING MACHINERY
For Mines, Water Supply, Irrigation, Graving Dock Drainage of Docks and General Pumping Purposes
ALSO
HYDRAULIC MACHINERY OF ALL KINDS
The "DOMESTIC" MOTOR
CATALOGUES ON APPLICATION 52

Locomotive Tank Engine

designed and constructed by
MANNING, WARDLE, AND COMPANY,
Boyne Engine Works, Leeds 948
See their Illustrated Advertisement, page 37

Locomotive Tank Engines

TRAMWAY ENGINES AND CARS
Built by THE FALCON ENGINE and CAR WORKS Limited, Loughborough 52
See Illustrated Advertisement, page 11

The Patent Corliss Engin

And PATENT CORLISS GEAR ENGINE, wit special improvements by DOUGLAS and GRANT Dunnikier Foundry, Kirkcaldy, N.B. These engin are made *Horizontal or Beam*, Condensing, Non Co densing, and Compound. Also makers of Rice Mill and Paper Mills, and General Engineers. Machine shipped or trucked direct from the premises 55

John Cochrane, Engineer

BARRHEAD, N.B.,
Advertises his STEAM ENGINES, STEAM HAMMERS, STEAM PUMPS, &c., in this Paper ev Fortnight. Catalogues, &c., on application 53

Steel Hydraulic Cylinders.—

HENRY BESSEMER & CO., Limited,
SHEFFIELD
See Advertisement last week, page 3. 36

Tweddell's

Hydraulic Riveting Machine

14, DELAHAY STREET, WESTMINSTER, LONDON, S.W. 489

See Illustrated Advertisement last week, page 49

L. Sterne & Co., Limited

ENGINEERS,
Sole Makers of

Clark's Patent

Self-Starting Gas Engine

HIGHEST AWARD,
BRITISH SECTION ELECTRICAL EXHIBITION PARIS, 1881

GOLD MEDAL,
CRYSTAL PALACE ELECTRICAL EXHIBITION LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifier

WITH
STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels.

Emery Machines,

Spiral Springs

The Crown Iron Works, GLASGOW.

The Crown Iron Works (Hollinwood), MANCHESTER

10, Victoria Chambers, WESTMINSTER.

City Office and Show Rooms, 40, CANNON STREET, E.C.

University of Edinburgh.—

ENGINEERING DEPARTMENT

Professor FLEEMING JENKIN, LL D, F R S, will BEGIN his course of Engineering Lectures on TUESDAY, 4th NOVEMBER, at Nine a m.

The class of Mechanical Drawing (including Design) is open daily between Ten and One o'clock

Further particulars from

J G FAIRWEATHER, B Sc, C E.,
University of Edinburgh, Assistant to the Professor
October, 1884 J 72

TENDERS.

BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY COMPANY

BLISTER STEEL

The Directors are prepared to receive

Tenders, up to Twelve o'clock

Noon of Thursday, the 13th November, for the PURCHASE of about 15 tons 15 cwt 13 lbs of BLISTER STEEL, expected in the South West India Docks about the 10th November Particulars can be obtained at this Office

J PITT KENNEDY, Officiating Secretary
Offices 45, Finsbury Circus, London, E C,
28th October, 1884 J 122

BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY COMPANY

The Directors are prepared to receive up to noon on Tuesday, the 18th November,

Tenders for the Supply of

Fifteen LOCOMOTIVE GOODS ENGINES and TENDERS, also 200 Wagon Underframes and Iron Work

Tenders must be made on Forms, Copies of which, with Specifications, can be obtained on application at these Offices on payment of 21s each (which will not be returned)

The Directors do not bind themselves to accept the lowest or any Tender

By order, J PITT KENNEDY,
Officiating Secretary
Offices, 45, Finsbury Circus, London, E C,
22nd October, 1884 J 88

THE SOUTHERN MAHRATTA RAILWAY CO, LIMITED

The Board of Directors of the Southern Mahratta Railway Company is prepared to receive

Tenders for the Supply of—

PILLARS AND POSTS &c
GALVANISED STRAND WIRE, &c,

as per Specifications to be seen at this Office

Tenders to be delivered in sealed envelopes, addressed to the Secretary, marked "Tender for Pillars and Posts, &c," or as the case may be, not later than Twelve o'clock at noon on Wednesday, the 12th November, 1884

The Company is not bound to accept the lowest or any Tender By order of the Board

(Signed) EDW Z THORNTON, Secretary
Secretary's Office, 31 Lombard Street, E C,
23rd October, 1884 J 104

JERSEY (NEW) WATER WORKS COMPANY

TO CONTRACTORS

The Directors of the Jersey (New) Water Works Company desire to receive

Tenders for the Construction

of Filter Beds, Pure Water Tank, High Service Reservoir, Alteration to a Brook Course, Laying and Jointing Cast Iron Pipes, and other Works

Drawings and Specification may be seen, and a Copy of the Bill of Quantities obtained, for Half a Guinea, upon application to the Secretary of the Company, E F Le Cornu, Esq, 27, Broad Street, St Helers, or the Engineer, E R Bunnell (M Inst C E), 34, Pembroke Street, St Aldates, Oxford, on and after 8th November Sealed Tenders are to be sent to the SECRETARY, by post not later than 21st November, marked on the outside "Tender, Contract No 1"

The Directors do not bind themselves to accept any Tender J 113

JERSEY (NEW) WATER WORKS COMPANY

TO IRONWORK CONTRACTORS

The Directors of the Jersey (New) Water Works Company desire to receive

Tenders for the Supply of Cast

Iron Pipes, Special Castings, Columns, Rolled Iron Girders, Tie Rods, a Sandwasher, &c

Drawings and Specification may be seen, and a Copy of the latter obtained for Half-a-Guinea, upon application to the Secretary of the Company, E F Le Cornu, Esq, 27, Broad Street, St Helliers, or the Engineer, E R Bunnell (M Inst C E), 34, Pembroke Street, St Aldates, Oxford, on and after 8th November Sealed Tenders are to be sent to the SECRETARY, by post, not later than 21st November, marked on the outside "Tender, Contract No 2"

The Directors do not bind themselves to accept any Tender J 114

TO CONTRACTORS

NEWRY NAVIGATION COMPANY—CHANNEL IMPROVEMENT, NEWRY RIVER

The Committee of Management of the Newry Navigation Company are prepared to receive

Tenders for the Excavations

necessary for a Navigation Channel between the Doyle Hole, Newry River, and deep water in Carlingford Lough, in accordance with Plans and Specifications, which may be seen from Ten o'clock a m to Five o'clock p m daily, at the Office of James Barton, Esq, C E., Engineer to the Works, Exchange Buildings, Dundalk.

Tenders, upon a Form which will be supplied by the Engineer, must be delivered to the undersigned on or before 10th December, 1884

The Committee do not bind themselves to accept the lowest or any Tender

(Signed) GEO. R. ARMSTRONG,
Navigation Office, Newry. Secretary
24th October, 1884. J 101

BOROUGH OF SOUTHAMPTON

TO WELL SINKERS AND OTHERS

The Corporation invite

Tenders for Sinking a Bore

HOLE at Otterbourne, in the County of Southampton, according to a Drawing, Specification, and Conditions, to be obtained of Mr W Matthews, Waterworks Engineer, Municipal Offices, Southampton, upon payment of Five Shillings for each copy

Sealed Tenders, endorsed "Tender for Boring," must be left at my Office, by Eleven o'clock in the forenoon of Saturday, the 8th November next

No pledge is give to accept the lowest or any Tender

By order, R S PEARCE,
Municipal Offices, Southampton, Town Clerk
28th October, 1884 J 110

TO ELECTRICAL ENGINEERS AND ELECTRIC LIGHT COMPANIES

THE METROPOLITAN ASYLUMS BOARD are prepared to receive

Tenders for Lighting by

ELECTRICITY the three Hospital Ships, now moored in the River Thames at Long Reach, near Dartford, Kent, and the Administrative Buildings on shore

Copy of Specification prepared by Mr J Hopkinson, F R S, M Inst C E, and Forms of Tender may be obtained at his Offices, 4, Westminster Chambers, Victoria Street, S W on or after the 24th inst, between the hours of Ten and Four, where all further information may be obtained

Sealed Tenders must be delivered at the Offices of the Board 37, Norfolk Street, Strand, by or before Ten o'clock on Tuesday, the 11th November next

The Managers do not bind themselves to accept the lowest or any Tender By order,

W F JEBB, Clerk to the Board
Offices of the Board, 37, Norfolk Street,
Strand, W C, 18th Oct, 1884 J 65

SCINDE, PUNJAUB AND DELHI RAILWAY COMPANY

The Directors are prepared to receive

Tenders from Manufacturers

only, for the SUPPLY and DELIVERY of—

CAST IRON SLEEPERS (2 Sections),
CAST IRON CHAIRS FOR SWITCHES,
CROSS TIES, GIBS and CUTTERS,
STAFFORDSHIRE IRON BARS, and
STAFFORDSHIRE IRON PLATES

Forms of Tender Conditions of Contract, and Specifications, may be obtained, on payment only, no part of which payment will in any case be returned, by application at the Company's Offices, on and after Wednesday, the 5th November, and no Tender will be entertained unless made on the forms so obtained

Tenders are to be delivered in closed envelopes, marked on the outside, "Tender for Cast Iron Sleepers (Punjaub Section)," or as the case may be, addressed to the Chairman, and left at this Office not later than Ten o'clock on Tuesday, the 18th November, 1884

The Directors do not bind themselves to accept the lowest or any Tender

By order of the Board,
J H NORMAN,
Scinde, Punjaub and Delhi Railway Co, Secretary,
250, Gresham House, Old Broad Street,
London, 23rd October, 1884 J 107

OUDE AND ROHILKUND RAILWAY COMPANY LIMITED

The Directors are prepared to receive

Tenders for the Supply of—

Girders, Iron and Steel	Creosoted Timber
Steel Girder Ties	Bolts and Ironwork

Specifications and Drawings may be seen at the Office of Mr W F Batho, Consulting Engineer of the Company, 9, Victoria Chambers, Westminster, S W, from whom Copies of the same may be obtained on payment, which payment will not be returned

Tenders, endorsed with the names of the Stores to which they refer, should be addressed to the undersigned, and delivered in sealed envelopes at the Offices of the Company as under, not later than Eleven o'clock in the morning of Wednesday, the 12th November proximo

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By order of the Board
C C JOHNSTON, Managing Director
29, Martin's Lane, Cannon Street, London, E.C.,
29th October, 1884 J 120

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October 24th, 1884 J 121

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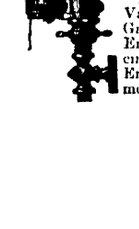
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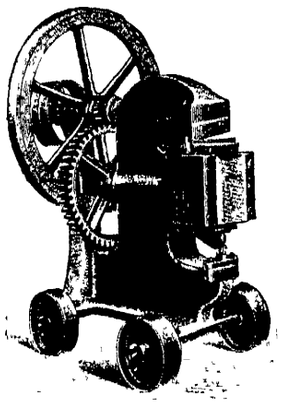
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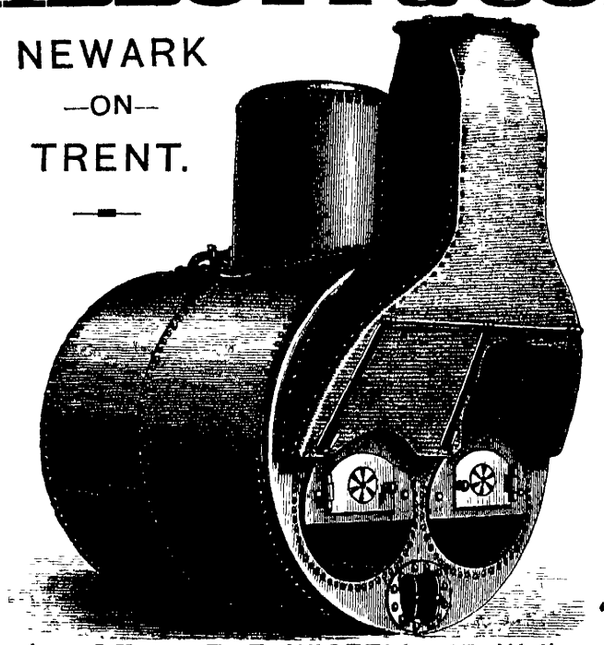
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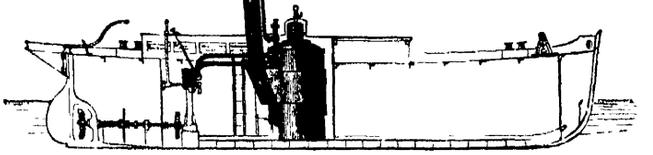
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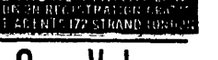


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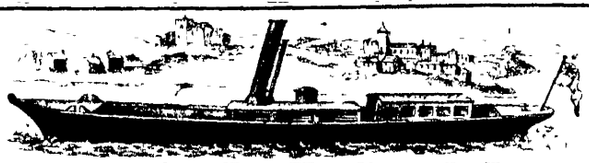
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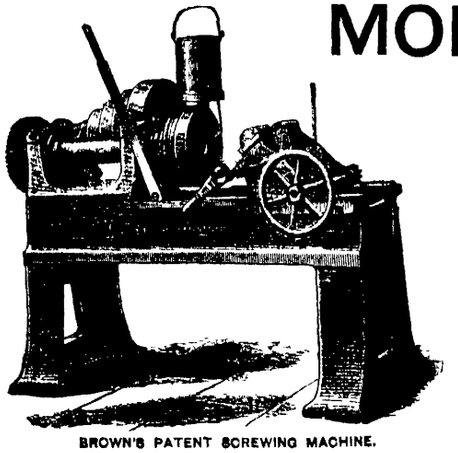
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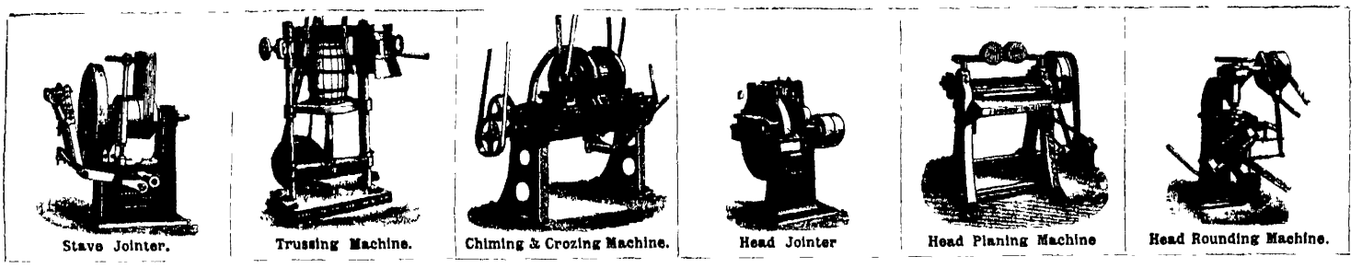
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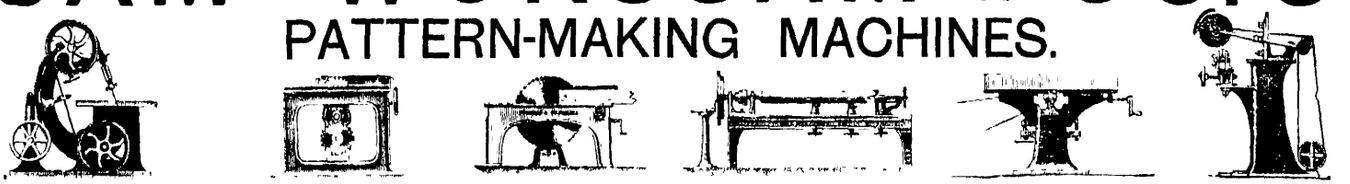
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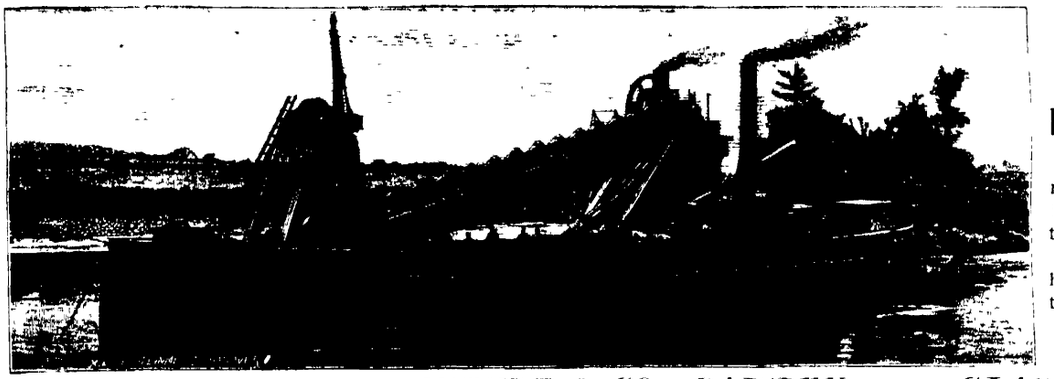
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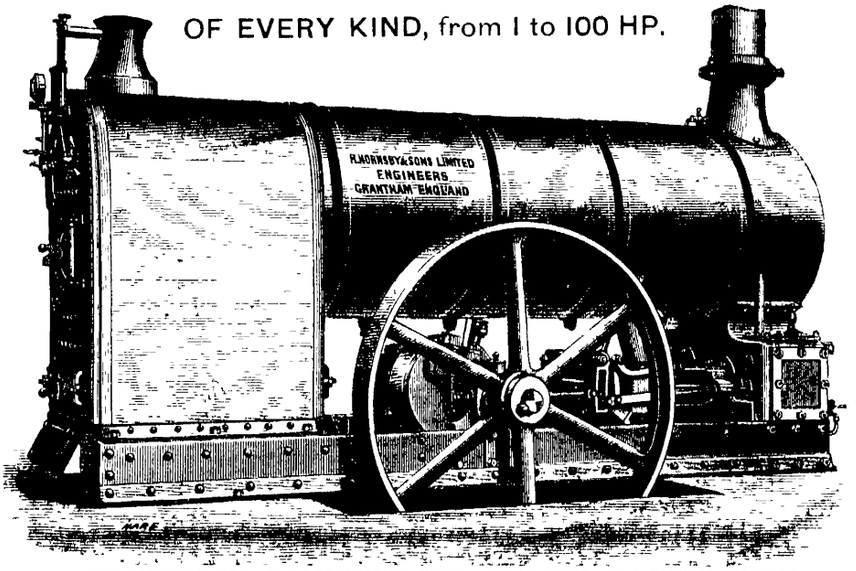
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Both Simple & Compound, with or without Condensers

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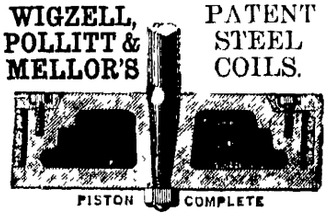
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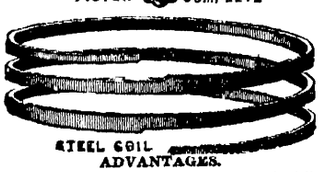
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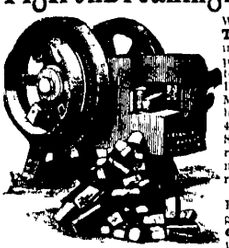
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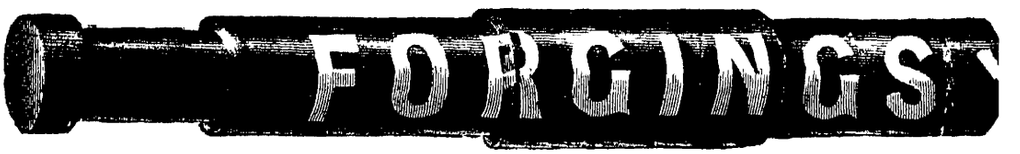
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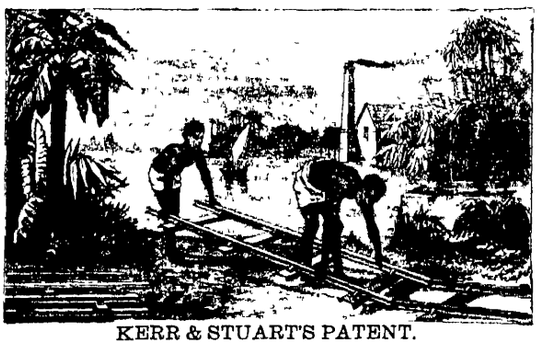
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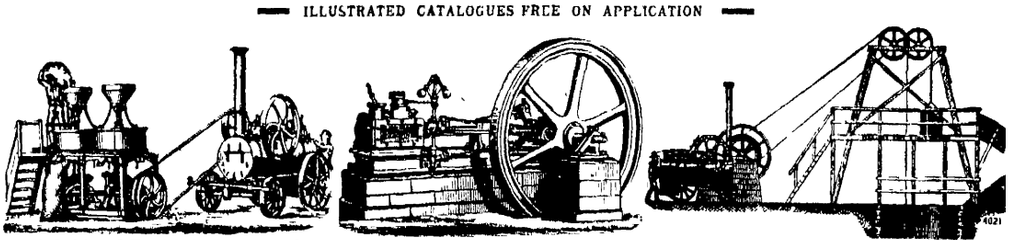
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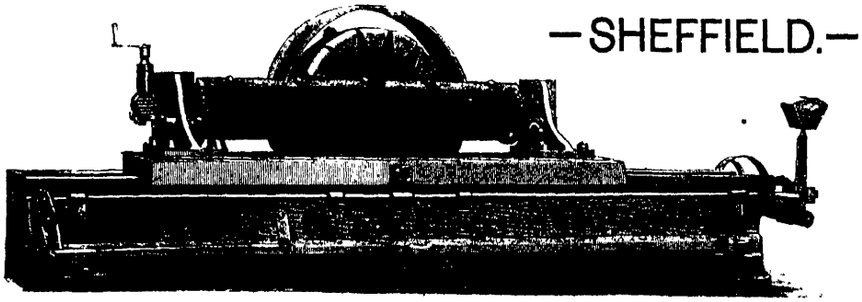


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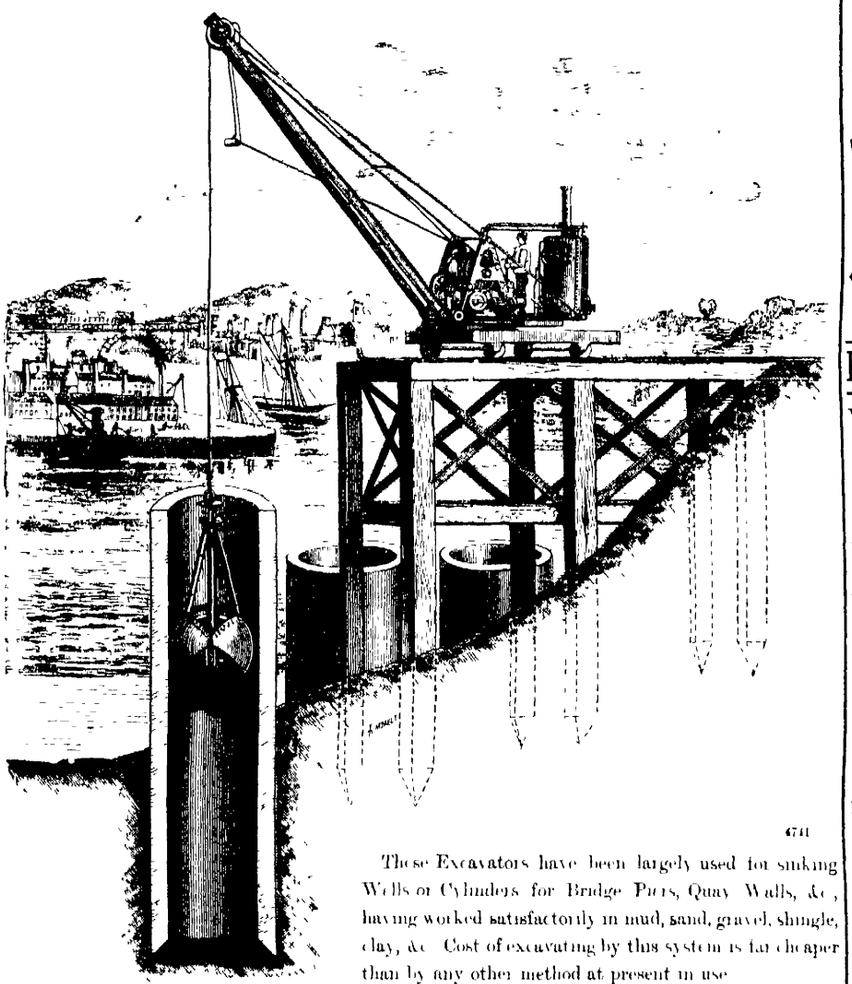
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4741

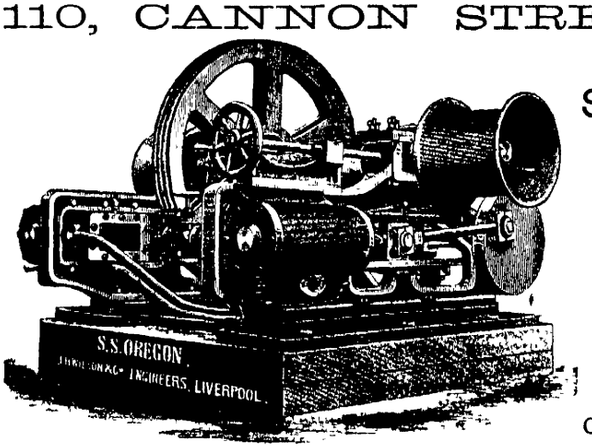
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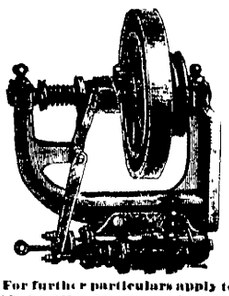
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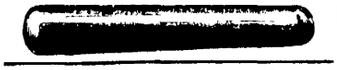
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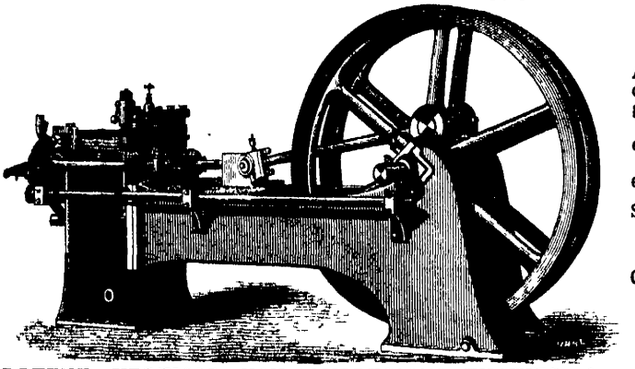
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CANNOT GET OUT OF ORDER. NO WORKING EXPENSES.

NO CHEMICALS USED.

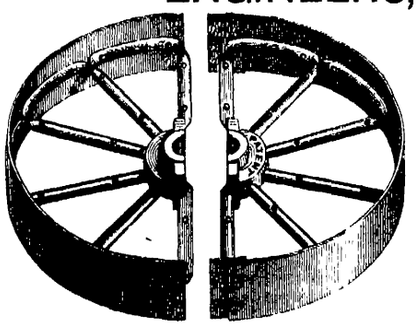
FOR FULL PARTICULARS APPLY 5334

THE PATENT STEAM BOILER COMPANY, 28, Heneage Street, Birmingham.

And 11, QUEEN VICTORIA STREET, LONDON. CONRAD KNAP, Representative

READING IRON WORKS. LIMITED

ENGINEERS, BOILER MAKERS,



Ironfounders, Millwrights,

AND

MANUFACTURERS of EVERY DESCRIPTION of

AGRICULTURAL MACHINERY.

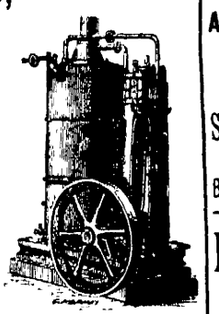
Sole Makers and Patentees of the

"UNIVERSAL"

Wrought Iron Split Pulley.

—o—

Estimates for all kinds of Ironwork



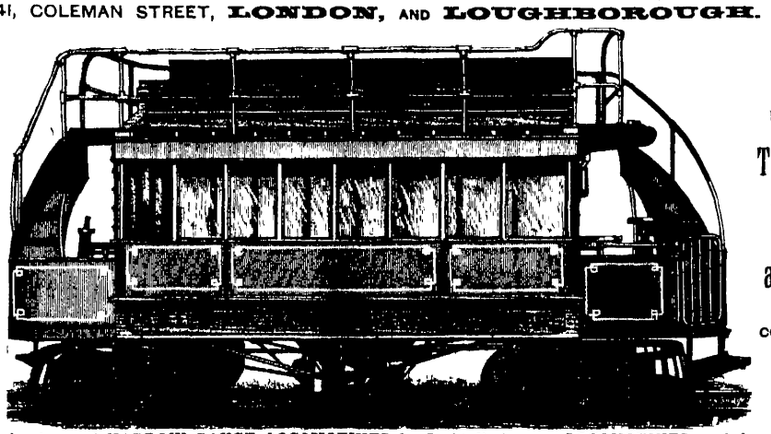
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THE FALCON ENGINE & CAR WORKS, LIMITED,

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BUILDERS OF

TANK Locomotive ENGINES FOR **CONTRACTORS.**



BUILDERS OF

TRAMWAY ENGINES and CARS FOR **CONTRACTORS.**

Collieries, Ironworks, &c., and **NARROW-GAUGE LOCOMOTIVES** for Light Railways **LOCOMOTIVES**, with from 4 in. to 16 in. cylinders, on Four or Six Wheels, all coupled or specially adapted for going round sharp curves or ascending steep gradients **ENGINES** of various sizes always in stock or in progress **TRAMWAY ENGINES** of every size **TRAMWAY CARS** and **CARRIAGES.** Open and Closed **WAGONS**, &c. 5207

SPECIFICATIONS, PHOTOGRAPHS, AND PRICES ON APPLICATION.

EDWARD HAYES, Engineer, STONY STRATFORD.

(LONDON OFFICE: 12, GREAT ST. HELENS, E.C.)

STEAM LAUNCHES

Speed from 10 to 25 miles per hour



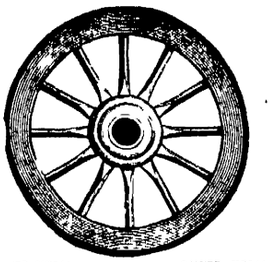
MACHINERY constructed for Boats Built Abroad.

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Engines and Boilers kept in Stock.

BUILDER OF STEAM TUGS AND LAUNCHES.

Speciality in Small STEAM TUGS for towing Barges and Lighters. 5103



SILVER MEDAL SILVER MEDAL

WHEELS.

Made by Machinery, all sizes, for Carriages, Carts, Vans, Wagons, Cabs, Omnibuses, &c.

WHEELS.

Large Stock always on hand Tyreing Repairs, and Special Orders executed at the shortest notice.

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PRICES ON APPLICATION.

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MACHINE-MOULDED WHEELS:

SPUR,
BEVEL,
WORM,
HELICAL.

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W. ROWLANDSON,

132, Boundary St., 5278

LIVERPOOL.

W. C. BAGNALL

STAFFORD



LOCOMOTIVES

PORTABLE RAILWAYS

TRUCKS AND WAGONS

4846

JAMES GOODWIN AND COMPANY,

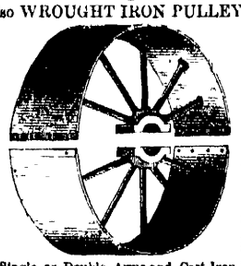
Ironfounders, Engineers, and Bridge Builders

CONTRACTORS for RAILWAY PLANT, viz Cast Iron Chairs, Sleepers, Tanks, Water Cranes, Axle Boxes, Screw Piles for Bridges, Piers, and Wharfs, Blast Furnace Castings, Ingot Moulds, and every description of Plant for Collieries, Iron Works, &c. Also all kinds of Castings for Engineers and Tool Makers Manufacturers of Iron and Steel Bridges, Iron Roofing and Buildings, and General Structural Work (Bridge Works at Motherwell). 2347

Works, Ardrossan, Johnstone, and Motherwell.

Shipping Ports: Ardrossan, Glasgow, Greenock, Leith.

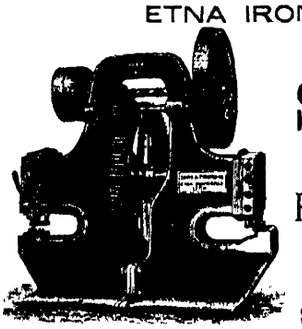
GEORGE CROSSLEY,
ALBION MACHINE WORKS,
CLECKHEATON, YORKSHIRE
Maker of all Descriptions of
WIRE MACHINERY.
Also WROUGHT IRON PULLEYS,



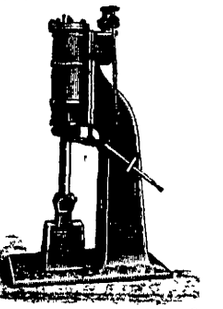
LONDON OFFICE: DUNCAN BROS., 33, Queen Victoria Street, LONDON, E.C.

With Single or Double Arms and Cast Iron Bosses which for CHEAPNESS, LIGHTNESS, and STRENGTH are UNSURPASSED. Price List on Application 4411

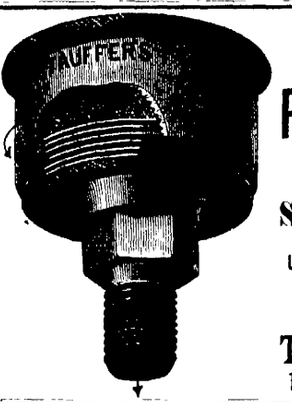
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ETNA IRONWORKS, BANGOR ROAD, LEITH, N.B.



IMPROVED DOUBLE-ACTING
STEAM HAMMERS
FOR FORGES, SMITHIES, STAMPING, &c.
AWARDED THE
FIRST PRIZE AT SYDNEY EXHIBITION, 1880.
Sizes from 1¼ cwt to 12½ cwt usually in Stock.
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SHIPBUILDERS' AND BOILER MAKERS' TOOLS, &c.

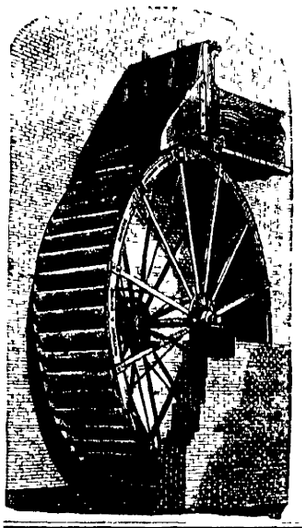


Filtration
IN ANY QUANTITY, OF THE DIRTIEST RIVER OR CANAL WATER, FOR MANUFACTURING OR OTHER USES
UNDERTAKEN BY THE PULSOMETER ENG^E Co^Y L^D.
Nine Elms Iron Works London SW



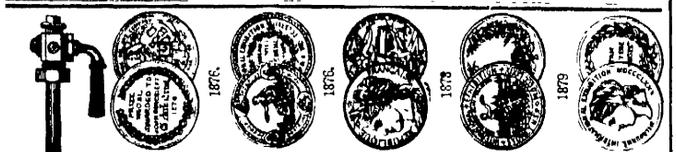
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STAUFFER'S
PATENT LUBRICATOR
AND
LUBRICANT
SAVE 90 % over Liquid Oil.
UNIVERSALLY APPLICABLE. WORK IN ANY POSITION.
THE LOOSE PULLEY LUBRICATOR.
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MANUFACTURERS OF
Improved Steam, Water, & Wind,
FLOUR MILL MACHINERY.



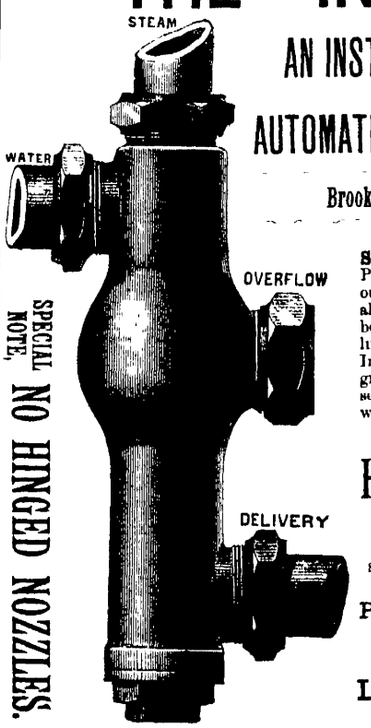
Ironworks
WICKHAM MARKET, SUFFOLK.
London Offices
28, MARK LANE, E.C.
WATER-WHEELS
of every description upon the largest or smallest scale
MAKERS OF
OVERSHOT, UNDERSHOT, & BREAST
WATER-WHEELS,
Of the best and most modern construction, in cast or wrought Iron or of Wood, calculated to utilise the maximum power available from the stream or source of supply
W & B have patterns of large and strong wheels for the heaviest work, and also of lighter useful wheels of all forms, widths, and diameters, from which any requirement may be promptly met 5377
Prices and full particulars on application

WOOD ENGRAVING
Draughtsmen & Engravers on Wood
HARE & Co
31 ESSEX STREET, STRAND
ESTIMATES ON APPLICATION
LONDON



THE PERTH GAUGE GLASS,
Warranted to stand upwards of 1500 lbs. pressure to the square inch, and bear great variation of temperature
These Medals have been awarded for the above-mentioned qualities
JOHN MONCRIEFF, 5265
North British Glass Works, PERTH

THE "INFLUX"



AN INSTANTANEOUS STARTING
AND
AUTOMATIC RESTARTING INJECTOR
Brooke, Holden, & White's Patent.
The only Lifting Injector devoid of Spindles, Levers, Adjustable Internal Parts, or hinged Nozzles which lifts without manipulation and restarts automatically. Instantaneous action on Steam being turned full on. Works equally well lifting up to 12 ft., or as a "non-lifter" Invaluable for Locomotives, Traction Engines, Marine, and other Boilers Can be seen working on application, or reference will be given as to their perfect reliability
SPECIAL NOTE, NO HINGED NOZZLES.
For Prices, &c., apply to
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ST. SIMON WORKS,
SALFORD,
SOLE MANUFACTURERS.—Also Sole Makers of
BORLAND'S 5086
PATENT BOILER DRILL
For Drilling Boiler Shells.
LICENSEES FOR THE SOUTH:
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Representation Agent Required
FOR
SPECIALITIES OF
STEAM FITTINGS, PUMPS, & FILTERPRESSES.



KLEIN, SCHANZLIN, & BECKER,
Frankenthal (Rheinpfalz), Germany. 5359



WATER METERS.

H. FROST'S PATENT.

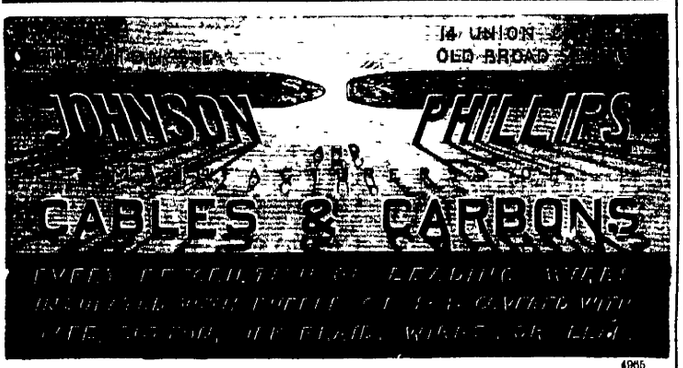
POSITIVE! RELIABLE! DURABLE!

Many Thousands in use both at Home and Abroad.

THE MANCHESTER WATER METER CO., Ltd.

TIPPING STREET, ARDWICK, MANCHESTER.

ESTABLISHED 1860 4438



4966



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BARNETT & FOSTER,

"NIAGARA WORKS,"

25Q, EAGLE WHARF ROAD,

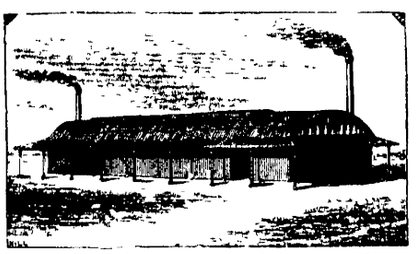
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Have in constant readiness a staff of competent DIVERS, and a large stock of Apparatus, which enables them to undertake on the shortest notice submarine operations of all kinds, requiring skilled and experienced men, such as repairing submerged Pumps, Dockgates, Locks, &c.

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Galvanized and Painted Corrugated Sheets.

IRON ROOFS, IRON BUILDINGS,

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Constructional Iron Work and Smiths' Work of every description. 5027

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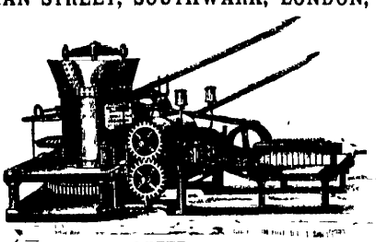
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Sole Manufacturers, THOMAS MIDDLETON & Co., Engineers,

LOMAN STREET, SOUTHWARK, LONDON, S.E.

Patent Steam Driven Cutting Tables.

Patent Lubricating Solid Die, for all sorts of Clay



Patent Plunger Brick Press, for Bricks or Tiles.

Patent Brick Shaping Apparatus, for all kinds of Fancy Bricks.

IMPROVED ROLLER BRICK MACHINE, 12,000 to 40,000 Bricks per day, for Clamp and Kiln Burnt Bricks 5104

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MANN & OWENS' PATENT GAS VALVES

Supplied to upwards of

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THE MOST RELIABLE VALVE MANUFACTURED



Full Way Rack and Pinion Gas Valve

Sizes from 2 in. to 18 in.

All Valves are carefully tested before leaving the Works

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MANUFACTURERS OF

Improved Gas-Exhausters,

Steam Engines, Boilers,

BLAKE'S PATENT STEAM PUMPS

For Tar, Water, and Ammoniacal Liquor

PILLAR VALVES, SELF-ACTING BYE PASS VALVES, OUTSIDE RACK AND PINION-VALVES, HYDRAULIC MAIN VALVES, DISC VALVES



Screw and Cam Gas Valve

Every description of Pumping Apparatus, Hydraulic Lifts, &c., suitable for use in Gas-Works, made to order.

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OF



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BABBITT'S & KINGSTON'S PATENT ANTIFRICTION METALS,

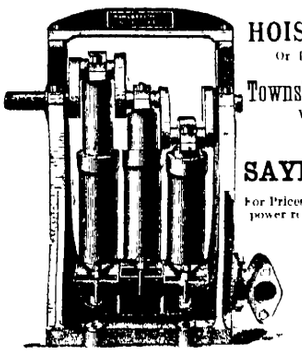
PLASTIC METAL AND WHITE BRONZE.

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Agents—London HAUGHTON & CO., 110, Cannon Street, E.C.
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Scotland P. & W. MACLELLAN, Trongate, Glasgow

JOHN RAMSBOTTOM'S

PATENT WATER ENGINES & STEAM PUMPS



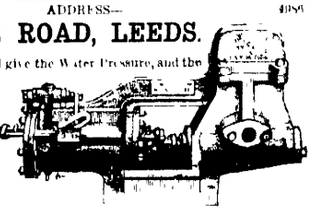
Are for HOISTING USES, Or Driving all kinds of Machines by Towns' Water Pressure Where sufficient

This Pump is UNSURPASSED Either for SIMPLICITY, PRICE, Or for General Efficiency

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For Prices should give the Water Pressure, and the power required

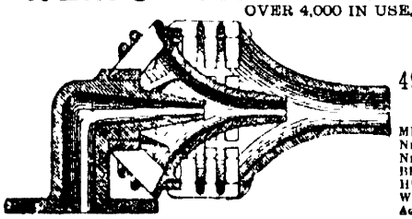


HIGH PRESSURE MARINE BOILERS.

Best and Cheapest Means of Preventing Unequal Expansion.

"WEIR'S" PATENT HYDROKINETER.

OVER 4,000 IN USE.

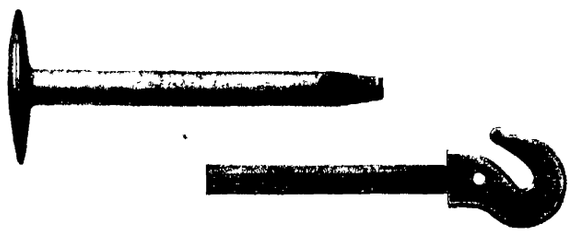


G. & J. WEIR,

49, JAMAICA STREET,

GLASGOW.

MENZIES & BLAGBURN, King Street, Newcastle on Tyne WM. REID & CO., 5, New London Street, London, E.C. A. & R. BROWN, Waterloo Road, Liverpool. R. HUGHES & CO., Fulton Street, ditto W. S. VON ESSEN, Engineer, Hamburg, Agent for Scandinavia & Germany 5281



Apply THE KIRKSTALL FORGE CO., near Leeds 4030

"STANDARD" STEAM BOILING NOZZLE

FOR

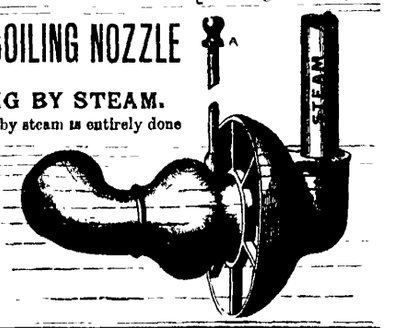
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The objectionable noise when boiling by steam is entirely done away with, and the liquor Heated or Boiled QUICKLY, ECONOMICALLY, and SILENTLY.

½ ¾ 1 1½ 2 3 4 in pipe

50/- 80/- 65/- 100/- 130/- 175/- 260/-

NUMEROUS TESTIMONIALS 4991



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SUGAR, RICE AND FLOUR MILLS,

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Boilers,

LINOLEUM MACHINERY.

SUGAR MACHINERY

JAMES LANDALE,

Engineer, KIRKCALDY, N.B. 4945

East Ferry Road Engineering Works Co., Limited,

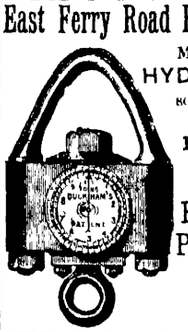
MILLWALL, LONDON, E

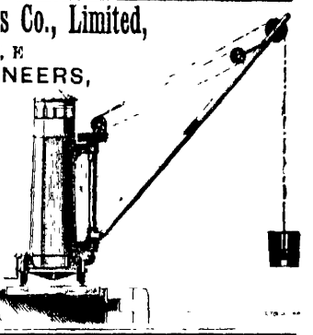
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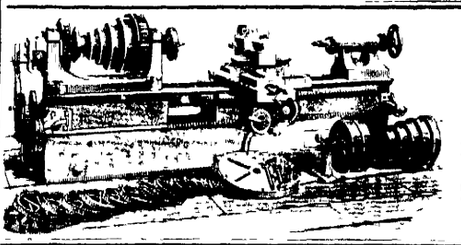
THE BOWLING HOOP

STEEL CASTINGS

THE BOWLING IRON Co LTD BRADFORD YORKS ORIGINAL PATENTEES AND SOLE MAKERS

OF EVERY DESCRIPTION IN IRON OR STEEL

4667



SPECIALITY IN LATHES

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Makers of all kinds of

Improved Self-Acting, Sliding, and Screw Cutting Lathes,

For Foot or Power 5250

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A DEEP GONG from Astern to Ahead

A SHRILL GONG from Ahead to Astern

TELEGRAPH WORKS WATERLOO ROAD,

GLASGOW 50 ANN ST IRON QUAY LIVERPOOL. LONDON 96, FENCHURCH ST

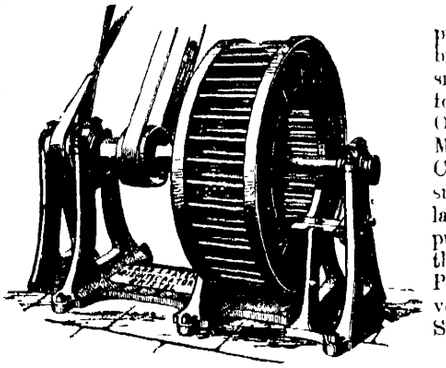
4040

"CARR'S DISINTEGRATOR,"

Registered Trade Mark, No. 6380.

AWARDED BRONZE MEDAL, PARIS UNIVERSAL EXHIBITION, 1878.

CARR'S PATENT DISINTEGRATOR.



This Machine effectually pulverizes by the combined influences of percussion and of centrifugal force, Iron, Zinc, and other Ores, Asphalte, Artificial Manures, Phosphates, Fine Clay, and many other substances It is also largely in use for the pulverization of Coal for the manufacture of Coke, Patent Fuel, &c., and is very effective for mixing Sugar.

These Machines are capable of reducing to a fine granular powder from 50 to 200 tons per day (according to size) of any unfibrous material Machines made to order from 18 inches diameter, to suit special requirements of purchasers, these small machines being specially adapted to the requirements of Chemical Manufacturers for Mixing and other purposes.

No Agents All Machines will in future bear the Registered Trade Mark ("Carr's Disintegrator") in three places—viz on Bedplate, and on outside Face of each Cage

A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee, 2523

PHILIP TRIGGS, Albion Chambers, BRISTOL.

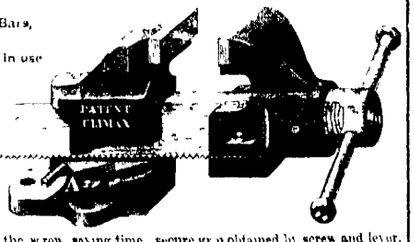
"CLIMAX" Patent PARALLEL VICES.

Steel Jaws and Wrought Iron Sliding Bars,

INSTANTANEOUS in action,

SIMPLE in construction, ECONOMICAL in use

Width of Jaw	Opens	Depth	Price
3 in	6 in	1¼ by 1 in	5/8
4 in	8 in	2 by 1½ in	10/8
5 in	10 in	2½ by 1¾ in	20/8
6 in	12 in	3 by 1¾ in	30/8
8 in	14 in	4 by 2¼ in	50/8



easily and quickly adjusted without using the screw, saving time, secure grip obtained by screw and lever, the best combination for the purpose. Screw is never exposed and only used for tightening the grip, opens double the width of the jaws few and simple in its parts not liable to get out of order, there being no cams, toggles, hooks and clutches strong, and durable, working parts wrought iron and steel

PATENTEES AND MANUFACTURERS 5362

CRAMPTON BROS., 25, West Bar Green, SHEFFIELD

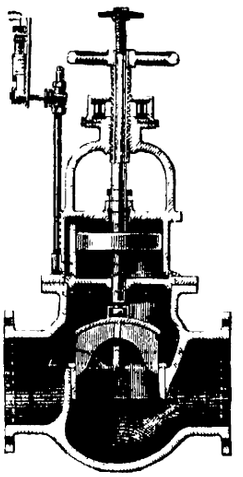
TATE'S PATENT

Electric Valve-Closing Apparatus

FOR STEAM ENGINES.

Medals Awarded AT THE INDUSTRIAL EXHIBITION, BRADFORD, 1882.

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THIS *APPARATUS* IS LARGELY USED ON STATIONARY ENGINES WITH THE GREATEST SUCCESS.

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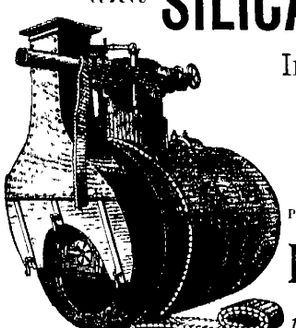


Illustration Showing Application of Silicate Cloth

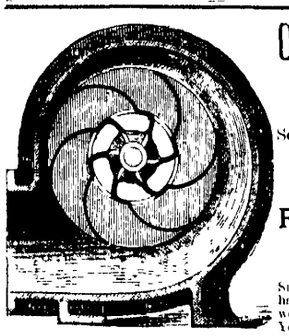
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Best Non-conductor Extant.
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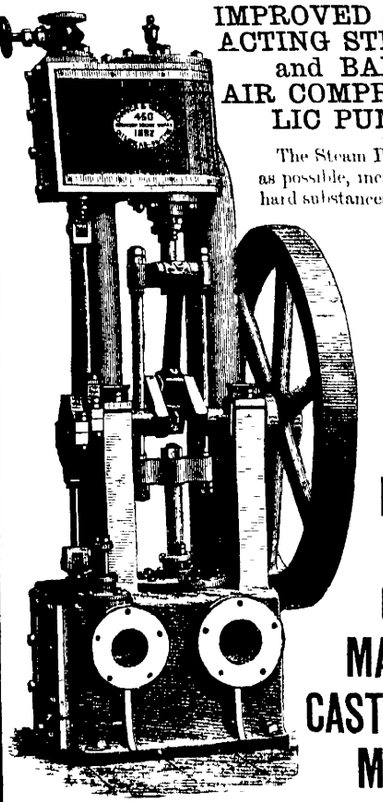
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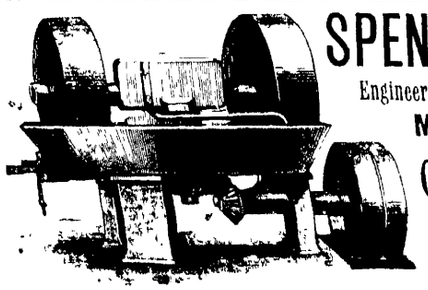
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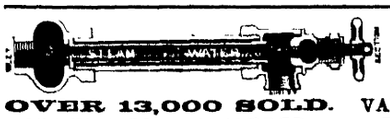
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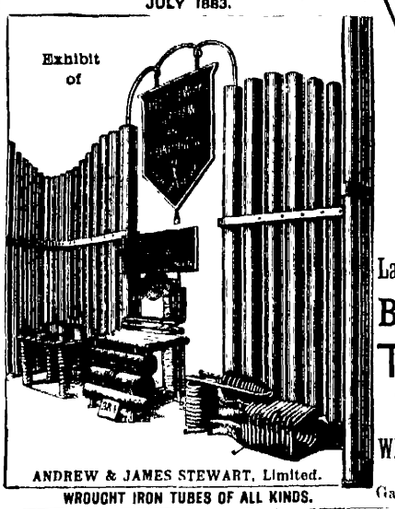
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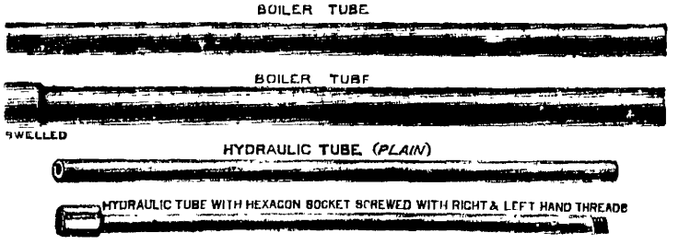
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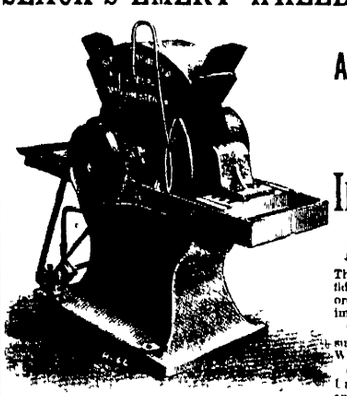
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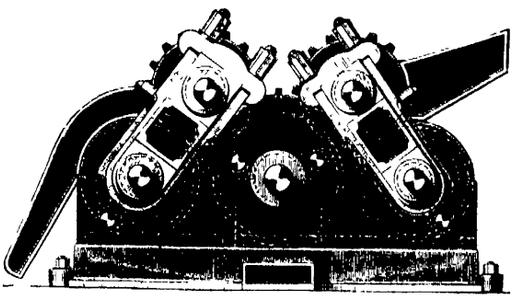


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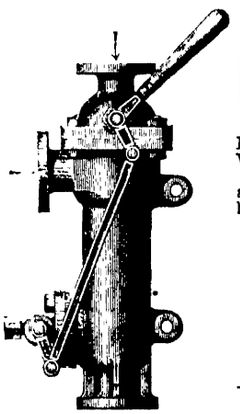
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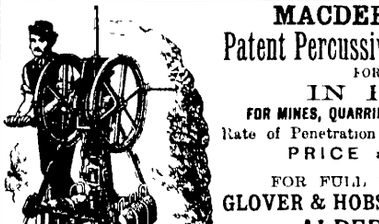
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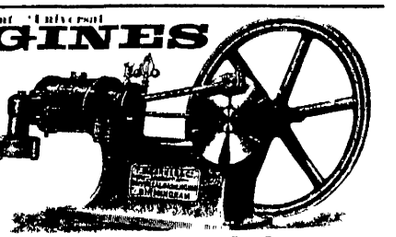
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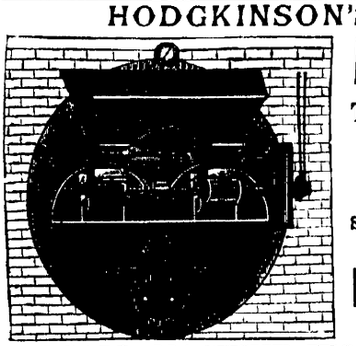
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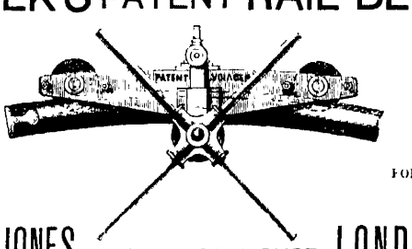
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LONDON OFFICE: 37, WALBROOK. 5270

(See Illustrated Advertisement October 10th, page 0)

VOJACEK'S PATENT RAIL BENDER



FOR PARTICULARS APPLY TO

FOR PARTICULARS APPLY TO 528

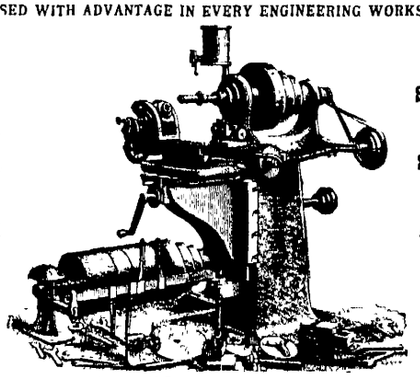
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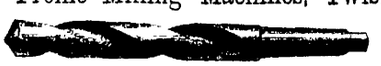
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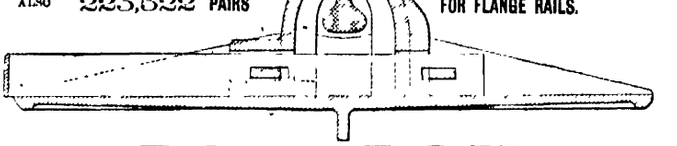
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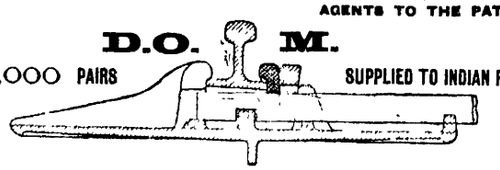
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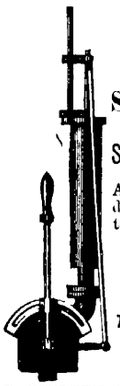
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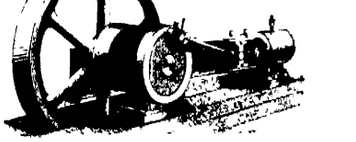
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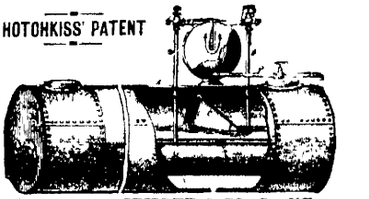
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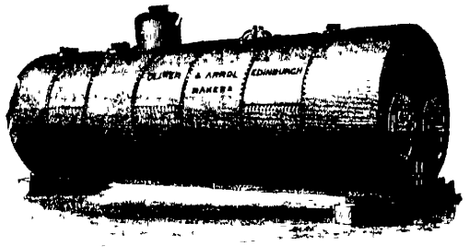
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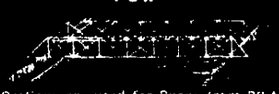
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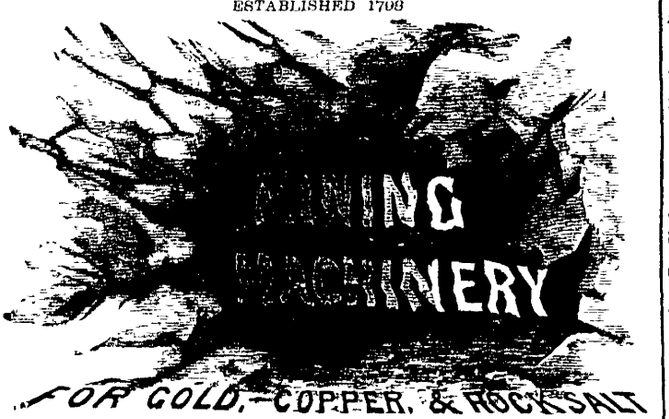
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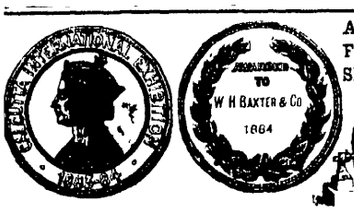
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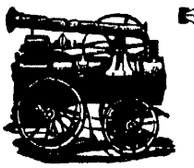
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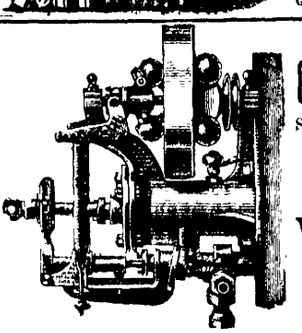
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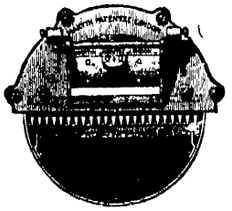
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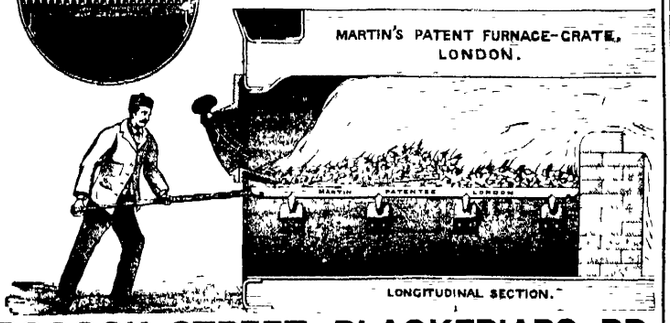
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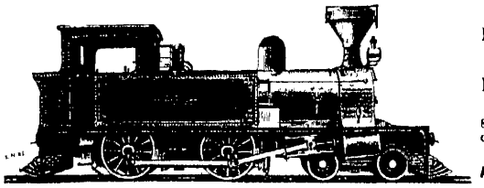
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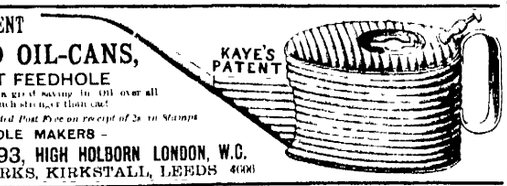
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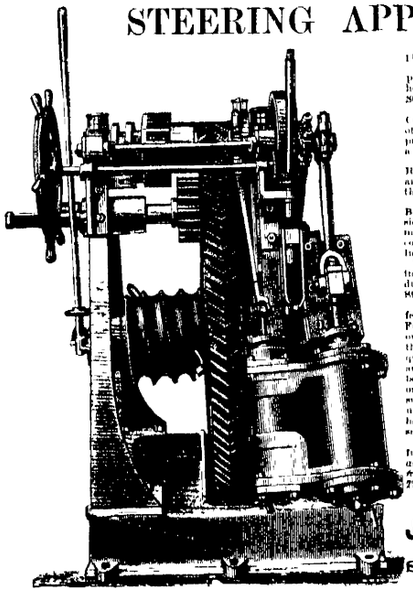
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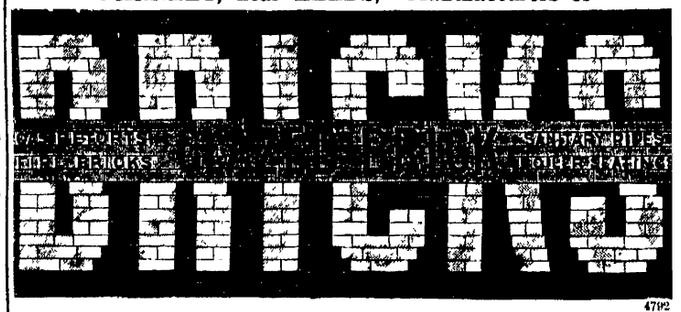
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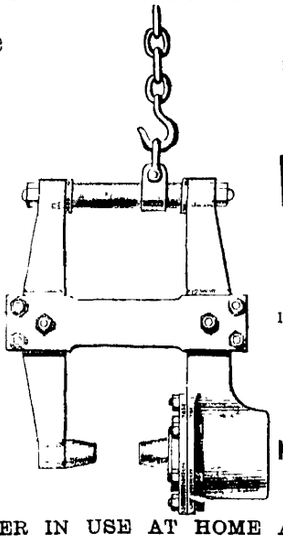
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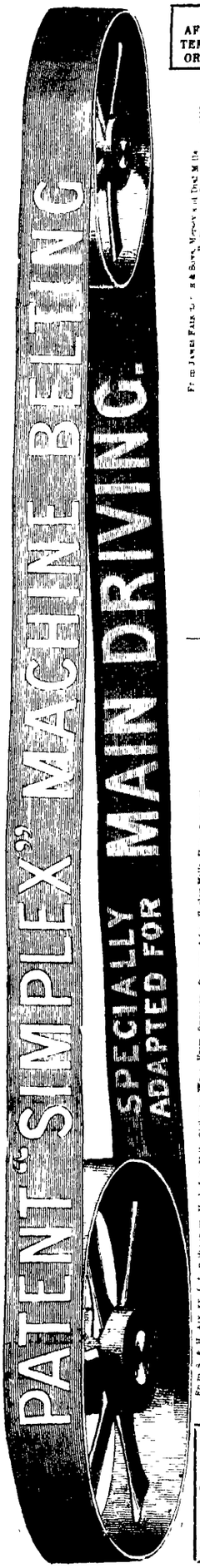
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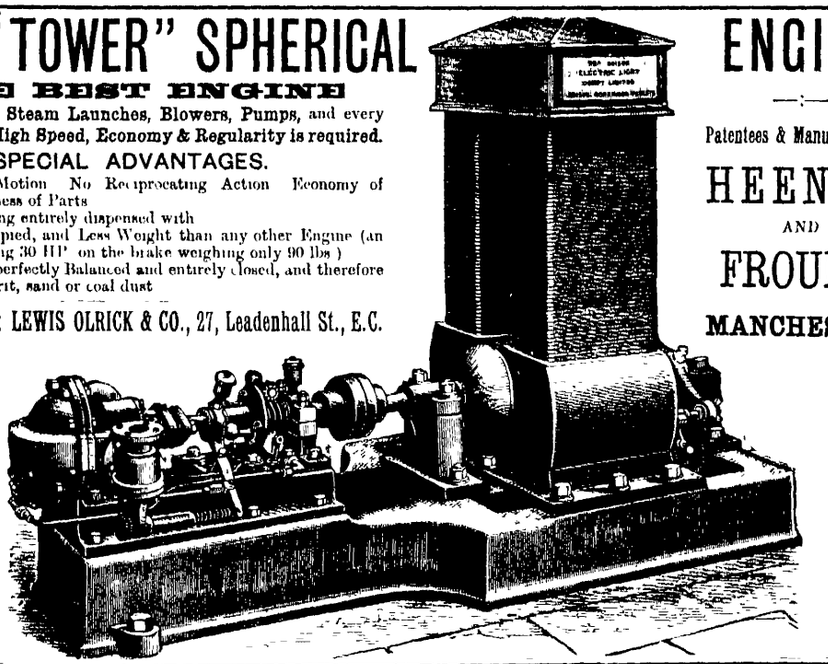
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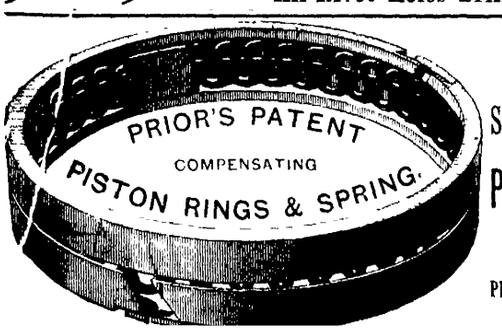
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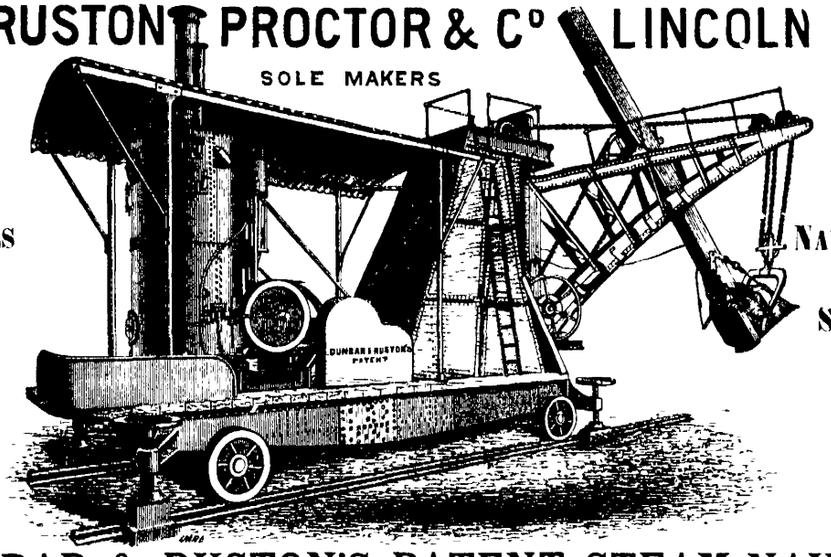
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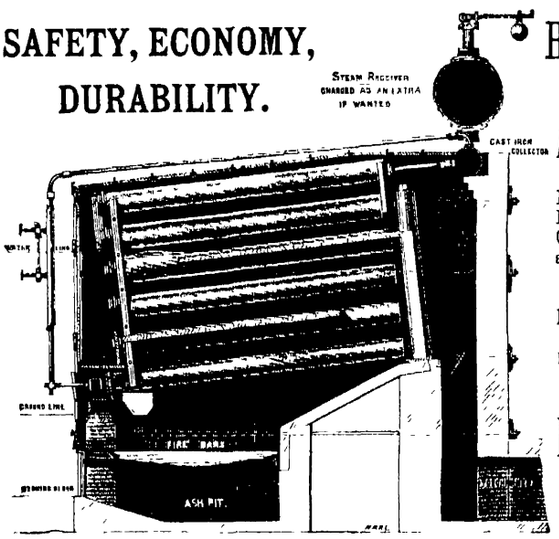
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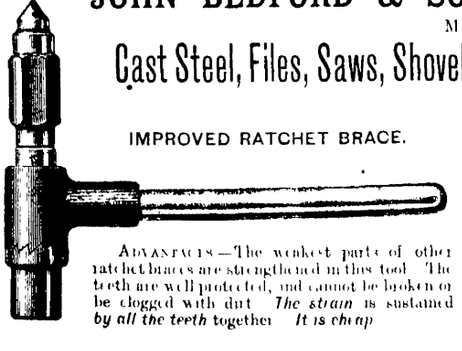
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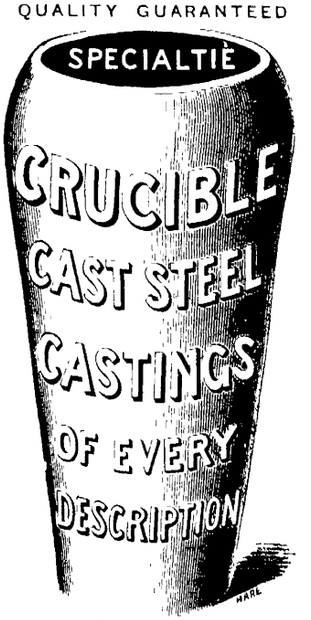
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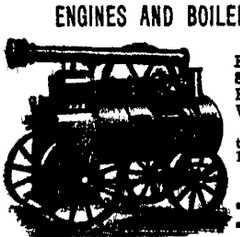
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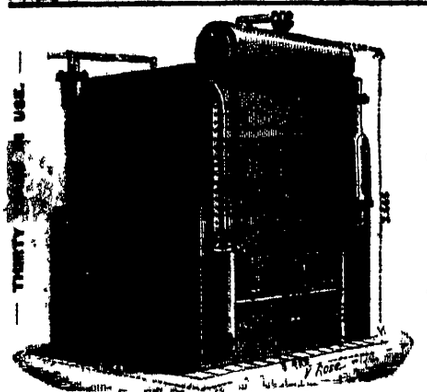
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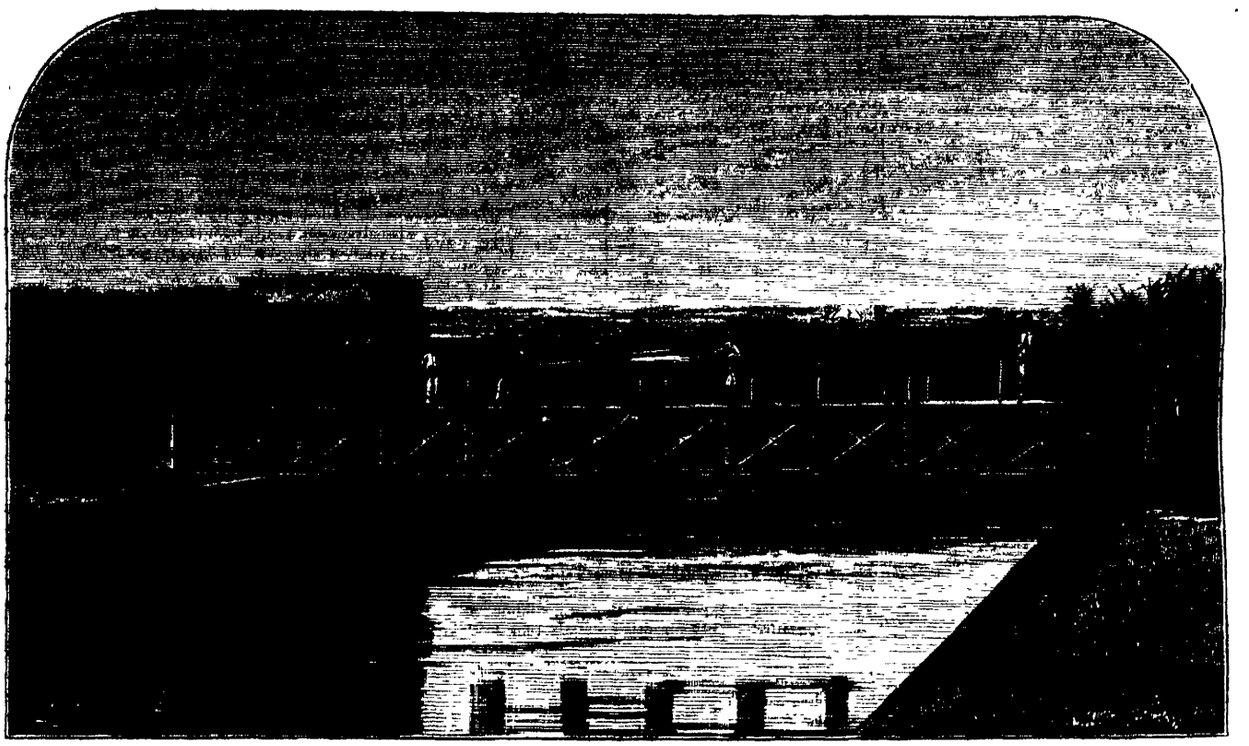
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(*For Description, see Page* 401.)



INTERNATIONAL HEALTH EXHIBITION.

London Water Supply.

(*Concluded from page* 393).

The chapter which deals with the quality of the water supplied is the most interesting in the handbook under notice, and we shall quote from it at some length. It consists of the official report for the year 1883 of Professor Frankland, and the joint report made for the companies by Messrs. W. Crookes, W. Odling, and Dr. C. Meymott Tidy. Professor Frankland tells us he made his first report on samples of the London waters, taken monthly, in the year 1865. At that time all the large towns in the basins of the Thames and Lea freely discharged their raw sewage into these rivers or their tributaries. The water companies, on the other hand, being ill provided either with storage reservoirs or filtering appliances, were compelled to draw from the rivers in times of flood, and the water was not by the treatment rendered even clear and colourless to the eye. The Royal Commission on Water Supply which sat in 1869, reported "that when efficient measures are adopted for excluding the sewage and other pollutions from the Thames and Lea and their tributaries, and for insuring perfect filtration, water taken from the present sources will be perfectly wholesome, and of suitable quality for the supply of the metropolis." Dr. Frankland goes on to point out that the improvements that have taken place in sewage disposal since that date have taken the form of attempts at sewage purification rather than sewage exclusion. "Indeed," says the official analyst, "the expense involved in carrying out any scheme for excluding the sewage from the rivers is so great as to render such a plan practically impossible." The methods adopted for cleansing the sewage of the principal towns in the Thames basin are chiefly systems of irrigation or downward filtration. These yield equally good results when properly carried out, whilst the various methods of chemical treatment effect comparatively little improvement in the sewage, excepting so far as the coarser matters in suspension are concerned. Although the adoption of these several methods may contribute to the improvement in appearance and even chemical quality of the river waters, yet, Professor Frankland goes on to remind us, they offer no guarantee against the admission into the rivers of noxious ingredients capable of spreading zymotic disease, although the risk is no doubt diminished. In the smaller towns and villages in the Thames basin, cesspits are generally used, and the overflow from these usually communicates with the nearest watercourse; whilst in other cases the street drains convey sewage matter into the nearest running water. Thus the River Thames still receives much raw sewage matter, together with the effluents from sewage works.

The water companies have, however, done much towards improving the quality of the water supplied by them, chiefly by means of increased storage accommodation and more efficient filtering appliances. Larger storage capacity enables the companies to exercise more discrimination as to the times at which they can draw their supply from the river, and periods of flood, when the water is turbid, can generally be avoided. Thus in the year 1868, out of 84 samples of distributed river water, there were only 48 clear, whilst last year out of the same total number 73 samples were clear. Moreover, all the 11 turbid samples in the past year were only "slightly turbid," whilst in 1868 out of 36 turbid samples, 20 were "slightly turbid," 9 "turbid," and 7 "very turbid." The occurrence of moving organisms in these turbid waters is now much rarer than in former years. In 1869 they were seen altogether 24 times, or in 80 per cent. of the turbid samples, whilst last year they were only observed on six occasions, or in 55 per cent. of the comparatively few turbid samples. Two Tables referring to this part of the subject are quoted further on. When the rivers are in protracted flood the water distributed generally contains a large proportion of organic matter, and in 1860 that drawn from the Thames and Lea contained a larger proportion than in any year during which the analyses have been made. But we are again reminded, even with organic pollution at its lowest point, there is no guarantee against germs of zymotic disease being present in the water distributed. Dr. Frankland says he is informed that several of the companies drawing their supplies from the Thames and Lea are impressed with the necessity of abandoning these sources, and some have already completed works for using subterranean waters. Such works deserve every encouragement.

The following tabulated data, taken from the report, further illustrates the points discussed.

Comparative Proportions of Organic Impurities Present in Water delivered in London.

Year	Thames Water	Lea Water	Deep Well Waters
1868	1000	484	264
1869	1016	618	312
1870	795	550	246
1871	928	604	150
1872	1243	819	221
1873	917	693	250
1874	993	583	287
1875	1030	751	250
1876	993	562	246
1877	907	596	243
1878	1056	747	323
1879	1165	947	387
1880	1254	1013	398
1881	993	705	405
1882	1033	711	400
1883	950	620	321

It will be seen from the above that the water of the Lea is purer than that of the Thames, a fact which is probably opposed to popular belief; whilst the proportion of organic matter in the deep well waters is but little more than one-half of that in the Lea, and considerably less than one half of that in the Thames. The amount would have been even less but for extensive alterations which were being made at the works of the Tottenham Local Board of Health. The improvement observed during last year in the Thames water is attributed to the more energetic action of the conservators and the greater storage capacity of the companies reservoirs.

The maximum amount of organic pollution nearly always occurs during the winter months both in the Thames and Lea. During the last sixteen years the worst results in this respect have been obtained from the Thames during the month of January on six occasions, February three times, March once, October twice, November twice, and December three times. In 1872 January and December were coupled as being equal. For the River Lea the record for a corresponding period was January three times, February five times, March twice, June once, July once, November once, December three times.

Table showing the Temperature and Relative Amounts by Weight of Impurities, &c., contained in 100,000 Parts of the different Companies' Waters during the Year 1883.

Name of Company or Local Authority	Temperature in Centigrade Degrees.	Total Solid Matter.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Combined Nitrogen.	Chlorine.	Total Hardness.
Inner Circle.									
Thames									
Chelsea	11 9	27.12	.156	080	.000	.198	.223	1.5	19 1
West Middlesex	12.7	27.76	184	.083	0	.206	.238	1 5	19.7
Southwark	12.9	28 52	184	.029	0	.206	.215	1.5	20 1
Grand Junction	12 2	28 07	164	084	0	199	234	1 5	19 9
Lambeth	11.8	29 30	184	080	0	.222	222	1.6	20 6
Lea									
New River	11.8	28 48	.106	.021	0	.255	.286	1 6	20.4
East London	11 4	30 12	.148	025	0	.290	255	1.7	20.8
Deep Wells:									
Kent	12 1	41.71	050	.015	0	.470	.484	2 6	28 0
Outer Circle									
Colne Valley	.	15 56	.058	016	.001	.489	.456	1.7	7 1
Tottenham Local Board	.	29 04	.077	.022	.050	.057	.120	2.7	22.5

Note.—The numbers in this Table may be converted into grains per imperial gallon by multiplying them by seven and then moving the decimal point one place to the left.

The above Table has been compiled from data contained in the report.

A comparison can be made of the proportional amount of organic elements in the waters of the different companies named for the year 1883 by means of the following figures, the average amount found in the Kent Company's water during the nine years ending December, 1876, being taken as unity:

Chelsea	3 1
West Middlesex	3.7
Southwark	3.6
Grand Junction	3.4
Lambeth	3.6
New River	2 2
East London	2 9
Kent	1.1
Colne Valley	1 2
Tottenham Local Board	1 7

In further explanation of the above Table, the following points are noted,

With regard to temperature, the water distributed by the Chelsea, West Middlesex, Southwark, Grand Junction, and Lambeth Companies varied from 3.1 deg Cent. (37.6 deg. Fahr.) in March to 22 0 deg. Cent. (71.6 deg Fahr.) in July. The Lea water from the New River and East London Companies varied from 3.4 deg. Cent. (38.1 deg. Fahr) in March to 20.0 deg. Cent. (68.0 deg. Fahr.) in July. The deep well water of the Kent Company varied in temperature from 3 4 deg. Cent (38.1 deg. Fahr) in March to 15.5 deg. Cent. (59.9 deg. Fahr.) in June. Thus the temperature of the well water was more equable, it remaining of an agreeable coolness in summer when the river waters became warm and unpalatable.

In dealing with the second column of figures, it is remarked that a large proportion of the solid matter consists of mineral salts, which are quite unobjectionable in drinking water, although they are very undesirable in that used for washing or manufacturing purposes. A small portion of the solid matter is, however, organic. That which is of a vegetable nature is said not to be objectionable in small quantities in drinking water, but organic matter in river water which receives sewage may at any time become objectionable to health. The greatest amount of total solid matters was found in the deep well water of the Kent Company and that of the Tottenham Board of Health, whilst the Colne Valley Company's water contained very far less, although obtained from the same source. The latter company uses Clark's softening process, which is carried out by means of lime, and it is stated that the other metropolitan waters could be brought to about the same state by a similar treatment.

The question of organic impurities has already been considered. It will be valuable, however, to quote the following figures, as they show the maximum and minimum organic elements (organic carbon and organic nitrogen) noted in the course of twelve months. This is an important point, as an excessively impure supply of water concentrated within a single week, or even a single day, might do more harm than a larger proportion of impurities distributed over a longer period of time. The figures refer to the year 1883, and the Kent Company's average for nine years ending 1876 is again taken as unity.

Source.		Maximum	Minimum	Average
Deep Wells	Kent	1.5	0.9	1.1
	Colne Valley	1.6	1.0	1.2
	Tottenham	2.3	1.1	1.7
River Lea	New River	3 6	1.3	2.2
	East London	5.0	1.9	2 9
River Thames	Chelsea	4.7	2 0	3 1
	West Middlesex	5.7	2.0	3 7
	Southwark	6.6	1.9	3.6
	Grand Junction	5.3	2.4	3.4
	Lambeth	5.7	2.0	3.6

We will extract two more Tables from Professor Frankland's valuable report, and must then refer our readers to Sir Francis Bolton's volume or to the original report for other details that may be required:

Results of Observations Respecting the Efficiency of the Filtration of the Waters of the Thames and Lea during the Year 1883.

Companies or Local Authorities.	Number of Occasions when Clear and Transparent.	Number of Occasions when slightly Turbid.	Number of Occasions when Turbid.	Number of Occasions when very Turbid
Thames				
Chelsea	11	1	0	0
West Middlesex	11	1	0	0
Southwark	7	5	0	0
Grand Junction	9	3	0	0
Lambeth	11	1	0	0
Lea				
New River	12	0	0	0
East London	12	0	0	0
Deep Wells				
Kent	12	0	0	0
Colne Valley	12	0	0	0
Tottenham Local Board of Health	11	0	0	1

The turbid sample of the Tottenham water was collected when alterations were being made in the bore hole.

The sediment deposited by the turbid waters on standing was in every case examined microscopically. During the past year these examinations revealed the presence of moving organisms in three samples of the Southwark Company's water, whilst one sample of the Chelsea, Grand Junction, and Lambeth Companies' waters respectively exhibited the same phenomenon, as did also the sample of the Tottenham water.

The following Table gives the results of these microscopic examinations made during the past fifteen years:

Number of Occasions when Moving Organisms were Found.

Company.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
Chelsea	3	2	2	3	2	5	4	4	1	0	2	0	0	0	1
West Middlesex	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Southwark	3	1	4	1	2	5	3	7	5	3	1	0	0	0	3
Grand Junction	4	1	1	2	3	3	7	3	3	1	1	2	0	0	1
Lambeth	5	0	4	6	3	4	5	4	1	1	0	2	1	1	1
New River	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0
East London	4	3	3	1	0	2	0	0	0	0	2	0	0	1	0
Kent	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Colne Valley	..	..	..	..	..	..	..	..	..	..	0	0	0	0	0
Tottenham	..	..	..	..	..	..	..	..	..	..	0	0	0	0	1

The report of Messrs. Crookes, Odling, and Tidy, the analysts to the water companies, follows that of Dr. Frankland. A good deal of stress is laid on the colour of the water supplied. A large number of samples have been examined by means of the colorimeter, and the results recorded, in a graphic form, by means of curves plotted according to the state of the examples operated upon. The colorimeter was designed by Messrs. Crookes, Odling, and Tidy especially for the purpose of determining with something like scientific accuracy the varying degrees of clearness or turbidity of the water. Two hollow wedges, one opposed to the other, are filled with blue and brown liquids respectively, so as almost exactly to imitate the varying tints of potable water. In this way a certain definite value can be fixed for the arbitrary terms of "turbid," "slightly turbid," or "very slightly turbid," hitherto used. The use of the coloured wedge, and also of the hollow wedge filled with a coloured solution, are, as the analysts point out, by no means new, but the application of the two wedges is decidedly a step in advance.

The results of the analyses of the 2224 samples examined last year show that 32 samples were very slightly turbid, five slightly turbid, and 2187 were perfectly bright, clear, and well filtered. In three of the slightly turbid samples the result was due to the fact of works being carried out in connection with the supply of the neighbourhood. It has also been found that throughout the year (1883) practically the water was fully aërated or oxygenated. The framers of this report were the first to institute a series of experiments on an extensive scale to determine the amount of free oxygen in potable water, and the extension of the subject is still engaging their attention. The growing importance attached to the purifying effects of oxygenation will render the results of great interest. Out of 318 samples tested for ammonia and organic matter, on two occasions $\frac{1}{333}$rd part of a grain per gallon, and on five occasions $\frac{1}{143}$th part of a grain of free or saline ammonia per gallon were discovered. On forty-eight occasions the $\frac{1}{1000}$th part of a grain per gallon was recorded, whilst 263 examinations revealed no appreciable trace of ammonia whatever. The quantities of nitrogen, as nitrates and nitrites, and of chlorine, were estimated from daily samples. The former ranged from about 0.150 to 0.225 of a grain per gallon, the quantity being on the average somewhat lower in the summer and autumn than in the winter and spring. The quantity of nitrogen existing in the form of ammonia and of organic matter, together with that in the form of nitrates and nitrites, constitute the total combined nitrogen of the water. It is from this quantity that Dr. Frankland calculates the previous sewage contamination. According to the present report the nitrogen amounts to about one-third that met with in the spring water supply. The quantity of chlorine amounts throughout the year to close upon, or a little over, one grain per gallon, corresponding to about one and three-quarters of a grain per gallon of common salt. With regard to the remaining question of "hardness," it is stated that the mineral matter held in solution consists mainly of the carbonates of the alkaline earths, with a small quantity of sulphates, nitrates, and chlorides. These salts, it is stated, are beneficial rather than prejudicial to the animal economy.

The report concludes with some general observations animadverting on the reports of Dr. Frankland. No exception is taken to the official analyst's strong dislike to the river sources from which 90 per cent. of the water supply of London is derived, or generally to the actual analytical results set forth in his tables. The water companies' analysts do however protest most strongly against what they style Dr. Frankland's peculiar modes of statement, and the comparisons he employs, made "with the obvious intent to disparage the river water supply and exalt the well-water supply of the metropolis." The statement is quoted (contained in the report of the Royal Commission on Water Supply) "that a minute portion of organic matter, variable in amount with the season, is a normal constituent of river water; and there is no reason whatever to consider this proportion of natural organic matter is in any way prejudicial to health; and that there is absolutely no chemical evidence to indicate that the minute proportion of organic matter present in the water supply of London is different, either in quantity or kind, from the natural organic matter of the river." Lake water, it is said, such as is usually resorted to for town supply, contains, for the most part, about the same proportion of organic matter as is present in river water; while good spring water is characterised by containing a considerably

smaller proportion of organic matter than either, although it has a considerably higher proportion of total nitrogen. Messrs. Crookes, Odling, and Tidy consider that the notion that spring water is the proper type of what metropolitan water should be, "is a notion entirely without foundation." We have not space to follow the discussion in detail, but the general contention of the supporters of the existing source of supply appears to be that the quantity of organic matter contained in the samples of water analysed is so small as to be within the limits of wholesomeness. There is, however, one passage in the report worth quoting: "Whether or not," say the water companies' analysts, "variations—it may be relatively large, but always falling within the limit of a very small absolute quantity per gallon—are matters of any real significance, must obviously depend on the character of the dissolved organic matter present in the different waters, or in the same water at different times. We are not unmindful of the predominant importance of this consideration, and should any charges be made impugning the wholesomeness of London water by reason of the ascertained nature of the small proportion of organic matter which it is found to contain, we shall, as we believe, be prepared to meet these charges; or undoubtedly failing this, to admit them."

We are afraid that the above sentences will only half reassure the doubting consumer. "Organic matter," in connection with potable water, is looked on by the ordinary lay mind as a suspicious characteristic, and although it may be a wise maxim in the law to consider every man innocent until proved guilty, few of us are prepared to carry this charitable doctrine into questions of water supply.

There is one term—of all others the most ominous to the ears of the water-drinker—which we miss from the report of the scientific advisers of the water companies, although it occurs in that of the official analyst. Last year Dr. Frankland found, by microscopic examination, "moving organisms" on seven occasions in the monthly samples of water analysed. Whether Messrs. Crookes, Odling, and Tidy would consider these examples of organic matter as being "within the limits of wholesomeness" we have no means of judging by the extracts which Sir Francis Bolton quotes. It is a point on which the unscientific public would be glad for a little comforting reassurance; although in any case we think ordinary consumers would prefer to take their water without "moving organisms" of any kind, especially in view of the threat of cholera next year.

The next section of the handbook is devoted to a history of the London water works, treating the subject in brief from the time of the foundation of each of the companies respectively. In an early volume of ENGINEERING* we devoted a good deal of space to this subject, and by means of a series of articles, which were very fully illustrated, gave the then existing state of the different works and the machinery employed at the time. We shall now therefore merely glance at this part of Sir Francis Bolton's work.

We commence with the company of the Proprietors of the Kent Water Works incorporated in the year 1809. This company has entirely abandoned the original source of supply, the river Ravensbourne, and draw only from five wells in the chalk situated at Deptford, Plumstead, Crayford, Shortlands, Shooters' Hill, and Farnborough. The figures of Dr. Bernay's analysis of the Kent Company's water occupy several pages.

The greater part of the space devoted to the New River Company's Works is occupied by the early days of this historic company, which was founded two centuries and a half ago.

The East London Water Works Company, which sprung out of the Shadwell Water Works founded in 1669, has nine stations. At Old Ford a Cornish pumping engine, erected by the company in 1807, is still at work and doing good duty.

The rise and progress of the Southwark and Vauxhall Water Works is given in an interesting manner. It appears that the borough of Southwark has enjoyed the advantages of an artificial water supply for over three hundred years, for the London Bridge Water Works extended their operations to that quarter of the metropolis in the year 1582. At the present time this company is engaged in sinking a deep well to the chalk on land that has been acquired at Streatham.

The West Middlesex Water Works Company received incorporation in 1806; the districts supplied including the parishes of Hounslow and Kensington and intermediate parts. Operations have, however, not been carried further west than Kew Bridge, although on the north the mains are laid to Hendon. Within the last two years some excellent new machinery by Messrs. Simpson and Co. has been erected at the Hammersmith pumping station, and considerable additions have recently been made to the subsiding reservoirs on the Surrey side of the Thames. The supply of water is carried under the Thames in a conduit from the reservoirs to the pumping station.

The Grand Junction Water Company sprung out of the Grand Junction Canal Company, the latter body, in the year 1798, having obtained powers which enabled them to supply their canal water for domestic purposes. In 1811 the water supply was transferred to a separate company which continued to draw its water from the canal until the year 1819, when the source of supply was transferred to Chelsea. In 1835 the intake was placed at Kew Bridge and remained there until the Act of 1852 compelled all companies to go above the tideway for their supply The area supplied extends from the intake at Hampton to the original district at Paddington.

A very interesting account is given of the Lambeth Water Works from the time of their first Act in the year 1785. The way in which the original works in Belvedere-road, close to the southern end of the footway over the present Charing Cross Railway Bridge, have grown into the existing undertaking, is pleasantly told. At the present time the company's service is laid down from the intake at Molesey to Beckenham. The account of this company's rise and progress and present position is the most complete and best written of the series.

The Chelsea Water Works Company received its first charter in 1723, and drew its supply direct from the Thames at Chelsea. The present type of filter beds was first introduced by the company in the year 1829, they having been designed and constructed by the late Mr. Simpson, the company's engineer. The district is a small although important one, and comprises that part of the metropolis which lies in the bight of the river running between Hammersmith and Westminster Bridges. The intake was first carried to Surbiton, and finally to a point about half a mile below Sunbury Lock.

A separate map of each district is given in the handbook, besides which there is a large Table setting forth the amount of capital, income, expenditure, &c., for each company. We do not propose, however, to deal with the financial aspect of the question in the present instance, as we shall go somewhat fully into the matter on another occasion. In the remaining part of the book there is a description of the old London Bridge Water Works, which has been reprinted from the *St James's Gazette*, following which is an appendix containing the statutory duties and powers of the water companies, rates of supply, and other points of general legislation. A second appendix gives a brief description of the Water Companies' Pavilion at the Exhibition.

On the whole, no doubt Sir Francis Bolton has put the resources his official position gives him to a good use, and has produced a work which fairly well fills the position he claims for it as a water consumers' *vade mecum*; although on account of the size of the volume we must not take the expression in too literal a sense.

* See ENGINEERING, vol. ii., pp. 164, 184, 230, 252, 274, 296, 341, 377, 394, and 401.

COTTRAU'S PORTABLE BRIDGE.

In our issue of August 15 last we illustrated Mr. Alfred Cottrau's system of portable bridges, in which rectangular braced frames are bolted together to form a girder, frame being added to frame until the required length to cross the span is obtained. This week, on page 399, we give a perspective view of such a bridge, which has been erected on the River Sarno at Castellamare. The span is 22.5 metres (73 ft. 9 in.) and is crossed by two girders containing eleven frames each. Above these there is a light roadway with a railing at each side.

METALLURGICAL NOTES.

Condensation of Sulphuric Acid Gas.

In the *Berg- und Huettenmännische Zeitung*, No. 42, 1884, there is a description, with illustrations, of a somewhat complicated and elaborate apparatus in use at Rosdzin, in Silesia, and patented by the owners of the works. The sulphurous gases from the calcining furnaces are taken to a lead-lined tower packed with coke, flints, or any other suitable material, in the usual manner, down which water trickles from a cistern on top of the tower; the water absorbs the sulphurous acid gas, and also the sulphuric acid and soluble sulphates which may be carried over from the calciners. It then flows out of the bottom of the tower, and is taken through a lead pipe to a series of closed shallow lead pans, a dozen in number, arranged one above the other in a firebrick chamber, through which pass the hot gases from the calciners on their way to the condensing tower. The lead pans communicate with each other by lead pipes, placed in diagonally opposite corners, and arranged so that the liquor is taken out from the top of each pan and flows into the bottom of the pan below it. The hot gases passing around and between the pans cause the liquor to leave the lowest pan at considerable heat. This hot liquor then rises, through another lead pipe, to the top of a smaller tower, of cylindrical shape, and lined with lead, in the centre of which revolves a shaft, covered with lead and having several discs of lead attached to it. These discs, revolving on the shaft, alternate with fixed ledges or shelves on the sides of the tower, and as the liquor flows down in a cascade over these ledges and discs, it is broken up into very fine spray. At the same time a current of hot air is passing up the tower, and takes up and carries away the sulphurous acid gas which is liberated from the hot spray. It is drawn off from the top of the tower and led away to the sulphuric acid chambers, or other point at which it may be desired to further operate with the sulphurous acid. The hot liquors which have thus been freed from the sulphurous acid taken up in the condensation tower, flow into a long closed cistern of lead, through which pass a large number of lead tubes, arranged like a surface condenser The air which is to pass into the spray tower is first forced through these tubes, which are surrounded by the hot liquor, and is in this way warmed. The apparatus is so made that the pipes expose sufficient surface to completely cool down the liquor, which then leaves the cistern and is pumped up to the top of the condensation tower, to again absorb sulphurous acid, &c., and perform the same round. The warm air from the lead tubes is taken through heaters, which are exposed to the hot gases coming from the calciners, and being thus made quite hot, passes into the spray tower as described. By continually circulating in this manner, the liquor finally takes up a considerable amount of sulphuric acid and soluble sulphates, and when sufficiently concentrated a portion is drawn off and is evaporated down in lead pans, a corresponding quantity of fresh water being added in the condensation tower.

Use of Blast-Furnace Slags.

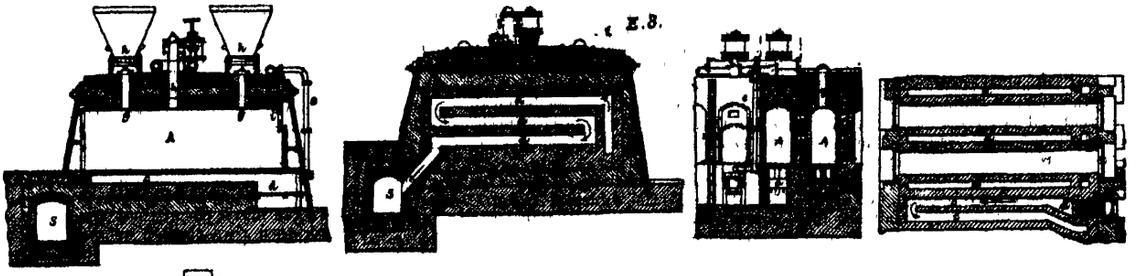
At Stuttgart, sand made from blast-furnace slag has recently been used largely for laying on the public promenades. It is found very clean, as it does not get muddy in wet weather, nor very dusty in dry weather. It is brought from the works at Wasseralfingen, some fifty miles away, and costs 4½ marks, or 4s 6d. per cubic metre, at Stuttgart, as against 7 to 9 marks for good river sand.

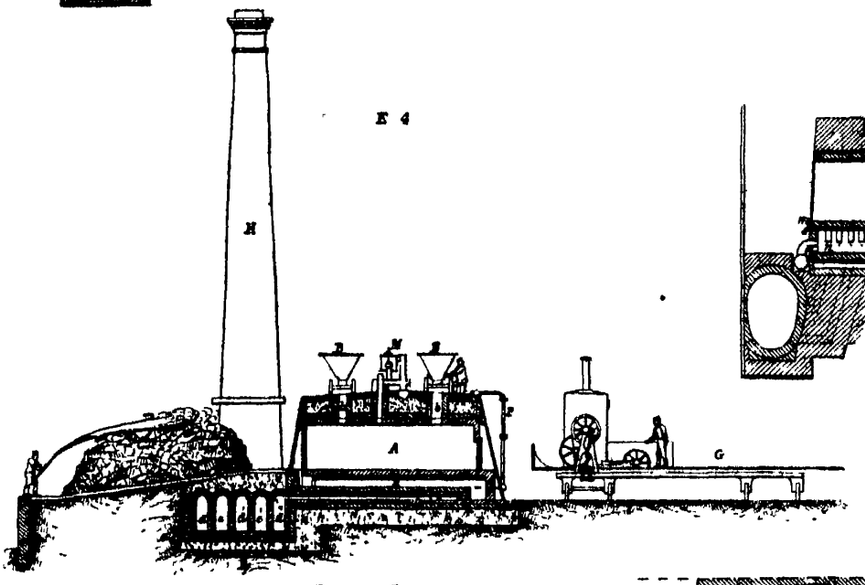
Production of High-Grade Ferro-Manganese.

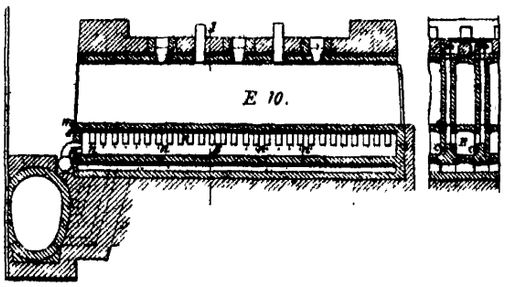
C. Stockmann has recently published in the *Engineering and Mining Journal* the results of his experience in 1877 at the Phœnix Works in Germany, which confirmed the theory he had formulated as the result of previous observations. Herr Stockmann asserts that the secret of the successful production of high-grade ferro-manganese lies in the use of a large proportion of lime in the charge, and he lays it down as a rule, that in the cinder the oxygen in the lime, plus that in the magnesia and alumina, must equal or exceed in amount that which is present in the silica. He cites the following results as proof of this rule. On April 23, 1877, he began charging furnace with mixture of ores as follows. 33.6 per cent. of Auxbach ore (42 78 per cent. iron and 7.22 per cent. manganese), 34.3 per cent of Eisengarten ore (47.19 per cent iron, and 10 97 per cent. manganese), and 32.1 per cent of Heinrich ore (27.84 per cent. iron, and 15.63 per cent. manganese). The ore charge contained 42.12 per cent. iron, 11 31 per cent. manganese, and 18.37 per cent. silica. Following the former practice of working in the Siegen district (*at one time the exclusive home of the manufacture of* spiegeleisen) this would have yielded a 10 to 11 per cent. spiegel. As soon as the charges had come down the iron carried 10 per cent. manganese, and quickly rose to 17.67 per cent., the charge of lime being 45 per cent. Theoretically the iron ought to have carried 19.89 per cent. manganese, so that the quantity actually reduced was 81.3 per cent. The cinder contained 30.85 per cent. silica, 8.33 per cent. alumina, 43.02 per cent. lime, 6.50 per cent. magnesia, 0 41 per cent. iron, 3.28 per cent. manganese, and 2.85 per cent sulphur. The oxygen ratio between the silica and all the bases was as 10 to 11.42. On May 1 the ore charge was changed as follows: 40.1 per cent. of Cartagena ore (22.59 per cent. iron and 27.08 per cent manganese), 26.3 per cent. of Auxbach ore, and 33 6 per cent. of Heinrich ore. This gave a charge carrying 30.96 per cent. iron, 18.12 per cent. manganese, and 17.45 per cent. silica. With 39 per cent. of lime the furnace

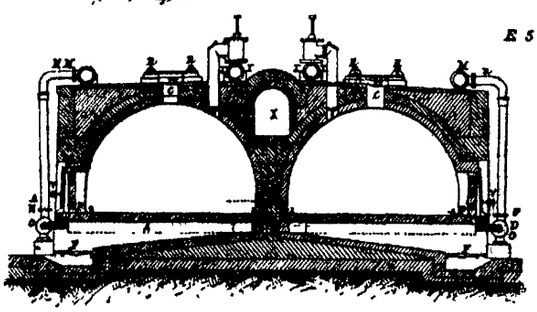
TYPES OF COKE OVENS.

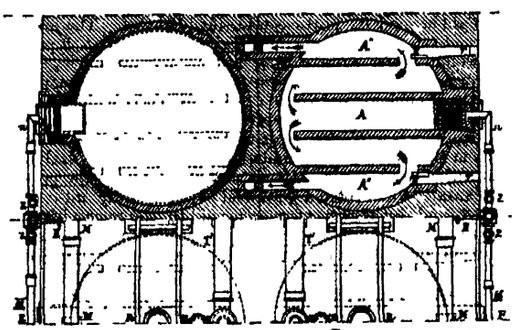
(See Column E of Professor Watson Smith's Table, Page 306 ante.)

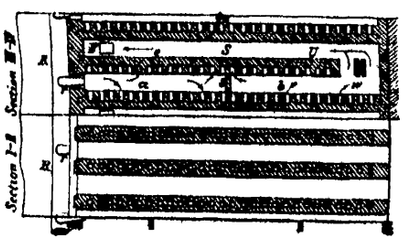


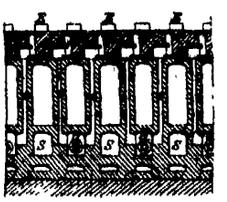


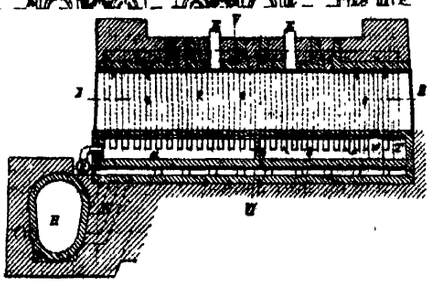


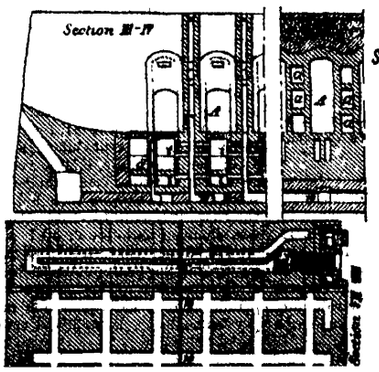


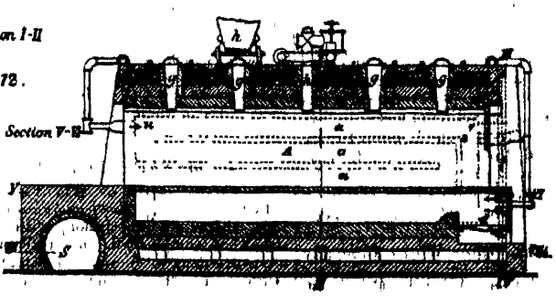






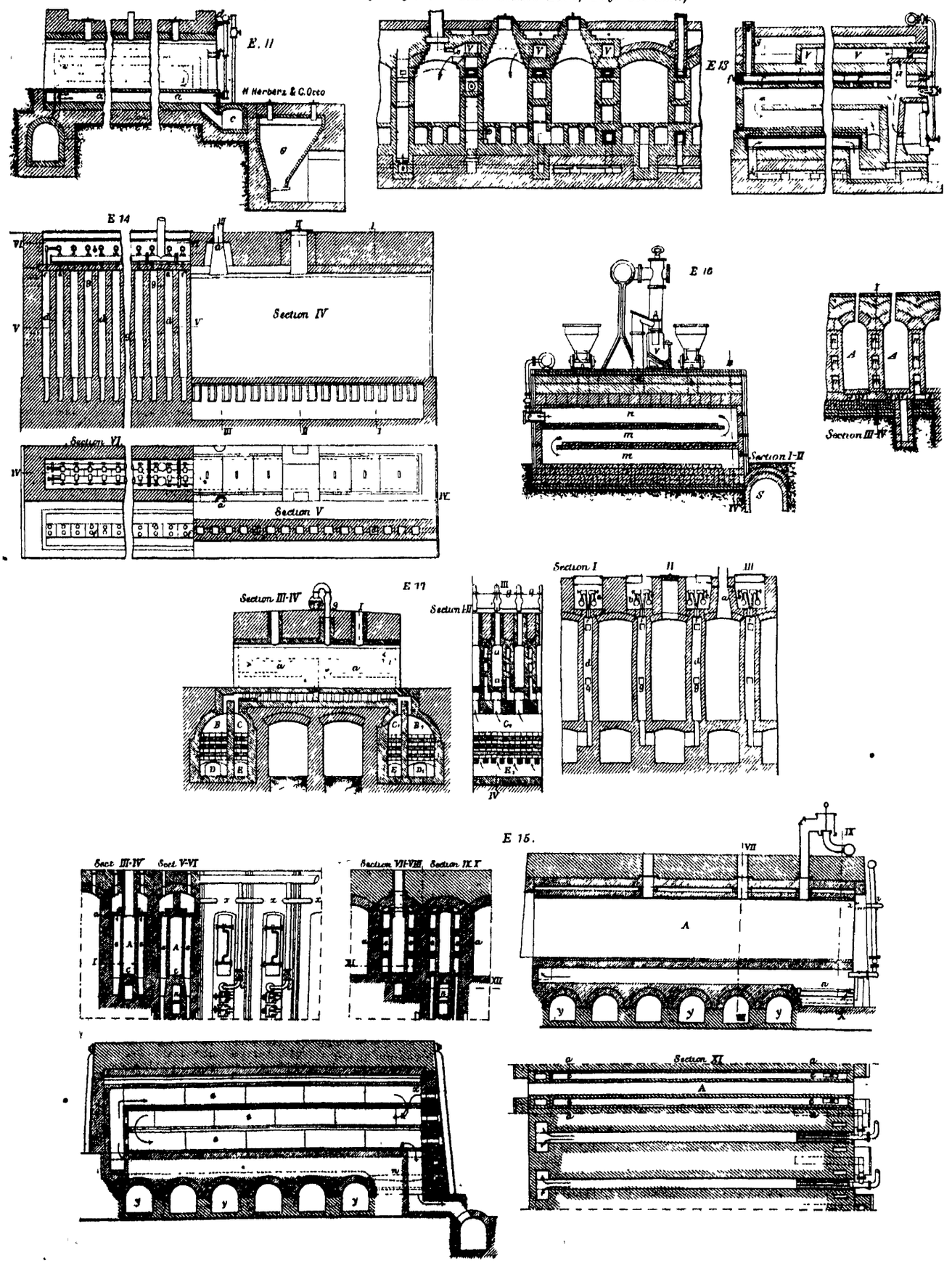






TYPES OF COKE OVENS.

(See Column E of Professor Watson Smith's Table, Page 306 ante.)



gave pig containing 30 07 per cent. manganese, while theoretically it should have contained 34.7 per cent., showing that 86.7 per cent. of the manganese in the charge had been reduced The cinder contained 4 3 per cent. of manganese, the oxygen ratio being 10 to 12 41 per cent. The charge was then changed to Cartagena ore alone, but as it was feared there would not be enough cinder, 10 per cent. of blast furnace cinder was added, ferro-manganese of 45.13 per cent. being made with lime charge of 27 per cent. As the doubts concerning the amount of cinder proved to be unfounded, Cartagena ore was used exclusively, with 28 per cent. of lime It made ferro-manganese of 45.98 per cent., and as the theoretical amount was 50.2 per cent. this showed that 86 4 per cent. of the manganese in the charge had been reduced. The cinder contained 8.39 per cent. manganese, the oxygen ratio being 10 to 13.35 per cent.

Fine Wire Drawing.

H. F. Read, of Brooklyn, has, according to the *Mining and Scientific Press*, drawn platinum wire so fine that it is invisible to the naked eye, though its presence can be detected by the touch, and it can be seen against a white card by aid of a magnifying glass. A small platinum wire, about No 18, was inclosed in a close-fitting tube of silver This was the drawn down till the tube containing the wire was only as large as the original wire. A short length of this was cut off, inclosed in a second tube of silver, and drawn down in the same way. This was repeated till the platinum wire was sufficiently reduced in diameter The last wire was drawn as fine as the dies would permit, after which the coating of silver was removed by nitric acid. During the work it was necessary occasionally to anneal the wire It was intended to use the wire for the cross wires in telescopes, &c., but its extreme weakness made it almost impossible to handle it.

THE BYE-PRODUCTS OF COAL.

*The Recovery of Bye-Products from Coal, with Special Reference to the Coke and Iron Industries.**

By Watson Smith, F.C.S., F.I.C.

(*Concluded from page* 363.)

The Bye Products.—From all the considerations now given, and quoted, perhaps chiefly of an engineering character rather than of a chemical, I have deliberately come to the opinion, from a mechanical point of view alone, that the best form of oven for coking coal for metallurgical purposes and yielding good and valuable bye products is the Simon-Carvès oven, in spite of the various attempted modifications and improvements so far attempted upon it, for these so far have added complications; and of all things simplicity of structure must be aimed at in plant like coke ovens, which has so high a temperature to withstand As regards the bye products as well as the coke, the success of this oven seems to me due, firstly, to the high temperature employed in a true destructive distillation of the coal; and, secondly, to the mode of application of the high temperature.

Mr. Sadler tells me that he finds that the Simon Carvès tar varies a good deal, particularly in the yield of the light products (the benzenes). With regard to what investigations I have so far made of Jameson and Simon-Carvès coke oven tars, as well as of the Gartsherrie blast furnace and Sutherland gas-producer tars, I beg to refer readers to the "Journ. Soc. Chem. Industry," vol. ii. [12], p. 500, and vol. iii. [1], p 9.

It will be noticed in my Table in column C that I have classed in this column together with Jameson's coke oven, Alexander and M'Cosh's blast furnace process, and that of the Sutherland gas-producer. I do this because the tars are all similar in quality, and are formed under similar circumstances, viz., there is more or less admission of air in carbonising in all the cases, and in all these tars curiously enough oxy-aromatic hydrocarbons, or phenols, exist in large quantities, and phenols of a very peculiar and novel character, together probably with phenol ethers. Besides these phenols, however, paraffins predominate. All that I can conceive these tars good for at present, is for such applications as the creosote or heavy oils of coal tar are suitable for, *i.e.*, as antiseptics, for creosoting timber, making asphalte, varnishes, &c. Owing to the artificially high prices of coal tar and its products, especially benzol, of late creosote oil has also greatly risen in price, and so a fair price could be for a time accorded for Jameson's oils, and similar oils and tars, making it almost appear as if they were passing muster as coal tar; but let tar fall in price a little, and creosote oil to fall to about ¾d. per gallon, as I have known it stationary at for long periods (even at ½d. per gallon at times), and then the difference will be marked enough. I should consider Jameson's oils the best creosoting material in the market, and it would yield a capital antiseptic varnish for woodwork. Moreover, these oils are thin enough to be employed, if well settled from water, direct and without distillation, whereas Sutherland tar and the Gartsherrie tar would for some purposes require to be distilled.

I have heard various proposals made for so improving the Jameson process as to cause the alteration of the tar oils into true coal tar; as, for example, by passing the oils through red-hot tubes. Now some eight or nine months ago I had myself already drawn up a specification in this direction, and had all but committed myself to the Patent Office. It may be interesting to state my process, and my reason for drawing back at the last.

I have stated that Jameson's oils contain considerable quantities of aromatic phenols, and phenol ethers. Now Baeyer showed, some years ago, that if carbolic acid C_6H_5OH be passed through a red-hot tube filled with zinc dust, that zinc oxide remains, and benzene C_6H_6 is evolved. I tried this with iron borings, and got fair yields of benzene; but I observed also considerable deposition of carbon in my tube, and evolution of black smoke. My idea then was not to condense the vapours from the Jameson coke ovens at once, but cause them all to pass previous to condensation through two or three long fireclay retorts containing coke, and heated outside to bright redness by return gas after condensation mixed with air. It was expected the oxy-compounds might thus become reduced. Now, I believe this process would answer, but it would only answer after a great deposition of carbon, and so with great loss. In short, I don't believe in passing oils through red hot tubes for industrial processes, unless these oils are to be had for almost nothing; the losses are too ruinous; and in short, the crude oils might be used or sold generally to better advantage. It is a different matter for the theoretical chemist, who to obtain a new hydrocarbon will grasp eagerly at only a one or even a half per cent. yield on his raw material. A little while ago, in Baku, South Russia, the waste oils or petroleum residues were being thus treated by modifications of Lierbermann and Burg's and Letny's processes, and anthracene was obtained thus, and was worked up into alizarin; but the waste was too serious, and the processes are now discontinued.

As regards the higher phenols already referred to, existing in the tars from Jameson's, Sutherland's, and Alexander and M'Cosh's processes, Professor Nolting, of Mülhausen, has recently investigated some of these higher phenols contained in the heavy coal-tar oils in regard to their value for yielding colours. He finds that they combine with diazo-compounds to form yellowish or reddish-brown colouring matters, and that these colours have no commercial or industrial value. On closer investigation of these high-boiling phenols, Nolting found evidence, strange to say, that amongst them are phenols of the anthracene and phenanthrene series. I have prepared a large quantity of these with other crude phenols by fractional distillation of the Gartsherrie blast-furnace tar, which is particularly rich in them, and I hope shortly to investigate them. They form liquid or solid substances, some of them boiling between 300 deg. and 400 deg. C. Before the publication of Nolting's results with the higher phenols of normal coal tar, I had tried experiments with the peculiar phenols from Jameson's oils and the Gartsherrie tar, by diazotising them, but, like Nölting, I have never succeeded so far in obtaining any but dull yellow or brownish-red colouring matters.

Ammonia Recovery.—Cl. Winkler, in the "Jahrb. f. das Berg- u. Huttenwesen im Konigreich Sachsen auf das Jahr 1884," says, "In spite of all the efforts of modern times, of the improved coke ovens of Knab, Carvès, Hüssener, Otto, and others, a much further step is still necessary before a general and thorough going recovery of ammonia from coke oven gases takes place." "For the solution of this ammonia problem," says Winkler, "the processes of coking and of the working up the volatile products ought to be treated quite separately, and should be thoroughly studied at some special experimental station, with an experimental oven of the usual size fired with a gas generator." I think Winkler is quite right, and I might add, let the same be said of the problem of producing valuable coal tars by coking processes, in the simplest and most economical manner.

It will never be possible, as, indeed, Winkler says, to make available the whole of the nitrogen of coal. The following are some facts we already know as to thermal conditions of formation and dissociation of ammonia:

1. The usual coking temperature is about 780 deg. Cent, and ammonia dissociates into nitrogen and hydrogen at about 500 deg. Cent.

2. But ammonia does not dissociate so easily at a high temperature in presence of moisture or steam as when quite dry.

3. Nitrogen mixed with hydrogen and subjected to the action of the dark electric discharge, *i.e.*, not the highest temperatures of the electric discharge, yields ammonia.

4. Nitrogen mixed with hydrogen in presence of aqueous vapour, and subjected to the strong electric discharge, *i.e.*, at the highest temperatures, yields ammonia.

5. However, ammonia is decomposed at a strong red heat; and

6. Also by the continuous passage of electric sparks, if the gas be dry.

Chemically, it may be stated that in the destructive distillation of coal at high temperatures, the tendency of the hydrogen, as the temperature rises, is to combine with oxygen and carbon; at still higher heats, in presence of the red-hot carbon, it is no longer possible for hydrogen to combine with oxygen; both hydrogen and oxygen combine with carbon, and the nitrogen unites with what little remains of the meagre supply of hydrogen. If steam be injected into red hot coke, all the nitrogen is obtained as ammonia, but then the coke is burnt up.

Mr. Tervet proposes to turn into fresh gas retorts the very last gases, largely consisting of hydrogen, from retorts in which the process is nearly completed, so as to afford a more abundant supply of hydrogen for the nitrogen in the retorts in earlier stages. He states that good results have followed the use of his process.

H. Simon and I have proposed to inject a mixture of steam and cheap hydrocarbon oils, preferably paraffins, in containing most hydrogen of any hydrocarbons, into gas retorts or coke ovens about the middle stage of the process. We believe that the hydrocarbons, with steam in presence of red-hot carbon, and at a high temperature, will cause the formation of carbonic oxide and nascent hydrogen, which will act more powerfully on the nitrogen in the coke than ordinary hydrogen. We propose to commence injection only about the middle of the carbonising process, when the hydrogen of the fuel is falling short and the temperature is high. It is known that paraffins, and so oils containing these chiefly, in presence of steam and red-hot coke, yield benzenes amongst other things (Schultz, "Die Chemie des Steinkohlentheers"); illuminating gas is also formed—in fact, a kind of carburetted water-gas; and furthermore, the upright pipes dipping into the hydraulic mains are never choked by carbonaceous matters, but remain perfectly clean when our process is adopted. Experiments have been tried with two kinds of crude hydrocarbons with steam injection, in two different gas works in Manchester. In one case, using Russian crude petroleum residues and steam, it was found that the amount of ammonia obtained was doubled, and that the volume of gas was substantially increased, and the illuminating power was also slightly raised. In the other case, ordinary coal tar was tried, and in just the proportion to the coal experimented on, as was equivalent to the production of the tar. In this case the volume of gas was much increased, the candle power slightly diminished, and the ammonia was also increased, but not nearly so much so in the other case. This was to be expected, for the tar used was only used in such proportion as to illustrate a case of a gas manufacturer consuming just the amount of tar he makes and no more. The aromatic hydrocarbons, moreover, contain less hydrogen, and that hydrogen held much more tenaciously than in the case of the other hydrocarbons—the paraffins. Calculating the value of tar as it was then, some months ago, *i.e.*, at a high price (its value is lower now), the balance in favour of the advantages gained was not great as set against the tar lost, as its value then stood. It may be remarked that such an advantage as that of continually clean upright pipes from retorts to hydraulic mains, and no stopping up, is one of those apparently small mechanical advantages of, in fact, real value.

In our process we do not find the coke suffers perceptible loss in weight, for by adopting the proportions between the water and oils, the mutual decomposition furnishing carbonic oxide and hydrogen takes place in the vicinity of the red-hot coke, but only at the mutual expense of the reacting vapours. Practically, I should allow the steam to be in slight excess, since its influence can only be good so long as no appreciable loss of coke occurs. No experiments with our process have yet been tried on the Simon-Carvès ovens, but one valuable result of our process would be that the exhauster could be worked more quickly, and thus the tar and ammonia vapours being more rapidly removed from the intensely hot atmosphere of the ovens, would be obtained unburnt in increased quantities, and the valve boxes would be kept clear of any accumulation of thick tar and pitch, for the vapours would now be more rapidly carried on to the mains and condensing apparatus.

Somewhat recently M. Scheurer-Kestner wrote an article in the "Comptes Rend.," 97, entitled, "The Carbonisation of Coal, with the Conversion of its Nitrogen into Ammonia."

At the outset M. Scheurer-Kestner inquires if the loss of caloric due to the preparation of the coke in the coking processes does not risk in many cases the carrying off with the heat thus lost all the advantages gained in the condensation of the ammonia, or even more advantage than is gained?

In other words, he asks, Is it not possible to get so much more heat out of your fuel as coal than as the coke obtained therefrom, that it shall actually pay better to lose the nitrogen, which can be otherwise eventually obtained as ammonia, than to gain it at the sacrifice of the heat lost in coking?

M. Kestner then refers to Mr. W. Foster's paper read before the Chemical Society ("Jour. Chem. Soc," February, 1883, p. 105), where it is shown that out of 100 parts of the nitrogen contained in the coal, only 14.5 parts go to form ammonia, 1.5 parts going to form cyanogen, 35 parts escaping as free nitrogen, and 49 parts remaining in the residual coke. He then calculates the calorific power of the gases evolved in coking and used in the process, and he adds this to the calorific power of the coke obtained, deducting the sum of these from the calorific power of the coal, and finds a loss expressed thus:

One kilo. of coal converted in coke and illuminating gas loses 1415 calories or 19.3 per cent.

Coal.	Coke.	Gases.
7500 cals.	−(4524	+ 1561)=1415 calories lost.

Thus, he says, 1415 cals. are lost and 0.004275 franc is gained in the ammonia. M. Kestner reckons that if the price of coal be 22.65 francs per ton the condensation of ammonia no longer pays. (The price of sulphate of ammonia is put at half a franc per kilo.) In coking in ordinary ovens, M. Kestner continues, "where the heat lost is much more considerable," the cost of the coal must be even as low as 10 francs per ton, to enable the profit gained in ammonia to very little more than cover expenses.

It seems to me that M. Kestner has overlooked a few items in this argument. (1) The increased calorific value gained in coking, owing to the altered physical condition of the fuel. 2. The quantity of water as moisture contained in all coals, which is not very small, absorbing heat in the furnaces in which it is employed. 3. In calculating the calorific power of the coal gas obtained in the coking process, M. Kestner has betaken himself to an old table of the composition of that gas found in Wurts' "Dictionary of Chemistry," where ethylene and marsh gas appear as the principal constituents, and benzene is quite absent. But benzene (as well as the vapours of other volatile hydrocarbons of the paraffin or olefiant gas

* Paper read at the Chester meeting of the Iron and Steel Institute.

series) must be present, and so the calorific power, as calculated by M. Kestner, would require some modification. 4. Then M. Kestner finally takes no account of the tar condensed and its value, though, perhaps, he may be referring to coke ovens, where the tar and gases are consumed in the process. Still M. Kestner's observations, as supplementing Mr. Forster's results, are worthy of the careful consideration of coke manufacturers, pointing as they do in the following important directions:

1. In the direction of nitrogen lost by volatilisation at the high temperatures of ignition in the coke and in the tar.

2. In that of the importance of getting good value in the tar obtained; and

3. In that of the importance of utilising the heat evolved in the coking process in the best possible manner.

APPENDIX.

In a private communication, dated Bonn, October 19, 1884, Dr. Ad Gurlt has furnished me with some most interesting information of special historical moment as being the earliest record of the coking of coal with recovery of bye-products. By this it appears that coal was coked in coke ovens, probably resembling Pernolet's adapted beehive, more than any other more modern form, though of course bearing a somewhat rude resemblance to the latter, earlier than the year 1775. Consequently a historical sketch would be incomplete without some account of the ovens referred to and of the man to whose skill and intelligence the origin and working of these ovens was due.

In the work of De Genssanne, "Traité de la fonte des Mines par le feu du Charbon de Terre," two vols., 4to. Paris, 1775 and 1776, is to be found (vol. i., page 263 *et seq.*, and in Tables 32, 32) the description of singular coke ovens formed of dome-like fireclay retorts, which were heated from the outside, and which before the year 1767 were in actual operation at the iron works (blast furnaces) of Sulzbach, near Saarbrücken (probably about 1764), and were visited by De Genssanne. There were nine ovens side by side in a battery, of which three in a group were always in the same stage of distillation, and each oven required three days to work off its charge, so that each group of three worked off three charges in this space of time. These retorts, or rather "muffles," were charged by a door at the front, and at the back was a pipe made of copper, which formed the continuation of the inclined bottom. Through this pipe the liquid products escaped, "les huiles et bitumes," and collected in a large pot with a lid, a kind of tar-well. According to De Genssanne the "bitumen" sank to the bottom, whilst the "oil" resembled distilled petroleum (page 277), though less inflammable, and was used for burning in peasants' lamps, and in the miners' lamps in the Sulzbach coal mines; "its smell was bituminous, and it smoked much."

Now, in 1771, Goethe, then a student of Strassburg University, made a trip on horseback accompanied by his friends Engelbach and Weyland, through Lothringen and the principality of Nassau-Saarbrücken. In his "Aus meinem Leben," Wahrheit und Dichtung, part ii., book x., Goethe describes his visit to the alum works and the "burning hill" of Dutweiler near Saarbrücken. Here he met with an old technologist named Stauf, who inhabited a lonely cottage in the forest, and this Herr Stauf Goethe called a "Kohlenphilosoph," and a "Philosophus per ignem," and described him further as a worn out, haggard little man, with a boot on one foot and a slipper on the other. Stauf was the manager of the works, and he conducted the visitors up the hill to a row of coke ovens, where coal was "desulphurised" for the use of iron works, and where old Stauf had produced oil, "bitumen," and lamp-black. Moreover, not ignorant apparently of the value of ammonia, he had also made a cake of sal-ammoniac, collected from the "burning hill." The works, however, did not seem to pay, and the old philosoper feared they would have to be abandoned.

It is extremely probable, as Dr. Gurlt thinks, that both localities mentioned by De Genssanne and by Goethe are identical, for Sulzbach, mentioned by the former, and Dutweiler (now Dudweiler on the map), mentioned by Goethe, are only a couple of English miles apart. Although De Genssanne (in 1764 or 1765) makes no mention of the quaint old philosopher Stauf, whom Goethe saw in 1771, he may still none the less have been the originator of the ovens at Sulzbach, and most certainly, as Gurlt says, "his name ought to be preserved in the annals of chemical technology."

From the description of the construction of Stauf's ovens given by De Genssanne (assuming the plant described by De Genssanne and by Goethe to be identical), it is pretty certain that he is right, and that the oils would resemble petroleum oils, and would contain paraffins chiefly, for the mode of applying the heat to the coal in ovens of such a shape (dome or muffle-shape), and from the fact that the coal must have lain in dense masses on the oven floors or beds, the charges being large ones requiring "three days to work off," would preclude the possibility of obtaining other than what might be termed the lower temperature products, in the shape of tars, *i.e.*, tars of lower specific gravity, and resembling in composition shale tars.

THE STATE OF THE NAVY.

TO THE EDITOR OF ENGINEERING.

SIR,—If your recent able articles on the above subject need any confirmation, they cannot fail to receive it at the hand of any one who, like the writer, is familiar with Admiralty doings. No portion of your articles is truer than that which states that much more might be done with the existing money grant. The delays due to alterations, not only in design, but in partially constructed details, are many, although they are usually heralded as the last departure suggested by recent experience. Now experience, of course, is a most valuable function in all sound design, but it would be far more satisfactory to builders and contractors generally, if the projected improvements were insisted upon before the work was made. But to a casual observer the official mind seems to take cognisance only of concrete objects, and the results of recent experience only seem to focus themselves with the required intensity when an object is presented which does not meet with approval; the knowledge seeming to be of a purely negative nature, and consisting of knowing what is *not* wanted.

Surely from men in official positions one might expect some positive direction and clear indication of future wants; instead of which our officials seem to be irregularly impelled by the sluggish current of Admiralty experience.

A point which at present has escaped comment in your articles, is the fast growing complication of detail in our service vessels, notably in the case of the pipes and connections generally. The pipes present almost as formidable a study as the human economy, and would seem to require a special nervous system to regulate their functions, while the various valves, which occur in rich clustering bunches of gun-metal, only add to the already bewilderment. Notwithstanding the fact that gun-metal is considerably reduced in strength by comparatively small elevations of temperature, as shown by Admiralty experiments, this alloy is still insisted upon for all purposes, and the valves are reduplicated and amplified in arrangement to a serious extent.

Again, the various stop and safety valves are provided with spindles and gears leading to various parts of the ship, such as 'tween decks, stokeholds, engine rooms, &c. This alone is a special study and suggests the expediency of the gears being fitted with interlocking arrangements as in railway signal boxes, if disaster in working is to be averted, to say nothing of the ordinary fortune of war.

Much of this complication is due to the absurd nature of Admiralty contracts, which allows unlimited powers to the inspecting officers and throws the entire responsibility on the contractors, a state of things which would probably be ended if ever the subject of legal proceedings, and most likely without occupying the time of the court unduly.

A lingering fondness is still shown by the Admiralty for the almost obsolete Kingston's valve—most people's estimation a nervous attempt to meet a fanciful emergency and which probably owes its long life in the service to that excellent work, "Murray on the Steam Engine." Its self-acting principle is spoilt (if it has ever existed) by being fitted with screws for opening and closing the valve, yet it is almost invariably insisted upon for all inlet purposes, great and small, in all its majesty and in gun-metal, and often in cases where a large part of the inlet could equally well be of ship plate.

I mention these few points; many others will be in the minds of some of your readers and have already been noticed by you.

I am, Sir, yours obediently,

DUPLEX.

THE BAR OF THE MERSEY.

TO THE EDITOR OF ENGINEERING.

SIR,—Absence from town prevented me seeing, until now, your issue of the 8th August, or I should have replied sooner to certain remarks contained in it.

In an article on "The Manchester Ship Canal" (see page 131 *ante*), you say with reference to my proposal for dredging away the bar at Liverpool, that "If the currents were capable of maintaining a deeper channel they would in time form such a channel through sandbanks, and as this is not formed it follows that there is not power to maintain it, and it would silt up so rapidly as to defy any efforts to keep it open." From this I must differ, and as experience is the best guide in such matters, perhaps you will excuse me giving mine.

In 1862 I was, when in the late Mr. Walker's office, sent to take charge for a short time of the breakwater works at Tynemouth in Northumberland. I saw Mr. Ure, the engineer of the upper part of the river, and he asked me when we were going to scour away the bar at the mouth of the river, I replied that we would never scour it away, but if he would take his new dredging machines he could dredge away the bar. He did so, and there was no bar at mouth of the Tyne three years afterwards. Here is a case where the current could not make a deep channel, but where the silting up is easily dealt with by dredging.

It may be said there are piers which train the water, but where the dredging was done, the bar was far outside the stump end of breakwater which then existed, and was practically in the open sea. Again, in 1866 I reported to the Commissioner of Sounds that the Kurrachee bar could be dredged away, and it was dredged away. Here the Public Works Department said dredging would be no use, and stopped all the harbour works. Calais bar has been dredged away and is maintained by one small dredging machine at the required depth of water; so at Dunkerque.

It should be remembered that the mighty mass of water passing over the bar of the Mersey, acts as a wall preventing the Jordan Flats and other sandbanks being driven close in shore, and all that will require to be dredged will be the sand which travels along the coast, and which now is forced by the winds and waves *across* the bar, and also some silt which will be deposited at dead high and low water.

Further you say, "It is when a bar is formed of hard material such as rock or even clay that dredging a channel proves effective." Having given four instances where dredging has been effective in sand, I must differ from this also. I am informed that at Brading, in the Isle of Wight, dredging is successful in removing the bar, and it does not rapidly reform.

The old idea that the sands of the sea *below* low water are always in motion, is one I do not hold, and I also believe that dredging machines can now do work which was formerly impossible, first, because we had not the machines, and secondly, there was not the trade to pay for them.

I may mention that if it were attempted to treat the Mersey by training walls, and if they progressed at the same rate and cost, the same amount per yard, as the works on the Tyne, such training walls would cost eight or nine millions sterling, and take 160 years to complete.

Dredging, therefore, is the only practicable manner of removing the Mersey bar, and that it can be done under the amount given by me in your paper, I am as nearly certain as I can be of anything.

Your obedient servant,

RUSSEL AITKEN.

36, Great George-street, Westminster, October 27, 1884.

P.S.—The position of the bar may now be considered as fixed, although, of course, there may be, as there is on every other bar, slight variations in the shape of the lands and the depth of water on the bar, owing to prevailing winds and other causes. The great variations in the position of the bar, which formerly took place, were due to the extension of the docks on the Liverpool side of the rivers, altering the direction of the currents of the tides entering and leaving the Mersey. Now that the docks on the Liverpool side are extended past New Brighton on the Birkenhead side, the current issuing from the Mersey will not be altered by future extensions. R. A.

ROLLER MILLING.

TO THE EDITOR OF ENGINEERING.

SIR,—Having been travelling about, I only to-day, under the heading of Roller Milling, see the letter of Messrs. Sanderson and Gillespie appearing in your issue of August 1.

Will you allow me a word of correction. I do not doubt the fact that Messrs. Sanderson and Gillespie erected a mill on their system in 1878, but this does not alter the fact that my first mill, started about the same time, *was the first complete roller mill* erected in the United Kingdom. Everybody knows that Messrs. Sanderson and Gillespie's system is not a roller mill system, at least certainly was not a roller-mill system in 1878, when rolls only acted a very subordinate part in their mills, the salient feature of which was an adaptation of the principle best known as Carr's disintegrator.

It is possible that experience may have shown Messrs. Sanderson the necessity of transferring a much larger proportion of the work to be done on the grain to roller mills, but even at present I don't think that they will claim the title of "*complete* roller mill" for any of the milling plants they are constructing, as so far as I am informed they still chiefly rely on the disintegrator for the reduction of their grain. I therefore must adhere to the fact, of which necessarily I am rather proud, of having constructed in this country the first complete roller mill plant without the use of millstones.

Yours truly,

HENRY SIMON.

20, Mount street, Manchester, August 15, 1884.

[The publication of this letter has been accidentally delayed.—ED. E.]

SHEFFIELD TECHNICAL SCHOOL.—The Council of the Sheffield Technical School, at their meeting on the 28th ult., appointed Mr. W. Greenwood as Professor of Metallurgy and Mechanical Engineering, and Mr. W. Ripper, Assistant Professor of Mechanical Engineering.

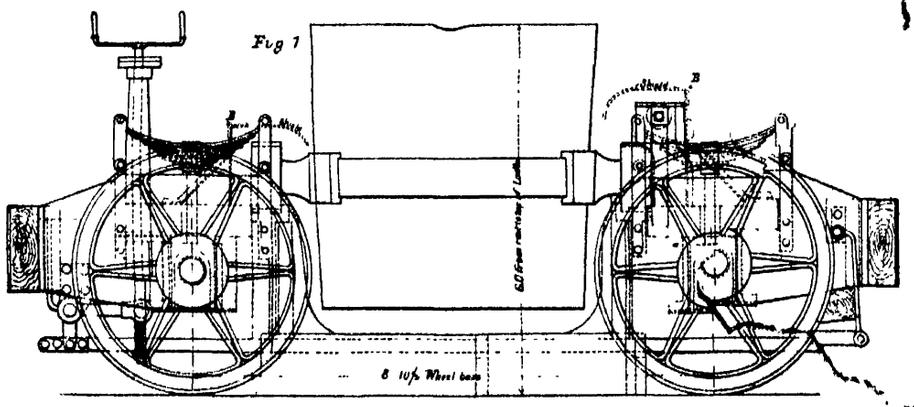
THE MINERALOGICAL SOCIETY.—The anniversary meeting was held in the theatre of the museum, Jermyn street, on Tuesday, October 21, at 8 p.m. The Rev. Professor Bonney, F.R.S., presided in the chair. The Hon. Sec., Mr. W. H. Scott, read the report of the Council, and the President delivered an address. Mr. R. H. Solly then read a paper "On Fine Specimens of Lilac Calcite from Tankerville Mine, Salop." Mr. Siemens read a paper, "Further Notes on Euargite." M. Guyot de Grandmaison exhibited a very fine crystal of "Parisite." Mr. Rudler and Mr. J. Davies also exhibited several interesting minerals.

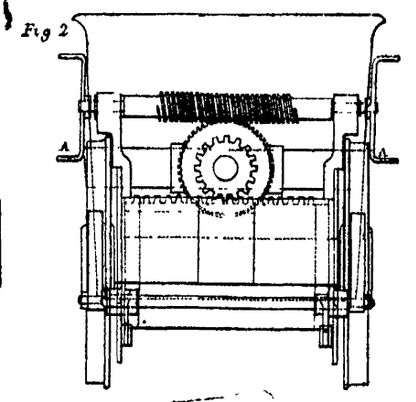
OILING THE WAVES.—A cheap form of breakwater, which has been devised by Mr. E. Hale Clark, of Starcross, Devon, produces smooth water on the well known principle of oiling the waves. A number of metal cylinders or buoys are strung together by a rope or chain, and moored outside the area to be protected. Each vessel contains at its lower side a quantity of oil, the remaining space being filled with cotton-waste or tow, which acts as an enormous wick to draw up the oil by capillary attraction, and feed it through holes in the upper side of the vessel. As the waves break over the buoys they carry with them a film of oil, and losing their crests sink into still water on the other side.

MESSRS. SIMPSON AND CO.—We have several times had to direct attention to the economical performance, as proved by careful trials, of the compound beam pumping engines constructed by Messrs. Simpson and Co., of Grosvenor road, S.W., and we are glad to notice that the firm have lately received orders for seven pairs, varying from 180 to 250 horse power. In addition to these they are making compound mill engines for India, pumping machinery for the Admiralty, hydraulic lifts, and centrifugal pumping machinery. They have just completed an exceedingly well-arranged plant with vertical cylinders for lifting water from one of the chalk wells 200 ft. deep. Besides this they have a large quantity of small machinery in hand, and large orders for gas and water valves.

LADLE CARRIAGE AT THE EBBW VALE STEEL WORKS.

CONSTRUCTED FROM THE DESIGNS OF MR. THOMAS WOOD, ENGINEER.





We give above two views of a ladle carriage which has been constructed from the designs of Mr. Thomas Wood, the chief engineer to the Ebbw Vale Steel, Iron, and Coal Company. These works, as we stated in our recent description of them (*vide* p. 119 *ante*), cover a large extent of ground, the Victoria furnaces and the Ebbw Vale furnaces, both of which supply one steel plant, being over a mile apart. Although this gives a long distance over which the molten metal from the furnaces has to be carried, it is by no means unprecedented; the Barrow furnaces for instance being situated still further from the steel works they supply. Until a short time ago, however, the Ebbw Vale Company had their Sirhowy furnaces in blast. These are, or rather were, for now they are dismantled, situated six miles by rail from the converters they supplied at Ebbw Vale, consequently the ladle containing the 10 tons of molten metal had to be brought this distance each time the converters were charged. In order to meet the exigencies of such a service the ladle carriage we now illustrate was designed by Mr. Wood.

By means of the gearing of wormwheel, rack, and pinion, which are clearly shown in Fig. 2, the ladle can be retained in the centre of the carriage and kept upright for running; a clip which is easily knocked out of gear being fitted to retain it in the necessary position. When the ladle is in the required spot to enable the charge to be tipped into the runner which takes it to the converter, the loose wrought-iron handle A is slipped on to the square end of the wormshaft, and by turning this the ladle is tipped, and at the same time travels on the rack from its position in the centre of the carriage, one man being sufficient to perform the operation. The dotted lines at B represent a wrought-iron shield for protecting the tipping gear from splashes of metal, &c.

With the old cast-iron frame carriage the weight of the ladle and charge is practically carried by the two bearings on one side, as the ladle has to be overhung from the centre of the carriage, in order that the metal may tip clear of the rails and into the well; supposing of course there are not conveniences for tipping direct into the converter

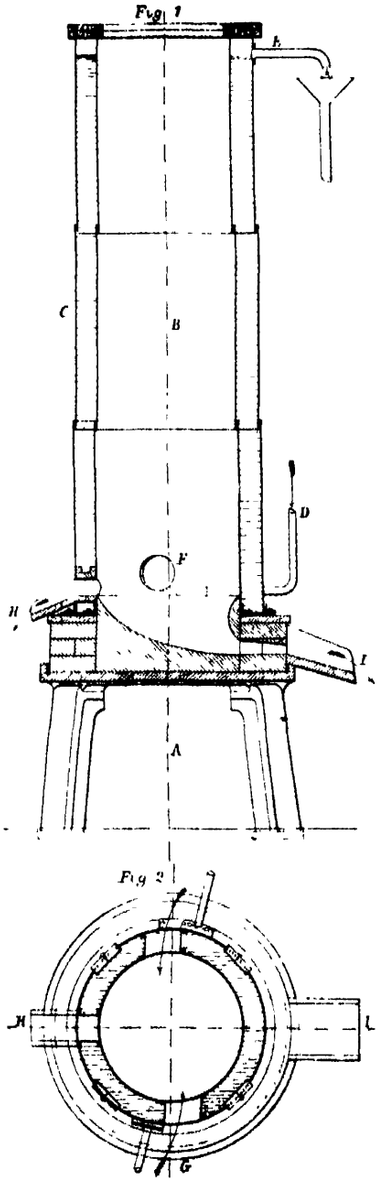
It will be seen that in Mr. Wood's arrangement, when the ladle is in a vertical position it stands fairly in the middle of the carriage, but the action of tipping carries it to the side so that the charge will clear the rails This carriage has now been in work for about three years, and since its introduction there has not been the slightest hitch, even when running ten tons of metal at a considerable speed over the six miles of line from the Sirhowy furnaces. This has been a pleasing contrast compared to the trouble that used to be experienced at Ebbw Vale with the original cast-iron frames. These, under the heavy duty put upon them, were continually breaking on the side which had to carry the weight, and this would entail the metal having to be tipped on the ground so that it might be broken for recharging.

Although the exceptional nature of the work at Ebbw Vale called forth this arrangement, it will of course be understood that the advantages it possesses are also manifest upon shorter journeys.

DR. OTTO GMELIN'S CUPOLA.

The cupola shown in the annexed engraving was invented by Dr. Otto Gmelin, of Budapest, for smelting iron, copper, or other metals, and has during the last few years won ground in Austro-Hungary and is now also being introduced in Germany.

The illustration hardly requires any further explanation considering the simplicity of the principle on which the furnace is constructed. Two concentric cylinders of boiler plates with two annular spaces between them, closed at the bottom and open at the top, are placed on a foundation ring of brickwork.



Cold water enters the annular space at the bottom and the warmed water flows off below the upper edge of the cylinders.

The interior of the inner boiler-plate cylinder is made rough and is covered with fireclay. The circular space between the two cylinders is covered over by a cast-iron plate which lies loosely on the top of the two cylinders. Two circular grooves in the cast-iron top plate maintain the two cylinders at the correct distance from each other.

The outlet of the melted metal and of the slag takes place through tubular boiler-plate connections passing through the water space and attached to the inner and outer cylinders. The construction has lately been considerably simplified and strengthened by making the inner furnace cylinder of a welded tube, with tubes for air inlets welded on all in one piece.

The novelty of the above construction consists chiefly in the cooling of the smelting furnace by water without using an air-tight water space. The inner cylinder can expand and contract without any resistance as the temperature in the furnace changes, and the consequence is that repairs are hardly ever required. The first furnace built upon this principle has now been at work daily for the last 2½ years without ever having required any repairs to the boiler plates of the cylinders. The smelting operations can therefore also be kept up for any length of time without interruption. The energetic cooling of the inner smelting cylinder, which takes place with this system of furnace, is also stated to afford advantages as regards the saving of fuel (equal to 6 to 8 per cent), and the decrease of burnt metal as well as the good and equal quality of the castings. The upper part of the furnace never gets hot, and the coke does not begin to burn until it arrives at the lower part of the furnace where the smelting process takes place The carbonic acid formed here escapes unchanged without being reduced to carbonic oxide as it passes through the upper charge of the furnace. The metal thrown in at the top of the furnace arrives completely unchanged into the smelting zone, where it is brought to the smelting point at once by a very strong blast.

The furnace remains always round and smooth, which is also a very important feature with regard to economy of coke and good quality of the castings. It is likewise unaffected by chemical action, and the quality of the castings will therefore be considerably improved by the fact that this furnace admits of an addition of any quantity of basic substances without any risk of damage.

This furnace offers special advantages in cases where scrap iron can be had cheaply, as on account of the small consumption of coal and silicium much more scrap iron than usual can be used along with the pig iron, without any fear of obtaining hard castings. The arrangement also offers advantages in cases where it is necessary to produce special qualities of castings—for example, hard castings—as the foreman can with much greater accuracy calculate the proportions of the materials to be put into the furnace to procure an even quality throughout, than he can with ordinary cupolas.

The firm of Ganz and Co., of Ofen, who have a very high reputation for their chilled rolls, is now altering all its furnaces to Dr. Gmelin's principle, and a number of other firms of high standing have also adopted Dr. Gmelin's furnace; namely, the machine factory of the Hungarian Government Railway, Budapest; the Ozterr Alpine Montangesellschaft, Vienna; the Austro-Hungarian Goverment Railway, Vienna; the Eisenhütte, Undine; Count Waldstein's Iron Works, Sedlec, Bohemia; and Howaldt Brothers, Kiel, Germany.

THE HOSPITAL SHIP "CASTALIA."

The twin-ship Castalia was bought some little time ago by the managers of the Metropolitan Asylum Board, to convert into an hospital for small-pox patients. The managers had the matter before them of making

THE "CASTALIA" HOSPITAL SHIP AND TENDER.

MR. ADAM MILLER, ENGINEER.

Fig. 5.

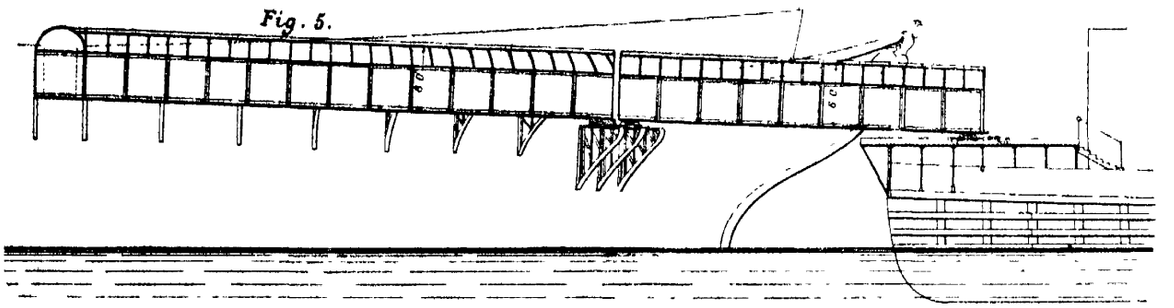


Fig. 6

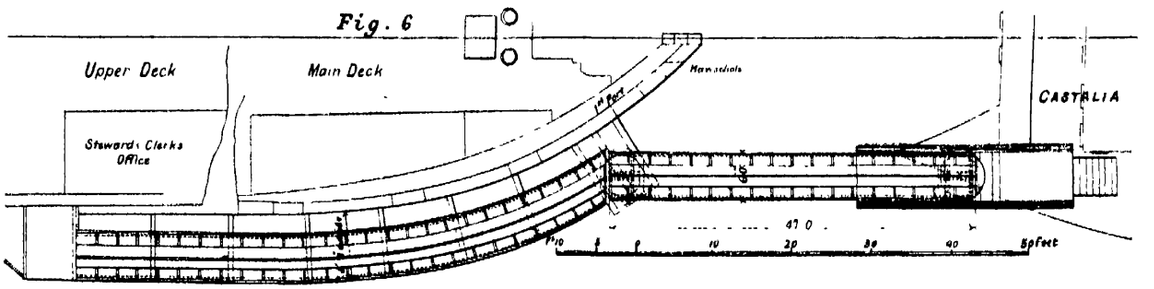


Fig. 7.

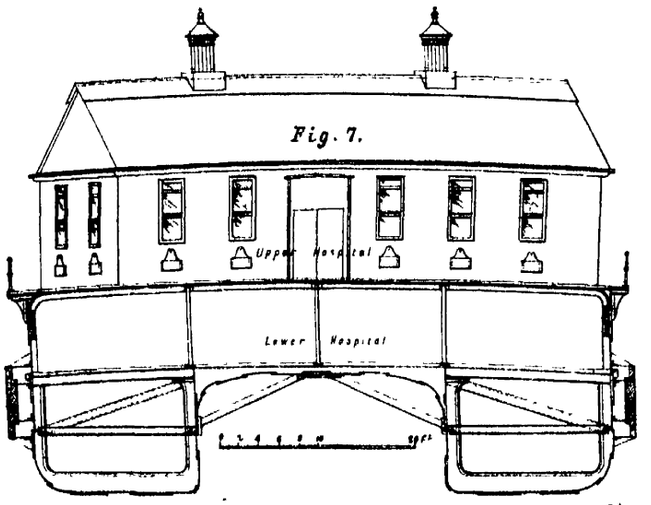


Fig 10

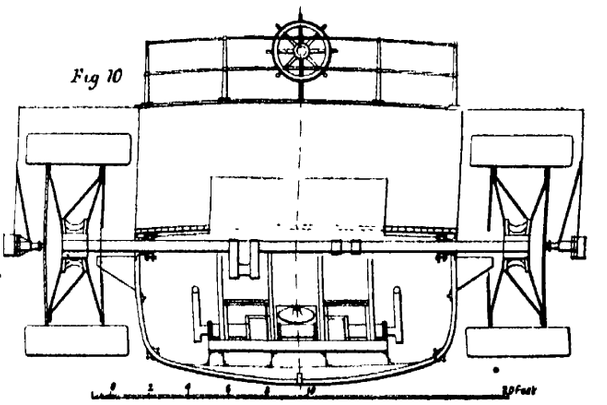


Fig 8

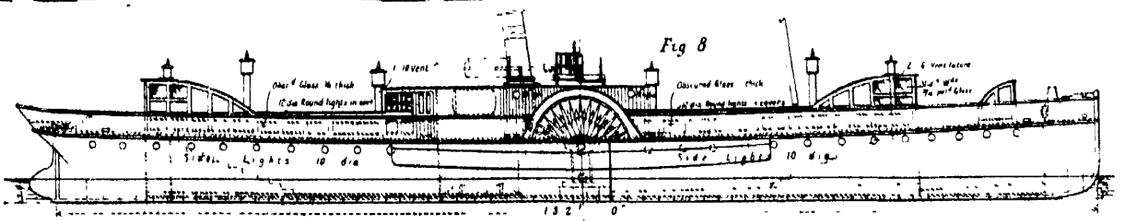
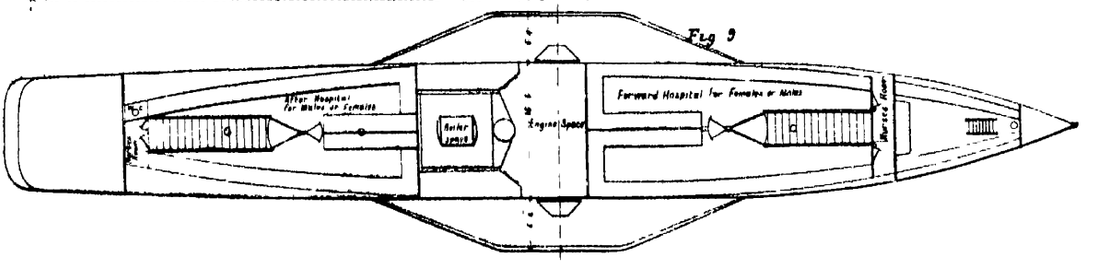


Fig 9



floating hospitals on pontoons, and this vessel, the Castalia, suited their views very well, they entrusted the conversion of the vessel into an hospital to Mr. Adam Miller, of Riches-court, Lime-street, London.

It was decided to make five large wards of the old cabin arrangement, and to build other five wards on the top, and place them in echelon (Figs. 1 and 2, page 410), so as to have them at angles with the centre line of the ship; giving more air, better light, and also reducing the number of patients in each ward; in fact these upper wards are each a cottage hospital of itself The dimensions of the wards vary a little, but the height is 23 ft., that is to say, the walls are 13 ft. and the roof 9 ft. The windows are made similar to those in the hospitals on land, and are 7 ft. by 3 ft.

The inlet of air is by slides worked by a screw, so that the quantity of air admitted may be graduated to the amount required. The air is drawn out by Boyle's extracting ventilators; each ward has two of those large ventilators, and, in the event of calm, close, sultry weather, there is fitted to each ventilator an air blast, sent up from a large Farmer blower of Schiele's make, fitted in the engine-room below. This blast of air is sent up the pipes of the ventilators and

causes an upward current of air to take place in these pipes. In this way the wards are kept cool and the air changed so many times an hour in each ward.

Each of the isolating rooms, bath rooms, and lavatories is fitted with Boyle's ventilators and air inlets similar to the wards. The hospital throughout is heated by steam coils, fitted by Messrs. Ridsdale and Co., Minories, London, each coil having a separate inlet and outlet into silent blow-off pipes. The temperature in any compartment may be raised or lowered as required, or as the doctor decides.

The upper hospitals with the isolating wards (Figs. 1 and 2) contain a large cubical space. There are attached to these upper wards, at each end of the vessel, outhouses for the use of patients; these contain four bath-rooms, ten wash basins, eight water-closets, four latrines or sinks, and two urinals. One hot closet or hot carving table (Fig. 4) is fitted up and heated by steam, in each of the end upper wards, this is to keep the food warm for the patients. A scullery is also fitted up in each of the end wards for washing up dishes after meals.

The upper hospital wards are built with coamings of plate iron 15 in. by ½ in., rivetted to an iron deck, which covers the lower hospital (Fig. 7, page 407). Frames of angle iron are rivetted at regular intervals to this coaming, they stand up 13 ft; the roof principals spring from this height, and they are also made of angle iron. The sides, ends, and roofs are planked with yellow deal horizontally. The sides and ends have also a cross lining on the outside of American yellow pine, making the thickness 2¼ in. The roofs are covered all with 6 lb. lead, instead of cross-lined with yellow pine.

The lower wards of the hospital ship are five in number (Fig. 3, page 410), and are arranged to make use of the iron bulkheads that are fixed across the two vessels, binding the hulls together. These divided the Castalia into first and second saloons, &c., for passengers. The sides and ends of the lower wards are made of iron plate; the upper deck which forms the roof is plated all over with iron plating and covered with 2½ in. pine deck planks, caulked water tight. The lower wards are thus really cased with iron. They are similarly supplied with lavatories, hot closets, and sculleries, as the upper wards; two skylights are provided in each ward to assist in giving light from above. The windows are all made as large as possible, they are 3 ft. 6 in by 2 ft 6 in., divided into three sashes, similar to the upper windows.

The means of ventilation are, of course, much greater in the lower wards than the upper ones; the lower wards being much larger and not so high in the roof, the height from deck to deck being 8 ft.

At both ends of the lower and upper wards large isolating wards are fitted up. These rooms are provided for the purpose of isolating patients who may have been sent under the mistake that they are suffering from small-pox, and who prove, when examined at the ship by the medical staff, to be affected with measles, fever, &c. Every care is taken that patients with other diseases than small pox shall not come into contact with any small pox patients.

The patients are brought to the hospital ship by the ambulance steamers (Figs 8, 9, and 10) and are taken first into the reception room and there examined, and are then allotted to the wards by the resident doctor. The separation of the sexes is rigidly enforced. The Atlas is now kept as a female hospital and the Castalia has been made a male hospital. The whole of the Castalia has been painted with Griffith's white paint and the Sanitary Company's enamel paint, every precaution has been taken, by painting, to prevent the germs of this disease from getting into the woodwork. Mr. Wythe, of Dalston, executed the paintwork. Messrs. R. and H. Green were the contractors to convert the Castalia into a hospital ship. Messrs. Jas. Patterson and Co., of Ratcliff Engine Works, Stepney, supplied and fitted up all the machinery and pipes for the air blast and the pumps for throwing water, for the water closets, washing decks, fire hose, &c. The engines are of the compound type, with cylinders 10 in and 20 in respectively, with a stroke of 2 ft. They are constructed to drive the Schiele's fan, and also a dynamo machine for the electric lighting if required.

Very great attention and care was given to the ventilation of the hospitals. Professor F. De Chaumont, Dr. Bridges, Surgeon-General Bostock, and Mr. Barrington Kenneth discussed the matter fully and arranged that Boyle's air-pump ventilators should be adopted. They also fixed the dimensions of these ventilators for the several wards according to the space to be relieved. The ventilators were tested one day during a smart breeze, and the speed, registered according to three anemometers placed in the ventilators, was at the rate of 500 ft. per minute, giving 50 per cent. of the speed of the wind blowing outside, so that the atmosphere in the hospitals may be changed many times in an hour. Dr. Birdwood has since found that he can raise or lower the temperature in a few minutes, and he has caused the wards (when empty) to be filled with smoke by burning greasy waste, brown paper, cayenne pepper, &c. The fan blowers were put on, and in from three to four minutes all the smoke was cleared off.

The ventilators were made each with heads 6 ft. in diameter, and were fitted with pipes varying from 3 ft. 9 in. to 2 ft. 6 in. in diameter. The lower wards have two ventilators of 3 ft. 9 in. and eight of 3 ft. 3 in. The upper wards have four ventilators of 3 ft. and six of 2 ft. 6 in. The lavatories and isolating rooms have sixteen ventilators of 16 in. diameter. The cubical contents of the lower hospital are 73,465 ft.; the superficial area, 9308 ft.; the window opening, 984.44 sq. ft. The cubical contents of the upper hospital are 84,607 ft.; the superficial square area, 9054 ft.; the window opening, 1792.52 sq. ft.

To provide for the satisfactory embarkation of passengers piers are provided at various points by which they can be transferred from the ambulance to the steamer free from contact with the public. The first of these is the Longreach pier, which is erected close to the hospital ships lying off Purfleet at Longreach. The patients embark and disembark to and from the ambulance steamers, and to the hospital ships, as may be arranged. The pier also accommodates the laundry staff in going and returning to their work from the staff ship Endymion. It is 193 ft. in length over all; the moving portion is 125 ft. long, the fixed part is 68 ft. in length. The pier is lined throughout with yellow pine, and roofed over with glass, so as to keep the patients and others from getting wet. The moving portion of the pier rests at one end on a pontoon, which rises and falls with the tide; the other end is fixed to a stack of piles by a joint bolted to each of the girders, and also securely bolted on the piles. The fixed portion of the pier is also bolted to the same joint, thus making the connection of the moving and fixed parts. The pier is made so that ambulances may be taken down or up, with or without the horses. A porch has been built upon the pontoon; it is fitted with a waiting-room, stove, water-closet, urinal, &c.

A similar porch with conveniences is erected at the land end of the pier. The ambulances drive into this porch to take in or discharge patients under cover. The Rotherhithe Pier at Acorn Wharf is of similar design and accommodation, but is not roofed in. The length of Acorn Pier is two fixed spans each of 84 ft. and one moving span of 125 ft., in all 293 ft. The contractor for both piers is Mr. S. Chafen, Albion-street, Rotherhithe. This pier at Acorn Wharf is for the accommodation of patients living in the south-eastern districts.

There is a pier building for Blackwall at Brown's wharf for the accommodation of patients living at the east end of London. This pier will only consist of a moving part of 125 ft. in length, resting on a pontoon similar to the other in accommodations, &c. The wharf at which this pier is to be attached will be roofed in so that all the ambulances may be accommodated on the wharf, and shut in from the street, and that the public may be kept clear.

The fourth pier is to be erected close to Wandsworth Bridge, it is to be for the accommodation of patients in that district. This pier will be similar to Blackwall Pier. These piers have been designed by Mr Adam Miller, and are being erected under his superintendence. The Endymion and the Castalia are connected by a covered gallery (Figs. 6 and 7), which will allow a certain relative motion of the two vessels.

There are, in connection with the Castalia, three steamers for the ambulance service, viz., Red Cross, Albert Victor, and Maltese Cross. The illustrations, Figs 8, 9, and 10, page 407, represent the latest, the Maltese Cross, built by Messrs. Edwards and Symes, Cubitt Town, E. This steamer is designed with two hospitals, viz., one aft and one forward, and is made to carry twice as many patients as the first steamer, Red Cross, constructed by the same builders. The dimensions of this steamer are as follows: Length, 132 ft; breadth. 16 ft. 6 in.; depth, 7 ft. 6 in. The engines are of the oscillating type, with cylinders of 23 in. diameter, with 30 in. stroke, steam pressure of 40 lb.

The hospital arrangements for the patients in the matter of beds and conveniences, ventilation, &c., have been carried out to the instructions of Surgeon-General Bostock, who has taken a great interest in all the ambulance arrangements. The accommodation for the crew is put forward. The captain and medical officer are placed on deck abaft the boiler casing. The nurses have a berth in each hospital; a store-room is made under deck, right aft the transom for medical comfort. Filtered water cisterns are placed on deck at each entrance to the hospitals; a galley, with a cooking range, is fitted at one of the wings of the paddle-boxes, so that in the event of the ambulance steamer being delayed by fog in the river the patients would have the same comfort as in the hospital proper.

The ambulance steamers have also been designed by Mr. Adam Miller, and the Albert Victor has also been converted by him into an ambulance steamer.

The ratepayers, or the outside world, have not any idea of the great amount of attention and labour given to the asylums of London by the chairman, Mr. Galsworthy, and the managers of the Metropolitan Asylums Board. During an epidemic many of the managers simply work night and day. The chairman, Sir Edmund Hay Currie, of the General Purposes Committee, and the members of that Committee, may be seen at work often at midnight, on Sundays, as well as other days, getting patients sent on to the hospital ships.

THE WESTINGHOUSE BRAKE.

The following is a translation of an interesting report dealing with the experience with the Westinghouse on the Western Railway of France, which has been made to the directors of that line by the Department of Material and Traction:

Paris, October 4, 1884.

After a thorough study of the subject, the Western of France Railway Company began to use the Westinghouse automatic brake at the end of 1877.

Relying on a success already guaranteed by the extensive use of this brake in England and America, the Western Railway Board voted considerable sums for fitting up with automatic brakes, not only all its passenger rolling stock for their suburban lines, but also the stock comprising the express trains on their main lines. The money thus voted was at once made use of, and before the opening of the Exhibition of 1878, the Ceinture service, as well as that of the Champs de Mars, was run with trains fitted with this new brake. The results obtained were encouraging in every way, and it is not without interest to mention here the dates at which the first trains of this company were successively worked with the brake (see Table A).

In April, 1879, the fast trains and most of the suburban trains of the Western Company were running with these automatic continuous brakes; and two years later, in April, 1881, the equipment was complete, not only for all the fast trains, but also for all suburban trains. The Minister of Public Works at that time, moreover, recognised the efforts that the Western Company had made in the following terms, when writing on the 2nd of November, 1881:

"I have pleasure in stating that your company has, in regard to the fitting of continuous brakes, anticipated the rate which our circular had fixed, and that it has rapidly been able to extend the use of continuous brakes on its line."

Since that time the fitting up of brakes has been still further extended. Table B, appended to this report, gives the amount of rolling stock fitted with the Westinghouse automatic brakes on the 1st of January of each year, and finally that on the 1st of September, 1884.

If now we come to the question of the choice of a brake system, we must mention what was and still is our position in regard to this matter.

Since our first introduction of continuous brakes in 1877, of the different systems then existing, we adopted the Westinghouse automatic as containing the best possible elements for securing thorough efficiency. We have had, besides, the satisfaction to find since then, that the principles upon which this brake system is based, are in perfect harmony with the programme recommended by the superior administration, as the result of elaborate investigations and prolonged discussions.

It must be observed, and this is a point of supreme importance, that so far there has been no case in which the brake has failed to act in a case of necessity, a result which was only to be expected, on account of its automatic principles, and our company cannot but congratulate themselves as to the choice they have made, since the results obtained have been most satisfactory, both in regard to the increased security, as well as the advantages in the working of the traffic which results from its use.

It is also important to mention that the use of this brake has enabled us to save considerable time when approaching junctions and stations, and finally the numerous accidents to trains or to persons have been avoided owing, to the certainty of action of these brakes. We have given in Table C, added hereto, the most important of those accidents which have been recorded.*

When we began to use the brake, various causes gave rise to some difficulties by bringing about unforeseen stoppages, but the delays from this cause were of trifling importance, and were generally easily made up again by the driver, and now that the servants are more familiar with the use of the apparatus, our company has succeeded in considerably reducing the number of unforeseen stoppages brought about by other causes than the bursting of hose pipes, as is shown in the following Table:

	Proportion of Stoppages brought about by other Causes than the Bursting of Hose Pipes.	
	Main Lines.	Suburban Lines.
Year, 1880	1 for 45,604 kilom. run.	1 for 19,000 booked stops.
First half year, 1884	1 for 90,800 kilom. run.	1 for 132,850 booked stops.

In regard to the other unforeseen stoppages—that is to say, those caused by the bursting of hose pipes, we have endeavoured to find different means of averting this difficulty, and more particularly by the use of metallic couplings. One hundred of these (of the last pattern) have been fitted to fifty carriages since the beginning of

* [In this Table C, which is too lengthy to reproduce here, full particulars are given of forty-two accidents which have been avoided by the use of the brake.—Ed. E.]

the year, and have given most satisfactory results. It may, therefore, be hoped that by means of this or some other contrivance to which we are also giving our attention, a great reduction in the number of such incidents will be made.

We must moreover point out that the great advantage of automatic action is forcibly proved by most of these incidents; inasmuch as even a slight derangement of any part of the apparatus acts as a tell-tale and guards against its consequences; whereas, in the case of non-automatic brakes, similar occurrences escaping attention whilst the train is running, would only show themselves by the failure of the brake to act at the moment it was required, that is to say, with all the grave consequences which might be the result if it became necessary to stop suddenly before an obstruction.

A last advantage of the Westinghouse brake lies in the fact that it has given us the means of satisfying one of the demands of the superior administration, and at the same time the desire so persistently expressed by the public, by establishing a communication between passengers and the train servants without adding any new connection between the vehicles. This apparatus which is comparatively of a slight cost, and so to say, infallible, answers its purpose entirely, and thus adds considerably to the security of the travelling public.

TABLE A.—*Western of France Railway.—Material and Traction Department.*

Dates of first use of Westinghouse Brake:

April, 1878,	Ceinture trains and Champ de Mars service (Exhibition).		
August	,,	Express trains,	Paris, Trouville, and *vice versâ*.
October	,, ,,	,,	Paris Le Havre and *vice versâ*.
Feb., April	1879, ,,	Local trains, ,,	Versailles (left bank). ,, (right bank).
Dec.,	1880,	,, ,,	St. Germain.
Jan.,	1881,	,, ,,	Circular trains (West Northern).
Feb.	,,	Express trains,	Paris-Havre, Paris-Dieppe, and *vice versâ*.
April	,, ,,	,,	Paris Rennes, Paris-Angers, Paris-Caen, Paris Granville, and *vice versâ*.

Year 1882 Trains from Paris-Pontoise (by Argenteuil), Achères-Pontoise; Mars-Mézidan, Le Havre-Motteville; Redou-Rennes; Malannay-St Valery; Lisieux-Trouville, &c.

TABLE B.—*Western of France Railway.—Material and Traction Department.*

Statement of Rolling Stock fitted with the Westinghouse Brake since the first adoption, September 1, 1884.

Periods.	Engines	Carriages.	Vans	Total Carriages and Vans	Remarks
From March 14, 1878, to Jan 1, 1882 ..	275	1802	320	2122	
From Jan 1, 1882, to Sept. 1, 1884 .	178	734	216	950	
Total stock fitted	453	2536	536	3072	

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Last Thursday was a *dies non* in what is known as the "iron ring" of the Glasgow Royal Exchange, on account of the occurrence of the Autumn Sacramental Fast-Day. On the following day the market was again strong, chiefly owing to the covering of oversales in anticipation of further advances in price. The closing prices were 2d. per ton over those of Wednesday, thus making the gain 4d. per ton over that week. Business was done on forenoon 'Change at 41s. 11d. up to 42s. 1d. cash, also at 42s. 1d. up to 42s. 3d. one month, the close being sellers at 42s. cash and 42s. 3d. one month, with buyers at ½d. per ton lower. Up to 42s. 1½d. cash was paid in the afternoon and 42s. 3d. one month, which were the closing quotations for sellers, with buyers near. Firmness was also the rule in Monday's market, and a large amount of business was transacted, the close showing an advance of ½d. per ton over last week's closing quotations. Transactions took place during the forenoon at 42s. 1½d. up to 42s. 3½d. and back to 42s. 1½d. cash, also at 42s. 3½d. up to 42s. 5½d., and back to 42s. 3½d. one month, with sellers at the close at 42s. 2d. cash and 42s. 4d. one month, and buyers offering ½d. lower per ton. In the afternoon business was reported at 42s. 1½d. and 42s. 2d. cash, also at 42s. 3d. to 42s. 4d. one month, the close being sellers at those prices, with buyers at ½d. per ton under. Yesterday's market was likewise strong, and a large business was done, the close showing a further advance of 1½d. per ton. In the morning the quotations were 42s. 1½d. and 42s. 2d. cash, and 42s. 3d. and 42s. 3½d. one month, with sellers at the close wanting the higher rates and buyers offering the lower; and in the afternoon the quotations ranged from 43s. 1½d. up to 42s. 3½d. cash, also from 42s. 4d. to 42s. 5½d. one month, the market closing with sellers at the top quotations and buyers offering ½d. per ton under. A further advance was made to-day, 42s. 5d. cash and 42s. 7d. one month being reached in the forenoon market, and as high as 42s. 6d. cash and 42s. 8d. in the afternoon. The latter were the closing quotations for sellers, with buyers near. It is evident that there is now some speculation going on, but it seems to be almost entirely due to purchases by the trade and is not the result of any outside influence or improvement, as the reports from all quarters continue to be very depressed, the state of trade remaining unchanged and the prospects being far from encouraging; still there is decidedly less disposition to sell in any quantity for forward delivery at present prices. The shipping demand is steady, and the quotations for special brands are being well maintained. Up till the end of last week there had been an improvement in prices amounting to 1s. 3½d per ton above the lowest market prices during the period of five a half months from the close of April; and during the past four weeks the improvement has been about 1s. per ton from 41s. 6½d. on October 2 to 42s 6d on October 29 The number of blast furnaces in actual operation is still 95, as compared with 105 at this time last year. Last week's shipments from all Scottish ports amounted to 10,806 tons, as against 10,245 tons in the preceding week, and 12,758 tons in the corresponding week of last year The decrease for the year up till last Saturday was 71,939 tons—1884, 402,248 tons, as against 534,187 tons in 1883. Over the same period there were imported from Middlesbrough 208,931 tons, showing a decrease of 8642 tons The shipping returns for last week show that 1540 tons were sent to the United States, 936 tons to Canada, 300 tons to Australia, &c., 399 tons to France, 1000 tons to Italy, 1620 tons to Germany, 800 tons to Russia, 1037 tons to Holland, 100 tons to Spain and Portugal, 110 to China and Japan, and lesser quantities to other countries. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores yesterday afternoon stood at 580,662 tons, as compared with 581,027 tons yesterday week, showing a decrease for the week of 365 tons.

Progress of the Glenury Viaduct.—Rapid progress is being made with the work of reconstructing the long viaduct which carries the Caledonian line of railway to Aberdeen over the Glen of Ury. As originally constructed the viaduct consisted of stone piers supporting fourteen wooden arches. Time was telling markedly on the wood work, and last year the directors resolved to rebuild the bridge. Plans were prepared, and the work intrusted to Messrs. Blaikie Brothers, of Aberdeen, the contract price, it is understood, being about 28,000*l*. The work has been in progress all through the summer, and, favoured by specially suitable weather, has been carried on without intermission. The whole of the wooden arches on the down line have been replaced by substantial iron girders, and eight of those on the up line have also been renewed, leaving only half-a-dozen to complete. During the time the work has been going on the traffic has been wrought on a single line, and it is satisfactory to report that as yet not the slightest accident has occurred. The rebuilding has been carried on under the personal inspection of Mr. T. Winning, district inspector of way.

Sewerage Scheme for Kelso.—Impelled by the action raised against them by the Duke of Roxburghe for polluting the river Tweed by the town sewage, the Kelso Pollution Commissioners have now under consideration two schemes for dealing with the sewage. One is a precipitation and filtration scheme, which is estimated to cost in all a sum of 6859*l*, with an annual cost of 887*l*., besides the rent of five acres of land for the filtering works, and the other is an irrigation and filtration scheme, requiring seventy acres of land, and estimated to involve a capital expenditure of 4677*l*, besides tanks and carriers, and a yearly outlay of at least 400*l*., in addition to the rent of the land. Both of the alternative proposals have been devised by Mr. C. J Mellis, C.E, London.

The Powburn Drainage Scheme, Edinburgh.—An important drainage scheme, the aim of which is to deal with a certain portion of the southern outskirts of Edinburgh, and which may be spoken of as the Powburn district, is now under the consideration of the municipal authorities of the northern metropolis It has been devised by the Burgh engineer, with the approval of Mr. Thomas Stevenson, C.E., and is estimated to cost from 20,000*l* to 25,000*l*

The Glasgow Water Engineer —A proposal is now under consideration by the Glasgow Corporation Water Commissioners to advance the salary of Mr. James M. Gale, their engineer, from 1000*l*. to 1400*l*. per annum, and to give him an honorarium of 1000*l*. for past services.

Short Time in Greenock.—Messrs Caird and Co, shipbuilders and engineers, Greenock, have just resolved on putting their workmen on short time, namely, from 10 a.m to 5.30 p.m. daily.

Institution of Engineers and Shipbuilders in Scotland.—The opening meeting of the new session of this Institution took place last night. Professor James Thomson, C.E., F.R.S., President, occupied the chair, and delivered his inaugural address. Subsequently there was a discussion on Messrs. Purvis and Kindermann's paper submitted to the Institution at the closing meeting of last session.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the attendance on 'Change at Middlesbrough was smaller than usual and very little business was transacted. No. 3 Cleveland pig was again quoted 36s. 3d. per ton by sellers, but buyers held off and for prompt delivery were unwilling to give more than 36s. For delivery over the winter months No. 3 was quoted 35s. 9d. to 36s. The shipments are well maintained, although they fall short of the exports last month or the corresponding period last year. There is no alteration in the condition of the manufactured iron trade. Prices are the same as those quoted last week. The hematite trade remains unchanged.

The Wages Question.—The proposed arbitration to fix the wages of the ironworkers of the North of England has been delayed owing to the illness of the operative secretary of the Board of Arbitration, Mr. E Trow, of Darlington, but now that he is convalescent arrangements are being made for holding the arbitration court before Dr Watson at Newcastle. In consequence of the unavoidable delay the question to be settled now is different to that which was first arranged. Instead of the arbitrator fixing the wages for two months ending the 30th November, he will now have his power enlarged and will decide whether the employers are entitled to a reduction of 5 per cent or the operatives to an advance of 5 per cent. for four months ending the 31st January next In the meanwhile the present rate of wages will be paid pending the award, which will be retrospective from the 1st of October.

Engineering and Shipbuilding —Engineers are not so well employed as they were some months ago, but they hope to tide over the winter without much more slackness, and look forward to better trade in the spring of the year. Shipbuilders are in a similar position During the past month or two a few orders for steamers have been booked by builders on the northern rivers, but these go only a little way to affording employment for the thousands of men out of work. The distress on the Tyne and Wear is widespread and intense. On the Tees there is not so much poverty, although at Middlesbrough the number of unemployed men is large.

The Salt Trade —Messrs Bolckow, Vaughan, and Co., of Middlesbrough, are now making progress with their sinking operations for salt, and expect in the course of a week or two to reach it. Messrs Bell Brothers are doing a capital business in chemicals, having, since they pioneered the salt trade, erected extensive soda works at Port Clarence, Middlesbrough Other companies are carrying on sinking operations, and expect in the course of a few months to be able to raise brine at Middlesbrough There is every probability that the iron town will become a great centre for the chemical trade

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Proposed New Lock Entrance at Goole —At a meeting of some of the trustees of the undertakers of the Aire and Calder Navigation, at Goole, sanction was given to a work of great importance to the port. At present the docks are connected with the Ouse by three locks, the most important of which is the steamship lock, about 270 ft long and 58 ft wide This has become inadequate to the requirements of the port, and the need for another entrance, as well as for an increased extent of quay frontage on the river, has long been felt. The project now is to take down the old post-office and other property, and to run a long lock of about 60 ft wide parallel with the present lock, from a point not far from the iron bridge across the Lockhill, and through Murham-lane, Staith, into the river near the end of the Victoria Pier, the landing stage of the Goole and Hull Steam Packet Company. It is understood the work of demolition will be commenced shortly, the excavations following as rapidly as possible The probable cost is 50,000*l*

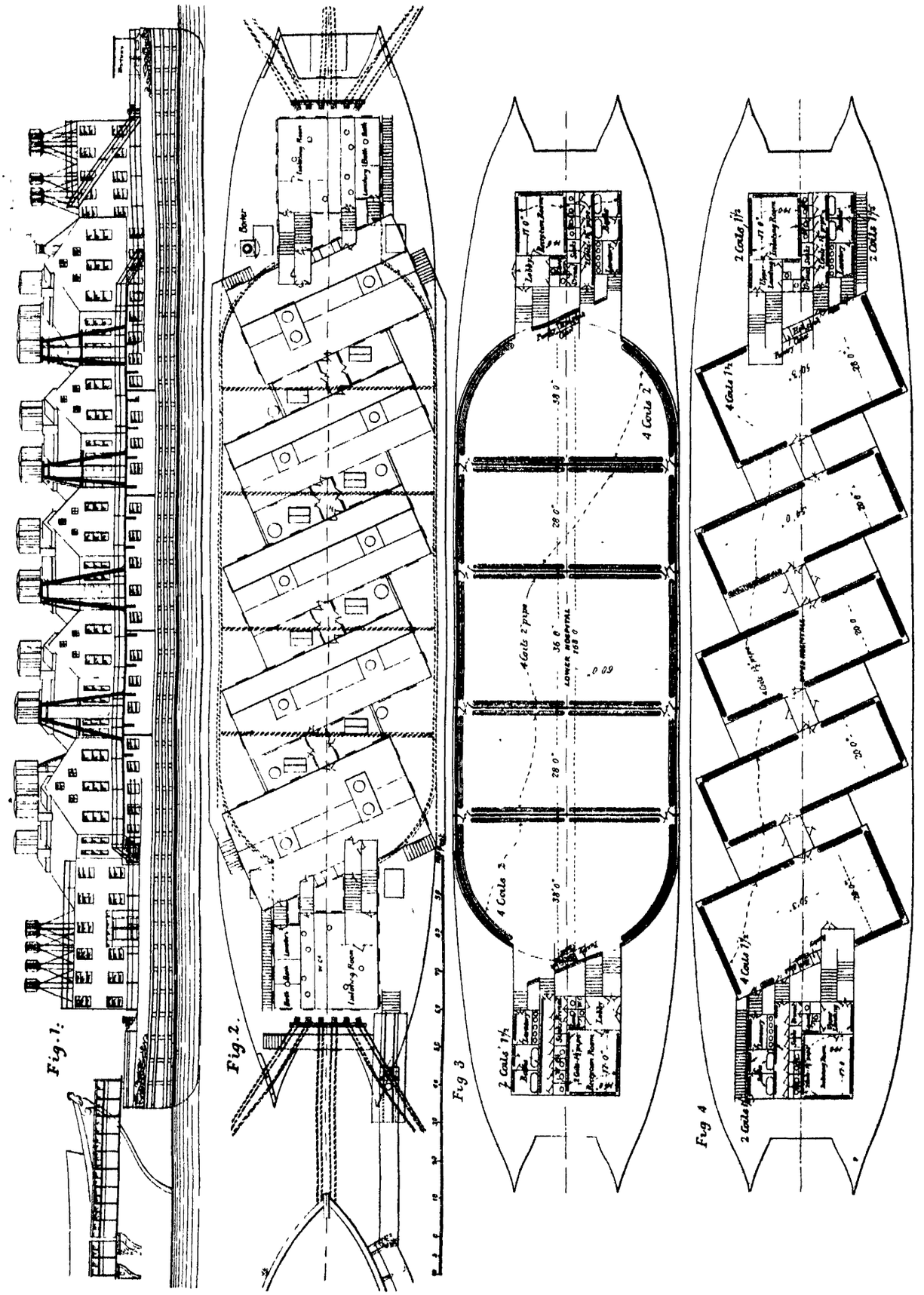
The Proposed Purchase of the Kingston Gas Works — A meeting of the Lighting Committee of the Hull Corporation has been held at the Town Hall The minutes of the sub-committee appointed to negociate for the purchase of the works of the Kingston Gas Company, were read by Mr Duncan (town clerk's department), and the correspondence which had passed between the town clerk and the clerk to the Gas Company's Board (Mr F. A. Scott), showed that the directors of the company had declined to nominate any one from their body to meet a deputation of the Corporation Light Sub committee, and confer upon the basis to be agreed upon for the purchase of the works, but had expressed their willingness to consider any amount that the Corporation might offer for the purchase of the works Ald Witty moved, and Mr Myers seconded, a resolution to the effect that the sub-committee, together with Mr Councillor Rayment, be desired to report as to the desirability of making an offer to the various gas companies, and to name an amount to the general committee which they think just and equitable This was carried.

QUEENSLAND RAILWAY EXTENSION —There has of late been a revival of agitation for railways in many parts of Queensland, and a number of fresh surveys have been undertaken. A surveyor has started on a preliminary examination for a proposed Fortitude Valley Railway. The route is at present quite undecided. Instructions have been issued for a permanent survey to Caboolture, but the point of commencement is not yet decided, as there are several rival routes It seems likely, however, from what has previously transpired in various ways, that at least a portion, if not the whole, of the Sandgate line will be made use of. This would considerably reduce the length of line to be made, and would, at the same time, carry out the expressed intention when the Sandgate line was originally passed, that it should be part of a railway to Caboolture. Whatever is done, the new line will doubtless be made to give access to the fine agricultural district of Bald Hills A surveyor has left for Logan to extend the survey to Beaudesert, a distance of about twenty miles, and the works will be started at once. The survey of the Harrisville branch has now been extended to the Teviot, a distance of some eighteen miles through pretty easy districts. This survey passes about midway between Passifern Station and One-Eye Water-hole, and ends near the Dugandan saw mill. The line, it is said, is capable of further extension with advantage to local traffic, and if carried to the border would end at a point about sixty miles from Tenterfield, and the line from Brisbane by this route would be about 100 miles shorter than by Warwick and Stanthorpe, though nothing is definitely known as to the kind of country to be met with on the New South Wales side.

THE "CASTALIA" HOSPITAL SHIP.

MR. ADAM MILLER, ENGINEER.

(For Description, see Page 406.)



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The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

NOTICES OF MEETINGS

INSTITUTION OF MECHANICAL ENGINEERS.—The next ordinary general meeting of the Institution will be held at Nottingham on Wednesday, November 5, in University College, at 4 p.m., when Mr. I. L. Bell will take the chair. The ballot lists will be presented to the meeting, and the names of those elected will be announced The nomination of officers for election at the next annual meeting will take place. The following papers will be read and discussed, so far as time will admit "On the Mineral Wagons of South Wales," by Mr Alfred Slater, of Gloucester; "On the Application of Electro-Magnets to the Working of Railway Signals and Points," by Mr. Illius A Timmins, of London, "Second Report on Friction Experiments," by Mr. Beauchamp Tower, of London Members are invited to inspect the College, the Corporation Gas and Water Works, several of the local lace and lace machine works, and the Midland locomotive works at Derby.

PHYSICAL SOCIETY.—November 8, 5 p.m "On Certain Phenomena Attending Mixture," by Dr Guthrie, F.R.S., "On Voltaic and Thermo-Voltaic Constants," by Dr. C. R. Alder Wright, F.R.S., and Mr C. Thompson.

ENGINEERING.

FRIDAY, OCTOBER 31, 1884.

THE INTERNATIONAL HEALTH EXHIBITION.

YESTERDAY the second of the series of four great exhibitions, which it was arranged should be held in the metropolis during four consecutive years, was brought to an end without the melancholy festival of a closing ceremony. The popular success attained must have exceeded the expectations of the most sanguine supporters of the show. Over four million persons have passed the turnstiles since the opening day on the eighth of May. It must not, however, be supposed that this total of over four millions represents the number of paying visitors who have passed the turnstiles. A very large number of "complimentary" admissions must necessarily be allowed in an undertaking of this kind, and this year a great many conference tickets were distributed gratuitously. Again, in endeavouring to make an estimate of the income that has been derived from admissions, allowance must be made for excursion tickets, which undoubtedly were issued to the railway companies at a considerable reduction on the regular admission price. The exhibitors' passes would also account for a large number of admissions. It will be seen, then, that the four million odd attendances do not by any means represent even four million shillings—putting aside the half-crown Wednesdays—paid into the exchequer. But with even the most liberal allowances for the non-paying visitors, the venture cannot fail to be a brilliant financial success, in addition to having added to the knowledge of large numbers of people upon a subject which is of all others the most important in our modern domestic life.

The utility of the show has been questioned in many quarters, and it has become the fashion to repeat a smart saying of some one's (which is merely a paraphrase of another smart saying) "that if there had been a little about health at the Exhibition, there would have been a little of everything." This is certainly unfair to the promoters of the undertaking. No doubt a great deal that is contained in the Exhibition has but the remotest connection with health or education. In fact, we will go further, and say that the greater part of the display was not strictly germane to the avowed object of the undertaking; but in spite of this it cannot be questioned that any man of ordinary intelligence could have gained sufficient instruction from the exhibits to enable him to become fairly expert in the matter of domestic sanitation, and to know how to counteract those dangers to health which commonly beset modern life. We are not desirous of becoming apologists for those who had the conduct of affairs, and fully recognise that there were many things that might be better arranged if the thing had to be done over again. The chief section of the Exhibition, the great south gallery, was little more than a collection of advertising show cases; the great popular attraction of all, the Old London Street, had not the remotest connection with health; and the space devoted to pretty gimcracks, which gained admission under the shallow pretence of being educational, was altogether disproportionate to their importance. But however much the conscientious searcher after hygienic truth might regret the presence of such distractions it must be remembered that these were the features that attracted the great mass of the general public who brought the shillings and half-crowns to the money-takers, and prevented the undertaking from collapsing through want of funds. The exhibition that yesterday completed its course, as a Health Exhibition, will not bear comparison with last year's show as a Fisheries Exhibition; but then the Fisheries was, we believe, the most perfect class exhibition that was ever held. This year the foreign section was comparatively weak in spite of the large contribution of Belgium, which was of very limited interest, and the much talked of Chinese Court, which we hold to be far inferior to the collection sent from the same country last year. But the great loss that every one who knew the Fisheries Exhibition must have felt was the absence of any representative display from America. It is to be hoped that next year, when the Inventions Exhibition is opened, that that country, of all others the home of inventive ingenuity, will be well to the fore.

The literature of the Health Exhibition maintains the high standard which Mr. Trendell set in the Fisheries Exhibition literature. The subject treated of this year is much more comprehensive than that of last year's show, and it naturally follows that the official publications in the present instance do not so fully exhaust the subject as the Fisheries literature may fairly be said to have done in its own field. Still the twelve volumes of handbooks, conference papers, and lectures which are on the list include a vast amount of matter containing information that should be of the greatest value to all classes, whilst medical men and architects may gain instruction on many points bearing on the object of their labours, but which have not come within the range of their professional studies.

Mr. Trendell, the literary superintendent, has been fortunate in securing the co-operation of some of the most eminent men in the country to treat of the various subjects selected. Amongst others we may mention the names of Sir Henry W. Dyke Acland, K.C.B., M.D., who wrote the handbook Health in the Village; Mr. Robert W. Edis, F.S.A., who contributes a handbook on Furniture and Decoration, Captain Douglas Galton, C.B., who writes on Heating, Lighting, and Ventilation; Mr. A. W. Blyth, on Dirt, Dr. Attfield, on Water; Dr. G. V. Poore, the author of the excellent handbook on Our Duty in Relation to Health, Dr. W. H. Corfield, Mr. W. Watson Cheyne, Professor Gamgee, M. Louis Pasteur, and many others. The lecturers amongst several of the above, included such names as Dr. T. Pridgin Teale, Mr. W Eassie, C.E, Professors F. de Chaumont, M D., and Charles Graham, Dr. Thudichum, Hon. Lewis Wingfield, and Mr. William Morris. With a list of authors containing such names as these, the Health Exhibition literature could hardly be otherwise than of great value. This year, too, the publication of the volumes is well forward, and it is said that had it not been for one or two laggards amongst the contributors, the complete series would have been ready by the closing day The publication of this literature is one of the most successful and valuable features that has been introduced in connection with the present exhibitions, and Mr Trendell may fairly be complimented on the result of his labours. The large amount of good work he has got through with a very limited staff is really surprising, and it can only have been compassed by unremitting attention on all hands.

On Monday last the awards of the juries were announced in a special supplement of the *London Gazette*. Honours have been distributed with a liberal hand. There are over sixteen pages of names in the *Gazette*, averaging about 120 names to a page. In addition to this there are the prizes given by the Society of Arts Some of the exhibitors have secured a dozen or so of medals, one firm scoring no less than nine gold, fifteen silver, and five bronze medals. When rewards are so freely given they cannot fail to lose a great part of their distinctive value, and indeed the whole system of prize giving is, in the opinion of many, a bad one. Even supposing the juries are perfectly competent and unbiassed, and have ample time and opportunities for comparing the various matters adjudicated upon—propositions by no means to be taken as matters of course—the award of a gold medal for any collection of manufactured goods simply means that the recipient exhibited certain articles of a superior quality. The goods will have been prepared especially for exhibition, without regard to expense in production, and cannot in all cases be taken as representing a fair trade sample It is said that in some cases rewards have been given to those who have not produced a single article exhibited. This is obviously the case in one prominent instance. Perhaps it would be impossible to attract contributors without the bait of a possible medal, at any rate, exhibitors appear to attach considerable importance to the awards, whatever their intrinsic value may be.

In concluding this notice it may perhaps be of interest to give a few figures as to the number of visitors at this Exhibition in comparison with other exhibitions of note that have been previously held in London.

The Fisheries Exhibition had the advantage of being first opened to the general public on a Whit Monday, and the total admissions for the week amounted to 132,949. During the first week of the Health Exhibition the total only amounted to 66,970. It was not long, however, before the Health Exhibition forged ahead, and we find that during Whitsun week, which commenced on June 1, the total numbers were 154,149. On all the principal days the Health Exhibition has registered larger numbers; thus on the August Bank Holiday this year—when the largest total during both years was recorded—the total amounted to 71,884 attendances, whilst the corresponding day of last year gave a total of 55,868. The largest week at the Fisheries was that commencing October 22, when 212,104 persons passed the turnstiles. The largest week this year was commencing Monday, October 20, when 260,575 was the number of attendances registered. The heaviest day at the Fisheries was on the last Saturday, October 27, when the record was 60,523, or over 11,000 less than the August Bank Holiday this year. The first million was reached this year on Saturday, July 5. The third million was attained on September 25, and the fourth million on Monday last. The last whole week this year saw 260,575 attendances, last year the numbers were 212,104. The grand total last year was 2,703,051. The exact total for this year

we are at the time of writing unable to state, but as we have said the fourth million was reached on Monday. It may be worth while to compare these figures with the statistics of the former two great exhibitions held in London. In 1851 the total number of visitors was 6,039,195. The fullest day was on October 7, four days before closing, when 109,915 people were admitted; on the four last shilling days, the average daily number was 104,576. On the opening day, May 1, the admission was only by season ticket; during the next two days the charge was 1*l.*, which 1041 persons paid on both days. After that for nineteen days 5s. was charged for admission. After that the admission was 1s. for four days a week, 2s. 6d for Fridays, and 5s. on Saturdays. Afterwards the Saturday fee was reduced to 2s. 6d. The daily averages taken throughout the time the Exhibition remained open give the following figures.

Season tickets .	5,473
Paying 1*l.*	521
,, 5s. . . .	8,703
,, 2s. 6d. .	19,310
,, 1s. . .	55,493

The Exhibition of 1862 had a grand total of 6,211,103 visitors during the 171 days that it remained open, which time exceeds that of the 1851 Exhibition by 30 days. The first day admission was by season-ticket. On the second and third by payment of 1*l*, after that for twelve days the charge was 5s., for twelve days 2s. 6d., after that the price was 1s. on four days a week, and 2s. 6d. on Friday's and Saturday's excepting on the day of the declaration of the jury awards, when it was 10s. The daily average was 36,328, and the largest total on one day 67,891.

LLOYD'S REGISTER.

There is no commercial corporation in the world better known by name than Lloyd's. Whenever anything goes wrong in the shipping world, whether it be a wreck, a collision, or a fire, the first person on the spot, at least in an official capacity, is sure to be one of Lloyd's agents, who not only represents the interests of the underwriters whose property is at stake, but in the eyes of the general public is the emblem of law and order. For the great body, whose deputy he is, have always administered their affairs with such liberality and justice, that it is almost forgotten that they are a voluntary association, and an official character, begotten by upright dealing and business acumen, has gathered around them So great has been their success that foreigners have not only copied their procedure, but have also clad themselves in their name, the North German Lloyd's, and the Austrian Lloyd's, being well-known examples.

Lloyd's, like all other great corporations, is not the growth of a day, and neither does it all spring from one root. In its progress it has absorbed or formed close alliances with other institutions, and under its gigantic patronage their separate identity has been almost lost. Such is the case with *Lloyd's Register*, the fiftieth anniversary of which was celebrated last evening. This publication has become so closely identified with the body whose name it bears, that to the outside world it is regarded as their organ. But this is not so, it is and ever has been, the product of a voluntary association of merchants, shipowners, and underwriters, and the reason why it assumed the name of "Lloyd's" in 1829, before the present issue was commenced, is not known, but it may easily be guessed that the proprietors desired to avail themselves of the already widespread fame of the body to which they thus affiliated themselves.

Lloyd's Register of British and Foreign Shipping is a record which in one form or another has existed about 150 years, and which in its present form has now attained its jubilee. It is an institution to which, as Englishmen, we can point with pride, for no other nation can show an informal corporation, without patronage and without Government aid, which has raised itself by its integrity and intelligent management to the position of giving the law to an enormous body of men like the mercantile community, not one of whom is bound to take any cognisance of its existence unless he chooses to do so. And this has been done while the practice of shipbuilding has changed, not once, but many times. The Register commenced in the days of wooden sailing ships, and has seen every change from that to the modern steel steamers and yet it has not only accommodated itself to every alteration in the structure of the vessels on which it sits in judgment, but it has also reformed its own constitution to meet the development which has occurred in the mercantile world. The history of such a movement is exceedingly interesting, and we make no apology for dwelling on it at somewhat great length, taking as our guide a book which has been published in connection with yesterday's celebration.*

The first recorded attempt to establish anything like an organised registry of ships dates back no further than the last century, although the classification of merchant shipping in some form is probably contemporaneous with the business of marine insurance, that is, in all likelihood, with maritime commerce itself. The Phœnicians, the Greeks, and other ancient people, were all, we are told, in the habit of guarding themselves against some of the risks of maritime enterprise, by various systems of insurance, whether by means of loans or of mutual guarantees. "Nautical insurance" was exempted by the Justinian laws (A.D. 533) from the general limitation of six per cent. to which usury was subject, and in the Middle Ages maritime insurance was regularly carried on in the Italian republics, even the depth to which each vessel should be loaded being defined by law.

With the practice of insuring ships would arise the necessity of some ready means of ascertaining their qualifications, other than by the costly process of employing an expert to report to each merchant or underwriter in every transaction, and from this there would grow some kind of register. The earliest practice of this kind, which can be identified now, consisted in the keeping of "Ships' Lists" by the frequenters of Lloyd's Coffee-House. This establishment, which is mentioned in the *London Gazette* of February 18, 1668, was situated first in Tower-street, and from 1692 onward in Lombard-street, at the corner of Abchurch-lane. It was owned by a Mr. Edward Lloyd, and became the great resort for all persons connected with shipping, gradually developing into the head-quarters of maritime business, and especially of marine insurance. Lloyd started that system of shipping intelligence, which under the direction of the Great Marine Insurance Corporation of "Lloyd's," has grown to be one of the most extensive and most perfect organisations in the world of commerce. He issued, for a short time, a newspaper called *Lloyd's News*, which was the forerunner of the world-famous *Lloyd's List*, which was commenced in 1726, and has continued to the present day. With the exception of the *London Gazette* it is the oldest newspaper now in existence.

At Lloyd's Coffee-House were started those ships' lists, already alluded to, containing the germs of the *Register of Shipping*, which sprang into existence at some period during the last century, and which, besides being the first English classification society of which there is any record, is the parent of all other shipping registers now in existence. These lists, which were written by hand, contained an account of vessels which underwriters who met at Lloyd's Coffee-House were likely to have offered to them for insurance. They were most probably first put into type and circulated for the use of subscribers about 1726, the year which witnessed the establishment of *Lloyd's List*. In 1770 the principal underwriters and brokers formed themselves into an association, which has ever since continued under the name of "Lloyd's." The earliest *Register of Shipping* now in existence, bears the date 1764-5-6, and gives the former and present names of the vessels, the owners and masters, the ports between which the vessels traded, the tonnage, the crew, the guns, and the port and year of build. A blank column was left for the insertion of alterations. The vessels recorded in the volume are mostly small, but there are several of 400, 500, and 600 tons, two of 800, and one of 900 tons.

The next register in existence, in point of date, is for the years 1768-9. This volume contains, further, references to the vessels' rigs, and afforded information as to the repairs effected. New symbols of classification were also adopted, the letters a, b, c, &c., representing the class of the vessel, and the numerals 1, 2, 3, and 4, the state of its equipment. Thus a 1 denoted a first-class ship with a first-class equipment. This was the first step towards the well-known designation "A 1," which appears in a register dated 1775-6. This volume contained the load-draught of water, in place of the number of the crew, and the alterations which, in the earlier copies, had been made with pen and ink, were now posted weekly in type as at the present time.

It appears probable that the Register was supported exclusively by underwriters for their sole use as "Members of the Society," and strict rules were adopted to confine the use of the books to the subscribers only. The meetings of the committee were always held at Lloyd's Coffee-House, but the office of the registry was situated first in Sun-court, and subsequently in Castle-court, Birchin-lane. In the Register for 1797-8 a new style of classification was introduced, which depended entirely upon the place of build and the age of the ship. Thus while a vessel built on the Thames would be entitled to continue on the first class for thirteen years, another ship of the same description, built at one of the northern ports, would be considered eligible for a period of only eight years, while prize ships could receive no characters whatever. This change caused great dissatisfaction, and ultimately led to the formation of a rival Register. The aggrieved shipowners made strong representations to the committee, and in 1799 several of them started the *New Register Book of Shipping*, which was usually known as the *Red Book* in contradistinction to the old or *Green Book*. Singularly enough the Shipowners' Committee also adopted a method of classification based almost entirely upon the locality in which the ships were built, but with the important difference that subsequent classification at the expiration of the original class, depended upon the condition of repair in which the vessel was found. Thames-built ships, if entirely of British oak, were classed twelve years, and country-built ships ten years. The second class included all vessels kept in perfect repair; the third class those that did not seem safe to carry dry goods, although otherwise seaworthy; the fourth class those which were not deemed safe for a foreign voyage.

At the beginning of 1800 the *Green Book* numbered 233 subscribers and the *Red Book* only 125, but during the year the latter received an accession of no less than 76 subscribers, whereas the *Green Book* had an addition of only 31. The latter, however, returned in part to the old method of classification and again distanced its rival. The vessels classed in the oldest register-book extant, that dated 1764-5-6, amounted to 4500. In 1800 the number was 8271, and in the issue of 1801 there were 9145 vessels in the old book and 9540 in the new. It is not until 1822 that we find any record of a steamship in the Register. In that year there is entered the name of the James Watt, of 294 tons, built at Greenock in 1821 and classed A 1. This, of course, was many years after steam had been practically tried on board ship. The number of classed steam vessels increased rapidly, and the book for 1827 included 81 steamers, and that for 1832 no fewer than 100. The concurrent existence of two registers was soon found to be productive of inconvenience, and the General Shipowners' Society offered their mediation with a view to amalgamating the two. This was followed in 1823 by a public meeting with the same object, and having the further purpose of effecting changes in the entire organisation and administration of the registries. But the proposal to interfere in any way with the existing systems of classification, met with most determined opposition from a large and important section of the members of Lloyd's, including the committee. After much wrangling, it was decided that a committee of inquiry should be appointed to go into the whole question.

The committee contained eight merchants, eight shipowners, eight underwriters, and nine representatives of the outports; and after two years of hard work, it reported on February 8, 1826, that the principles adopted under the existing system were "most fallacious and erroneous," while "the partial degree of actual survey required by the system" was "rendered practically nugatory by the insufficiency of the salaries paid to the surveyors." The committee propounded a scheme for the establishment of a registration society on a proper basis, with a set of rules for the classification of ships. As to the constitution of the proposed society, the committee suggested that the future classification should be intrusted to a committee of thirty-two members, consisting of six ship merchants and six shipowners of London, to be appointed by a general meeting of merchants and shipowners respectively; six members of Lloyd's, to be appointed by that body; one representative of the Royal Exchange, London, Alliance, and Mutual

* Annals of Lloyd's Register, being a Sketch of the Origin, Constitution, and Progress of Lloyd's Register of British and Foreign Shipping.

Indemnity Assurance Associations, respectively; and one representative resident in London for each of the following outports, viz.: Liverpool, Hull, Glasgow, Newcastle, Bristol, Whitby, Yarmouth, Leith, Whitehaven, and Sunderland. Vessels were to be arranged in three classes; the first to comprise those built under survey, the number of years assigned ranging from twelve to six; the second to contain those no longer entitled to the first class, but capable of carrying dry cargoes, and the third to include vessels safe to carry cargoes not injured by water. Provision was also made for the restoration of vessels, under proper survey, to the first class, after the expiration of the original term.

Several years elapsed before any effectual steps were taken in furtherance of the scheme, but in the mean time the gradual decay of the two registries strengthened the hands of the reformers. At last affairs grew so bad that it was feared the mercantile community would be left without a book at all, and great efforts were made to effect an amalgamation. A committee was appointed to draft a fresh constitution, and they proposed that the superintendence of the affairs of the society should be entrusted to a committee in London to be composed of twenty-four members, merchants, underwriters, and shipowners, and that the funds should be found by a subscription of three guineas from each member of the society, who should be entitled to one copy of the book, and by fees levied on the shipowners for the expenses of survey. This was agreed to, and the provisional committee continued to manage the affairs of the society until October, 1834, passing the rules for classification, selecting and appointing the surveyors and other officers, examining the reports of survey sent in by the surveyors, classifying the ships for entry in the book, and making all other arrangements. Having brought their labours to the satisfactory termination by the production of the first edition of *Lloyd's Register of British and Foreign Shipping*, they dissolved on the 21st of October, 1834, and handed over their trust to the permanent committee.

The advent of the present Register Book forms a fitting opportunity to take note of the state of the shipping interest fifty years ago. For instance, there were built

Year.	In the United Kingdom. Vessels.	In British Colonies. Vessels.
In 1830	750	367
,, 1831	760	370
,, 1832	759	221

Of the 750 vessels built in 1830 the tonnage was composed as follows:

	tons.
About 210 were under	50
,, 200 ,,	100
,, 150 ,,	200
,, 150 ,,	300
,, 30 ,,	400
,, 10 ,,	above 500

Of the vessels belonging to the United Kingdom in 1830 the following is a summary of the tonnages:

	Ships.
50 tons and under	6,542
50 ,, to 100	5,212
100 ,, ,, 200	3,942
200 ,, ,, 300	1,948
300 ,, ,, 400	969
400 ,, ,, 500	329
500 ,, ,, 800	110
800 ,, ,, 1000	15
1200 ,, and upwards	48
Total	19,110

In addition to these there were 4547 vessels of 330,227 tons registered in the British Colonies.

The rules laid down by the provisional committee treated of the construction of wood ships in brief and general terms, and contained but slight reference to the building of wood steamers. There was little direction laid down beyond the description of timber to be used in the construction of vessels for the respective terms of classification, and the scantlings of the principal parts of a ship. Four grades were provided for, denoted by the letters A, Æ, E, and I. New vessels to be entitled to rank in the A class must have been surveyed at certain stages of their construction. Vessels not built under survey were to have one year subtracted from their class, and those that were not protected by an efficient roof during building also lost a year. At the expiration of the term of years vessels in the A class could be restored to that grade, if found satisfactory after a most searching survey. The rules issued in 1834 directed that steamers should be surveyed twice in each year, and that their machinery should also be certified by a master engineer.

A staff of sixty-three surveyors was appointed, of whom thirteen were exclusively the servants of the society, and these were distributed at the different ports in proportion to the average tonnage built at or sailing from the district. These surveyors were of two classes, known as "shipwright surveyors" and "nautical surveyors," the former attending principally to vessels building, and the latter to those afloat. The duty of classifying the ships according to the surveyor's reports was undertaken by a sub-committee, and this formed an essential difference between the procedure of the new society and the older ones, in which the classification was left entirely in the hands of the surveyors. The new society did not command universal approbation, and the outports sent in memorials to be allowed to join in the representation, and when these were rejected the Liverpool people issued a local Register of Shipping. In 1844 a proposal was made that the two societies should undertake a common revision of their rules, and on April 20, 1845, the amalgamation of the two bodies was finally approved, the other ports being propitiated by the introduction of local men on the London committee. Other causes of opposition arose from the stricter system followed by the new society, which in comparison with its predecessor, it often appeared arbitrary in its decisions. But it lived through all this dissatisfaction, and soon obtained a firm footing in the commercial world.

Although no rules for the construction of iron ships were promulgated by the society till 1855, vessels of this description were admitted to classification at a much earlier date. The first iron ship that received a class was the Sirius, of 180 tons, built in London in 1837. The next iron ship was the Iron side, of 270 tons, constructed in 1838 in Liverpool, by Messrs Jackson and Jordan. From 1838 to 1844, the committee continued to record iron ships with no other designation than "built of iron." In August, 1843, however, they determined to collect all the evidence available from their staff in regard to iron ships, and in the following January they announced that in future the character A I would be granted to iron ships built under survey, and in other respects satisfactory. During the next few years information was diligently collected as to the construction and performances of iron ships, and in 1855 a code of regulations was issued prescribing the minimum thickness of plates and substance of frames to entitle to the character A. The thickness of the plating, together with the spacing of the frames, determined the number of years assigned, there being a difference in thickness of $\frac{1}{16}$ in between each grade, and a difference of frame spacing of 2 in. between the highest and the lowest grades. These rules, with slight modification, remained in force for ten years, but did not gain universal approval. In 1863, the committee decided that ships built on peculiar principles should be specially surveyed every two years and marked "Expl. (B S)," denoting that they were of an experimental character, and were subject to a biennial survey. In this way they rendered their system elastic, and left a way open for improvements on the part of builders and naval architects, their only demand being satisfactory proof that the method of construction rendered the vessel strong and seaworthy.

After the amalgamation of the society with the Liverpool Register in 1845, no further change took place in the constitution of the committee until 1863. But the intervening years did not pass without a renewal of the applications from the provinces to be admitted to a share in the management of the society. The enlargement of the London Board by the admission of nominees from Liverpool touched the susceptibilities of the other outports, and the north-eastern districts were not slow to take advantage of the opportunity thus afforded to urge their claims. The result was that an addition of ten members was made to the committee; four from Liverpool, two from the Clyde, one from the Tyne, one from the Wear, one from Hull, and one from Bristol. In the following year another member from the Tees and Hartlepool was added. A proposal that one of the new members should represent the shipbuilders was negatived as being contradictory to the constitution of the society, which represented merchants, shipowners, and underwriters only. An attempt was made in 1870, and again in 1873, to effect an amalgamation with the "Underwriters' Registry for Iron Vessels," which was established in Liverpool in 1862, but both efforts failed.

In 1863, after nine years' experience of the working of the rules for iron ships, the Committee again took the subject under their consideration with a view to revision in those particulars which had been found to require it. It was considered that as iron did not decay like wood, it was not reasonable that the character of a ship should suffer simply because she had attained a certain age. The Committee therefore determined to class iron ships under three grades $\frac{A}{100}\ \frac{A}{90}\ \frac{A}{80}$, and that these classes should be retained so long as the state of efficiency of vessels entitled them thereto. With these new rules the frame spacing was increased to 21 in., and in certain cases to 23 in. Many other modifications were also made, and the attention given to this important question in 1863 marks an interesting epoch in the history of the society, as the rules then formulated constitute the groundwork of those in operation ever since. In 1870 an important modification was made to the effect that the scantlings of iron vessels should be fixed by certain of their dimensions, and not by the tonnage. The element of proportion of length to breadth was recognised as affecting the scantlings, and a better distribution of material, admitting of considerable reduction in the scantlings previously insisted on, was thus rendered possible. With these amended rules the symbols 100 A, 90 A, 80 A, &c., were introduced, and vessels were rendered capable of retaining their class as long as they were in a satisfactory condition. In 1871 the rules were still further revised, and tables added giving sizes of beams, breadth of stringer plates, and particulars for the construction of iron and steel masts and yards. With some modifications in the details the rules passed in 1870 remain in force to this day.

Although from the commencement of the society's existence it was styled a Register of British and Foreign Shipping, yet for many years there was no provision made for the survey of ships abroad. At last, after repeated refusals, a surveyor was appointed in 1852 for Quebec and the River St. Lawrence, and in the following year another was stationed at St John's. Several others followed, and in 1856 Mr. Preteous was sent as surveyor to Holland and Belgium, where he stayed till 1861. No further appointments were made on the Continent until 1866, when Mr L. Meyer represented the society in Holland and Belgium. After this, surveyors were appointed abroad very rapidly, and at the present time there are no fewer than sixty-six non-exclusive surveyors abroad.

The rules issued in 1834 provided, as stated above, that the machinery of steamships should be surveyed by a "master engineer" twice a year. A few years later the serious loss of life resulting from boiler explosions on board ship caused a committee to enforce a more rigid compliance with the rules, and from this arose the machinery surveys which now constitute so important a feature of the society's operations. In 1874 the Committee decided to appoint engineer-surveyors, and secured the services of Mr. William Parker as the chief of that service. At the present time the staff consists of one chief engineer-surveyor with two assistants, twenty engineer-surveyors, and seven ship and engineer-surveyors, all of whom are exclusively the servants of the society, while there are ten engineer-surveyors, and sixteen ship and engineer-surveyors in foreign ports, not exclusively employed by the society. To show the work undertaken by the society in this branch it will suffice to state that in August, 1878, there were 246 sets of engines and boilers being constructed under special survey. In the same month, in 1879, there were 126, in 1880 there were 202, in 1881 there were 401, in 1882 there were 456, and in 1883 there were 424. Besides these, there are at all times a large number of new boilers being made to replace those worn out in old vessels.

The requirements of our space compel us to hurry over the remainder of this most interesting history. The first application for the classing of a steel vessel was made in 1862, and was refused. In 1864 the Viceroy of Egypt's yacht of 2400 tons was built partly of steel, and the Committee consented to a reduction in the steel scantling of one-fourth, as compared with iron, and in 1866 a ship of Barrow steel, with material two-thirds of the usual sectional area, was classed as "Experimental." After one or two other attempts the matter dropped until 1877, when the question came prominently to the front again, and after a searching inquiry by the society's

officers, the conditions under which steel could be accepted were formulated. The following is an account of the tonnage built of steel under inspection during four years.

Year.	Steel Ships.	Steel Steamers.	Total Tonnage.
	tonnage.	tonnage.	
1880	1,342	34,031	35,373
1881	3,167	39,240	42,407
1882	12,477	113,364	125,841
1883	15,703	150,725	166,428

It has already been remarked that a column containing "the feet of the draught of water" appears in the third earliest copy of the Register extant. The subject seems to have dropped until 1870, when it was partially revived, and in 1874 it was decided that every awning-decked vessel should be marked with a load line. At this time Mr Martell was engaged in preparing tables of freeboard based on the principle of every vessel having a certain amount of surplus buoyancy. So great was the undertaking, that it was not until August, 1882, that these tables were approved and issued.

In the autumn of 1882 the representation of the outports was again discussed, and a further alteration of the constitution of the committee resulted, the members being raised from 41 to 50, distributed as follows: London, 26; Liverpool, 8; Glasgow, 4; the Tyne, 3; Hartlepool, Stockton, and Middlesbrough, 2; Sunderland, 2; Cardiff, Newport, and Swansea, 1; Leith and Aberdeen, 1; Greenock, 1; Hull, 1; and Bristol, 1. Constant alterations have been made in the Register Book. In 1874 all British ships of 100 tons, whether classed or unclassed were inserted; two years later an alphabetical list of owners was added, and the latest feature is a list of all dry docks and patent slipways in the world. About 8000 reports are received from the surveyors per annum and are considered by a committee which meets twice a week There are on the register 195 vessels over 3000 tons; of these 14 are above 5000 tons, and 62 are above 4000 tons.

This brings us to the close of our history, and it only remains to name some of the men who guided the proceedings of the society so successfully The office of chairman was filled by Mr. Thomas Chapman from 1835 to 1881, his election following year by year until his age counselled retirement. Then his place was taken by the present chairman, Mr. W. H. Tindall, the son of the late Mr. W. Tindall, who was a member of the committee at the formation of the society. Among the officers we find the names of Mr. N Symonds, Mr. Charles Graham, and Mr. G. B. Seyfang, as secretaries. Mr. G Bayley was the earliest of the principal surveyors. He was followed by Mr. A. F B. Creuze, F.R.S., and at his death the post was filled jointly by Mr. J. H. Martin and J. Ritchie. Mr. Waymouth followed them, and when he became secretary Mr. Martell took the office. In 1874 Mr. Parker was appointed to be the head of the newly-formed engineering department.

That the growth of the society's business has been co-extensive with the perfecting and extending of its organisation is evident when it is stated that the shipping built under its inspection in the United Kingdom and elsewhere during the last few years amounts to:

		tons.
In 1879	501 vessels of	531,338
1880	480 ,,	517,664
1881	582 ,,	757,302
1882	682 ,,	989,002
1883	848 ,,	1,116,555

While out of the total number of merchant vessels built in the United Kingdom during the same period, including those of every type and nationality, about 90 per cent. have, on the average, been surveyed and classed by the society.

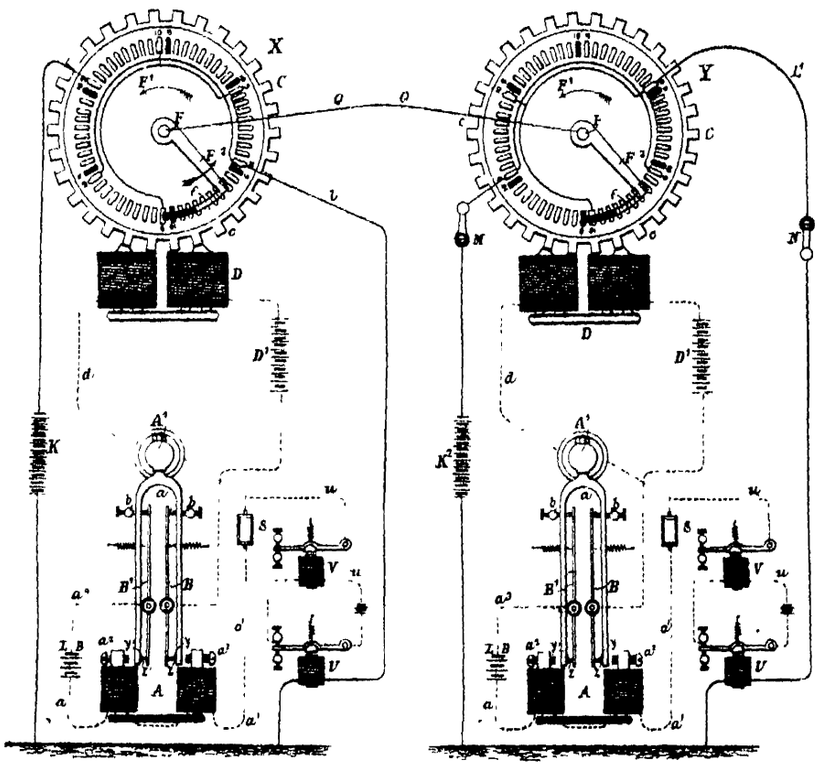
THE PHILADELPHIA ELECTRICAL EXHIBITION.—No. V.

By J. C. B. Woodbury, Boston.

The telegraphic display lacks some of the characteristics essential to form a representative display of the American telegraph systems, although the most important of them are exhibited, but not always in operation. In the exhibit of the United States Patent Office, which has been previously referred to, there are models of telegraphic instruments which possess the interest due to pioneers, as well as those of inventions of subsequent commercial importance. When one considers the significance which would be attached to operating lines equipped with these forms of telegraph, it must be confessed that, as a whole, the art of telegraphic communication is not as completely represented as the magnitude of such interests would lead one to expect.

The exhibit of Mr. Edison contains examples of a great number of telegraphic instruments devised by this fertile inventor, embracing duplex, quadruplex, harmonic, and automatic telegraph instruments; the embossing instrument for retransmission of messages; the printing and the autographic telegraph; besides several forms of stock printing telegraph. Elsewhere is an exhibit of the harmonic telegraph of Professor Elisha Gray. The Baltimore and Ohio, and the Western Union Telegraph Companies, both have commercial offices in the building.

The synchronous multiplex system of Mr. Patrick B. Delaney represents an entirely different method of transmission from either the harmonic or the duplex and quadruplex systems, now in common use on Morse telegraph lines. By this system six



messages may be sent at the rate of fifty words per minute over any ordinary telegraph circuit, and twelve messages may be sent at the same time, if not more than twenty words per minute are sent by each operator.

Mr. Delaney has accomplished this result by giving to the wire twenty-two impulses three times every second, and these may be collected so that each operator has the use of thirty-six impulses every second at equal intervals, and these impulses are faster than any operation in opening and closing a Morse key in transmitting that alphabet.

Mr. Delaney has arranged his device so that these impulses shall all act on the relay of the receiving operator in the same direction, by using a relay with a polarised or magnetised armature and using a double battery on the line, so that closing the key sends the armature in one direction, and opening the key closes a back contact and sends the armature in the opposite direction. In this manner the series of impulses occurring, for instance, during the transmission of a letter *l* in the Morse alphabet, simply hold the relay points closed through the sounder circuit, and produce merely a long dash instead of a series of dots, as would naturally be expected.

The apparatus by which this regular succession of impulses is sent through the circuit is simply a revolving disc divided into segments over which a revolving arm sweeps. This arm is provided with an arrangement which insures that it shall revolve in exact conformity with the arm on similar discs at the other end of the line, which is in contact with corresponding segments at the same instant.

This is accomplished on the principle of the phonic wheel of M. Paul la Cour, of Copenhagen, and consists of a motor for turning the arm, and a method of accelerating or retarding this motor, if at any point the two revolving arms at extreme ends of the line are not simultaneously in identical positions. The motor consists of a toothed wheel of soft iron, close to which is a magnet, in circuit with a breaking point, operated by a tuning-fork. This tuning-fork, besides opening and closing the motor circuit, also opens and closes a circuit which keeps it in vibration, and it is to this arrangement that the synchronising device is applied. This will be seen by referring to the engraving below, in which are represented two stations at any distance, connected by the line Q Q.

The telegraph station at one end of the line is represented by X and that at the other terminus by Y. D represents the motor magnets whose circuit extends through the battery D^1 to the breaking points on the tuning-fork *y*, and thence the wire is completed through the return wire *d*. The point y^1 on the prong of the tuning-fork is in circuit with the battery L B and the magnet A, whose pole-pieces are provided with adjustable screws a^2. If the arm F^1 at the disc in station X is ahead of the arm F^2 in station Y by one segment, it will reach segment No. 10 on the disc at station X, when the arm on the disc at station Y has only reached segment No. 9, then there will be a circuit closed through the line *l*, at station X, to the relay U, thence to ground, and thereby through line battery K^2 and switch M to segment No. 9 at station Y. The relay U, in closing, opens the circuit through relay V and battery *u*. When the relay V opens, it closes the circuit through the line *v* and into the resistance S; thereby increasing the amount of current thrown into the magnets A, which keep the tuning-fork B B in vibration, thus producing an increase in the amplitude of the vibrations of the tuning-fork and slightly diminishing the rapidity of its vibrations; and this reduction in the rate of vibrations acts upon the motor D in a corresponding manner.

If the arm in F^2 in station Y is in advance of that at station X, the same action occurs at segment No. 10 at the lower side of the disc as represented at station Y, except that the motor at Y, instead of the one at X, is acted upon, and both of these correcting impulses may be given at segments 60 deg.

on each side of the segments used for purposes of illustration.

If the arms are in identical positions on either respective discs, the blackened segments, numbered 10, are touched instead of those numbered 9, and these are "dead," that is, have no circuit attached to them, and consequently no correcting impulse is given. The blackened segments merely leave the correcting line open as long as the arms are simultaneous, and serve no other purpose, but the surface of the disc contains in addition to these segments and the six adjoining ones, seventy-two, which may be used for the transmission of impulses, and between each of these there is a segment connected directly to the ground, for the purpose of discharging all surplus charge, static or otherwise, and earth currents, in order to clear the line between the impulses transmitted over it.

The method of applying this system to Morse circuits for high-speed transmission is to connect every sixth segment on the disc together, thus giving twelve impulses from that source during each revolution of the arm; as these arms revolve three times per second, the operator receives the use of the line thirty-six times per second, the breaks in the line occurring with so much greater rapidity than he can open and close his key, that the practical result of the operation of transmission is identical with that of a continuous current for constant use.

If the speed of transmission is as low as twenty words per minute, it will suffice that every twelfth segment be connected together. It is unnecessary for the operators to confine their work to this speed; the rates cited above refer only to the maximum speed advisable to be used. The line can be used both ways, by connecting some segments in series of six and others in series of twelve, and a printing telegraph can be used at either end of the line if it receives the benefit of only one segment to each revolution of the discs. It is found in practice that a speed of four words per minute can be obtained from the use of one segment on the disc.

This apparatus will allow the same telegraph wire to be used for three fast Morse circuits, two slow Morse circuits, six printing telegraph circuits at a speed of eight words per minute, and twelve printing telegraph circuits at a speed of four words per minute, all working on one telegraph line without interference or interruption with each other, as long as the line is complete. This is no theoretical assumption, as such a line, about fifty miles in length, is in practical operation between Boston and Providence. Another advantage pertaining to this system, is the safety against theft of messages, for if any form of sounder is inserted in the line, or the wires of a hand telephone placed near the line, the abstractor would only hear a confused jumble of sounds, and not those pertaining to the messages of any single operator. If a system of apparatus, similar to those used at the terminals of the line, were inserted in the line, no results could be obtained, for it would prevent the instruments at the terminals of the line from being synchronised, and thereby stop all transmission of messages and thereby give an indication of some interference with the line.

The Delaney system of synchronous-multiplex telegraphy in its ingenuity of design and simplicity in practical operation, constitutes an advance in telegraphic science, which is capable of practical application.

ELECTRIC LIGHTING AT THE INTERNATIONAL HEALTH EXHIBITION.

No. X.

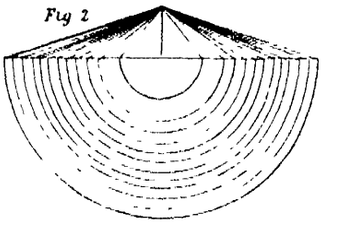
A considerable number of the electric lights at the Health Exhibition, particularly those of the Jablochkoff Company, are inclosed in lanterns glazed with glass designed by Mr. A. P. Trotter, of No 7, Furnival's Inn, E.C., to give a uniform distribution of light. This glass has a grooved or corrugated surface on both sides, the lines on the outer surface running horizontally, and those on the inner surface vertically. The sections of the corrugations are such that light from a luminous point within the lantern is uniformly distributed over a given circular area of floor, the larger portion being deflected towards the edge of the ring which would naturally be the worst lighted, and comparatively little being thrown into the centre, which is usually unpleasantly bright. When using naked lights, or lights inclosed in ordinary globes, a given spot in the area below is illuminated inversely as the square of its distance from the light, and directly as the reverse of the angle of incidence. This law may be represented graphically by a curve (Fig. 1), whose ordinate at any point of the base is a measure of illumination at that point. Taking the length A B, representing the degree of illumination on that



Fig 1

point of the plane nearest to the source of light, as unity, the degree of illumination at any point C is $\frac{\cos\theta}{A\,C^2} = \cos^3\theta$; the equation to the curve is $y^2 = \left(\frac{1}{1+x^2}\right)^3$, taking B as origin, and the solid contents of the figure of revolution of the curve about A B is 2π.

If it be assumed that the circle to be illuminated from a given luminous centre have a diameter equal to seven times the height of the light from the ground, then the degree of illumination at any point will be represented by the height of a cylinder whose diameter is seven times its length, and whose volume is equal to that of the said solid of revolution This is 0.163 That is at any point on the area, the illumination will be 0.163 of the maximum of the ordinary distribution. Under ordinary circumstances the illumination falls off so rapidly that at a distance from the foot of the post, equal to three-quarters of its height, it has decreased by one-half, at an incidence of 45 deg on the ground there is 0.353, and at a distance of twice the height of the lamp, there is but 0 0316 of the maximum In considering the problem of effecting a uniform illumination, it was assumed by Mr Trotter that the light was emitted from one central source, and that the area to be covered was circular. Suppose such an area to be divided into annuli of equal area; the radii being as $\sqrt{1}\cdot\sqrt{2}\ \sqrt{3}$, &c, the same quantity of light has to be directed to each annulus Hence the rays, emanating at equal angles with each other, must be so refracted that the tangents of these new inclinations to the vertical are as $\sqrt{1}\cdot\sqrt{2}\ \sqrt{3}$, &c. (Fig 2)

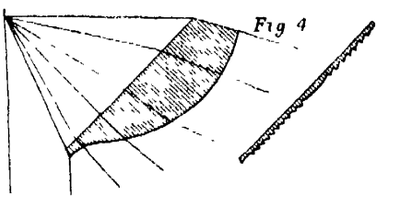

Fig 2

In 1802 Smethurst and Paul patented a reflector to utilise light from a lamp which would otherwise be lost, and to distribute it over the whole area to be illuminated, in such a way that the total illumination due partly to the direct rays and partly to the reflected rays, should be uniform To do this a curve (Fig. 3) can be constructed with


Fig 3.

reference to a focal origin, and a reflector generated by the revolution of this curve about a vertical axis passing through this focus. The combination of this with a hemispherical reflector below the light, is a solution of the problem, but is not worth while putting into practice on account of the serious loss from absorption in the best reflecting material; neither is it possible to illuminate satisfactorily the more distant parts of the area by merely reflecting thither the otherwise useless rays.

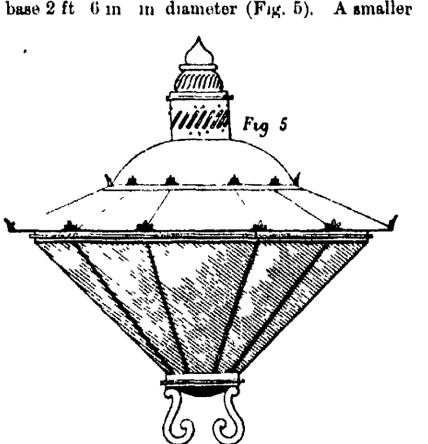
Dealing with the problem by refraction, considering one vertical plane, and considering only the rays passing in directions below the horizon, the simplest method is to direct the rays making large angles with the vertical towards the more distant parts of the area to be illuminated, and those making small angles with the same to the more central parts of the area. Neglecting the rays which make less than 15 deg. with the vertical, as they are generally obstructed by the mechanical arrangements of the lamp, if the source of light be one-seventh of the diameter of the area above the centre, the inclination of the limiting ray will be 74 deg. 12 min.; the horizontal ray has, therefore, to be deviated through 15 deg. 48 min, and the other must be deviated, in the manner explained above, towards the proper point of the area. The required deviation of the rays can be most readily produced by making the glass lantern in the shape of an inverted cone, for by the refraction at the first or inner surface, the upper rays are deflected downwards and the lower rays upwards within the substance of the glass. Taking a right-angled cone, the horizontal ray has an incidence of 45 deg, and the angle of the prism necessary to produce a deviation of 15 deg. 48 min. with this incidence, is 24 deg. 30 min ($\mu = 1.51$). Taking a number of rays, say twenty, emanating at equal angles with each other, incident on the inner surface of the cone at known angles, the refractory angle from each ray is determined, so that, on leaving the glass, the tangents of their inclinations to the vertical are in the relation of the square roots of the natural numbers. A polygonal figure is thus found, and from this the curve to which it approximates—as the number of pencils is made infinitely large—is drawn (Fig. 4) To put


Fig 4

this in a practical form, to avoid excessive thickness of the glass, prismatic zones would be formed, as in the polygonal lenses of Browster, &c, each zone having the curvature of the part of the vertical curve to which it corresponds.

There are two important disadvantages attending this method First, the light received at any point on the illuminated area is admitted from a corresponding point on the glass, and is, therefore, as dazzling as a naked light, secondly, if the light be not emitted uniformly from the source, as in the case of most arc lights, there will be a corresponding inequality of distribution

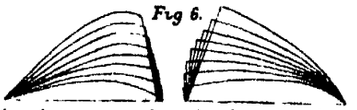
The system adopted has been to form a number of prismatic zones, of such curvature that light passing through each is distributed in the required proportion over as much of the area as is possible, without so near an approach to the critical angle as to incur risk of chromatisation or of total internal reflection These prisms are formed at ¼ in. pitch on the surface of a sheet of glass by a peculiar process of moulding or pressing Ten panes of this glass go to form a right-angled inverted cone having a base 2 ft 6 in in diameter (Fig. 5). A smaller


Fig 5

pattern for use with incandescence lights is a cone 12 in in diameter made in one piece. The calculation for these prisms were made graphically thirty times full size, as an example. The figure of the uppermost prism is found as follows. The width being small compared with the distance from the focus, the rays are assumed to be parallel The in-

cidence in this case is 45 deg. (Fig. 6). The glass used has a refractive index of 1 51. The internal deviation will be 17 deg. The series tan θ, calculated to the nearest 15 min. for a series of 25 angles, the limit being 17 deg. 45 min., is, 0 deg., 35 deg. 15 min., 45 deg., 50 deg. 45 min., 57 deg. 45 min., &c. It is required to deflect one of each of the 25 rays to one of these angles respectively. The first ray θ is beyond the power of the glass; the second, 35 deg.

Fig 6.

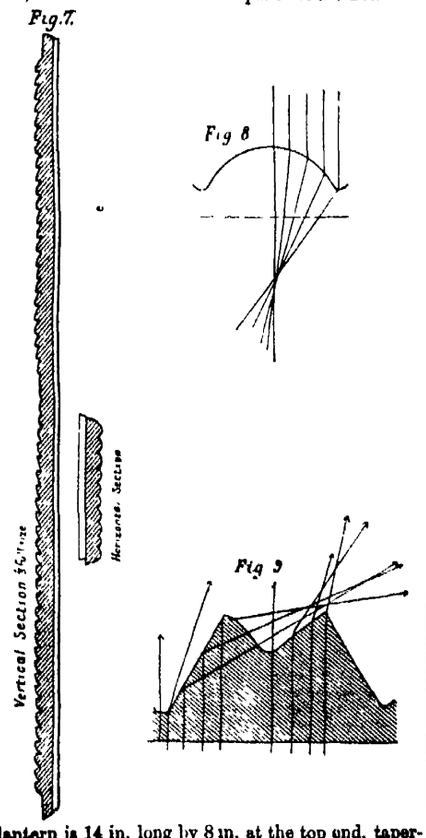


15 min., is too near the critical angle; the next, 45 deg., requires an angle of 64 deg 45 min. as the angle of the prism; the next, 54 deg. 45 min., requires an angle of 57 deg., and so on for each of the series. The angles are set out, and the curve, to which the resulting polygon is approximate, is drawn. Fig. 6 shows a series of sixteen of these curves, called distribution curves, corresponding to rays making angles of 89 deg, 80 deg., 75 deg., 70 deg, &c, with the vertical. Each curve is terminated by a surface parallel to the path of the adjacent ray within the glass.

Each prismatic zone then sends light to a considerable portion of the area, and conversely, from any position on the area, light is received in uniform quantity from a considerable number of the prisms, but only from one point on each. The light would, therefore, proceed from a row of images in one vertical plane. If the original immersion is not uniform at different angles with the horizon, these images will not be of uniform brightness, but the resulting illumination of the area will be unaffected. Such an arrangement would afford little improvement on the one first described, as far as its dazzling appearance is concerned. To meet this a series of vertical flutings is produced on the inner surface of the cone, as in ships' lanterns, and the section of the flutes is a curve. The same result might be obtained by combining the two series of curves to form lenses, whose figure would be generated by a distribution curve sweeping through a dispersion angle.

The glass is produced by Messrs Moore and Co, of South Shields. Each pane for the 2 ft. 6 in.

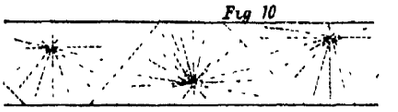
Fig. 7.



lantern is 14 in. long by 8 in. at the top end, tapering to 2 in. at the bottom. A complete section of it is shown in Fig. 7. Ten of these go to form the cone.

Diffusion of light may be produced by forming a series of small lenses (Fig. 8) of a certain figure, or by two series of flutings, one on each side of the glass at right angles. The light, as seen from any point, is then spread out into a sheet of images of the actual light. On an 18 in. globe some 6000 points of light would be seen by using lenses or flutings of $\frac{1}{4}$ in. pitch. Each of these points would be $\frac{1}{6000}$th of the power, but of the same intensity or quality as the light itself. The loss by absorption of such a shade is only 10 to 15 per cent., as against 40 to 60 per cent. in ground or opal glass. The uniformly diffusing curve is obtained by drawing (say) ten lines representing ten parallel rays. One of these passes directly through the glass; the next is to be deflected through (say) 5 deg., the requisite refracting angle is found and set, the next ray is to be deflected through twice this amount, and the next through 15 deg., until the critical angle is approached. The curve to which the resulting polygon is an approximation is the curve required. For the purpose of diffusion only a compound curve, operating by total reflection and refraction, has been designed (Fig. 9). This gives a uniform diffusion through about 150 deg. This must be used on the exterior of the glass and cannot well be combined with the distributing system. The use of lateral diffusion in the distributing lanterns is not limited to the mere agreeable softening of the light, but by suitable disposition of the flutings the light can be so concentrated as to illuminate a square or triangular-shaped area, a modification of the latter being specially adapted for street lighting (Fig 10).

Fig 10



The engravings illustrating Mr. Trotter's system are reproduced by permission from the Proceedings of the Institution of Civil Engineers.

THE WESTINGHOUSE BRAKE.

The prominence which has of late been given to the question of efficient brakes renders any authentic evidence on the subject of interest. In our number of July 11 appeared the report of Mr. T. E. Harrison, engineer-in-chief of the North-Eastern Railway, on the Westinghouse brake, which after some seven or eight years' experience, Mr. Harrison found left nothing to be desired, there being, it appeared to him, no point "in the principle and arrangement of the Westinghouse brake, as now in use, requiring alteration." That such experience is not confined to this country alone, may be seen by a perusal of a report on the same subject made by the Western Railway Company of France, and a translation of which we publish on page 408 of the present issue. The Western Railway Company's knowledge of the brake dates from the year 1877, when they first began to fit their trains, and the results were so encouraging in every way that the equipment of the stock has been steadily proceeded with, until on the 1st of September last there were 453 engines and 3072 vehicles provided with the Westinghouse brake. The report states that the Western Company made their choice of the Westinghouse brake, because they found it contained "the best possible elements for securing thorough efficiency." It would be well for the public if certain companies in England would make "thorough efficiency" the real test of a brake, and leave personal prejudice out of the question. It is not without interest at this moment to recall the fact that the French Minister of Public Works adopted what are virtually our Board of Trade recommendations, so that certain railway authorities in this country would have found their obstructive propensities quite as foreign to the general feeling in France as they are to that of England. The Western Company draw particular attention to the fact that "there has been no case in which the brake failed to act when wanted," a result, they go on to say, "which was only to be expected on account of its automatic principle;" and further, "our company cannot but congratulate themselves as to the choice they have made, since the results obtained have been most satisfactory both in regard to the increased security, as well as the advantages in the working of the traffic which result from its use." The tendency of an automatic brake to occasionally apply itself when not wanted was, as usual, found on the Western Railway, but experience has led to such cases almost disappearing, and the report in question wisely draws attention to the fact that such incidents forcibly prove the great advantage of automatic action, by acting as a tell-tale of its state of efficiency. The brake is thus always ready when wanted, and owing to this certainty of action there have been many accidents prevented on the Western line, details being given of no less than forty-two of the most important which have been recorded.

This interesting document concludes by pointing out that a last advantage of the Westinghouse brake lies in the fact that it affords the means of a perfect signalling communication between passengers, guards, and driver, which without adding any new coupling between the carriages answers its purpose completely, and affords increased protection at a very slight cost. The more information which comes to hand regarding the various brakes, only confirms the position we have from the first taken up, that there is practically no choice in the matter, and that there is at the present time only one brake fit for general adoption.

NOTES.

Death from Lightning.

At a recent congress of German medical men, held at Magdeburg during the end of September, a paper was read by Herr Heusner on the effects of lightning stroke on human beings, and the author showed that when the lightning discharge passed through the skin its passage was much easier, that is to say the internal organs are much more conductive than the epidermis. This fact was pretty well known, but it is not so well known that the brain and spinal cord are apparently conductors, and hence a lightning stroke on the head does not materially injure the brain beyond shattering the nerves, and causing temporary derangement. Most persons struck by lightning do not remember anything about the stroke; but others describe a sensation such as would be caused by their being struck a heavy blow, and some have likened the shock to what they would be supposed to feel if torn into small pieces. The subject is an obscure one, but happily it is now beginning to engage the attention of physiologists as well as physicists.

African Railways.

A line from the east coast of British South Africa, at East London, is now within 55 miles of its ultimate present destination, Aliwal North, on the Orange. The line now passes through the districts of East London, King Williamstown, Queenstown, and the south end of the Albert district, its total length being about 230 miles. A short flat of about six miles, after leaving Sterkstroom, is terminated by what is known as Bushman's Hoek, which must be surmounted to reach the steppe upon which Molteno is situated, 73 miles beyond Queenstown. This is accomplished by a cutting seven miles long from the foot to the highest point. The gradient in parts is 1 in 40. From Molteno there is an easy section to Burghersdorp, 17 miles, and to this point the line is expected to be opened by December. After this there remains but a link to Aliwal, 37 miles further on, and then the eastern trunk line will be completed. Molteno is 175 miles from De Aar, and 246 miles from Hopetown. It is thought that it will soon be found desirable to construct a section between the trunk lines, and to extend the line from Molteno to Naauwpoort. This will place the diamond fields in direct communication with the Stormberg coal mines. The Border line, as at present constructed, runs through some of the richest mineral and grazing districts of the Cape Colony, and it has been completed thus far with promptitude, taking into account the particular difficulties of the working. A bridge of two spans of 75 ft. each crosses the Lessegton, and a bridge of similar size crosses the Hex.

St. Petersburg Maritime Canal.

This canal, which has just been completed, is intended to enable ships of large tonnage coming from abroad to reach the port of St. Petersburg direct, and to take in cargoes there, without having recourse to the hitherto inevitable transhipment at Cronstadt. The canal extends from Goutouïew on the Neva, as far as the small roadstead of Cronstadt. A branch has been excavated along the Pontilow Railway in the direction of the Catherinehof, an arm of the Neva. The Neva has also been dredged to meet the requirements of the Russian navy, between the canal and the source of the Catherinehof. The length of the canal is 17¼ miles,

and the length of its branch is 2½ miles. The bed of the Neva has been dredged for a distance of 5333⅓ ft. The canal and the dredged portion of the Neva have a depth of 24½ ft. The depth of the branch varies between 17½ ft. and 23½ ft. On the portion of the canal which is protected by embankments, the width of the base is 213 ft. for the first four versts from the Neva. This width is carried to 276½ ft. for the next 3½ miles, and to 355½ ft. for the remainder of the canal, which is the portion of it which is not protected by embankments. The work of excavating the canal was almost entirely carried on by means of nine dredgers. The imperial order prescribing the construction of the canal, was signed June 1, 1874, but the works were not actually commenced until September, 1878. Water was admitted into the canal in the presence of the Emperor Alexander III., November 12, 1883; but it is only recently that the canal has been finally made available for the passage of vessels. The works of the canal cost altogether 1,042,464*l.*

Australian Telegraphy.

Western Australia is engaged in constructing a line of telegraph along about 700 miles of its coast line, from Northampton to Roebourne, the object being twofold, viz., first to establish speedy means of communication with the settlements near Roebourne; and secondly, to induce an English company to run a cable to North-West Cape from Java. The first and most difficult section, from Northampton to Hamlyn Pool, a distance of 140 miles, has just been completed; of this, for 115 miles, the line runs over heavy sand plains and hills, and as, unfortunately, it had to be constructed in the summer, it has proved a trying task for man and beast Mr. Carey has been intrusted by the Government with the charge of this most important work. His staff consists of Mr. Parish (overseer), and a light survey party, with which he keeps in advance, pegging out the route for the line, himself returning from time to time to inspect the line, while Mr. Parish, the Government overseer, is closely watching the construction on behalf of the Government to see that the specifications are carried out. The transport consists of 20 horses, 2 wagons and wagonette, and 30 camels, recently purchased in South Australia at the suggestion of Mr. Kean. With the camels there are five Afghan drivers thoroughly broken into this work. A ketch of about 70 tons follows the party along the coast, laying poles, stores, and water at all available landing-places. The working party consists of white men and Chinamen, 15 in all. The poles used on this line are iron, they are in two sections, the short section is 4 ft. 6 in. long, and is supposed to be driven into the ground where practicable, or, if the ground is too hard, inserted in a hole bored by an auger. The use of the auger, however, was found to be a slow and tedious process and was abandoned for the spade in both hard and soft ground. The socket once in, the long section is lifted up and dropped into the socket, cement being then poured in to bind them together.

H.M.S. "Agamemnon."

This vessel, which is an armoured citadel turret ship of the Inflexible type, has recently been ordered to proceed to the Mediterranean. She has been hurriedly prepared for sea service after being nearly nine years in process of construction and undergoing alterations and modifications of various kinds. Her estimated cost has been enormously exceeded, and we recommend any member of Parliament who wishes to learn something really worth knowing of how money is spent upon our ships of war, to move for a return of the estimated and actual costs of all the ships recently added to the Navy, with the cost also of alterations and additions made to the vessels now in progress. This information would show how much of the present wasteful expenditure is caused. The Agamemnon is one of those vessels which has enormously exceeded her original estimates, and has been nearly nine years building instead of the four—the time at first estimated. It may be supposed by some that an approximation to perfection is reached as a result of all this vast expenditure of time and money. This is not the case, however, with the Agamemnon. She is going upon active service with steering power so defective as to make her a terror to her officers and dangerous, in some circumstances, to herself. Her movements are of a very erratic and uncontrollable character, and she cannot be kept properly in command by the helm. Steering is one of the most important qualities for a fighting ship to possess, and constitutes one of the prime elements of efficiency. The Agamemnon is being sent upon active service with this essential quality disgracefully and dangerously deficient. It is said that if the officers find that they can do nothing with her she is to put into Malta for alterations. How can Malta do what it has been impossible to do here in nine years? or if not impossible, why was it neglected here? The cause of the defective steering is plainly to be seen in the form of the stern, which is so ingeniously contrived that the water is prevented in almost every possible manner from properly acting upon the screws and rudder. We commend a study of this stern to naval architects as an example of what should be avoided in designing the after part of a ship. A model should be obtained for every naval museum.

NOTES FROM THE UNITED STATES.

Philadelphia, October 17, 1884.

As to the actual business done, there is very little improvement in the American iron trade, but the result of the Ohio elections, which is regarded as a sure indication of a Republican victory in November, and consequent continuance of protection, has imparted new life and hope to the trade, which was *drooping* and spiritless. Even the most sanguine do not expect any great activity or material advance in prices this year, but a steady improvement is looked for, and a gradual steadying of prices. It is admitted by the most reliable authorities in the iron trade that the depression is reported to be much greater than it really is; that, in reality, as much pig iron is being made this year as last, and, of course, it is going into consumption, as there are no stocks on hand anywhere. The decline in railway construction has undoubtedly had a very depressing effect on the iron trade, but most of the dulness is to be attributed to the fact that productive capacity has been too rapidly extended, and too much material is being made. Prices have not declined any farther, and in some directions a little more steadiness is reported. Steel rails have not advanced farther, as buyers have not much confidence in the upward tendency, and, when 29 dols. to 30 dols. for small lots was reached, they refused to place orders, which has resulted in makers lowering their views a little, and to-day small lots are to be had at 29 dols at mill, and large lots at a little less. Buyers do not like even these prices, and are offering 27.50 dols to 28 dols for large lots, and some good orders are likely to be placed at these figures. Pig iron is in dull request in all markets; a few large sales of the finer makes were closed here a day or two ago, but there is no active demand. Prices are as usual, from 19 dols. to 21 dols for No. 1 foundry grades, and from 17 dols. to 17.50 dols. for special makes of mill iron, with lower prices quoted on inferior makes. Requirements for several large engineering enterprises are in sight, but specifications are not yet given out, and nothing is being done except in a retail way. The mills on bridge and building iron are well supplied with work for a short time, but many of the plate and bar mills are very short of business Foreign iron is not selling here, and is reported dull and weak in all markets. At the monthly meeting of the Franklin Institute, on the 1st inst., the report of the Director-General of the International Electrical Exhibition was read, showing that, where no profit had been looked for, the Institute would have a clear 10,000 dols. in hand, after paying all expenses. Two hundred and eighty-five thousand persons visited the Exhibition, which has been pronounced a grand success. The International Navigation Company, owning and operating the Red Star Line of steamers between Antwerp and Philadelphia, and Antwerp and New York, has purchased the American line steamships, four in number, and will run them under either the English or Belgian flag, owing to the advantages thus to be gained. These vessels, the Ohio, *Indiana, Illinois*, and the *Pennsylvania*, were built principally at the expense of the Pennsylvania Railroad Company, and cost about 2,500,000 dols., but being smaller than the English ships with which they were in competition, and being run at greater expense, they long since ceased to pay, and the Pennsylvania Railroad Company grew tired of bearing losses on them. The anthracite coal companies have announced that they will suspend work in the entire region during the first week in November, and the first and last week in December, owing, to the backwardness of demand. Prices are well maintained, and with all the restriction which has been effected this year, the production falls but little more than a million tons short of the production for the same time last year.

THE FOUNDATIONS OF A ROMAN BRIDGE IN THE RIVER TRENT.

In the course of carrying out large dredging and other works for the improvement of the Trent Navigation, which connects Hull, Grimsby, and Goole by water with Birmingham and the Midland Canal system, a most interesting discovery has been made, and one which seems likely to receive more than an ordinary share of attention from antiquarians and historians.

On the passing of the Trent Improvement Act last spring the Navigation Company commenced operations in a reach of the river lying between the villages of Collingham and Cromwell, north of Newark. Near the former of these is supposed to be the Roman station of Crocolana, and the latter is given by Carlyle as the nursery of the Cromwell family.

The works in progress include a large amount of dredging, the quantity of material already removed from the river bed amounting to some 50,000 yards, and it was during this operation that the workmen came across what had been formerly mistaken by Trent boatmen for a sunken barge or keel, but what proved on further probing and careful examination to be the pier of an old wooden bridge. About 40 ft. or so closer to the north bank another of similar appearance was found, and it is presumed there are six or seven of those piers forming the whole bridge.

A decision was come to by Mr. Rofe, engineer in-chief, to blow up the two piers obstructing the navigable channel with dynamite; this was done carefully and effectually under the superintendence of Mr. Whieldon, surveyor to the company, and Mr Johnson, of Tower-street, Dudley, acting for the Explosives Company, Limited, of St. Swithin's lane, E.C.

As this "record of old time" lay in mid-channel 4 ft or 5 ft. under water with a strong current running, it was fully expected that holes would have to be drilled into the solid masonry, and the shots fired by electricity from the shore. This being a very tedious and expensive method, Mr. Johnson decided to try much easier but still more risky means. The dynamite having been made up into waterproof packages of 10 lb each, the operator with surveyor and assistants started in a small boat guided by ropes from each side of the river to the scene of action. On arriving immediately over the old foundation which was found to be diamond shaped, a charge was lowered on to the one end; all being ready the fuze was lighted and the boat drawn rapidly down the river out of harm's way Inspection proved that the old foundations had been hit very hard. Another heavy charge was then placed in the centre and exploded in a similar way, bursting the whole structure, and throwing up an immense cone of water, the falling spray from which was driven by the wind at least 200 yards away. Eight shots in all were fired, the last of which made a clean job by blowing up the old oak centre baulk and crosspieces, the whole lot floating down mid-channel like a huge whale In three hours eight charges judiciously disposed completely wrecked the remains of a work which has withstood the action of weather and water for sixteen centuries or more, and over which many a hard contested struggle has taken place, as shown by the numerous human skulls and bones which have been dredged up. A portion of the wood and stonework was, however, afterwards recovered, and excavations are to be made with a view to finding and preserving another of the remaining piers.

From observations previous to blasting, it appeared that the foundations were formed of wood set in Lancaster or somewhat similar stone; the oak walings and backs were black and hard, but mostly in good condition; the mortar was still quite hard and adhesive, the walings were tied across through a large centre back by tie-pieces of wood having octagonal heads, through which wedges had evidently been driven to keep the structure together There is room for doubt whether any similar structure of wood now remains in such complete preservation, although in Rome itself some traces of a wooden bridge, supposed to be either the Pons Aemilius or the Pons Sublicius, have been seen in the Tiber, but they do not appear to have been distinctly recognisable

From Ratne or Leicester the ancient Fosse road makes its way through Vernometum and Margidunum, thence by the Trent banks to Lindum or Lincoln Between Margidunum and Lindum two stations are given in the history of Antonimus, the sites of which have been a matter of some dispute amongst the learned Of these two Crocolana seems to have taken up its position by general consent at Brough, near Collingham, and Ad Pontem, the other, is generally placed at Farndon At first it would appear that the position of Ad Pontem had been solved by the discovery near Collingham, but the distances given by Antoninus do not there correspond, and the bridge now traced can only be fixed upon as adjacent to the station Ad Pontem by the supposition that Crocolana and Ad Pontem have been accidentally transposed in the Iter of Antonine Local historians have attempted to fix the position of Ad Pontem at Newark and Southwell; there are really no proofs in existence which go to show that Newark was a Roman station, but Southwell, if it was not actually the Ad Pontem, bears evidence of having been held by the Romans as an advanced post across the Trent in their northward advance.

As the Romans were excellent engineers, it is probable they were not particular to a bridge or two across the Trehenta, the banks of which for commercial and other reasons would at that time be very populous, and the bridge now discovered was probably a connecting link between the district of Lindum and Crocolana and the station Ultra Trehentam (Ad Pontem, or some other) on the way northward.

It may be mentioned in connection with these works for the improvement of the River Trent, a matter which Staffordshire manufacturers take great interest in, that there appears to be some possibility of an agreement being come to between the Navigation Company and the Corporation of Nottingham, who have hitherto strongly and rather ill-advisedly opposed the proposals of the company.

The corporation are to subsidise the company, and in return the company are to commute the river tolls on

sanitary cargoes, to give the corporation an *ex officio* representative on the directorate and control of certain floodworks within their municipal boundary; such an agreement would no doubt save a most costly Parliamentary struggle and will be viewed with favour by many interests in the Midlands who are anxiously looking forward to improvements in our system of inland navigation and water carriage.

TRIAL TRIPS AND LAUNCHES.

On Monday, October 6, Messrs. Cox and Co., engineers and shipbuilders, launched from their yard at the docks, Falmouth, a screw tug 107 ft. by 19 ft. by 13½ ft., and classed 100 A 1. She is fitted up with turtle back aft, and with stanchions and beams for light teak awning to be fixed when she arrives at her destination in the neighbourhood of Bassein (British Burmah). She has been fitted by her builders with engines 22 in. and 40 in. cylinders, and 26 in. stroke, the valve gear being of the elliptic type. On Wednesday, October 22, when on trial, the engines indicated rather over 450 horse-power, and her speed, on a run of six knots, was 11½ knots per hour; the bunkers, which contain 65 tons, being full, and her total displacement rather over 260 tons. She is fitted with a powerful steam fire engine and salvage pump (made by Messrs. Shand, Mason, and Co.) capable of supplying four hoses.

On Tuesday, October 21st, Messrs. Edward Withy and Co. launched from Middleton Shipyard, West Hartlepool, an iron screw steamer named *Vane Tempest*, built to the order of the Marquis of Londonderry, and intended to trade between Seaham Harbour and Nine Elms Wharf, London. This is the fifth steamer for the same owner. Her principal dimensions are: Length between perpendiculars, 184 ft. 6 in.; beam extreme, 30 ft.; depth of hold, 13 ft. 6 in. She had been built under the personal superintendence of Mr. S. J. Ditchfield, Seaham Harbour. Engines of 90 nominal horse-power will be fitted by Messrs. T. Richardson and Sons, Hartlepool.

On Tuesday, the 21st of October, Messrs. Alexander Stephen and Sons, Limehouse, Glasgow, launched an iron sailing barque named the Edinburghshire, a vessel of 1350 tons net register, for the "Shire" Line, owned by Messrs Thomas Law and Co., Glasgow. She measures 236 ft. by 36 ft. by 21 ft.

Messrs. Robert Duncan and Co., Port-Glasgow, on the 24th of October, launched the Godavari, a steel twin-steamer of about 200 tons, and measuring 160 ft. by 23 ft 6 in. by 7 ft. 6 in. She has been built to order of Messrs. Dunsmuir and Jackson, engineers, Glasgow, who are to supply the engines, and is to be engaged in the Bombay coasting trade.

On the same day the screw steamer Azorian, a vessel of 900 tons, built by Messrs. Dobson and Charles, Grangemouth, for Messrs. Humphreys and Co., London, had a successful speed trial on the Firth of Forth, the rate attained on the measured mile being 11½ miles per hour.

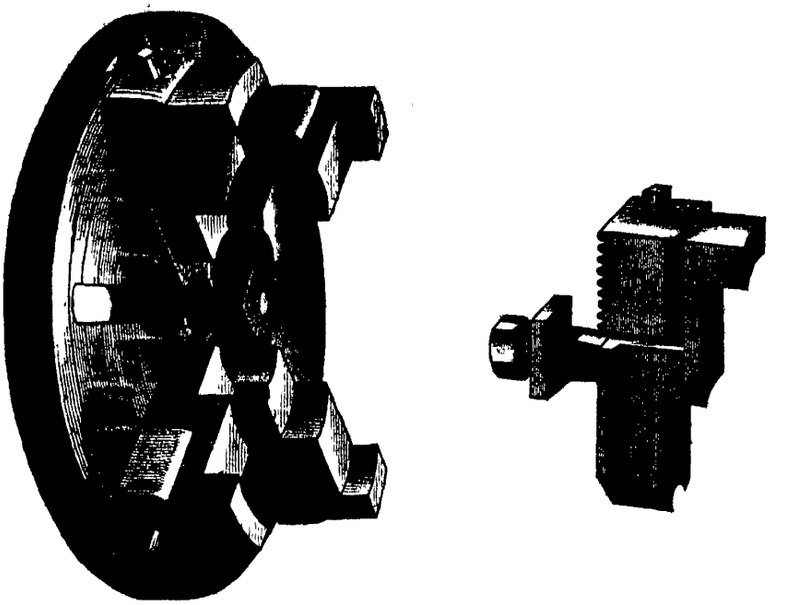
Messrs. Murdoch and Murray, Port-Glasgow, on Saturday, the 25th of October, launched an iron screw steamer named the Scott-Harley, a vessel measuring 148 ft. by 22 ft. 6 in. by 11 ft She is to be engined by Messrs. William Kemp, Govan. Her owners are Messrs. Scott, Harley, and Co., Cork.

Refrigerating Machinery at the International Health Exhibition.—The highest awards, Classes 11 and 12 (two gold medals) has been assigned to Messrs. J. and E. Hall, of Dartford, for their cold-air machines. They have also received the Society of Art's Special Trevelyan Prize Gold Medal for the best exhibit in Class 11, that is for apparatus and processes for conserving, storing, conveying, and distributing fresh food of all kinds. Messrs. Siebe, Gorman, and Co., 187, Westminster Bridge-road has been awarded a gold medal for their exhibit of Lightfoot's patent dry air refrigerator. This machine was recently illustrated and described by us.

International Health Exhibition.—Mr. Arthur Carey, the engineering superintendent at the Health Exhibition, has recently had presented to him a handsome clock, together with a cheque for 200*l*. These had been subscribed for by the exhibitors at the Exhibition in the department over which he presides. The presentation was made at a dinner held at the Holborn Restaurant on Friday last, when Mr. Frederick Foster, of the firm of Barnett and Foster, took the chair. Mr. Carey has most ably filled a troublesome and difficult office, and the Exhibition authorities are fortunate in having for next year's show, which will consist largely of machinery, an engineer on their staff so well able to undertake the difficult position.

The Crewe Scientific Society.—A Scientific Society has recently been formed at Crewe, and on Friday last, the 24th inst., the inaugural meeting took place at the Crewe Town Hall. On this occasion, Mr. F. W. Webb, by whom the formation of the Society has been promoted, opened the proceedings by explaining the objects of the Society, and urging the young men of Crewe to avail themselves of its advantages, Mr. Webb's speech was followed by an inaugural address delivered by Professor Alexander B. W. Kennedy, of University College, London, who took for his text, "The Relation between the Science and Practice of Engineering." At a place like Crewe this new society ought to meet with abundant support, and we wish it every success.

STOREY AND PHILLIPS' JAW CHUCK.

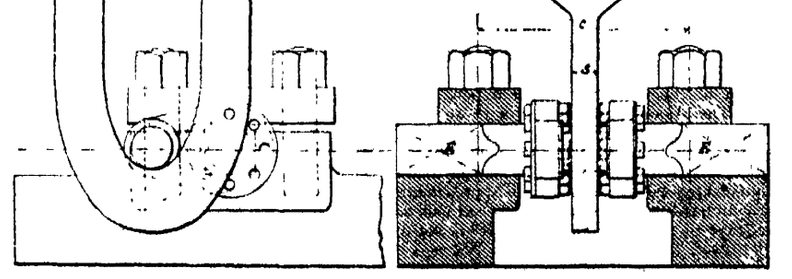


We illustrate above a new arrangement of jaw chuck or dog plate, invented by Messrs. Storey and Phillips, and manufactured by Messrs. Phillips and Co., of 92, Holborn Viaduct, London. A face plate is crossed by two shallow diametrical grooves at right angles to each other, and these form guides for the four dogs. At each end of the grooves there are racks or rows of projections designed to engage with corresponding projections, on the hinder piece of the dogs, and to give them a firm hold of the plate. Each dog consists of a clamping piece with teeth gearing into the rack on the face plate, and a jaw piece which can be moved relatively to the clamping piece by a screw, to obtain a grip of the work. Ranges of motion which are beyond the limit of the screw, are obtained by shifting the clamping piece along the rack. In a modified chuck the clamping piece has no projections, but is bolted directly to the plate, and can be moved by slackening the nut, and thus sliding the piece either inwards or outwards. If the clamps be removed the plate is available as a face plate.

DICKINSON'S CRANKSHAFT.

In our issue of October 27, 1882, we gave an account of a series of tests made upon material cut from a portion of a crankshaft constructed on the system patented by Mr. J. Dickinson, of Sunderland. In this method the crank-pin and the two webs are formed together, and a flange resembling the half of a face coupling is formed on each end of each piece of the shaft adjacent to the crank. In each web a recess is provided into which one of the flanges fits, and the whole is secured together by bolts. The first series of tests were satisfactory as showing that cast steel was a reliable material from which to form the pin and crank arms, but diverse opinions having been expressed regarding the locality of rupture of the crank under the influence of extraordinary stress, it was resolved to carry out a further series of experiments for the sole purpose of placing this locality out of the region of *à priori* assumptions. With this intent eight cranks were prepared to one-twelfth the size, equal $\frac{1}{12}$ the strength of a crank in process of manufacture (see the figures below, and also plate D on page 420), each being a duplicate of the others (to gauge), except those used in the 2nd, 4th, and 5th tests. These three varied from the others only in the configuration of the web, the lines joining the two radii being concave inwards instead of straight, as in the remainder. In order to confine the strains to the webs and bolts and to minimise the residual phenomena due to the breadth of the shackle S and the distance apart of the centres C, it was decided to make the shaft ends E of forged steel and larger in diameter than they would have been, had they been proportioned to the coupling. The boltheads were not recessed in order to save labour in manufacture. The whole of the experiments were carried out at Newburn Steel Works, in the presence of representatives of Board of Trade, Lloyd's Registry, Bureau Veritas Register, and several scientific gentlemen interested in the use of those cranks, July 17, 1884.

The figures below clearly explain the method of testing. The degrees of deflection given are deduced from linear measurements taken from the extremity of a pointer, radial to, and about 6 in. from the axis, and include that due to the stress on the keeps and bolts of the bearings. From the Table on the opposite page it will be seen that the first three tests were made with gun-metal crank webs, the object in using these alloys being to get a material for the webs such that it should be ruptured about the same time as the coupling bolts. It is interesting to note that the tensile stress of the first alloy is about one third that of the steel used, and as this sheared the bolts it is reasonable to suppose that the section of the steel crank might be reduced in that ratio. The fourth test was with an iron crank made from the same bar of iron as the bolts. The 5th, 6th, 7th, and 8th cranks were made from steel test-pieces cut from a crank supplied to Messrs. C. M. Palmer and Co., about May, 1883, the size of these pieces fixing the scale of the experimental crank; in no case was special steel cast for the purpose of experiment.



No. 8 was originally made to test the apparatus. In breaking it gave similar results (unrecorded) to Nos. 5, 6, and 7; it was then fitted with fresh bolts $\frac{1}{8}$ in. in diameter, the centres remaining the same, and was broken as recorded. It was then decided for experimental purposes only to reduce the thickness of the webs.

TESTS OF MATERIAL FOR EXPERIMENTAL CRANKS.

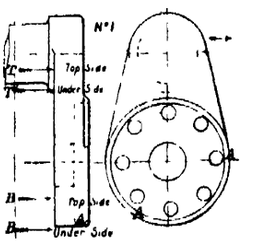
Order of tests	1	2	3	4	5	6 and 7
Date of tests	July 16, 1884	July 17, 1884.	July 17, 1884.	July 16, 1884.	June 20, 1883.	June 20, 1883
Mark on crank	No. 7	No. 3	No. 5	Iron.	P¹	P³ and P⁴
Size of specimen	997×.99	diameter .758	.764	997×.997	.755	.759
Original area in square inch	.987	.4512	.4584	.974	.4476	.4524
Fractured area in square inch	.8519	.4334	.4584	.5328	.1870	.1901
Permanent set induced tons per square inch	5.86	6.413	7.30	15 125	15.88	13 50
Maximum strain " "	8.82	7.915	7.88	22.45	26.73	27 33
Contraction of area per cent	13.68	4	nil.	40 16	58 22	58 24
Elongation in length	8 in.	6 in.	6 in.	8 in.	4 in.	4 in
" " 2 in. "	12.6	2.6	.5	32 5	29 5	31
Appearance of fracture silky "					43	44
" " fibrous "				100	100	100
" " granular "						
" " coarsely crystalline "	100	100	100			

REMARKS.—No. 7, soft gun-metal Iron, best forged iron; No 3, ordinary gun-metal, No. 5, gun-metal (1 tin), P¹, P², P³, cut from castings of Dickinson's patent crank for Palmer's No. 516, tested in presence of Mr. Allison from Lloyd's Newburn Steel Works Test Office.

1st Test.—Date, July 17, 1884. Mark on crank, No. 7. Material of crank webs, soft gun-metal; tensile stress, 8.82 tons; material of crank bolts, best forged iron; tensile stress, 22.45 tons.

	deg.	min.
Deflection with 1½ tons on crank-pin	0	30
" " 2 " "	0	45
" " 2½ " "	1	0
" " 3 " "	1	30
" " 3½ " "	2	12
" " 4 " "	2	45
" " 4½ " "	3	12
" " 5 " "	3	48
" " 5½ " "	4	30
" " 6 " "	5	30
" " 6 " "	6	0 broke.

With 6 tons weight on, the crank gradually moved from 5 deg. 30 min. to 6 deg. and broke, shearing all the bolts on both sides, the crank webs being uninjured, except in the parts marked A in the coupling flange, which were bulged out after the bolts were sheared. The bolts sheared gradually, and the holes were distorted about $\frac{1}{10}$ in. by compression.

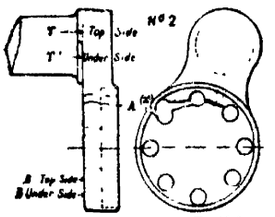


Distance at T, 1 $\frac{1}{16}$ in.; distance at B, 1 $\frac{1}{16}$ in.; distance at T', 1 $\frac{1}{16}$ $\frac{1}{32}$ in.; distance at B', 1½ in.

2nd Test.—July 17, 1884. Mark on crank, No. 3 Material of crank webs, ordinary gun-metal; tensile stress, 7.915 tons; material of bolts, best forged iron; tensile stress, 22.45 tons.

	deg.	min.
Deflection with 3 tons on crank-pin	1	30
" " 4 " "	2	15
" " 5 " "	5	30
Broke with 5½ " "		

The crank webs were fractured through the top bolt holes shown at A on sketch. A slight flaw in the alloy was visible at (x).



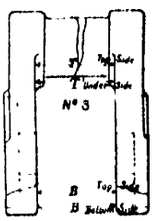
Distance at T, 1½ in.; distance at B, 1½ in.; distance at T', 1½ $\frac{1}{32}$ in.; distance at B', 1½ in.

3rd Test.—Date, July 17, 1884. Mark on crank, No. 5. Material of crank webs, bronze with 1 of tin; tensile stress, 7.88 tons; material of bolts, best forged iron; tensile stress, 22.43 tons.

	deg.	min.
Deflection with 3 tons on crank-pin	0	48
" " 4 " "	1	12
" " 5 " "	1	24
" " 5½ " "	2	24
" " 5¾ " "	3	0

A slight flaw was visible in the crank-pin before testing. At 5¾ tons the crank-pin broke through the middle. The stress was continued until the webs broke all over.

This was intended to be a metal with a fair tensile strength, but unreliable for any other stress.

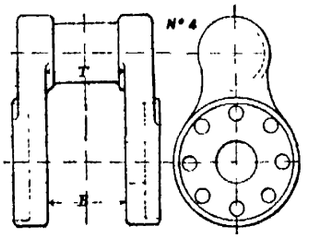


Distance at T, 1⅜ $\frac{1}{32}$ in.; distance at B, 1⅜ in; distance at T', 1½ in.; distance at B', 1½ in.

4th Test—Date, July 17, 1884. Mark on crank, "iron." Material of crank webs, best forged iron; tensile stress, 22.45 tons; material of bolts, best forged iron; tensile stress, 22 45 tons Shearing stress 1 in. in diameter, 31.964 tons double shear.

	deg	min.
Deflection with 4 tons on crank-pin	2	0
" " 4½ " "	2	36
" " 5 " "	3	0
" " 5½ " "	3	42
" " 6 " "	4	42
" " 6½ " "	5	42
" " 7 " "	6	36

The crank moved before 7 tons were quite on, and all the bolts on one side were sheared.



Distance at T, 1½ $\frac{1}{64}$ in.; distance at B, 1 $\frac{1}{16}$ $\frac{1}{32}$ in.

5th Test.—July 17, 1884. Mark on crank, P¹. Material of crank webs, cast steel; tensile stress 26.73 tons; material of bolts, best forged iron; tensile stress, 22.45 tons. Shearing 1 in. in diameter, 31.964 tons double shear.

	deg.	min.
Deflection with 4 tons on crank-pin	1	54
" " 4½ " "	2	0
" " 5 " "	2	30
" " 5½ " "	3	6
" " 6 " "	3	48
" " 6½ " "	4	48
" " 7 " "	7	12

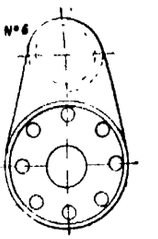
Sheared all the bolts on both sides, webs uninjured
The bolts were sheared sharply, the holes being uninjured, same as Nos. 6 and 7.

6th Test.—July 17, 1884. Mark on crank, P². Material of crank webs, cast steel; tensile stress, 27.33 tons; material of bolts, best forged iron.

	deg.	min.
Deflection with 4 tons on crank-pin	1	33
" " 4½ " "	2	3
" " 5 " "	2	24
" " 5½ " "	2	48
" " 6 " "	3	45
" " 6½ " "	4	18
" " 7 " "	5	12
" " 7½ " "	5	33
" " 7¾ " "	6	0
Broke " 8 " "		

Shearing all the bolts on both sides; webs uninjured.

The bolts were sheared sharply, the holes being uninjured, same as Nos. 5 and 7.



7th Test.—July 17, 1884. Mark on crank, P³ Material the same as used in the 6th test.

	deg	min.
Deflection with 4 tons on crank pin	1	13
" " 4½ " "	1	45
" " 5 " "	2	18
" " 5½ " "	2	51
" " 6 " "	3	24
" " 6½ " "	3	54
" " 7 " "	5	0
" " 7½ " "	5	54
Broke " 7¾ " "		

Shearing all the bolts on both sides, crank webs uninjured.

The bolts were sheared sharply, the holes being uninjured, same as Nos. 5 and 6

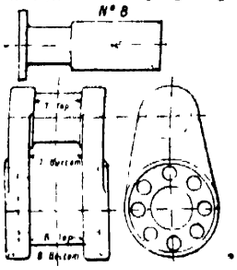
8th Test—July 28, 1884. Mark of test, No 8 Material of crank webs, cast steel; material of bolts, forged iron $\frac{7}{8}$ in. in diameter

	deg.	min
Deflection with 3 tons on crank pin	1	6
" " 5 " "	1	36
" " 6 " "	2	6
" " 7 " "	3	12
" " 8 " "	3	54
" " 8½ " "	4	30
" " 9 " "	5	48
" " 9½ " "	7	0
" " 10 " "	8	12

Permanent set, 5 deg Crane put on until bolts sheared Probable breaking weight, 12 tons.

This was originally made for testing the testing apparatus, the old crank was then fitted with new bolts to the old centres.

Distortion of crank end coupling 1 deg 30 min

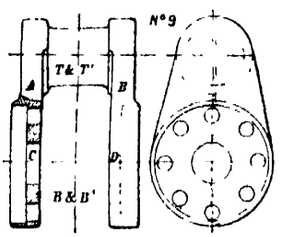


Distance at T, 1⅜ in; distance at T', 1 $\frac{5}{16}$ $\frac{1}{32}$ in.; distance at B, 1½ in.; distance at B', 1⅜ in

9th Test—August 8, 1884. Mark of test, No 9 Material of crank webs, cast steel; material of bolts, best forged iron.

	deg.	min.
Deflection with 5 tons on crank pin	1	48
" " 6 " "	2	30
" " 7 " "	3	48
" " 7½ " "	4	36
" " 8 " "	6	12
" " 8½ tons just when all the bolts		

sheared sharply, crank webs uninjured but twisted as per figures.



	in.
A=0.444	T top side 1⅜
B=0 4417	T' bottom side 1 $\frac{1}{32}$
C=0.24	B top side 1⅜
D=0.22145	B' bottom side 1 $\frac{1}{16}$

10th Test.—August 8, 1884. Mark of test, No 10. Material of crank webs, cast steel; material of bolts, best forged iron.

	deg	min.
Deflection with 3 tons on crank-pin	0	36
" " 4 " "	0	54
" " 5 " "	1	15
" " 6 " "	2	15

	deg.	min.
Deflection with 7 tons on crank pins	3	42
,, ,, 8 ,, ,,	5	12
,, ,, 8½ ,, ,,	6	12

Nine tons were just on when all bolts sheared sharply. Crank webs uninjured but slightly twisted.

The letters A, B, &c., refer to the figure with Test 9.

		in.
A = 0.4612	T top side	1⅛
B = 0.464	T' bottom side	1⅛
C = 0.283	B top side	1⅛
D = 0.29	B' bottom side	1⅛

11th Test.—August 8, 1884. Mark of test, No. 11. Material of crank webs, cast steel; material of bolts, best forged iron.

	deg.	min.
Deflection with 4 tons on crank-pin	1	0
,, ,, 5 ,, ,,	1	30
,, ,, 6 ,, ,,	2	0
,, ,, 7 ,, ,,	3	0
,, ,, 9 ,, ,,	5	4

At 8½ tons all the bolts sheared sharply; webs slightly cracked after shearing of bolts. Before breaking the webs opened out considerably, but closed again immediately stress was off

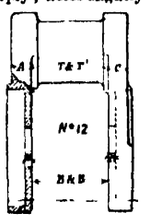
Permanent twist very slight. (See Fig 9).

		in.
A = 0.37	T Top side	1⅛
B = 0 361425	T' bottom side	1⅛
C = 0.1412	B' top side	1⅛
D = 0 275	B'' bottom side	1⅛

12th Test.—September 9, 1884. Mark of test, No. 12. Material of crank webs, cast steel; material of bolts, best forged iron.

	deg.	min.
Deflection with 4 tons on crank-pin	1	24
,, ,, 5 ,, ,,	2	15
,, ,, 6 ,, ,,	3	24
,, ,, 7 ,, ,,	5	12
,, ,, 7½ ,, ,,	6	18
,, ,, 8 ,, ,,	8	36
Broke ,, 8¼ ,, ,,		

Shearing all the bolts on both sides; webs uninjured. Bolts sheared sharply; holes slightly distorted.

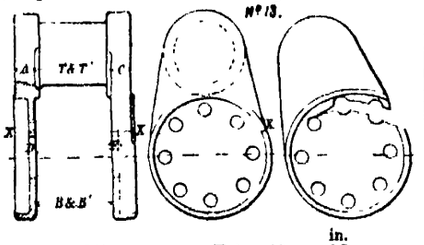


		in.
A = 0 35	T top side	1⅛
C = 0 341	T' bottom side	1⅛
D = 0.1418	B top side	1⅛
E = 0 141	B' bottom side	1⅛

13th Test.—Date, September 9, 1884 Mark of test, No. 13 Material of crank webs, cast steel; material of bolts, best forged iron.

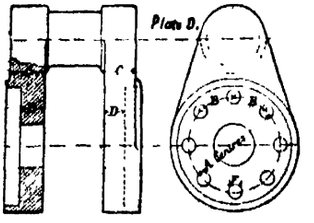
	deg.	min.
Deflection with 4 tons on crank-pin	3	30
,, ,, 5 ,, ,,	5	0
,, ,, 6 ,, ,,	6	36
Broke ,, 6½ ,, ,,	flange being sawn	

through at × to insure webs breaking.



		in.
A = 0.341	T top side	1⅛
C = 0.304	T' bottom side	1⅛
D = 0.126	B top side	1⅛
E = 0.149	B' bottom side	1⅛

The following are the dimensions of the test cranks:



A = 1.75 in. for tests Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13.

B = 0.67 ,, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13.

C = 0.625 ,, Nos. 1, 2, 3, 4, 5, 6, 7, 8.

D = 0.4375 ,, Nos. 1, 2, 3, 4, 5, 6, 7, 8.

F = 0.36 diameter of bolts for tests Nos. 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13.

F = 0.3125 diameter of bolts for tests No. 8.

NOTES FROM THE SOUTH-WEST.

Dowlais.—There are signs of activity in the Dowlais works, and it is rumoured that during the past week or so, some good orders have come in. The blast furnaces have recently been reduced working on Friday night, but instructions have been given to keep them in full blast, and thus instead of being lowered on Friday the furnaces are kept working Saturday and Saturday night.

Pembroke Dock.—On Tuesday the Lords of the Admiralty arrived at Pembroke Dock from Devonport on board of the Admiralty yacht Enchantress, for the purpose of making their annual tour of inspection. The party consisted of Admiral the Right Hon. Lord Alcester, G.C.B.; Rear-Admiral Thomas Brandreth; Colonel Prenez Smith, Royal Engineers, Director of Works; Mr. F. K. Barnes, Inspector of Dockyards; and Mr. H. R. Yorke, private secretary to Lord Alcester. Their lordships landed at the dockyard shortly after ten o'clock, and were received by Captain Chatfield, R.N., the superintendent, and also by Messrs. G. C. Froyne, chief constructor; G. Malpas, assistant-constructor; P. Tinkler, civil engineer; A. M. Wiele, cashier; Penfold, secretary; and other officials of the establishment. Their lordships proceeded to inspect the ships building and the principal workshops, &c., in the yard. They inspected the gunboat Acorn, lying at Hobb's Point, recently launched from the Milford Haven Shipbuilding Perrar Works. Their lordships afterwards entertained proposals for new works submitted to them by the principal authorities of the dockyard.

Drought in the West.—The rainfall recorded at the offices of the Bristol Water Works Company from the 1st of August last to the 28rd of October, is 4.28 in., a deficiency of over 6 in. as compared with the average rainfall for the same period of the preceding ten years. The record for 1864 is 4.99 in.; the present deficiency is, therefore, greater than it was in that year of extreme drought. The importance of the local rainfall may be gathered from the fact that while a few years since the Bristol Water Works supply was 2,500,000 gallons per day, the demand in the suburbs has now reached 6,000,000 gallons per day.

Shot-Firing in Mines.—A special meeting of the workmen's representatives on the Ocean Collieries Sliding Scale Committee, was held on Saturday, at Treorky, to take into consideration the new rule proposed to be introduced into the code of rules for the working of all collieries of a fiery character, and which requires that, when shots are fired in these particular collieries, all men working underground shall be withdrawn, except those men especially entrusted with the duty of firing shots. It was resolved that the workmen of the Rhondda, Aberdare, and Merthyr Valleys should appoint one of their number to take part in a deputation which will in a few days wait upon the Home Secretary with regard to the question.

Cardiff.—During the past week the steam coal market has presented a somewhat quieter tone. Quotations for the best qualities of steam coal are still, however, well maintained at from 10s. to 11s. per ton. The house coal season may now be considered as rapidly advancing, and merchants are well supplied with orders. The patent fuel market continues to maintain a satisfactory tone, and prices are firm. There is no improvement in the iron ore market. Last week's clearances comprised 108,040 tons of coal, 3476 tons of patent fuel, 1390 tons of iron, and 170 tons of coke. From Bilbao there arrived 10,606 tons of iron ore.

Taff Vale Railway.—It is announced that the Taff Vale Railway Company, in consequence of the heavy mineral traffic now passing daily from the Rhondda Valley, Aberdare, and Merthyr through the Pontypridd Station, has decided to widen the line at that place. The main line at the station will be devoted entirely to passenger trains, and the siding into which the Rhondda passenger train runs, will be extended, and a new bridge thrown over the Llantrisant road, over which the mineral trains will run. The present goods station will be removed, and extended lines of rails will enter the main line below the station. Another line will be constructed between this line and the Pontypridd court-house.

Bristol and the Severn Tunnel.—At a meeting of the Bristol Town Council on Tuesday the following resolution was agreed to, on the proposition of Mr. Wills "That this council concurs in the great desirability of a railway being made to connect Avonmouth Dock with the Severn Tunnel, with a view of increasing the trade between that dock and South Wales, more especially as regards the export of coal, and resolves that the Great Western Railway Company be respectfully asked to obtain the necessary powers in the next session of Parliament, so that the work may be completed contemporaneously with the opening of the Severn Tunnel."

Newport.—There has been scarcely any change in the steam coal market. The house coal market is in a fairly healthy state. The iron ore trade remains in an unsatisfactory state. In the manufactured iron and kindred trades a depressing state of things prevails. The quantity of iron cleared last week has been 1165 tons to Santos and 500 tons to Paysandu. Last week's clearances amounted to 59,918 tons. From Bilbao there were received 10,420 tons of iron ore, and 6750 tons came to hand from other sources.

Water Supply of Cardiff.—A meeting of the Water Works Committee of the Cardiff Town Council was held on Friday to consider tenders sent in for the construction of filter beds at the Llanishen reservoir. The lowest tender received was for something over 19,000*l*. After a last discussion the matter was referred to the council.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF SPECIFICATIONS FILED DURING 1883 AND PUBLISHED SINCE SEPTEMBER 1, 1884.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in Italics.

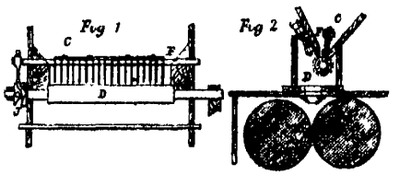
Copies of Specifications may be obtained at 32, Cursitor-street, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, addressed to H. HEARDER LACK, Esq.

5276. Manufacture of Belting: J. K. Tullis, Glasgow. [6*d.* 6 *Figs.*]—This relates to belting made of canvas or cotton and woven belting generally. A strip of leather is attached to each edge of such belting, and is sewed down upon the outer face or between the layers of the woven material. The belting is sewed with copper, brass, steel, or aluminium bronze wire. The strip of leather projects beyond the edges of the canvas or cotton, and protects it from the fork employed to shift the belt. (June 9, 1883).

5176. Apparatus for Detaching Coal and Stone: T. W. Asquith and R. B. Ormsby, Seaton Delaval, and T. Nicholson, Markham-on-Tyne. [6*d* 6 *Figs.*]—This comprises an expansible plug constructed of two semi cylindrical segments having V spaces between them at the end, and a pair of oppositely-directed wedge-shaped blocks sliding in the V spaces, and drawn towards one another by right and left-handed screw threads on a spindle. The spindle traverses the expanding plug axially, and is worked by an ordinary ratchet and lever. The spindle may be supported centrally in the hole by a loose wood plug, and a key or crutch is provided for pushing the expansible plug home and steadying it until it is tight in the hole. The limbs of the crutch bear on the two segments and keep them in position on the wedges whilst the plug is being pushed into a bore hole and prevent the plug from turning until it is tightened in the hole. (October 31, 1883).

5355. Treatment of Sulphurous and Arsenical Composite Ores containing Nickel, Cobalt, and other Metals: E. J. E. Mills, London. (*P. Manhès, Lyons, France.*) [4*d* —The ores are treated by fusion in a cupola or reverberatory furnace with the addition of a suitable flux, and the matter obtained is concentrated in a fixed or movable converter until the iron is nearly eliminated, at which point the blowing is stopped. This product may be treated by the wet method, by electrolysis, or in a basic cupola or other furnace, with excess of bases and carbon. (November 13, 1883).

5852. Roller Mills for Grinding: W. P. Thompson, Liverpool. (*D. E. Dowling, New York, U.S.A.*) [6*d.* 2 *Figs.*] —This consists essentially in the combination with two grinding rolls of a feed hopper extending from end to end above the rollers, a feed roll beneath the mouth of the hopper and above the grinding rolls, and an agitator within the hopper and provided with

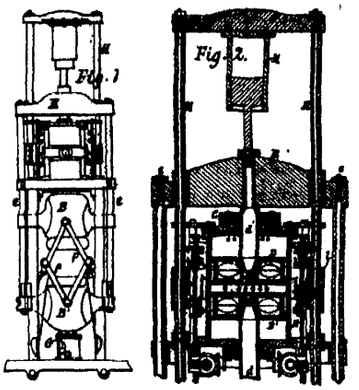


teeth or fingers arranged to reciprocate immediately above the surface of the feed roll and lengthwise of the same. The illustration clearly shows the construction of the mill. The non-rotating bar F is arranged within the hopper C above and parallel to the feed roll D and is reciprocated longitudinally by means of a cam J as shown. The bar is provided with a series of depending teeth constructed of wire in ∩ form as shown. (December 5, 1883).

5666. Toggle Presses: H. H. Lake, London. (*E B Meatyard, Lake Geneva, Wisc, U.S.A.*) [6*d.* 6 *Figs.*]—The object is to provide a powerful press, the operation of which will drive out all the air, gas, and liquid cinders, and make the ingots dense and pure, and also to provide for the employment of two or more presses arranged in line, one half on each side of the toggle operating mechanism. The outer ends of the actuating toggle arms are pivotted respectively to upper and lower blocks guided by flanges of upright channel beams; their inner ends are bifurcated and pivotted to knuckle nuts arranged on an ordinary right and left hand screw operated by worm gearing. Each press is provided with a press toggle composed of a toggle block and upper and lower toggle arms pivotted respectively to the head piece of the press and to the followers. These toggle arms are arranged in pairs, one pair above and the other below, and are preferably in the same vertical plane. The toggle blocks are connected by guide toggle arms to the guide block to which the actuating toggles are connected. The followers are connected by beams arranged one on each side of the presses outside of the vertical guide bars, and guided by upright bars. This press is shown applied to the casting of steel tyres for car and other wheels. (December 20, 1883).

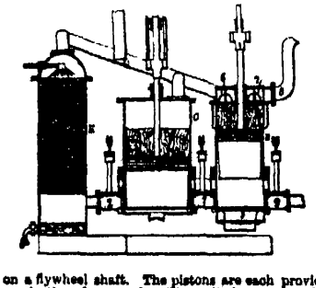
5693. Steam Hammers, &c: H. H. Lake, London. (*E B Meatyard, Lake Geneva, Wisc., U.S.A.*) [6*d.* 19 *Figs.*]—Referring to the illustrations, the two rams B B' of the machine are cast hollow under pressure so as to provide for the cooling of the metal, the centring of the dies and piston rods, and the fastening of the piston rod through the axis of the rams to the dies. The steam cylinder C is mounted on the cap of the frame and receives two pistons D D'. The rod *d* of the lower piston passes through a stuffing-box, and is connected directly to the upper ram The rod *d'* of the upper piston passes up through a stuffing-box, and is secured to a crosshead E connected by rods *s* to the arms of the lower ram. The arms are balanced by means of the radius bars F and toggle arms *f*, the lower ram is provided with an air cushioning device G. A strut H is attached at its lower end to each of the arms of the upper ram; these struts carry at their upper ends a crosshead. An upper air cushion is provided by attaching to the underside of the crosshead an air cylinder fitted with a piston and rod connected to the main crosshead E. The steam chest at the back is provided with a hollow rotary valve, and is connected by suitable ports with the interior of the cylinder between the pistons, and with the usual inlets near the ends of the cylinder. Behind the steam chest is a box containing check valves. At the front of the tool is the exhaust chest provided with a valve similar to the steam valve. The working of the valves is effected by means of the slide K connected by links with the crank-arms of the valves. The lower portion of the slide is of channel form, and to its sides a bow spring is attached, and is received between the jaws of a collar *l* secured to the strut; the movement of which thus operates the valves. In order to provide a variable cut-off, the upper ends

of the slides K are cylindrical and surrounded by spiral springs between plates moving up and down within limits. The plates move between lugs on the inside of the guide bars, and the lugs stop the plates when the springs are expanded to their fullest extent. The guide bar is movable in slides, being operated by means of a wormwheel on its screwed end driven through suitable gearing from a handwheel, and carries with it the plates. As the slide is moved up and down, the spring between the plates will be compressed, so that as soon as the jaw moving the slide ceases to act, the recoil of the spring will cause the slide to move at once in the opposite direction sufficiently to cut off the steam. The rams are connected to their respective stems in the following manner. The piston rod is hollow and its end is provided with a flange somewhat larger than the central opening in



the ram. The ram has at one end the die, a circular projection on which fits the opening in the ram. Dovetail recesses are cut in the edges of this projection and steel rods have heads adapted to enter these recesses, from which they extend through the central opening of the ram and through the flange on the rod, and are held by nuts. The pistons are connected to the rods as follows: The end of the rod is threaded for a distance equal to the thickness of the lower section of the piston, and this section of the rod is quartered for the same distance by radial slots. The rod beyond the threaded section is cone-shaped for a distance equal to the thickness of the upper section of the piston which has a conical opening to fit the rod. A screw plug is forced into the threaded end of the rod, making it steam tight, and at the same time forcing outward the body of the rod and lugs inserted in the radial slots. (December 10, 1883).

5797. Producing Motive Power: M. P. W. Boulton, Pegli, Italy, and R. Perrett, London. [6d. 11 *Figs.*]—The heater for the engine consists of a strong vessel containing firebricks built up loosely with interstices between them for the passage of air. At the bottom is the firegrate on which is burnt the fuel for heating the firebricks, the firedoor being open, as is also a valve at the top of the apparatus leading to the chimney. The products of combustion ascend through the interstices of the firebrick, are deflected by a dome and descend an inner annular passage surrounding the firebricks, and finally ascend by an outer annular passage and valve to the chimney. When the bricks are sufficiently heated the firedoor and valve are closed and the air in the upper or cool part is forced in from the pipe S and passes by the annular passages, interstices of the firebricks, pipe and supply valve 9 to work the engine. The engine has two cylinders B C fitted with pistons connected to cranks set opposite to one



another on a flywheel shaft. The pistons are each provided with a shield projecting downwards. The cylinders are made in two parts, the lower or hot part being connected to the upper or cool part by bolts, several layers of asbestos being interposed between them. The lower part of the cylinder B is heated by a firegrate 5 or by gas flames, and the upper part is kept cool by a water casing and is provided with suction and discharge valves 6 and 7 so as to act as an air pump. The lower part is connected with the supply valve 9, and with a discharge valve 1 forming the supply valve of the cylinder C which is fitted with a discharge valve 2. The cooler E consists of a vessel containing bricks or porous material with interstices between them for the passage of air kept wet by means of a stream of water. The operation is as follows: The hot fluid from the heater is admitted by the valve 9 under the piston of the cylinder B, which in ascending forces the fluid above it past the valve 7, and by the pipe S to the heater. The valve 9 is then closed and valve 1 opened, the fluid passing as the piston in B descends by the valve 1 into the larger cylinder C where it expands; the piston in B at the same time draws in above it cold fluid from the upper part of the cooler E. The valve 1 is then closed and the valve 2 opened and the piston in C descending forces the fluid under it into the lower part of the cooler E where it in rising becomes cooled. If the engine takes its supply from the atmosphere or from a compressed air reservoir, the exhaust is discharged into the atmosphere and the cooler is dispensed with. The steam from an ordinary boiler on its way to the engine may be passed through a heater as described above, two heaters being employed, one being heated whilst the other is in communication with the boiler and engine. (December 18, 1883).

5823. Breechloading and Repeating Firearms: G. V. Pearsey, Albury, Guildford. [6d. 9 *Figs.*]—A lever pivoted to the breech is arranged at one side of the breech and in combination with suitable mechanism, so that by a simple movement of the lever the breech-block can be unlocked and withdrawn from the barrel, the hammer cocked and the empty cartridge case extracted and ejected, and by the reverse movement the breech-block can be pushed forward to insert a fresh cartridge in the barrel, and to close the breech and can be locked in position. (December 20, 1883).

5844. Signalling by Sound at Sea: W. B. Barker, London. [8d. 17 *Figs.*]—The apparatus is capable of indicating, by different audible signals, the eight principal divisions or points of a mariner's compass, the signals representing the eastern divisions or points being distinguished from those representing the western by differences of pitch in the sounds commencing the signals. The apparatus is constructed to produce long and short sounds of high and low pitch by means of a single reed or tongue. The inventor refers to his former patents 2590 of 1879 and 2806 of 1881. (December 22, 1883).

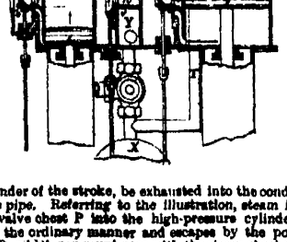
5862. Rotary Engines and Rotary Blowers and Pumps: W. Paddock, Birmingham. [10d. 23 *Figs.*]—A series of concentric hollow cylinders or drums are mounted on a shaft so as to rotate with it. In the annular spaces between these drums, other concentric drums are situated, and are eccentric to the first series of drums, with which they are always in contact along one line. The outer drum of the first series carries a radially projecting plate or piston passing inwards through slots in the other drums. Steam is admitted to the fixed casing of the engine and passes into the annular spaces between the drums and presses upon the flap or piston described, and causes it to rotate and carry round the main shaft and the drums. As the two series of drums rotate, the spaces inclosed between their curved faces and the flap or piston increase, and the motion of the drums is continued through a complete revolution. The first rotation being completed, the exhaust steam passes out by a suitable port, and fresh steam entering the spaces between the drums, the operations described are repeated. Compound rotary engines of a similar type are also described. (December 28, 1883)

5889. J. Stanfield, London. Hydraulic Lifts, Floating Docks, Pontoons, &c. [10d. 24 *Figs.*]—Rigid arms project from the side of the floating dock to a fulcrum either upon the shore or upon another floating structure, and serve to prevent the dock from listing to one side or the other. The illustration shows a transverse vertical section of a U-shaped floating dock connected to a series of girder-like cantilevers secured to one side of the dock by pins or rivets, and hinged at the shore end to a bracket C. The dock may be lowered to any depth or on to the gridiron G by opening inlet valves and allowing water to flow into the body P or sides S of the dock. The dock, as it radiates round the bracket C, is moved somewhat from its horizontal position, and to avoid this the fulcrum is arranged so that it may be raised or lowered. In one arrangement the cantilevers are connected to a series of nuts traversing a series of screws caused to revolve by powerful worms and wormwheels. The lever B may have vertical pins instead of horizontal to connect it to the dock, so that it may be disconnected from the nut and folded alongside the dock for transport. The two end levers may be so hinged that they can be used as powerful cranes. In another modification the bracket C is secured to a rectangular floating pontoon which, as the water is pumped out more or less from the port or starboard side of the dock, will be pressed into or raised out of the water and inclined in a greater or less degree, maintaining the dock in a horizontal position. The weight of this pontoon renders it impossible for the dock to capsize in one direction and its buoyancy in the other. Water ballast is employed in the pontoon. Fig 2 shows the lever



B attached by a link L to a rocking weight W, the lifting or depressing power being indicated by a dynamometer or by a graduated post as shown. Stops E limit the traverse of the weight. Several other forms of similar apparatus are shown and described. The floating docks may be constrained to parallel movement by means of chains, ropes, cables, or parallel levers. The docks are connected with the pumps by telescopic pipes arranged below the water level, &c. Shores and chocks are employed to bring the ship to a central position when docking it. The side shores consist of beams which can be advanced inwards from the opposite sides of the dock in pairs, each beam having a rack upon it with which a pinion engages. A wormwheel upon the axis of the pinion gears with a worm on a vertical axis rotated by manual labour. The vertical axes on opposite sides are coupled by bevel gearing and a transverse shaft. The bilge chocks comprise two blocks rounded at their upper ends and mounted on a carriage which can be drawn inwards beneath the ship by a chain. These blocks support between them the rounded lower end of a strut projecting from the under side of the block which is to bear against the ship. Pivots capable of moving up and down in guide slots connect the lower end of the strut with the carriage. The block is held at the desired inclination by a spring arm which allows it to adjust itself to the inclination of the ship's side. (December 28, 1883).

5900. Steam Engines: W. B. Lake, London. (*T. W. Porter, Chelsea, Mass., U.S.A.*) [6d. 1 *Fig.*]—The exhaust ports of the high-pressure cylinder are so connected, by suitable conduits and valvular devices, with the low-pressure cylinder and the condenser or escape pipe, that as soon as the steam escaping at each stroke from the high-pressure cylinder shall have produced an equilibrium of pressure in the two cylinders it will then, during



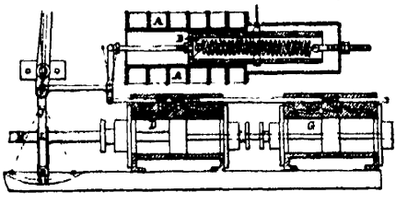
the remainder of the stroke, be exhausted into the condenser or by the waste pipe. Referring to the illustration, steam is admitted from the valve chest P into the high-pressure cylinder I by the valve b in the ordinary manner and escapes by the port *f* to the chamber R, which communicates with the steam chests of the low-pressure cylinder L through the port A and with the auxiliary chamber Y, through which the port A passes by two ports *v*. The ports A *v* are governed by the valve *g* operated by an eccentric. The steam entering the chest S passes by the valve to the cylinder L and escapes by pipe T to the condenser X. The chamber Y is connected to the condenser. (December 28, 1883)

5906. Apparatus for Raising Sunken Vessels, &c.: E. P. Wylie, London. [6d. 8 *Figs.*]—One or more lines of pipe are attached to an air pump and are connected at desired intervals to elastic or compressible receivers situated in position in the interior of the object to be raised. Air being forced from the air pump through the main tubes, the several receivers are expanded until a sufficient amount of water is displaced to raise the object. Between the main pipes and each receiver is a valve or stop-cock, so that the receiver when filled with air may be disconnected and another empty receiver connected. Each receiver is provided with a safety valve. (December 29, 1883).

5922. Gas Engines: E. J. C. Welch and R. C. Napier, London. [4d.]—This relates to that class of gas engine in which the gas is burnt under pressure quietly and continuously in a combustion chamber, the whole products of combustion being utilised in the working cylinder and an excessive temperature being avoided by injecting a suitable quantity of water. The gas and air are compressed by separate pumps arranged in line and having very small clearance spaces, and are conveyed separately to a furnace inclosed in an iron or steel chamber, so as to withstand the necessary pressure. In their passage they may be heated by the exhaust. The furnace is composed of rings of fire clay arranged to insure an efficient circulation, the upper part of the innermost ring being filled with granulated refractory material piled loosely amongst and above the gas burners. The gas issues from a number of small holes pierced in fireclay burners, the air rising through apertures in close proximity to the gas. To start the engine, gas is admitted at the ordinary pressure of the mains and an air valve is opened at the bottom of the apparatus. When all is heated the engine is started. Hand pumps may be provided for starting. Water is injected amongst the products of combustion either in the furnace or in the passages leading to the cylinder, the quantity being regulated by a thermostat. (December 29, 1883)

5933. Securing or Shoring up Dangerous Structures, &c.: W. E. Heath, London. [6d. 10 *Figs.*]—A foot-piece has one end inserted in the structure to be shored, and then projects outwards horizontally, and is prepared to receive the foot of the raking shore. The upper end of the raking shore is fitted to receive a vertical rod, chain, or rope passing downwards, and secured to the foot piece as near as possible to the base of the structure. The rod is fitted with swivelling screw connections in a portion of its length so that it can be shortened and thus exercise a pressure on the vertical structure to be supported (December 29, 1883)

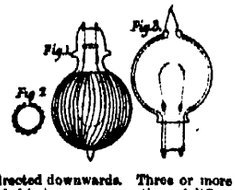
5945. Governors for Regulating the Electromotive Force of Electric Currents and the Speed of Motors: W. Hartnell, Leeds, F. W. Willans, Thames Ditton, and R. E. B. Crompton, London. [10d. 16 *Figs.*]—The illustration shows an arrangement of electrical governor consisting of a governing solenoid, auxiliary cylinder, dash pot or controlling cylinder, and connection to centrifugal governor. The core B of the governing solenoid A is connected as shown to the valve of an auxiliary cylinder D, whose piston is connected to the piston of a controlling cylinder G provided with a valve. The mechanical governor is connected to the lever J carrying the fulcrum of the vibrating lever L driven by the piston rod M. The lever L is connected by a link to the lever connecting the core B and the valve rod of the cylinders D and G. The piston rod M is connected to the throttle valve or expansion gear of the steam engine. When the current passing through the solenoid decreases, the spring draws in the core and opens the valves of D and G. The steam will then move the piston of D until the gear closes the ports, the piston being locked by the cylinder G, and more steam being admitted to the engine. The speed will then begin to rise, and electromotive force rising, the core B will be drawn in slowly until equilibrium is again restored at the normal electromotive force. When the electromotive force decreases the contrary actions take place. The mechanical governor is not in all cases required, and a mechanical governor may be substituted for the governing solenoid. In a modification the dash pot is provided with two loaded escape valves, such that its piston cannot be moved unless sufficient force is applied to overcome the load on the valves. In another arrangement these escape valves are fitted in the piston or the piston may be provided with a small escape hole. In a modification of the governing apparatus, the governing solenoid's core is connected by a link to the core of a second solenoid furnished with a dash pot



This link is also connected to the valve of a small auxiliary cylinder, sliding on its fixed piston and connected to the valve of the main auxiliary cylinder. The ports of this latter valve are controlled by a supplementary valve connected to the lever L, which is arranged as in the illustration. In place of the separate steam cylinder and dash pot there may be two chambers containing a fluid above the dash pot. Steam is admitted to or exhausted from these chambers by means of a slide valve, the water being forced through suitable passages to the desired end of the dash-pot cylinder, it passing a valve which stops communication when in its central position corresponding to the time when the steam ports are closed. The motion of the piston is communicated to the outside by means of a rocking shaft with a lever in the centre of the piston. The ports in the valve are spiral, the governing solenoid giving an end motion and the rocking shaft a rotary motion to the valve. Other similar arrangements are shown and described. The electric governing or controlling device may actuate mechanism which alters the ratio of the speeds of the motor and dynamo-electric machine. Where there are two motors, one may be governed by the electrical apparatus and coupled to the other by differential gear, the part of the apparatus differentially moved being connected to the valve of the motor to be controlled. Each motor may be provided with a compiste electrical governor, the solenoids being wound with three distinct coils. Two coils act together and are opposed by the third. The first is a shunt of high resistance to the mains, the second is of low resistance and carries the whole current from the machine, the motion of which is to be controlled, and the third carries the whole current of the mains. In some cases only two windings are employed, one in a shunt circuit and the other in series as described. (December 31, 1883).

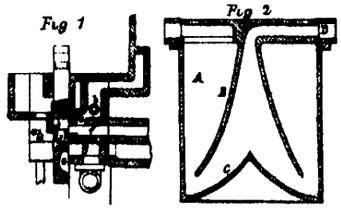
5955. Manufacture of Carbon Filaments, &c., for Incandescent Lamps: D. Bazni and A. Shippey, London. [8d. 11 *Figs.*]—The filaments are prepared from ordinary moss, straw, felt, Mexican fibre, rhea, china grass, seagrass, or other suitable substance which is brought to the condition

of pulp. To three parts of this pulp is added one part of sugar, and when it has attained the requisite consistency, it is made into flat sheets which are cut into strips. These strips are compressed, moulded to shape, and carbonised, fuller's earth being placed around them in the crucible, and a layer of plumbago outside the fuller's earth. The filaments are then washed in *aqua-regia*, and carbonised in a receptacle containing coal gas by being heated by the electric current. They are then dipped in the solution of a suitable metallic chloride, washed in dilute hydrochloric acid, then in ammonia, and finally in water or in a solution of gum, sugar, and soot. The filaments are then oxidised by dipping them in a solution of salts of platinum, iridium, palladium, or ruthinium; for lamps of high resistance compressed felt or goldbeater's skin is used for the filaments. The filaments may be made with two downwardly extending loops. The bulbs are made with a small chamber at the top which allows for the expansion and contraction of the glass and prevents blackening, the carbon being deposited in this chamber. Figs. 1 and 2 show a lamp made with dioptric sections or spiral ribs. Fig 3 shows a lamp suitable for coal and other mines, the globe being surrounded by a glass covering, leaving a space between the two, for passage of air. Several other forms of lamps for different purposes are illustrated. The globe or bulb may have an upper section of opaque or coloured glass, and a lower one of clear glass so that the full power



of the lamp is directed downwards. Three or more lamps having their globes divided in two or more sections of different colour may be arranged in a group to be rotated by any suitable means for signalling or other purposes. The support for the lamp may be filled with moss or other ornamental material. (December 31, 1883).

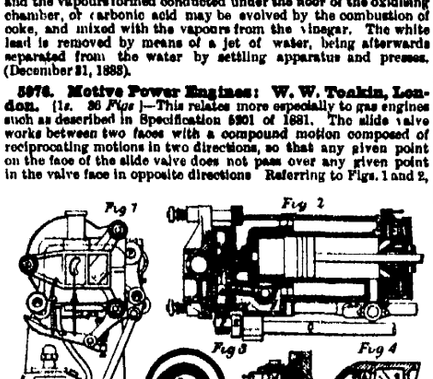
5956. Gas Engines: E. G. Westfield, Liverpool. 6d. 3 *Figs.*]—The gas engine is constructed with two or three cylinders having one water jacket surrounding all the cylinders. Fig 1 shows the slide valve, the air enters by the passage *a* and meets the gas issuing through a perforated pipe *b* extending across the passage *a*, and enters the cylinder through the port *f*. The



exhaust cavity *e* connects the port *f* with the exhaust *g* at the proper time. The cavity *d* contains the firing light which is re lighted after each explosion by the stationary light *c*. The exhaust passes from *g*, Fig 1, to the chamber A, Fig. 2, entering by the port D and down the trumpet-shaped cone B, the gases are deflected by the cone C and lose their speed and pressure and gradually and quietly escape by the outlet. (December 31, 1883).

5962. Manufacture of White Lead: E. J. Haddan, London. (*F. Schmoll, Cologne, Germany*) [6d. 6 *Figs.*]—The lead is formed into thin plates either by casting or rolling, or into a spongy mass of thin shavings or threads, and is then placed on boards side by side and superposed or suspended in oxidising chambers. Vinegar is then evaporated in a closed copper boiler, and the vapours formed conducted under the floor of the oxidising chamber, or carbonic acid may be evolved by the combustion of coke, and mixed with the vapours from the vinegar. The white lead is removed by means of a jet of water, being afterwards separated from the water by settling apparatus and presses. (December 31, 1883).

5976. Motive Power Engines: W. W. Toakin, London. [1*s.* 26 *Figs.*]—This relates more especially to gas engines such as described in Specification 5201 of 1881. The slide valve works between two faces with a compound motion composed of reciprocating motions in two directions, so that any given point on the face of the slide valve does not pass over any given point in the valve face in opposite directions. Referring to Figs. 1 and 2,



the valve is driven by means of the cranks P, P¹, P²; the crank P is fixed on the shaft Q, driven at the same speed as the engine. The crank-pins work in bearings fixed on the valve. The cranks P¹ and P² are idle cranks, and are so disposed in relation to the crank P that dead points are avoided. The valve A (Fig. 3) is shown in the position it assumes at the commencement of the working stroke. The compressed air enters, from the air reservoir through the port F, into the space A of the valve, and by the port E into the cylinder. Suitable ports admit the gas mixture to the centre nozzle of the cylinder, the air and gas being admitted through suitable ports and throttle valves and mixed. Several modified arrangements for operating the valve are described and illustrated. The pump for forcing the gas or vapour into the engine is shown in Fig. 4, and consists of a chamber U in which is a flexible diaphragm. Ordinary suction and delivery valves are provided as shown on one side of the diaphragm, which is actuated by compressed air admitted to and exhausted from the back of the diaphragm through a passage and port 2 in the cylinder port face, with which the ports 3, 4, 5, 6, and 7 in the valve A come successively in communication in the order named. In order to economise the air, it exhausts into receivers 8 and 9 through ports 3 and 4, and finally exhausts through 6. The receiver 8 is, at the next stroke of the diaphragm, brought into connection through the port 7 before admitting compressed air through the port 5. The air in 9 may be utilised as desired. When the pressure of the gas delivered to the suction side of the diaphragm is not sufficient to force in the gas against the resistance of the diaphragm and of the atmospheric pressure behind it, a slight vacuum may be created in the air exhaust either by an induced current of air or by opening a communication through a lift valve with the bottom of the working cylinder during its suction stroke. The delivery of gas may be assisted by the inducing action of the current of compressed air entering the cylinder along with the gas or by supplying the air for working the gas pump at a pressure above that of the supply to the engine. Gas supplied at the ordinary pressure of the mains is injected into the firing port K by means of the induced current caused by a jet of compressed air, the admission of which commences before that of the gas for the purpose of clearing out the ports. All connection between the firing port and the gas and air inlet passages is cut off before explosion. In order to restore more or less of the heat lost after and during compression of the air and whilst passing to and from the reservoir, a regenerator *c*, composed of an extended surface of metal, is placed in the tangential exhaust passage *a*. Fig 5 shows an arrangement by which an ordinary gas pump U is made to commence to deliver gas direct into the engine at the beginning of the stroke. A small relief valve 19 operated by a diaphragm 18 is arranged to relieve any excess of pressure in the gas delivery pipe 13 by allowing the surplus gas to escape to the reservoir 20 or suction pipe 22. When the intermediate chamber 20 is employed a non-return valve is placed at 21. Compressed air is led to one side of the diaphragm by a small pipe 17. 16 is an adjustable spring. The gas pump U may be operated as shown in Fig 1. Fig. 6 shows the delivery valve 13 of the gas pump connected to a flexible diaphragm, the object being to regulate the relative pressures of the air and gas. A similar arrangement may be applied to the air compressor, the air pipe 17 being omitted and the spring 16 being made sufficiently strong to resist the desired constant air pressure. For effecting the lubrication of the cylinder, oil is dropped in a cup by a special arrangement and is drawn therefrom through a suction valve along with a small proportion of air at each suction stroke of the piston, the entering passage being preferably pointed upwards. The balls of the governor are connected to a sleeve on the spindle, this sleeve carries bevel wheels driving a friction plate in contact with a friction pinion having a screwed axis which acts on the throttle valve. As the governor balls rise or fall the friction plate moves to one side or the other of the centre of friction pinion which is rotated in one or the other direction. A somewhat similar modification is also described. (December 31, 1883)

5980. Railway Rolling Stock and Wheel Tyres: F. J. Brougham, London. (*Gesellschaft für Verwerthung von Erfendungen im Eisenbahnwesen, Berlin*). [1*s.* 40 *Figs.*]—This relates to railway rolling stock and wheel tyres, and has for its principal object to secure the proper radial position of the axles of carriages with two axles and the end axles of carriages with three axles and of locomotives. The wheel frames of the carriages are arranged to swing round the centre of the axle in such manner that their radial positions on curves are produced by forced lateral movements of the frames, these movements being limited by frame bearers or by an arrangement of guides. Several arrangements of frames and means for effecting this adjustment are described. The tyre sections are especially adapted to such adjustable axles in which only a lateral adjustment of the axle box is intended. The tyre sections are formed with steps or angles in the section of their cylindrical surface. Other forms of tyres are described. (December 31, 1883).

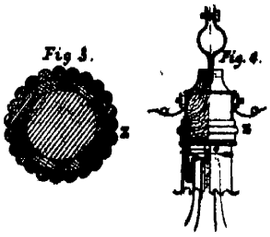
5981. Generation, Storage, Distribution, Regulation, and Utilisation of Electricity: J. S. Williams, Riverton, N.J., U.S.A. [1*s.* 50 *Figs.*]—This relates to a system for the operation of movable torpedoes for coast defence and marine operations as well as for the operations of railways and tramways. The patentee refers to a numerous list of patents taken out by himself, most of the specifications relating to which are very voluminous, and which, with the limited space at our disposal, cannot be referred to. The system of coast defence was fully illustrated and described in our issue of October 17, 1884. (December 31, 1883).

5983. Generation, Storage, Distribution, Regulation, and Utilisation of Electricity: J. S. Williams, Riverton, N.J., U.S.A. [1*s.* 2*d.* 34 *Figs.*]—The objects are (1) to decompose or distil carbonaceous or vegetable material or compounds of these with mineral constituents such as coal peat, &c.; (2) to recover the volatile products from coal peat refuse or compound substances by the decomposition or distillation of the same, with or without a subsequent treatment of one or more of the residual products for the separation or recovery of nitrogen as ammonia, and the recovery of benzole; (3) to distil or decompose coal or carbonaceous material so as to produce gaseous fuel; and (4) to recover the nitrogen driven off from blast furnaces or other firing chambers, chimneys, or retorts with the refuse products of combustion. (December 31, 1883).

5986. Electromotors, &c.: E. Haller, London. [6d. 9 *Figs.*]—The magnets each consist of a series of rings of iron of graduated sizes having grooves or spaces between the rings, into which is wound the insulated conducting wire, the object being to increase the area of the surface of the magnet. In the motor a ring shaped piece of metal has its face formed integral with magnets of alternating polarity facing radially in a circle. These magnets are faced by the armature magnets, the polarity of which is reversed as they pass the fixed magnets. Modifications are described. (December 31, 1883).

5987. Incandescent Electric Lamps: L. Gelberg and A. L. Fyfe, London. [6d. 11 *Figs.*]—In order to produce a filament of any shape, a thread is wound over pins which can be placed in different positions in a block so as to give the desired shape, care being taken that no two threads touch each other. The block is then placed in a crucible and carbonised in the usual way. The carbonised filaments are then attached to the platinum conductors preferably made with tubular or socketed ends, in which the filaments can be firmly fixed by cement, pressure, or electro-deposition. Figs. 1 and 2 show one form of lamp holder. The metallic half-cylinders H are mounted on an insulated block and have soldered to them connecting screws for the leads. The lower edges of H are swayed outwards to admit of easy insertion of the lamp. Two metal prongs M connected to the platinum conductors of the lamp have their ends pointed and bent outwards. These ends take into holes in the half-cylinders H, and thus connect the filament to the leads. J is a clip for connecting the holder to any suitable support. In a modification the neck of the bulb carries two half metal rings connected to the lamp conductors, and each having a ridge which passes down a vertical groove in the holder, and (by turning the lamp partially round) into an annular groove, where they meet with the terminals of the leads. A switch for the holder is shown in Figs. 3 and 4. An ornamented ring Z of non-conducting material is mounted on the holder, and





has two metal quadrants X. This ring works in an annular groove, and, when the quadrants X make contact with the metal half rings and the leads as shown, the lamp is lighted. In a modification the ring Z actuates cams by means of pins working in slots in the cams and making contact between the leads and half metal rings. (December 31, 1883).

5989. Endless Cable Traction Railways and Tramways: E. F. Alexander, London. (*C. W. Rasmussen, Chicago, Ill., U.S.A.*) [1*s.* 2*d.* 26 *Figs.*]—This relates to railways and tramways the cars of which are propelled by means of an endless cable travelling within a tube placed between the rails, and acting upon movable projecting arms carried upon an endless chain or band, and depending from the car to connect with stops or trucks placed at intervals along the cable and supporting the same, the projecting arms being supported upon sprocket drums, the movement of which is controlled by means of friction clutches operated from the winding posts at the end of the car, so that when the drums are locked the endless chain or band is arrested with one of its arms in the slot of the cable tube in position to be caught by a truck of the moving cable, and when the drums are free to turn the projecting arms are moved freely by the cable trucks without effecting the propulsion of the car. (December 31, 1883).

5993. Life Boats, Rafts, &c.: F. W. Brewster, London. [10*d.* 11 *Figs.*]—These are built with two or more separately formed or independent tubular or other shaped pontoons to which the deck is connected. Several modifications are described, viz.: 1 Those wherein the vessel is made collapsible or capable of closing up, and in which arched stays connecting the deck to the pontoons are hinged. 2. Those wherein the deck is not collapsible, but in which the arched stays are hinged for the purpose of allowing the pontoons to be closed up, and (3) those in which no part is collapsible, but in which the deck is divisible or non-divisible. (December 31, 1883).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

BELGIAN COAL EXPORTS.—The exports of coal from Belgium in the first eight months of this year were 2,694,542 tons, as compared with 2,696,183 tons in the corresponding period of 1883. The increase observable in the exports this year is due to the fact that 2,724,054 tons of Belgium coal went to France up to August 31 this year, as compared with 2,696,188 tons in the corresponding period of 1883.

COMMERCE OF ANTWERP.—The movement of shipping at Antwerp has very greatly increased during the last quarter of a century, and a larger class of vessels is also now frequenting the port. In 1860, 2158 sailing vessels arrived, of an aggregate burthen of 406,834 tons. The number of steamers which arrived in the same period was 410, of an aggregate burthen of 128,610 tons. It follows that 2568 ships of all descriptions, of an aggregate burthen of 546,444 tons, entered the port during the year. In 1870 the number of sailing ships which arrived was 2380, of an aggregate burthen of 682,741 tons. The number of steamers which arrived was 1745, of an aggregate burthen of 772,865 tons. The number of ships of all descriptions which entered the port during the year was, accordingly, 4125, of an aggregate burthen of 1,455,606 tons. In 1880, 1236 sailing ships, of an aggregate burthen of 502,665 tons, arrived, while 3156 steamers, of an aggregate burthen of 2,360,562 tons, entered the port. The whole arrivals for the year were, accordingly, 4483, of an aggregate burthen of 3,063,227 tons. In 1883 the number of sailing ships which arrived was 992, of an aggregate burthen of 390,804 tons. The number of steamers which entered the port during the year was 3760, of an aggregate burthen of 3,437,491 tons. The whole number of vessels of all descriptions which entered the port during the year was 4752, of an aggregate burthen of 3,828,295 tons. It will be seen that the increase has occurred entirely in steam shipping, the number of sailing vessels entering the port having steadily declined since 1860.

A FIRST-CLASS LUBRICANT.

12 YEARS IN USE. See Testimonials.

MORE EFFICIENT AND ECONOMICAL THAN TALLOW, SUET, LARD-OIL, OR OTHER LUBRICANT.

"ENGELBERT'S LUBRICATOR."

PRICE **3s. 9d.** PER GALLON, DELIVERED FREE.

FOR CYLINDERS & VALVES, HEAVY BEARINGS, SHAFTING, MACHINERY RUNNING AT HIGH SPEED, &c. &c.

LEAVES NO DEPOSIT IN CYLINDERS OR BOILERS, and ENTIRELY PREVENTS "PITTING."

Cannot Gum or Clog Machinery, Preserves India Rubber Valves, Removes Scale in Boilers, Keeps Condenser Tubes Clean.

CORROSION IMPOSSIBLE.

PARTICULARS AND TESTIMONIALS ON APPLICATION TO THE PATENTEES AND SOLE MANUFACTURERS,

Non-evaporative at 600°.
Free from Spirit.
Will not Burn.
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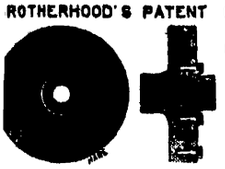
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Will not Saponify.
Hardens Metal Surfaces.

E. & Co. NEVER sell to Merchants or Brokers, and are in no way connected with a lubricating oil that is being sold, marked with their Initials in Diamond. None is genuine unless SUPPLIED AND INVOICED BY ENGELBERT & CO. 4918

ROTHERHOOD'S PATENT



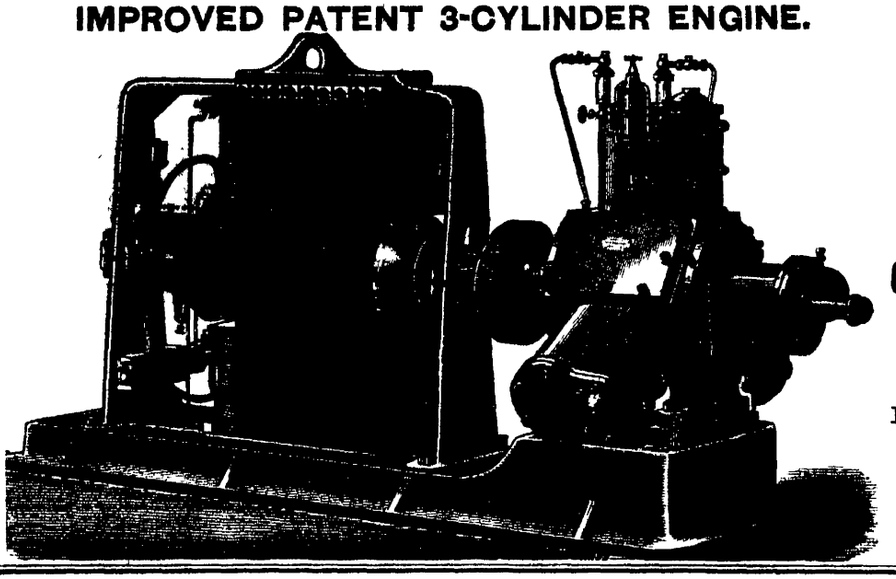
FLEXIBLE COUPLING

PETER BROTHERHOOD,

MECHANICAL ENGINEER.

BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.

IMPROVED PATENT 3-CYLINDER ENGINE.



BROTHERHOOD'S PATENT



FLEXIBLE COUPLING

THE MOST
ECONOMICAL
AND
EFFECTIVE
FOR
SHIP LIGHTING
As in General Use in the British, French, Italian, Danish, &c., &c., Navies.

FOR DRIVING
FANS,
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PUMPS,
AND OTHER
HIGH-SPEED
MACHINERY.

5904



Uptake arrangement.

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1540 OF THESE BOILERS ARE NOW IN USE. They are the lightest and most economical in the market. We can show several 50 HP. Boilers occupying a floor space of only 6 ft. 6 in. square, which are evaporating 10.93 lbs. of water per lb. of coal, after eight years' hard work.

140,000 TUBES HAVE BEEN SUPPLIED FOR INSERTION IN EXISTING BOILERS. 5044

LEWIS OLRICK & CO., BOILER MAKERS to H.M. GOVERNMENT. Offices: 27, Leadenhall Street, London.



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THE BEST AND MOST DURABLE METAL FOR

BEARINGS AND BUSHES OF EVERY DESCRIPTION; HYDRAULIC PUMPS, PINIONS, VALVES, &c., &c.

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SOLE MANUFACTURERS UNDER SEVERAL PATENTS. 1475

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TANGYES' HYDRAULIC "PRINTERS'" PRESS

For Bookbinders, Printers, and others.



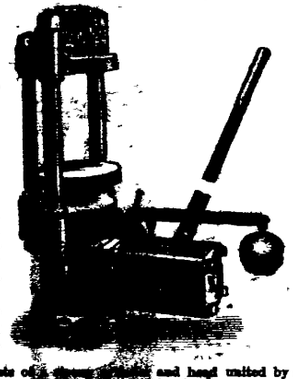
With Two Pumps, £5 extra.

No.	Diam. Ram	Rise Ram	Power Tons	Distance between Table and Top when down	Distance between Pillars	Size of Table	Price with Cistern and one Pump on base
120	3 in.	10 ins.	10	15 ins.	15½ × 10½ ins.	17½ × 13 ins.	£13
121	3 ,,	10 ,,	10	20 ,,	15½ × 10½ ,,	17½ × 13 ,,	15
122	3½ ,,	10 ,,	15	20 ,,	23 × 20½ ,,	27½ × 23½ ,,	19
123	3½ ,,	10 ,,	15	40 ,,	23 × 20½ ,,	27½ × 23½ ,,	20
124	4 ,,	10 ,,	20	20 ,,	32½ × 22 ,,	35½ × 25½ ,,	25
125	4 ,,	10 ,,	20	40 ,,	32½ × 22 ,,	35½ × 25½ ,,	26
126	4½ ,,	10 ,,	25	20 ,,	32½ × 22 ,,	35½ × 25½ ,,	27
127	4½ ,,	10 ,,	25	40 ,,	32½ × 22 ,,	35½ × 25½ ,,	28
128	5 ,,	10 ,,	30	20 ,,	32½ × 22 ,,	35½ × 25½ ,,	28
129	5 ,,	10 ,,	30	40 ,,	32½ × 22 ,,	35½ × 25½ ,,	29
130	5½ ,,	10 ,,	35	20 ,,	36½ × 22 ,,	36 × 24½ ,,	31
131	6 ,,	10 ,,	50	23 ,,	36½ × 22 ,,	36 × 24½ ,,	33
132	6 ,,	10 ,,	50	40 ,,	36½ × 22 ,,	36 × 24½ ,,	34
133	6 ,,	12 ,,	50	42 ,,	24 × 18 ,,	24 × 18 ,,	40

168

TANGYES HYDRAULIC "DENTIST" PRESS

For the use of Dentists, &c.



This Press consists of a strong cast base and head united by steel screwed pillars, and has metal pressure plate, worked by hand lever.

It is suitable for the special requirements of Goldsmiths, Druggists, Dentists, &c. &c.

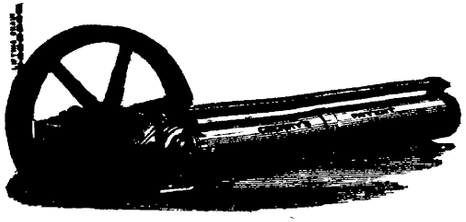
No. 150.

Power	tons	25
Diameter of Ram	ins.	4
Length of Stroke	,,	6
Between Pillars and Head	,,	7
Diameter of Pillars	,,	3
Price	£	15

169

CHERRY'S PATENT HYDRAULIC HOIST

TANGYES LIMITED, SOLE MAKERS.



The distinctive feature of this hoist is the simple and direct method by which the motion of the piston is made to rotate the winding drum or pulley

The working parts consist of a Piston to which is attached a Steel Pitched Chain, passing over a Toothed Wheel on the Drum Shaft.

The only other moving part is the Valve, the Lever of which controls the Starting, Stopping, and Lowering motions.

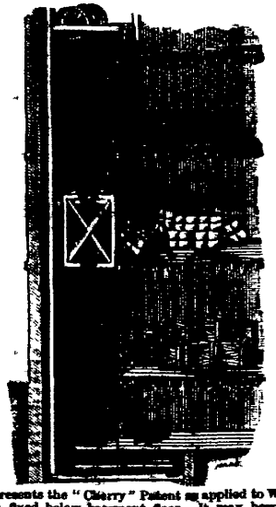
This hoist is in use for a great variety of purposes, and is particularly suited for employment where space is an object. It is used for "whipping" on board steam ships, where its quick and noiseless motion compares most favourably with the clattering noise of the ordinary steam winch.

Quotations on receipt of necessary particulars. 173

CHERRY'S PATENT

HYDRAULIC WAREHOUSE HOIST

TANGYES LIMITED, SOLE MAKERS.

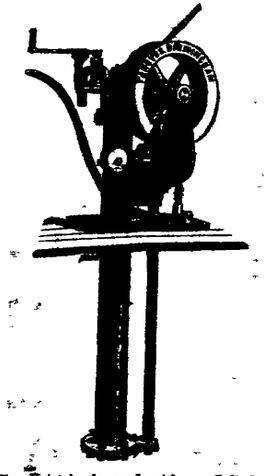


The Illustration represents the "Cherry" Patent as applied to Warehouse Lifts.
The Hoist is shown fixed below basement floor. It may, however, be bolted to the joists of ground-floor, or fixed in any suitable position.
The pressure may be obtained from the Town Mains, or from a Special Steam Pump, see pages 48 and 49, or from Accumulator and Pumps, see pages 152 to 155.
Quotations on receipt of necessary particulars. 175

CHERRY'S PATENT

SHIP WHIPPING AND CARGO HOIST

TANGYES LIMITED, SOLE MAKERS.



This Hoist is also made with two Cylinders.

N.B.—The Cylinder may be placed horizontally upon or under the deck, or vertically in the hold. 176

CHERRY'S PATENT

SHIP WHIPPING AND CARGO HOIST

TANGYES LIMITED, SOLE MAKERS.

This is an application to Ships' purposes of the Hoist described on page 174.

The working parts consist of a Piston, to which is attached a Steel Pitch Chain, passing over a Toothed Wheel on the Drum Shaft.

The only other moving part is the Lever, which controls the starting, stopping and lowering motions.

The wear and tear, noise and vibration, of the ordinary Ships' Deck Winch is avoided in this arrangement, and the speed of working is found in practice to be equal to all requirements in the way of quick discharge.

For whipping, the Hoist can keep the largest practicable gang employed.

Diam. Cyl.	Tested to With 60 lbs. Steam	Tested to With 90 lbs. Steam	Price
6 ins.	2½ cwts.	3½ cwts.	£40
7 ,,	3½ ,,	5 ,,	45
8 ,,	5 ,,	7½ ,,	50
9 ,,	7½ ,,	10 ,,	55
10 ,,	9 ,,	13 ,,	60

Height of Lift 24 ft.

N.B.—The Cylinder may be placed horizontally upon or under the deck, or vertically in the hold. 177

ENGINEERING. 19th DEC. 1890.

DICK, KERR & CO., Engineers and Contractors, (Five Medals awarded, Calcutta International Exhibition, 1883-4.)



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WAGONS & LOCOMOTIVES

FOR ALL CLASSES OF WORK.

Catalogues and Prices on application. 5024



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JAMES ARCHDALE & CO.,



MANCHESTER WORKS, LEDSAM STREET, BIRMINGHAM.

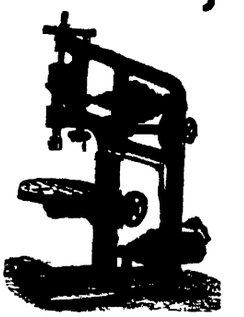
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CONTRACTORS TO THE BRITISH & FOREIGN GOVERNMENTS.

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WHERE A STOCK OF OUR TOOLS MAY ALWAYS BE SEEN. 5351





New Patent Barring Engine.

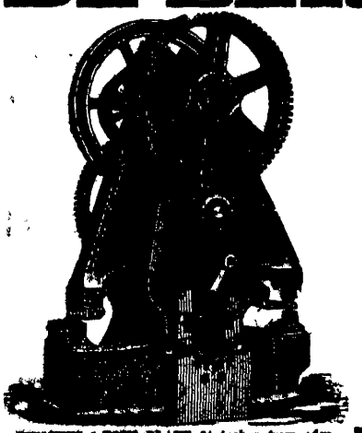
AUTOMATIC MOTION FOR MOVING INTO GEAR, AND FALLS OUT OF GEAR AUTOMATICALLY WHEN MAIN ENGINE STARTS.

The SIMPLEST, SAFEST and BEST, and also the CHEAPEST Automatic Safety Apparatus for Turning Main Engines.

Sole Makers: HICK, HARGREAVES & CO., ENGINEERS, MILLWRIGHTS, AND BOILER MAKERS.

SOHO IRONWORKS, BOLTON. 5199

DE BERGUE & COMPANY, LD.,



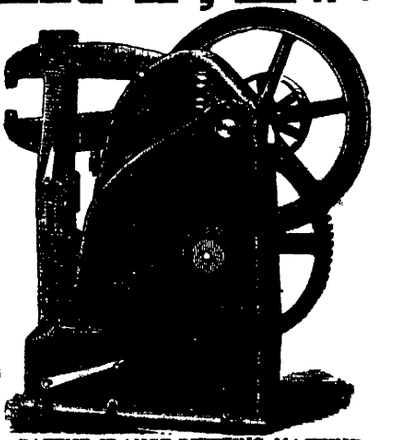
PUNCHES 1-INCH PLATE 24 inches from edge. CUTS ANGLE-IRON 3×3×½, any length cold.

ENGINEERS, CONTRACTORS,

AND MAKERS OF

Punching and Shearing Machines,
Boiler and Girder Riveting Machines,
Flange Riveting Machines,
Angle and Tee Iron Straightening Machines,
Rail Straightening Machines,
Rivet-making Machines, Rivets,
Rivet and Bolt Head Dressing Machines,
Plate Mill Shearing Machines,
Scrap and Bar and Puddled Bar Shearing Machines,
Plate Edge Planing Machines, &c.

WROUGHT IRON BRIDGES, GIRDERS, AND ROOFING. 4905



PATENT FLANGE RIVETING MACHINE.

MANCHESTER.

TRADE MARK.

JOHN LYSAGHT, Limited,

IRON ROOFS & BUILDINGS,

DESIGNS AND ESTIMATES UPON APPLICATION.

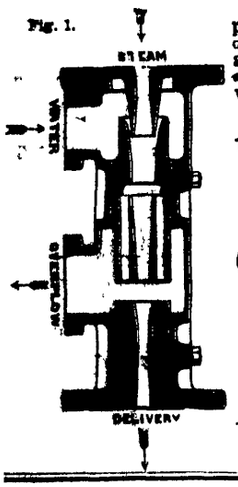
GALVANIZED CORRUGATED AND PLAIN SHEETS.
GALVANIZED STEEL SHEETS FOR WORKING UP.
GALVANIZED WIRE, WIRE NETTING, TANKS, &c.
WROUGHT AND CAST IRON GIRDERS, COLUMNS, &c.

BRISTOL: ST. VINCENT'S GALVANIZED IRON WORKS.
WOLVERHAMPTON: SWAN GARDEN MILLS.
LONDON: 28, GRACECHURCH STREET, E. C. 4088

GRESHAM'S PATENT IMPROVED SELF-ACTING INJECTOR

For Supplying Stationary, Locomotive, Agricultural, or Marine Steam Boilers with Water.

Fig. 1.



The Self-acting Injector possesses the following great advantages over all other Injectors:—It is perfectly Automatic, and cannot fail to work. It will lift its water supply 15 ft.; and can, when specially ordered, be made for greater lifts. It will work with more ease and certainty with hot water than any other Injector. If it ceases working from any cause (for instance, shortness of water, and consequent admission of air), it will re-start Automatically immediately the cause is removed. It will work equally well at any pressure from 10 lb. to 200 lb. It may be fixed in any position above or below the water supply.

The combining and receiving Cones of Fig. 2 can be taken out and cleaned without breaking any pipe joints.

The above and every other class of Injector, Ejector, and Elevator in stock and in progress; also Brass Fittings for Locomotive and other Boilers.

Upwards of **100,000** *of Gresham's Patent Injectors are now in use.*

GRESHAM & CRAVEN,

ENGINEERS, PATENTEES, & MANUFACTURERS,

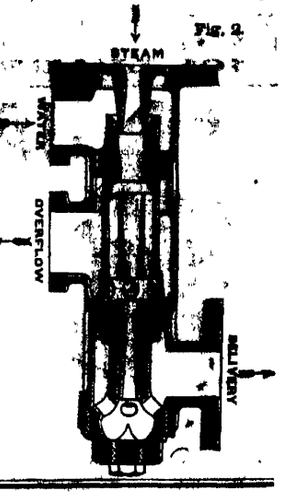
Craven Ironworks, South Hall Street, Ordsal Lane, Manchester.

LONDON OFFICE:

A. L. SACRE, 60, QUEEN VICTORIA STREET, E.C.

AGENTS—Glasgow: WILLIAM LESTER, 58, Renfield Street. Newcastle-on-Tyne: TANGYE BROS., St. Nicholas Buildings. Birmingham: TANGYES LIMITED, Soho. 5039

Fig. 2.

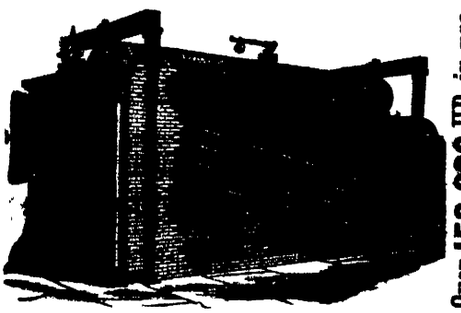


THE BABCOCK AND WILCOX CO.

(NEW YORK & GLASGOW)

PATENT

WATER-TUBE STEAM BOILER.



Over 150,000 HP. in use.

Safe, Economical (as to space and fuel), and Durable; Having Perfect Water Circulation, and Spacious Steam-room; Easy of Transportation, and perfectly Accessible for Cleaning external and internally.

For Illustrated Circular and full particulars apply to our European Offices,

107, HOPE STREET, GLASGOW, SCOTLAND;
40, CANNON STREET, LONDON, E.C.; and
3, VICTORIA BUILDINGS, DEANSGATE, MANCHESTER.

For the Colonies and New Zealand, apply at No. 3, Spring Street, Sydney, N.S.W. 4770

THE MERSEY FORGE, LIMITED



CRANK SHAFT FOR No. 206.
Forged Weight, 24 tons 11 cwt.; Finished Weight, 15 tons 5 cwt. 2 lbs.

LIVERPOOL,

MANUFACTURERS OF

Marine and other Crank Shafts,

STERN AND RUDDER FRAMES,

FORGINGS OF ALL KINDS

IN IRON AND STEEL.

WORKS: GRAFTON STREET.

Town Office: 5, Harrington Street. 4770

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ENGINEERS, LEEDS,

Makers of the heaviest class of Machinery used in the manufacture of **IRON** and of **STEEL** by the Bessemer and Siemens processes.

COGGING, RAIL & PLATE MILL ENGINES.

Armour Plate and Forging Presses.

STEAM HAMMERS.

Hydraulic Cranes and Capstans. 6203

WORKS:
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LONDON, S.E.

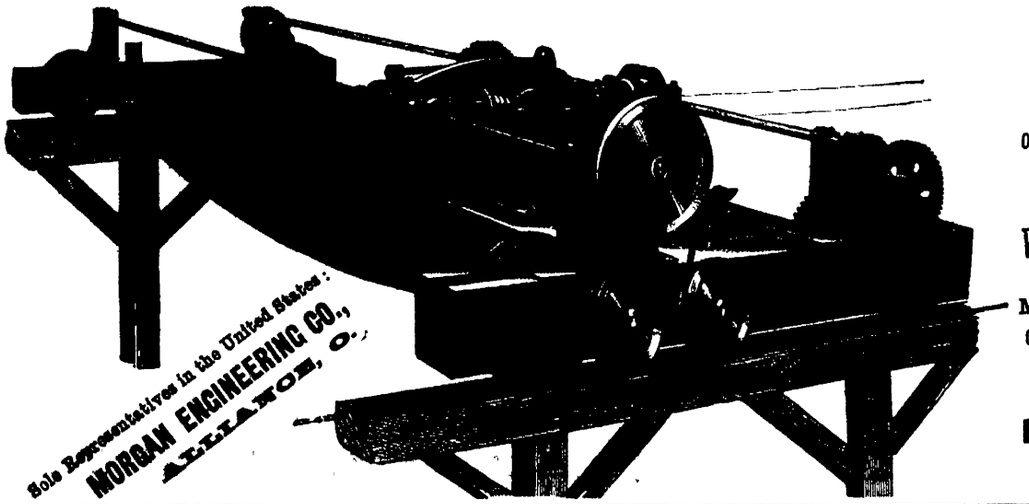
APPLEBY BROTHERS.

CITY OFFICE:
89, CANNON ST.,
LONDON, E.C.

Cranes,
STEAM, HAND, AND HYDRAULIC, FIXED, PORTABLE OR LOCO.

OVERHEAD TRAVELLERS
And Lifting Machinery of all descriptions.

Boilers.
All types of Land and Marine, and in all sizes.



STEAM ENGINES
Of all types and powers for Mills, Mines, Water Works, &c.

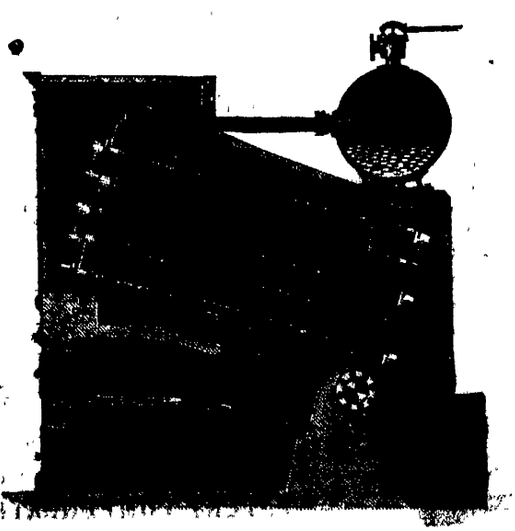
Winding Gear,
PUMPING MACHINERY,
Combined or separate.

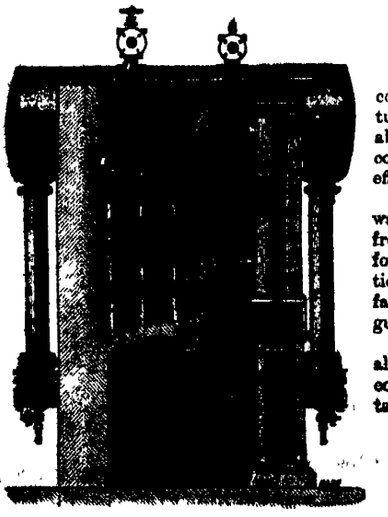
IRON BRIDGES,
Iron Roofs and Girder Work of all kinds. 4044

HARDINGHAM's Patent Sectional STEAM BOILER

ANNULAR WATER-TUBE SYSTEM.

FOR
FULL PARTICULARS,
Apply to
G.G.M. Hardingham
Engineer,
194, Fleet Street,
LONDON, E.C.





By this improved construction of Water-tube Boiler, considerable economy in first cost and in working is effected.

Although the water-ways are exceptionally free from liability to fouling, the construction affords peculiar facilities for their regular inspection.

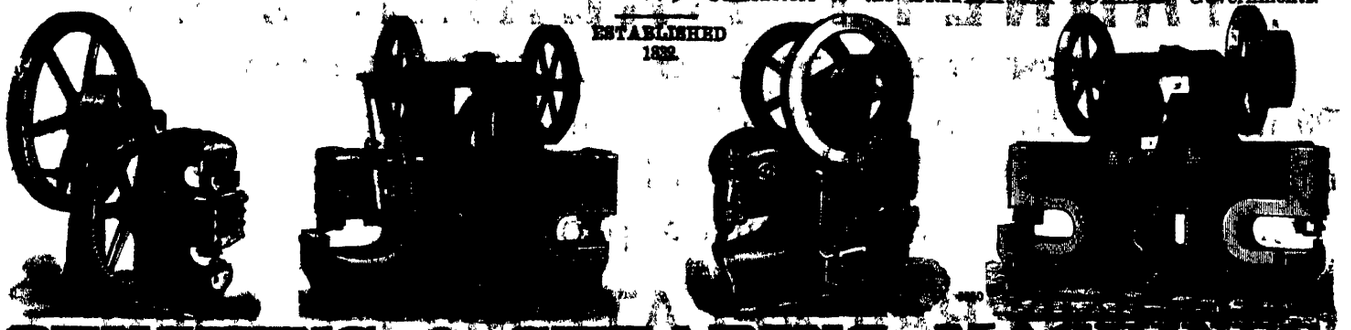
The system further allows of extreme compactness being attained.

4067

FRANCIS BERRY & SONS,

Ironfounders, Engineers, and Tool Makers,
SOWERBY BRIDGE, ENGLAND.
Contractors to the BRITISH and FOREIGN Governments.

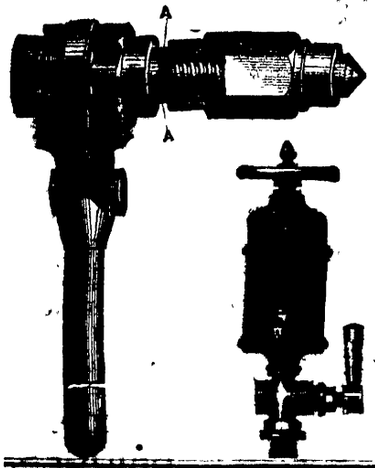
ESTABLISHED 1832



PUNCHING & SHEARING MACHINES.

NETTLEFOLDS LIMITED, BIRMINGHAM,

SOLE MANUFACTURERS OF
WESTON'S STORER'S
PATENT DIFFERENTIAL RATCHET BRACE.—PATENT OPEN TOP SUET LUBRICATOR.



These BRACES, which have been several years before the public, and are MUCH APPRECIATED by them, NETTLEFOLDS have lately CONSIDERABLY IMPROVED by enclosing the SCREW in a SLEEVE (A) which always PROTECTS it from INJURY either from DIRT or BLOWS. This SLEEVE also acts as a GUIDE for the NUT, thus keeping it steady throughout the whole of its traverse, and consequently enabling the drilling to be effected with PERFECT ACCURACY.

The SUET LUBRICATOR has effected a saving of 70 per cent. in the cost of lubricating material used for Nettlefolds' Engines, and has now been fully tested in their works on 15 Cylinders working to 750 horse-power.

Messrs. HICKS, HARGREAVES & Co. write:—"We find the saving in *excess* of that stated in Messrs. Nettlefold & Chamberlain's Report—viz., 70 per cent., and the cylinders to which these Lubricators have been applied are in beautiful condition. We shall adopt them for all our engines."

By this Invention the steam is lubricated before passing to the valves, while the supply of grease is uniform and constant.

SOLD BY THE UNDERMENTIONED AGENTS:—

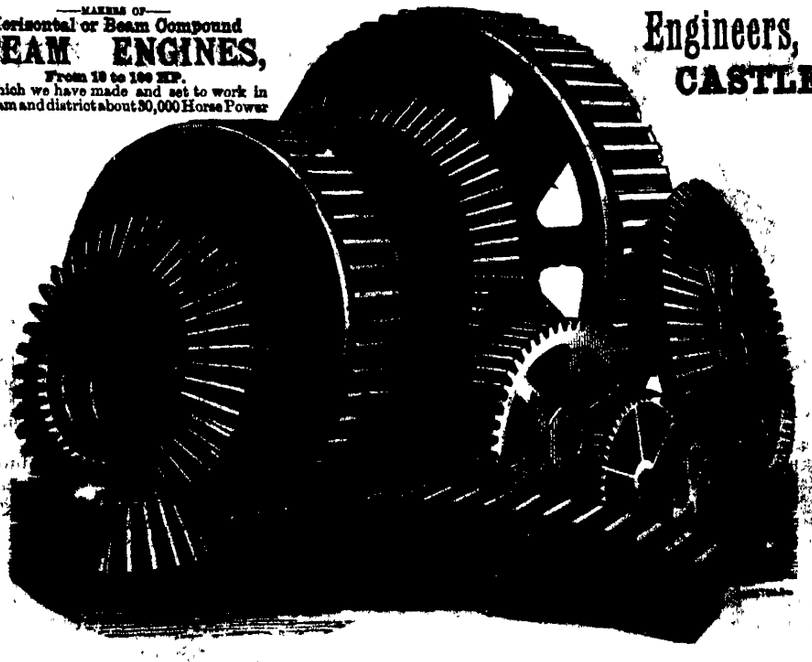
BIRMINGHAM	Wakeman, G. H., 64, Charles St.
LONDON	Nettlefold & Sons.
LIVERPOOL ..	Sharp & Carlisle, 84, Roscoe Street.
MANCHESTER	Edmondsons & Co.
GLASGOW ..	W. McGeoch & Co., Schaffer & Budenberg.
EDINBURGH ..	Redpath, Brown & Co., Thos. Scott.
BRISTOL	Weston, J. D., & Son.
SHEFFIELD ..	Wilkes Brothers & Co., Tasker Sons & Co.
NEWCASTLE-ON-TYNE	Galloway & Co.
NOTTINGHAM	Manlove, Alliott, Fryer & Co.
BELFAST	Patterson, R., & Sons.
DERBY	Handyside & Co.
RUSSIA	Sumner, John M. & Co., Manchester.
AUSTRIA	Simon, Henry, Manchester. 788
GERMANY	Schaffer & Budenberg, Manchester.

OF WHOM PRICED LISTS AND FULL PARTICULARS MAY BE OBTAINED.

BUCKLEY AND TAYLOR,

Engineers, Millwrights, and Ironfounders,
CASTLE IRONWORKS, OLDHAM.

—MAKERS OF—
Horizontal or Beam Compound
STEAM ENGINES,
From 10 to 100 HP.
Of which we have made and set to work in Oldham and district about 30,000 Horse Power



—MAKERS OF THE—
COMPOUND ENGINES
Driving the Textile Machinery at the Oldham Exhibition.

LANCASHIRE STEAM BOILERS,
Made with the best Machinery, with Holes Drilled or Punched, and Plates Planed.

PATENT ELASTIC SPRING
PINION AND BEVEL WHEELS,
Specially designed, and adapted for heavy work, varying loads, and sudden shocks.

PATENT BEVEL WHEELS,
WITH SEPARATE STEEL RIMS,
SPECIALLY TO CARRY WHERE GREAT STRENGTH IS REQUIRED.

MAIN DRIVING DRUMS,
[illegible] up to 30 feet diameter.

All [illegible] provided by our Patent Machinery.

[illegible] & CO.'S (Sheffield) 4729
PATENT COMPENSATING PISTONS.

RANSOMES & RAPIER,

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MAKERS OF ALL KINDS OF RAILWAY PLANT,

INCLUDING

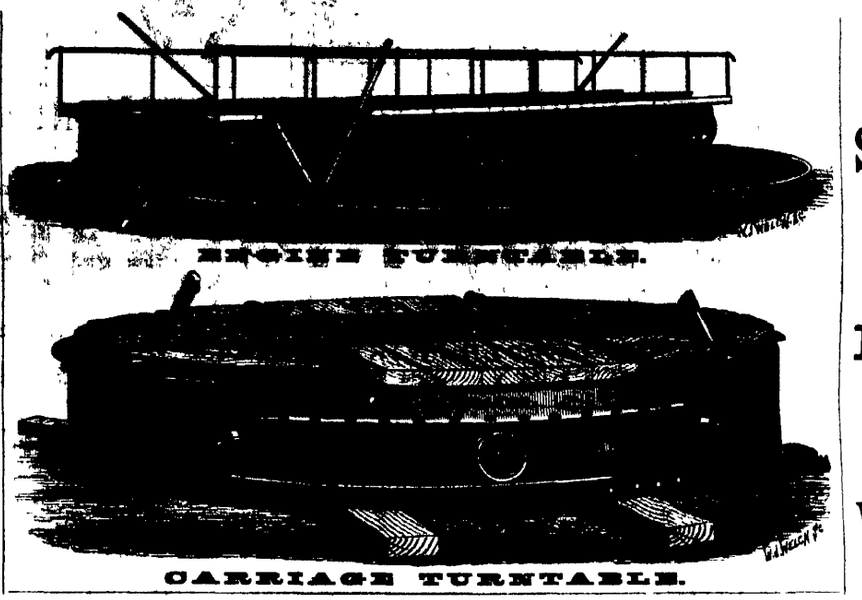
SWITCHES,

CROSSINGS,

Engine Turntables,

CARRIAGE TURNTABLES,

TRAVERSERS.



ENGINE TURNTABLE.

CARRIAGE TURNTABLE.

INCLUDING

SIGNALS

HYDRANTS,

PUMPS,

TANKS,

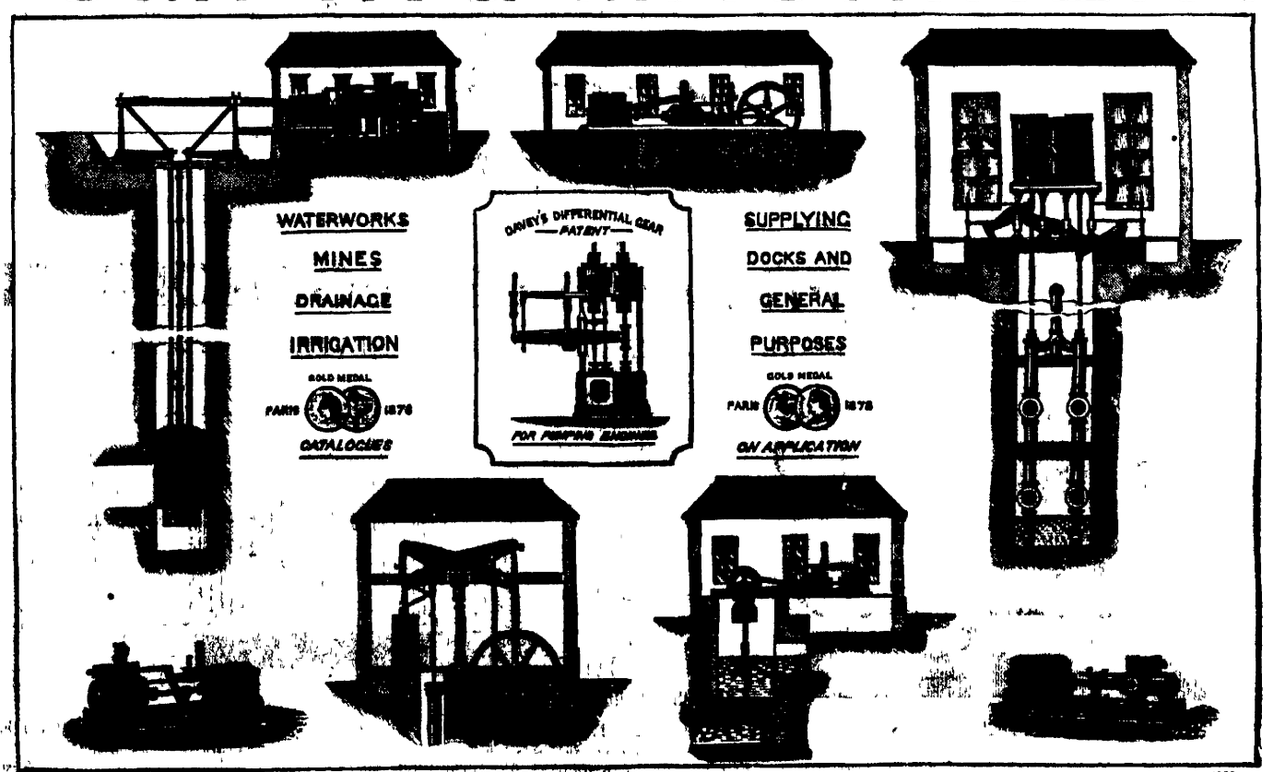
WATER CRANES

ALSO ALL KINDS OF

STEAM AND HAND CRANES.

Prices and Illustrations on application to RANSOMES & RAPIER, 5, Westminster Chambers, London. 5068

PUMPING MACHINERY.



4973

HATHORN, DAVEY & CO., LEEDS.

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

The most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
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9. Will Burn either Tan, Breese, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

8ft. long,	5ft. 0in. diameter,	20-horse power.
10ft. "	5ft. 6in. "	30 "
12ft. "	6ft. 0in. "	40 "
13ft. "	6ft. 6in. "	50 "
14ft. "	7ft. 0in. "	60 "
15ft. "	7ft. 6in. "	70 "
16ft. "	8ft. 0in. "	80 "
17ft. "	8ft. 0in. "	90 "
18ft. "	8ft. 0in. "	100 "

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5149

BRASS & COPPER TUBES

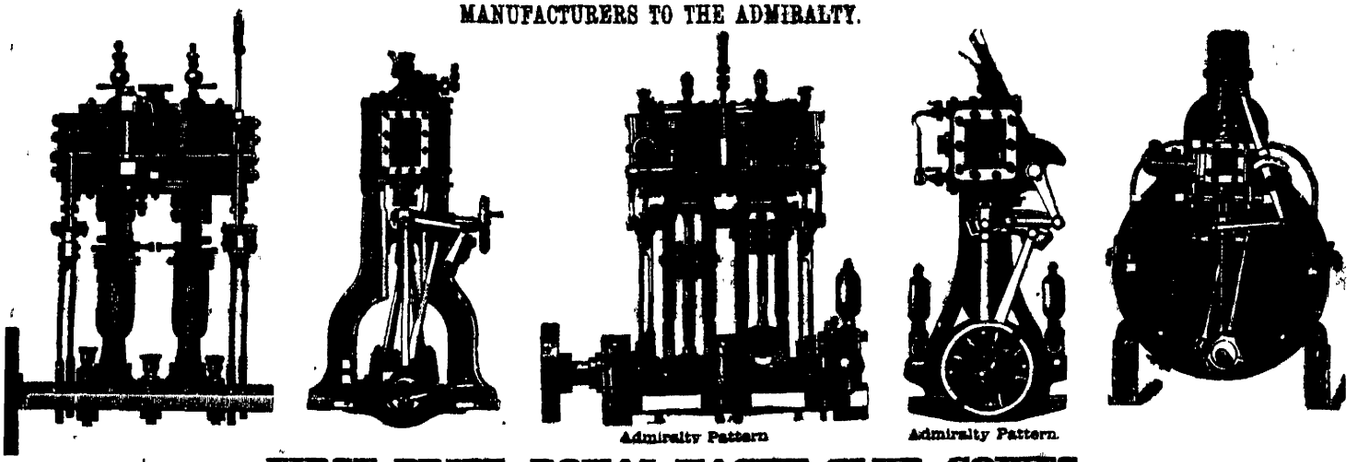
SEAMLESS & BRAZED, FOR BOILERS, SURFACE CONDENSERS &c

BRASS & COPPER WIRE, SHEETS &c.

BIRMINGHAM BATTERY & METAL CO. BIRMINGHAM. 4837

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MANUFACTURERS TO THE ADMIRALTY.



Admiralty Pattern. Admiralty Pattern.

FIRST PRIZE, ROYAL YACHT CLUB, COWES.

PATENT ENGINES AND BOILERS FOR SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &c. 4227

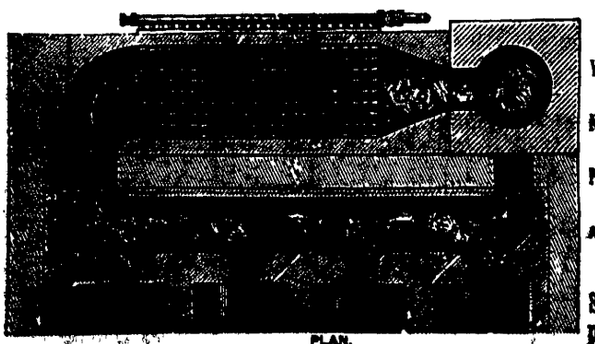
Simple, High-pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works.

Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(FOR UTILISING THE WASTE HEAT FROM STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION



PLAN.

SPECIAL ADVANTAGES.

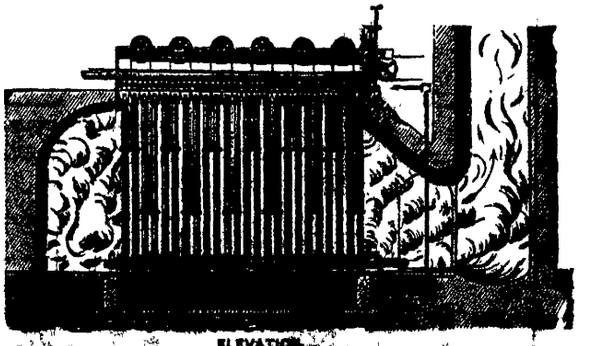
Vertical Pipe Castings. Guaranteed sound and perfectly true.

New Patent Spiral Scrapers The most effectual removers of soot.

Patent Reversing Gear. Never sticks or gets out of order.

ALREADY IN OPERATION TO HUNDREDS OF STEAM BOILERS.

Saves from 20 to 25 per cent. of the fuel.



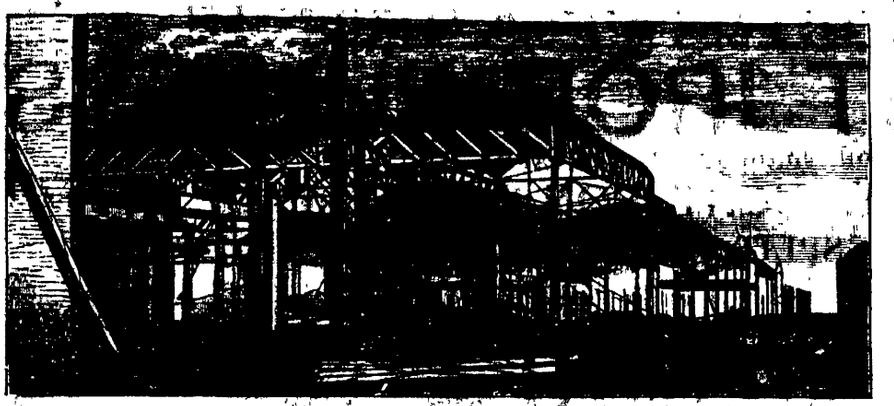
ELEVATION.

N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and abroad.

PRICES, TESTIMONIALS, AND FURTHER PARTICULARS ON APPLICATION TO 4420

ARTHUR LOWCOCK, (PATENTEE & SOLE MAKER) Coleham Foundry, Shrewsbury, England.



From Photo. of STEEL ROLLING MILLS, covering many acres, showing ROOFS in IRON and STEEL, in course of erection by MOREWOOD & CO.

Roofs and Buildings
IN IRON AND STEEL.

MOREWOOD & CO.
WOODFORD IRONWORKS,
SOHO, BIRMINGHAM.
LONDON OFFICES—158, LEADENHALL STREET, E.C.

CORRUGATED AND GALVANISED SHEETS,
LION WORKS, BIRMINGHAM
Manufacturers of every description of Roofs and Buildings in Iron and STEEL for Forges, Rolling Mills, Railway Stations, Goods Sheds, Yards, Docks, Stores, and General Purposes.
Special Curved Corrugated Iron Roofs without Framing for moderate Spans.
WROUGHT IRON WATER TANKS, any size.
ANNEALING AND GALVANIZING POTS.
Corrugated Iron & STEEL Sheets & Fastenings, &c.
Ridges, Gutters, and Tanks, Galvanised or Painted.
Wrought-Iron Lattice and Plate Girders. Railway, Road and Foot Bridges.
DESIGNS AND ESTIMATES ON APPLICATION. 6909

Paris, 1878.—GOLD MEDALS AWARDED.—Melbourne, 1881.

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MANUFACTURERS OF

EVERY DESCRIPTION OF TOOL STEEL & STEEL CASTINGS,

Cast, Shear, German, Spring, Blister & Sheet Steel for all purposes.

Files of First Quality.—Steel Lagging Plates for Cylinders.—Steel Boiler & Ship Plates & Forgings of all kinds.

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DAVY BROTHERS, LIMITED,

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MANUFACTURERS OF

STEAM HAMMERS

From 1 Cwt. to 50 Tons, for every kind of work,

Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.

BESSEMER STEEL WORKS PLANT,

FORGE AND ROLLING MILL MACHINERY,

Steam Engines for Mills, Ironworks, Collieries, &c.

SINGLE AND DOUBLE FLUED BOILERS. 5178

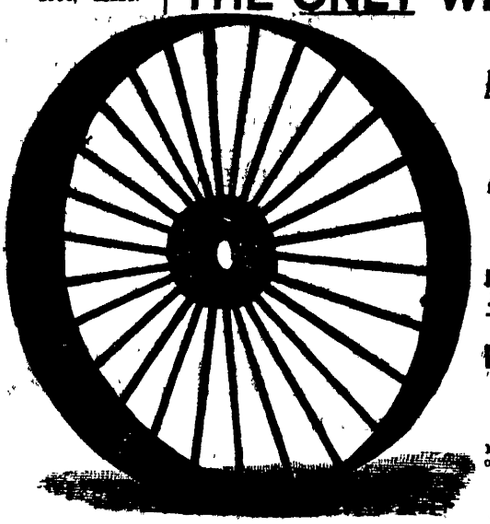
RODGERS' PATENT
WROUGHT IRON PULLEYS

Telegraphic Address, "LOOO," LEEDS.

WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.

THE ONLY WROUGHT IRON PULLEY MADE.

Telegraphic Address, "LOOO" LEEDS.



SPLIT OR SOLID.

All Sizes up to 24 feet Diameter.

40,000

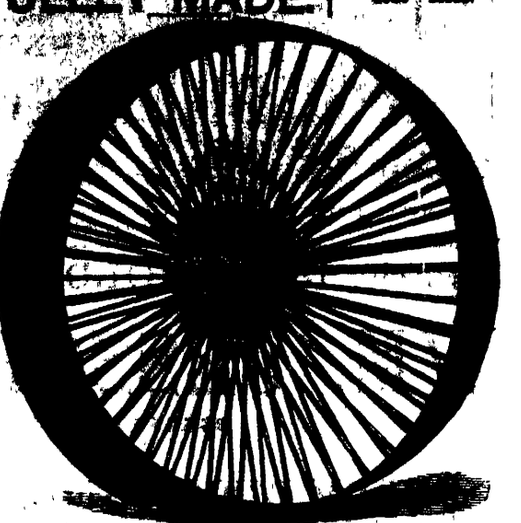
IN USE.

The Best Pulley in the World

USED SOLELY FOR

DRIVING THE ELECTRIC LIGHT AT THE HEALTH EXHIBITION, SOUTH KENSINGTON.

Messrs. Marshall, Sons and Co., Limited, keep a Stock of our Pulleys at their Depôt, Marshalls' Buildings, 79, Farringdon Road, London, E.C.



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HUDSWELL, CLARKE & CO.,

RAILWAY FOUNDRY, LEEDS.

— SOLE AGENTS —

France—O. SORISSOW, Rue a Fiens, 3ter, Lille.
Russia—S. G. MARTIN, Galerny No. 12, Quartier 8, St. Petersburg.
Austria—J. EGLI, I, Berz Freiung 7, Vienna.
Saxony—W. W. BERRAM, Leipsic.
Belgium—D. GRANDY, Rue de l'Abattoir 80, Gand.

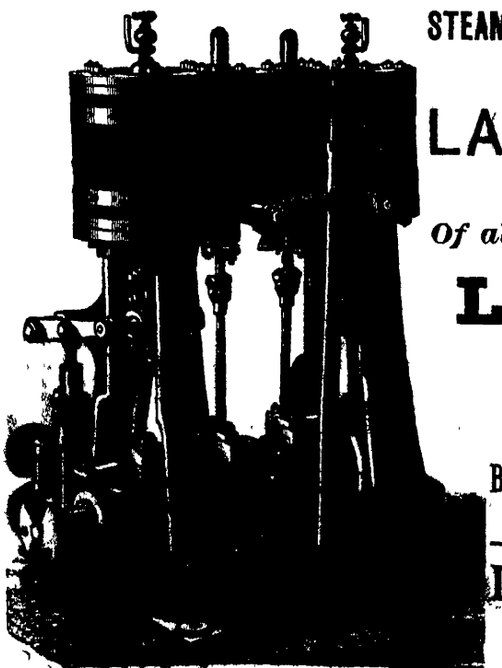
Italy—A. SINGTON & CO., Manchester and Milan.
Holland—VAN RIETSCHOTEN EN HOUWENS, Rotterdam.
Portugal—ALFD. HARRISON, Rua Nova St. Domingos 95, Oporto.
Dominion of Canada—T. J. CHURCH, 672, Craig St. Montreal.
Lancashire & District—F. S. WELCH & CO., Market St., Manchester.

Australia & Tasmania—John J. Horrocks & Co, Adelaide & Sydney.
North of England—Snowball & Co., Side, Newcastle-on-Tyne.
W. of England—Townsend & Young, Arch House, John St., Bristol
Glasgow & District—Robertson & Co., 9, Old Sneddon St., Paisley.
South of Ireland—Jas. F. Roberts, 72, Francis Street, Dublin.
New Zealand—Walter Brown, 1, College Green, Wellington. 492

MATTHEW PAUL & CO.,

MAKERS OF

STEAM AND HAND WINDLASSES,



STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,

And every Description of Ship Fittings.

LAND AND MARINE ENGINES

Of all Sorts and Sizes up to 1,000 I. HP.

Launch Engines,

WITH

Patent Valve Motion.

Builders of LAUNCHES, BARGES, & YACHTS

UP TO 100 FEET LONG.



LEVENFORD WORKS, DUMBARTON.

In the above the reversing is accomplished with single eccentric for each cylinder, and the numerous complications and working joints of link motion are dispensed with, while all the properties of same are retained, and the steam and exhaust cut-off [illegible] stroke at the same [illegible] whether in full gear or not.

Only Gold Medal for Gauges at the Paris Exhibition, 1878.

BOURDON'S E. BOURDON Limited & Manchester GAUGES (OWN MAKE)

NEGRETTI & ZAMBRA, OPTICIANS, HOLBORN VIADUCT,
SOLE AGENTS IN LONDON. [Telephone No. 5583

M. BOURDON cautions Persons using Steam Gauges that a large number of very inferior instruments are sold, bearing his name, which are not of his manufacture, a great proportion of them also having a forged Trade Mark.

AGENTS:—J. CASARTELLI, 43, Market St., Manchester; CHADBURN & SONS, 71 & 73, Lord St., Liverpool. 1797

NEGRETTI & ZAMBRA'S NEW CATALOGUE of Scientific Instruments, 500 pages, 1,000 Engravings, is now published, price 2s. 6d.

N. & Z. are Sole Agents for Ritchie & Sons' Patent Liquid Compasses, and for Steinheil's Patent Photographic Lenses and Prisms.

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COWANS, SHELDON & CO., LTD., ST. NICHOLAS WORKS, CARLISLE. 5008

ABERCORN SHIPBUILDING CO.,

HANNA, DONALD & WILSON, ABBEY WORKS, PAISLEY, N.B.

BUILDERS OF DREDGERS, Copper Barges, Steam Tugs, AND Steam Ferry Boats.



BUILDERS OF Steam Yachts, Launches, AND Torpedo Boats, in Iron and Steel.

Builders of STEAM VESSELS, up to 220 ft. long. Makers of MACHINERY and BOILERS for FIRST-CLASS TORPEDO BOATS for the ADMIRALTY.

KINNIPLE'S PATENT CAISSONS FOR DOCK GATES AND BRIDGES. 4474

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

Scotland Shipping Co., Limited.

S.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

Bell's Asbestos Works, Southwark.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure.....110 lbs. Vacuum.....26 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,
D. HENDERSON, Chief Engineer, S.S "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department.
Grimsby, April 10th, 1884

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing with other packings, I am confidently recommend your Asbestos Packing. It is especially valuable where high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success on a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way satisfactory.

Yours truly,
Mr. J. BELL. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts.
Admiralty, Whitehall, 26th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos packing to complete submitted.

Metallic core.....required, | Elastic core .....round.

To Mr. JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Cork Packing with solid and hollow rubber cores, and Fig 3 without core, but with rubber lead.

As these packings are extensively imitated, and as it is a common practice among silent and unscrupulous makers to copy manufactures at any list prices, users are requested to see that they purchase only those bearing the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This special material by combining the free oxygen that is in the water entirely checks pitting and corrosion. By covering up scale formation so immediately as to prevent its hearing to the plates.

Not only is the destruction of boilers effected by keeping boilers clean, but the risk of burning the plates becomes entirely removed.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. coal; ⅛ in., 25 per cent.; ¼ in., 50 per cent.

Thus the Preservative avoids dangerous boiler explosions, as boilers are inseparable from sealed pistons, lengthens the life of a boiler, and covers its own cost a hundred fold by economy of fuel.

It is entirely harmless, and for surface condensers or vessels.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks, proper directions for use, without which name is genuine.

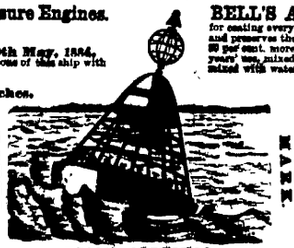
BELL'S ASBESTOS YARN & SOAPSTONE PACKING,

for Piston Rods, Pumps, Slide Valves, &c., running at very high speed with little friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To Messrs Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the packing we had formerly; and this I attribute to your Packing, on account of its great pliability and general excellence of quality.

I am, dear Sirs, yours faithfully,
THOMAS WINTER, Colliery Engineer



— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depots and not through agents or factors.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up, adheres to metal and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 25 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 H.P., gave the following results:—

Temperature on Plates	12½ deg.
Coverings.	24 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov 26th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly,
"W SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,
Mr JOHN BELL, Southwark, S.E. Gunnislake, Tavistock 8th April, 1884.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,
W J CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ⅛ in. to 3 in. wide, and any thickness from 1 16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at any price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

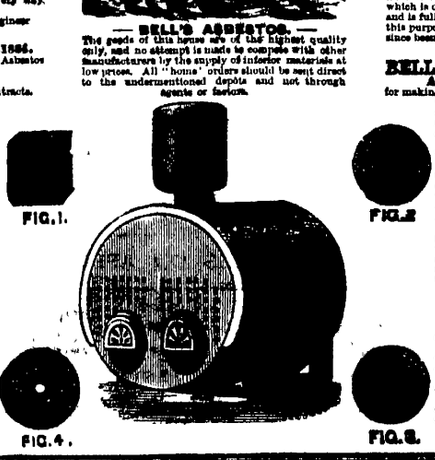


FIG. 1. FIG. 2

FIG. 4. FIG. 3.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and 1 millimetre to 26 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts.
Admiralty, Whitehall, S.W., 12th May, 1884.

Sir,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT.

Mr. JOHN BELL. Director of Navy Contracts

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The Indiarubber Washer is protected from the action of heat and grease by an outer coating of vulcanized Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REGD.

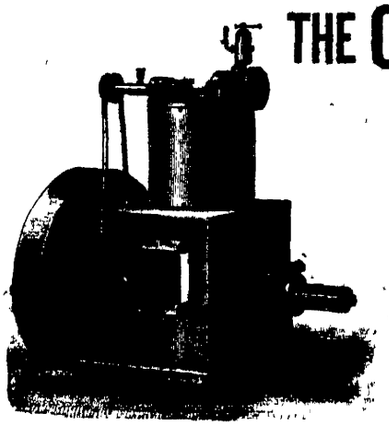
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OR THE DEPOTS—

Victoria Buildings, Deansgate, MANCHESTER. 11 & 12, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

4042



THE COALBROOKDALE COMPANY, LIMITED

SOLE MAKERS OF

ELWELL & PARKER'S PATENT

HIGH SPEED ENGINES,

THE MOST EFFICIENT AND RELIABLE MADE.

Also LIGHT BALANCED PULLEYS, SHAFTING, &c.

Electric Lighting and Plating Installations, complete. 5139

COALBROOKDALE, R.S.O., SHROPSHIRE.

THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

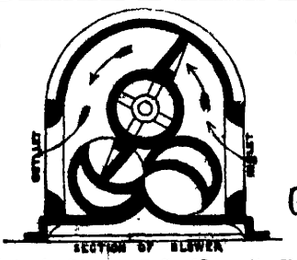
Baker's Patent Rotary Pressure Blower and Gas Exhauster

—:o:—

BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

—:o:—

HALL'S PATENT STONE BREAKER.

—:o:—

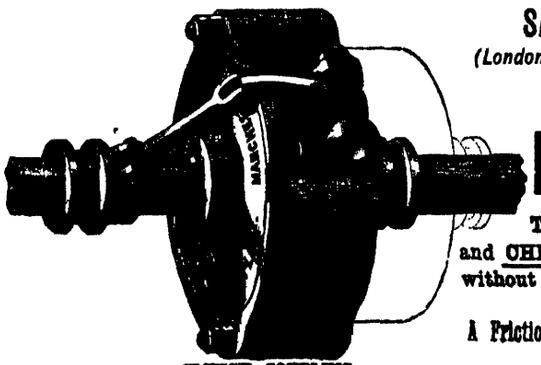
General Machinery of Every Description

London Offices and Exhibition Rooms, 63, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4884

MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

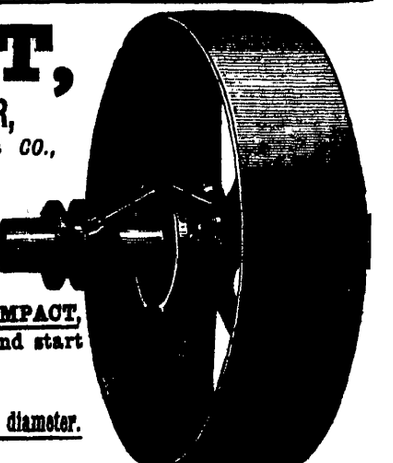
(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.)



CLUTCH COUPLING.

PATENT

FRICTION CLUTCH.



These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.

LIBERAL TERMS TO THE TRADE. PRICES ON APPLICATION.

CLUTCH AND PULLEY 5000

GOODFELLOW & MATTHEWS,

(LATE S. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

MAKERS OF

ROPE & WHEEL GEARING

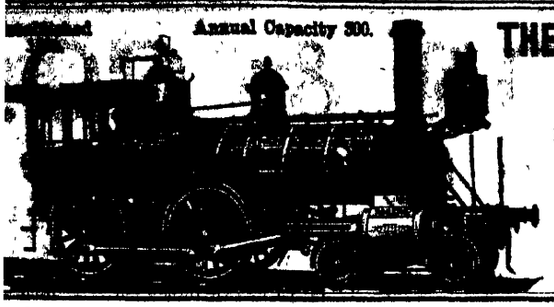
All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEAR

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION, &c.



Annual Capacity 300.

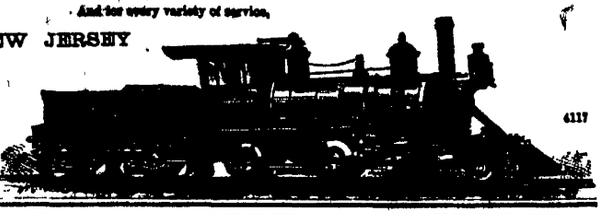
THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

BUILDERS OF LOCOMOTIVE ENGINES OF ALL GAUGES

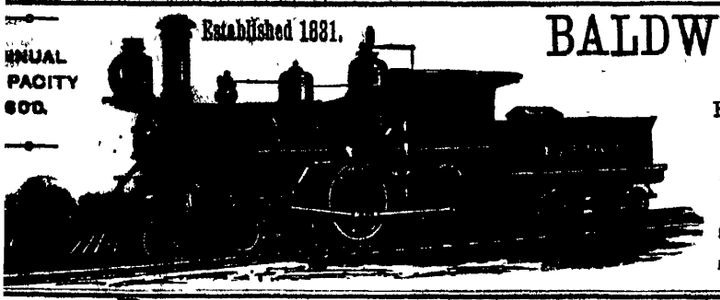
And for every variety of service,

PATERSON, NEW JERSEY

UNITED STATES OF AMERICA.



4117



Established 1831.

BALDWIN LOCOMOTIVE WORKS,

PHILADELPHIA, U.S.A.

BURNHAM, PARRY, WILLIAMS, & Co., Proprietors.

MANUFACTURERS OF

LOCOMOTIVE ENGINES,

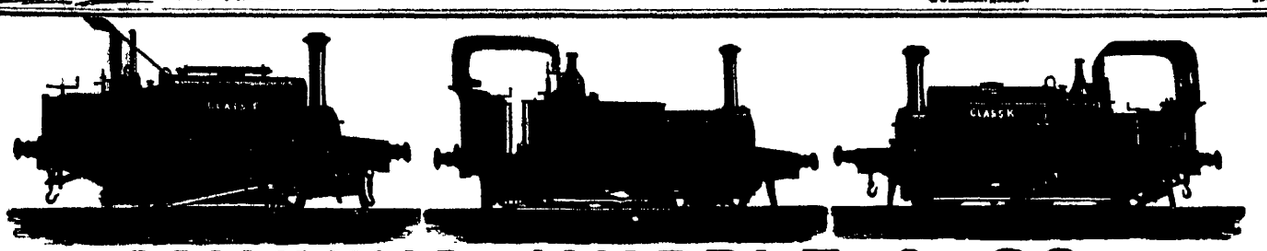
Adapted to every variety of service, and built accurately to standard gauges and templates. Like parts of different engines of same class perfectly interchangeable.

PASSENGER AND GOODS LOCOMOTIVES.

MINE LOCOMOTIVES, NARROW GAUGE LOCOMOTIVES

STEAM STREET CARS, &c.

ILLUSTRATED CATALOGUES FURNISHED ON APPLICATION OF CUSTOMERS. ALL WORK THOROUGHLY GUARANTEED. 1796



MANNING, WARDLE & CO.,

BOYNE ENGINE WORKS, LEEDS,

ve designed and constructed one hundred various types of Tank and other Locomotive Engines for upwards of thirty different widths of gauge, adapted where necessary for passing round sharp curves and ascending
p gradients, suitable for any climate, and for burning coal or wood, &c.: also for special duties required by Railway Companies, Contractors, Collieries, Iron Works, and Mines, Brick Works, Quarries, Gas Works,
p Yards, Docks, Sugar Plantations, &c., &c. They are built accurately to standard gauges and templates in order that like parts of various classes of Engine will fit different Engines of the same type, and so that
plicates can be supplied on the shortest notice. The materials are the best of their respective kinds, and the workmanship cannot be excelled.

MANNING, WARDLE & Co., having designs and models of such a great variety of Engines, are enabled to execute orders for Locomotive Engines adapted to most requirements in a very short time.

Locomotive Tank Engines from 8 inches to 15 inches Cylinders on Four or Six Wheels all accepted, always in Stock or in Progress. 2498

SPECIFICATIONS, PHOTOS, AND PRICES, ON APPLICATION.

RICHARD MORELAND & SON, 3, Old St., London, E.C.,

MANUFACTURERS OF

HIGH CLASS STEAM ENGINES,

Simple or Compound, with Jet, Surface or Evaporative Condensers, up to 1,000 Indicated Horse Power.

PUMPING MACHINERY

Of the most powerful and economical type, for Water Supply, Irrigation, Docks, Drainage Works, and other purposes, and all Classes of General Engineering Work.

CONSTRUCTIONAL IRON WORK FOR BUILDINGS, &c.

FOR TYPE OF OUR DIRECT-ACTING PUMPING ENGINES, SEE "ENGINEERING," 3rd OCTOBER, 1884. 5975

SHAFTING

Turned true and bright to Whitworth's Gauges, any length, from 2 in. to 8 in. diameter, 12s. per cwt. at Nottingham. Also Couplings, Pulleys, Plummer Blocks, Hangers, Machine-made Spur, Bevel, and Mitre Wheels, Friction Gearing, &c. 4187

H. HIND & SON, NOTTINGHAM, AND 62, BLACKFRIARS ROAD, LONDON, S.E.

BRIDGE FOUNDATION CYLINDERS.

THE STOCKTON FORGE CO.,

STOCKTON-ON-TEES.

Make a Speciality of this work, turning out over 100 tons per week; also large quantities of Railway Chairs. 4209

SHEPHERD, HILL & CO.

MACHINE TOOLS.

LEEDS, YORKSHIRE.

LONDON OFFICE—21, PARLIAMENT STREET.

(E. B. SAUNDERS, Agent). 4067

Planing, Slotting, Drilling, Punching, Shearing, Bending, and Screwing Machines, suitable for every class of Engineers and Shipbuilders

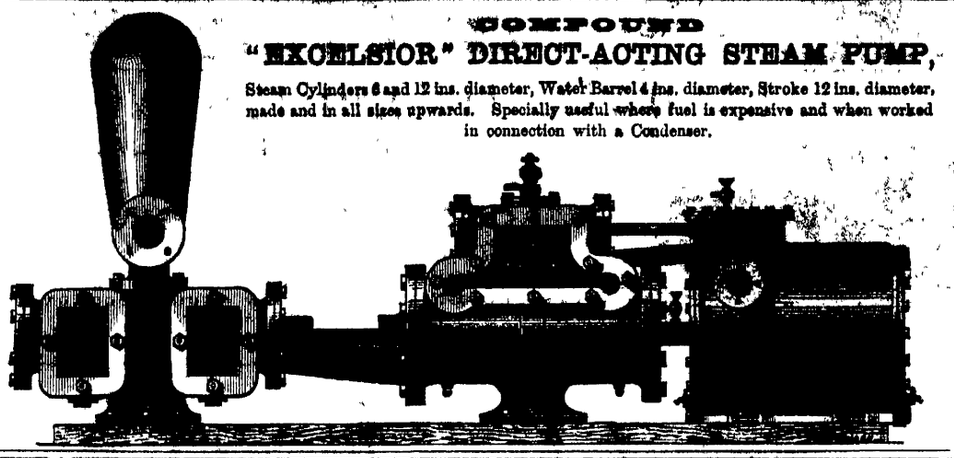
ALEX. WILSON & CO.,

ENGINEERS.

COMPOUND

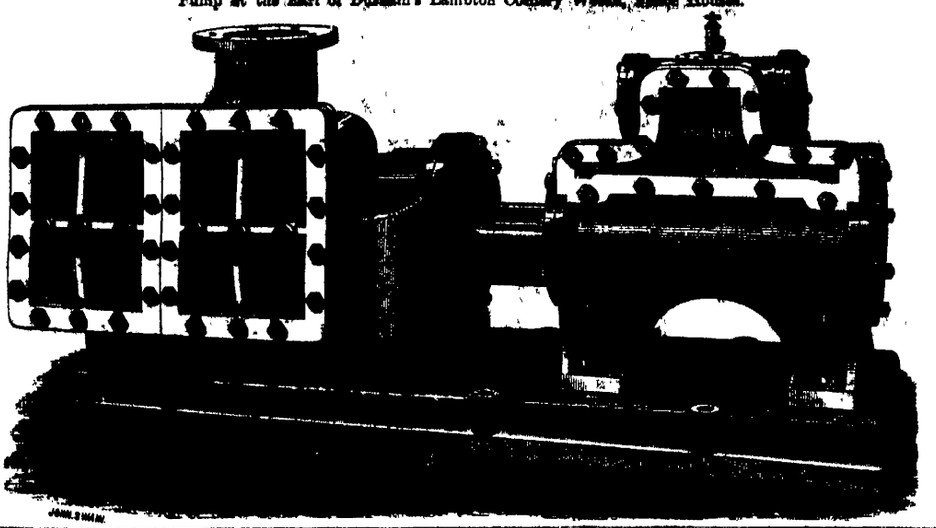
"EXCELSIOR" DIRECT-ACTING STEAM PUMP,

Steam Cylinders 8 and 12 ins. diameter, Water Barrel 4 ins. diameter, Stroke 12 ins. diameter, made and in all sizes upwards. Specially useful where fuel is expensive and when worked in connection with a Condenser.



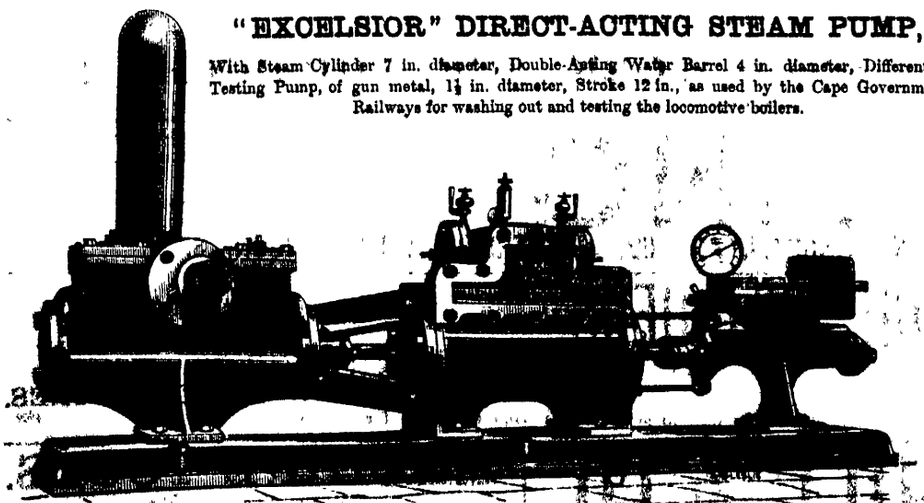
"EXCELSIOR" DIRECT-ACTING STEAM PUMP,

With Steam Cylinder 12 in. diameter, Double-Acting Water Barrel 14 in. diameter, Stroke 24 in., as used for a Circulating Pump at the Earl of Durham's Lambton Colliery Works, Fence Houses.



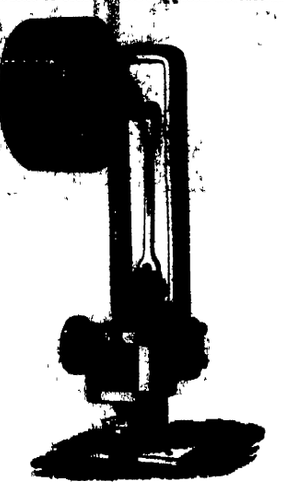
"EXCELSIOR" DIRECT-ACTING STEAM PUMP,

With Steam Cylinder 7 in. diameter, Double-Acting Water Barrel 4 in. diameter, Differential Testing Pump, of gun metal, 1¼ in. diameter, Stroke 12 in., as used by the Cape Government Railways for washing out and testing the locomotive boilers.



PUMP,

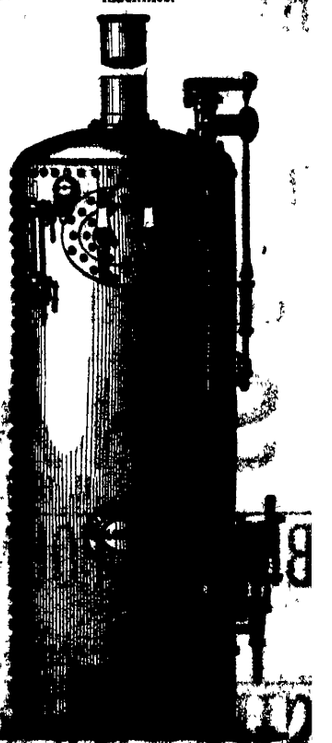
Driven by Belt from a line of shafting where more convenient than a supply of steam. Larger sizes have a wheel and pinion, and bear on each side of crank. Also supplied horizontally



VERTICAL BOILER,

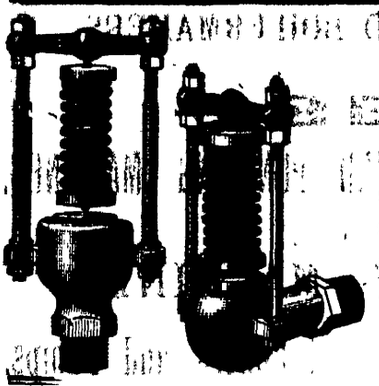
FITTED WITH A SMALL "VAUXHALL" DONKEY PUMP FOR FEEDING IT.

These Boilers are adapted for Steam Winches and fresh-water Condensers, also for Steam Hammers and other independent engines and machines.

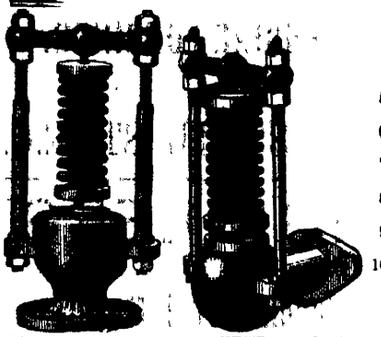


VAUXHALL IRON WORKS, WANDSWORTH ROAD, LONDON, S.W.

BLAKE'S STEAM ENGINE CYLINDER AND BOILER SAFETY VALVES.



	£	s.	d.
1-in. ...	1	5	0
1½-in...	2	2	0
2-in. ..	2	15	0
2½-in....	3	10	0
3-in. ...	4	10	0
4-in. .	5	15	0



	£	s.	d.
5-in. ..	8	0	0
6-in. .	11	0	0
7-in.	14	0	0
8-in. . .	18	10	0
9-in, ...	22	10	0
10 in. .	28	0	0

These Valves prevent many Costly Breakdowns of Steam Engines through presence of Water in the Cylinders.

NUMBER OF THESE VALVES SUPPLIED TO THE FOLLOWING FIRMS:—

Messrs. John Musgrave and Sons, Engineers, Bolton ..	700
,, Buckley and Taylor, Oldham	325
,, Hick, Hargreaves and Co., Bolton	96
,, J. and E. Wood, Bolton	66
,, Calvert and Sons, Cotton Spinners, Preston ..	39
,, R. R. Jackson and Co., Cotton Spinners, Blackburn	35
,, R. Haworth and Co., Cotton Spinners, Manchester	31
,, G. and R. Dewhurst, Cotton Spinners, Preston ..	30
,, Barlow and Jones, Bolton	25
,, Wolstenholme, Rye, and Co., Engineers, Oldham .	26
,, Abraham, Ormerod and Brothers, Todmorden	20
,, Oldham, Whitaker, and Sons, Ashton-under-Lyne	19
,, J. Shuttard and Sons, Higham Mills, Burnley	17
Mr. W. Forest, Blackburn	16
Messrs. John Musgrave and Sons, Cotton Spinners, Bolton ..	16
,, R. Wesson and Co., Church	16
,, Tunstall Brothers, Brierfield	15
,, Walker and Lonsax, Cotton Spinners, Bury ..	14
,, R. Smetanrst and Co., Cotton Spinners, Chorley	14
,, Lewis Brothers, Cotton Spinners, Blackburn . .	14
,, Voss and Dallas, Manchester	180
,, Julius Allman and Co., Manchester	24
,, J. and W. McNaught, Engineers, Rochdale .	44
Mr. George Saxon, Engineer, Manchester ..	56
Messrs. John Petrie and Sons, Engineers, Rochdale ..	44
Mr. William Breeewell, Engineer, Burnley	36
Messrs. G. and W. Bertram, Engineers, Edinburgh .	16
,, Thomas Eccles, Sons, and Co., Preston ..	16
,, Olive and Partington, Paper Makers, Glossop .	14
,, Sir Elkanah Armitage and Sons, Manchester .	12
Mr. James Greaves, Derker Mills, Oldham .. .	12
Messrs. Joseph Heaward (Limited), Stockport . ..	14
,, The Union Foundry Co., Bolton	17
,, W. and J. Galloway and Sons, Manchester . ..	12
,, Richard Thompson and Sons, Padiham	12
,, The Clivigor Coal Co., Burnley	14
Mr. J. R. Crompton, Bury	12
Messrs. The Holfind Mill Co., Marple .. .	10
,, Woods and Co., Wigan	19
,, Thompson and Birtwistle, Great Harwood ..	12
Mr. James Thompson, Blackburn .. .	12
Messrs. James Tunstall and Sons, Preston .. .	12
,, Norris Brothers, Heywood	12

TESTIMONIALS.

From Messrs. John Musgrave & Sons, Engineers, Bolton.

After five years' experience in the use of your Relief Valves, and having applied about 600 of them, we are pleased to say that they have given the greatest satisfaction to ourselves and customers, and we think no steam engine is complete without them.

From Buckley & Taylor, Castle Iron Works, Oldham.

We have much pleasure in bearing testimony to the efficiency of your Relief Valves. They prevent many costly breakdowns. In the last four years we have used nearly 300 of them with the most satisfactory results.

From Messrs William Calvert & Sons, Cotton Spinners, Walton-le-Dale, Preston.

Please send us 20 Relief Valves, same as the four previously supplied, which gave us great satisfaction.

From The Hollins Mill Co., Marple, near Stockport.

We have had eight of your Relief Valves at work for eighteen months, during which time they have given us entire satisfaction. We believe them to be a perfect safety against breakages from the presence of water in the cylinders, and can with confidence recommend them.

From Messrs. R. Thompson & Sons, Cotton Spinners, Padiham.

Send us four more 5 in. Relief Valves, same as we have had in use for some time; we find them to answer our purpose well.

From Mr. Richard Haworth & Co., Egerton Mill, Ordsall Lane, Salford

Please send us twelve 4-in. and six 5 in Relief Valves, same as last, which are very satisfactory

From Messrs. R. R. Jackson & Brother, Cotton Spinners, Blackburn

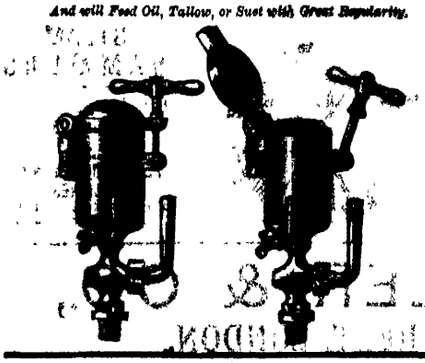
Please send us 21 Relief Valves similar to 10 already supplied.

BLAKE'S SELF-ACTING LUBRICATOR FOR STEAM ENGINES.

THIS LUBRICATOR IS

SIMPLE, ECONOMICAL, & RELIABLE,

And will Feed Oil, Tallow, or Suet with Great Regularity.



TESTIMONIALS.

From The Whalley Abbey Printing Co., Whalley, February 10, 1880.

After twelve months' experience in the use of your patent Steam Engine Lubricators, we are pleased to hand you an order for fifteen more, same size as the [illegible] you [illegible].

From Messrs. Brooke, Swindells & Co., Clarence Mills, Bollington, near Macclesfield, March 13, 1880.

I am well satisfied with your patent Lubricators, which answer our purpose here very well. They are, in my opinion, the most efficient and simple Lubricators of numbers that I have tried.

(Signed) JOSEPH BROOKE.

From Messrs. The Great Harwood Coal Co., near Accrington, September 27, 1880.

We like your Lubricators, which have been in use here some two years, and have decided to apply them now to other engines. We enclose you formal order for eight more.

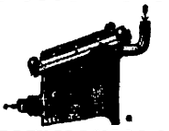
From Messrs. The Hollins Mill Co., Marple, April 6, 1879.

Your patent Steam Engine Lubricator, which we have tested against others we have selected as the best, and now hand you an order for two more.

PRICES.

	£	s.	d.
No. 1 Size, external diameter of Cup, 2 in. by 3 in. inside depth, exclusive of Cover	1	10	0
No. 2, ditto, ditto, 2½ in. by 3½ in. ditto, ditto	2	0	0
No. 3, ditto, ditto, 3 in. by 4½ in. ditto, ditto	2	12	0
No. 4, ditto, ditto, 3½ in. by 5½ in. ditto, ditto	3	5	0
No. 5, ditto, ditto, 4 in by 6 in. ditto, ditto	4	0	0
No. 6, ditto, ditto, 4½ in. by 6½ in. ditto, ditto ..	5	5	0
No. 7, ditto, ditto, 5 in. by 7½ in. ditto, ditto	6	8	0
No. 8, ditto, ditto, 5½ in. by 8½ in. ditto, ditto	7	10	0
No. 9, ditto, ditto, 6 in. by 9 in. ditto, ditto . .	9	0	0

BLAKE'S EQUILIBRIUM HIGH PRESSURE STEAM TRAP.



TESTIMONIALS.

From Mr Joshua Tricker, Green Bridge Print Works, Waterfoot, near Manchester.

Dear Sir,—The two large Steam Traps you sent me 16 years ago are a great success, during that time they have only had their covers removed twice. Will you please send me one more No. 5 size.

From Messrs. J. and E. Wood, Victoria Foundry, Bolton.

Dear Sir,—We have found your Equilibrium Steam Traps very satisfactory. They are the only good Steam Traps for high pressure. We have had somewhere about one hundred of them from you, and we are likely to want many more.

Hall Carr, Rawtenstall.

Mr John Blake, Accrington.

Dear Sir,—We have in all fifteen of your Steam Traps at work in various parts of our establishment, and have much pleasure in bearing testimony as to their entire efficiency. Since we adopted them we have been spared much annoyance from broken joints, &c.

We are, dear Sir, yours very truly,
JAMES H. ASHWORTH & CO.

Birkacre Print Works, Chorley.

Mr. Blake.

Dear Sir,—Would you please send us as soon as possible eight of your No 1 Steam Traps We are very well satisfied with them after several years' experience

We are, yours truly,
M'NAUGHTON & THOM.

Gorton Mills, near Manchester.

Mr. John Blake.

Sir,—We have got the eleven Steam Traps at work that you sent us. We like them very well. Will you please forward us two more as early as you can.

Yours truly,
P. F. RYLANDS & SONS.
CHRISTOPHER GELDRED.

Prices of High Pressure Steam Traps.

		£	s.	d.
No. 1 size,	½-inch bore	2	10	0
,, 2 ,,	¾-inch ,, ...	3	10	0
,, 3 ,,	1-inch ,, ...	5	0	0
,, 4 ,,	1¼-inch ,, ...	6	0	0
,, 5 ,,	1½-inch ,, ...	7	10	0
,, 6 ,,	2-inch ,, ...	10	0	0
,, 7 ,,	2½-inch ,, ...	12	0	0
,, 8 ,,	3-inch ,, ...	14	0	0
,, 9 ,,	4-inch ,, ...	16	10	0

BLAKE'S FIRST-CLASS STRONG IRON CIRCULAR SAW BENCHES



With Planed Table, Fence, Pulleys, and Cast Steel Spindle.

PRICES WITHOUT SAWS.

		£	s.	d.
No. 1, Table, 36 in. by 28 in. will take 16 in. Saw		10	0	0
,, 2, ,, 42 in. by 30 in. ,, 24 in. Saw		11	10	0
,, 3, ,, 60 in. by 30 in. ,, 30 in. Saw		15	5	0
,, 4, ,, 66 in. by 36 in. ,, 36 in. Saw		17	0	0
,, 5, ,, 66 in. by 38 in. ,, 42 in. Saw		19	0	0
,, 6, ,, 72 in. by 36 in. ,, 48 in. Saw		24	15	0
,, 7, ,, 84 in. by 36 in. ,, 60 in. Saw		30	0	0

WITH RISING AND FALLING SPINDLE.

No. 1, with Rising and Falling Spindle	13	0	0
,, 2, ,, ,, ,, ...	15	10	0
,, 3, ,, ,, ,, ...	22	10	0
,, 4, ,, ,, ,, ...	26	0	0
,, 5, ,, ,, ,, ...	30	15	0

JOHN BLAKE, Engineer, ACCRINGTON, LANCASHIRE.

JOHN BEATSON & SON,
ST. MARY'S GATE, DERBY.



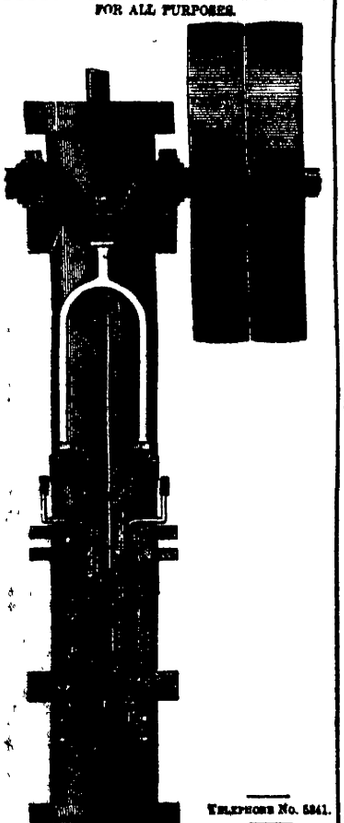


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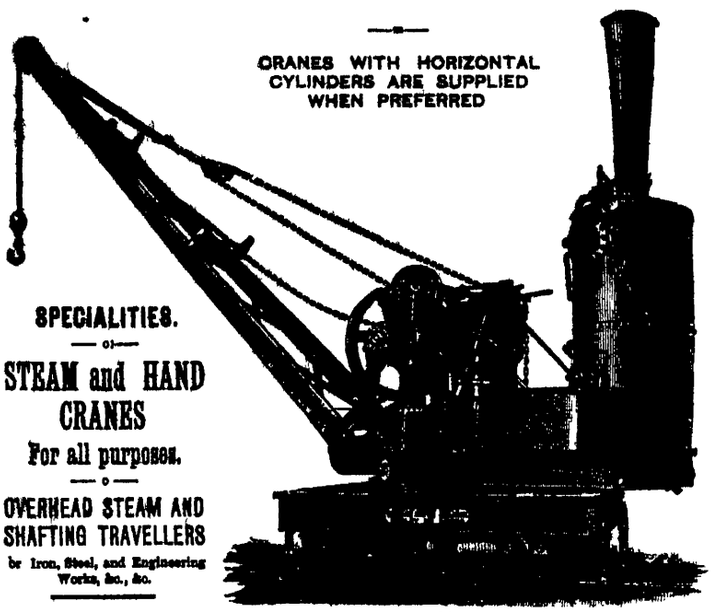
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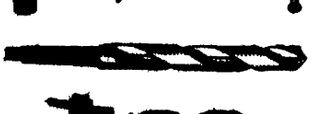
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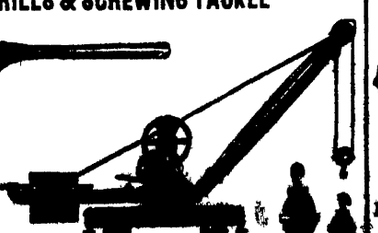


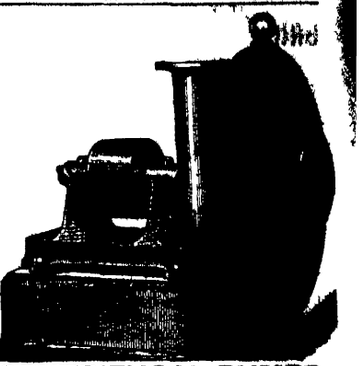




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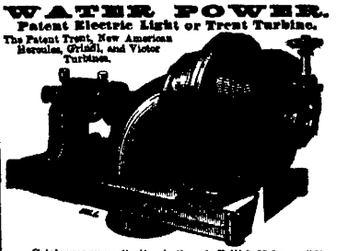
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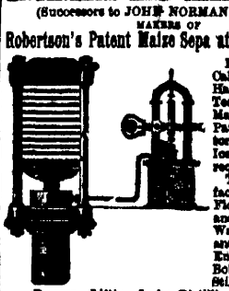
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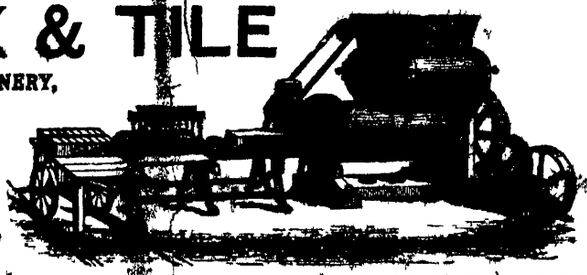
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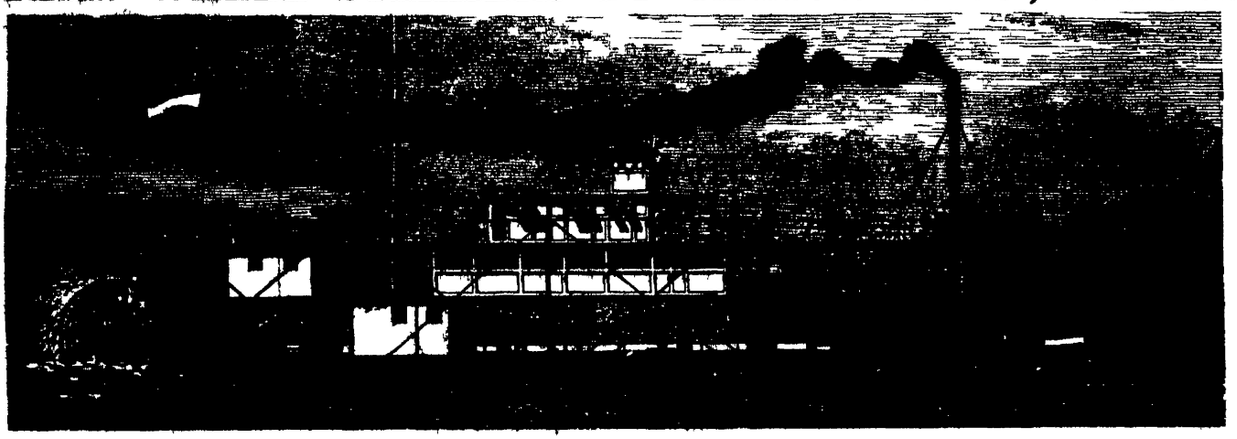
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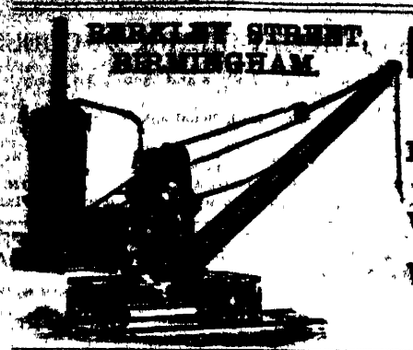
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5 × 3½	= 10 ,,	4½ × 3	= 6 ,,
5 × 3	= 9 ,,	4 × 3½	= 6 ,,
4½ × 3½	= 8 ,,	4 × 3	= 5 ,,
4 × 3½	= 7½ ,,	3½ × 3	= 4½ ,,
4 × 3	= 7 ,,	3 × 2½	= 4 ,,
3½ × 3	= 6½ ,,	3 × 2	= 3½ ,,
3 × 2½	= 5½ ,,	2½ × 2	= 3 ,,
2½ × 2	= 4½ ,,	2 × 1½	= 2½ ,,
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6 × 4	= 12 ,,	6 × 6	= 18 ,,	9 × 4½	= 22 ,,	12 × 6	= 50 ,,
6 × 6	= 18 ,,	6 × 4½	= 14 ,,	10 × 4½	= 22 ,,	14 × 6	= 60 ,,
6 × 4½	= 14 ,,	6 × 6	= 18 ,,	10 × 5	= 26 ,,	16 × 6	= 68 ,,
4 × 3	= 10 ,,	5 × 3½	= 10 ,,	10 × 6	= 30 ,,	17½ × 6½	= 82 ,,
4½ × 3½	= 9 ,,	6 × 5	= 20 ,,	8 × 6	= 24 ,,	19½ × 7½	= 100 ,,

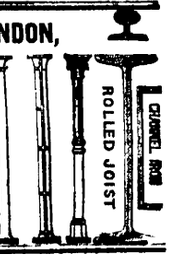
Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to 2".

TEES.

5½ × 5½	
4 × 4	
3 × 3	
2½ × 2½	
2 × 2	
1½ × 1½	
1 × 1	

CHANNELS.

12 × 5	
9½ × 3½	
9½ × 3	
8 × 3½	
6½ × 3½	
4½ × 3	
3½ × 1½	
1½ × ¼	



P. R. JACKSON & COMPANY,

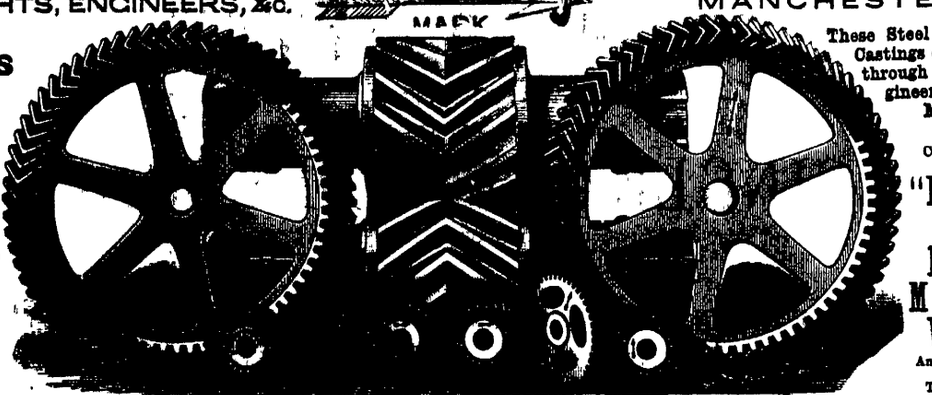
STEEL AND IRONFOUNDERS
MILLWRIGHTS, ENGINEERS, &c.

TRADE MARK

SALFORD ROLLING MILLS, MANCHESTER.

MANUFACTURERS OF
JACKSON'S
Machine-Moulded
Spur, Bevel, AND Worm Wheel
CASTINGS.

PULLEYS
BITHER FOR
Straps or Ropes,
Spur or Bevel
Mortice Wheels
with Machine
cut Cogs.



These Steel or Iron Wheel Castings can be obtained through almost any Engineer, Millwright, or Machinery Merchant.

Care should be taken to specify "P. R. Jackson & Co.'s MACHINE-MOULDED WHEELS."

And each Wheel should bear the above TRADE MARK

Fly Spur Wheels Rope or Strap Pulleys to 30 ft. diameter, bored, turned and key-grooved by Machinery, and erected when required.

MAKERS OF RAMSBOTTOM'S PISTONS & PISTON PACKING RINGS, in Iron, Steel, or Brass. More than 28,000 of these Piston are at work. 4330

EDWIN LEWIS & SONS,

WOLVERHAMPTON, STAFFORDSHIRE.

LAPWELDED IRON BOILER TUBES.

BUTTWELDED GAS, STEAM, and WATER TUBES.

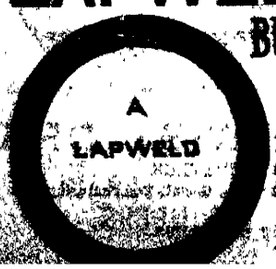
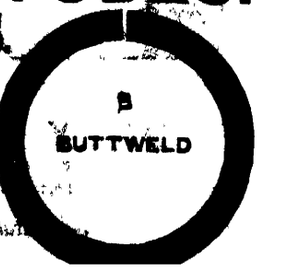


DIAGRAM SHOWING LAP AND BUTT WELDS.

These two Engravings, representing sections of Lapwelded Wrought Iron Tube (at A) and Buttwelded (at B) show conclusively the superior strength of Lapweld, which has nearly four times the surface in contact in the Weld over that given in Buttweld.



All Gas, Steam, or Water Tubes over Two-inch size are

WATER PURIFICATION

JOHN HENDERSON PORTER, PATENTEE,
1 & 2, TUDOR STREET, LONDON, E.C., furnishes the necessary Plant.

The PORTER-CLARK PROCESS

Removes Lime, Magnesia, and Iron from Hard Waters, and thus, the causes of Incrustation in Boilers and Pipes. This Process is in use in Paper Mills, Breweries, Sugar Works, India-rubber and Telegraph Works, Ice Manufactories, Mustard and Oil Mills, &c. One Railway Company employs it for feed-water to the extent of 1,000,000 gallons daily, and one of the London Water Companies at two of its Pumping Stations. It is also in use in County Asylums, Public and other Schools, and Private Mansions. The pure water of the chalk wells, and muddy water of the Thames between Blackwall and Woolwich are rendered soft and clear.

DESCRIPTIVE CIRCULAR ON APPLICATION. 5236

15 PRIZE MEDALS.] **THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED,** [15 PRIZE MEDALS.

4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1882, 1



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 4794

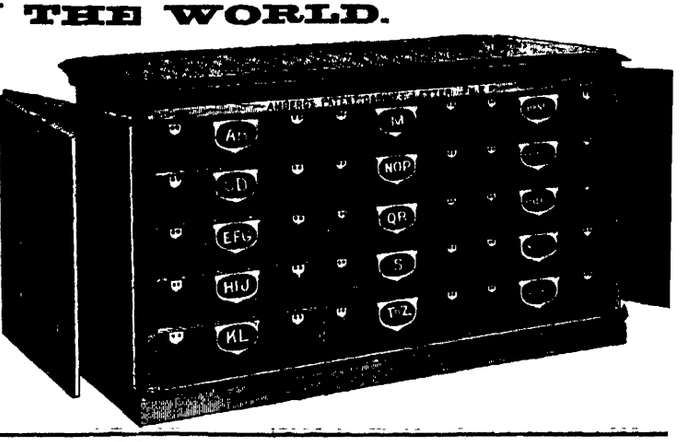
AMBERG'S PATENT SYSTEM OF LETTER FILING

THE BEST IN THE WORLD.

These CABINET LETTER FILES are made in many sizes, containing as few as six and as many as one hundred files each, at prices ranging from £4 upwards. They are elegantly and substantially made, the woodwork being of the best seasoned WALNUT, and the metal parts of BRASS and STEEL, NICKEL PLATED. They are arranged for any class of correspondence, and can be adapted to ANY requirement. Each drawer or file divides the correspondence very minutely on the "Directory" plan. The system is extensively used by the Nobility, Members of both Houses of Parliament, Banks, Insurance Companies, the leading Firms and Companies, as well as many Private Gentlemen. Any correspondence, however large, may be so arranged that any one and all letters of whatever date, from any person, can be found instantly. The labor of folding, endorsing, numbering, pasting, binding, or indexing, is entirely dispensed with, and the saving of time, labor and expense over the ordinary methods is very great.

FIFTEEN FILE CABINET, with Doors, as Illustrated

375 INDEXED DIVISIONS WILL HOLD 9,000 LETTERS.



Illustrated Catalogue, with Testimonials, on application to

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SOLE MANUFACTURERS,
27, LITTLE BRITAIN, LONDON, E.C.
71 & 73, Lake Street, Chicago; 69, Duane Street, New York 5387

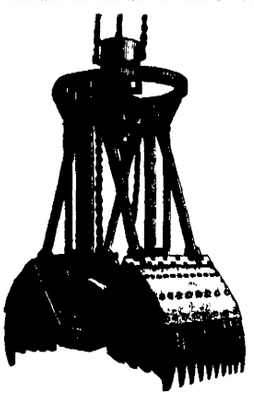


Fig. 533.—OPEN. HALF-TINE DREDGER.

STOTHERT & PITT, LIMD.

— ENGINEERS, BATH, —

SOLE MANUFACTURERS OF WILD'S PATENT

SINGLE-CHAIN DREDGERS

FOR USE WITH ORDINARY STEAM CRANES.

Makers of all kinds of

STEAM AND HAND CRANES, HARBOUR-MAKING PLANT,
CONCRETE MIXERS, PILE DRIVERS, ETC.

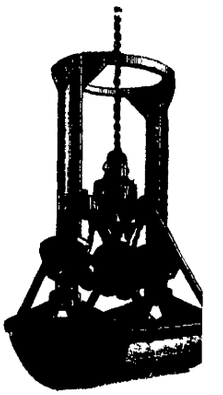


Fig. 533. CLOSED.

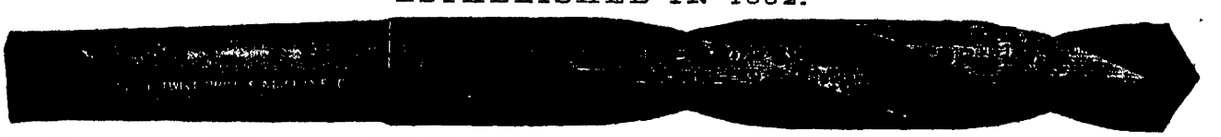
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AMERICAN MACHINERY AND TOOL IMPORTERS

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ESTABLISHED IN 1862.



C. C. & Co. have just removed to much larger premises with ample show rooms and warehouse, and will carry a greatly increased stock of all the best American tools.

SOLE AGENTS FOR

THE ONLY GENUINE AMERICAN MORSE TWIST DRILL

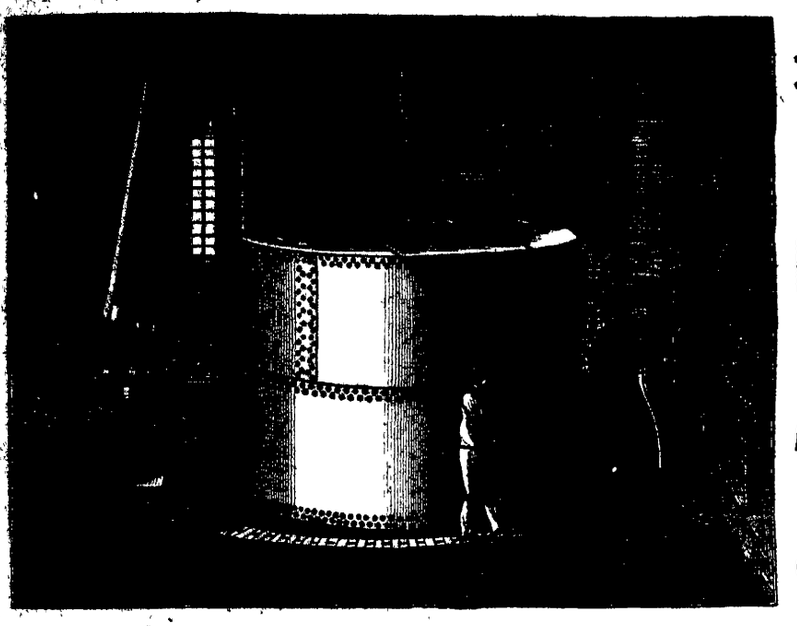
WITH CENTRE GRINDING LINE, STOCKS AND DIES, REAMERS AND MILLING CUTTERS,

Stephens' Patent Vices, Horton Chucks, Cushman Chucks, Westcott Chucks, Sweetland Chucks, Stanley Rule & Level Co.'s Planes, &c., &c., Gould's Manufacturing Co.'s Pumps, and a great variety of New American Tools.

New Catalogue for 1883 just issued, 215 pages Quarto, sent on receipt of One Shilling in Stamps.

(THE LARGEST CATALOGUE OF AMERICAN TOOLS EVER PUBLISHED IN GREAT BRITAIN.)

HYDRAULIC RIVETTERS



OF THE MOST REGENT TYPES.

Punching, Shearing, Bending, Forging, Hoisting,

AND OTHER HIGH-PRESSURE

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ANDERSON & CALLWEY

Hydraulic Labour-Saving Machine Makers,

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CHELSEA, LONDON, S.W.

Contractors to the British and Foreign Governments.

GEORGE SALTER & Co.

WEST BROMWICH,

MANUFACTURERS OF

Spring Balances, Roasting Jacks,

BOURDON'S, SCHAEFFER'S, & SILVESTER'S

PRESSURE GAUGES,

COLLIERY SIGNAL BELLS, RASTRICK'S TUBE SCRAPERS,

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DYNAMOMETERS

For Testing Strength of Wire, Rope, Cement, Cloth, &c.

GOODS SUPPLIED THROUGH ALL MERCHANTS AND FACTORS



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FOR MINING, **LEATHER**

ENGINEERING, **INDIA-RUBBER**

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GEO. ANGUS & Co. NEWCASTLE-ON-TYNE LIVERPOOL.

13, BILLITER STREET, LONDON. And BUTE DOCKS, CARDIFF.

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PRICE AND PARTICULARS ON APPLICATION. 5311

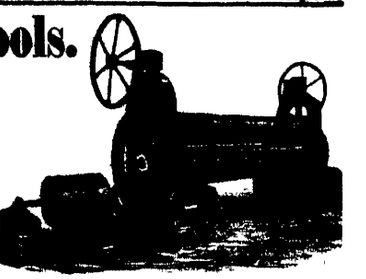


PLATE-BENDING ROLLERS.

TAYLOR & CHALLEN,
ENGINEERS,
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SOLE MAKERS OF
WITHINSHAW'S PATENT
Feed Water HEATER.



The most powerful invented.
Great Saving in Boilers, Coals, and Labour.
LARGE HEATING SURFACE
Solid Drawn Brass Tubes.
Free Expansion.
No Scurf adheres to the Tubes.
6897
List on application.

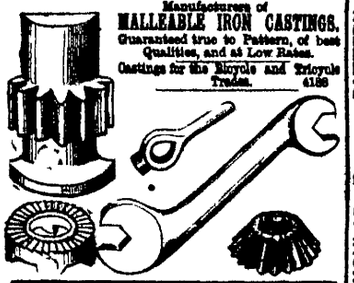


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For Red Lead, Putty, Crushing Lumps, &c.

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Messrs Gwynne & Co., London: "Are satisfied with it." Hayward Bros. & Co., London: "It saves time, &c." Mr. H. Mobbs, Northampton: "I am satisfied with it." Mr. W. Allabin, Northampton: "It is most useful." Messrs. Clayton & Shuttleworth, Lincoln: "We like it very much." Messrs. Tangye Bros., Birmingham: "Work is better than hand." Messrs. Foster & Co., Lincoln: "We think it well worth the money." 5104
Price with handle £1 18s. As above sketch, £2 2s.
G. R. MATHER, WELLINGBOROUGH, ENGLAND.

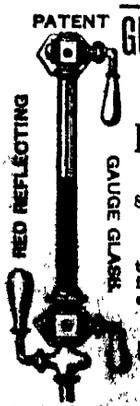
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Manufacturers of
MALLEABLE IRON CASTINGS,
Guaranteed true to Pattern, of best Qualities, and at Low Rates.
Castings for the Bicycle and Tricycle Trades. 4188



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GAUGE GLASSES
AND
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For Iron, Cast-iron, Copper, &c.

PATENT
GUILBERT MARTIN
Patentee and Manufacturer of the
PATENT
RED REFLECTING GAUGE GLASS,
Showing through the water a Broad Red Line.



N.B.—All Glasses are of the finest quality, and manufactured expressly to resist extreme pressure.

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SELECTED FOR USE AT THE
NEW DOCK WORKS, TILBURY,
Where 69 are now in constant work.

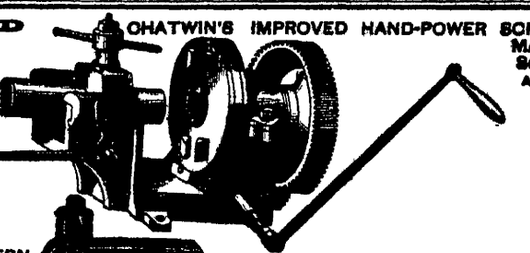


SPECIALITIES:
CRANES,
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WINDING ENGINES,
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MILL ENGINES
FITTED WITH
COLLMANN'S PATENT VALVE GEAR.
Cheapest and Most Efficient Crane in the Market.
ALL OUR CRANES HAVE TWO CYLINDERS AND LINK REVERSING MOTION.
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LONDON OFFICE: 118, Cannon Street, E.C.

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A
Gold & Silver Medal
AND
Two 1st Class Certificates at
Calcutta Exhibition, 1884.

CHATWIN'S IMPROVED HAND-POWER SCREWING MACHINE, SCREWING AT ONCE OVER.



WHITWORTH PATTERN GUIDE STOCKS AND DIES.

PATTERN STOCKS AND DIES.



ENGINEERS' ANGULAR



BUDDING SPANNER.

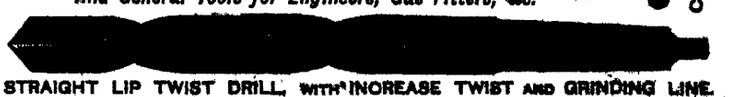


CLYBURN SPANNER

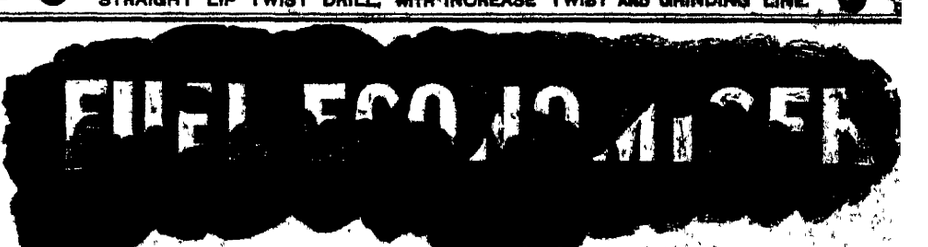


GAS TUBES

THOMAS CHATWIN,
GT. TINDAL STREET, BIRMINGHAM,
MANUFACTURER OF
STOCKS, DIES, AND TAPS,
PATENT HAND-POWER SCREWING MACHINES. TWIST DRILLS,
STANDARD CYLINDRICAL GAUGES, RIMERS,
CLYBURN, BUDDING, AND OTHER SPANNERS,
RATCHET BRACES, TUBE CUTTERS, TUBE WRENCHES, TUBE VICES,
And General Tools for Engineers, Gas Fitters, &c. 4234



STRAIGHT LIP TWIST DRILL, WITH INCREASE TWIST AND GRINDING LINE.



GREEN'S PATENT
Has been awarded the GOLD MEDAL at the CALCUTTA EXHIBITION, [illegible] MEDALS previously given at other Exhibitions.
ST. ANN'S SQUARE, MANCHESTER. WORKS: [illegible]



—20—

Catalogues of Steam Engines, Ring Machines, Mills, Wagons, Tramps, and all kinds of Contractors' Plant on application.

—10—

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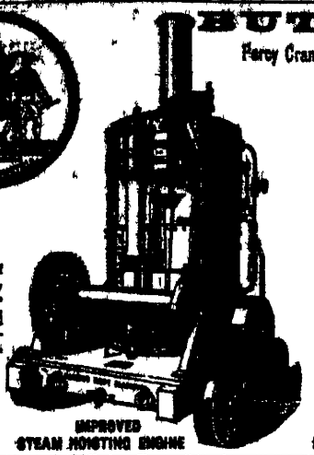
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PATENT DERRICK CRANES,

From 15 Cwt. to 80 Tons



IMPROVED STEAM HOISTING ENGINE



STEAM PORTABLE CRANE

Contractors' Engineers,

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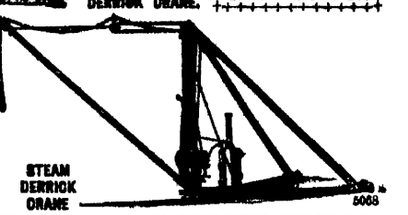
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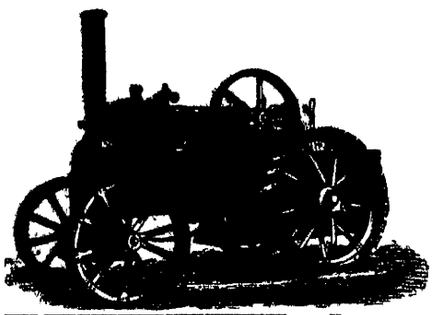
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FOR IRRIGATION,

Suitable for India, Egypt, and Elsewhere.

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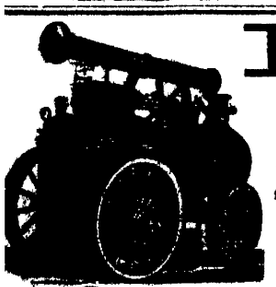
Locomotives of various gauges

CALCUTTA EXHIBITION, 1884, FIVE FIRST PRIZES.

Budapest Agricultural Meeting 1882—Two Gold Medals and other Awards.
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3061

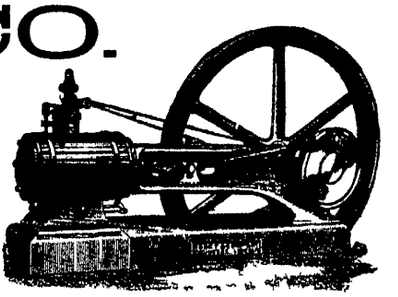
ROBEY & CO.



SUPERIOR PORTABLE ENGINES 2½ to 50 HP

First PRIZE for PORTABLE ENGINES, Melbourne Exhibition, 1881.

PARIS, 1878, GOLD MEDAL.

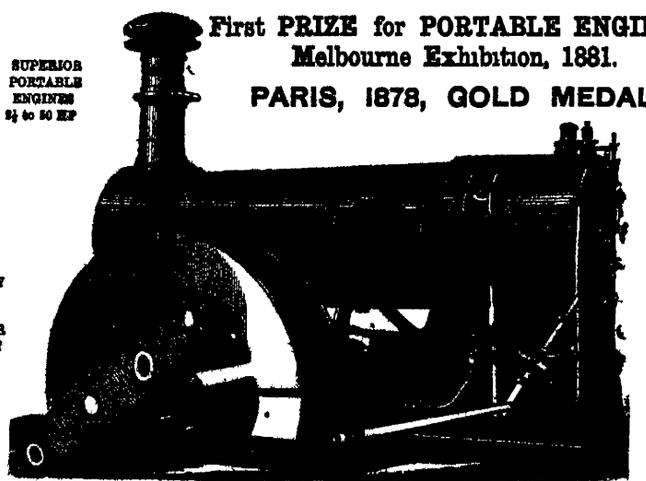


HORIZONTAL FIXED ENGINE, 4 to 60 HP

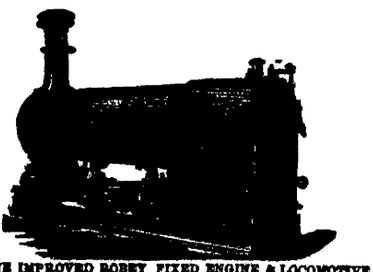
☞ References can be given to upwards of 9 000 Engines now at work



VERTICAL STATIONARY STEAM ENGINE AND BOILER Combined, of all Sizes, from 1½ to 16 HP



The Patent "Robey" Mining Engine, 4 to 65 HP.



Prices and full Particulars of the Machinery here Illustrated on application to the Manufacturers

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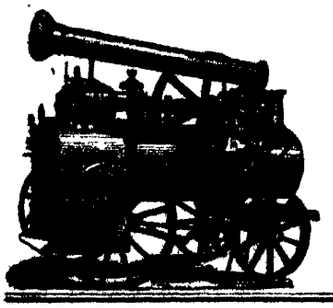
THE IMPROVED ROBEY FIXED ENGINE & LOCOMOTIVE BOILER Combined, 4 to 65 HP, and COMPOUND ROBEY SEMI-FIXED ENGINE.

4961

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BRITANNIA IRONWORKS, GAINSBOROUGH, AND MARSHALLS' BUILDINGS, 78, FARRINGDON ROAD, LONDON, E.C.

MANUFACTURERS OF PORTABLE, SEMI-PORTABLE, HORIZONTAL, FIXED, VERTICAL, AND TRACTION ENGINES, THRASHING, CORN GRINDING, SAWING AND TEA PREPARING MACHINERY.



PORTABLE ENGINES, 1½ TO 35 HORSE POWER,

Adapted for all Countries, and constructed to burn Coal, Wood, Straw, Vegetable Matter and Refuse as Fuel.

Also fitted with Patent AUTOMATIC EXPANSION VALVE GEAR, for ensuring Great Economy in Fuel and Regularity of Speed under varying loads when required.

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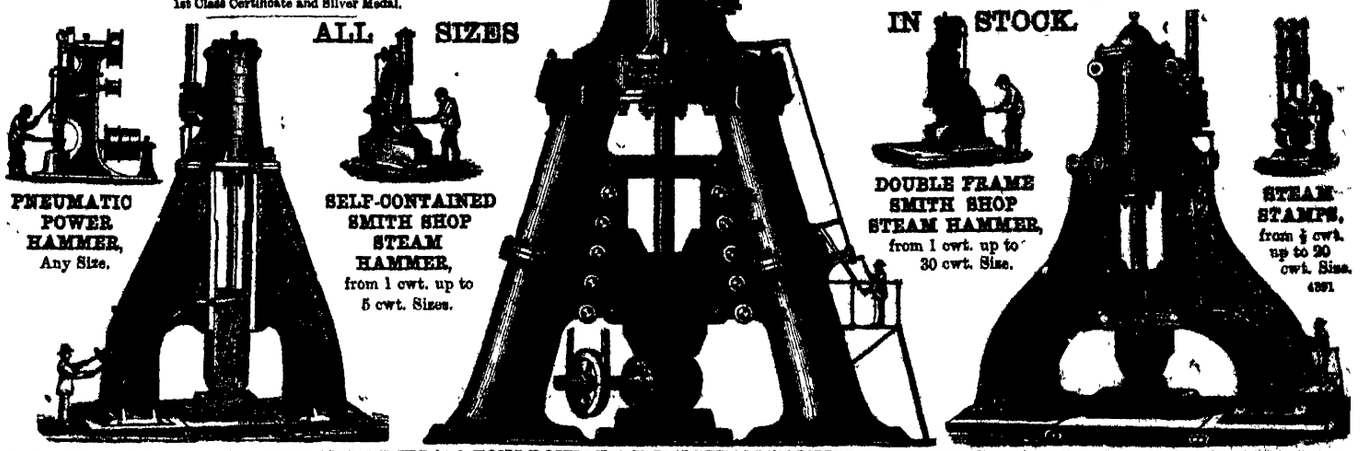
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THOMAS ADAMS
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WEST GORTON MANCHESTER.
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Hoists, Rest work, reduced prices. Dixon's special Corn Iron Roofs are the most economical for spans up to 30 ft. Gratings, Designs, Estimates on application, Dixon, Sheaf Windsor Ironworks, Liverpool. 4736

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HYDRAULIC MACHINERY OF ALL KINDS
The DOMESTIC MOTOR
CATALOGUES ON APPLICATION 5

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See their Illustrated Advertisement, page 41.

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TRAMWAY ENGINES AND CARS.
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SHEFFIELD
See Advertisement last week page 37 5

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Hydraulic Rivetting Machine
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See Illustrated Advertisement last week page 53.

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Sole Makers of
Clerk's Patent
Self Starting
Gas Engine
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Royal Indian Engineering College, Cooper's Hill, Staines. The course of study is arranged to fit an engineer for employment in Europe, India, or the Colonies. Sixty Students will be admitted in September, 1885. For competition the Secretary of State will offer FIFTEEN APPOINTMENTS in the Indian Public Works Department, and TWO in the Indian Telegraph Department. For particulars apply to the SECRETARY at the College 5422

TENDERS.

MIDLAND GREAT WESTERN RAILWAY OF IRELAND

CONTRACTS FOR 1885.

The Directors of the Midland Great Western Railway of Ireland Company are prepared to receive

Tenders for the Supply of the undermentioned STORES The Contracts to commence from the 1st of January next, and terminate on the 31st of December, 1885 :—

No. of Form.
1 General Ironmongery
2 Bolts, Nuts, Rivets, and Rail Fastenings
3 Beaters, Picks, and Shovels.
4 Cold Sets, Crowbars, Hammers, &c.
5 Iron, Staffordshire Bars and Plates, and Wire
6 Iron, Yorkshire Bars and Plates.
7 Steel Tires and Axles
8 Springs, Steel, and Files.
9 Iron Castings.
10 Brass and Copper Tubes, Plates, and Sheets
11 Ingot Copper, Tin, Lead, Gun Barrel, &c
12 Cocks and Gasfittings
13 Carriage Fittings
14 Timber, Slates, &c.
15 Bricks, Flags, Tiles, &c
16 Barrows and Trucks
17 Tool Handles
18 Brushes and Brooms
19 Baskets
20 India Rubber Goods
21 Leather Belts, &c.
22 Ropes, Canvas, &c.
23 Lime
24 Cements
25 Candles, Soap, &c.
26 Oils and Tallow
27 Waste and Wicking
28 Varnish, Paints, Oils, &c
29 Glass
30 Lamps and Lamp Fittings, &c
31 Clothing
32 Carriage Trimmings
33 Fog Signals

Patterns and Samples can be inspected, on application to the General Stores Department, Broadstone Station, Dublin, on and after the 20th instant, between the hours of Ten a m and Four p m

Contractors cannot be allowed to tender to supply goods to their own patterns, nor can the Company's patterns be sent away for inspection

Forms of Tender can be obtained on prepayment of 6d. for each Form

The Directors will not consider any Tender unless furnished on the Company's Forms, nor any Tender in which any alteration of the Form has been made

The Tenders to be sent in by post sealed, and endorsed on the envelope, "Tender for Stores, Form No ——," and addressed to "The Chairman, Broadstone Station, Dublin," so as to be with him on or before Tuesday, the 2nd December, 1884

The Directors do not bind themselves to accept the lowest or any Tender. By order,
GEO WM GREENE, Secretary
Broadstone Station, Dublin,
12th November, 1884 J 199

GREAT SOUTHERN AND WESTERN RAILWAY COMPANY, IRELAND

CONTRACTS
FOR YEAR ENDING DECEMBER, 1885

The Directors of the Great Southern and Western Railway Company are prepared to receive

Tenders for the Supply of the undermentioned STORES The Contracts to commence from 1st January next, and terminate on 31st December

	No of Form		No of Form.
Baskets	19	Hinges (Wrought)	11
Brooms and Brushes	13	Hardware (Sundry)	17
Brass Fittings for Lamps and Carriages	18	India Rubber and Waterproof Goods	9
Brass Fittings for Water	26A	Implements	21
Brass Fittings for Gas	26B	Iron Tubes and Fittings	29
Canvas, Waterproof Roofing, and Sacks	6	Iron Wire and Wirework	30
Carriage Laces	7A	Leather	12
Cloth, Rugs, Flags, Linen, &c	7B	Locks and Keys	19
Curled Hair	7C	Malleable Iron Castings	18
Cement and Plaster of Paris	34	Mats (Cocoa-nut Fibre)	13
Cotton Waste, Wick, and Sponge Cloths	5	Nails	31
Colours	2	Railway Fastenings	10
Chain	14	Rivets, Coach Screws, and Washers	15
Dry salteries (Petit)	8A	Rain Water Pipes and Gutters	25
Do (Chief)	8B	Ropes, Twine, and Flax	4
Emery, &c	28	Sewer Pipes, Fire Bricks, &c.	32
Edge Tools	20	Soft Goods	8
Files and Tool Steel	20	Stone and Bricks	33
Grindstones	28	Signal Wire Pulleys	18
Galvanised Wagon Roofs, Buckets, &c	23	Screws and Split Pins	14
Grates, Stoves, and Fenders	24	Tin Plates	22
Glass	27	Varnish	1

Forms of Tender can be obtained on payment of 6d each from the Company's Storekeeper, at the General Stores, Inchicore, Dublin Patterns may be inspected at the same place on and after the 24 inst., between the hours of Ten a m and Five p m.

The Directors will not consider any Tender except those furnished on the Company's Forms.

The Tenders to be sent in endorsed "Tenders for Stores," and addressed to the undersigned, so as to be with him before Ten o'clock a.m , on Monday, the 8th proximo

The Directors do not bind themselves to accept the lowest or any Tender. By order,
(Signed) FRANCIS B. ORMSBY,
Kingsbridge Terminus, Dublin. Secretary
3rd November, 1884. J 168

TO CONTRACTORS.

NEWRY NAVIGATION COMPANY.—CHANNEL IMPROVEMENT, NEWRY RIVER.

The Committee of Management of the Newry Navigation Company are prepared to receive

Tenders for the Excavations necessary for a Navigation Channel between the Doyle Hole, Newry River, and deep water in Carlingford Lough, in accordance with Plans and Specifications, which may be seen from Ten o'clock a.m. to Five o'clock p.m daily, at the Office of JAMES BARTON, Esq , C.E., Engineer to the Works, Exchange Buildings, Dundalk.

Tenders, upon a Form which will be supplied by the Engineer, must be delivered to the undersigned on or before 10th December, 1884.

The Committee do not bind themselves to accept the lowest or any Tender.
(Signed) GEO R. ARMSTRONG,
Navigation Office, Newry. Secretary.
24th October, 1884. J 101

EAST INDIAN RAILWAY COMPANY.

The East Indian Railway Company is prepared to receive

Tenders for the Supply and DELIVERY of the STEEL-WORK, IRON-WORK, &c, for two Girders (each 420 ft in span), for the Hooghly Bridge, the total weight of steel and iron in the two spans being about 1,950 tons,

As per Specification and Drawings to be seen at these Offices

Tenders are to be delivered in sealed envelopes addressed to the undersigned, marked "Tender for Steelwork, Ironwork, &c , for the Hooghly Bridge," not later than One o'clock p m , on Thursday the 27th day of November instant

The Directors do not bind themselves to accept the lowest or any Tender
By order of the Board,
A. P DUNSTAN, Secretary.
Nicholas Lane, London, E.C ,
6th November, 1884 J 176

TO ELECTRIC LIGHT CONTRACTORS AND OTHERS

Notice is Hereby Given that

Tenders will be Received by the GROSVENOR GALLERY MANAGEMENT for—
1 ENGINES AND BOILERS
2. SUPPLYING AND LAYING CABLES, WIRES AND ACCESSORIES
3 ELECTRIC LIGHT FITTINGS

Plans and Drawings of Engine space, together with general conditions of contracts, copies of Specifications, Forms of Tender, and all further information can be had and seen at the Offices of the Engineers, Messrs MACKENZIE & BROUGHAM, 15, Great George Street, Westminster, S W , on and after Thursday, the 20th inst., upon payment of One Guinea, which is not returnable

Sealed Tenders, endorsed "Grosvenor Gallery Lighting," are to be delivered at the above Offices of the Engineers by or before Twelve o'clock noon on Saturday, the 29th inst

The Management do not bind themselves to accept the lowest or any Tender
By order,
F B WADE, Architect. J 205

APPOINTMENTS OPEN.

Draughtsman.—Wanted, at the Reading Gas Works, a first rate DRAUGHTSMAN, one used to the construction of modern gas works, must be thoroughly good at quantities, estimates, strains, levelling, &c —Apply, at once, stating age, qualifications, and salary required, with any other particulars, to Mr EDWARD BAKER, the Company's Engineer, Gas Works, Reading

Applications will be considered as confidential if required J 189

Wanted at once, Draughtsman with thorough experience in designing modern engines and colonial work, must be able to prepare estimates and take out quantities, one with some knowledge of book keeping preferred, permanent engagement to steady man —Apply, giving references and stating salary required, to G 24, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C J 190

Wanted, Draughtsman thoroughly acquainted with designing and arrangement of Gradual Reduction Plants for Flour Mills None but a properly qualified experienced man need apply —Address, J 188, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand J 188

Wanted, a First-Class Loco- MOTIVE DRAUGHTSMAN —Apply, BEVER, PEACOCK & CO , Limited, Gorton Foundry, Manchester J 200

Junior Draughtsman Wanted to make ROUGH WORKING DRAWINGS, &c , for Knitting Machinery and other light delicate machinery — State age, wages for 48 hours per week, and full particulars of education, training, and previous employments, also when at liberty, to A PAGET & CO , Loughborough J 191

South Africa. — A Firm of ENGINEERS manufacturing specialities in great demand, wish to meet with a House to REPRESENT them in South Africa.—Address with full particulars to M I M E , Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. N B —The above will be held open for three months. J 204

Agents Wanted, to push First- class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool 5233

Lists of Berths Vacant or WANTED. See "ENGINEERING REVIEW," weekly 1d — E. & F. N. SPON, 16, Charing Cross, London, or of all News Agents. 5575

SITUATIONS WANTED.

Wanted, by a Mechanical Engineer, resident in Russia, a SITUATION as Manager or Assistant Manager in an Iron, Engineering, or Steamship Company's Works; has large and varied experience, and first-class references.—Address, A Z., care of WATKINS & CO., Booksellers, St. Petersburg. J 168

Engineer (Good), age 40, Re- QUIRES BERTH, last six years in entire charge of saw mill and extensive wood-working plant, doing all repairs; well up in Mill Machinery, Pumping and other Engines; has taken engines abroad.—BROCK, 9, Marment Road, Peckham, S.E. J 218

Draughtsman, Experienced, thoroughly practical, with first-class general, and some experience in electrical work, DESIRES an ENGAGEMENT — Address, ALPHA, Offices of ENGINEERING, Strand, London, W C. J 196

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Traveller.—Wanted, by thoroughly practical Mechanical Engineer and Draughtsman, active business habits, APPOINTMENT to REPRESENT Engineering Firm; references and security given —Address, J 184, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C J 184

Fitter Wants Situation (had the erection of machinery), to take charge of engine and machinery in factory, or otherwise, good references as to ability, &c —W. JONES, Little Chart, Kent J 197

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WANTED, &c.

"Engineering."—Wanted, the Numbers for July 27th, August 3rd, and November 23rd, 1883 Good price given.—Address, A B , 62, Loddige's Road, Hackney, London J 209

"Engineering." — Wanted, Copies of Jan 11, 1884 —State price to J E G , Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C J 203

Lists of Machinery Wanted or on SALE. See "ENGINEERING REVIEW," weekly 1d — E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5202

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MISCELLANEOUS.

PATENTS, DESIGNS, AND TRADE MARKS ACT, 1883

In the matter of Letters Patent granted to DAVID HUNTER, of Troon, in the County of Ayr, North Britain, for an invention or "Improvements in apparatus for cleaning or scrubbing the sides and bottoms of ships afloat" Dated 11th September, 1883. No. 4340.

Notice is Hereby Given that an application has been made by the said DAVID HUNTER, and ALEXANDER DONALDSON SPIERS, and ARCHIBALD SCOTT BROWN, Assignees of parts of the said Letters Patent, for leave to amend the Specification filed by the said DAVID HUNTER in pursuance of the said Letters Patent

A copy of the Specification as proposed to be amended can be inspected at the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W C, and full details of the proposed amendment are contained in the Official Journal of the Patent Office, published on the 7th November (page 1029 30)

Any Persons intending to oppose such application must leave particulars in writing of their objections to such proposed amendment at the Patent Office, 25, Southampton Buildings, Chancery Lane, London, W C, within one month from the date hereof

Dated this 7th day of November, 1884 J 215

(Signed) H READER LACK, Comptroller General

PATENTS, DESIGNS, AND TRADE MARKS ACT, 1883.

In the matter of Letters Patent granted to GEORGE WESTINGHOUSE, Junior, of Pittsburgh, Pennsylvania, in the United States of America, for the invention of "Improvements in apparatus for working brakes, and communicating signals on railway trains" Dated 1st May, 1874 No 1540

Notice is Hereby Given that the said GEORGE WESTINGHOUSE has applied under Sections 18 to 21 of the Patents, &c, Act, 1883, and Rules 48 to 50 of the Rules made thereunder, for leave to amend the Specification filed by him in pursuance of the said Letters Patent

A Copy of the Specification as proposed to be amended can be inspected at the Patent Office, 25, Southampton Buildings, London, W C, and full details of the proposed amendment are contained in the Official Journal of the Patent Office, published on the 7th November (Page 1029).

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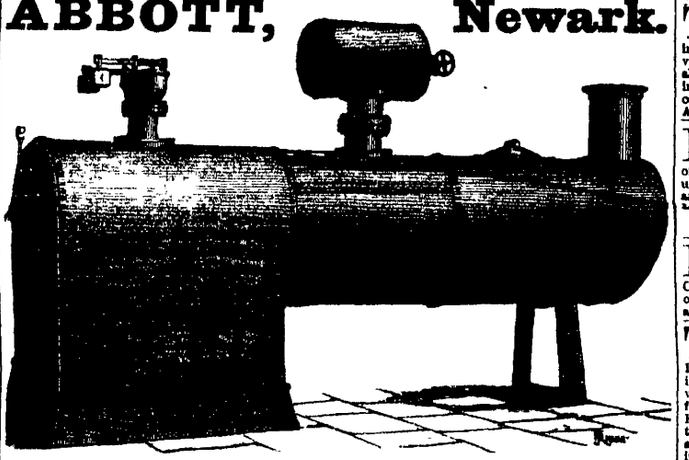
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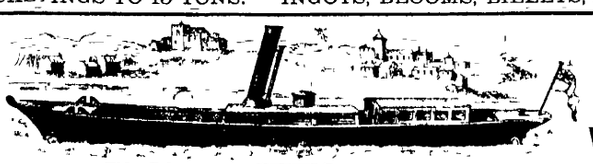
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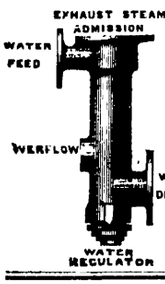
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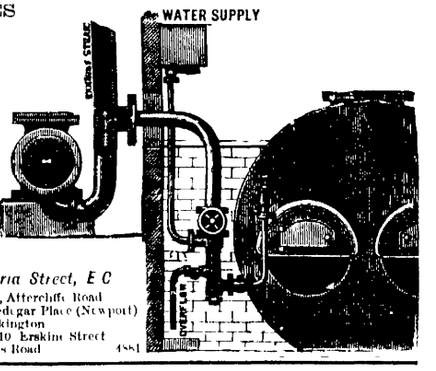
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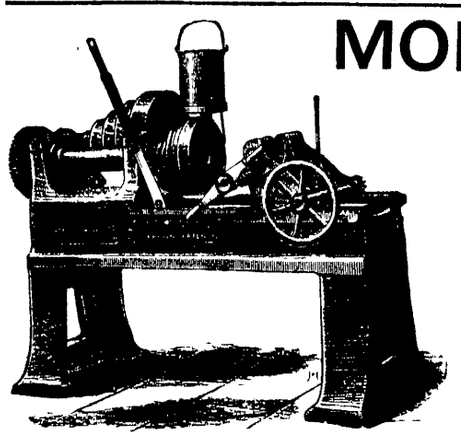
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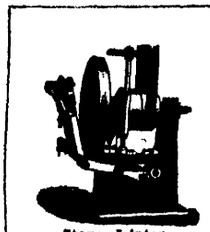
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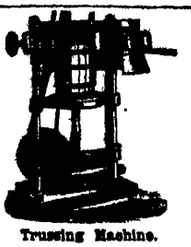
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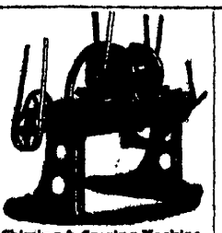
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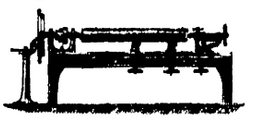
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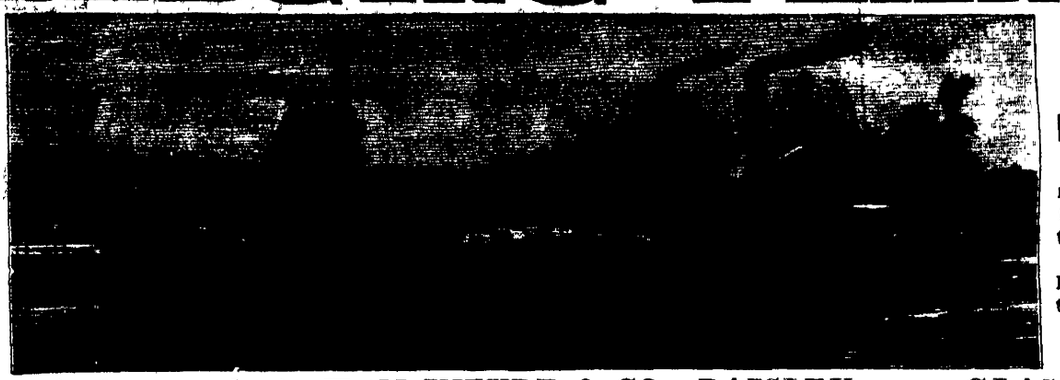
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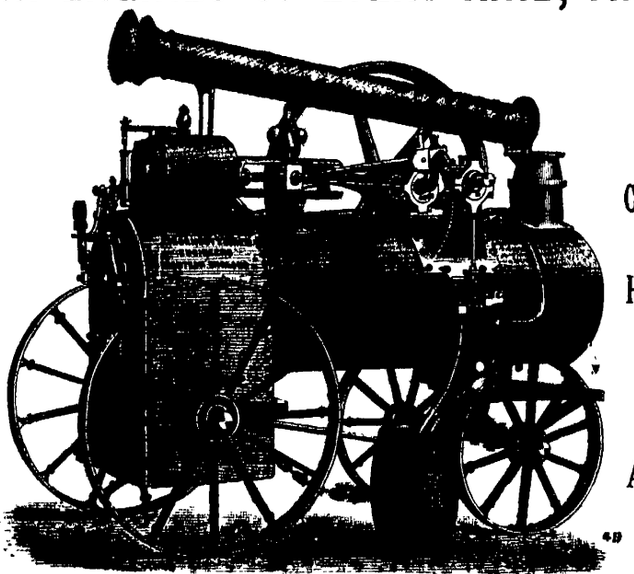
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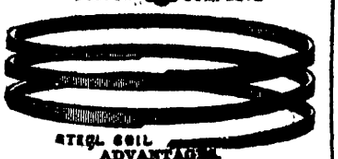
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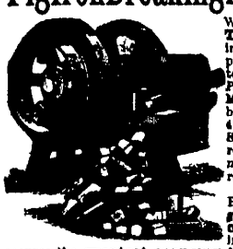
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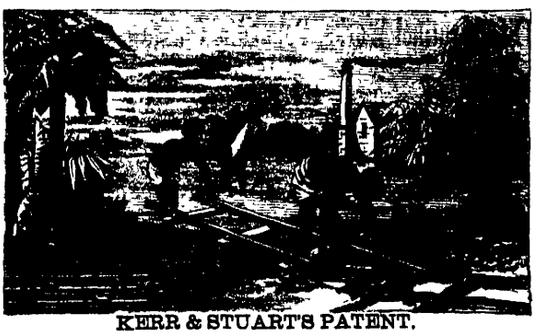
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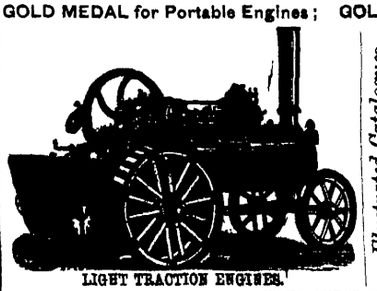
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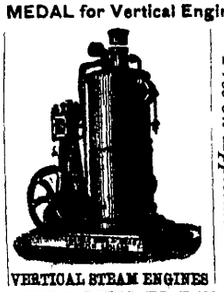
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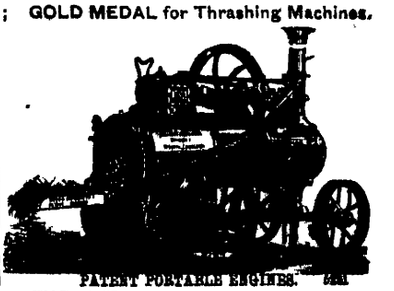
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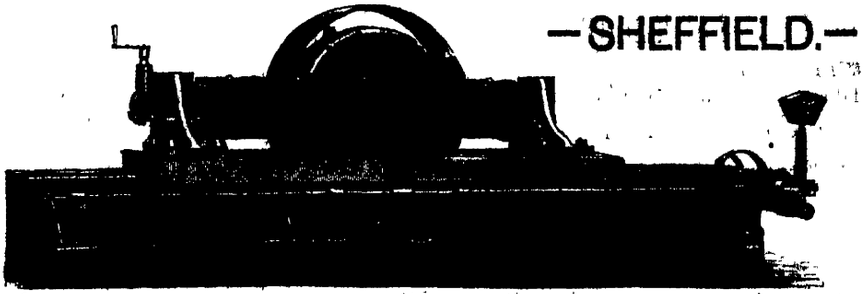


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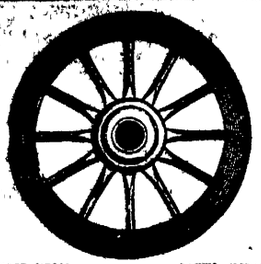
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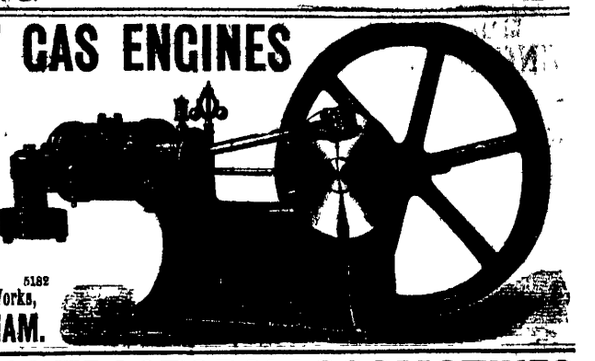
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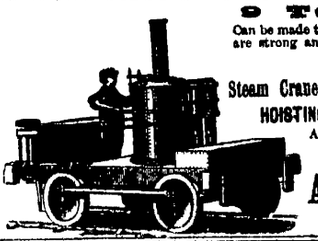
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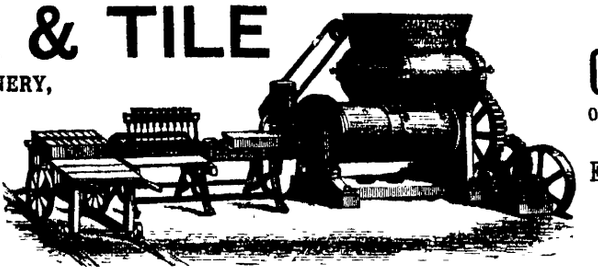
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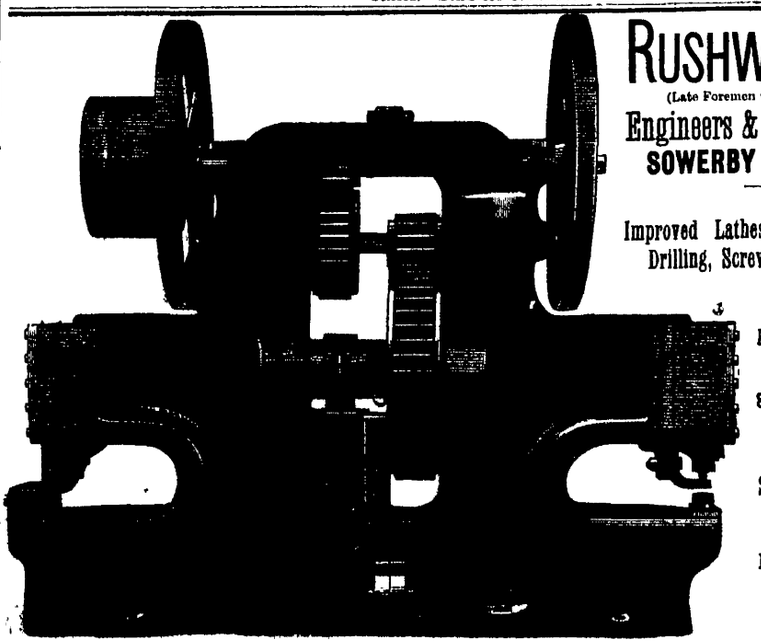
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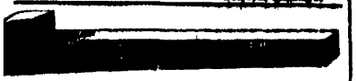
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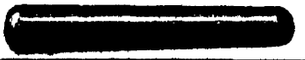


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Size Nos.	3	3	4	6	8	10	14	22	24	26	27	28	30	32
Diameter of Pump	3	1½	1½	1½	2	2½	3½	¾	⅞	1	1¼	1¼	1½	1¾
Gallons per hour	60	97	119	184	330	466	727	900	1200	1455	1800	2809	4800	12400
H.P. of Boiler	4	6	8	12	21	35	55	60	90	110	130	160	225	740
Hand Lever, extra	7/6	7/6	8/6	9/6	10/6	12/-	13/-	15/-						
Prices d/d London	£4 15	£5 5	£7	£10	£13 10	£15	£19	£17	£21	£25	£29	£35	£53	£84

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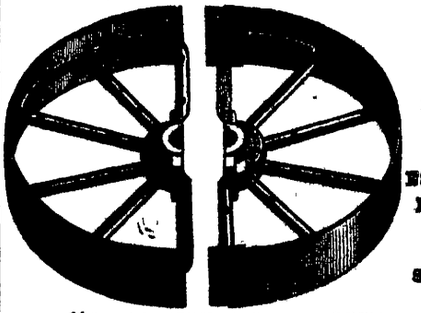
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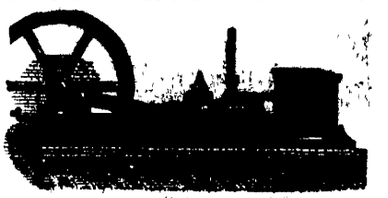
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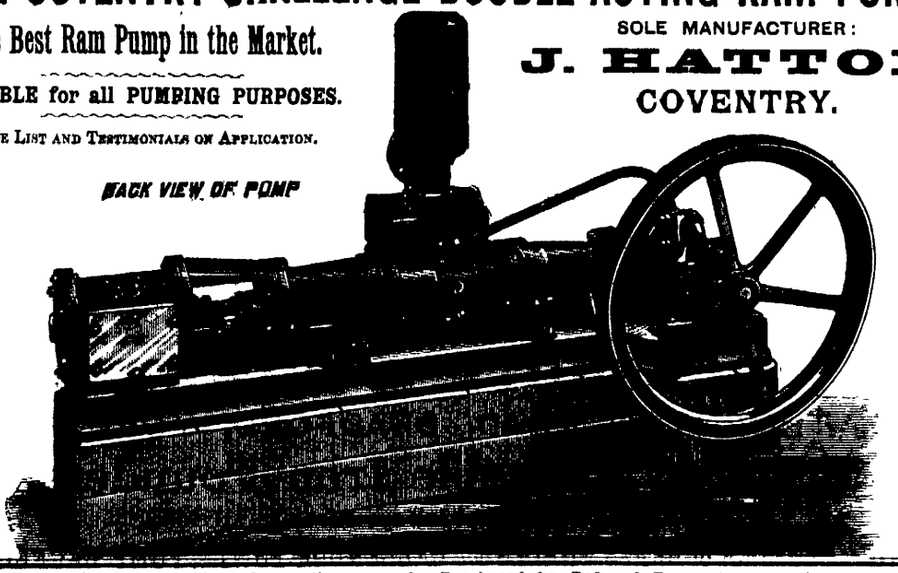
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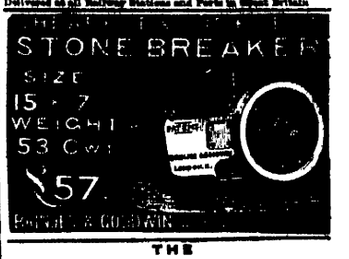


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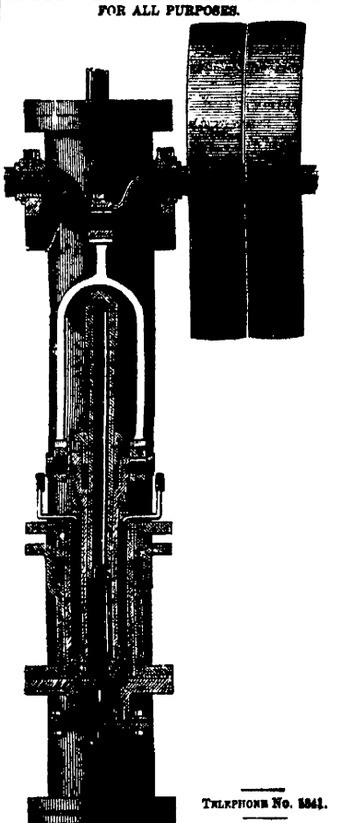
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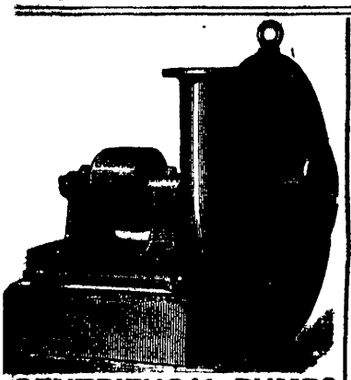
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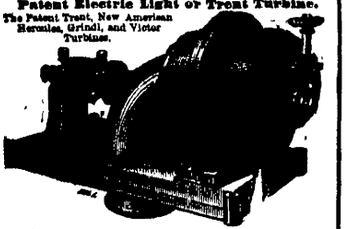
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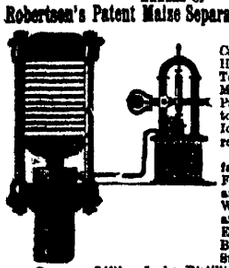


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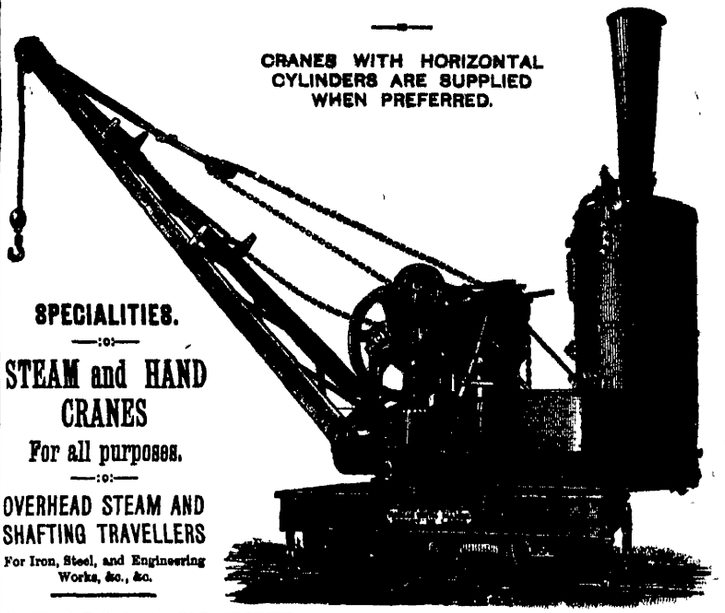
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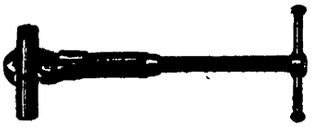
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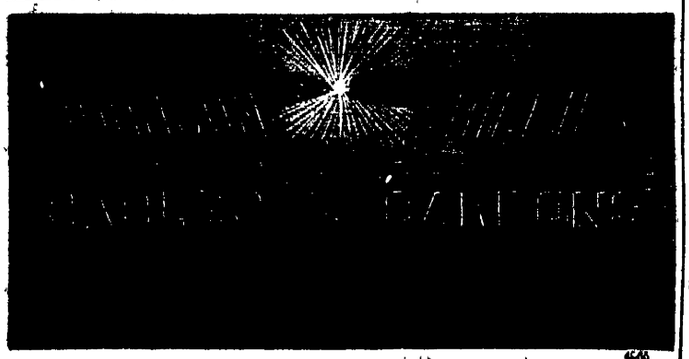
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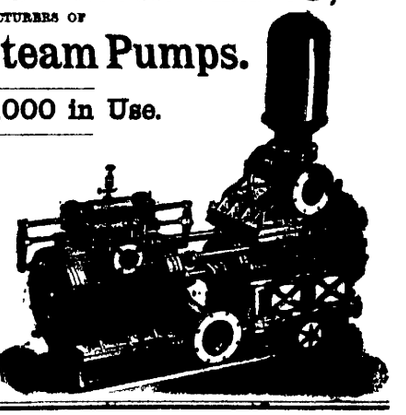
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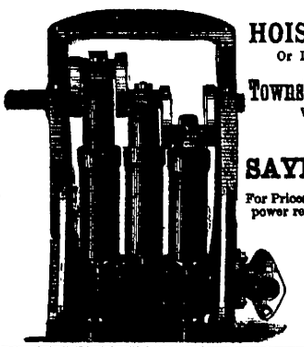
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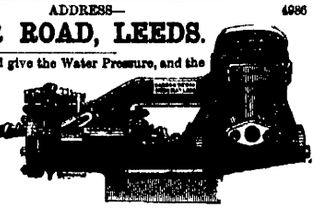
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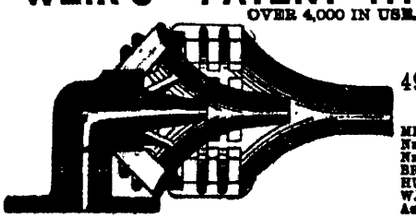


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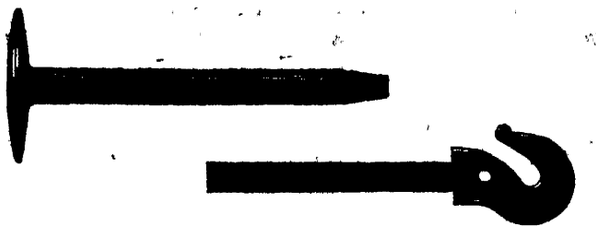


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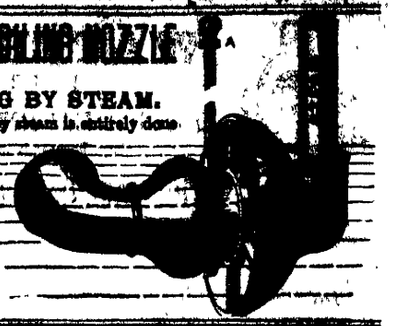
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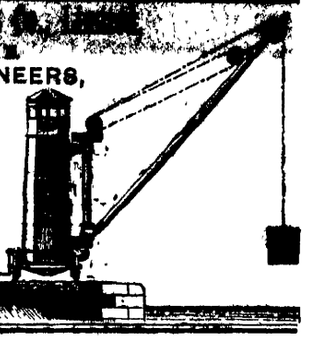
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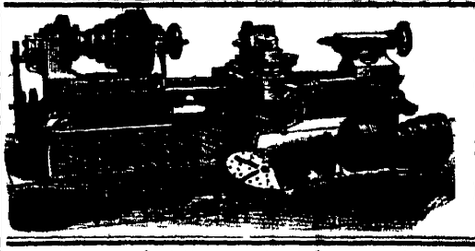
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Steel Jaws and Wrought Iron Sliding Bars,

INSTANTANEOUS in action,

SIMPLE in construction, ECONOMICAL in use.



Width of Jaw.	Opens.	Size of Bar	Price
3 in.	3 in.	1¼ by 1 in.	32s.
4 in.	3 in.	1½ by 1¼ in.	40s.
5 in.	10½ in.	2½ by 1½ in.	55s.
6 in.	22 in.	3 by 1½ in.	70s.
7 in.	14 in.	3½ by 1¾ in.	100s.

Easily and quickly adjusted without using the screw, saving time; double grip obtained by screw and lever, the best combination for the purpose; screw is never exposed and only used for tightening the grip; opens double the width of the jaws; few and simple in its parts; not liable to get out of order, there being no cams, toggles, hooks and clutches; strong and durable, working parts wrought iron and steel.

PATENTEES AND MANUFACTURERS: 5068

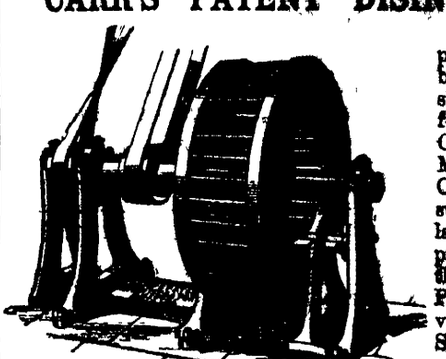
CRAMPTON BROS., 25, West Bar Green, SHEFFIELD.

"CARR'S DISINTEGRATOR,"

Registered Trade Mark, No. 6350.

AWARDED BRONZE MEDAL, PARIS UNIVERSAL EXHIBITION, 1878.

CARR'S PATENT DISINTEGRATOR.



This Machine effectually pulverises by the combined influences of percussion and of centrifugal force, Iron, Zinc, and other Ores; Asphalte, Artificial Manures, Phosphates, Fire Clay, and many other substances. It is also largely in use for the pulverization of Coal for the manufacture of Coke, Patent Fuel, &c.; and is very effective for mixing Sugar.

These Machines are capable of reducing to a fine granular powder from 50 to 80 tons per day (according to size) of any earthy or stony material. Machines made to order from 18 inches diameter, to suit special requirements of purchasers; these same machines being specially adapted for the various requirements of Chemical Manufacturers for Mixing and other purposes.

No Agents. All Machines will be found to bear the Registered Trade Mark ("Carr Disintegrator") in three places—viz.: on Bedplate, and on outside Face of each Cap.

A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee,

PHILIP TRIGGS, Albion Chambers, BRISTOL.

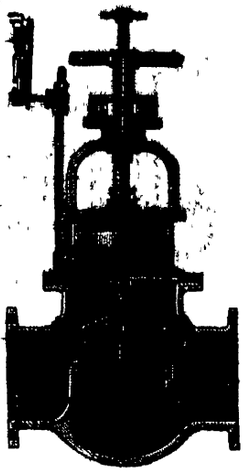
TATE'S PATENT

Electric Valve-Closing Apparatus

FOR STEAM ENGINES.

Medals Awarded AT THE INDUSTRIAL EXHIBITION, BRADFORD, 1882.

INTERNATIONAL FISHERIES EXHIBITION, LONDON, 1883.



THIS APPARATUS IS LARGELY USED ON STATIONARY ENGINES WITH THE GREATEST SUCCESS.

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AND
79, COMMERCIAL STREET, DUNDEE.

TELEGRAPHIC ADDRESS—"DOUCINE, LONDON."

Monthly List of New Machinery in Stock, POST FREE. 4190

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PLANING, SLOTTING, SHAPING, BORING, DRILLING, AND SCREWING MACHINES.
SPECIALITY:
Punching & Shearing, PLATE BENDING, PLATE PLANING, *ANGLE-IRON BENDING,*
And all Classes of Shipbuilders' and Boilermakers' Tools.

ALSO SELF-ACTING STEAM HAMMERS.
Contractors to the British and Foreign Governments. 4748



SLAG WOOL *Loose* and SILICATE CLOTH *Felted.*



Illustration Showing Application of Silicate Cloth.

Incombustible.
Best Non-conductor Extant.
Easily Applied.
Removable.
Re-applicable.

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PATENT FELT MANUFACTURERS, &c.
10, London Street, Fenchurch Street, LONDON; 118, Broomielaw, GLASGOW; and Lagan Felt Works, BELFAST.



CAPELL Double-Power FAN

(PATENT),
THE MOST POWERFUL YET MADE.

See *Engineer*, February [illegible], 1884, and Tests of Mr. D. K. Clarke, C.E., [illegible], March 28th, 1884.

LICENSEES FOR THE NORTH:
R. LLOYD & CO., [illegible], Newhouse Lane, [illegible]

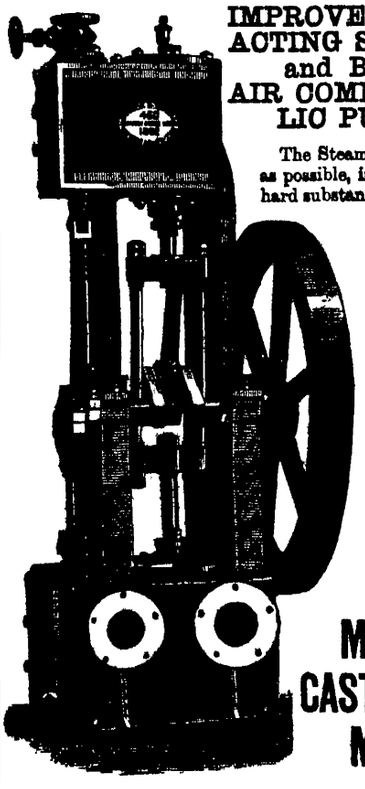
Acorn and Brittania Works, [illegible] June.—"Dear Sirs,—In reply to yours of [illegible] 20 in. Fan we had of you is working [illegible] quite as much work as the 30in. it replaced, [illegible] less power to drive it.—Yours truly, J. Simpson & Sons."

From A. Norrswood & Son, Viaduct Foundry, Birmingham.—"We have [illegible] in testifying to an excellent manner in which the Capell Fan works which you supplied to us [illegible] ago. Although a 42in. Fan than we had previously in use, it takes *considerably* less power to drive [illegible] and Fan we do not drive up to speed."

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CARRICK & WARDALE,

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The Steam Pumps as illustrated are, as nearly as possible, incapable of being choked, save with hard substances; and in working it has been found that shavings, waste, corn, small coals, &c., pass easily through, which renders them eminently suitable for ballast pumps for ships.

They are largely used in Chemical Works, Breweries, &c., where ordinary lifting valve pumps are readily choked; and by Railway Companies for supplying water at watering stations.

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THE STEEL COMPY. OF SCOTLAND,

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(SIEMENS PROCESS).

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IRON SHEETS, PLATES AND BARS

FOR SHIPS, BOILERS, BRIDGES, &c.

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	P S	P SS	P SB	P SB
	Steel	Steel	Steel	Steel

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Boiler End & Furnace Plates, Flanged & Welded. Special Steel for Anti-Collapse Rings & Welded Tubes.
IRON AND STEEL FORGINGS OF ANY DIMENSIONS FOR MARINE ENGINES AND OTHER PURPOSES.
IRON AND STEEL CRANK SHAFTS OF SPECIAL MANUFACTURE.

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London, 11, Queen Victoria St., E.C. .. W. J. MARTIN | Hamburg, Hopfensack No. 11. . Wilh RUMP 5332
Newcastle-on-Tyne .. .. .. Wm. KELSEY | Antwerp .. .. .. Capt RYAN
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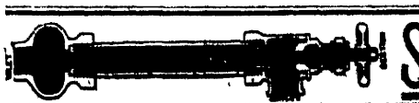
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FOR

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3½ ft. pan, 5 cwt. Rollers £117
4½ ft. „ 10 cwt. „ £227

— LARGER SIZES FOR MORTAR, LIME, ORE, &c., ON APPLICATION. — 5102



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OVER 12,000 SOLD. VAUGHAN'S PATENT WATER
SILVER MEDAL AWARDED. EJECTOR OR STEAM TRAP.
POSITIVELY THE ONLY RELIABLE APPARATUS EVER MADE.

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London Agent: JAS. KEITH, 57, Holborn Viaduct. Belfast: Messrs. PATTERSON & SONS.

ENGINEERING & METAL TRADES' EXHIBITION, LONDON, JULY 1884.

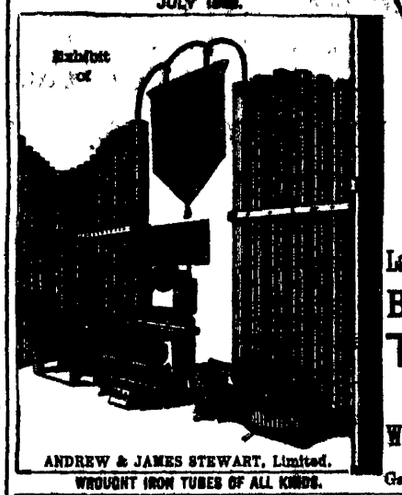


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BOILER TUBES
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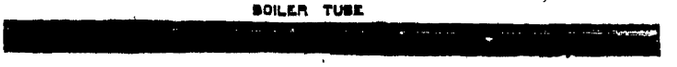
WROUGHT IRON TUBES
FOR 5105
Gas, Steam, Water, &c., &c.

THE WELDLESS STEEL TUBE COMPY.,

ICKNIELD PORT ROAD, BIRMINGHAM,

MANUFACTURERS OF

BOILER TUBE



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SWELLED

HYDRAULIC TUBE. (PLAIN)



HYDRAULIC TUBE WITH HEXAGON SOCKET SCREWED WITH RIGHT & LEFT HAND THREADS



PATENT WELDLESS STEEL TUBES

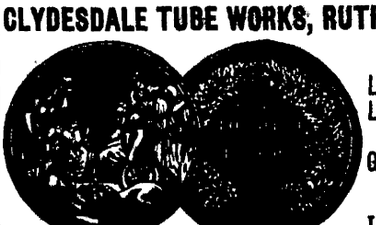
For Boilers, Hydraulic Presses, Ferrules, Boring Rods, Bushes, Shafting, Couplings, Spindles, Collars, and other uses.

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Established 1832.



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LOCOMOTIVE TUBES WITH COPPER ENDS.
GAS, STEAM & GALVANIZED TUBES.
STEEL TUBES. 6196

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Attention is invited to the New

Improved Tool Grinders,

SPECIALLY

ADAPTED FOR ENGINEERS' TOOLS.

These Machines are made in six sizes, and are confidently recommended as being much superior to an ordinary grindstone — grinding more rapidly and imparting a much better edge to the tool.

These Machines can be fitted with Wheels specially suited for Brass Finishers' Tools, and also for Grinding Wood-working Tools of all kinds.

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IN IRON OR STEEL.

WROUGHT IRON AND STEEL BUOYS OF EVERY DESCRIPTION.

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HIGH-PRESSURE SCREW ENGINES, COMPOUND SCREW ENGINES, Patent SURFACE CONDENSING ENGINES,

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4213

ILLUSTRATED PRICE LISTS ON APPLICATION.

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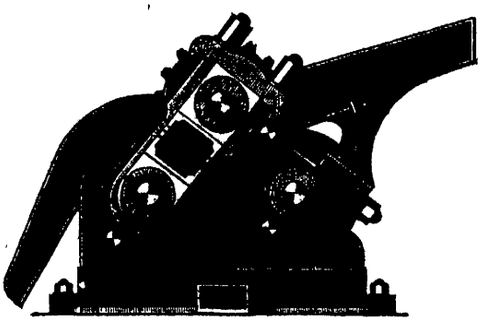
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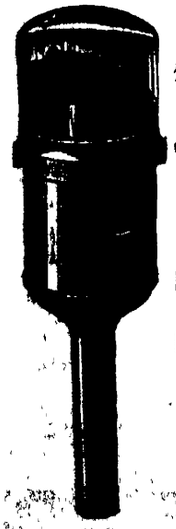
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HEATING ARRANGEMENTS WITH STEAM OR HOT WATER. 5067

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THIS alloy is an improved brass, hard, durable, and strong as mild steel, possessing a beautiful golden colour; when melted it produces sound castings of fine grain; it can be forged hot and cold, and takes a very high polish.

DELTA METAL IS BEING LARGELY USED FOR ALL KINDS OF MACHINERY

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Guaranteed, if required, to stand the Admiralty or Lloyds' Tests.

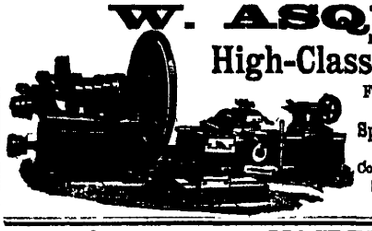
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Contractor to the British and Foreign Governments.

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FOR HAND-LABOUR ONLY

IN HARD ROCK.

FOR MINES, QUARRIES, AND GOVERNMENT CONTRACT WORK.

Rate of Penetration in Granite 1¼ to 2 inches per minute.

PRICE £50 COMPLETE.

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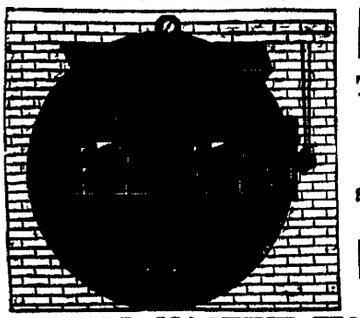
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EVER MANUFACTURED IN SOUTH WALES FOR 5144

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Mechanical Stoker.

THE BEST, SIMPLEST, AND MOST DURABLE

Yet Introduced.

Successfully applied to every description of Furnaces.

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Lindsay's Patent Steam & Hydraulic Packing



Is the best for Stationary, MARINE, and Locomotive Engines.
Is the most Economical Packing in the Market.
Is Self-expansive and requires no Screwing-up when Engines are working.
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Will keep Tight on longest Voyages.
Is made of the Softest Materials.
Is suitable also for Air-Pumps, Circulating Pumps, and Stem Glands.

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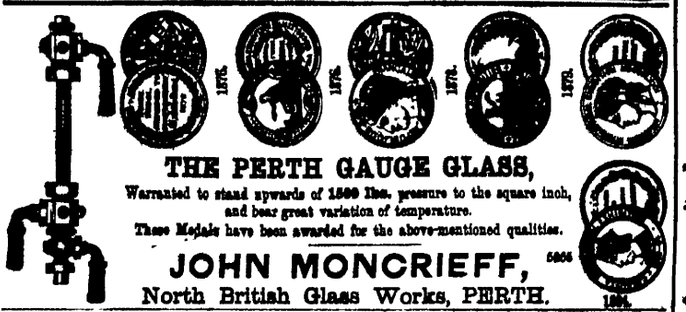
Steam Pumps, Steam Engines, Steam Winches, Steam Dryers, Steam Traps, Steam Reducing Valves, Steam Purifying Apparatus for Boilers, Water Engines and Hoists for Warehouses.

WILLIAM HANSON,

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LONDON OFFICE: 37, WALBROOK. 5870

(See Illustrated Advertisement November 7th, page 31.)



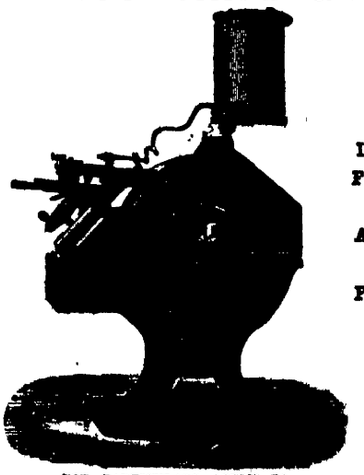
THE PERTH GAUGE GLASS,

Warranted to stand upwards of 1500 lbs. pressure to the square inch, and bear great variation of temperature.

These Medals have been awarded for the above-mentioned qualities.

JOHN MONCRIEFF, 5805
North British Glass Works, PERTH.

SMITH & COVENTRY'S
PATENT TWIST DRILL GRINDER.



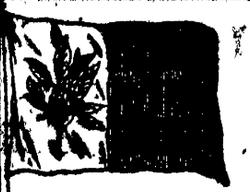
THE ONLY PERFECT MACHINE FOR GRINDING TWIST DRILLS.

IT IS MADE IN FOUR SIZES EMBRACING A RANGE OF DRILLS From 1/4 to 3 in. in Diameter.

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ORDSAL LANE, SALFORD, MANCHESTER,
MANUFACTURERS OF PATENT, SPECIAL, AND GENERAL
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TWIST DRILLS ARE ALWAYS IN STOCK AT THE WORKS. 5851



For Textile and Chemical Manufacturers.
Engineers, Contractors, Dyers, Paper Makers, Millers, &c., &c.
Also for
STEAMSHIP, RAILWAY, TELEGRAPH, Agricultural, and other Technical Purposes,
Are exclusively and actually MANUFACTURED BY THE
NORTH BRITISH RUBBER CO., Limited.
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WAREHOUSES: 37, Moorgate Street, LONDON. 6, Charlotte Street, MANCHESTER. 18 & 15, Oswald Street, GLASGOW. 2661

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WORKS: SILVERTOWN, ESSEX.] (LIMITED). [MANUFACTURERS OF

VULCANISED INDIA-RUBBER (Contractors to the Lords Commissioners of the Admiralty). "Special Quality" to resist the action of Mineral Oil at High Pressure Steam; Sheet Rubber, and Bearing Springs; Valves for Marine and Land Engines, Wheel Tyres, Cylinders, Insertion Sheet, Cord and Tubing, Gauge-Glass Rings.
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VULCANISED INDIA-RUBBER MACHINE BELTING
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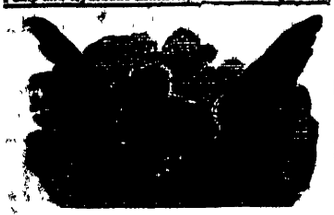
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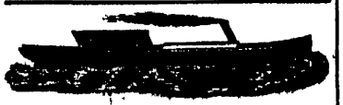
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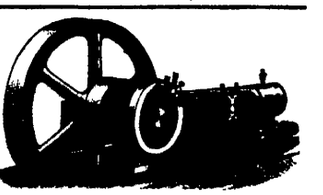
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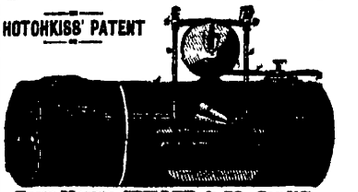
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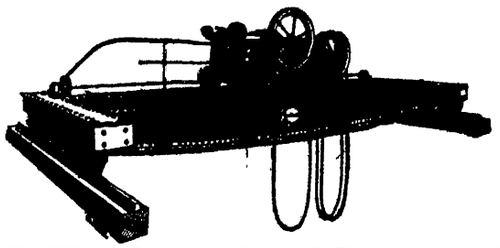
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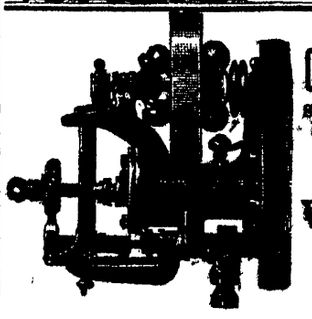
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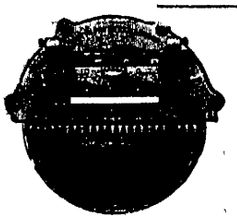


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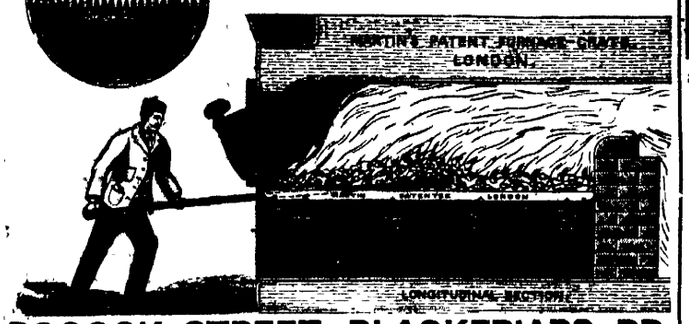
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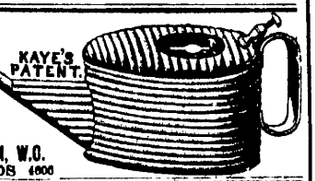
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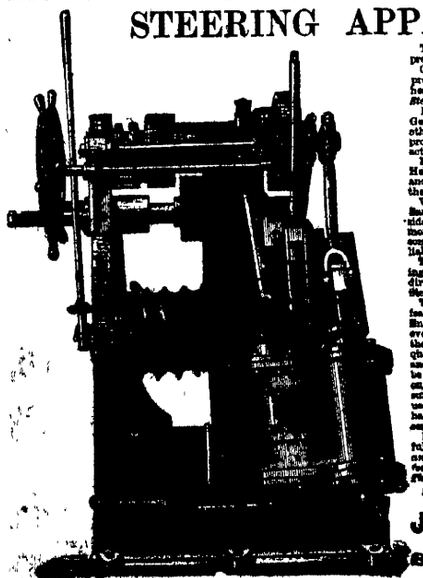
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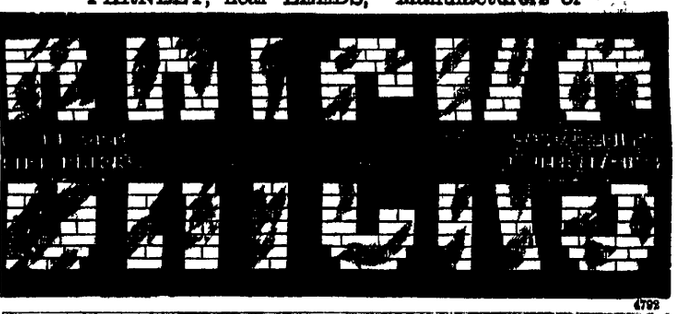
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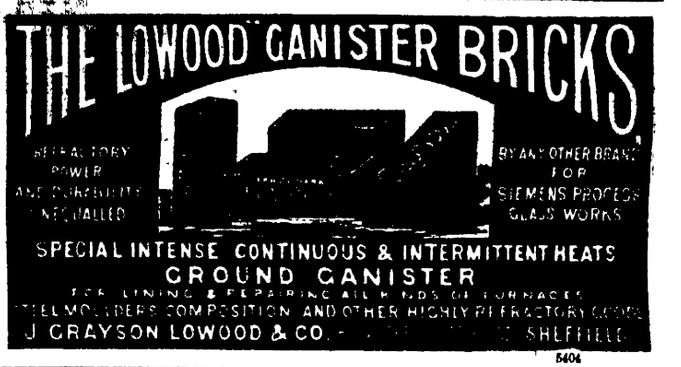
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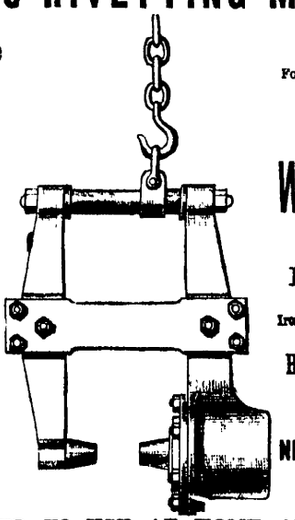
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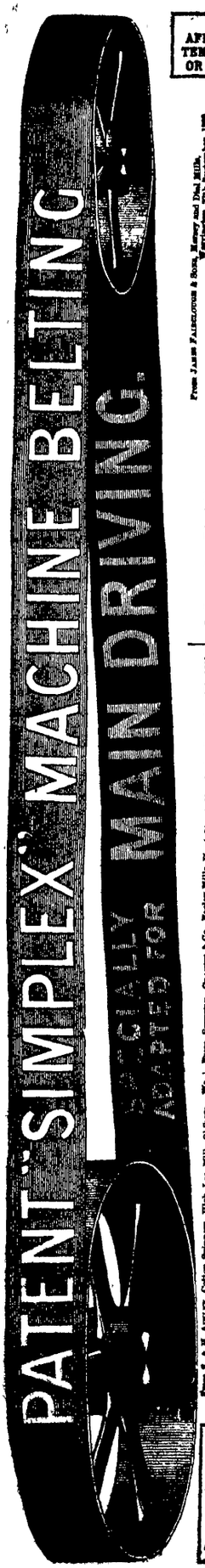
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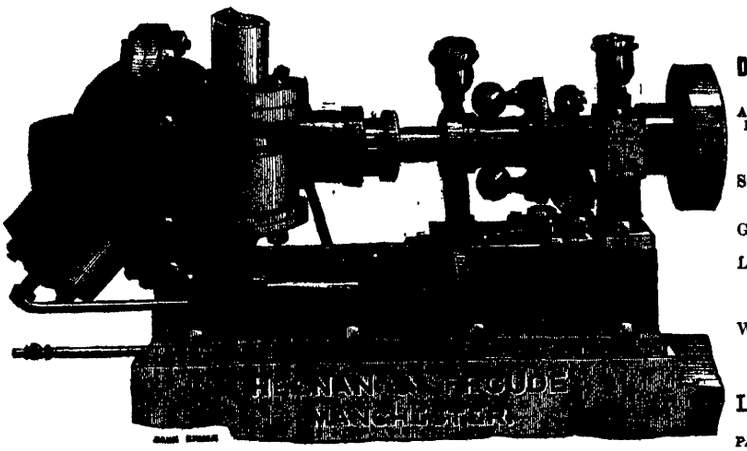
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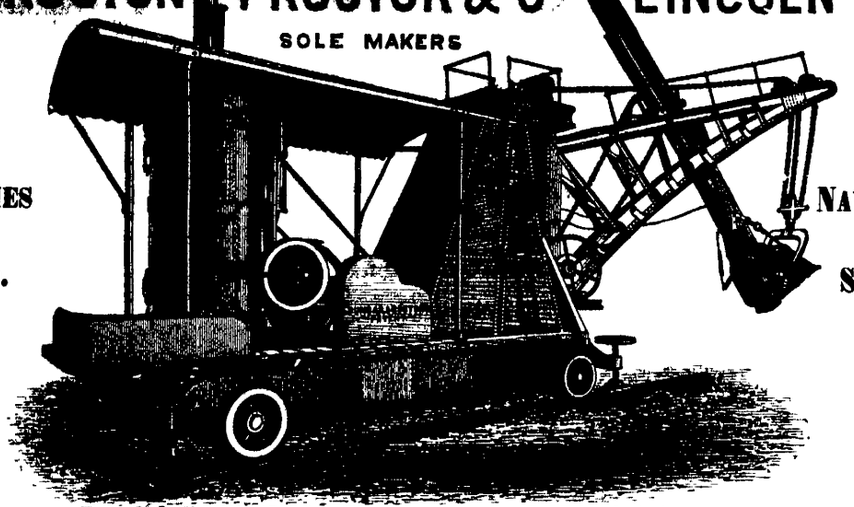
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Requires two men and a boy to drive the Engine and guide the Machine; excavates and delivers in trucks the hardest clay and material known (not being rock), at the rate of from 400 to 600 cubic yards per day.—Full details, with prices on application to 4666

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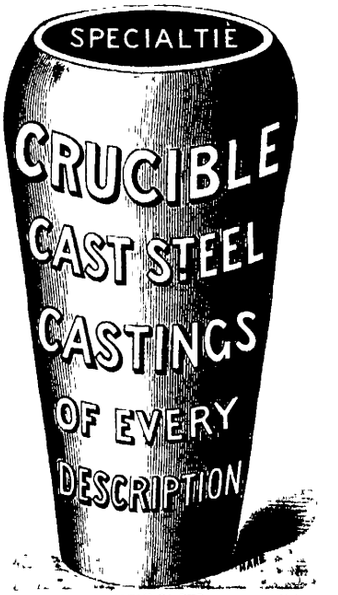
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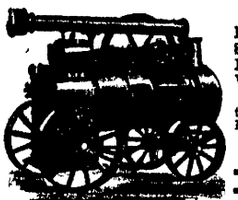
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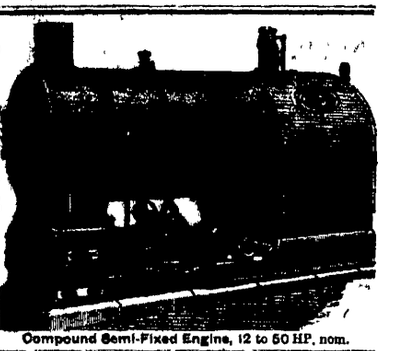
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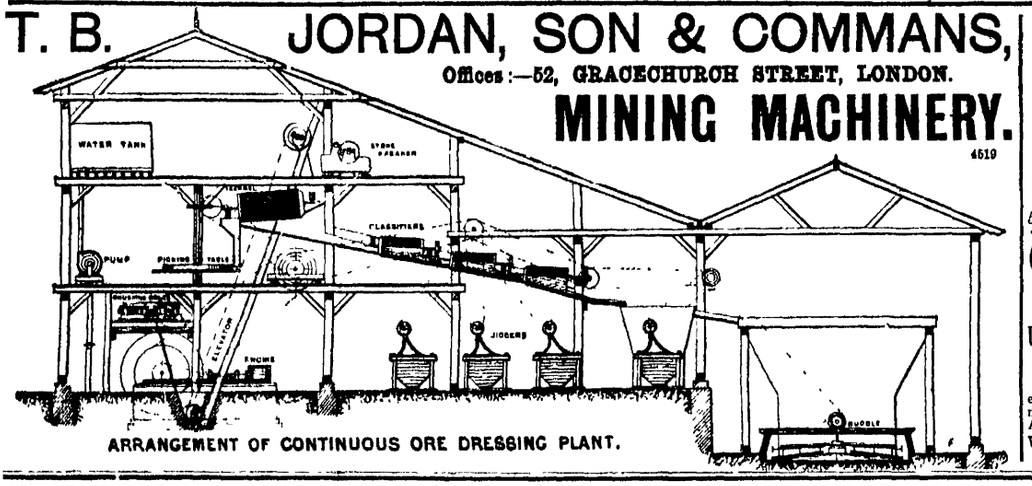


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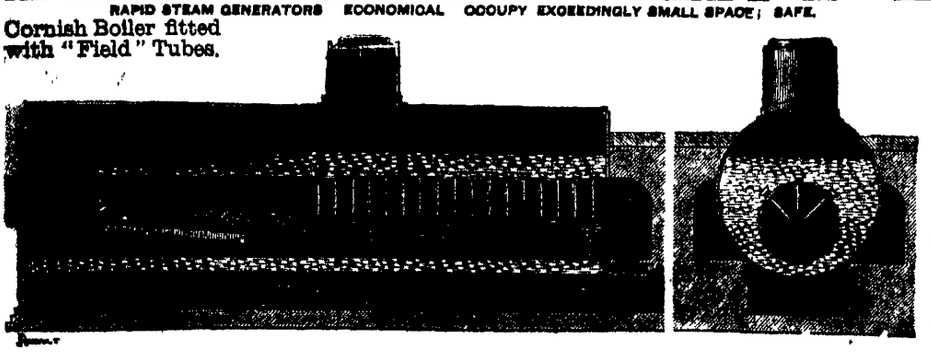
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RAPID STEAM GENERATORS ECONOMICAL OCCUPY EXCEEDINGLY SMALL SPACE; SAFE.

Cornish Boiler fitted with "Field" Tubes.



TESTIMONIALS.

INFANT ORPHAN ASYLUM, WANSTEAD, March 3rd, 1884.

GENTLEMEN,—I have pleasure in reporting that the "Field" Patent Tubes which you inserted in our Cornish Boilers give every satisfaction. Our coal consumption in each of these boilers was 5½ tons per week, and we had difficulty in keeping steam before the Tubes were inserted. We now have plenty of steam, and our coal consumption is 4 tons per week, and the results have been altogether so satisfactory that we are preparing a third boiler to be fitted.—I am, Gentlemen, yours truly, (Signed) R. J. HAMMOND, Engineer.

We have just received the following testimonial from a customer in Grahamstown:—

GENTLEMEN,—I have fixed the 38 2½ in. Field Tubes I received from you in my boiler, and they are acting splendidly. I reckon they save me at least 30 per cent. of fuel.—Yours faithfully,
(Signed) J. McLEOD,
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Easily fitted in Cornish, Egg-ended, Cross Tube and other Boilers.

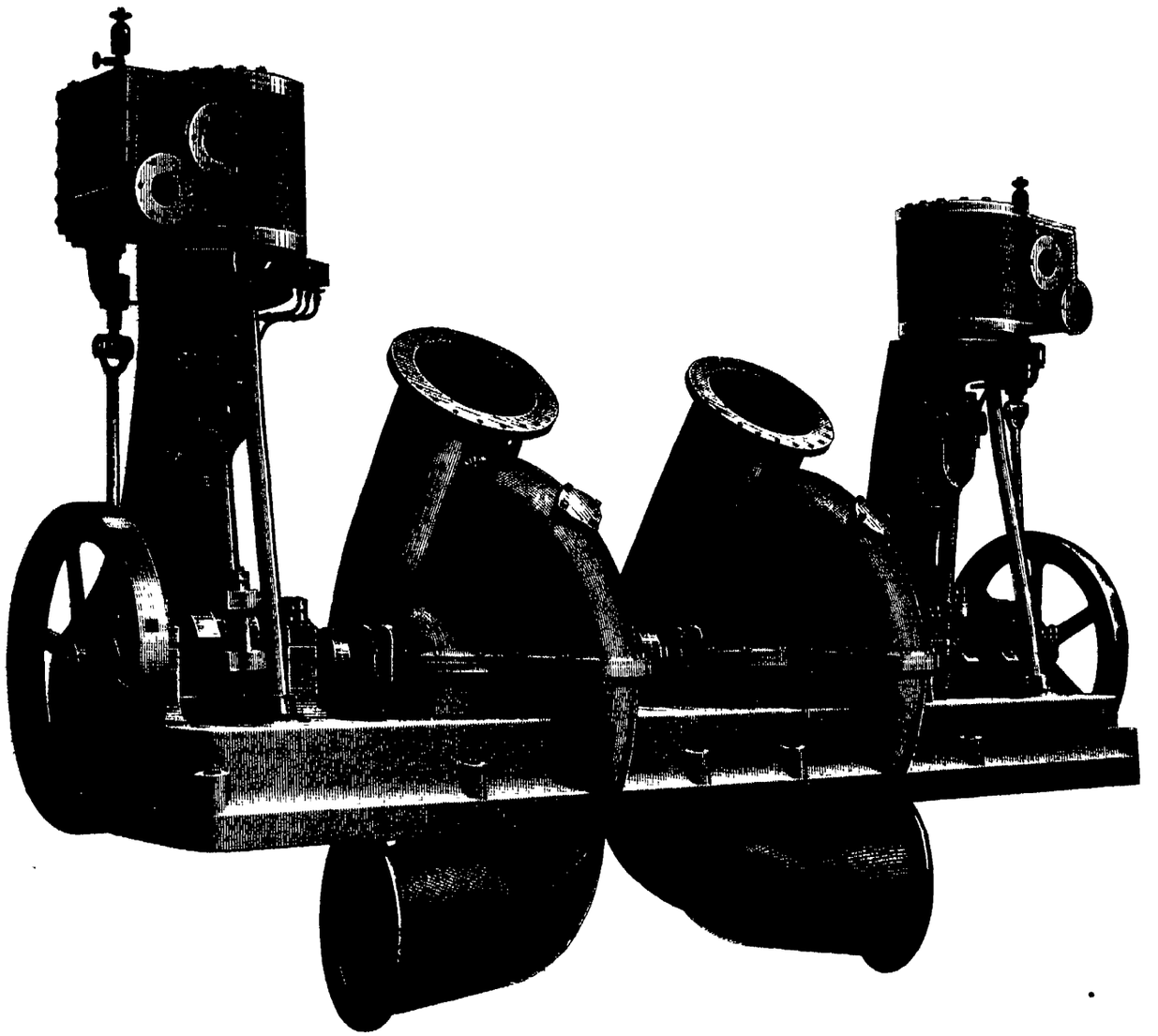
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CONSTRUCTED BY MESSRS. W. H. ALLEN AND CO, ENGINEERS, LONDON.

(*For Description, see Page* 445)



LITERATURE.

Minutes of Proceedings of the Institution of Civil Engineers, with other Selected and Abstracted Papers. Vol. LXXVII. Edited by JAMES FROST, Secretary.

THE last issue of the Proceedings of the Institution of Civil Engineers contains reprints of three most interesting papers which have lately been read before the members, together with a full account of the discussions and correspondence that ensued. These were "Hydraulic Propulsion," by Mr. S. W. Barnaby; "Wire Gun Construction," by Mr. J. A. Longridge; and "Experiments on the Composition and Destructive Distillation of Coal," by Mr. W. Foster. These have all been, the second more particularly, already noticed in these columns, and if the volume before us contained nothing beyond the papers themselves, there would be little to add to the abstracts we have already published.

But the value of the records of the weekly meetings held in Great George-street, does not depend upon the papers offered for consideration any more than the tediousness of a sermon is, of necessity, proportional to the length of the text. In two of the examples before us, capital papers preceded most important discussions, and the most recent practice, theory, and experiment were laid before a body of hearers whose views represented the most intelligent and educated opinion of the day upon the particular subjects in hand. We have not the space to summarise even most briefly the remarks of the speakers, and all that we can do is to give the impression left on the mind by a quiet perusal of the speeches, many of which, of course, were widely diversified in their views. The majority of the speakers in the discussion on "Hydraulic Propulsion" appeared to hold the opinion that it was impossible that the jet propeller should ever be equal to the existing methods, since there were three factors involved in calculating its efficiency, the engine, the pump, and the jet, while there were only two in screw propulsion. Further than this the figure of efficiency of the pump, which was the characteristic feature of the whole design, was exceedingly low, and practically this part of the system represented a loss of more than one-half the power. A respectable minority, however, pointed out to the meeting that few attempts had been made with the hydraulic propulsion, while thousands of experiments in screws had been tried, and they argued that further research would give better results, and that if a moderate improvement only could be effected, there were purposes for which it would be worth while, as in torpedo boats, to sacrifice economy of fuel for the sake of the many advantages which would be gained in other respects. On the whole, however, the sense of the meeting, especially the engineering portion of it, as distinguished from naval officers, was decided that there was little to hope from the revival of the question.

Mr. Longridge's paper was distinctly superior to the discussion it evoked. Indeed it was scarcely to be expected that a manufacture which is practically carried on in this country at two places only, Woolwich and Elswick, should be known to any but a few, many of whose mouths are closed by gags of red tape. Colonel Maitland was doubtless hampered by his official position, or else he would have expressed much more decided opinions than he did. Mr. W. H. Barlow and Sir Frederick Bramwell spoke, the first as to discrepancies between the author's figures and the results he should have anticipated from a comparison of the performances of other guns, and the latter on the details of construction. The remaining speakers contented themselves with dealing with very minor matters, and it cannot be said that anything of great importance resulted from the discussion of a subject, which from its novelty and the confidence of its author, might have been expected to arouse sharp criticism.

The discussion on the composition of coal was more a chemist's than an engineer's question, but there were many present capable of entering deeply into it. Mr. I. Lowthian Bell, speaking of the condensation of blast furnace gases, stated that the ironmasters of Scotland hoped that the value of the ammonia and tar obtained would equal the cost of the coal they consumed. There was a great divergence in the views of the speakers as to the evils of sulphur in lighting gas. Some held that it was

formed principally into sulphurous acid, and by its disinfectant qualities rendered good service in houses, while others were of opinion that it became sulphuric acid, and was exceedingly destructive. The idea of supplying a cheap heating gas found few friends, and it was proposed that the quality of the present gas should be improved, and it should be made to serve both for heating and lighting. The chemists were particularly opposed to the introduction of a gas largely composed of carbonic oxide into houses. The discussion is followed by twenty-eight pages of correspondence directed mainly to the point raised by the author, that a great proportion of the nitrogen in the coal remains in the coke in gasmaking.

The three papers already mentioned are followed by others which have not been read, but which have been selected for printing. These are mostly descriptions of works, but the last three are independent investigations, of which one, "The Comparative Value of Labour in different Countries," by Mr C. O Burge, will be interesting to all who have to estimate for foreign work. The author takes four classes of work, viz., earthwork, bricklaying, hammer-squared rubble, and painting, and gives the amount done in a given time by men of various nationalties, and the cost per unit as the various rates of wages which obtain in the respective countries. The English artisan is credited with the greatest production in a given time, but when his high rate of wages is taken into account he is nearly always the dearest workman.

The volume contains a long obituary notice of Sir William Siemens, and the accustomed abstracts from foreign technical journals, and is, as usual, capitally edited.

Notions Générales sur l'Eclairage Electrique. By HENRY VIVAREZ. (Extract du Bulletin de l'Association des Elèves de l'Ecole des Mines.) Paris: J. Michelet. 1885. [Price 1 franc]

M Vivarez's pamphlet, although only a short and popular account of the rise and present position of electric lighting, is written in a scientific spirit, and while apparently addressed to the commercial or literary man, rather than to the scientist, yet it is strictly accurate, and the difficult points are not shirked. It can be understood by any person of fair education, and if carefully perused will give the reader a good insight into the means whereby electricity is generated and utilised for lighting, and a fair conception of the laws by which the phenomena are controlled.

It commences with an account of the units of electrical measurement, and of the relation which exists between them, adding the name of Pouillet to that of Ohm, in connection with the well-known formula $I = \frac{E}{R}$. The production of the electric current is rapidly traced through the voltaic battery and the early mechanical generators, to the modern dynamo, the chief characteristics of which are described. With regard to the storage of electricity, M. Vivarez declares, after narrating the incidents attending the formation of the Faure Company, that the mountain has brought forth a mouse, but he thinks that secondary batteries will attain importance when the lead can be replaced by a lighter body. If such a body, half the weight of lead, could be discovered, then, he prophesies, the horse will be superseded by electric traction and will depart by way of the shambles. Under the head of the "canalisation of electricity," the author takes the opportunity to explain in a very lucid manner the difference between the electromotive force and the intensity of the current, a point which is a constant stumbling-block to the unmitiated. He describes various methods of maintaining a constant difference of potential and a constant current in the mains. The three kinds of lamps, regulators, candles, and glow lamps are briefly described, the efficiency of the last being put at the somewhat low figure of 100 to 120 candles per horse-power, that is from five to six lamps per indicated horse-power. The Cruto lamp, as a novelty, is described at greater length than the others. A thin platinum wire is heated by a current in a carburetted atmosphere. A film of carbon is deposited on the metal, and then the temperature is raised until the metal is melted, and a hair-like tube of carbon is left which acts as the filament when the globe has been exhausted.

The economy in the light is an open question in France as here, but it is consoling to read that the use of it is spreading in England faster than in any other European country, in spite of the comparatively low price of gas here. We had fancied that, with the exception of ship lighting, the progress in France was more rapid than here. However, M. Vivarez has been intimately concerned with the business in France for many years, and is well able to speak both of its commercial and scientific aspects.

An Analysis of the Accounts of the Metropolitan Water Companies for the Year ending December 31, 1883, and March 31, 1884. Compiled and arranged by ALFRED LASS, Fellow of the Institute of Chartered Accountants. London: Walter King [Price 15s.]

This is the fourth year that this analysis has appeared. It shows (1) the total quantity of water supplied by each of the companies monthly and for the year; (2) the number of houses supplied during each month of the year, and the average for the year; (3) the total quantity of water supplied, the average daily supply, the number of houses supplied, the average daily supply per house, and the average daily supply per head; (4) the number of houses on constant supply and the increase for the year, (5) the share and loan capital authorised, raised, and expended, also the capital employed per million and per thousand gallons supplied; (6) the gross and net water rates, income and expenses (detailed) per million and per thousand gallons of water; (7) the expenses of management, profit, interest, &c., per million and per thousand gallons; (8) net profit, dividends, contingency fund per million and per thousand gallons; (9) comparison between the compiler's extractions and the accounts of the company; (10) contingency and reserve accounts, rates of supply; (11) amount required per million and per thousand gallons to pay 10 per cent. on that part of the capital not limited to a lower rate, and the maximum dividend on the remainder; report of case of Dobbs *v.* the Grand Junction Water Works Company; map of London.

This volume represents an immense amount of labour, all the details being given separately for the eight metropolitan companies. In the matter of expenses it is most comprehensive and supplies a large amount of information, which is most valuable to all who are interested in water works. The cost per million and per thousand gallons supplied, is given for maintenance of reservoirs, maintenance of mains, compensation for damage, pumping, filtration, salaries of engineers, &c., rents, water rights, premises, rates and taxes, superannuation allowances, law and Parliamentary expenses connected with maintenances, fees of directors, auditors, secretary, and accountants, collectors' wages, general charges, law and Parliamentary expenses, and official auditors' and water examiners' fees. The question of supply is treated almost as fully, and the work although small, forms a most complete analysis of the proceedings of the London water companies. All who imagine they are suffering from unjust demands as to rates, or who take an interest in the scheme for procuring a better and purer supply, will find here much that will be valuable to them.

BOOKS RECEIVED.

The Assay and Analysis of Iron and Steel, Iron Ores, and Fuel. By THOMAS BAYLEY. Reprinted from the *Mechanical World*, with Additions. Illustrated by Seventeen Wood Engravings. London and New York: E. and F. N. Spon. Manchester. Emmott and Co.

The Theory of Deflections and of Latitudes and Departures, with Special Applications to Curvilinear Surveys for Alignments of Railway Tracks. By W. ISAAC W. SMITH, C E. New York. D. Van Nostrand. London: Trübner and Co.

CABLE TRAMWAYS.

By J. BUCKNALL-SMITH.

(*Continued from page 426.*)

FROM what we have already written upon the relative success that attended the working performances and attainments of the earlier cable railways, it will be apparent that the various inventors of more recent date who sought to apply the principle of rope haulage to tramways, were far from working in the dark, that they had indeed a substantial basis to work and stand upon, and could turn to a large and valuable amount of prior experience to guide them.

Before proceeding to consider in detail the various applications in practice of cable haulage for tramways proper, we will briefly review in chronological order some of the earlier schemes and inventions relating to the subject.

From the particulars previously given regarding cable haulage by stationary engines in mines and upon railways, it will have been seen that the endless cable system, with its necessary tension apparatus and operating appliances, was in practical use upwards of forty years ago, whilst the means of imparting, from the continuous movement thus obtained, an intermittent motion to vehicles, by means of suitable gripping gear carried on separate or special independent cars, was well known and largely employed about twenty-five years back. From the first proposed adaptation of cable haulage to the working of tramways upon streets, it will be apparent that it was recognised that the tractive agency selected would have to be so applied and operated as not to interfere with the practical efficiency of the road surfaces, or with the carriage and foot traffic for which they had been originally constructed. This was obviously the chief problem that presented itself for solution.

As early as 1812, Messrs. W. and E. Chapman proposed to employ a fixed cable or chain upon roads or streets for the purpose of propelling cars thereon, by winding or hauling upon the same from the platforms of the cars, and about 1824 other similar schemes were enrolled at the British and United States Patent Offices. Amongst the latter was one by a W. James, who proposed to employ a travelling chain for the haulage of carriages upon highways, the chain being operated within a tunnel or channel provided in the rails. In 1829 an endless cable traction scheme, actuated by a stationary source of power, was propounded by a Mr. M. Dick. Nine years later W. J. Curtis applied for the protection of certain improvements in machinery for facilitating transport upon railways, and amongst his numerous suggestions relating to rope or cable haulage, is an interesting description of an independent "leading car" provided with a cable-gripping apparatus fitted with vertically moving clamping jaws, for imparting intermittent motion to a train upon rails from a continuously moving "ground rope." It is further mentioned, that "at first the rope slides through the clamps and thus prevents concussion, but as the train gets into motion the sliding becomes less and less until the train attains the full velocity of the rope." This is precisely the action common to the cable-gripping appliances of to-day.

In 1845, W. Brandling proposed to employ a rope or cable system of traction for street tramways. In order to avoid any interference with street surfaces, he proposed to arrange the hauling rope so as to work within a box or channel constructed in combination with the track. A prong-shaped gripping apparatus was to be operated from each car on the line, in such a manner as to be capable of picking up or dropping the motion of the travelling rope. This appears to be the first example of the proposed employment of a constantly running cable within a longitudinally slotted underground tube or channel.

In March, 1858, E. S. Gardiner, of Philadelphia, U.S.A, directed his attention to the subject and gave a very able solution of the problem. His invention consisted in the employment of a continuous underground tube or tunnel, between the rails, having a narrow longitudinal slot throughout its length, at the level of the road, practically a similar arrangement to the continuous slotted ground or track tubes proposed and used in atmospheric railways some years before. Within this tube he proposed to mount a series of suitable supporting and guiding pulleys, so that a travelling cable could be employed within it for the purpose of hauling the cars along the track, without impeding the passage of other vehicles upon the road. The narrow slot or aperture running axially through the tubes or tunnels and in such a manner as to penetrate the street as above referred to, was to allow the passage of the cable-gripping appliances, which were to be operated from the cars in such a manner as to permit of the latter participating in the motion of the cable when required. No particular gripping apparatus was especially described.

It does not appear that Gardiner ever pursued his ingenious invention or tried it in any practical form, but it is only fair to recognise that all cable haulage schemes at present in use for street tramways, have been constructed in accordance with the principles laid down by him.

In the following year, Messrs. Foster and Brown, of the United States, proposed to employ an overhead endless travelling rope for working street tramway traffic. A suitable gripping appliance was devised for operating above the cars so as to catch or release the cable at pleasure.

In 1860, W. Greaves proposed to lay down a tube between the rails of a street tramway for the purpose of receiving a haulage rope, suitable means being provided on the cars for attaching and detaching them. This arrangement of rope-haulage was stated to be peculiarly advantageous for "working street tramway traffic in towns, busy districts, and on turnpike-roads." A subsidiary arrangement is also mentioned in which the haulage rope is caused to travel in hollow longitudinal sleepers in connection with the track, instead of in a special central tube.

In 1864, P. W. Barlow described an endless cable traction system to be worked by stationary hydraulic power, and stated to be particularly suitable for working traffic in tunnels or subways.

In 1866, C. F. Harvey, U.S.A., proposed a cable scheme consisting in the employment of collars or ferrules upon an underground travelling rope, so as to engage with gripping forks or claws to be lowered from the cars on the track. The cable in this case was to be worked in an open tube.

Three years later, G. F. Beauregard, of New Orleans, U.S.A., followed upon the lines proposed by Foster and Brown, and previously mentioned, namely, elevated cable traction systems, or which he devised an ingenious cable grip or catch for passing or clearing the overhead pulleys, by arranging the supporting arm and operating parts out of the vertical plane of the cable and gripping jaws This arrangement of gripping apparatus was for dealing with cases in which the supporting pulleys were situated between the hauling rope and the vehicles on the line.

Subsequently, Hyde, Monkton, Thompson, Hawthorn, and others patented certain devices connected with street cable traction, but they worked in somewhat impracticable directions and appeared to be unaware of, or to disregard, the useful hints afforded by Gardiner many years previously

During 1870, 1871, and 1872, A. S Hallidie, of San Francisco, proposed arrangements for street cable haulage, and to his ability and subsequent energy the practical inauguration of street cable tramways was mainly due.

It is worthy of notice that overhead and other cable transporting devices, were at this time coming extensively into use Of such we may mention the application by the Eberhard and Aurora Company, Nevada, U.S.A., the sugar-cane transports in Brazil and Peru; the salt mines wire-rope railways of the Indian Government in the Punjaub, the British War Office's line for carrying casks of gunpowder at Purfleet; in Bohemia, for transporting fireclay; in the mining industries of the Spanish Government at the Asturias Mountains, &c The names of Messrs. Hodgson and Carrington are most intimately associated with this class of work

Subsequently Mr Hallidie directed the application of cable haulage to the working of street tramcars in San Francisco, where many of the gradients are too severe to be economically worked by horses or locomotives

Mr. Hallidie's proposed arrangement consisted in the employment of a continuously moving endless wire rope carried within a longitudinally slotted tube arranged below the surface of the street and between the tram rails. The travelling cable was maintained in its proper position by passing over and under suitable pulleys mounted within the tube, and received its requisite motion from a stationary engine situated at either terminus of the line, or at any suitable intermediate position, the power being transmitted from the motor used, to the endless rope by means of a grip pulley or driving drum.

The uniform motion thus imparted to the cable beneath the road, was intermittently communicated to the cars on the line, through the intervention of suitable gripping appliances attached to the cars by steel bars or plates, capable of passing through the slot in the upper part of the cable tube. About the same time (1872) that Mr. Hallidie was introducing his street cable traction scheme in California, U.S.A., Captain J. Roberts, of Seaford, Sussex, applied for a British patent for certain improvements in the construction and operation of street tramways. The object of his invention was also to dispense with the use of horses upon tramways, and consisted in the employment of an endless travelling rope within a longitudinally slotted tube arranged between the tracks and below the road surface. The endless travelling cable for hauling the cars upon the rails was not however carried by pulleys within the tube, but was buoyed up by floats attached thereto, which were intended to lie upon the surface of water with which the tube was to be filled. This inventor describes the essence of his invention as consisting in the employment of water within the underground slotted cable tube for the purpose of supporting and guiding the cable in the manner above mentioned, the idea being that there would be almost entire absence of friction and constant lubrication of the moving parts. Receiving and circulating tanks were proposed at the termini of the line, but how the system could be applied to the working of steep gradients is not apparent.

The only interest attaching to this impracticable suggestion is the following. The system proposed by Captain Roberts was devised for the purpose of extending a north metropolitan system of tramways up Highgate Hill from the Archway to Highgate, and the inventor, with this view, offered his invention to the London General Omnibus Company, Messrs Hunt and Sacre, engineers, and others, who naturally declined to entertain the project. Ten years later the first cable traction system was installed at Highgate by the Steep-Grade Tramways and Works Company, Limited.

It may be mentioned that a simple cable-gripping device is also described in Roberts's specification, with vertically operating jaws in connection with suitable shank plates for working through the narrow slot in the cable tube.

(To be continued.)

THE MONA COPPER MINES

These mines are situated about three miles from Amlwch Station, on the northern coast of the Isle of Anglesea. They are somewhat difficult to approach, being on the top of a high hill, about 500 ft above the sea level At one time the workings were of great importance, and large sums of money were made, but just now copper mining appears to have fallen upon less prosperous times, owing, no doubt, to excessive foreign competition, and there is not much being done in getting out ore at the present time in this district The approach to the mine is excessively picturesque, the hill side being scarred and seamed, and the tip heaped in the most fantastic manner. With a bright day and a fresh breeze, the drive up from Amlwch, with the grand view of the Irish Sea to the northward, should afford pleasure to those who will be content with such sights, even if there is no scene of busy activity to instruct visitors who may be seeking for more practical results

There is, however, a vast network of levels run through into the mountain side, and an exploration of these might be of great interest to the geologist The precipitation of copper from the pumping of the mine water, which we are about to describe, is also worthy of attention.

Passing from the offices, we soon come to the great open-cast, where copper was first found 130 years ago. The lodes run east and west, dipping north, but they are now exhausted, so far as open-working is concerned The principal levels are entered from here. These run for a distance of half a mile, and are about a quarter of a mile across in the widest part; they are traversed by means of ladders in the precipitous parts Some of the workings are 40 yards high

The pumping is ordinarily done by a windmill The pump is geared 2½ to 1, and is worked by means of connecting beams of wood about 6 in square. There are 200 ft of this mode of connection on the surface, the shaft in which the pumps work being that distance from the mill. The timber connections slide on rollers placed at intervals for their support. For use in calm weather there is a 24 in. cylinder horizontal engine by the Sandycroft Foundry Company. This is supplied with steam by a couple of Lancashire boilers, which are 6 ft. and 7 ft. in diameter respectively, one being kept in reserve The fires are always banked, so as to be ready to take up the work when the wind drops The engine is, however, used as little as possible; for, as Mr. Hughes, the captain of the mine, shrewdly observes, "It costs a lot of money to bring coal to the mountain top, whilst the wind comes without even asking." It is computed that the windmill affords a saving of 50s. a day when working. The pumps are situated at a depth of 220 yards from the surface in the shaft, and are made of elm with leaden valves and valve-boxes. There are three "balance bobs," at various depths for balancing the weight of the vertical rods There is also a small oscillating engine with a 16 in. cylinder, used for winding, this works three shafts, respectively 90, 160, and 220 yards deep

The ore, when brought to the surface, is dressed by hand, the best pieces being carefully sorted out. It will contain 5 per cent. of copper, and 35 to 40 per cent of sulphur. When dressed, it is taken direct to the smelting works, about two miles off, on the coast at Amlwch Port, and which belong to the same company. The usual process of calcining the ore and making sulphuric acid is gone through at these works. The burnt ore is then smelted with South Wales coal, in furnaces, of which there are five The result is a regulus containing about 50 per cent. of copper, which is run in pigs and sold In old times the whole of the ore was used for producing fine copper, the operations being carried on by the dry process on the mountain top

The precipitation, to which we have made reference, is carried on by means of a large number of shallow open pits placed in tiers on different levels on the hill side. There are over 100 acres of water surface in all employed in this work. The water, as it is pumped from the mine, is carried by an adit, and together with the surface water from the hill side, is run into these pits, passing continuously from one to another. In the first and every alternate pit, is placed a large quantity of old iron scrap, of which 500 to 800 tons a year are used This causes the copper in the water to precipitate, the whole being kept agitated by rakes The heavier particles of copper settle to the bottom and deposit on the iron, whilst the lighter constituents pass with the water into the next pit The communication is then closed, and the water is allowed to become still, so that the lighter particles in turn settle, and the process is again repeated Finally the water passes into large ponds, which are opened once in from three to five years or so The copper slime produced in this way is smelted with the ore but is much richer in copper, containing on an average 12 per cent. Some of it is far richer than this, that taken from the first pit having the appearance, when washed, of finely powdered copper, and has 20 per cent of pure copper The settlings from the intermediate pits are composed of ochre, which sells at from 10s. to 50s per ton. There is on the plain below an ochre-washing plant, which is worked by a windmill A certain amount of native ochre is also got from the mine

Another product of these mines is the ore known as "blue stone" It contains zinc or blende, lead, and silver. It is exported to Antwerp, where it is treated, but this, like the smelting from ore, is a branch of industry not now in a very flourishing condition.

CENTRIFUGAL PUMPING ENGINES

We illustrate on page 443 a pair of very fine combined circulating pumping engines manufactured by Messrs W. H. Allen and Co, of York-street Works, Lambeth, for the new steamer Umbria, the latest addition to the Cunard Line These engines, which form parts of the main engines of 13,000 horse power, are of unusually large proportions, and are capable of delivering each 10,000 gallons per minute to a height of 30 ft. They have been made with extra large discs so as to revolve at a moderate speed

The engines have cylinders 15 in. in diameter by 12 in stroke, and the parts are proportioned for working with a steam pressure of 110 lb. per square inch The arrangement of the engines is such that either engine can work either pump, and especial attention has been paid to the designing of all details and particularly to the provision of efficient means of lubrication.

ALBARET'S ENSILAGE CUTTER

At the Royal Agricultural Society's Show, held in Shrewsbury last summer, the problem of preparing and storing ensilage attracted considerable attention, and was illustrated by a large number of exhibits of silos, as well as of apparatus for preparing the forage. It will be remembered that some of these latter did extremely good work, especially that of Messrs. F and J S. Bust, of Winterton, whose machine we shall publish on a future occasion Another cutter, shown by M. Albaret, of Liancourt (Oise), France, also did good work, although it was specially adapted for dealing with a different class of forage. As the Albaret ensilage cutter may be regarded as a standard machine in France, where the practice of ensilage is much more developed than in this country, we publish illustrations of the machine on pages 446 and 447 As will be seen from the figures, the machine and

ENSILAGE CUTTER WITH CENTRIFUGAL ELEVATOR.

CONSTRUCTED BY MESSRS. ALBARET AND CO., LIANCOURT (OISE), FRANCE.

Fig 1.

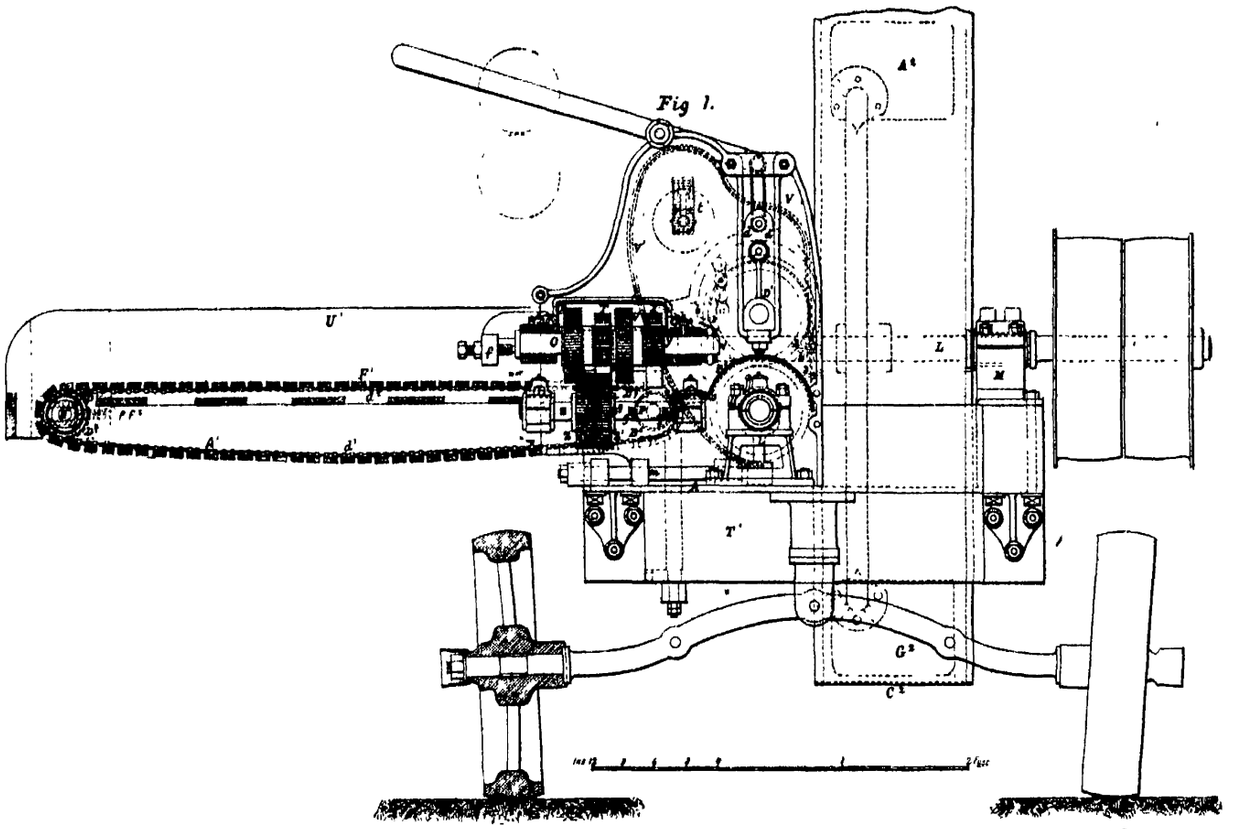
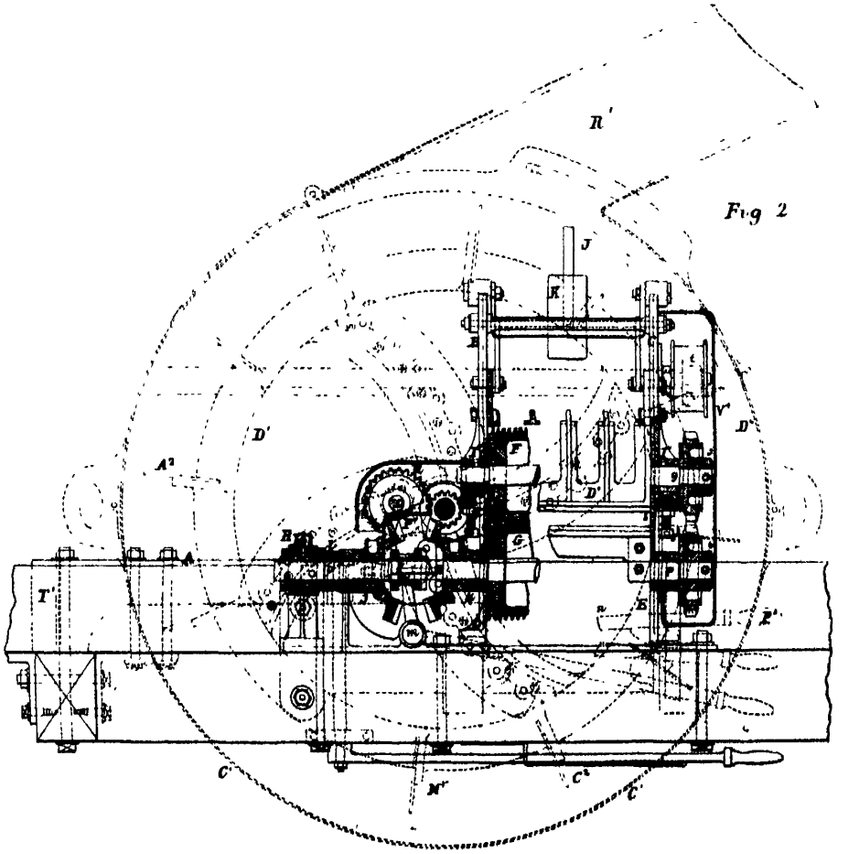


Fig 2



elevator belonging to it, are mounted on a bedplate A, attached to a carriage T, with large wheels, by which it is easily transported. On the bedplate is a box B, C, D, E, which, together with the gearing for the rollers, forms the most important part of the machine The rollers F and G, that pass through the box, are grooved, in such a way as to facilitate the feeding of the forage to the knives. As will be seen they are of considerable diameter, in order that the contact surfaces may be as large as possible; they are also very heavy, a necessary condition to insure a uniform and easy feed The lower roller is fixed and turns in two bearings H and I The upper one is supported by the piece D^1, to which the bearings I^1 I^1 are bolted, which surrounds it and forms by means of the parts b and b^1, the inlet and outlet for the stalks, as they come under the knives. This frame slides on the two sides of the box, where it is held and guided by the grooves d and d^1. The piece D^1 and the upper roller are thus free to rise and fall parallel to the lower roller. A weighted lever is added to control the movement of this roller, and a variation in the pressure exerted upon the forage, is obtained by shifting the counterbalance. The shaft of the flywheel L is mounted at the side of the box, and is carried by the bearings M and N. The latter is provided with a stop f to prevent longitudinal movement of the shaft, which arises from wear. Close to this shaft and parallel to it, is a second shaft O, and in the same plane as the axis of the lower roller is a third shaft P. This latter is equidistant from L and O On the flywheel shaft is keyed the pinion Q, driving the double gearing R S. The wheel S commands the wheel T of the double gearing T U. The pinion U drives the wheel V of the gearing V Y, and the pinion Y gears into the wheel X. The double gearings T U, R S, V Y are each in one piece, and, as well as the wheel X, turn loose on the shafts L and O. The third shaft P carries two wheels Z and Z^1; the former can be thrown into gear with the wheel R, and Z^1 with the wheel T. This can be done easily at will by means of the lever P^2 acting on the fork p between which the wheels Z and Z^1 are placed, as is shown in the illustration. By means of the wheels Z^1 and T, the forage is cut into lengths of 2 centimetres (.79 in). and by Z and R, and the lever P^2, then falls into the position P^3. The wheel Z^1 can also be thrown into gear with V, by withdrawing the pin g, and throwing forward the wheels Z and Z^1 in such a way as to engage Z^1 with V, and then replacing the pin g in the hole g^1; by this means a cut of 1 centimetre can be obtained. When the wheel Z^1 gears with the wheel X, the length of cut is 5 centimetres (1.97 in.) In this latter case the operation is the same as before, the wheels Z and Z^1 are thrown over, until Z^1 is in gear with X, and they are then placed between g^2 and g^3. In all the positions assumed by

ENSILAGE CUTTER WITH CENTRIFUGAL ELEVATOR.

CONSTRUCTED BY MESSRS. ALBARET AND CO., LIANCOURT (OISE), FRANCE.

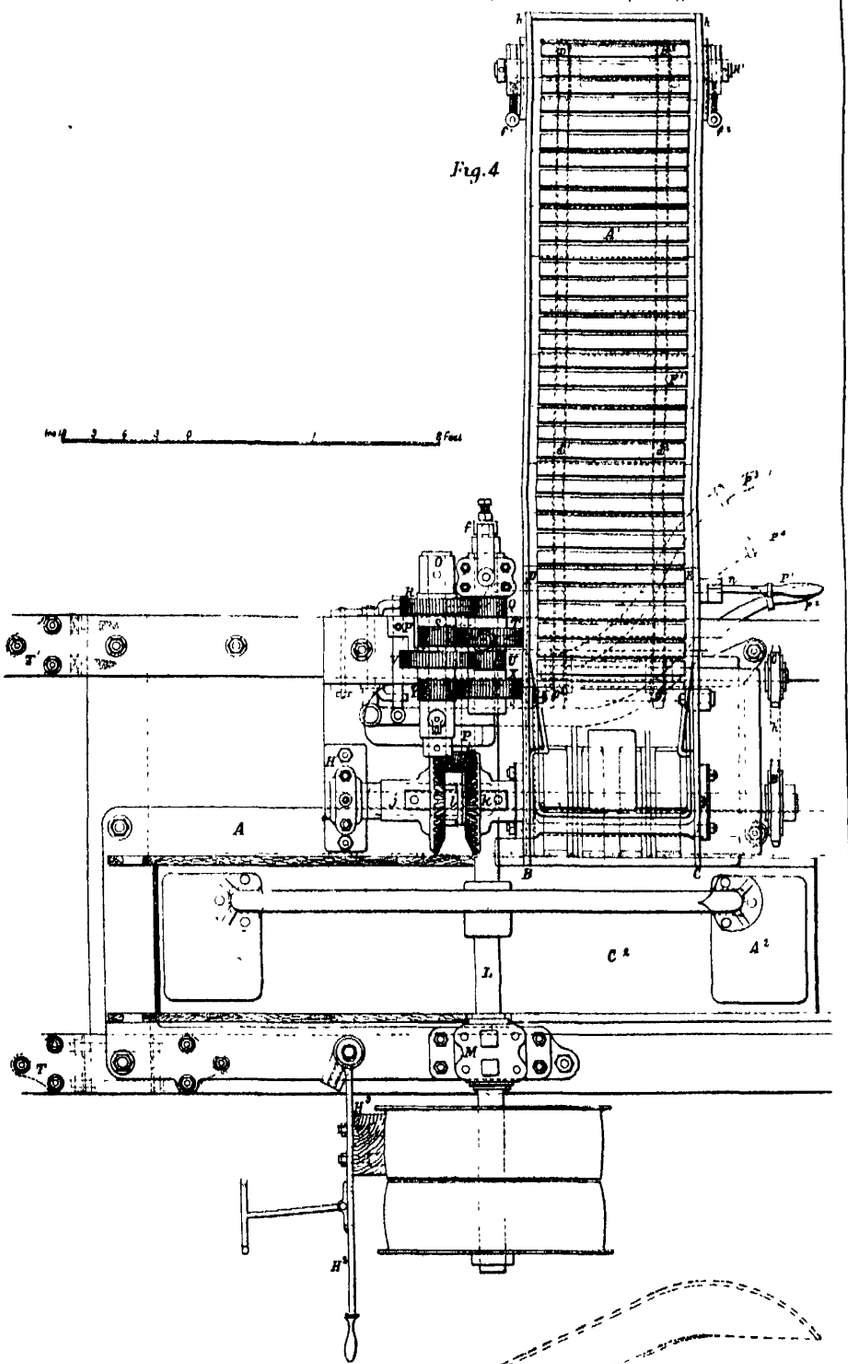


Fig. 4

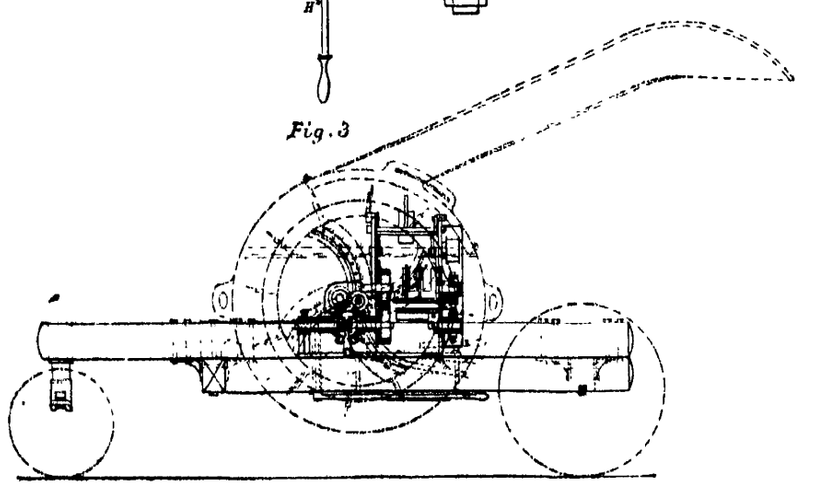


Fig. 3

Z and Z', the same lever P^2 serves to stop the cut when desired, the out of gear position being indicated by P^4. The spurwheels having twice the diameter of the pinions, it is clear that the speeds of the shaft P will vary with the different combinations. These variations are proportional to the numbers 1, 2, 3, 4, and 8. The shaft P controls the lower roller by means of a system of bevelled gear wheels $s\ j\ l$. The pinion s gives movement to the wheels $j\ k$, which are loose on the shaft of the roller, and turn in opposite directions. A clutch sleeve l is placed between the two wheels $j\ k$, and can be made to drive the shaft by means of a fixed key, on which it slides to and fro. The clutch can be set fast with one or other of the two wheels j and k, on the bosses of which are inclined projections corresponding to the form of the clutch. When the latter is thrown over to l^1, one of the two wheels is set fast as well as the lower roller, on the shaft of which it is mounted. When the sleeve is in the middle position, the roller ceases to move The clutch is operated by the finger P^1 which is moved by the lever n^1 on the shaft m. The automatic feed A^1, Figs. 1 and 4, is controlled in the same way as the lower roller, by the finger P^1, as it is driven off the shaft of the roller by means of the two geared wheels B^1 and C^1 and by a pitched chain h^1. This feed or carrier consists of four geared wheels D^1, D^2, D^3, D^4 of equal diameter, and driving in pairs, two pitched chains d^1 d^2, on which are fastened at short intervals the strips F^1, which, as the chain travels, feed forward the forage to be cut, up to the rollers. The attendant has therefore only to place the stalks in the box U^1, no manual feeding being required. The tension of the pitched chains d^1 d^2, can be regulated at will by the screws $f\ f^2$, which are arranged to shift the two bearings of the shaft H^1, and which move on the slides $h\ h^1$ of the box U^1 The upper roller is controlled as follows On the shafts p^1 and q of the two rollers, and on the side opposite to the flywheel shaft, are two toothed wheels $r\ s$, over them runs a pitched chain, that passes also over the pulley t In this way the upper roller is driven by the lower one, revolving of course in a direction opposite to the latter. By the arrangement already described, the upper roller rises and falls with the varying thickness of the charge passed through The spindle of the pulley t is mounted in a groove, and held there by a special arrangement, which allows the pulley to shift, and the pitched chain to be stretched as it extends by wear. A projection, V, prevents this chain from slipping off the wheels, when the direction of the rollers is changed, or if by accident too great a charge of forage is fed into the machine This pitched chain is covered over with a cast iron box V^1, the lower part of which serves as an oil reservoir to secure a constant lubrication. The gear wheels driving the rollers are also boxed in by a cast-iron cover p^{11}, and the wheels that run loose on their axles are furnished with hermetically closed lubricators, so that they work freely for a considerable time without attention.

From the foregoing description, the suitability of the machine for cutting straw, hay, or maize, will be readily understood By the various combinations of change wheels, several different lengths of cut can be obtained, 1, 2, 4, and 8 centimetres (39 in., 79 in., 1.58 in., and 3 15 in.), if the flywheel is fitted with two knives. The corresponding lengths would be 1, 2, and 4 centimetres (.20 in., .79 in., and 1.58 in) If the flywheel has four knives, but if only one cutter be used, lengths up to 16 centimetres (6 29 in.) can be delivered. This great range of cut is secured with feed rollers double in diameter of those usually employed, the rates of the speed of the flywheel, and that of the feed rollers being doubled without any complication, and the gearing employed to produce the different results, is very simple, and unlikely to get out of order. A special advantage in the use of large rollers, is that sufficient weight is secured to maintain a uniform feed, and this weight is especially necessary in dealing with green maize, the strong stalks of which are flattened only with difficulty, and which slide over one another when subjected to small pressures. The means of at once stopping or reversing the travelling bands and the rollers is within the reach of the attendant who feeds the machine, and the large diameter of the rollers renders it possible to reverse these latter, before the forage, which is between the rollers, has reached the knives The upper roller is always under perfect control no matter in what position it may be, and combs 3, 3, &c., placed on each side, and above and below it, prevent any clogging of the rollers by the material fed in winding around them. The means of adjustment provided insure also that any thickness of forage, from the diameter of a single straw to the whole width of opening, is regularly and uniformly fed forwards to the knives. In cutting maize it is found preferable to maintain a certain opening between the rollers, and this is effected by means of screws against which the upper side of the roller comes in contact. The width of the opening can of course be regulated at will. The edges of the box B, C, D, E, when the operation of cutting takes place, that is, the

sides 4 and 5 of the mouth, are fitted with hard steel plates that can be easily replaced.

The centrifugal elevator which forms a part of this machine is arranged to deliver the forage direct into the silo or into carts as it is cut. It consists of a cylindrical casing C^1, closed on each side so as to shut in the flywheel on which blades A^2 are fixed. A tangential trunk R^1 completes this part of the apparatus, which thus forms a centrifugal fan The cut forage falls into the box C^2, with which the mouthpiece of the machine communicates. There it at once comes under the influence of the blades on the flywheel, and the blast thus produced, discharges it through the tangential trunk. In the middle of the fan casing are two openings covered with sliding doors D^1 D^{11}, which allow the entry of air, the admission of which is thus under complete control. By means of the same doors the casing can be cleared out and the cutting blades adjusted. Another door is also provided to empty the casing. The whole of the elevator is so arranged as to be easily removed. The trunk R^1 is made adjustable so that the height and direction to which the cut forage is discharged may be altered according to circumstances, and several openings for delivery may be provided for a more even distribution into the silo. The fan blades A^2 are of wrought iron rivetted to projections on the flywheel, the diameter of which is made as large as possible to promote the centrifugal action of the elevator. The shaft L of the flywheel carries one fast and one loose pulley for driving the machine The belt from the engine is controlled by the lever H^2 which has a wooden sabot H^3, that acts as a brake in such a way that in shifting the belt the machine can be stopped almost instantaneously In conclusion, we may add that the working speed of the Albaret ensilage cutter varies from 300 to 400 revolutions per minute, and the delivery of cut maize is about 12 tons per hour.

THE ATTOCK BRIDGE

We publish this week in a two-page plate, the first of a series of illustrations of a bridge recently constructed across the Indus River at Attock for the Punjaub Northern State Railway This bridge, which was opened on May 24, 1883, was erected under the direction of Mr. F L O'Callaghan, engineer-in-chief, Mr. H Johnson acting as executive engineer, and Messrs R. W. Egerton and H. Savary as assistants. We shall postpone our description of this important work until the publication of further details.

ELECTRIC LIGHTING NOTES.

UNDERGROUND CONDUCTORS FOR GREENOCK.

THE Kinetic Engineering Company have received the order for the underground electric light cables for the lighting up of several of the streets in Greenock under the provisional order obtained by the Police Board These cables will be of three types, namely, the main cable, consisting of 36 strands of copper wire, 1.5 millimetres in diameter; the branch main, consisting of 12 strands of 1.6 millimetres, and the leads for the lamp-posts, consisting of 1 strand of 1.2millimetres diameter. These cables will be of the Berthoud Borel type, insulated with Berthoud-Borel material and encased in a double sheathing of lead, the two sheathings being separated by a layer of gas-tar. A conductivity of 96 per cent. and an insulation of 1000 megohms per mile at the ordinary temperature are guaranteed These cables will not be laid in any troughs or pipes. They will be tarred and then laid on a layer of fine sand placed in the bottom of the trench and covered with the same to a depth of about 4 in. A plank of wood or layer of bricks will be placed over the sand to indicate the presence of the cable to workmen afterwards taking up the street and save it from injury by their tools. Large quantities of these cables have thus been laid in many of the principal Continental towns and give complete satisfaction. By this method of laying the Berthoud Borel cables effect a great saving in time and labour in placing mains underground.

THE ELECTRIC LIGHT ON SHIPBOARD.

AT the first meeting of the present session of the Institution of Civil Engineers, on the 11th of November, Sir J. W. Bazalgette, C.B., President, in the chair, a paper was read on "Electric Lighting for Steamships," by Andrew Jamieson, Assoc M Inst. C.E., F.R.S.E.

The author commenced with the statement that, although it was not more than three years since the first application of incandescence electric lighting to the general illumination of steamships, the advantages accruing therefrom had been so universally recognised, that more one hundred and fifty ships had been fitted with it, and scarcely a man-of-war or a first class passenger steamer now left the builder's hands without having it on board. This rapid success was mainly due to the following causes: 1. Electric lighting on the incandescence system, when properly fitted, was more healthful, cooler, more easily handled, and more artistic than other systems of lighting; there was no smell, and no products of combustion to tarnish gilt work, it was more agreeable in every way than any of the older methods of illumination. 2. The danger from fire was less, as neither matches nor lighted tapers were required. 3. The daily cleaning and replenishing of lamps, as well as the keeping in store of highly inflammable oil, paraffin, or candles, could to a greater extent be dispensed with. 4. The expense of maintenance was not much in excess of that of the other methods of illumination (in some cases less), whilst the space occupied by the plant was not great, and its position near to, or in, the engine room caused no annoyance to passengers.

As the dynamo which furnished the electricity for feeding the incandescence lamps had to be driven at a uniform velocity, neither the ship's main engines, nor the donkey nor winch engines, were suitable for the purpose. The dynamo must have an engine for itself. It was, in most cases, necessary to place this special engine and the dynamo in such a position that the men on watch at the main engines could, with a minimum of trouble, also attend to the electric plant. This position, therefore, was naturally somewhere near the starting platform, and if possible on the ship's floors, so that undue vibration and noise might be avoided. Frequently a convenient recess could be provided, either immediately behind the main starting platform or opposite to the thrust-block, just outside the screwshaft-tunnel door. Only in large installations would it pay to have on board an electrician solely to attend to the dynamo, its engine, and lamps. In such cases a convenient and cool position was generally selected between decks, in the same compartment with, or in that next to, the refrigerating machinery, if such should be on board, so that one man might attend to both of these novel appliances.

Where practicable the axes of dynamos with large, heavy, armatures should be placed fore and aft, to obviate as much as possible the effects of gyrostatic action, since the angular velocity due to rolling was greatest athwartship. The author here gave Sir William Thomson's formula and examples, to show the pressure produced on the dynamo bearings, under different circumstances, by gyrostatic action.

In selecting a dynamo it was necessary to determine whether or not it fulfilled certain requirements: 1. It must develop electromotive force suitable for a certain lamp when driven at a certain definite speed. 2. It must be self-regulating; that was, the electromotive force generated at the given speed must remain constant to within 5 per cent., whether working one lamp or more, or the full number of lamps. It was preferable to have a slight fall in electromotive force as the number of lamps was reduced. 3. There must be no undue emission of sparks at the commutator brushes. 4. When running light, or with less than the full number of lamps, there must be no undue heating of any of the parts. 5. The conductivity of the copper wire with which it was wound must not be less than 96 per cent. of pure copper. 6. The insulation resistance of the armature and electro-magnets should not be less than 10,000 ohms per volt generated at the required speed. The dynamo should be tested mechanically and electrically before being put on board ship, and afterwards, when fixed in position, by a final trial of not less than six hours' duration, with its own engine, and with all the lamps in circuit. There was considerable diversity of opinion regarding the limit of speed of a dynamo on board ship. As a consequence of the general desire for low speeds, most of the best forms of dynamos, the Siemens, the Edison, the Edison Hopkinson, the Victoria, the Ferranti-Thompson, and the Pilsen-Schuckert, had been specially modified for ship use, so as to produce the required electromotive force and current, at speeds varying from 400 to 650 revolutions per minute.

The success or failure of an installation on board ship depended as much upon the engine as upon the dynamo, and every care should be taken to procure one that needed the minimum of attention, and was not likely to break down The engine should be capable of driving the dynamo during a voyage to Australia and back, without a hitch and without requiring overhauling. The demand for such engines, more especially for those driving direct, had led to the production of a great variety, many of them excellent in workmanship and in detail. It was frequently necessary that the engine should be capable of doing its work when supplied with steam either from the main or from the donkey boilers, so that the electric light might be available in port as well as at sea. This entailed capability for working under variable pressures, and thus the size of the engine must be adapted for the lower pressure. One of the most important adjuncts to the engine was its governor It should be sufficiently sensitive and reliable in action to keep the engine within 5 per cent. of its normal speed, with a load varying 90 per cent, and a boiler pressure varying 10 lb. per square inch. No mechanical governor could do this, and consequently a good electrical governor, which would automatically open and close the throttle valve, in perfect synchronism with the load, or work to be done, and leave the valve in its last position until a change was made either in the load or in the steam pressure, was greatly to be desired. The author showed how this problem had been solved by means of his electrical governor.

Then were detailed the different methods of driving dynamos on board ship by belts, ropes, gearing, direct-driving fast-speed engines, such as Brotherhood's, the Westinghouse, Messrs. Siemens' frictional drive, &c. The author explained the methods of fitting leading wires into vessels, instancing certain well-known cases by plans of the s.s. Adelaide and the s.s. Arawa; and gave a practical rule which he had been in the habit of using for the dimensions of such wires. Insulation resistance was too often neglected by electric light engineers. Amongst submarine telegraph engineers it was considered of vital importance to watch the insulation resistance with the most rigid accuracy, not only during the manufacture of a cable, but during its submersion and after it had been laid; whereas, in the case of electric lighting, those charged with the fitting up of an installation very seldom thought of, or even knew how to take insulation tests, either of the dynamo or of the leading wires. It was far from right to allow leads to be run up like bell wires, without the slightest knowledge as to whether a flaw or a fault had crept in, and all engineers should insist upon rigid inspection, as well as thorough and searching tests, before an installation was passed. The insulation resistance standard need not be nearly so high as in the case of submarine cables; but nevertheless it did require to be several hundred times more than the copper resistance, otherwise a fault would soon develop, and short-circuiting occur, under the combined influences of the electromotive force, and damp or wet. The dielectric should, therefore, in addition to being a good insulator, be thoroughly water-tight, and as little liable as possible to be affected by atmospheric changes. The author then gave a description of what he had found to be the best form of switches, fusible plugs, lamp-holders, lanterns, and globes. Finally he directed attention to the powerful search-lights used on board men-of-war, and to the novel application of arc-lighting for salvage and fishing purposes.

The paper was illustrated by a large number of diagrams.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a fairly good attendance on 'Change, but like previous weeks of late, the amount of business transacted was very limited. Prices were practically unchanged, No. 3 Cleveland pig selling at 30s. 3d. for prompt delivery and 30s. 6d. to 30s. 9d. per ton for forward. Within the past fortnight there has been a great deal of excitement in the Glasgow market, but it has not had any further effect here than to cause some purchases to be made for forward delivery by Glasgow merchants. Shipments of pig iron from the Tees continue fairly satisfactory, considering the advanced period of the year. The lower numbers of Cleveland iron are in better request for prompt delivery.

The Manufactured Iron Trade.—There is nothing new to report in this branch of industry. Most of the works continue to be only partially occupied. Prices remain as low as ever, and there is the same difficulty to obtain orders as there has been for many months past. At last a date has been fixed for holding the arbitration court at which the wages question of the iron workers throughout the North of England is to be settled. Dr. J. Watson, of Newcastle, the arbitrator selected to dispose of this matter, has decided to sit on the 20th inst., and seeing that there has been so much unavoidable delay, he will no doubt give his award as soon as possible after the arbitration.

Cleveland Institution of Engineers.—The annual meeting of this Institution was held at Middlesbrough on Monday evening. There was only a small attendance. The report showed that there were 311 members, and that there was a balance in the bank to the credit of the society amounting to 38*l.* 13*s.* 3*d.* One of the founders of the Institution pointed out that there were 65*l.* still owing by members in arrears, and that had it not been for 110 members having voluntarily paid double subscription, there would have been a large deficit instead of a surplus. The newly elected president, Mr Alf. C. Hill, delivered an interesting address, in the course of which he gave the history of the improvements that have been made in the manufacture of Cleveland iron and steel. In conclusion, he took a cheerful survey of trade generally, and predicted for the Cleveland district a brilliant future. During many years past there have been some very excellent papers on subjects of importance to engineers and ironmasters submitted for discussion at the meetings of the Cleveland Institution of Engineers, but latterly the members have manifested an indifference in the proceedings, which has been very discouraging to the promoters of the Institute. It is felt that great national organisations like the Institution of Civil Engineers and the Mechanical Engineers supply all the requisite information desired by professional men, and local institutions are unable to compete successfully with those powerful societies whose head-quarters are located in London.

Railmaking Plant for Spain.—For some time past the Teesside Iron and Engine Works Company have been busily engaged upon an order for one of the largest rail mills yet manufactured in the Cleveland district. The mill is for the Sociedad de Altos Hornos y Fabricas de Hierro y Acero de Bilbao, and is equipped with live roller gear, pull-over gear, hydraulic crane for readily handling the blooms, hydraulic roll-adjusting gear, steam rail saw, and scroll gear for hot bank. The rail-finishing mill is a 30-in., and will be capable of rolling rails of the largest sections now used, and in lengths of 180 ft. Adjacent to this mill will be placed the roughing mill, together with a 39-in. blooming mill, the standards of which latter weigh about 20 tons each, and the rolls for the same will each weigh between 14 and 15 tons. The Teesside Company are also supplying in connection with this mill plant, a large bloom shearing machine capable of cutting steel blooms 12 in. by 12 in. This shearing apparatus when finished will weigh about 75 tons; the largest casting in it, weighing 27 tons, was successfully cast at the Teesside works a few days ago. The cogging mill has been temporarily erected, and tested under steam with the most satisfactory results. The above is only one of several important orders which the Teesside Iron and Engine Works Company have received from the Spanish Company above named. A large quantity of steel-producing plant is also being turned out at this establishment for Consett and other steel and iron works.

The Coal and Coke Trades.—All kinds all fuel are in good request and prices are firm.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Last Thursday's pig-iron warrant market was irregular, with transactions reported during the forenoon at 43s. 3d. down to 43s. 3d. and back to 43s. 4d. cash, also at 43s. 5½d., 43s. 4d., and 43s. 5d. one month, the close being sellers at 43s. 4d. cash and 43s. 5½d. one month, with buyers at ½d. less per ton. Business was done in the afternoon at 43s. 3d. down to 43s. 11½d. and back to 43s. 1½d. cash, and the close was sellers at 43s, 1½d. cash and buyers at 43s. 1d. The market opened dull on the following day, but recovered, and the quotations advanced to 3d. per ton over those current at Thursday's close, but in the afternoon the advance was lost. On the week there was an advance of 4½d. per ton, and on the month an advance of 1s. 6d. Business was transacted in the morning at 43s. to 43s. 4½d. cash, the latter being the nominal closing quotation. In the afternoon there were transactions at 43s. 4½d. down to 43s. 1½d. cash, which was nominally the closing price. On Monday another serious advance took place in the price of warrant iron, which, it was feared, would tell severely on iron brokers who had been selling extensively for a fall. In the morning both buyers and sellers seemed to be feeling the pulse of the market, and prices continued steady at last week's closing rates; but in the afternoon there was some excitement, and buyers were numerous, with the result that prices were sent up 1s. 1½d. per ton. Transactions took place during the forenoon at from 43s. up to 43s. 1½d., the market closing with the latter as the nominal price. In the afternoon the market was very strong, and prices ranged from 43s. 4d. to 44s. 4½d., with sellers at the close asking 44s. 3d., and buyers offering 44s. 1½d. cash. The market opened yesterday with holders very firm, and prices were run up 5d. per ton, but there was a smart reaction attended with a drop of 1s. 1d. per ton. The close, however, was 3½d. over the lowest quotation, and 4½d. under the previous day's close. Business was done in the forenoon at 44s. 4½d. up to 44s. 9d. cash, and the market closed with sellers at 43s. 10d. nominally. At the afternoon market business was done at 43s. 10d. down to 43s. 8d., and then back to 43s. 10d. cash; and subsequently there were sellers at 43s. 10d. cash and 44s. one month, and buyers at ½d. per ton lower. Business was reported this forenoon at from 43s. 10d. down to 44s. 3½d. cash, and at the close of the market sellers were wanting 43s 4d., and buyers were offering 43s. 3d. cash, the month's price being nominally 43s 6d. In the afternoon there were transactions at 43s. 3½d. cash, and subsequently there were sellers at that price, and at 43s. 5½d. one month, with buyers offering ½d. per ton less. The demoralisation which has reigned in the Glasgow pig-iron market for some days has been the result of rash speculation on the part of certain brokers, who, with heavy sales to meet in a steadily rising market, were compelled to suspend payment. The first to fail was a broker, who, within the last fortnight or so, was oversold to the extent of about 92,000 tons. On Thursday and Friday two other firms gave way, one of them having been oversold to the extent of 26,000 tons. The assets of the three firms are understood to have been equal to 1s. 8d., 7s. 6d., and 7s. 3d. per 1*l.* respectively. It is hoped that the speculative collapses referred to will have the effect of placing the market on a more healthy footing as regards the relative cost and selling price of pig iron, than has lately been the case. Genuine business in the iron trade is, if anything, quieter than it has yet been; there is certainly no improvement to report. Very few orders of any importance are being received, and, so far, buyers show no inclination to purchase ahead. Continental orders seem to have dropped almost entirely, and those persons who bought a short time ago are trying rather to curtail than increase their holdings. American orders are almost *nil*, notwithstanding the fact that freights are but nominal. There are now 96 blast furnaces in actual operation, one additional having been blown in at Langloan Iron Works. At this time last year there were 101 furnaces in blast. The production during last month was about 8000 tons less than that of the same month last year. Shipping iron is steady in price, but only a moderate export business is doing. Last month there was a falling off in the shipments to the extent of about 12,000 tons; and up to the end of last week the decrease for the year was 78,648 tons. The shipments for the week ending last Saturday amounted to 6783 tons, as compared with 8949 tons in the preceding week, and 7574 tons in the corresponding week of last year. They included 955 tons to the United States, 300 tons to Australia, &c., 326 tons to France, 400 tons to Italy, 1271 tons to Germany, 150 tons to Russia, 470 tons to Holland, 235 tons to Spain and Portugal, and lesser quantities to other countries. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood yesterday afternoon at 580,171 tons, as compared with 580,306 tons yesterday week, showing a decrease for the week of 135 tons. Another failure in the pig-iron trade was announced this afternoon. It is understood that the bankrupt had an open account of 5000 tons.

John Elder Chair of Naval Architecture.—The opening address in connection with the recently founded Chair of Naval Architecture in the University of Glasgow was delivered yesterday afternoon by Professor Elgar, who pointed out that the occasion was in more than one sense unique. No British university had ever before included in its curriculum anything like a complete treatment of the science of naval architecture, and this was also the first time that naval architects and shipbuilders had had an opportunity of entering upon a course of scientific training intended to be specially and fully adapted to their requirements.

Short Time on the Clyde.—A large number of the ship building yards on the Clyde have been, or are about to be, put on short time, a condition of things which has never so generally prevailed at any former period in the history of Clyde shipbuilding. It is usually three-quarter time arrangements that are being established, the hour of commencing work being in most cases 8 o'clock a.m., one meal hour being allowed, and Saturday being a *dies non* every week or alternate week. By the adoption of such a plan any work that is in hand is spread over a larger number of workmen than would otherwise be employed, and in this way absolute destitution will not be nearly so general as it recently threatened to become. Another advantage is one in favour of the employers, namely, that of reducing the consumption of gas or other artificial light to a minimum. Three quarter time work has been adopted in the Port-Glasgow and Greenock yards of Messrs. Russell and Co., who are at present in quite a unique position as regards the amount of work which they have in hand, embracing, it is said, seventeen sailing vessels, generally ranging from 1400 to 1600 tons or upwards.

NOTES FROM THE SOUTH-WEST.

South Wales Coal and Iron.—The exports from Cardiff and the other South Wales ports, both of coal and iron, last month show a falling off, as compared with some previous months. The coal shipments from Cardiff are low. The coal exports last month were Cardiff, 571,288 tons; Newport, 136,508 tons; Swansea, 71,265 tons; Llanelly, 9971 tons. The coastwise shipments last month were: Cardiff, 95,275 tons; Newport, 100,826 tons; Swansea, 59,590 tons; Llanelly, 10,042 tons. The foreign exports for October last year were Cardiff, 507,790 tons; Newport, 143,817 tons; Swansea, 72,772 tons; Llanelly, 5889 tons. The coastwise coal shipments for October, 1883, were: Cardiff, 98,726 tons; Newport, 88,854 tons; Swansea, 68,591 tons, Llanelly, 7896 tons. The iron shipments last month were: Cardiff, 7142 tons, Newport, 7938 tons; Swansea, 572 tons. There were also sent from Cardiff last month 2465 tons of coke; from Newport 922 tons, and from Swansea 351 tons From Cardiff there were also shipped 15,715 tons of patent fuel, and from Swansea 17,732 tons.

Shot Firing in Mines.—A large deputation, representing the colliery owners and colliers of South Wales, waited upon Sir William Harcourt at the Home Office on Tuesday for the purpose of submitting their objections to a proposed new special rule respecting shot firing in mines. The object of the new rule is to make it clear that whenever shot firing takes place in any mine under certain specified conditions, no persons other than those firing the shots, shall be allowed underground, and that, to insure the complete observance of this precaution, a specified time shall be fixed for firing the shots. The Home Secretary observed that he did not want to make a new law, but rather to make the existing one clear.

The Great Eastern (s.s.)—Mr. E W. Pine, special commissioner of the New Orleans Exhibition, has signed a contract chartering the Great Eastern steamship for twelve months. The great vessel will proceed from Milford Haven, during the last week in November, for New Orleans direct, with English art and collective educational exhibits, which will be conveyed and returned to England freight free. She will be moored in the Mississippi, and utilised as a floating hotel and place of public entertainment for evening fêtes, &c. With this object a large sum will be expended in fitting her up.

Newport.—The past week's clearances show more satisfactory results than those of the immediately preceding period. There is no change to report in steam coal. House coal is in fair demand, and as the winter approaches better prices are looked for. The new Pontypridd and Caerphilly line is being well patronised. The iron ore trade continues dull. In the manufactured iron and kindred trades business remains depressed. Last week's iron exports were 500 tons to Paysandu, 310 tons to Eusenada, 173 tons to Rio Grande do Sul, and 330 tons to Halifax. The arrivals of pitwood have been comparatively small. The coal clearances of the week were 59,705 tons. From Bilbao there arrived 12,094 tons of iron ore.

The Bute Collieries.—After a long term of slackness these collieries are now working more regularly.

The New Cardiff Harbour Scheme.—This undertaking consists in the construction of a sea wall from the Low Water Pier at Cardiff to the quay of the basin at Penarth Dock, thus inclosing an area nearly 500 acres in extent. In this sea wall will be two half-tide basins of about 20 acres each, and divided by a lock pit or main entrance to the harbour, 600 ft. long, by 80 ft. wide. It is not intended at first to dredge the whole of the ground inclosed, but only those portions necessary for the formation of the tidal basins, the channels to the lock gates, and a space alongside the sea wall, where movable tips could be constructed or jetties built. The entrance sills to the two basins and to the lock pit will be 2 ft. 6 in. deeper than the sill at the Roath basin. There will be 40 ft. of water above the sills at the highest tides, and from 25 ft. to 28 ft. at the lowest.

The Aberdare Valley.—An agitation which was commenced some months past by the enginemen and stokers of the Powell Duffryn Company, in favour of the eight hours' movement, threatens to become serious. The object which the men have in view is to assimilate their wage rate and the number of hours which should constitute their turns, with those of the enginemen and stokers of Messrs. Nixon and their workmen in the Rhondda Valley.

Cardiff.—There is nothing new to report in the steam coal trade. Business generally continues quiet House coal has not been quite so brisk. Last week's clearances comprised 111,114 tons of coal, and 2690 tons of patent fuel. From Bilbao there arrived 9568 tons of iron ore, and 1608 tons came to hand from other sources.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Dore and Chinley Railway.—A meeting has been held at the offices of Messrs. Fowler and Sons, surveyors, Sheffield, at which the following directors were present. The mayor (Alderman W. H. Brittain), in the chair, Mr. G. H. Cammell, Mr R. How Ashton, Mr. J. S. A. Shuttleworth, and Mr. W. H. G. Bagshawe. There were also present Mr. Robert Fowler, of London, solicitor to the Bill, Mr. F. Fowler, land agent, and Mr Edward Parry, engineer. The meeting was called for the purpose of considering a scheme prepared by the engineer to make certain alterations and improvements on the plans of the line deposited last year. These are chiefly to make a new junction or curve between the proposed new line of railway and the Midland Railway from Sheffield to Dore, and also to somewhat lengthen and make more direct the tunnel from Totley to Grindleford Bridge, and the other tunnel from Barber Booth to Chinley. The effect of the first of these alterations will be to enable passengers or merchandise from Hathersage and other parts for Chester field, to join the Midland line without being obliged to run into Dore Station. The alterations in the tunnels will give a more direct line, and will shorten the distance by from a quarter to half a mile. New plans and book of reference are now being prepared to show these alterations, and a short Bill will be promoted in the next session of Parliament, the proposed plans being outside the limits of deviation, and rendering the application for a fresh Bill necessary. It is understood that the present proposals will meet with the approval of the Duke of Rutland

The Railway Communication between Goole and York.—At a meeting of the directors of the Goole Chamber of Commerce, a discussion took place in regard to the railway communication between Goole and York, and the North Eastern Railway having failed to meet the requirements of the Chamber, it was decided to approach the Lancashire and Yorkshire with the view of obtaining their assistance in inducing the North-Eastern Railway to complete the junction at Hook between the two systems.

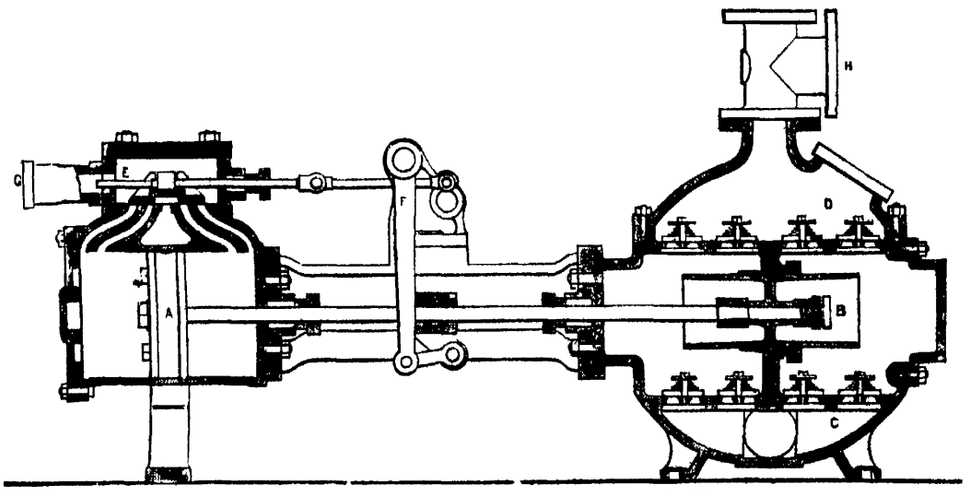
Lecture on Coal Mining.—A lecture on this subject has been delivered at the Firth College, Sheffield It is the fourth of a series on the subject, and that selected on this occasion was, "Boring Appliances, with Cutting Tools used in Boring, and Contrivances for removing Debris and Broken Tools." A short history of boring from the earliest times was given, and then the various tools used were theoretically and practically considered There was a very fair attendance at these lectures from the neighbouring collieries.

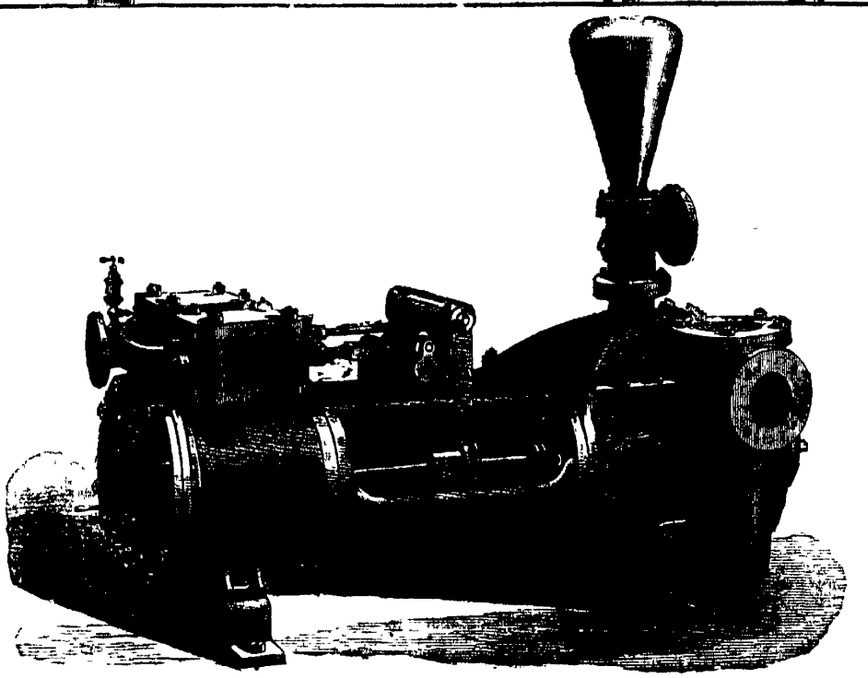
THE LATE CHARLES MANBY, F.R.S.—At the first meeting of the Council of the Institution of Civil Engineers after the recess, the death of Charles Manby, F R S., honorary secretary, having been officially reported, it was resolved, "That the Council of the Institution of Civil Engineers desire to place on record their high sense of the eminent services rendered to the Institution as a body, and to the members individually, by Charles Manby during the many years that he held the positions of secretary and of honorary secretary of the Institution."

SOCIETY OF ARTS.—The first meeting of the 131st session of the Society of Arts will be held on Wednesday, 19th November, when the opening address will be delivered by Sir Frederick Abel, C.B, D.C.L, F.R.S., Chairman of the Council Previous to Christmas there will be four ordinary meetings, in addition to the opening meeting The following papers (among others) will be read during the session "The International Health Exhibition," by George Buchanan, M.D, F.R.S; "Electric Lighting in America," by W H. Preece, F.R.S., "Education at the International Health Exhibition," by J G. Fitch, M.A.; "The Employment of Hydraulic Machinery in Engineering Workshops," by Ralph H. Tweddell; "The History and Manufacture of Playing Cards," by George Clulow; "The Musical Scales of Various Nations," by A. J. Ellis; "The Painless Extinction of Life in the Lower Animals," by B W Richardson, M.A, M.D., F.R.S, "Marine Biological Laboratories their Organisation, Work, and National Importance," by Professor E Ray Lankester, M.A., F.R.S. "The Preparation of Butterine," by Anton Jurgens; "Recent Improvements in Coast Signals," by Sir J. N. Douglass; "Prospective Sources of the Timber Supplies of Great Britain," by P L Simmonds; "The Influence of Civilisation upon Eyesight," by R Brudenell Carter, F R.C.S; "The Evolution of Machines," by Professor H. S. Hele Shaw, "Tempered Glass," by Frederick Siemens. The first course of Cantor lectures will be on "The Use of Coal Gas," by Harold B. Dixon, M.A., the second course will be on "Climate, and its Relation to Health," by G. V. Poore, M.D.; the third course will be be on "The Distribution of Electricity," by Professor George Forbes; the fourth course will be on "Artists' Colours," by J. M. Thomson, F.R.S.E., F.C.S., Lecturer on Chemistry at King's College, London; the fifth course will be on "Carving and Furniture," by J. H. Pollen; the sixth course will be on "Photography and the Spectroscope," by Captain W. de W. Abney, R.E., F.R.S.; the seventh and concluding course will be on "The Manufacture of Toilet Soaps," by C. R. Alder Wright, D.Sc., F.R.S., F.C S. A special course of lectures will be delivered under the Howard Trust, on "The Conversion of Heat into Useful Work," by W. Anderson, M.I.C E. The two juvenile lectures will be given on Wednesday evenings, December 31, 1884, and January 7, 1885; particulars will be announced in the Journal.

THE WORTHINGTON STEAM PUMP.

CONSTRUCTED AT THE HENRY R. WORTHINGTON HYDRAULIC WORKS, NEW YORK.





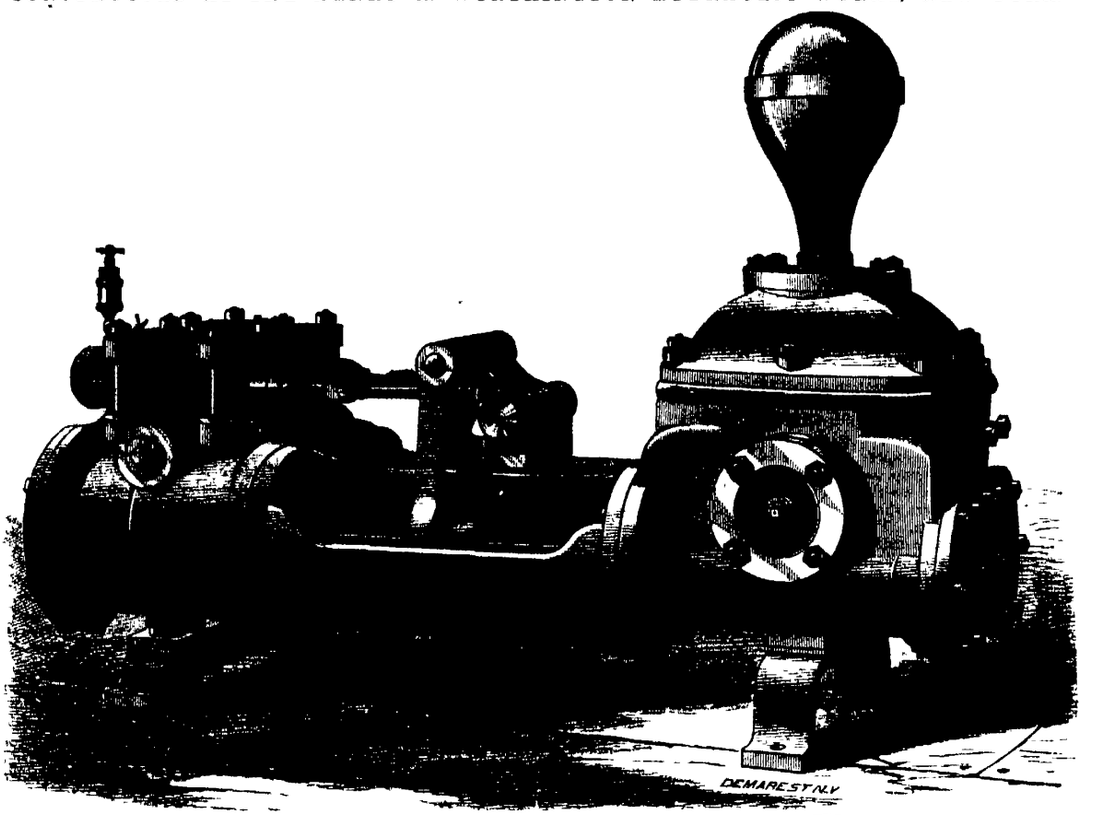
The Henry R. Worthington Hydraulic Works, of 145, Broadway, New York, is the leading establishment for the production of steam pumping machinery in the United States, and it has been in operation since the year 1845. The late Mr. Worthington, during his long career, turned out a far larger amount of pumping power than any other single engineer, and at this moment there are 254 Worthington engines, for water works purposes alone, at work in America, with an aggregate contract capacity of 875,000,000 American gallons in twenty-four hours. The recital of enormous quantities, stated in millions of gallons, conveys little idea to the mind, and perhaps the tremendous total will be better appreciated if we say that it is almost exactly one and a quarter times the average summer flow of the River Thames past Ditton. We do not know the general lift of the pumps, but, judging from the service for which they are designed, it may be supposed to be considerable, and it is safe to assume that they could not only absorb one and three quarter times the amount of water which has come over Teddington Weir during the late dry summer, but could deliver the whole over a stand-pipe more than 100 ft. high. Putting this in another way, it means that the Worthington pumps would supply with twenty-five English gallons per head per diem (a liberal allowance) a population of 28,000,000 people, that is, more than the inhabitants of England and Scotland together. In the face of such facts as these all testimonials and expressions of opinion fall unheeded, for the manufacturer who supplies one of the few actual necessaries of life to a nation, occupies a unique position, which it must have needed the most wonderful combination of design, good workmanship, and business ability to have attained. Of course, water works engines are only one department of pumping machinery, and Mr. Worthington has thousands of smaller pumps at work for all purposes, from serving petroleum pipe lines to working hydraulic elevators and feeding boilers. The uniform high quality of the work, and, above all, the steady action and the great simplicity of the arrangements, have carried these engines all over America, and the Worthington Company is now commencing to introduce them into this country, having opened branch offices for this purpose at 114, Queen Victoria street.

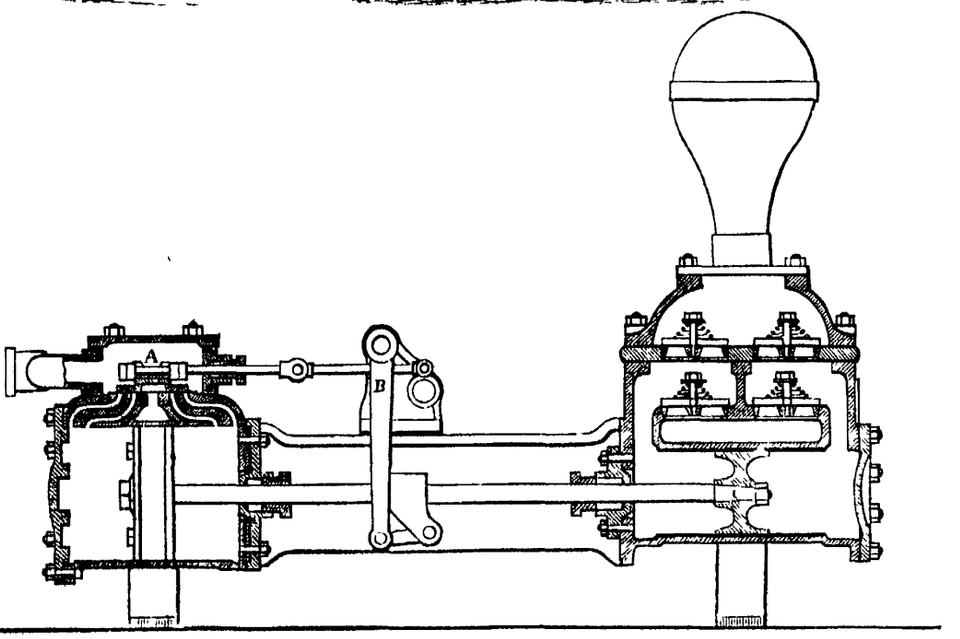
The original Worthington pumps had valves worked by tappets, aided by the pressure of steam on subsidiary pistons, an arrangement which has been tried in a thousand modified forms in this country and America. But this was soon given up for a plan involving only a plain slide valve, and it was when this change was made that the popularity of the pump really commenced. About the year 1850 the use of one large water valve with a considerable lift was abandoned in favour of a considerable number of small valves with a very short rise, the idea being that they could fall to their seats with much greater rapidity and much less shock than the large valve, and thus save time and leakage at each end of the stroke. This, of course, is well understood to-day, but a quarter of a century ago, pumping practice, it must be remembered, was far behind the present standard. Other improvements followed, and soon the mechanism took the shape shown in our engravings on the present page, in which all the parts are clearly to be seen.

The illustrations above are sectional and perspective views respectively of a Worthington high-pressure steam pump of ordinary construction. There are two steam cylinders, side by side, each working a separate pump barrel. Each cylinder has a plain D slide valve E operated by a weighshaft driven by a swinging arm F coupled to the piston rod of the other cylinder. There are no tappets; the valve travels backwards and forwards steadily without shock or interruption, and the two cylinders keep time with each other, one being at the end of its stroke when the other is about at the middle. There is no crankshaft in any Worthington engine and no flywheel. The force of the impact of the steam is thrown on to the ascending column of water, instead of on to a moving mass of metal, and the outflow is maintained constant by the alternate motion of the two plungers, both of which are double-acting. There are separate steam and exhaust ports to each end of the steam cylinders, and the exhaust passages open into the cylinder at some distance from the end, so that the piston A closes them before it reaches the end of the travel, and imprisons a quantity of steam in front of it to act as a cushion and arrest its motion. In the drawing the slide valve is shown in mid position, and not in the position it should occupy with relation to the piston. This arrangement of exhaust ports is required, because it is a most important characteristic of the design that each piston finishes its stroke before the opposite piston opens the port to admit steam for the succeeding stroke.

THE WORTHINGTON BREWERY PUMP.

CONSTRUCTED AT THE HENRY R. WORTHINGTON HYDRAULIC WORKS, NEW YORK.





There then succeeds a pause in which the valves of the pump have time to adjust themselves. The water from the suction pipe continues to flow into the pump cylinder until the whole of the space is filled, and then the valves drop by gravity and cover their seats without noise or vibration. As soon as the plunger begins to get into motion again it finds the pump chamber filled and there is no lost space. Its initial velocity is moderated by the steady resistance it encounters, and the outlet valves are lifted quietly and steadily. On the return stroke the operation of the valves is reversed, but here again the velocity of the current dies away gradually and the valves fall by gravity. To appreciate the advantages following this method of working it is necessary to consider what would happen if the change of direction of the pump were abrupt, as it usually is in small pumps. The plunger commences its backward stroke before the water has had time to fill the vacuous space behind it, and meeting no resistance at first, it strikes the water a powerful blow which hammers the valves, which are almost at the top of their lift, down on to their seats with a force that rapidly brings about their destruction. At the same time the outlet valves are as suddenly raised.

The plunger B works in a deep metallic packing ring, bored to an accurate fit. This ring is not elastic and is not capable of any adjustment except in some special types. When it is worn out both it and the plunger can be renewed at a moderate cost, all the parts being kept in stock, and experience has shown that this is the cheapest cost in the long run. The tendency of a plunger is to wear at the centre more than at the ends, and if the packing be adjusted to make it tight at that part, an excessive friction is set up at the other portions of the stroke. The expense of an occasional renewal is very little compared with a constant increase in the fuel bill. The steam cylinders and the water cylinders are coupled by hollow castings which transmit the steam direct from one to the other. The pump cylinders form subsiding chambers in which dirt or grit can accumulate, instead of being carried on to the plunger, and the passages are exceedingly direct, the straight course from the suction to the delivery valve being only broken by the plunger. The sizes of the cylinders shown in the engravings of the high pressure pump on the opposite page, are 12 in and 9 in., with a stroke of 10 in. The piston speed is from 50 ft. to 100 ft. per minute.

The Worthington compound steam pump is similar to the pump already described, except that for each water cylinder there are a pair of tandem compound steam cylinders. The two slide valves are arranged on the same rod, and are operated exactly as in the former case, the exhaust from the high-pressure cylinder being conducted to the valve chest of the low-pressure cylinder, so that the escaping steam is expanded, with a resulting economy of 30 to 33 per cent. This design of pump is made in seventeen different sizes, the smallest having steam cylinders 8 in. and 12 in. in diameter with a 10-in. stroke, and the largest having cylinders 18½ in and 29 in. in diameter with 18 in. stroke. By the admission of high-pressure steam to the large cylinder a greatly enhanced effect can be obtained in emergencies, as for instance during a fire

The views on the preceding page illustrate a Worthington brewery pump. In this the valve and passages are made of increased area to permit of the circulation of thick liquids without danger of clogging. The plunger C works in a composition-lined cylinder, and the suction pipe can be connected to either or both sides. This pump is made in eight sizes, of which the smallest has cylinders 4½ in. and 3¾ in. in diameter by 4 in. stroke, and the largest cylinders 10 in. and 6 in. in diameter, with 10 in. stroke.

Besides the types we have already mentioned there are the low-service pump, the pressure pump, the fire pump, the mine pump, of which an illustration is given on page 454, the packed plunger pump, the wrecking and draining pump, the power pump, the compound condensing pressure pump, and the water works *engine*. At a future date we shall illustrate some of these, and for the present shall only give a few words in explanation of each. The low-service pump is designed for railroad water stations, oil tanks, and the like, and has plungers of about equal area with the steam pistons. In other respects it resembles the pump shown on page 450. In the pressure pump the single plunger reciprocating in a packing ring is abandoned, and in place of it two solid plungers are employed, one entering at each end of the water cylinder, which is divided in two by a diaphragm. One plunger is driven direct from the piston rod, and the other, which enters the water cylinder at the opposite end, is driven by two side rods which pass outside the water cylinder and are coupled to a crosshead on the piston rod. Both rams pass through stuffing boxes. These pumps are made in all sizes from 4½ in. to 20 in in diameter of steam cylinders The fire pump is of the ordinary type except that the passages are made large to permit of a high rate of speed. The size varies from 100 gallons to 800 gallons per minute. The mine pump, illustrated on page 454, again departs from the standard type; the pump cylinder is divided into two independent cylinders in which a solid ram works, one end being in each. The packing ring is replaced by two stuffing-boxes, and thus all danger of water leakage from one side to the other is avoided. The pump is constructed to work at pressures up to 200 lb. on the square inch, and with steam cylinders from 14 in. to 18½ in. in diameter. The drainage pump has only a single steam cylinder, and does not exhibit the general characteristics of the Worthington system. The slide valve is worked by a tappet arm on the piston rod, and there is no forcing action, suction alone being aimed at. The steam cylinder varies from 6 in. to 19 in. in diameter. The power pump is designed to be driven by a belt, the rods from the pump plungers being connected to a crankshaft. The compound condensing pumping engine has the air pumps arranged in a pit under the bed, and worked by L levers from the crosshead on the piston rod. The plungers emerge at each end of the water cylinder, as already explained, and will force liquid up to 4000 lb. on the square inch. On the oil pipe lines, a number of these engines, varying from 200 to 500 horse-power each, are in constant use, some of them being required to deliver 15,000 to 25,000 barrels per day against pressures varying from 1000 lb. to 1500 lb. per square inch. It is stated that the pipe companies have found the percussive effect of single cylinder pumps causes leakage of their joints.

The Worthington Water Works engine is, in principle, similar to that shown on page 450. It is, of course, in some types, as we have seen, compounded and provided with a condenser, an intermediate reheater and other refinements for the economy of fuel, but these do not alter the essential features of the design. Its duty under favourable circumstances is from 70,000,000 to 80,000,000 foot-pounds, and its regular performance under proper management, may be taken at 65,000,000 foot-pounds per 100 pounds of coal, or reduced to the English standard of 112 pounds of coal, from 78,000,000 to 89,000,000, with 72,000,000 foot-pounds in actual work It in not professed that this is equal to what has been attained by more elaborate designs of engines, but it is contended that when the saving in first cost, buildings, foundations, maintenance, and repairs, is taken into account, the Worthington engine will be found to compare well with all others, and that it is only in special cases that it is surpassed on the bare record.

PRESSURE OR VACUUM FOR CONTINUOUS BRAKES?

To the Editor of Engineering.

Sir,—The battle of the brakes has so far been fought on ground which left room for great diversity of opinion, since the combatants were constantly trying to compare things which were utterly incomparable.

The question was, until recently, should brakes be automatic or non-automatic? Or, were the officers of the Board of Trade right in recommending automatic brakes, or not? There is no doubt that such a question opened a large field for arguments pro and con., and the underestimation of advantages and over-estimation of disadvantages, has made it a matter of the utmost difficulty to arrive at a settlement.

The Westinghouse Brake Company has all along consistently supported the principle of *automatic* action, whereas the Vacuum Brake Company represented the opposition by defending *non-automatic* brakes. The Vacuum Brake Company, however, have since the Penistone disaster, suddenly changed front, and have now openly declared that "on the whole an *automatic* brake is desirable." This declaration has somewhat startled the technical world, and great thanks are due the Vacuum Brake Company for their frank and open statement; the more so because it, to a great extent, simplifies this much-vexed brake question.

Indeed the question is no longer, must brakes be automatic or non-automatic? But simply, must automatic brakes be worked by *compressed air* or *vacuum*? This changes the whole aspect of the problem, and I think it will not be difficult to show which is the proper answer to give. In order to be clear it should be explained that automatic compressed air brakes and automatic vacuum brakes both use air pressure as the motive power for actuating the brakes. In other words, *air-pressure* brakes use air *of* a greater pressure than the surrounding atmosphere, and vacuum brakes use air of less pressure than the atmosphere. The difference might be still more correctly explained by using the words *positive* and *negative* air pressure. But in both cases the medium is air of a certain pressure.

In the case of vacuum brakes the pressure available on the brake piston cannot very well be more than 8 lb. or 10 lb. per square inch; whilst in the case of compressed air brakes 50 lb. or 60 lb. is quite common, and could even be increased if necessary. This great difference in the pressure necessitates the use of vacuum piston surfaces about seven times larger than those for air pressure, and the apparatus consequently becomes much more bulky and weighty To this point I shall refer again hereafter.

This being established, it is further necessary to distinguish between the two elements in the construction of continuous brakes, viz., the apparatus to produce the motive power, and the brake apparatus itself.

The first is generally an air pump for compressed air, and an ejector for producing rarefied air. Sometimes it is also preferred to use air pumps for the production of rarefied air, which shows that on this head there is not much room for logical dispute, the one being considered *as good as the other. This, however, might be said* against the ejector, that one is never certain that it will act at the moment when required, and there is no store of power, whereas in the case of the air pump used for compressed air, it is always evident whether the pump is working or not, and besides there is a store of power which can be relied upon, in the shape of a main reservoir, constantly filled with compressed air, and sufficient for several stoppages. However, this point is not of great moment for the brake question.

Coming to the brake apparatus, automatic brakes require in all cases a *main pipe*, a *brake cylinder*, a *reservoir*, and a *valve* regulating the flow of air from the one to the other; and the only question at issue is as to the proper mode of constructing these parts:

1. The main pipe. This is as simple in the one case as the other, except that the pipe for vacuum is much larger and heavier.

2. The reservoir and brake cylinder. These are in both cases most elementary mechanical parts, and are as simple for air pressure as for vacuum, but the latter of course are *much* more cumbrous.

3. The distribution valve. In the case of air pressure this consists of a valve of peculiar construction called a "*triple valve*," and in the case of vacuum of a valve called a "*ball valve*."* The construction of these valves is quite different, and it would therefore seem as if the whole brake question, so far as the construction of the apparatus goes, would turn upon the advantage of the one over the other, and, in fact, most of the arguments against the use of air pressure brakes are directed against the use of a triple valve. I think, however, that I shall be able to show beyond dispute that this is a misunderstanding, and nothing more.

The advocates of vacuum brakes say, "Look at the triple valve, how complicated it is; and look at our ball valve, of the utmost simplicity." True, but here comes in the question of "efficiency." It would be one of the easiest things in the world to substitute for the triple valve a ball valve equally simple as that in the vacuum apparatus, and there would therefore be no further complaint on account of complication of parts. But the efficiency of the apparatus would undoubtedly be considerably impaired. The brake would become much slower in action, and not nearly so sensitive. The vacuum advocates may be certain that Mr. Westinghouse has quite as great a regard for simplicity of construction as they themselves, but he has also always placed *efficiency* in the first place and *simplicity* in the second, and if the triple valve appears more complicated in construction (although in reality it is exceedingly simple, as shown in Mr. Harrison's report) than the ball valve, there have been very good reasons for making it in its present form, since by its use a degree of efficiency has been attained, such as has never been approached by any other brake.

It is very easy for Mr. Martin to say that his company's automatic vacuum brake is equally efficient as the Westinghouse, but it is impossible for him to prove this, because it is simply untrue. The laws of nature are opposed to it. To any man of common sense it must be evident that a longer time is required to exhaust or fill a brake pipe *and* brake cylinder, than is necessary to exhaust or fill the brake pipe alone, and this only partly; and if Mr. Martin wishes to make an effort to bring his vacuum apparatus up to anything like the Westinghouse brake, he will in the first place have to substitute for the ball valve a triple valve quite as complicated as the Westinghouse triple valve, in order to render it possible to act on the brake pipe alone for applying and releasing the brakes. Mr. F. W. Webb's utterance at the Euston meeting of 1881, that the principle of the vacuum brake appears to be much simpler than the pressure brake, is simply nonsense; and it is astounding that a man of Mr. Webb's standing should risk his reputation as an engineer in putting forward such an absurd theory. Long before Mr. Martin thought of automatic brakes with ball valves, Mr. Westinghouse had passed over and left that ground.

The foregoing clearly proves that all the objections to the so called complications of the Westinghouse brake and its triple valve fall to the ground when properly investigated. The best proof that all the arguments used against complications are worthless, is that in practice the triple valve (which is considered the most complicated part of the Westinghouse brake), gives really no trouble at all, whereas the simplest part of the apparatus, viz., the hose pipe, is the only one causing trouble. This, however, is only a question of material, and is sure to come right in the course of time. It will be clear to all impartial men that automatic vacuum brakes must be just as complicated as automatic pressure brakes if they are to approach to the same degree of efficiency. I say "approach," because, even if vacuum brakes are provided with triple valves, they can then never reach the high efficiency of the Westinghouse brake, for they cannot be so quick in action on account of the low pressure used and the necessarily large capacity of the pipes and other apparatus.

Low pressure entails slow action, high pressure means quick action Vacuum brakes have the further disadvantage of great bulk and weight of the apparatus.

Nothing has yet been said about the cocks in the main pipe, but the reasoning is precisely the same. The advocates of vacuum brakes point to these cocks as a complication which they have not in their apparatus. They wilfully forget that the Westinghouse brake could very well omit these cocks, if those using it were willing to put up with the inconvenience which results from the absence of such cocks, and which is daily experienced by the users of the automatic vacuum brake. Such arguments are very absurd, and it is very surprising to find that otherwise clever engineers in this country have attached any value whatever to them.

One may perhaps account for this ostrich-like policy by mentioning that the Vacuum Company could not conveniently put cocks in the main pipes, even if they would, and it does not require much to prove that they would be very glad to do so if they could. This, therefore, is another disadvantage of the vacuum apparatus.

Finally, a little anecdote might here be given for the purpose of illustrating what has been said above. An engineer of much common sense was endeavouring, with the assistance of a vacuum brake man, to arrange the Smith vacuum brake for the heavy bogie carriages of his line, allowing 20 in. of vacuum, or say 10 lb. per square inch. One Smith sack was out of the question, and two fell short of the power he required. The vacuum man suggested that the diameter of the sacks should be considerably increased, but on account of the enormous bulk and weight of the apparatus this did not satisfy the engineer, who, after pondering over the drawings again, suddenly exclaimed, "Why not use much smaller cylinders and 60 lb. pressure instead of 10 lb.?"

Dux.

* I pass over in silence the leakhole brake of the Midland and Great Western Companies. In that case the hole in the piston acts as a valve which is constantly standing open. This arrangement is so defective, and has been so frequently condemned by the officers of the Board of Trade and other competent persons, that it might fairly be considered as a dangerous contrivance, and one which must before long be abandoned.

AWARDS FOR VENTILATORS AT THE HEALTH EXHIBITION.

To the Editor of Engineering.

Sir,—As we are informed that a *select* number of ventilators have been tested by the jury on ventilation at the late Health Exhibition, for the purpose of assisting them in adjudicating the awards, we beg to state that we know nothing of these tests until they were completed, nor was our air-pump ventilator included amongst those tested. It appears that our ventilator was not the only one excluded, as several other exhibitors of ventilators were also not invited to submit their ventilators to the tests. Now, it would be interesting to know why so many ventilators, ours amongst the number, were excluded from these tests, seeing that they were all sent to the Exhibition for the purpose of competing for prizes?

We are afraid the jury have committed a blunder they will have some difficulty in explaining; for they may depend upon it that the matter will not be allowed to drop until it has been sifted to the bottom. We understand that the method of making the tests was a complete farce, the ventilators being placed inside a tube about 8 ft. long by 3 ft. square, and a blast of air driven on to them by

means of a fan; the bottoms of the pipes attached to the ventilators were also inside the tube. It is scarcely credible that such ignorance amongst professed scientific men could exist in this the nineteenth century.

We have written to Sir Philip Cunliffe Owen, but from our experience of these matters are not sanguine about the result.

We formally protest against the awards given for ventilators on the ground that our self acting air-pump ventilator was not tested, and that we were not invited to submit it for the purpose of being tested along with the others, and that, therefore, the awards given do not show that the ventilators receiving them were justly entitled to them.

We are, &c.,
ROBERT BOYLE AND SON.

64, Holborn Viaduct, November 4, 1884.

NOTES FROM SOUTH AFRICA.

TO THE EDITOR OF ENGINEERING.

SIR,—It must be admitted that the path to the Temple of Truth is always thorny, but when British readers strive to get a true clue to facts occurring in South Africa, they must traverse a genuine jungle before it is possible to clew up the tangled skein so as to be intelligible, for even to those on the spot the situation is most perplexing, and growing more complex every week. The report of the meeting in London, in which Mr. Forster and some well-known Cape authorities were conspicuous, has given colonists hope that the Government will soon take steps to vindicate its honour, authority, and humanity, for all have been seriously impugned by recent deplorable events, which indicate *mala fides* on the part of the Transvaal Volksraad. It is even suspected that this body will connive at the acquisition by Germany of a footing in St. Lucia Bay, after the fashion of Little Popo, Cameroons, and Angra Pequeña, where slight disaffection has already been exhibited by the population. The energy shown in the annexation of Escardos, Forcados, and Ramos, in the Bight of Benin, is a trifle surprising after the apathy manifested about the partition of our border territory by bands of pure filibusters, who do not even rank with Texan cowboys in manly qualities, but seem to be on a par with the Greek bandits who butchered the Vyner party. Here the victims lack powerful friends, and so spoliation and murder has had its saturnalia. The leaden feet of Justice may, however, be approaching to deal out retribution, and to stay the destruction of native friends and allies, otherwise the position of Natal will become precarious To-day we have a private advice from Thaba N'chu, stating that the Basutos are well armed with Martini and Winchester rifles, and would buy Hotchkiss carbines if they could, as they incline to retaliate on the Free State, for the late sudden seizure of the Baralong country, where hundreds of horses were taken and sold for the benefit of the depleted treasury. Matters certainly look cloudy in that rocky country, and Free State farmers are already advised to prepare for the impending storm.

The State has recently emptied its coffers in building handsome bowstring bridges of steel over the Caledon and other rivers, which will be most useful to wagoners, but do not promote railway enterprise, which is resolutely opposed by an obstinate clique in the Volksraad, dreading the wedge of English ideas and the march of progress. These worthies are genuine Rip Van Winkles of the first water, and cling to the practice of their ancestors, as it saves the trouble of thinking and conserves tissue. They have a decided objection to acceleration and innovation, as they hear unpleasant accounts of the effect of our high-pressure system of education, which is not happy. However, the locomotive whistle will soon sound at Aliwal and be heard across the broad Orange River, as Firbank and Co. are completing the steel track at a great rate. The Cyfergat coalfield is already linked to the border line, which will be opened to Burghersdorp by the end of the year. Mr. Hopkinson, who has represented the contractors on the Port Alfred Railway, is proceeding to Aliwal, and will act as maintenance engineer north of Queenstown, the line being 90 miles thence to the Orange. All the engines use the local fuel, which is found to improve in heating power, but is still shaly. The mine is worked on the adit system, and chiefly by native labour. Signs of copper have been found in the district, but no lodes to equal those near Maritzburg, which are said almost to rival those of Mitchell's Reef, eight hours from Sydney, where several smelting furnaces are erected. The Natalians seem sanguine about the Swartkops deposit, which is being opened by Cornishmen. The ore can reach Durban in about six hours from the mine. Natal is showing energy in tea-planting, and the Kaffrarians find that the shrub also suits their beautiful hill-slopes, where wine-making has been established with encouraging results. Ensilage is now proved in the colony, and a large silo will soon be opened by Mr. Irvine, near King William's Town. Hereford cattle have recently been brought out by the steamer Trigon, and sent over 100 miles up the line.

Kaffrarian farmers maintain an Agricultural Chronicle at Cathcart, and we hope to see them emulate Australia by importing Percheron stallions and Scinde camels, as the country suits ostriches and all kinds of stock. The Fingo people make rapid advances in agriculture, and now raise many pigs, and a variety of grain and root crops. They also erect schools and chapels, under the guidance of Captains Blyth and Hook, and Mr. Levey, resident magistrates of the Transpei, which abut on the splendid region of the St. John's River, about to be opened to commerce. By an outlay of 20,000*l.* the grand river can be made permanently viable for cruisers of the Comus and Leander class, as it has a 40 ft. channel inside, with high cliffs, like those at Clifton, but far grander. The twin-screw Lady Wood now runs there from Natal and East London, but a dredger is urgently needed to improve the entrance off Porpoise Point The Priestman grab dredger now in the Buffalo should be moved there, on the arrival of the Simon's "hopper," now clamorously demanded by the depressed community at East London, which sees all the heavy outlay of years inoperative in improving their estuary. Until a clearance is effected, Kaffraria remains congested, and her rich coal mines unavailable for exportation. The country has also a repute for fine wheat and maize. Cotton will likewise grow well, as the Peruvian variety thrives near Port Alfred, to which seed has been sent by Mr Flannery, London and Liverpool. In the Albany division two crops of wheat can be raised annually, and in passing through last month on the locomotive "Bathurst," from Leeds, we saw excellent crops following the bounteous rains. Other bogie engines are expected from Hunslet, so as to cope with the Christmas holiday traffic. When the British Association holds a scientific synod in the palatial Parliament House at Cape Town, the members will find plenty to see in South Africa, and obtain a reception equal to the Canadian, for the Saxon element is still strong One Montreal paper contemplates a future session at Sydney or Auckland, and it is well to remember that we are only twenty-one days from London and other British cities.

The Tartar, Mexican, and the stately Castles are both splendid and speedy, with space to stow a hundred *sarans* most comfortably. No doubt Sir D Currie would be pleased to come out as cicerone to Kimberley, Albany, and Natal, for he has often promised to visit Africa, when the times are propitious. Next year our mineral prospects in the Transvaal will be defined, and perhaps our political platform may be planked permanently, so that investors can act courageously. At present the natural timidity is both paralysing and destructive to British interests, whilst immigration has practically ceased. The poverty of the colony and the extinction of respect for English authority has caused such a development of robbery by the natives that in some districts farmers are migrating to the Free State, as they cannot bear the losses, and obtain no protection from the executive. The promotion of canteens has wrought much havoc, and the substitution of fiery brandy for the simple native beer, which looks like thin gruel, has produced most dire results. Missionaries, magistrates, and schoolmasters protest, but all progress is proscribed, for the delusive revenue from the Excise Tax, which paralyses measures of reform elsewhere Thus the Government creates hordes of thieves, miscreants, and murderers, whilst agriculture, its true backbone, cannot obtain decent labour, and is crushed by ceaseless degradation, without liberty to employ means of self-protection. In a Dutch republic, stock thieves are liable to be shot, so property enjoys fair respect. Attempts are to be made in the fair forest district of the Knysna to set forth its attractive features for the restoration of invalids, as well as for the residence of small capitalists The country will soon be served by the Cape Central Railway, now making from Worcester to Swellendam, after the plans of Mr. R. Elliott Cooper, Westminster, the engineer of the Port Alfred Railway, and of the Sutton Harbour Works, Lincolnshire. It is also within a few hours' easy drive of Mossel Bay, where all the Union and Currie mail steamers call, to discharge cargo. There are several famous hot springs, the country abounds in clear rivulets, fine timber, fruits, tobacco, and cereals, and the climate is perfect. The beautiful mountain ranges are also auriferous, and small nuggets are being found

To become an industry, machinery is, however, necessary, and Dutch farmers confine themselves chiefly to the vine, maize, tobacco, feathers, and wool. Knysna Harbour can be safely entered by steamers of 15 ft. draught, and it is very spacious with good leading marks. The cutting of railway sleepers is an industry, the yellow wood almost rivalling Italian oak, but not quite so heavy and close grained. We have initiated the growing of the *Catalpa speciosa*, which is cultivated on the Texan railways, for sleepers and fencing posts. Memel ties are used on the Komie Railway, which is well equipped at the sea depôt with workshops, engine house for six, and a neat station, and goods sheds Old rails with a double slot, have been utilised for indicating gradients by a movable strip, the post being whitewashed and the zinc painted The cantilever bridge near Grahamstown is a noble structure, and worthy to rank with some fine spans on the Aarlberg Railway. It is nearly 200 ft. high, and was furnished by Messrs. Handyside and Co., Derby, a work of the same type is desired over the Buffalo at East London Mr. H. Parker, who put up a bridge from Derby, over the Murray at Albury, erected the Blauwkrantz Viaduct, in which he was aided by Messrs. Hopkinson, Cotterell, and other experts of the scientific staff, who all received tributes of praise for zeal, skill, and energy. As the cantilever appears on the Fraser River, the Ohio and Niagara, it will no doubt take the lead in pontine constructions, as it dispenses with scaffolding Near the pretty city of Grahams town, the Milwall Company contributed a trio of beautifully finished plate girder spans of 50 ft by 16 ft., with the new corrugated flooring. There is an arched bridge of stone and brick, close to town, and regular traffic has begun over the 42 miles. The mouth of the river has much improved, and will probably have a channel with 20 ft. in a few months, as the walls extend. Coasting steamers now enter frequently, and also trading ships from Mauritius and Adelaide. The s.s. Kennett is now here from China, and proceeds to England. A steamer has also brought us 100 cases of Tasmanian jam, but wheat is desirable, as our large steam mill is standing, owing to the want of overdue cargoes from India and Zealandia. The machinery is on the roller pattern, from Manchester and Hamburg. Violent gales early this month caused the barque Paz to go ashore here, and also five cargo launches We also hear of a tremendous sea breaking near Melbourne, which compelled H M S. Nelson to change her course The volcanic drift from Java is now reaching our shores and abounds in Durban Bay Heavy masses are reported by vessels from the eastward. We have accounts and diagrams of the Tasmanian ketch employed by Sydney firms to transfer live fish from Launceston to the coast of New South Wales, and the example is instructive. At the Cape Exhibition a few fish have been shown in tanks, but several broke down when the affair opened. It is now popular, and has promoted railway excursions. Sea fishing is yet a small industry here, but it may grow, for the Mauritius trade Excellent soles are taken by steam trawling, which is followed intermittently.

Irrigation work is advancing in the valley of the Sundago River, whence we shall receive superior tobacco, cigars having already been made by an amateur. Vines have also been planted freely, and the maize is truly amazing, both for altitude and mass Polled cattle should thrive there, as well as at Totara, New Zealand, where we read of a noble herd, for the ordinary breed of the country fatten quickly The s.s Nuddea is loading railway material at Cape Town for Egypt, and made a good run from Bombay We also hear that the Anglia has proceeded to Alexandria, and we have here the Pretoria in place of the disabled Spartan, which the Anglia paddle towed to Southampton from Funchal By the Pretoria it is probable that Messrs Watson and Rose, our railway engineers, will accompany Captain Owen to England This gentleman has just returned from the Baltimore service, which was found to be unremunerative. We hope that the Union Company may have better fortune elsewhere, and the opening of a bed of steam coal in Somerset should be beneficial to Southampton in the competition starting between Swansea, Holyhead, Preston, and Bristol, for ocean traffic. No coal has been struck here, although the late Professor Hochstetter, of Dunedin, said that it ought to be found near this port at Balmoral

The Mangold Boring Company are very busy with steel drilling machines, and despatch them frequently inland, for artesian borings They are also constructing a pumping windmill with iron vanes of helical form Our farmers are importing Australian rams, and begin to see the great boons conferred by fencing Messrs. Hermiele wiez and Co, 47, Moorgate street, of fencing fame, send us works on ensilage, which have assisted our local society in starting a model silo. The colony still suffers from scab in sheep, and small-pox and other dangerous diseases among black and white We hope that the boracic acid treatment may help to curb, and finally to suppress, these blighting sporadic pestilences, which result from curable causes.

With the lunar eclipse, splendid rains have extended widely, removing dread of drought, and if a firm policy is pursued towards the freebooters on our borders, a general rally may be firmly anticipated; for the lambing season has been good, the sowing of cereals extensive, the vines are most promising, and large diamonds are constantly reported, whilst the coal mines pay a dividend, and salt figures in our exports, steadily in the ascendant The great desideratum is recognition by the Imperial Government of its duties to this great and promising country, which is very loyal, although sorely tried by studied neglect and brutal rebuffs, and is intrinsically as valuable to the English nation as Australia, added to its better climate and facility of access Its claimant defect is financial weakness, which can be gradually remedied, by judicious action on the Thames.

Yours truly,
Algoa Bay, October 13, 1884 P. FRANCE

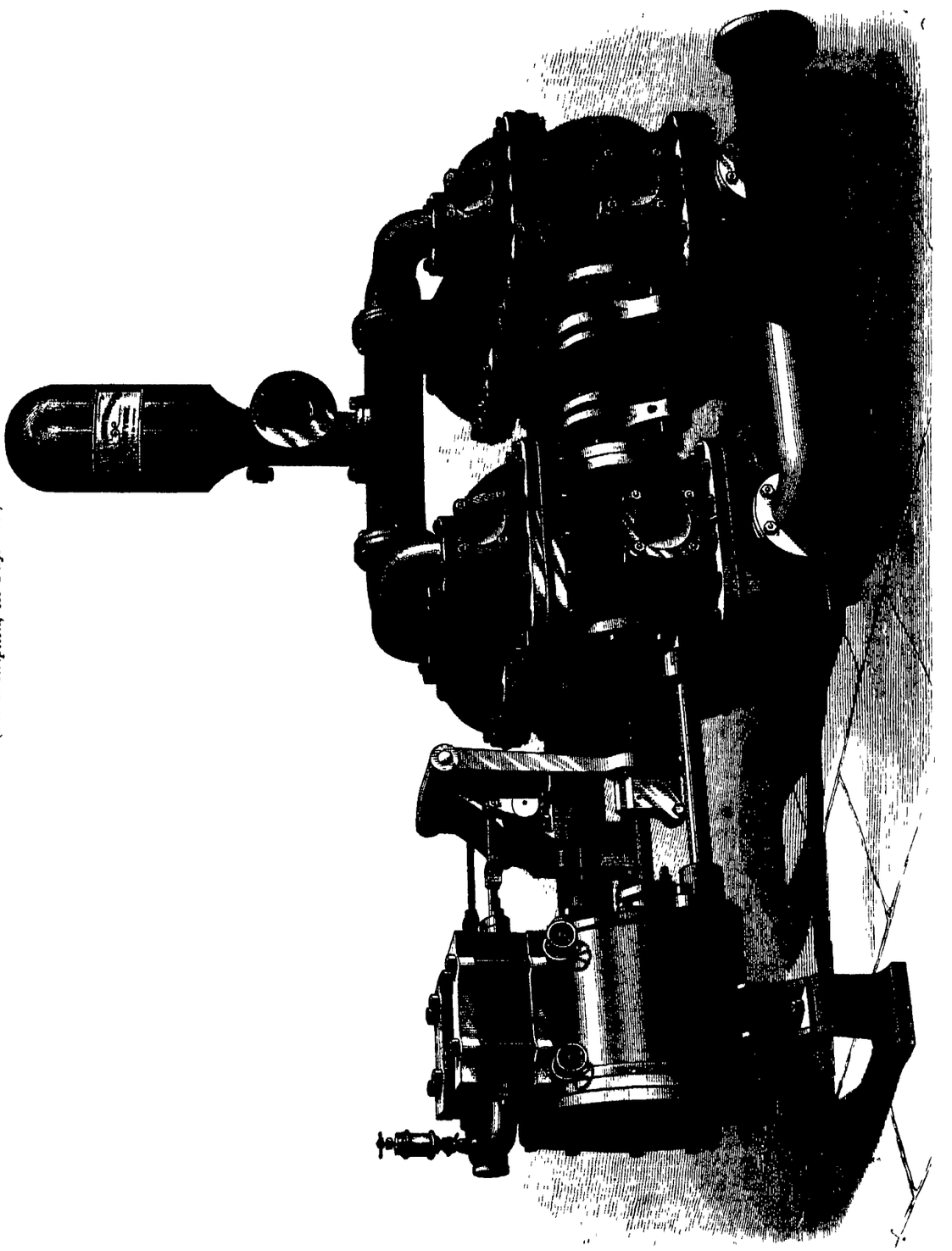
P S.—We await the Arawa with some interest and note the thirty one days' run of Sorata from Adelaide to Plymouth

BRIDGING THE OHIO.—A bridge which the Louisville and Nashville Railroad Company is constructing across the Ohio at Henderson, Kentucky, is approaching completion The bridge proper will be 3686 ft. long, with a trestle approach on the Indian side three miles long, which, together with the Kentucky approach, will make the length of the whole structure over four miles The nature of the foundation necessitates the use of caissons for the commencements of the piers, the excavations being made by men working inside of the caissons in compressed air, as was the case with the great bridges at St Louis and Brooklyn. The work was taken in hand by the railroad company on April 15 of this year, owing to the slow previous progress made by the contractors. But four of the foundations had then been secured, and three caissons rested on the river bed out of position—3 ft out of level and 10 ft. below the surface of the water Great expense and delay were occasioned in recovering these sunken caissons. Seven foundations are now secured, and work is being done on all of the fifteen foundations. Pier No 2 has been finished, piers 3 and 4 were completed in September, and piers 5 and 6, the large piers of the channel span, were expected to be completed by October 1 The timber trestles for the first span of ironwork are up, and two of the bridge spans were erected last month Some 920 men were employed during July, about 300 of these were at work in compressed air The foundations for nine river piers are carried by pneumatic process to a depth of 30 ft. below the low water In two instances 8 ft. of this distance is through solid rock. The caissons are all bedded in the rock of the river bed The rockwork has made the process of sinking slower than usual in pneumatic work About 100 yards of stone are delivered daily, and the masonry is laid as fast as secured More than 1,500,000 ft. of white oak timber and 450 tons of iron have been used in the nine caissons of the river piers. More work has been done in stone this season than had been accomplished by the contractors in two years' work, and five of the piers are now above the highest flood stages of the Ohio.

THE WORTHINGTON MINE PUMP.

CONSTRUCTED AT THE HENRY R. WORTHINGTON HYDRAULIC WORKS, NEW YORK.

(*For Description, see Page 450*)





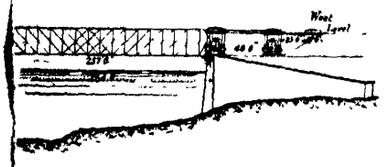
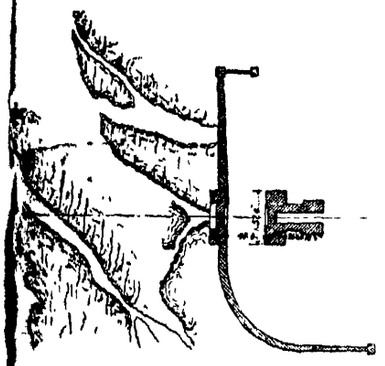




Fig 3



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We beg to announce that we have appointed the firm of John Wiley's Sons, 15, Astor Place, New York, the sole agents for ENGINEERING in the United States, and all subscriptions for the United States will in future be payable to them. They will also be prepared to receive advertisements for ENGINEERING, and will afford full information as to terms, &c, on application.

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The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

NOTICES OF MEETINGS

THE INSTITUTION OF CIVIL ENGINEERS.—Ordinary meeting, Tuesday, November 18th, at 8 p m Paper to be discussed: "Electric Lighting for Steamships," by Mr A. Jamieson, Assoc M Inst. C.E., F R.S E.

THE SOUTH WALES INSTITUTE OF ENGINEERS.—Thursday, the 20th inst., at the Royal Hotel, Cardiff The chair will be taken by the President, at twelve o'clock The minutes of the last general meeting will be read and confirmed. Candidates for admission as members will be balloted for, and the names of those elected will be declared New members who have been previously elected will be called to sign the roll book, and be formally admitted by the President. The names of the office bearers, retiring by rotation, for the session 1883-84, will be declared by the President. Office bearers, to succeed those retiring by rotation, will be nominated for election at the next annual meeting Two auditors will be appointed. The following papers, read at previous meetings, will be discussed: "Hot Blast Stoves," by James Colquhoun, F G S., President; "An Improved Type of Vertical Boiler," by Mr. Marcus Moxham; "Endless Rope Haulage adopted at the Clifton Colliery, Nottinghamshire," by Hort Huxam, F.G S., M. Inst. C.E., "Notes on Deposit of Iron Ore, at Marbella, Province of Malaga, Spain," by Mr William Mitchell Vivian. The following papers will be read: "Improvements in Coal Washing," by Mr. R. de Soldenhoff, "Miners' Safety Lamps, compared with the 'Morgan' Lamp," by Mr. A. Steer (through the secretary), "Ambulance Work in connection with Collieries," by Mr. C Henry James.

ENGINEERING.

FRIDAY, NOVEMBER 14, 1884.

AMERICAN SANITATION.

AN exhibit worthy of more than passing attention in the Health Exhibition, was that of our respected contemporary, the *Sanitary Engineer* of New York. On the whole the United States was but poorly represented at the late Exhibition, in this respect affording an unfortunate comparison with the Fisheries Exhibition of last year. We believe the failure of the American Government to make a more imposing appearance, was due to the fact that the official invitation to contribute was not received in time for necessary formalities to be gone through in order that the requisite appropriation of funds should be made. In this difficulty the proprietor of the *Sanitary Engineer* undertook to fill the gap as far as possible, and, although no exhibits of a very practical or substantial nature were procured, in the short space of four days a sufficient collection of official publications and other matter of a similar nature was got together to fairly well represent the progress of sanitary science in the United States.

Mr. Henry C Meyer, the editor and proprietor of the journal in question, is well known in America from the prominent position he has always taken in matters of sanitary reform, a subject which has there been attracting considerable attention during the last year or two, and in which, we may here remark, the New York Legislature appears to have adopted a more vigorous course of action than our own Government has thought fit to take

The capital city of the United States is governed, so far as sanitary matters are concerned, by the New York City Health Department, in which Professor Charles F Chandler appears to have been the leading spirit Dr Chandler was first made chemist to the New York Board of Health in the year 1866. In 1873 he was appointed president of the Board by the mayor of the city, and was reappointed for a second term in 1877 Last year he was again nominated president by the mayor, but the aldermen rejected the nomination

The present Board of Health, which has now been in existence for ten years, consists of four members, viz., the health officer of the port, the president of the Board of Police, and two health commissioners, one of whom is a practising physician. One of the most pleasing features in the composition of this body is the entire harmony with which its members have always worked together, for on only one occasion has the decisions of the Board been other than unanimous.

Four years ago a Board of Health was established for the State of New York also, and the president of the City Board became a member and chairman of the Sanitary Committee. The two Boards have acted in harmony and several salutary laws have been passed In May last year, a writer in the *Sanitary Engineer* claimed that New York had the most complete sanitary organisation in the world To carry on the work there are inspection, vaccination, and engineer officers, a disinfection corps, &c, numbering in all 125 persons, besides which there are 50 physicians and 30 sanitary policemen. There is also an extra corps of disinfectors and fruit inspectors employed in the summer. The appropriations for the year 1883 amounted to 500,000 dols. This sum includes moneys spent on hospitals.

We have said that New York is "governed" by a Board of Health, and we used the term advisedly. One of the first Acts of this Board after its organisation was to commence an active crusade against the stench nuisances The first attack was made upon the New York Rendering Company, which held the contract from the city for the removal of offal and dead animals beyond the city limits. The company, instead of complying with the terms of the contract, "rendered" the offensive material at the foot of West Thirty-eighth Street. The Board directed that this should at once be put a stop to and the material should be carried beyond the limits of the city. At first it was claimed that this was impossible, but when policemen were placed on the dock with orders to arrest the workmen if they continued the work, the company placed the material on a vessel, carried it down the bay, and threw it overboard. Most of it floated ashore and it became the cause of worse offence in new localities. As the company insisted it must either "render or dump," the Board declared the contract violated, and made another with other persons to carry all the material to Barren Island; an arrangement which has been in force ever since, with entire satisfaction.

It is really refreshing to read of such plain dealing in these days when vested interests, if supported by sufficient impudent persistency, are allowed to override public convenience, but better is yet to come. "The Rendering Company," proceeds our New York contemporary, "still retaining possession of the dock at the foot of Thirty-eighth Street, placed every obstacle in the way of the new contractors, and it became necessary to seize all their movable property, put it upon two hulks which had been tied to the pier, and tow them over to the New Jersey shore This resulted in a suit for over 100,000 dols, in which the Board was successful."

The active policy thus inaugurated was continued by an attack made upon a hulk known as the Agongum, which lay at the foot of Thirty-ninth Street, and was used for the purpose of rendering offal from slaughter-houses. Orders had been issued directing the owners to discontinue the business These were resisted, and the proprietors had the hulk moved out into the stream, where the offensive work was carried on out of reach of the official inspectors The Board met this manœuvre by making a night attack on the trucks engaged in carrying the offal to the end of the pier, but this step not proving sufficient to stop the business, a steam tug was obtained and the Agongum was towed to Barren Island and there tied up fast The business then came to an end. A gut-cleaning establishment next received attention, and remonstrance or threats proving vain, the Board adopted the simple expedient of sending a gang of labourers, who pulled down the buildings and burnt the materials "Fat-melting and lard-rendering were sharply followed up until every establishment engaged in the business was either suppressed or compelled to introduce improved machinery, by which the operations were rendered inoffensive."

The slaughter of cattle next attracted the attention of the Board, and through its action well-appointed abbatoirs were substituted for the small and offensive slaughter-houses which before were scattered throughout the city. The completion of this salutary reform was, however, retarded by the action of influential people and bodies, whose interests were threatened These persons succeeded in enlisting the press on their side and managed to considerably influence public opinion against the proposed reforms The Board, however, was not to be turned aside from the work it had cut out for itself, and benefitted the public in its own despite, although the reforms ultimately carried out were not so complete as they were intended to have been At present slaughtering is restricted to a few blocks on the East and on the Hudson rivers. For years it was customary to allow the blood from the slaughtered animals to run into the street gutters, but this the Board has stopped, and drying machines have been introduced by which it is inoffensively converted into a powdered fertiliser. The storage of stable manure proved one of the most difficult problems the Board had to deal with. For years it had been customary to accumulate the refuse in huge piles in one the most populous parts of the city These heaps of filth were soaked with water when it rained, or in summer putrefied under the rays of the sun. From time to time the disgusting mass had to be turned over to prevent it from burning through spontanous combustion, and the whole remained for months at the yard until it was in the required condition for use When the Board declined to allow this storing, the contractors tried the usual move (so generally successful in our own country) of creating a second greater evil in order to frighten the authorities into tolerating the original nuisance Pursuing this course the contractors refused to take away the manure at all, and each stable thus became a centre of offence But the Board was not to be intimidated, for it had successfully combatted such tactics on previous occasions, and, after a good deal of litigation, succeeded in banishing all storage heaps of manure beyond the city boundaries

The arrangements for removing nightsoil were not, when the Board came into power, very much more satisfactory than those for the disposal of stable refuse. A contract had been made by which the city, for the sum of 4000 dols. per annum, agreed to deliver to works on the Hackensack river all the nightsoil collected by scavengers from the 25,000

privy vaults of the tenement houses. The persons interested in these works had secured the contract for carrying the material at a cost to the city of 50,000 dols. a year. The work was performed badly, and caused great annoyance, so the Board declared the contract void and made other arrangements. The results was that a suit for the recovery of damages to the amount of 300,000 dols. was instituted by the contractors against the Board, but was successfully defended.

It would take too much space, interesting as the details are, to chronicle all the onslaughts made by this fighting board of official enthusiasts. One by one the many snug abuses which had grown up beneath the shelter of governmental apathy and neglect fell before their attacks. The noxious fumes of petroleum refining were banished from within the city boundaries, produce markets were no longer choked with garbage, contagious diseases were legislated for, plumbing and draining were looked after, and the sickening odours of the fertiliser factories were routed from their strongholds All this was not done without many bitterly contested battles in which the defenders exhausted all the resources of passive resistance, violent reprisal, and legal obstruction; indeed, at one time the Board found itself successfully indicted before the grand jury. But a hearing was obtained before Judge Sutherland, who promptly set matters right.

We cannot, however, leave this part of the subject without quoting one more episode in the history of this crusade against unsavouriness. Surrounding Washington Market, and covering half the roadway, were rows of two-story structures wholly given over to uncleanliness. Many efforts had been made to remove them, but without success. They are described as having been in "a filthy condition," and "great quantities of garbage had accumulated beneath them, giving rise to offensive odours tending to taint all food supplies exposed for sale in the market." After all peaceful methods had been tried in vain the Board decided to resort to force. As a violent resistance was anticipated, 150 carpenters and labourers, 300 policemen, and a couple of surgeons were led one evening to the spot by Dr. Chandler. Before morning the buildings were levelled to the ground, and the materials carted away to the corporation yards and burnt. In consequence of this night's work a suit for 60,000 dols. was instituted against the city authorities, but was successfully defended.

All these that we have narrated are indisputably high-handed proceedings, which little accord with our old-world ideas of reverence for vested interests. But in New York things are viewed in a different light, and ancient usage does not appear to be construed as prescriptive right to infect a whole neighbourhood with foul emanations by factory processes.

In New York, as in London, the "bitter cry" of outcast dwellers in the slums and purlieus of the city, has found expression in public agitation, and in America, as with us, the enterprise—although perhaps we might more justly say the philantrophy—of the proprietors or literary staff of a newspaper has served to reveal to the well-to-do classes the unimagined hardships of abject poverty. The part played by the *Pall Mall Gazette* in London had its counterpart in the action followed by the New York *Sanitary Engineer*. The proprietors of the latter journal and a few public-spirited citizens, struck by the misery caused by overcrowding in tenement houses,* offered a prize for plans of improved dwellings of this class capable of being erected on an ordinary city "lot," the dimensions of which are 100 ft. long by 25 ft. wide. The competition attracted a great deal of attention, no less than 190 architects sending in designs. These were exhibited at Clinton Hall, and although it was considered that the plans were a great improvement on anything then existing, it was also seen to be impossible to secure the requirements of physical and moral health within the narrow limits of an ordinary city lot, so long as the law stood as it then existed, and if it were stretched to its limits by the builder. The public interest aroused by this competition enabled an amendment on the Tenement House Act to be passed through the State Legislature, by which amongst other things it is required that only 65 per cent. of each lot shall be built upon, that all bedrooms shall have windows directly open to light and air, and generally that the Board of Health should have additional power to check abuses. The consequence has been that the condition of the poorer classes has been much improved, and it is no longer possible, as was formerly the case, for owners of wretched rookeries to grow rich on the miseries of those unfortunate beings who are too poor to make any effort to protect themselves.

Plumbing and draining have naturally occupied a great deal of the Board's attention. In America we hear of the same evils that exist in this country. Not only was work defective in execution, but it was generally found to be radically faulty in principle, and the Board undertook experiments to find how best to remedy the evils. The conclusions arrived at appear to have been in general principles about the same as those entertained by competent sanitary authorities in this country; a general idea of which may be obtained from the description of the sanitary and insanitary model houses in the Exhibition, which appeared on page 182 of our current volume. The practical result which followed the experiments of the New York Board, together with the action of the Sanitary Reform Association of that city, was that a law was passed which provides that the plumbing and draining of every building erected in New York should be in accordance with a plan previously approved by the Board of Health The rules adopted were matured after consultation with the best plumbers, architects, and sanitary engineers, and have proved so far satisfactory that they have been also adopted by many other large cities in America.

Such an uncompromising sanitary reformer as Dr. Chandler could not fail to arouse the enmity of all that numerous class which thrives on foulness and abuse. These disciples of uncleanliness have been too strong at last for the Quixotic professor; influences have been brought to bear, and the "Empire City" seems like returning to wallow in its own mire.

* Two-thirds of the deaths in the city occur in that half of the population which resides in tenement houses.

THE BOILER EXPLOSION AT BILSTON.

One of the most disastrous explosions that has occurred for some time took place at about eight o'clock on the evening of Wednesday, the 5th inst., at the works of the Staffordshire Steel and Ingot Iron Company, Limited, Spring Vale, near Bilston. The explosion resulted in instant death to three persons, and serious injury to about eight others, while the damage to property is variously estimated at from 10,000*l.* to 15,000*l.*

The peculiar feature of the explosion is that three boilers burst almost simultaneously, the boilers in question being the three outer ones in a group of ten, and numbered 1, 2, 3, reckoning from the right-hand side. The whole of the boilers were of the plain egg-ended type, fired internally, and measured about 35 ft. in length over all, by 6 ft. in diameter, and ½ in. in thickness. The boilers were of iron throughout, with the exception of one plate over the fire, measuring 6 ft. longitudinally by 8 ft. circumferentially, which was of steel The cylindrical portion of the shell consisted of nine belts of plating, each belt being in two plates double-rivetted at the longitudinal seams, and single-rivetted at the ring seams. The boilers were made by Messrs. Pigott, of Birmingham, and have only been working about six months. The pressure at which they were worked was 80 lb. on the inch. Each boiler is fitted with two open lever safety valves 3½ in in diameter, one glass water gauge, three test cocks, one feed valve, a steam stop valve, a brass gland blow-out cock, and a dial pressure gauge ranging to 100 lb. The boilers were insured for 1000*l.*, on what is known as the group system, in the Mutual Boiler and Employers' Liability Insurance Company (Limited), Manchester.

On examining the fragments it was seen that boiler No. 1 was severed into three portions at the ring seams of rivets, the front egg-end along with the first three belts of plating being shot forwards about 250 yards; the remaining portion of this boiler had severed at the ring seam uniting the fifth and sixth belts of plating, the two fragments being shot backwards about 50 yards. Boiler No. 3 was divided in two at the ring seam uniting the second and third belts of plating, the front egg-end along with the first two belts being blown about 320 yards forwards while the remainder of the boiler was thrown about 20 yards in the opposite direction. In the case of boilers Nos. 1 and 3 the rents are in each instance circumferential, and run through the ring seams, while the fragments are thrown fore and aft. In the case of No. 2, however, the fragments are all thrown in a backward direction, while it is evident that the boiler failed in the first instance longitudinally, the primary rent running through the solid metal across the third and fourth belts of plating at the left-hand side and just below the crown of the external brickwork flue. This piece of plating was torn completely out of the boiler and thrown about 40 yards to the right, the first two belts of plating along with the front egg-end being also thrown in the same direction, while the remainder of the boiler was shot backwards about 40 yards.

As to the cause of the explosion we think there can be no two opinions amongst those who have seen the fragments and are qualified to judge. At the part where the primary longitudinal rent occurred in No. 2 boiler, the scale is burnt off for a width of about 20 in., and the plate both on the fire and water side discoloured, while a similar discolorisation observable at the same level on the opposite side of the boiler leaves no room for doubt that the plates at this part have been overheated in consequence of the water level in the boiler being too low. How the shortness of water occurred is a point on which we hardly feel qualified as yet to express a definite opinion, but it will no doubt be fully investigated by those who are conducting the legal investigations. We are aware that "overheating through shortness of water" is frequently put forward as an explanation for boiler explosions, and often covers a multitude of sins, in the shape of wilful recklessness and neglect, and we are always chary of accepting this explanation till it is proved beyond dispute. In the present case, however, we think the evidence in favour of shortness of water is too clear and convincing to permit of question. Had the bursting of No. 2 boiler been due to excessive pressure, the primary rent would have occurred in all probability at a longitudinal seam. At all events we do not see how it could have started in the solid plate We may add that there were no signs of the plates being wasted by corrosion in any of the boilers. We think there can be little doubt that No. 2 boiler burst in consequence of overheating through shortness of water, and that the shock consequent on the explosion was so great that the boiler adjoining it on each side burst also.

The explosion is being investigated by the Board of Trade under the Boiler Explosions Act, the Parliamentary inquiry being conducted by Mr. Thomas W. Traill, the engineer surveyor-in-chief, in conjunction with his assistants, Mr. Peter Samson and Mr. James Ramsey. The inquest on the bodies of the three men who were killed was opened on Saturday last, but after formal evidence of identification had been taken the inquiry was adjourned to the 20th inst., in order to permit Mr. E. B. Marten, C.E., who is making an investigation on behalf of the coroner, to prepare his report.

The fact that the explosion arose from the bursting of three boilers almost instantaneously has excited considerable interest, and the scene of the disaster has been visited by the chief engineers of nearly all the boiler insurance companies. The subject of compound boiler explosions is an interesting one, and we propose to deal with it more fully in a future article.

ALTERNATING CURRENT MACHINES IN PARALLEL CIRCUIT.

In a lecture delivered last year at the Institution of Civil Engineers, Dr. J. Hopkinson, F.R.S., considered the theory of alternating current dynamos, and showed that if two such machines are coupled in series they will tend to nullify each other's effect; whereas if coupled in parallel they will assist each other In other words, he demonstrated that you may not drive alternate current machines "in tandem," but that you may drive them as a pair, or indeed any number abreast. If this latter condition is fulfilled there need be no more difficulty in feeding a system of conductors from a number of alternate current machines, than there is in feeding it from a number of continuous current machines. A little care only is required that the machine shall be thrown in when it has attained something like its proper velocity. A further corollary to his investigation is that alternate currents with alternate current machines as motors, may theoretically be used for the transmission of power.

These conclusions are very important, because

they show that one very large alternate current machine is not absolutely essential to the supply of a large electric lighting system worked by alternate currents; and that a number of small machines may be coupled together for this purpose.

In a second paper read before the Society of Telegraph Engineers yesterday evening, Dr. Hopkinson has again reverted to this subject and illustrated it more fully in a mathematical sense.

We need not follow Dr. Hopkinson in these equations, which will be found in his published paper, and in his article on Electric Lighting in the current edition of the "Encyclopedia Britannica." Our concern is rather with the results at which he has arrived, and especially those of a practical nature. Such, for example, is his proof that it is desirable in working arc lamps with alternate currents, to have the potential of the machine materially in excess of that required to maintain the arc; and that it is erroneous to estimate the power developed in the arc by replacing it by a wire resistance, and adjusting the latter till the current as measured by an electro-dynamometer is the same as with the arc, then assuming that the work done in the arc and the resistance are equal. The work done in the arc is proportional to the arithmetical mean value of the current taken without regard to sign, which is a different thing from the mean current as measured by electro-dynamometer.

Passing from these theoretical points, and also his proof of Dr. Muirhead's observation that the effect of an alternate current machine can be increased by connecting it to a condenser, we come to the principal subject of Dr. Hopkinson's recent paper, namely, his actual experiments to verify the proposition that two alternate current dynamos can be advantageously connected in parallel. These trials took place last summer with two De Meritens machines intended for the lighthouse of Tino, and supplied by Messrs. Chance Brothers and Co. Each machine has five rings of sixteen sections, and forty permanent magnets. The resistance of the whole machine, as connected for lighthouse work to feed a single arc, was 0.0313; its electromotive force, when running at 830 revolutions per minute, was 95 volts. The two machines were driven from the same countershaft by link bands, at a speed of 850 to 900 revolutions per minute, and at the very first attempt the experiment succeeded. As the speed increased, a pilot incandescent lamp, connected across the terminals, lit up intermittently, but in a few seconds more the machines dropped into step together, and the lamp lighted up to its full brightness and burned very steadily. An arc lamp was then introduced and a perfectly steady current of over 200 ampères drawn off without disturbing the harmony. In fact, Dr. Hopkinson has come to regard coupling two or more De Meritens machines in parallel, as practically the best way of obtaining exceptionally great currents when required in a lighthouse for penetrating a thick atmosphere.

THE JOHN COCKERILL COMPANY.

Another autumn has brought with it another report from the directors of the John Cockerill Company. The results disclosed in regard to the working operations of the past year are scarcely so satisfactory as those attained for the preceding twelve months. Nevertheless, the shareholders do not appear to have much reason to complain. The company's order book was filled during the last twelve months upon relatively less advantageous terms than in 1882-3; at the same time, the Council of Administration deemed it advisable to take orders so as to work on from day to day and afford employment to the staff which it is desirable that the company should retain. In spite of every obstacle, the company realised a profit of 124,684*l.* in 1883-4, the production which resulted in this profit representing a value of 1,544,670*l.* In 1882-3 the directors obtained a profit of 191,441*l.*, with a production of 1,707,130*l.* After making sundry statutory redemptions, and after adding dividends on investments and sundry miscellaneous receipts, the definitive balance at the credit of the profit and loss account for 1883-4, was 124,431*l.*, as compared with a corresponding balance of 149,850*l.* in 1882-3. From the balance of 124,431*l.*, representing the definitive profits of 1883-4, the Council of Administration further deducted 43,259*l.* for depreciation of premises and tools. The allocation made to provide for the depreciation of premises was at the rate of 3 per cent. on their cost price, and that to provide for depreciation of tools was at the rate of 7½ per cent. on their cost price. After allowing for sundry interests and commissions, general expenses, &c., a final balance of 56,104*l.* remained available for dividend upon the share capital of the company. This balance admitted of the payment of a dividend of 2*l.* 16*s.* per share, absorbing 46,409*l.*, and leaving 9695*l.* to be carried to the credit of 1884-5.

The production of the company's collieries was maintained last year at about the same level as in 1882-3, the output having been 389,000 tons, giving an average of 1410 tons per day of extraction. A higher average would probably have been attained if the directors had not been under the necessity of restricting working operations during the second half of the company's financial year, in consequence of the depression prevailing in business generally. The management succeeded in reducing the cost price of the coal raised by the company last year to an appreciable extent; but, on the other hand, the continued weakening of market prices considerably reduced the profits realised. The general condition of the collieries of the undertaking is regarded as satisfactory, and the directors do not anticipate any difficulty in providing for all the requirements of the company's works whenever a revival in business takes place. The company made last year 141,640 tons of coke, but this production was not sufficient to provide for the current consumption of the works of the undertaking, and it was, accordingly, necessary to continue to make purchases of coke last year. The sale price of coke experienced during the last twelve months an average reduction of 20 per cent., as compared with preceding years. The cost of production was reduced, however, to a corresponding extent, and better results are anticipated in the future. The company's mineral bearings produced last year 108,440 tons of ore, showing an increase of about 8000 tons, as compared with 1882-3. The sales of minerals effected by the company last year were 24,500 tons, as compared with 39,000 tons in 1882-3. The current quotations for minerals showed great weakness last year, and it will be seen that the company's blast furnaces consumed the greater part of the production. The company's three old blast furnaces, which have been in operation for more than fifteen years, continued to work well in 1883-4, and produced during the year 44,700 tons of pig of various descriptions, or 2400 tons more than in 1882-3. The profit realised from the blast furnaces, although still satisfactory, was affected to some extent by the downward tendency of quotations. The iron works of the company produced last year 26,818 tons of iron and plates of various descriptions, and the profit realised showed an improvement of about 18 per cent. as compared with 1882-3. A new rolling mill, erected by the company for the production of plates, worked satisfactorily last year. Steel rails were also produced last year upon advantageous terms. As regards the company's steel works, properly so called, they have fully realised the anticipations indulged in respecting them. The production last year was 85,500 tons of cast steel, and 92,500 tons of steel ingots, this result being attained notwithstanding the general slackening in business, and notwithstanding, also, the increased competition with which the company has had to contend. By the adoption of the most improved systems, the company has succeeded in producing steel rails last year upon terms not hitherto attained. The production of rails, tyres, and small articles of steel, amounted last year to 81,700 tons, or 1200 tons more than in 1882-3. In consequence, however, of the low prices realised, the profit acquired in this department of the company's operations was sensibly lower last year than in 1882-3. At the close of the financial year the company's steel rail mills had still sufficient orders on hand to insure them employment for 4½ months in advance. The preference given by certain railway companies for Martin steel has induced the Council of Administration to increase the company's means for producing this description of steel rails, and a second blast furnace, on the Martin system, has been brought into operation. The company has commenced of late the manufacture of steel cannon, and experiments conducted by the Belgian Minister of War satisfactorily established the excellence of the guns turned out by the company, which is now executing an order received from the Government of Morocco for a complete battery of steel guns. The company's construction workshops were not fully employed last year. The company's shipbuilding yards were also only partially occupied in 1883-4. The directors are now building a steamer of a new type for the company's flotilla. This vessel will be capable of carrying a cargo of 2100 tons, and it will be completed in December. A second vessel of a similar type is to be proceeded with. It may be interesting to add, in conclusion, that the directors, feeling the necessity of finding new outlets for the company beyond Europe, have been endeavouring during the last few months to develop the operations of the undertaking in Africa and the extreme East, as well as in Australia.

THE PHILADELPHIA ELECTRICAL EXHIBITION.—No. VII.

By C. J. H. Woodbury, Boston

Telemeters.

Among the newer applications of electricity at the Exhibition, none are capable of wider application than the telemeter, which consists of a means of electrically transmitting the position of an index hand on a circular dial to a similar dial in any place reached by the wires. The addition of a registering arrangement makes a permanent record of whatever results may be transmitted. It is applicable to the transmission of steam and water pressures, temperatures, counters, or any other similar data from the factory to the office of the manager. In applied science it adds to the powers of the observer, giving continuous indications of deep sea temperatures, barometric pressures, and to the Signal Service Bureau it could prove a valuable adjunct by replacing the corps of observers kept at great expense and personal hardship upon some of the high mountain peaks in the United States, by attaching this apparatus to the various meteorological instruments and transmitting a continuous record of the results by telegraph lines to more hospitable places in the valleys.

In one of the largest dry-goods stores in New York city, twenty-four thermometers indicate the temperature in as many rooms upon a single dial at police head-quarters; a circular switch, once in three minutes, throws the various thrermometers in circuit with the register, and any temperature can be noted at will, while an extreme heat will sound an electric alarm.

In its construction it differs so widely from the dial telegraph of Wheatstone used for the transmission of signals, that a description of its mechanism will be given.

Referring to the diagram, Fig. 1, on the following page, showing the connections, at the left hand the contact arm A is on a shaft and is moved by the initial physical instrument, whether it be a thermometer, barometer, pressure gauge, float, or other device. It is not insulated from the metal frame of the instrument, and is therefore electrically connected to the base, as are also the armature levers B B. On each side of the contact arm are two contact points, which are insulated from the frame and also from each other by the insulated sleeve at the centre. This sleeve is attached to the toothed wheel W, and as it revolves the continuity of the circuit is preserved by two insulated posts D D^1, which carry two wires resting in two grooves in the insulated sleeve, thus maintaining the circuit of D with C and D^1 with C^1 respectively. The index hand W is attached to the same shaft as the toothed wheel W. When not in actual operation, the pawls P P^1 are outside of the path of the teeth, and the wheel is held by the locking pawl L. When P advances it engages between teeth near its point and pushes the wheel until the pawl rests in the space between the wheel which it fits. In this position the under face of the pawl is tangent to the circle of which the pivot of the armature forms the centre; hence the face of the tooth pushes directly against the centre, and no force, such as the momentum of the wheel, resulting from the force of the blow given to the pawl, can disengage it. This constitutes a simple and complete locking device and the wheel cannot be revolved more than one tooth by a single impulse, and excess of battery cannot interfere with the operation of this escapement.

The wheel and pawl of the receiver are similar to those of the transmitter; hence, if both instruments receive a full impulse sufficient to carry the pawl P to its forward limit, they must move in unison, because neither wheel can move more than a tooth

EXHIBITS AT THE PHILADELPHIA ELECTRICAL EXHIBITION.

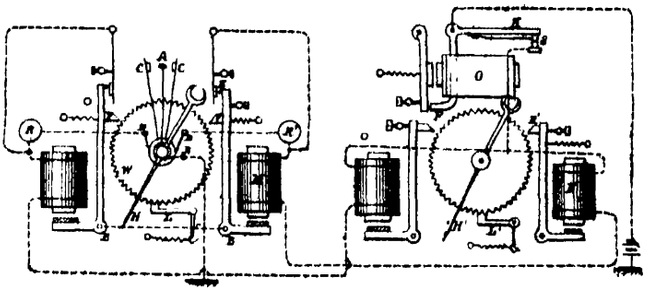


Fig. 1. Electrical telemeter.

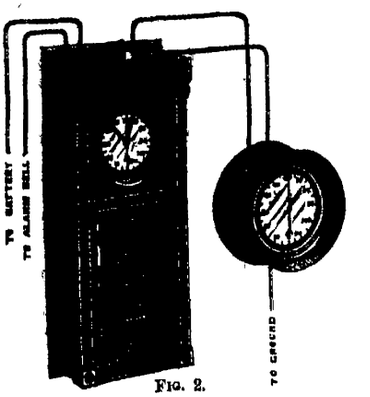


Fig. 2.

for a single impulse. When the index hand A is moved by a force and touches the contact point C, the magnets M, N, and O are in circuit, as also the small resistance coil B^1. M is so adjusted that it attracts its armature first, and this early movement of its armature causes a contact at E, which forms a shunt around resistance R^1 and contact A C. The continuous motion of the armature causes P^1 to engage a tooth and turn the wheel W until P^1 fits into the space between the teeth, thus locking the wheel and separating the contact A C

This operation has been produced without breaking the circuit, because a shunt was formed around A C before they were separated, and no spark ensued because they formed a branch circuit with R^1 resistance to a shunt with no resistance.

Simultaneously with the engagement of P^1 the corresponding pawl R^1 in the receiver also engages its wheel and the operation is repeated here. The magnet O is adjusted to respond last in the series, and the movement of its armature lever strikes the arm F, thus throwing up the horizontal arm K and breaks the circuit at S. The instant that S is opened, the armature levers are drawn back to their normal position, separating the points at E, and since A C are already open, when S closes again on its return stroke, the circuit is open and remains so until A makes another contact. Also the return of the armature levers disengaging P^1 and R^1 and permits L L^1 to complete the movement of one tooth and the corresponding index hands H H^1 have moved one division in unison on their respective dials. The spark is all transferred from the delicate contacts to the large rough contact S, which does not require any adjustment. By the use of a polarised relay and batteries of opposite polarity, one wire connecting the two instruments may be dispensed with. In the receiving instrument the hand H is moved by the force to be recorded, whether it be pressures of steam, air, or water, or any other movement of an index hand which it is desired to transmit to the hand H^1 on the receiver.

The instruments are far more simple in their general organisation than the spreading necessary to render the diagram a clear one, would seem to indicate.

American Numismatic and Archæological Society.

There was but little at the Exhibition which came within the scope of electricity as applied to the fine arts, but that little was most creditably represented by the fac-similes of coins in the national collection at the British Museum, contributed by the American Numismatic and Archæological Society of New York city. Through the efforts of Mr. Robert Hewitt, Jun., the collection was secured for this Society, and it certainly exceeds in its scope anything of the kind in America. It contains examples of Syrian, Phœnician, and Egyptian coinage, reaching back to B C. 400. Grecian and Roman coinage are more fully represented to the date of the Christian Era. The coins are arranged in their cases with a system which permits of their study either in regard to dates or locality; as by following along the lines horizontally the coins of the same nations are presented in the order of their dates; and by following vertical lines in the same case, one can observe the contemporaneous coinage of early civilisations. A number of numismaticians availed themselves of the opportunity to inspect this collection. In the first article on this Exhibition allusion was made to the workmanship of Messrs. Ready, electrotypers to the British Museum, in their own exhibit, and this collection affords a similar example of their skill in electro-metallurgy. A number of American collectors have expressed their appreciation of the catholic spirit of the administration of the British Museum in this policy of extending opportunities for numismatic study by allowing these reproductions to be made.

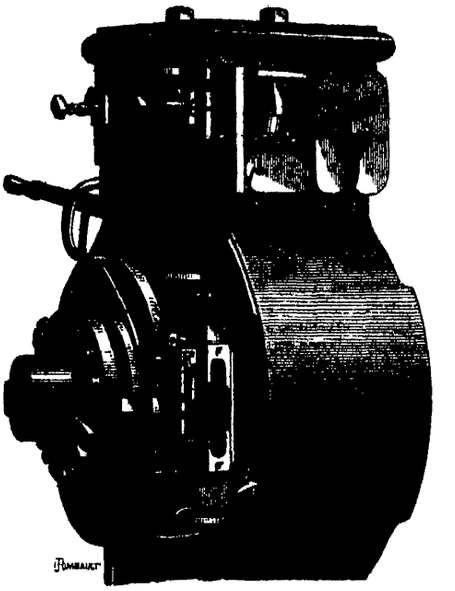


Fig. 3. The excelsior electric governor.

The Ball Unipolar Dynamo.

The Ball Electric Manufacturing Company, of Reading, Pennsylvania, exhibit their "unipolar" dynamo, see Fig. 5, whose novel construction attracts attention while its actual operation furnishes an example of the unexpected.

The term unipolar is somewhat misleading, because it has double polarity, as is essential in all electrical apparatus. It is provided with two Gramme armatures, each of which revolves principally within the inductive influence of only one pole of the magnet. Its operation seems to indicate that a revolving armature produces a somewhat wider range of effect upon the localisation of magnetic polarity in a field magnet than has been assumed. The operation of this dynamo would repay a careful exploration of the field of force in order to determine the effect of its peculiar design. The field magnets and other ironwork are made of wrought iron, and the weight of the dynamo is certainly less than other dynamos of equal capacity, a 20-light dynamo weighing only 780 lb.; and one which is sustaining 13 lights weighs 520 lb. The current is said to be eight ampères and the electromotive force 48 volts to the lamp. The 13-light machine is driven by a 1 in. belt on a 14 in. pulley at a speed of 1500 revolutions per minute. The inventors do not seem to have made any electrical investigations upon the machine, and it is hoped that the work of the Board of Examiners will supply this deficiency. The practical operation of the system seems to be satisfactory and all that is claimed by its representatives.

The Excelsior Electric Company.

The Excelsior Electric Company have a novel method of using the attraction of the field magnets to govern the Hochhausen dynamo to constant current The brushes are attached to a geared ring B C, Fig. 3, which can be turned in either direction by a small motor F with a pinion wheel *f* upon its armature shaft. This motor is controlled by a hinged armature *b* at the side of the field magnets, and the attraction of the magnets is resisted by a spring. When the current—and therefore the attraction of the field magnets—is at the normal quantity, then both terminals of the motor are at the same potential, and therefore it is stationary. Should the resistance of the external circuit be altered by varying the number of lights, then the corresponding difference in the strength of the field will cause the armature to shunt the current in one direction or the other, and turn the motor in the direction to move the brushes accordingly. In its mechanical construction this is one of the most simple devices to regulate an arc-lighting dynamo.

In the same exhibit was a large plating dynamo capable of depositing 600 lb. of chemically pure copper in ten hours. The current is 2500 ampères at 2.5 volts, the resistance being .001 ohm. A regulator of small capacity, for the use of incandescent lamps in multiple arc series, is also shown. If one lamp in a group breaks its carbon, an equivalent resistance is thrown in by means of a high resistance electro-magnet attracting its armature connected to a switch; if a second lamp breaks its carbon, another lamp which serves as an alarm is turned into the circuit in a similar manner. The group can then be switched out altogether.

The Arago Disc Dynamo.

The White House Mills of Hoosac, N.Y., exhibited the Arago system of arc lighting. A disc

EXHIBITS; PHILADELPHIA ELECTRICAL EXHIBITION.

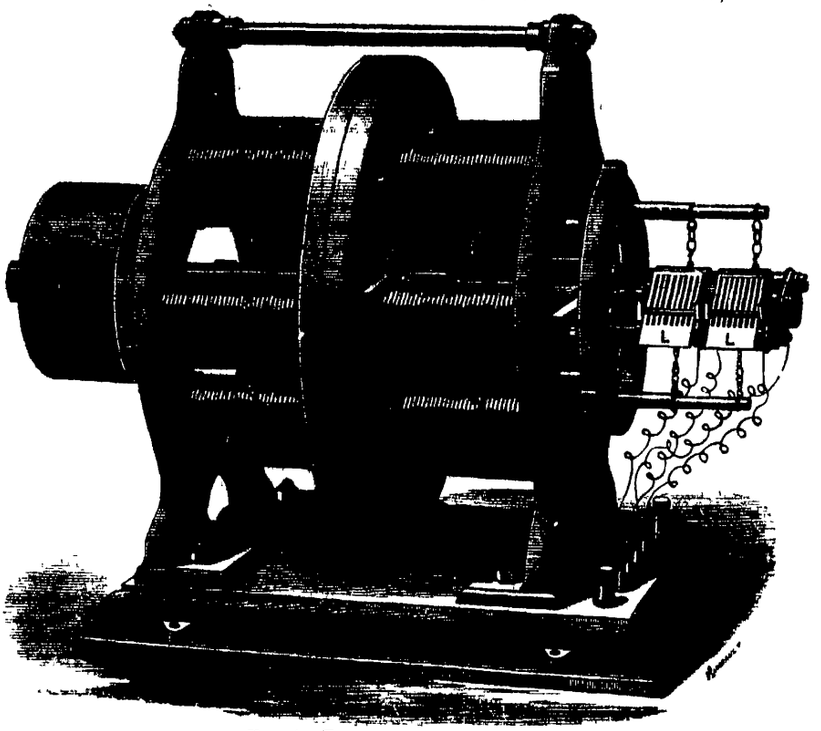


Fig. 4. The Arago disc dynamo.

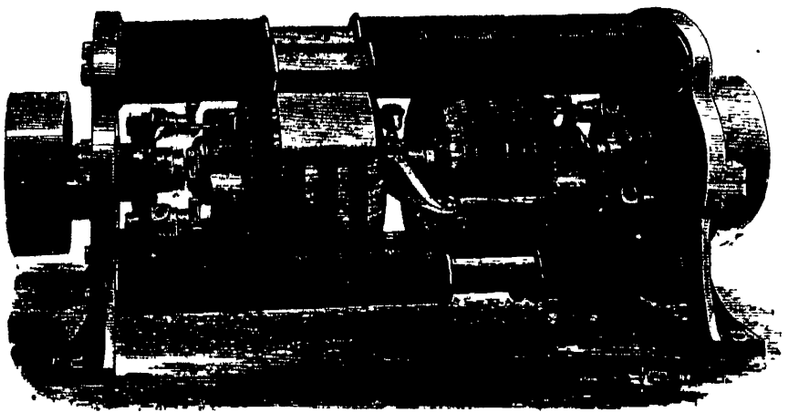


Fig. 5. Ball's unipolar dynamo.

armature surrounded by a copper ring C, Fig. 4, and without any core or iron in its construction, revolves in a multipolar field composed of ten pairs of magnets E E. The large diameter of the armature permits a very high circumferential velocity. The field coils are in series, and it is claimed that the dynamo will generate a constant current, independent of the number of lamps in circuit. The arc lamps are shorter than those of other systems, and some of them are supported by a bracket at the side, instead of suspended in the usual manner The cut-out mechanism which switches a lamp out of the circuit whenever its resistance becomes abnormal, by reason of consumption of the carbons, or any mechanical defect in the regulating apparatus of the lamp, is not placed in the lamp, but is contained in an iron case in the circuit near the lamps.

TEAK.

With the view of adding to the interest attaching to the late International Forestry Exhibition and of turning it to practical account in the future, the shipbuilders of the Glasgow district came to the assistance of the promoters by offering, in connection with their scheme of essays and reports, a special prize of 50*l.* for an essay on "The Best Method of Maintaining the Supply of Teak as regards Price, Size, and Quality, together with the Best Substitute for Shipbuilding Purposes." That fact has aided very much to direct prominent attention to the subject of that valuable timber in all the phases in which it may be studied, and the material itself figured very largely amongst the leading exhibits in the nave of the main building. The exhibitors in this instance were the Bombay Burmah Trading Corporation (Limited), who were represented by Messrs. Thomson and Gray, of Glasgow, of whom it may be said that they are the largest importers of teakwood in the United Kingdom. Their exhibits included logs of the timber as imported into the European markets, but specially dressed and polished for exhibition. One of them was remarkable for its great length, namely, 52½ ft. As might well be supposed, there is very great difficulty in bringing such exceedingly long logs from the forests. The other log was shorter, but was a good specimen of large timber. In both cases, the great beauty of the wood was made very evident by the dressing and polishing. Railway keys made of teak, and of various patterns, employed on Scottish railways, were also shown. Teak keys are rapidly coming into use throughout Great Britain, as the peculiar characteristics of the wood render it extremely useful and economical when employed for the purpose referred to, it being comparatively unaffected by ordinary heat, by dryness or moisture, while it is the only wood that can be used in close contact with iron without injury resulting to either material.

By way of illustrating the fitness of teak for ornamental work there was shown in the collection a richly-carved and very handsome mantelpiece. From the fact that the wood is practically unaffected by exposure to high ranges of temperature, it is peculiarly suitable for such purposes. Close by there was exhibited a remarkably fine specimen of figured teak used in the construction of a front door (or, rather, two folding doors), very massive, and well suited for some public building or a large mansion. This timber is coming more and more into use for house-building purposes, more especially for making doors, windows, &c., and it is also well adapted for shop fronts. Various exhibits were shown in this collection for the purpose of illustrating how the so-called refuse teak may be economically turned to account in construction. For example, there were two patterns of Robb's patent flooring. One of them was a sample of flooring for outside work, halls, &c , where considerable strength and great durability are the essentials ; and the other exhibits the system as applied to flooring for public rooms. The "Hatherley" step ladders and easels (Jones's patent) afford another excellent example of modes of economically using up small and refuse teak cuttings. A railway carriage wheel was also shown, the blocks of which were made of teak, according to Mansel's patent. We ought, perhaps, to have mentioned sooner, that the collection also included some teak planks, such as are taken off the sides of the logs during the process of conversion from the rough state into merchantable squares, and which are therefore produced much more cheaply than if they were taken direct from the squares. As regards their quality, such planks as we speak of are, if anything, superior to the others, as the best wood is the nearest the outside. Two of the planks exhibited had been dressed and polished, two had been simply dressed, and the remainder were in their rough state Along with the actual specimens of teak already spoken of, there were shown a number of very fine and exceedingly interesting photographs which convey an excellent notion of the working of teak in Burmah, and of the operations connected with the bringing of the material to the market. A set of these photographs was also displayed in the Indian section of the Exhibition. They embraced two views of the saw mill at Dulla, belonging to the Bombay Burmah Trading Corporation, two views of elephants at work in the mill yard, another of elephants at work in the Government timber depôt at Ahlone ; a view of a public sale of timber at the same depôt ; and a view of a steam launch towing rafts of timber in Rangoon river.

Throughout the India collections of exhibits under the general care of Colonel James Michael, C.S.I., who may be regarded as the pioneer of practical forestry in India, there were a number of examples of teak, but in no instance did they reach the magnitude of some of those in the collection of the Bombay Burmah Trading Corporation. In many instances they were so small as to elude the attention of the visitor unless he was exceedingly vigilant in seeking out the catalogue numbers. Sometimes they were shown as small slabs or planks, and in other instances in cross sections, while here and there were official papers bearing on teak plantations in various parts of India, as at Nilambur, in Malabar (1877 and 1878), Pegu, in British Burmah (1856), and one on "The Natural History and Biology of the Teak Tree," by N. A. Dalzell, M.A., F.R.S.E., Conservator of Forests (1869.) A considerable amount of interest attached to the teak specimens sent from Nilambur on account of the data given regarding th time of planting, the kind of soil in which the trees were grown, and their measurements, longitudinally and circumferentially. One that was planted in alluvial soil in the year 1844 had yielded a pole of 100 ft. in length by 93 in. in circumference at the base ; and another planted in the same kind of soil in 1847 had reached, respectively, to 103 ft. and 100 in. As another example of growth in the same kind of soil from the year 1868, when it was planted, mention is made of a teak tree that yielded a pole of 82 ft. long by 48 in. in circumference.

For a long time the supplies of teak timber for this country were drawn entirely from India, but as they became exhausted, owing to the enormous

waste in felling before conservancy regulations were adopted by the Indian Government, the immense forests of Burmah were brought into requisition, and they have for a number of years supplied almost the entire demand not only for this and other states, but also the bulk of what India has herself required. That the teak tree will never again, in any quantity, have the opportunity of attaining in India its full growth, as it does in Burmah, is very generally believed; yet the forests of Bombay, Mysore, the Central Provinces, &c., produce poles of considerable length which are valuable for building purposes. This, to some extent, lessens the demand for Burmah teak for the frontier trade, and other agencies are at work to assist in doing so. For example, there are now being brought into prominent notice on the frontier, as substitutes for teak for very many purposes for which that timber has hitherto been largely if not exclusively used, some of the numerous timber trees which abound in India and Burmah, and which have been proved to be eminently useful for such purposes. The growth of those timber trees is now actively encouraged by the Forest Department of India, in the hope that, other conditions being favourable, they may be able to supplant the teak poles with advantage to the users. Those other trees, most of which were indigenous in the same regions of country, had hitherto received but very little attention, nothing being done for their conservancy, as no person in the market demanded anything but teak.

It is a common error to suppose that teak grows over large tracts of land by itself, for it is not so, as the tree is found in what are called "mixed forests," by which we mean forests that contain various other species of trees in close proximity; indeed, without the presence of those other trees, teak does not seem to grow so favourably, or to attain the same value as regards size and quality. It is found in the forests of Burmah and the Shan States to the east of it from the mouths of the great rivers Irrawaddy, Salween, and Sittang, in latitude 16 deg. north, as far up at least as latitude 26 deg., in Lower or British, as well as in Upper or Independent Burmah, and in the Shan States subject to the King of Burmah and the King of Siam. Usually there are patches of four, five, or six teak trees together amongst other forest trees as large as or larger than itself; and the tree itself (*Tectona grandis*) succeeds best on well-drained slopes at from 500 ft. to 2000 ft. above the sea level. Its growth is more rapid on flat ill-drained or inundated land, but in such cases there is a tendency for the wood to become frushy in the grain and unsound at the heart.

When the forester is engaged making his rounds of inspection in order to determine what tree to mark for felling, he is greatly aided in detecting teak trees by their leaves or by their flowers. The former are very large, usually about 24 in. long by 18 in or 20 in. broad; and they fall towards the end of February, along with those of the other deciduous trees amongst which teakwood grows, the tender green leaves again shooting forth under the influence of the blazing sun of the hot weather towards the end of April. The flowers come forth in August, when its large white sweet-scented panicles of bloom—very much like those of the meadow-sweet in colour—become a beautiful feature of the forest landscape, and help to mark out the position of the trees to the keen eye of the forester on the hill-top. In the period elapsing between the shedding of the old and the bursting forth of the new leaves, great fires often rage through the forests, but though they frequently distort and check the growth of the young plants and consume dead and felled trees, they do little damage to living trees of large size, in which respect they are unlike the great conflagrations in the resinous pine forests of North America, which sweep away everything in their course.

As far as growth is concerned, timber of almost any size can be obtained, as the locality of the growth and the state of the country over which it has to be dragged, together with the streams by which it may have to be floated, are almost the only circumstances which limit the lengths that may be brought out. When teak is grown in a locality and within a zone of climate that are favourable, the tree assumes magnificent proportions. Trees of from 12ft. to 18 ft. in girth are common, and boles of still larger circumference are by no means rare, while the stem is often seen rising to a height of 75 ft. or 80 ft. without a branch; and even a height of 150 ft. is sometimes reached. The forester as he moves further north, south, east, or west, finds that the timber in the different tracts possesses distinctive features of its own and that there is a considerable variety in the rate of growth. These results are caused by changes of soil, level, or exposure, or by an alteration in the character of the trees which go to make up the "mixed forests." The last-mentioned circumstance, as already briefly indicated, is a most important element in the cultivation of teak, inasmuch as, when the tree is young, or until it has reached to a height of from 30 ft. to 40 ft. (which it does in a very few years), unless it is shaded by trees taller than itself whose leaves can properly distribute the heavy rainfall so as to allow a considerable quantity of it to evaporate and prevent the washing away of the soil around the roots of the young trees, it will not at maturity compare well with those that have been grown under more favourable conditions. Even at the best a teak-tree has a precarious life, as it is an especial favourite with climbing parasitic plants, and many a noble tree has been strangled and twisted out of all usefulness in their deadly embrace. Worms bore into it, woodpeckers tap it in its youth, wild elephants break off its top, and rot attacks its heart, so that the forester has to exercise his judgment in deciding as to the trees on which labour may profitably be expended. As a rule, a teak-tree grows rapidly in its youth, to a height of even 40 ft. or more in thirty years, though as it ages its growth becomes slow. In the transverse section of a tree of 8 ft. in circumference as many as 380 concentric rings of annual growth have been counted, and therefore it is but natural to suppose that the great trees measuring 6 ft. in diameter must have reached an age of several thousand years. After giving all due consideration to the opinions of scientific foresters, it seems on the whole that the average teak log of commerce produced from a tree about 6 ft. in girth represents an age of about one hundred years.

In respect of the quality of its grain, teak varies considerably, and foresters reckon several varieties, which may be classed broadly into two divisions—smooth grain and rough grain, of which the former is the better. There are likewise varieties in respect of hardness, colour, and weight; botanically, however, there is no distinction, and the variations appear to be caused by differences in the conditions of growth. The difference of grain, which is the most important point from a commercial point of view, is believed to be due to a difference of soil, of exposure, or of drainage, and yet trees of smooth grain and of rough grain have been seen growing close together under precisely the same conditions, apparently, as regards those points. Some consumers fancy that teak shipped at Moulmein, and therefore drawn from the Salween forests, is always of the smooth-grained variety and sounder; but in the opinion of experts that is a complete mistake. In the forests draining into the Salween the general conditions of growth are the same as those prevailing in the forests which drain from the west side of the same range of hills into the Irrawaddy and Sittang, and whether the timber goes to Rangoon or Moulmein is simply a question of water-shed. The smooth-grained variety is quite as common in the forests of the Irrawaddy and the Sittang, which find an outlet at Rangoon; and the great consuming markets of the Clyde and the Tyne, as well as the French and other foreign Governments, have realised the fact that the quality of Rangoon timber is quite equal to that of Moulmein timber, while in certain other points the former is the superior. The English Admiralty is now, we believe, the only consumer that still adheres to the exploded idea of a superior virtue in Moulmein teak. But as the more accessible forests in the Moulmein district appear to be approaching exhaustion, it becomes every year more difficult to get fair sized timber from Moulmein, and our Admiralty will probably be forced by the requirements of its specification to abandon its ancient prejudice.

(To be continued.)

NOTES.

Failure of the Vacuum Brake.

We have still to record the failures of the vacuum brakes. Early on Saturday, the 8th inst., the driver of the last train from Enfield was returning to King's Cross, and when approaching the station, he saw a train of empty carriages in front on the same line. He at once tried to apply his vacuum brake, and whistled for the guards' brakes, but to no purpose, for the brakes failed to act, and the train rushed into the empty carriages with great force, smashing the stops at the end of the platform. The fireman jumped off and was severely injured, and the driver, who remained at his post, had a very narrow escape from death after the collision, by the top of one of the carriages falling on him. Considerable damage was done to both engine and carriages, and it was a most providential circumstance that both trains were empty. The Smith vacuum brake cannot be applied by the guard, and has many times failed without warning in the hands of the driver; and as the London and North-Western Railway Company propose to extend its use, we fear that more cases of this sort may be expected should Parliament not intervene to insist upon brakes being fitted that comply with the Board of Trade conditions.

A New Dutch Port.

Fishing industry is a great source of wealth to the Low Countries. It employed last year 3016 boats with crews comprising altogether 11,200 men; and the Dutch Government is accordingly doing all it can to promote its further development, either by improving the existing ports of Holland or by creating new ones. A company has been recently formed for the creation of a port at Scheveningen. The cost of the works contemplated is estimated at 350,000*l.*; and contributions to the extent of 180,000*l.* will be made by the Dutch Government, the local provincial authorities, and the commune of La Haye, of which Scheveningen forms part. With these resources it is proposed to construct a port capable of admitting vessels drawing 10 ft. of water. Moles are to be built into the sea to a distance of 2666 ft. The port will have 20 ft. of water on the bar, and the entrance of the outer harbour will be 333 ft. in width. The works will be constructed of *béton*, and it is anticipated that they can be completed in four years. The plans have been prepared by Mr. Hara Siccama; and subject to some modifications, they have received official approval. The new port will, it is anticipated, extend the commercial relations of Holland with Great Britain.

The Geology of Madagascar.

Madagascar consists of a central plateau or highland rising from 4000 ft. to 5000 ft. above the lowlands of the coast, and from this plateau rise occasional volcanic cones, the highest, Ankaratra, being 8950 ft. above the sea. These volcanoes extend from the northern extremity of the island to the 20th parallel of south latitude. South of this appear granitic rocks, at least as far as 22 deg. south latitude. At higher latitudes than this the rocks of the interior are practically unknown to Europeans. According to a recent paper by Mr. F. W. Rudler, F.G.S., several crater lakes and mineral springs abound; and to the north of the volcanic district of Ankaratra there is a tract of country containing silver, lead, zinc, and copper ores. As regards building stones, besides the granite which is so general, there are vast beds of sandstone and slate between the district of Ankaratra and the fossil regions in the south-west of the central plateau. These fossils, according to M. Grandidier, the recent French traveller in the interior, are referable to the Jurassic system, and comprise remains of hippopotami, gigantic tortoises, and an extinct bird of the ostrich species. The coasts of the country are rich in timber and it would also appear that the interior is a good mineral field.

The Sanitation of the Panama Canal Works.

A report on the sanitary measures adopted for preserving the health of workmen engaged on the Panama Canal works has been made to M. de Lesseps by M. Regnier. According to this report the climate is warm and humid, but does not exercise on Europeans that depressing influence which is observed in some other tropical countries. The temperature varies from +24 deg. to 30 deg. Cent. in winter, and rises to +35 deg. Cent. in summer. Winter is the rainy season. Two great hospitals have been erected, one at Panama, the other at Colon, into which sick workmen are received; and along the entire length of the canal, doctors are stationed to visit workmen in their homes, and if necessary order them into the hospitals. Sisters of mercy are the nurses of the latter. A service of inspection has been organised since 1881 to examine the men sent to the works, for it was found best only to send men in sound

health and in the prime of life. The administration have also established a sanatorium at Tobago for convalescents; and some of those recovering from grave maladies are sent home. Workmen who have laboured for eighteen months or two years, and desire a visit home to recruit, are also permitted to do so, and most of these return afterwards to their duties at the works. Thanks to these excellent precautions the mortality amongst workmen in the isthmus is even below that in great cities and large manufactories.

The Steering of Balloons.

M. Duroy de Bruignac has brought before the French Academy of Sciences some theoretical considerations with respect to the steering of balloons, which have a special interest at the present time. One important condition to be fulfilled is the approximation of the centres of traction and resistances in order to diminish the perturbing moment of the vertical stability. It is probably because this condition was not quite fulfilled that MM. Renard and Krebs, in their balloon ascent at Meudon, experienced on "several occasions" oscillations of 2 deg. or 3 deg. of amplitude. A still more important consideration is that of resistance to progress caused by the air. A simple calculation shows that the resistance of the air to the translation of a balloon is proportional to the cube of the sine of the angle of incidence of the relative air-current or wind. Consequently, for small angles, which are those naturally adopted, a variation of angle from 2 deg. to 4 deg. nearly doubles or triples the resistance. This is a fact which ought always to be borne in mind; and it becomes advisable, not only to bring the centres of traction and resistance near each other, but to make them actually coincide. This last condition will be somewhat difficult to carry out, but it is not impossible to do so. If with one aérostat it is very difficult it will be much more easily done with two parallel ones With proper attention to this matter M. de Bruignac thinks that aeronautics will at once enter on a practical phase, even with motors less efficient than those which have been known for some years past.

The Proposed Saharan Sea.

With reference to the daring French project for flooding the desert of Sahara with what would be virtually a new sea, it may be well to recall the opinion expressed by M. Elisée Réclus, that at one period in the world's history the desert was covered by a sea very similar to the Mediterranean, and that this sea exercised a very great influence upon the temperature of France, as comparatively cold—or at at any rate cool—winds blew over it, while now the winds which prevail in the great expanse are of a much higher temperature, and are, in fact, sometimes suffocatingly hot. The appearance of the desert seems to support the theory of M. Elisée Rélcus, that it was at one time the bed of a sea of considerable extent, of which the great inland African lakes recently discovered, are possibly the remains. The present vast extent and configuration of the African continent would also appear to support the conclusion that at one time it comprised a less area of land than it does at present. The serious question which arises, assuming that the theory of M. Elisée Réclus is substantially correct, is what will be the effect of the creation of a second African sea in the room of that which has disappeared? Would the temperature of France, and possibly even of England, be again reduced? It is a geological theory that in the glacial period of the world's history Great Britain was covered with ice and snow very much as Greenland is at present. Some great influences must clearly have been brought to bear upon France and Great Britain, which rolled the ice over so many hundred miles northward. What was this influence? Was it the large African sea which French enterprise is endeavouring to recreate? If it were, we should say that whatever the French may gain in Africa by the realisation of a Saharan Sea would be much more than counterbalanced by what they would lose in France itself.

Determination of the Ohm.

In response to the desire of the International Commission on electrical units, MM. Mascart, De Nerville, and Benoit have made a series of experiments to determine the resistance of a column of mercury at zero temperature, representing the practical unit of electrical resistance, or, as it is called, the ohm. The absolute resistance of a conducting circuit has been measured by the current induced in it when displaced on the terrestrial magnetic field (Weber), or when it is submitted to the action of a neighbouring current (Kirchoff) These two methods have the advantage of presenting several common characteristics, and serve to check one another. To eliminate systematic errors, the commissioners above-named constructed five bobbins, of which two were covered with several distinct wires, and seventeen different combinations were utilised. In the first method a frame was made to revolve suddenly round a vertical axis through half a circumference. The frame was at first perpendicular to the magnetic meridian, and the impulse current was observed by the swing of a galvanometer needle in circuit. The resistance is given by the formula

$$R = 2S\frac{H}{h}.g.\frac{\pi}{\tau\theta}$$

Where S is the surface enveloped by the wire of the frame, H and h are the values of the horizontal component of the magnetic field at the points where the frame and ballistic galvanometer were placed; g is the constant of the galvanometer, that is to say, the action of unit current on the needle, θ is the angle of impulse or swing; τ is the duration of the infinitely small oscillations In the second method the induction on the frame was produced by the inversion of a neighbouring current. Calling I the inducing current, M the coefficient of mutual induction of the circuits, the resistance of the induced circuit is

$$R = 2M\frac{I}{h}\frac{\theta}{\tau}\frac{\pi}{\theta}$$

where the other letters mean the same as above The apparatus was installed in the Pavilon Français in the park of the Trianon, which the Minister of Public Instruction and Fine Arts placed at the disposal of the Commission. More than fifty complete series of observations were made, each occupying from two and a half to three hours. The resistance of the circuit was compared each time with that of a standard B.A. unit, the general mean came out

1 B. A. unit=0.9861 ohm.

To evaluate this resistance with the column of mercury, four tubes of 1 square millimetre in sectional area were prepared and chosen of a length which gave them, when filled with mercury, sensibly the same resistance as the B. A. standard. Each was carefully calibrated at the International Bureau of Weights and Measures, and filled with mercury in a vacuum, then compared with the B. A unit at the ordinary temperature, and in melting ice. Experiment, however, showed that filling in air did not appreciably affect the electric resistance nor the weights relative to calibration Correction for the end resistances was made by Lord Rayleigh's formula, which was directly verified by cutting a tube into several sections, connected together by vases with large openings, and determining the variation of resistance produced by each section Very concordant measures of the four tubes give the result that

1 mercurial unit=0.95374 B A. unit.

Hence

1 mercurial unit=0.9405 ohm.

It follows that the length of a column of mercury at zero Centigrade, and 1 square millimetre sectional area, which represents the value of an ohm, is 1063.3 millimetres. At the same time the commissioners from an attentive study of the results, and in applying some extra corrections, are of opinion that the length 1063 is perhaps a little too high.

Coloured Impressions.

Dr. E. L. Nichols has made a careful series of experiments on the duration of colour impressions on the retina. Plateau made a number of experiments on the same subject, and his results are given in the following Table:

Colour of the Object.	Total Duration of the Image. seconds.	Undimmed Duration of the Image. seconds.
White	0.35	0.00796
Yellow	0.35	0.00798
Red	0.34	0.00966
Blue	0.32	0.01229

Mr. Nichols' study of the duration of colour impressions produced by different portions of the spectrum confirms, in the main, these results of Plateau obtained with a revolving coloured disc The spectrum employed by Mr. Nichols was that given by an ordinary one-prism spectroscope giving a fairly pure spectrum of white diffused daylight, the Frauenhofer lines being well marked. A black disc 240 mm. in diameter, with four narrow open sectors 5 mm. each in width, was rotated before the slit of the spectroscope at the rate of two or three revolutions per second. He found that the persistence of the retinal image produced in this manner is a function of the wave-length producing it, being greatest at the ends of the spectrum and least in the yellow. It decreases as the intensity of the ray producing the image increases. The relative duration of the impression produced by different colours is not the same for all eyes The duration of the retinal image is in inverse order to the luminosity of the colours producing it. This is shown by Frauenhofer and Vierordt's results given in the following Table:

Relative Luminosity of the Spectrum.

Frauenhofer.		Vierordt.	
Red (B)	32	Red (B)	22
Orange (C)	94	Orange (C)	128
Yellow (D)	640	Yellow (D)	780
Yellow (D to E)	1000	Yellow (D to E)	1000
Green (E)	480	Green (E)	370
Blue green (F)	170	Blue-green (F)	128
Blue (G)	31	Blue (G)	8
Violet (H)	5.6	Violet (H)	0.7

Each wave length of the visible spectrum produces three primary impressions, red, green, and violet, of which green disappears most rapidly, and violet is the most persistent On the different rates at which these impressions die away depend to a great extent the subjective tints of moving objects. The duration of the retinal image depends on the length of time during which the eye has been exposed, being very long after short exposures and approaching a definite finite minimum value as the exposure increases.

THE PHYSICAL SOCIETY.

At the meeting of the Physical Society on Saturday last, the 8th inst., Professor Ayrton in the chair, Mr. Kavargee was elected a member of the Society. Professor F. Guthrie read a paper on "Certain Phenomena attending Mixture" In a previous paper Dr. Guthrie had noticed the increase of volume attending the separation of triethylamine and water effected by heat. The present paper is an account of a more thorough examination of this and allied phenomena. Experiments conducted with a number of different liquids showed that mixtures can be arranged in two distinct classes. Of the first a mixture of water and ether is an example, when shaken up together they mix, heat is evolved, and a diminution of bulk takes place. If any excess of ether present is poured off and the lower clear liquid heated in a sealed tube, it becomes turbid owing to the separation of the ether This is accompanied by an increase of bulk and absorption of heat Triethylamine and water and diethylamine and water are mixtures belonging to this class, the temperature of separation is a function of the ratio in which the two liquids are present A typical case of the second class is a mixture of alcohol and bisulphide of carbon. These mix with one another in all proportions above 0 deg. C. with increase of bulk and absorption of heat. Upon being cooled to about −17 deg. C. they separate. The separation of a mixture of ether and water and of a mixture of alcohol and the bisulphide was shown. In these cases the action is regarded as a chemical one, and generally an excess of one liquid or the other is present. To determine the combining proportions two methods were used. In the first a number of mixtures of the same two liquids in different proportions were taken, and the rise or fall of temperature produced by their mixture measured. When this was a maximum there might be assumed to be no "dead matter" present. In the second method, which is more delicate but more laborious, and which was used when the approximate combining proportion had been found by the first, the change of volume produced by mixture was noted, when this increment is a maximum the liquids are present in their combining proportions These experiments gave very concordant and definite results, for example, the molecular compound of ether and carbonic sulphide is represented by the formula $C_4H_{10}O\ ?CS_2$ and that of chloroform and carbonic sulphide by $CHCl_3, CS_2$. A striking confirmation of this view is afforded by the behaviour of the vapour tension of a mixture. The temperature being constant, if the vapour tension be plotted with the percentages of the more volatile liquid as abscissæ, the curve is, for a mixture of two liquids which have no chemical action upon one another, as the iodide and bromide of ethyl, a straight line. For ordinary mixtures, however, this is not the case. A curve is obtained in which there is observable at a certain point an irregularity. The corresponding abscissæ indicates the molecular combination found by the previous experiment.

Dr. C. R. Alder Wright read a paper by himself and Mr. C. Thompson on "Voltaic and Thermo Voltaic Constants." In a former paper the authors had stated that in a cell set up with two metals immersed in pure solutions of their corresponding salts, a given increment in the strength of the solution surrounding the metal acquiring the higher potential, causes an increment (a) in the electromotive force set up (e), while an increment in the strength of the other solution causes a decrement (b) in the electromotive force. This law is now substantiated;

it is however found that for dilute acids instead of metallic salts (*b*) may be negative. The authors also find that it is possible to represent the electromotive force of a cell by the difference of two quantities which they term the voltaic constants. These are quantities one relating to each plate and its surrounding liquid. The voltaic constant of a metal and a liquid is a function of the nature of the metal surface, the strength of the solution, and the temperature, but is independent of the opposed plate and its liquid; it is practically defined as the electromotive force set up when opposed to a zinc plate in a solution of the corresponding zinc salt of the same molecular strength. The authors further conclude that the electromotive force of a given combination usually stands in no simple relationship to the chemical action taking place in the cell, but that it may be expressed by the sum of the mechanical equivalent of the chemical action per electro-chemical equivalent, and the difference of two quantities, one being related to each metal and its surrounding liquid and being constant for that metal and liquid termed thermo-voltaic constants. This thermo-voltaic action may act with or against the chemical action in producing electromotive force. In some cases, as in that of a cell composed of iron in ferrous sulphate, and cadmium in cadmic sulphate solutions, the electromotive force is against and greater than that produced by chemical action, consequently the cell works backwards with absorption of heat. At the close of the paper Professor Ayrton and Dr. Guthrie remarked upon the apparent exception here shown to the second law of thermodynamics.

TRIAL TRIPS AND LAUNCHES.

On Thursday, the 6th inst., Messrs. Russell and Co. launched from their Kingston shipyard, Port-Glasgow, a beautifully-modelled iron sailing ship of 1116 tons gross register. She is named the Morecambe Bay, and was built to the order of Messrs Hatfield, Cameron, and Co., of Glasgow, and is intended for their "Bay" Line.

Messrs. Hutson and Corbett, on the same day, launched from the Grangemouth Shipbuilding Yard, lately owned by Messrs. Dobson and Charles, a steel screw steamer named the Ituna, a vessel measuring 160 ft. by 25 ft. by 12 ft. She has been built from designs, and under the superintendence of Captain Waters, for the London and Solway Steamship Company, for trading between London and Silloth, and is being fitted by the builders with engines and boilers.

On the following day Messrs. W Simons and Co., Renfrew, launched a new iron screw dredge of 600 tons, fitted with engines indicating 350 horse-power, and provided with machinery designed for dredging to a depth of 32 ft. She has been built for the Aberdeen Harbour Commissioners under the direction of their engineer, Mr. William Smith. This is the second dredger built for the same owners by Messrs. Simons and Co. The first was built in 1870, and after thirteen years of hard work she was accidentally sunk, then raised and restored, and last month she was sold for a sum equal to the original contract price.

Messrs. W. Dobson and Co., Low Walker, Newcastle-on-Tyne, have launched a steamer built to the order of Mr. F. S Hockaday, of Newport Her dimensions are Length, 160 ft.; beam, 23 ft.; and depth of hold, 11 ft.; carrying capacity about 500 tons She will be fitted with engines of 10 horse power, supplied with steam from a large steel boiler working to 85 lb. pressure, by Messrs. Wigham, Richardson, and Co., Neptune Works, Newcastle. The steamer was designed by Mr M. W. Alsbitt, of Cardiff and Newport, and on leaving the ways she was named the Delabole, by Miss Robson, of South Shields.

FOREIGN AND COLONIAL NOTES.

Baltimore and Ohio Railroad.—The approaches to a new Baltimore and Ohio Railroad bridge over the Monongahela at Glenwood are being constructed. The approach on the north side will be in the shape of a Y, and it is being built of timber with heavy stone foundations.

Dunedin and 'Anderson's Bay.—There is a project on foot for establishing a steam ferry between Dunedin and Anderson's Bay. The projectors have applied to the Otago Harbour Board for permission to cut a channel from the Portobello-road Bridge to the shore at Anderson's Bay, and to have an exclusive right of using the channel when formed.

Western Australia.—Mr. Hordern's proposed railway scheme from Beverley to Albany is progressing favourably. At Fremantle the adoption of Sir J. Coode's minor scheme for harbour works is being agitated.

Silverton.—Mr. C. S. Wilkinson, Government geological surveyor of New South Wales, has returned from an official inspection of the Silverton district. The report which he will furnish his Government is in accord with the statements published from time to time as to the value and permanence of the discoveries made in the district.

A South Australian Dredger.—The dredger Kooringa, which is the largest vessel yet built at Port Adelaide, was launched on Friday, August 8. It is estimated that a saving of between 2000*l.* and 3000*l.* will be effected by having the vessel built in South Australia.

American Locomotive Building.—There are now in the United States, sixteen locomotive works, not including shops owned by railway companies. Pennsylvania has five works, New Jersey and Massachusetts three each; New York, two; and Rhode Island, New Hampshire, and Maine one each. These works give employment to 14,000 men, and every year turn out about 2000 locomotives.

Gas in Paris.—The revenue collected by the Parisian Company for Lighting and Heating by Gas in the first eight months of this year amounted to 1,756,278*l.*, showing an increase of 1.54 per cent., as compared with the corresponding period of 1883.

American Portable Forges.—The Buffalo Forge Company is completing an order for portable forges to be forwarded to Turin and Odessa. Some forge appliances have also been recently supplied to the Canadian Pacific Railway Company for use at Winnipeg, Manitoba.

Breaking up a Monitor.—The once famous monitor Roanoke, built at a heavy expense by the United States Government, is now being broken up at Marcus Hook, on the Delaware. The vessel was sold recently to Mr. E. Stanard, of Westbrook, Connecticut, for 40,000 dols.

The German Iron Trade.—The blast furnaces of Upper Silesia have now attained an output of 35,000 tons per month.

Great Northern Telegraph Company.—The number of messages which passed over the lines of the Great Northern Telegraph Company in the first nine months of this year was 905,782, as compared with 913,708 in the corresponding period of 1883. The revenue collected by the company in the first nine months of this year was 208,680*l.*, as compared with 191,877*l.* in the corresponding period of 1883.

Madrid, Saragossa, and Alicante Railway.—The expenditure made on capital account by this undertaking amounted at the close of 1883 to 22,246,119*l.* The dividend paid upon the share capital for 1883, after provision had been made for all fixed charges, was at the rate of 4¾ per cent. per annum

Coal in Spain.—The value of the coal imported into Spain in the first half of this year was 615,720*l.*, as compared with 532,405*l.* in the corresponding period of 1883.

Belgian Mechanical Industry.—We learn that the Acoz Forges Company has contracted to supply the ironwork required for a number of bridges which the Dutch Indian Government is about to erect in Java.

Spanish Iron Minerals.—The exports of iron minerals from Bilbao, in the first eight months of this year amounted to 2,126,866 tons. The corresponding imports in the corresponding period of 1883 were 2,868,397 tons.

Another Spanish Ironclad.—The Terrenoire Works have just received an order for the steel plates and bars required in the construction of a Spanish ironclad.

South Australian Mechanical Industry.—A deputation representing the unemployed of Adelaide waited recently upon Messrs. Bray and Fox, the two city members, and asked them to urge upon the South Australian Government the advisableness of getting all the railway rolling stock required in the colony made within its borders. Messrs. Bray and Fox both expressed their sympathy with the proposal to protect colonial industry.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF RECENT SPECIFICATIONS PUBLISHED UNDER THE ACT OF 1883.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated
Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics
Copies of Specifications may be obtained at 33, Cursitor-street, Chancery Lane, E.C., either personally, or by letter, enclosing amount of price and postage, addressed to H READER LACK, Esq
The date of the advertisement of the acceptance of a complete specification is, in each case, given after the abstract, unless the Patent has been sealed, when the date of sealing is given.
Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act

STEAM BOILERS.

633. F. D. Rose, Flixton, Lanc. Construction of Steam Boilers. [6*d.* 4 *Figs.*] January 4, 1884.—The flue tubes of internally-fired boilers are formed with one or more corrugations which graduate from a maximum amount at the top of the flue to a plain plate, or nearly plain plate, at the bottom (*Sealed July* 22, 1884).

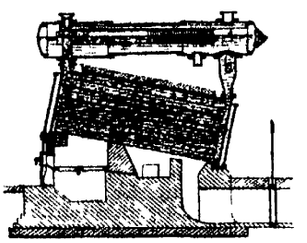
874. T. Calverley, Burnley. Stationary Steam Boilers. [6*d.* 3 *Figs.*] January 7, 1884.—An additional flue is placed longitudinally through the boiler from end to end in such manner as to displace the greater bulk of water below the ordinary double flue. Two mud or manholes are provided one on each side of the additional flue. (*Accepted October* 14, 1884)

3353. E. H. Nicholson and A. T. Allcock, Newark-on-Trent. Steam Boilers. [6*d.* 7 *Figs.*] February 15, 1884.—The boilers are made in sections for transport; each section consists of two subsections. The lower subsection is made in two parts bolted together by a face joint and furnished with upper and lower tubeplates through which run the fire tubes. The upper subsection is also made in two parts bolted together by a face joint and the lower part only is provided with a tubeplate carrying "Field's tubes." The two subsections are connected together by a water tube secured by lock nuts to the tubeplates and may be furnished with an inner circulating tube. The lower subsections of a complete boiler are connected together by a water pipe and the upper subsections by a steam pipe. The furnace may be arranged under one lower subsection, the gases passing up through the fire-tubes and to the second section down the fire-tubes of the lower subsection to the flue. In a modification the subsections are composed in three pieces consisting of a barrel and two end plates connected by face joints Both sections are fitted with Field tubes, the gases passing along the bottom of all the lower subsections and then back between the subsections (*Sealed May* 20, 1884)

4710. M. J. Haddan, London. (*R. Stewart and F. Watts, Illinois, U.S.A.*) Cleaning Steam Boilers. [6*d.* 3 *Figs.*] March 11, 1884.—A pipe is provided at the bottom of the boiler, and runs longitudinally inside it. The rear end of this pipe is closed, and at frequent intervals along it nipples are fixed bevelled on the inside to an edge. Outside the boiler an escape valve is fixed upon the pipe, and can be opened fully and closed, allowing a rush of water through the pipes, and then stopping the rush, thus vibrating the contents of the boiler which, with the agitation, will cause all scale and sediment to break off the boiler and be carried against the nipples and broken up. (*Sealed June* 20, 1884).

5346. J. H. Train, Sunderland. Lap-Riveted Joints for Boilers. [6*d.* 2 *Figs.*] May 23, 1884.—An accurately formed wedge-shaped filling piece is inserted at the double lap, which is rivetted through the filling piece, in lieu of forging or fastening the plates to close the outer and inner plates together where the intermediate plate terminates. (*Accepted September* 23, 1884).

11,186 L. and C. Steinmueller, Gummersbach, Germany. Steam Generators. [6*d.* 12 *Figs.*] August 9, 1884.—The boiler comprises two wrought iron chambers A and B. The lower chamber B consists of two chambers C connected together by a number of tubes D and to the chamber A by connections F G. The part B is entirely filled with water, which reaches to about the middle of the chamber A. The connection F rises within the part A to slightly above the water level, and is



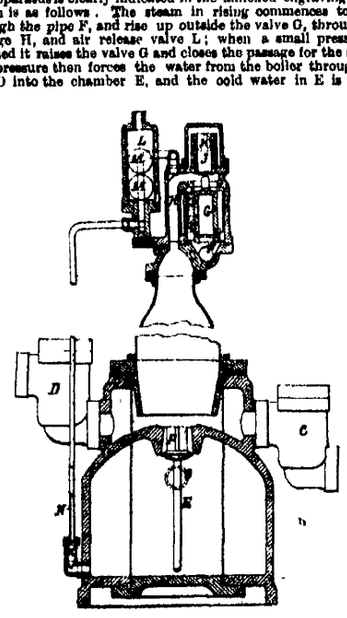
covered by a rectangular box along which the steam passes, and the connection G terminates at the bottom of A, the water rises and gives off its steam at F, the steam passing along the box H, which is open at the right-hand end, and is thoroughly dried. Plates arranged to form a serpentine passage may be fitted to the box H, and are provided with holes for the escape of the water The water deprived of its steam becomes heavier, and descends by the connections G, causing a very effective circulation. Openings are provided in front of the chambers C for removing any of the tubes (*Accepted September* 9, 1884)

12,416. A. W. L. Reddie, London. (*W. Craig, Brooklyn, N.Y., U.S.A.*) Getting up Steam in Steam Boilers. [6*d* 2 *Figs.*] September 15, 1884.—The method consists in first simultaneously circulating and heating the water in the main boiler before the fires are lighted in the furnaces by a current of steam from a supplementary boiler, whereby the water is drawn from one part of the main boiler, heated and discharged into another part, and in starting the fires in the furnaces after the water has become so uniformly heated as to greatly lessen the liability of strain due to unequal expansion by the heat of the fires. (*Accepted October* 17, 1884).

FEEDING STEAM BOILERS.

481. H. J. A. Bowers, London. Purifying the Feed Water of Boilers, &c. [6*d* 4 *Figs.*] January 3, 1884.—The feed water passes from the feed pump to a large pipe in the steam space of the boiler, where the water deposits any impurities The water then passes to the top of a separator outside the boiler comprising two vertical chambers connected to a lower vessel tapering downwards to a small outlet provided with a blow-off cock.

7647. A. Mayhew, London. Automatic Boiler Feeders. [6*d* 5 *Figs.*] May 13, 1884.—The construction of the apparatus is clearly indicated in the annexed engraving The action is as follows. The steam in rising commences to blow through the pipe F, and rise up outside the valve G, through the passage H, and air release valve L; when a small pressure is attained it raises the valve G and closes the passage for the steam The pressure then forces the water from the boiler through the pipe O into the chamber E, and the cold water in E is forced



through the pipe N past a weighted valve X into the passage H, and a small quantity is forced past the valve P into the cylinder A until it reaches the ball valves M, which are raised to their seats, closing the air release valves, and raising the water in the apparatus to boiler pressure. Supposing the boiler requires water, *i.e.*, when its level is below the foot of the pipe E, steam

passes in by the pipe K, and the increase of pressure due to the difference between the weights of the water and of the steam forces the valve J to descend into the valve G; steam then passes in and coming in contact with the water allows the water to fall through the cylinder A, and through the delivery valve D to the boiler. When the steam reaches the base of the cylinder A it comes in contact with the water in the annular chamber at the base of the cylinder, and its partial condensation raises the valve G to its seat, carrying with it the valve J, and water is forced up from the boiler through the pipe O forcing injection water in E into the cylinder, condensing the steam, and creating a vacuum which draws in water through the suction C. When the water reaches the pipe K the boiler pressure keeps the valve G to its seat, and the above operation is repeated. (*Sealed August* 15, 1884).

11,661. M. E. Lake, London. (*G. H. Nott, Chicago, Ill., U.S.A.*) **Purifying Water for Use in Steam Boilers.** [6*d.* 3 *Figs.*] August 26, 1884.—Carbonic acid and bicarbonate of lime are extracted from the water by placing burnt lime in a receptacle before reducing it to a hydrate and causing the entire stream or body of water to be purified to flow under pressure through the receptacle and through the lime and afterwards subjecting the stream to filtration. (*Accepted September* 26, 1884).

12,102. H. J. Haddan, London. (*G. Miles, Wellesley Hills, Mass., U.S.A.*) **Returning the Exhaust Steam of Steam Engine Cylinders to the Boiler.** [6*d.* 1 *Fig.*] September 6, 1884.—An auxiliary boiler generates steam at a higher pressure than that of the main boiler, such pressure being utilised for forcing exhaust steam into the main boiler by means of an injector. (*Accepted October* 10, 1884).

STEAM BOILER FURNACES.

85. R. H. Hepburn, London. Supplying Air and Steam to Furnaces to Cause more Perfect Combustion. [6*d.* 4 *Figs.*] January 1, 1884.—The apparatus is constructed with one common steam chamber to supply a series of nozzles and a corresponding series of compartments, the compartments having openings for the entrance of air thereto, and for the discharge of the steam and air therefrom into the furnace, the whole apparatus, except the nozzles, being cast in one piece. (*Accepted October* 17, 1884).

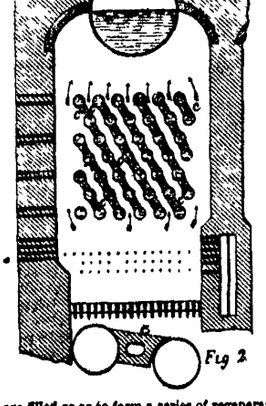
634. F. D. Rose, Flixton, Lanc. Mechanical Stokers for Furnaces. [6*d.* 4 *Figs.*] January 4, 1884.—A cylinder perforated through a part or the whole of its length and provided with an opening in its periphery near its far end for the deposit of ashes is mounted and revolved within the furnace and has an opening at the front and for the purpose of feeding the same. The cylinder is composed of fireclay or of iron bars and is formed with a web or Archimedean screw on its outer surface for withdrawing the ashes resulting from combustion. (*Sealed May* 20, 1884).

1378. L. Bregha, Dresden, Germany. Steam Boiler Furnaces. [6*d.* 4 *Figs.*] January 22, 1884.—The fuel is first charged on an inclined grate formed in steps on which it is heated before being burnt on the main horizontal grate. The space above the inclined grate is covered by an inclined vault forming an inclined passage for heating the air, and directing it downwards on to the burning fuel on the horizontal grate. An iron frame door is fitted between the two grates in which are arranged two kinds of blind or louvres disposed preferably horizontally and vertically, and serving to regulate and distribute the entering air. A tipping box is mounted on an axis above the inclined passage, and serves to receive fuel which is charged to the inclined grate by tipping the box. Under the horizontal grate is a rake, the teeth of which pass between the firebars, and which is moved to and fro at suitable intervals. (*Accepted October* 10, 1884).

2763. J. Sawyer, London. Furnaces for Steam Boilers. [6*d.* 2 *Figs.*] February 5, 1884.—A cast-iron bottom dead plate projects slightly beyond the front of the boiler, and above it is fixed a top dead plate, the front ends of the firebars resting on the bottom dead plate and between the two plates, which are riveted or bolted to the front of the boiler. The back ends of the bars rest on a plate cut away to allow air to enter behind the firebars and bolted to an upright plate at the back of the furnace. Another plate projects from the bridge over the ends of the bars, a space being left for the passage of a certain quantity of air to combine with the carbonic oxide near the bridge. The upper surfaces of the bars are notched, and the front ends are so fitted that every alternate bar is fixed and the intermediate bars movable longitudinally, that the alternate bars are movable in opposite directions longitudinally, or that each bar is movable independently longitudinally. (*Sealed May* 13, 1884).

5,681. O. Imray, London. (*J. Ferrando, Genoa*). **Furnaces of Steam Generators.** [6*d.* 3 *Figs.*] June 6, 1884.—The firebars of furnaces for burning small coal are more or less oblique in respect to the longitudinal direction of the axis of the furnace. The ashpit is closed, and openings or passages in the firebars replace the ordinary openings between the bars. The fire bars are cooled by means of steam or other gases except air, or by mixtures of gases and liquid. Suction may be applied to the chimney and pressure under the firegrate to increase the draught. (*Accepted October* 14, 1884).

10,646. C. A. Knight and G. W. Thode, Glasgow Boiler Furnaces. [6*d.* 4 *Figs.*] July 26, 1884.—The spaces between the tubes in the front section of boilers with inclined

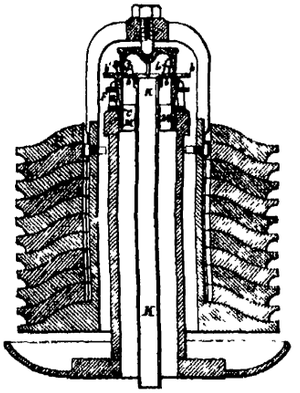


water tubes are filled so as to form a series of regenerators. Flues or passages are provided at one or both sides of the series of tubes. Referring to the illustrations, the front section of the tubes immediately over the firegrate of the boiler is filled with refractory blocks C, preferably made hollow. The gases generated by the burning of fresh fuel on the grate, and whose temperature may be below the ignition point, are, after admixture with air, highly heated in passing through the flues a, complete combustion being effected. (*Sealed October* 28, 1884).

12,289. T. E. Caddy, Nottingham. Firebars. [4*d.* 3 *Figs.*] July 18, 1884.—The bar is formed with an air tube, and has its faces chilled. The molten metal is cast round a wrought-iron tube forming the air tube and with metal plates forming the faces of the bars. The air passing through the tubes serves to keep them cool and to consume the smoke. (*Accepted October* 7, 1884).

STEAM BOILER FITTINGS.

496 T. Foster, Manchester. Safety Valves. [6*d.* 3 *Figs.*] January 4, 1884.—The safety valve has an upper valve seated on a lower one, the lower valve has a flange or broad face on its upper end which is coincident with the path of the steam as it issues from the lip of the upper valve. Referring to the illustration, the lip of the upper valve A rests upon a loose seating B forming a lower valve, and resting upon a seating C secured to a stand-pipe. The valve B is made in the form of a short tube with a flange *b* b^1 at its upper end, the portion b^1 coin



ciding with the path of the steam. The entire load upon the lower valve is thus reduced during the whole time that the issuing steam sweeps its upper face. An annular ring F may be attached to the guides H for the purpose of assisting in preventing the steam as it issues from the lower valve striking the underside of the flange b^1. The tube K secured to the flange *b* supplies the upper valve with steam. M M and L L are guide ribs, and P are annular weights for loading the valve. Slightly modified forms of valves are shown. (*Accepted September* 23, 1884).

1484. A. M. Clark, London. (*P. Brown and C. W. Johnston, Philadelphia, U.S.A.*) **Feed Water Regulator and Lower Water Alarm for Steam Boilers.** [6*d.* 3 *Figs.*] January 15, 1884.—A feed water regulating cylinder and a lower water alarm cylinder are arranged on opposite ends of a lever whose fulcrum is supported at the end of a second lever, and counterbalanced by weights. The feed water cylinder is arranged at about the ordinary water level and connected at the top and bottom by flexible pipes respectively with high-water level and low-water level. The alarm cylinder is connected at the top and bottom by flexible pipes to the boiler at a dangerously low-water level. As the level of water in the regulator cylinder varies with the water in the boiler, the alarm cylinder being always full of water, the first lever is turned in one direction or the other, and operates on the water supply. When the water falls below the dangerous level, both cylinders will be emptied of water and the second lever will be tipped and by a wire connection operate the lever of a steam whistle. (*Accepted September* 16, 1884).

PACKINGS.

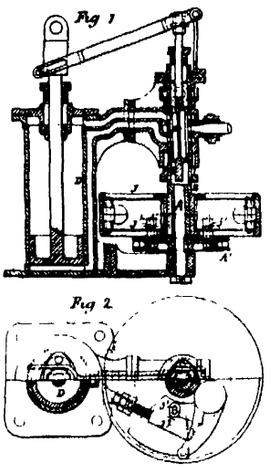
640. F. C. Bell, London. Packing for Valves and Joints. [4*d.* 3 *Figs.*] January 4, 1884.—Sheet india rubber is faced on each side with asbestos cloth saturated with caoutchouc or other gum, and caused to adhere to the india-rubber by means of a solution of india-rubber. (*Accepted October* 17, 1884).

2388. A. L. Normandy, London. Asbestos Packing. [2*d.*] January 30, 1884.—The asbestos paper, millboard, or cloth is saturated with a substance capable of preventing moisture affect the joint made with the asbestos. Boiled oil, grease, wax, liquefied stearine, or paraffin, red or white lead, driers, thin paint, varnishes, solutions of india-rubber or gutta-percha, resins, tars pitches, or asphaltes, alone or mixed more or less together, may be employed. The asbestos may be heated to a temperature which will destroy all organic matter and afterwards be submitted to the action of the saturating material. (*Sealed May* 9, 1884).

STEAM ENGINES.

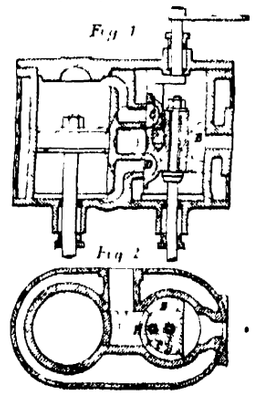
6060. D. A. Cormack, Leith. Compound Surface Condensing Steam Engines. [6*d.* 2 *Figs.*] April 8, 1884.—The two cylinders are in one casting placed side by side upon one column which is cast hollow to form a vacuum chamber. The steam supply is controlled by one slide valve having ports corresponding to those in the cylinder face which are seven in number, the three centre ports lead to the condenser; the two ports adjacent to these three, one on either side, open to the low pressure cylinder, and the extreme top and bottom ports open to the high-pressure cylinder. The cranks are placed opposite to each other, and the steam in the first instance is admitted over the end of the slide valve into the high-pressure cylinder, and steam escapes from the opposite end of the high-pressure cylinder into the opposite end of the low-pressure, direct through a passage cast in the slide valve. The line of the valve face is parallel to the crank shaft. For marine engines Chapman's air extractor is connected with a condenser placed outside the hull of a vessel, and having its hot-well and suction also placed outside. The tubes of the condenser may be enclosed in a chamber within the hull, but in direct communication with the sea. (*Accepted September* 12, 1884).

7378. W. Murdock, Glasgow. Operating the Governing Valves of Motive Power Engines. [6*d.* 7 *Figs.*] April 3, 1884.—This refers to Specification 5377 of 1884, in which is described an arrangement of governor valve in which a hollow cylindrical rotating valve is fitted within a cylindrical rotating shell, helical ports being cut in both, so that when such ports are over each other steam may pass through to or from the admission and exhaust ports of the governor cylinder, and when the cylindrical valves are moved on each other the helical ports close and shut off communication with the cylinder ports. Both valves are rotated together, the one being driven by the main engine and the other by a small engine at a constant speed. Instead of the small engine, this valve is now driven by a centrifugal or other governor. Referring to the illustration, the spindle A is driven by a belt and pulley A^1 from the main engine, and the hollow spindle B has keyed on it the governor casing J, driven from the pulley A^1 by means of ball levers *j* and studs or pins j^1. The two valve spindles rotate together, but according as the



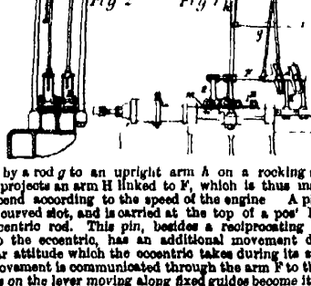
velocity of rotation increases or diminishes, ball levers *j*, pivotted to the casing J and the studs j^1, will fly out against the resistance of springs or be forced in towards the centre by the springs and the relative positions of the two spindles will be changed, and the valves *a b* will turn, the one on the other, and regulate the admission of steam to the governor cylinder D. The governor may be applied to a throttle valve as in the before mentioned specification, which may be cylindrical, conical, or of disc form. (*Accepted September* 23, 1884).

7955. E. C. Peck, Old Charlton, Kent. Slide Valves. [4*d.* 6 *Figs.*] May 20, 1884.—The valve is of cylindrical or of partly cylindrical form and has two working faces, one of the ordinary D type and the other of the Worthington type. Referring to the illustrations, the valve at one part, B, of its circumference is of the ordinary D type. The recesses C D in another part



are separated from the recess B by a plain part H of the casting slightly wider than the width of the ports, as shown in Fig. 2. By turning the valve by means of a lever, so that the recess B, instead of two recesses C and D, comes opposite the cylinder ports, the engine will be reversed. The valve may work in any intermediate position between these two. (*Accepted October* 3, 1884).

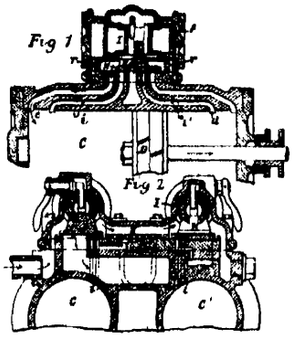
8190. C. J. Galloway and J. H. Beckwith, Manchester. Trigger Gear for Engine Valves. [6*d.* 3 *Figs.*] May 23, 1884.—This relates to gear of the type described in Specification 2439 of 1876. The two slides of the engine are operated from eccentrics fixed on the crankshaft, and each has a trigger gear. Referring to the illustration, a three-armed lever E is pivotted on the ends of the arms D carrying the trigger plate, and has one of its arms jointed to a horizontal arm F, having in its end an inclined curved slot. The sleeve of the governor is

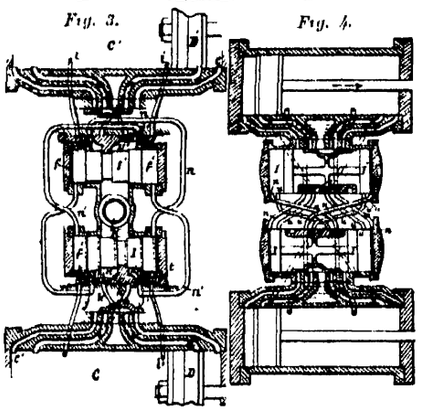


linked by a rod *g* to an upright arm A on a rocking shaft from which projects an arm H linked to F, which is thus made to rise or descend according to the speed of the engine. A pin engages in the curved slot, and is carried at the top of a pos' K, fixed on the eccentric rod. This pin, besides a reciprocating movement due to the eccentric, has an additional movement due to the angular attitude which the eccentric takes during its stroke, and this movement is communicated through the arm F to the lever E. Rollers on the lever moving along fixed guides become its fulcrum, and in being canted it raises the arm D and its trigger plate disengaging it from the catch plate M on the slide rod, and so re-

leasing the slide, permitting it to make its back stroke The governor, as will readily be seen, determines the point of disengagement (*Accepted September* 23, 1884)

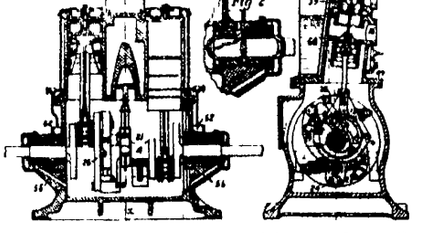
10,697 M. W. Hall, Brooklyn, N.Y., U.S.A. Duplex Steam Engines. [6*d* 10 *Figs.*] July 12, 1884.—Each cylinder is adapted to control the valve of the other cylinder. Figs. 1 and 2 show longitudinal and transverse sections of the cylinders, and Fig 3 is a diagrammatical view of the valves Referring especially to Fig 3, the operation is as follows: Steam enters the cylinder C through the port c^1, and drives the piston D to the right. When the piston reaches nearly the end of its stroke it uncovers the port d^1, and live steam passes through it, the groove m^1 in the valve H, into port f^1, and by the passage n^1 to the chamber J^1 of the steam chest J, forcing the plunger I and valve H^1 into the positions shown, the steam in the chamber f at the other end of the plunger I escaping by the passage n, port f_1





groove m in the valve H, and passage K to the exhaust d^1 from the cylinder C The valve H^1 in this position also admits steam through the port c to the cylinder C^1 and starts the piston D^1 (which has been at rest) on its leftward stroke When this piston uncovers the port f^1 no effect is produced, this port being closed by the valve H^1 When it uncovers the port e steam will pass in a similar manner to that above described to operate the plunger I and valve H to the left, and thus admits steam to force the piston D on its leftward stroke The plungers are cushioned at the ends of their stroke by means of a groove t which admits steam behind the piston of the plungers I Fig 4 shows a modified construction in which the passages n n^1 are used only for conducting the live steam to move the plungers H^1 The exhaust is led away by additional passages n n^1 The slide valves may be replaced by piston valves (*Sealed October* 28, 1884)

10,937 H. H. Westinghouse and A. G. Brown, Pittsburg, and H. Tabor, Allegheny, Penn., U.S.A. Steam Engines [6*d* 15 *Figs.*] August 5, 1884.—This relates to steam engines of the class having two vertical single acting cylinders, the pistons of which are connected to opposite crank pins, and are governed by a common distribution valve Fig 1 is a vertical longitudinal central section, and Fig 2 is a vertical section on the line x x, Fig 1 The eccentric 21 working the common distribution valve is provided with a slot so that it can move transversely of the shaft 4, and is pivotted, by means of an arm 28 on it, to a pin 24 fixed in a governor disc 25 secured to one of the inner crank arms, and carrying a centrifugal governor A pair of weights 26 are pivotted to the disc 25, and connected by a



link 23, the ends of which are journalled on pins fixed to the weights, one between its pivot and the weight, and the other beyond the pivot The centrifugal action of the weight is resisted by springs. A link 29 is coupled at one end to a pin on one of the weights, and at the other to a pin on the eccentric, which is, by movement of the weights, moved transversely to the crankshaft upon its pivotted arm as a centre. The distribution valve is formed with upper and lower pistons 38 and 39, the upper piston being larger than the lower, so that the steam pressure tends to balance the weight of the parts The pistons 38 and 39 are packed with rings, and are formed with circumferential grooves on their *steam sides, the opposite sides being open to the exhaust through* the centre of the valve, so as to hold the rings to their seats. Each cylinder head is provided with a relief plate driven or screwed into the body of the cylinder head against a shoulder, and a groove is formed in the plate to reduce its strength so as only to maintain the maximum working pressure, and so prevent damage from priming or water in the cylinders In order to provide for the escape of water from the cylinders, small ports uncovered by the pistons when at the lower extremities of their stroke lead to the exhaust 15 A drain pipe 47 passes from the exhaust pipe to the crank case, and by discharging condensed water maintains the lubricating mixture of oil and water at a proper level in the case The journals of the crankshaft are tapered from their inner to their outer ends, and rotate in cylindrical bearings provided with Babbitt metal bearings. Chambers for the reception of oil are formed in the ends of the journals by caps fitting over the shaft. Rings rotating with the chamber force the oil passing along the shaft into the chambers, from which it is returned by passages 56 to the crank case. An oil reservoir 58 is provided with oil feed pipes having regulating cocks, and discharges into oil cups 62 of the crankshaft bearings. (*Accepted September* 23, 1884)

ROTARY STEAM ENGINES

4996, M. L. Bennison, New Cross, Kent. Rotary Motors. [4*d* 10 *Figs.*] March 1, 1884.—The internal cylinder is constructed with four sliding blades working or acting as stops across the annular space between the revolving internal cylinder and the case The outer casing is provided with double passages for the inlet and exhaust, each passage being provided with two ports for allowing the steam, water, or air to be admitted and exhausted simultaneously on two opposite sliding blades. (*Sealed June* 6, 1884).

9689. A. M. Clark, London. (*D. McColgan, Butte, Montana, U.S.A.*) **Rotary Engines.** [10*d.* 10 *Figs.*] July 8, 1884.—A wheel having a semicircular groove in its face runs within a stationary ring, also having a semicircular groove, which, together with the groove of the wheel, forms a circular steam way Pistons are fixed to the wheel and abutments are arranged in the stationary ring to slide forward and backward. Slide valves shut off the steam while the abutments are moving, the abutments and valves being operated by cams on the shaft of the wheel (*Accepted September* 12, 1884)

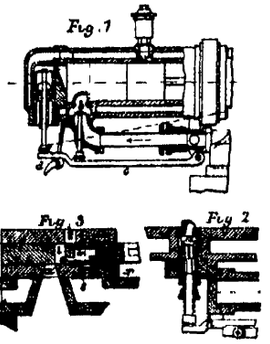
10,128. T. H. Thwaites, Bradford. Piston or Revolvers for Rotary Blowers or Pumps. [4*d* 3 *Figs.*] July 14, 1884.—The curved outlines of the pistons or revolvers are formed of a series of arcs of circles joined one to another in regular and flowing lines avoiding any breaks or angles at the junction of such arcs (*Accepted September* 9, 1884)

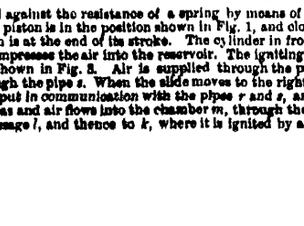
GAS ENGINES.

540 H. W. Whitehead and R. Steel, Leeds Gas Engines. [4*d* 3 *Figs.*] January 3, 1884.—A charge of explosive gas is first drawn in at the outer end of the cylinder by the first instroke, and during the first outstroke the charge passes through a check valve in the piston to the other side of the piston, expelling the products of combustion remaining in the cylinder The charge is compressed during the second instroke at the end of which it is ignited, the piston being propelled by the explosion during the first portion of the second outstroke, and the products of combustion being partially exhausted during the latter portion of this stroke. A portion of the products of combustion may if preferred be drawn in before the explosive gas, suitable ports being provided in a slide valve. The exhaust valve is opened at the end of each instroke by a projection on the crosshead, letting out a portion of the compressed mixture and preventing ignition before the crank has passed its centre. Watson's igniter described in Specification 1723, of 1881, is preferably employed (*Sealed April* 29, 1884).

859. T. Bradbear, Birmingham. Preventing Irregularity in the Flow of Gas in Mains Supplying Gas Engines. [4*d.* 1 *Fig.*] January 7, 1884.—The apparatus consists of a metallic case divided in two chambers by a horizontal partition, in which is a valve seat, provided with a conical valve suspended from one end of a lever whose other end is linked to a flexible diaphragm stretched over a small chamber at the upper part of the case, and supporting weights which may be varied at pleasure The gas is admitted to the upper chamber, and passes between the valve and its seat to the lower chamber and to the exit By raising or lowering the fulcrum of the lever the supply of gas is adjusted. (*Accepted September* 9, 1884).

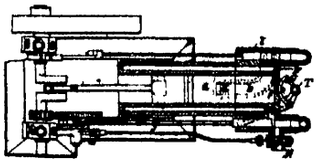
9949. E. Capitaine, London. (*Benz and Co., Mannheim, Germany*) **Gas Motors.** [6*d.* 4 *Figs.*] July 9, 1884.—Referring to the illustrations, and supposing the engine to have just completed its working stroke, the valve a is first opened to release the excess of pressure in the cylinder and afterwards a valve b, through which air enters from a reservoir at a pressure slightly above the atmosphere, to expel the products still remaining in the cylinder The valves are opened by a pivotted lever c operated by a cranked lever d When the piston has reached the position shown, both valves a b are closed, and during the remaining half of the stroke gas is forced into the cylinder by means of a gas pump, the mixture being compressed by the piston itself. The valve arrangement for admitting the gas is shown in Fig 2; the valve





is opened against the resistance of a spring by means of a lever A when the piston is in the position shown in Fig. 1, and closes when the piston is at the end of its stroke. The cylinder in front of the piston compresses the air into the reservoir. The igniting arrangement is shown in Fig. 3. Air is supplied through the pipe r and gas through the pipe s. When the slide moves to the right the passage n is put in communication with the pipes r and s, and a mixture of gas and air flows into the chamber m, through the orifice o to the passage l, and thence to k, where it is ignited by a continuously burning flame, and on further movement of the slide to the left ignites the mixture in the cylinder by means of the port x. An additional gas supply passage opens into the orifice o, so that the chamber m is filled with an explosive gas and only combustible gas flows out of the orifice and prevents the ignition striking back into the chamber m. The air and gas supply is cut off at the moment the passage l comes opposite x. (*Sealed October* 31, 1884).

11,437. W. Clark, London. (*G. M. Hopkins, Brooklyn, N.Y., U.S.A.*) **Gas Engines.** [6*d.* 4 *Figs.*] September 1, 1884.—This relates to that class of engine in which the explosive mixture is ignited and exploded under atmospheric pressure. The cylinder is water-jacketted, and is made in two parts a b, the piston sliding in the part a between the open end and the exhaust port E. The part of the cylinder between E and the cylinder head F constitutes a combustion chamber. The air and exhaust slide valves are arranged on opposite sides of the part B, and each consists of a cylindrical valve sliding in a casing on the wall of the water jacket The air valve is provided with an inclined inlet port e communicating with the combustion chamber and opening in the direction of the ignition aperture f, and is operated by the rod g, driven from a shaft as shown, the shaft making one revolution to every two of the engine. A gas supply valve N communicates with the interior of the air valve, and is opened by pushing in its stem against the pressure of a spring. The valve



stem is connected by a rod with an arm pivotted in a fixed bracket and carrying a roller operated by a cam, so that the gas valve is opened when the air port has been open for one-half its period; the gas and air valves close simultaneously The exhaust valve I communicates with the exhaust by a pipe, shown in dotted lines, and is opened during every instroke of the piston and closed during every outstroke. The igniting valve U consists of a segment of a hollow cylinder mounted on a rock shaft T, operated from the air valve as shown. The segment of the hollow cylinder works in a concave seat in the cylinder head, and has a small aperture opposite which is a small burner carried by the cylinder When the piston completes its instroke, after taking in air and gas, the apertures in the valve and head will be opposite one another, and the mixture will be exploded. The passage from the port K serves as a receptacle for oil or water that may accumulate in the cylinder, and is provided with a cock A method of regulating the flow of water required in cooling the cylinders of gas pumping engines that the cylinders may become neither too hot nor too cold, is described. (*Accepted October* 3, 1884)

ENGINE FITTINGS.

1741 A. Burton, Beighton, Derby. Crank-Pins and Crosshead Journals [4*d* 2 *Figs.*] January 19, 1884.—A sphere or ball is used in lieu of the ordinary straight neck in the crosspin and crosshead journal, and fitted with corresponding brasses, the object being to allow a side motion to the connecting rod In case of locomotives running round a curve, and in stationary engines to allow for straining of the connecting rod (*Accepted September* 26, 1884).

11,767. E. J. Pearson, Beeston, Notts. Throttle Valves. [4*d* 3 *Figs.*] August 29, 1884.—Throttle valves of the class in which the valve disc can, however placed, be removed by a side aperture in the casing, are constructed with the cap or cover of the aperture and the frame which receives the valve disc cast altogether in one piece, the casting being bored to afterwards fit the disc (*Accepted September* 30, 1884).

TRANSMISSION OF POWER.

10,531. P. A. Humbert, San Francisco, U.S.A. Transmission of Power for Operating Pumps in Mines [8*d* 18 *Figs.*] July 25, 1884.—The pumps are worked by means of an endless travelling wire rope or cable passing from the source of power over and around suitable sheaves to the pumps The invention includes the arrangement of sheaves to provide for the necessary course of the cable whether its power be transferred to stationary pumps or to a sinking pump required to be lowered periodically as the shaft is sunk; means for taking up the slack of the rope in either case, means for altering the stroke of the pumps without diminishing the speed of the cable, and means for lowering the sinking pump and its extensible suction and discharge pipes. (*Accepted September* 9, 1884)

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

DEFENCES OF SYDNEY.—The question of the defences of Sydney, which involves the consideration of the manner in which the Wolverene should be employed, has on more than one occasion been before the Government of New South Wales. It is said to be not improbable that a proposal will in due time be made for the purchase in England of a gunboat for the better defence of Sydney harbour.

IRON MINERALS IN FRANCE.—The imports of iron minerals into France in the first eight months of this year amounted to 880,201 tons, as compared with 1,092,653 tons in the corresponding period of 1883, and 939,918 tons in the corresponding period of 1882. In the first eight months of this year, Germany forwarded 285,832 tons of iron minerals to France, while Spain forwarded 300,056 tons, and Algeria 110,312 tons.

AMERICAN TELEGRAPHY.—The Baltimore and Ohio Telegraph Company is making great efforts to extend its lines. President Bates has been authorised to obtain estimates for extensions and improvements involving an expenditure not exceeding 2,000,000 dols. This sum has been raised by the Baltimore and Ohio Telegraph Company and its friends. Plans and estimates are now being considered for extensions of the Baltimore and Ohio system to St. Paul, Kansas City, Richmond, Virginia, Norfolk, Charleston, South Carolina, and Havannah, Atlanta, and Augusta, Georgia.

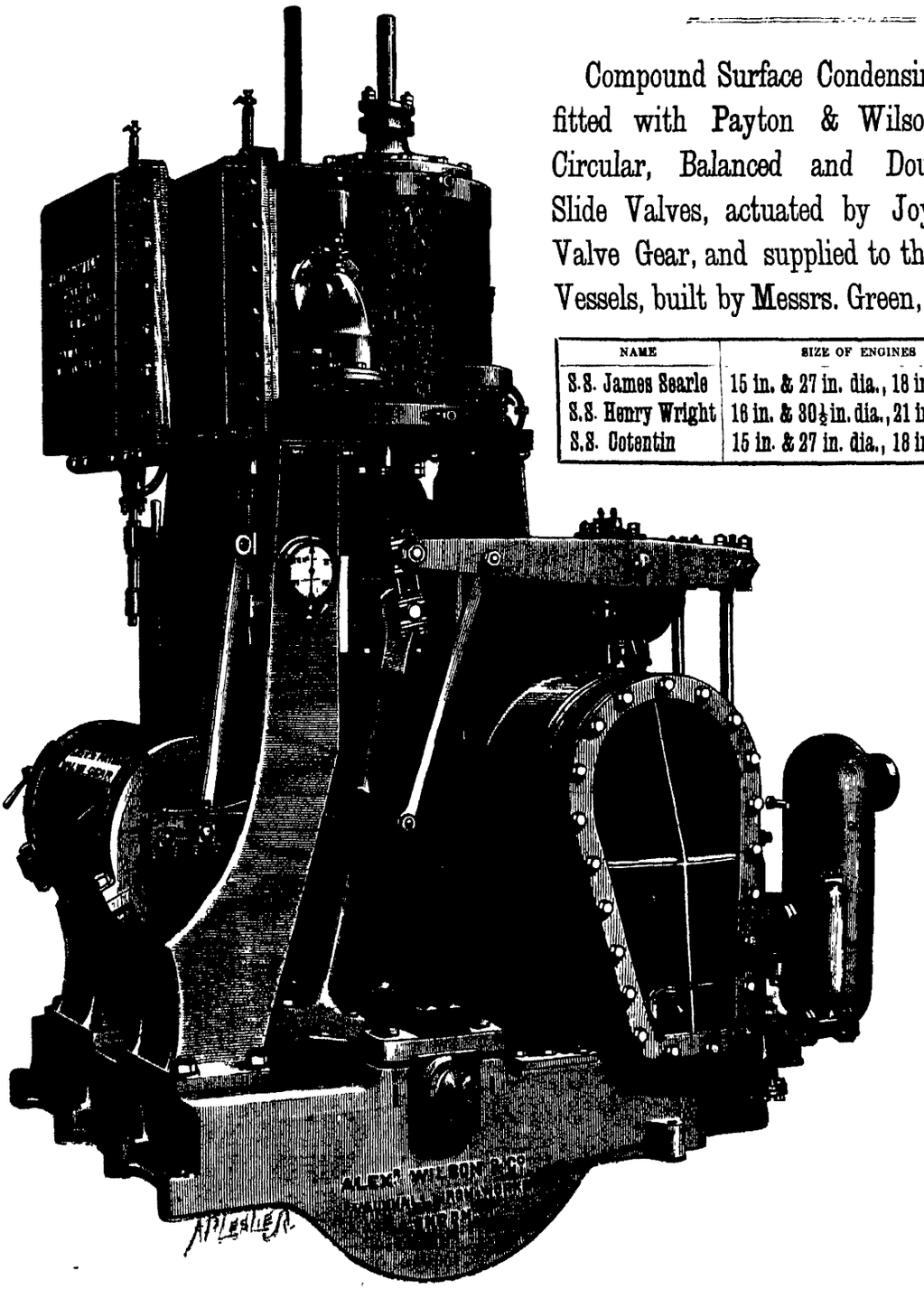
ALEX. WILSON & CO.,

ENGINEERS,

VAUXHALL IRONWORKS, WANDSWORTH ROAD, LONDON, S.W.

High Pressure, Compound and Surface Condensing Screw Engines of all Types.

ALL SIZES CONSTANTLY IN PROGRESS.



Compound Surface Condensing Engines fitted with Payton & Wilson's Patent Circular, Balanced and Double-Ported Slide Valves, actuated by Joy's Patent Valve Gear, and supplied to the following Vessels, built by Messrs. Green, Blackwall:

NAME	SIZE OF ENGINES	BUILT IN
S.S. James Searle	15 in. & 27 in. dia., 18 in. stroke	1881
S.S. Henry Wright	16 in. & 30½ in. dia., 21 in. stroke	1883
S.S. Cotentin	15 in. & 27 in. dia., 18 in. stroke	1884

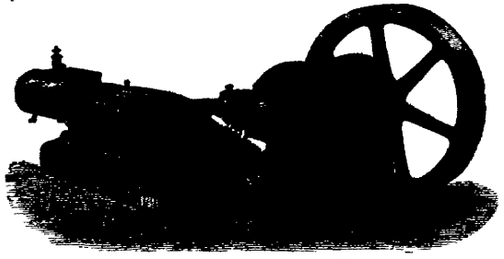
COMPOUND SURFACE CONDENSING ENGINE, 16 in. and 30½ in. dia., by 21 in. stroke, 220 I.HP., as fitted to the Church Missionary Society's Steam Yacht "Henry Wright," for service at Zanzibar.

TANGYES LIMITED CORNWALL WORKS, BIRMINGHAM

LONDON: 35, Queen Victoria Street. NEWCASTLE: St. Nicholas Buildings. MANCHESTER: Deansgate. GLASGOW: Argyle and Hope Streets. (F)

TANGYES' IMPROVED

ROTARY GAS EXHAUSTER



These Exhausters are supplied with or without Engine. The smaller sizes, (Nos. 1 to 6) when supplied with Engine, are mounted on strong cast-iron base plate (as illustrated), which also carries the Engine.

No.	Cubic feet per hour	In and Outlets	Horse Power of Engine	Price
1	2000	3 ins.	2	£60
2	3000	4 ,,	2	65
3	5000	5 ,,	2	75
4	7500	6 ,,	2	80
5	10000	7 ,,	3	95
6	15000	8 ,,	3	115
7	20000	9 ,,	4	125
8	30000	10 ,,	6	175
9	40000	12 ,,	8	210
10	50000	14 ,,	10	280

Prices of larger sizes on application. 194

MORTON'S SELF-SEALING RETORT LID,

With Holman's Patent Anti-Friction Catch and Self-sustaining Cross Bar.

TANGYES LIMITED, SOLE MAKERS.



These Patent Retort Lids and Fastenings are in extensive use in most of the Gas Works in Great Britain, America, and on the Continent, and have almost entirely displaced the older method of sealing by a luting of lime or other material. The Lids are made in three forms, D, oval and round (as shown above), in each of which we have a very extensive variety of patterns from which Gas Engineers contemplating the adoption of these Lids, are recommended to make their selection in order to avoid cost of pattern making, delays, &c., &c.

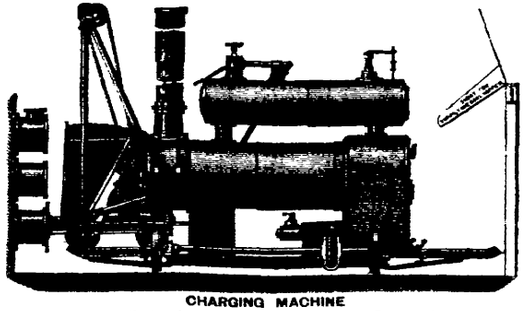
Mouthpieces with Circular Lids for Oval Retorts.

Pattern No.	Diam. Mouth	Internal Dimensions of Retort	Length of Mouthpiece	Price Lid & Fittings
13858	14 ins.	14 × 12 ins.	15 ins.	£1 6 6
4316	14 ,,	18½ × 12 ,,	12½ ,,	1 6 6
6851	15 ,,	16 × 14 ,,	13 ,,	1 8 0
7975	15 ,,	18½ × 13½ ,,	14 ,,	1 8 0
8969	15 ,,	21 × 15 ,,	15 ,,	1 8 0
6677	16 ,,	18½ × 15½ ,,	15½ ,,	1 9 0
7135	16 ,,	20 × 14 ,,	15 ,,	1 9 0
10221	16 ,,	24 × 16 ,,	12½ ,,	1 9 0
13770	17 ,,	20 × 14 ,,	14 ,,	1 12 0
6470	17 ,,	20 × 14 ,,	17 ,,	1 12 0
6818	17 ,,	20 × 15 ,,	15 ,,	1 12 0
4083	17 ,,	21 × 15 ,,	14 ,,	1 12 0
5306	17 ,,	22 × 14 ,,	14 ,,	1 12 0
13295	18 ,,	18 × 14 ,,	20 ,,	1 14 0
7356	18 ,,	21 × 14 ,,	13½ or 15 ,,	1 14 0
4569	18 ,,	21 × 15 ,,	14½ ,,	1 14 0
3628	18 ,,	22 × 16 ,,	14 ,,	1 14 0
7640	18 ,,	22½ × 15 ,,	18 ,,	1 18 0

Prices of Mouthpieces depends on number required, which please state when inquiring. The sizes given in List we have patterns for, new patterns are designed for at cost price. 190

THE "ROSS" PATENT STEAM GAS STOKER

TANGYES LIMITED, SOLE MAKERS.



CHARGING MACHINE

The Illustration shows the American Patent Machine for charging Gas Retorts with coal. The wrought-iron Hopper is fixed on a travelling frame for moving across the house. It is divided into three parts having angular movable partitions, each division holding a little over 3 cwt. or one charge. When the mouth of the Hopper is placed in the Retort the charge is blown in by a few sharp blasts of steam at 40 lbs. pressure, which is conveyed by a "walking" pipe fitted with carefully constructed joints. The Hopper is raised or lowered, and moved transversely by a small engine fitted on the Hopper Carriage which is carefully covered in to protect the working parts from coal dust.

Steam is supplied by a Multitubular Boiler of the Locomotive type, of ample size, having a Steam Receiver on the top and Water Tank underneath. The whole of the Machine is carried on a strong wrought-iron frame, fitted with axles and wheels. A separate Reversing Engine is supplied for traversing the length of Retort House.

All the handles are brought to a convenient position for working.

The great advantage of this machine is the speed with which the Retorts are charged, enabling the doors to be quickly closed and preventing waste of the best gas. Two men will do the work of four or five.

The Machines are in operation at the Windsor Street Works of the Birmingham Corporation, and at the Nine Elms Works of the London Gas Light Company.

Particulars on application. 188

MORTON'S SELF-SEALING RETORT LID

Mouthpiece for Round Retorts.

Diam. ins.	14	15	16	17	18
Price Lid and Fittings £	1 6 6	1 8 0	1 9 0	1 12 0	1 14 0

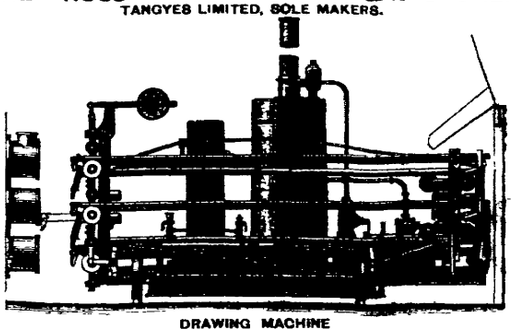
Mouthpiece with Circular Lids for D Retorts.

Pattern No.	Diam. Mouth	Internal Dimensions of Retort	Length of Mouthpiece	Price Lid & Fittings
5349	14 ins	14 × 13 ins.	7 ins.	£1 6 6
3463	15 ,,	15 × 13 ,,	14 ,,	1 8 0
6878	15 ,,	15 × 14 ,,	12 ,,	1 8 0
3661	15½ ,,	15½ × 13 ,,	12 ,,	1 9 0
13052	16 ,,	16 × 13 ,,	18 ,,	1 9 0
5801	16 ,,	16 × 14 ,,	15 ,,	1 9 0
6827	16 ,,	16 × 14 ,,	17 ,,	1 9 0
4494	16 ,,	16 × 14 ,,	14 ,,	1 9 0
3548	16 ,,	16 × 15 ,,	12½ ,,	1 9 0
6677	16 ,,	16½ × 13½ ,,	12½ ,,	1 9 0
9645	16 ,,	16½ × 13½ ,,	12½ ,,	1 9 0
4494	16 ,,	17½ × 14 ,,	14 ,,	1 9 0
6468	16 ,,	18 × 14 ,,	15 ,,	1 9 0
9015	16 ,,	18 × 14 ,,	18½ ,,	1 9 0
4327	16 ,,	18 × 15 ,,	15½ ,,	1 9 0
8049	16 ,,	18 × 15 ,,	17½ ,,	1 9 0
6137	16 ,,	20½ × 13½ ,,	13½ ,,	1 9 0
5918	17 ,,	18 × 14 ,,	14 or 17 ,,	1 12 0
5053	17 ,,	19½ × 12 ,,	14½ ,,	1 12 0
7548	17 ,,	20 × 13 ,,	15 ,,	1 12 0
6468	17 ,,	20 × 16 ,,	15½ ,,	1 12 0
4316 B	17 ,,	21 × 14 ,,	14 ,,	1 12 0
7975	17 ,,	21 × 15 ,,	14½ ,,	1 12 0
13459	17 ,,	21½ × 13½ ,,	15 ,,	1 12 0
12290	18 ,,	18 × 15 ,,	15 or 19 ,,	1 14 0
7135	18 ,,	18½ × 15 ,,	13 ,,	1 14 0
10221	18 ,,	18 × 16 ,,	12½ ,,	1 14 0
4506	18 ,,	20 × 13 ,,	19½ ,,	1 14 0
6470	18 ,,	20 × 13 ,,	15 ,,	1 14 0
6818	18 ,,	20 × 13½ ,,	17½ ,,	1 14 0
4083	18 ,,	20 × 15 ,,	16 ,,	1 14 0
5306	18 ,,	20½ × 14 ,,	13½ ,,	1 14 0
13295	18 ,,	20½ × 14 ,,	19½ ,,	1 14 0
7356	18 ,,	20½ × 13½ ,,	13 ,,	1 14 0
4569	18 ,,	21 × 14 ,,	18 ,,	1 14 0
3628	18 ,,	21 × 15 ,,	16 ,,	1 14 0
7640	18 ,,	22 × 12½ ,,	13½ ,,	1 14 0
7971*	20 ,,	20 × 15 ,,	18 ,,	2 0 0

*Patterns marked * have sockets at back to connect to Retorts all the others are flanged. Patterns marked B have curved Bottoms.* 191

THE "ROSS" PATENT STEAM GAS STOKER

TANGYES LIMITED, SOLE MAKERS.



DRAWING MACHINE

The Illustration shows the American Patent Machine for drawing the charge from Gas Retorts. The Rakes are generally three in number one for each line of Retorts, one only being in use at a time, but they are so arranged that they can easily be connected to the Travelling carriage for drawing. The Rake Bars are carried in guide rollers fixed in a lifting bar at the head of Machine, and so balanced that the workman can easily raise and pass the rake over the coke when entering the Retort.

The reciprocating motion of the Travelling Carriage is given by a chain passing round a wheel, rotated by a rack and pinion, the motive power being obtained by a direct-acting steam cylinder controlled by a cataract.

The whole of the Machine with Boiler is carried on a strong wrought-iron frame with large wheels and axles it is fitted with a small reversing Engine for traversing the Retort House.

All the handles are brought to a convenient position so that one man can work them. The Machine will easily draw 80 Retorts per hour, and enables two men to do the work of about 10 or 12, according to the number of Retorts.

The Machines are in operation at the Windsor Street Works of the Birmingham Corporation, and at the Nine Elms Works of the London Gas Light Company.

Particulars on application. 189

MORTON'S SELF-SEALING RETORT LID

Mouthpieces with Oval Lids for Oval Retorts

Pattern No.	Dimensions of Mouth	Internal Dimensions of Retort	Length of Mouthpiece	Price Lid and Fittings
9800	18 × 14½ ins.	18 × 14½ ins.	15 ins.	£1 15 0
9205	20 × 12 ,,	24 × 14 ,,	10½ ,,	1 18 0
10000	20½ × 14½ ,,	20½ × 14½ ,,	15 ,,	1 18 0
9680	21 × 15 ,,	21 × 15 ,,	15 ,,	2 2 0
10056	21 × 14½ ,,	21 × 14½ ,,	15½ ,,	2 2 0
13218	21 × 15 ,,	21 × 15 ,,	17 ,,	2 2 0
10514	22½ × 13½ ,,	22½ × 13½ ,,	13½ ,,	2 2 0
13766	20 × 17 ,,	20 × 17 ,,	15½ ,,	2 5 0
13269	24 × 15 ,,	24 × 15 ,,	16 ,,	2 8 0

Mouthpieces with D Lids for D Retorts

12292	15½ × 13 ins.	15½ × 13 ins.	12 ins.	1 14 0
9967	16 × 14 ,,	16 × 14 ,,	15½ ,,	1 15 0
13574	16½ × 13½ ,,	16½ × 13½ ,,	12½ ,,	1 16 0
9899	18 × 12 ,,	18 × 12 ,,	14 ,,	1 16 0
12980	16 × 16 ,,	16 × 16 ,,	18 ,,	1 17 0
13900	18 × 13½ ,,	18 × 13 ,,	16 ,,	1 17 0
9912	18 × 13½ ,,	18 × 13½ ,,	17 ,,	1 17 0
9962	18 × 13½ ,,	18 × 13½ ,,	16 ,,	1 17 0
10032	18 × 13½ ,,	18 × 14 ,,	15 ,,	1 17 0
11098	18 × 14 ,,	18 × 14 ,,	12 ,,	1 17 0
9492	20 × 13 ,,	20 × 13 ,,	15 ,,	1 19 0
9206	20 × 13 ,,	20 × 13 ,,	19½ ,,	1 19 0
10251	20 × 13 ,,	20 × 13 ,,	15½ ,,	1 19 0
12964	20 × 13 ,,	20 × 13 ,,	13½ ,,	1 19 0
9909	20 × 13½ ,,	20 × 13½ ,,	17 ,,	1 19 0
12969	19½ × 15½ ,,	19½ × 15½ ,,	14 ,,	2 0 0
13781	20 × 15 ,, Front 21 × 15 ,, Back	21 × 15 ,,	16 ,,	2 0 0
7692	21 × 15½ ,,	21 × 15½ ,,	16 ,,	2 0 0
12978	20 × 16 ,,	20 × 16 ,,	17 ,,	2 2 0
13252	20 × 16 ,,	20 × 16 ,,	18 ,,	2 2 0
13220	21 × 15 ,,	21 × 15 ,,	17 ,,	2 2 0
8977	21½ × 13½ ,,	21½ × 13½ ,,	18½ ,,	2 2 0
8976	21½ × 13½ ,,	21½ × 13½ ,,	18½ ,,	2 2 0
10497	21½ × 13½ ,,	21 × 13½ ,,	18½ ,,	2 2 0
8037	21½ × 13½ ,,	21½ × 13½ ,,	13½ ,,	2 2 0
9908	21½ × 13½ ,,	21½ × 13½ ,,	15 ,,	2 2 0
10404	21½ × 13½ ,,	22 × 14 ,,	18½ ,,	2 2 0
12410	21½ × 13½ ,,	22 × 14 ,,	12 ,,	2 2 0
13822	21½ × 13½ ,,	22 × 14 ,,	15 ,,	2 2 0
10515	22½ × 12½ ,,	22½ × 12½ ,,	13½ ,,	2 2 0
7924	24 × 14 ,,	24 × 14 ,,	15½ ,,	2 2 0
13807	24 × 15½ ,,	24 × 15½ ,,	16 ,,	2 2 0
9015 B	25 × 14 ,,	25 × 14 ,,	12½ ,,	2 5 0
10932	25 × 14 ,,	25 × 14 ,,	13½ ,,	2 5 0
12944 B	22 × 16 ,,	22 × 16 ,,	16 ,,	2 5 0

Patterns marked B have curved bottoms. 188

DICK, KERR & CO., Engineers and Contractors, (Five Medals awarded, Calcutta International Exhibition, 1883-4.)



SOLE MANUFACTURERS OF

KERR'S PATENT

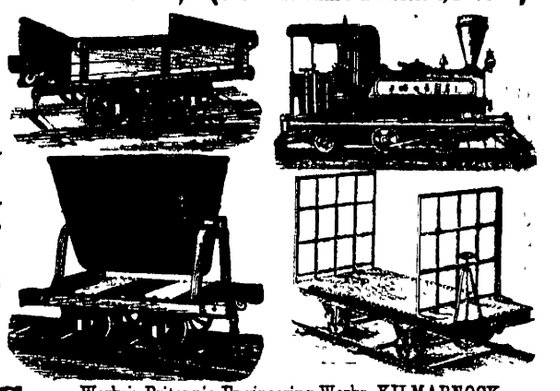
PORTABLE RAILWAY

SUITABLE FOR MINES AND PLANTATIONS

WAGONS & LOCOMOTIVES

FOR ALL CLASSES OF WORK.

Catalogues and Prices on application. 5024



101, LEADENHALL ST., LONDON, E.C. Works: Britannia Engineering Works, KILMARNOCK.

JAMES ARCHDALE & CO.,



MANCHESTER WORKS, LEDSAM STREET, BIRMINGHAM.

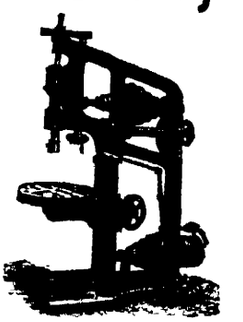
MAKERS OF ALL KINDS OF

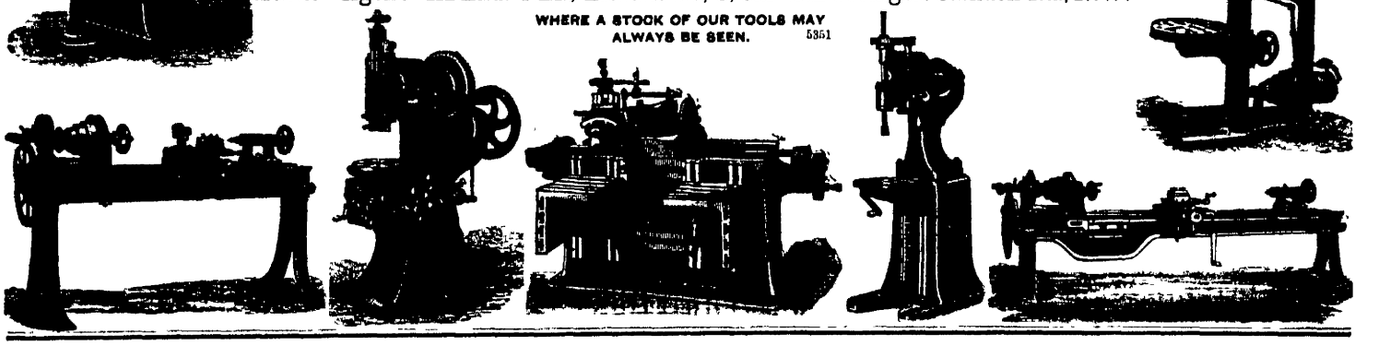
LATHES, PLANING, SHAPING, SLOTTING, DRILLING AND BORING MACHINES, &c., &c.

CONTRACTORS TO THE BRITISH & FOREIGN GOVERNMENTS.

London Agent: ALLEN LEE, Electrician, 3, Camden Cottages, Camden Rd., N.W.

WHERE A STOCK OF OUR TOOLS MAY ALWAYS BE SEEN. 5351





New Patent Barring Engine.

AUTOMATIC MOTION FOR MOVING INTO GEAR, AND FALLS OUT OF GEAR AUTOMATICALLY WHEN MAIN ENGINE STARTS.

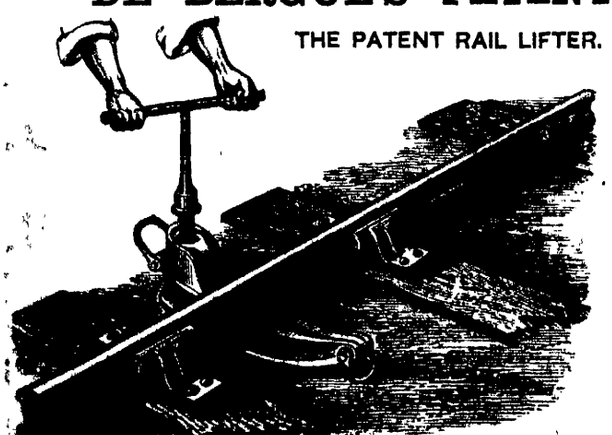
The SIMPLEST, SAFEST and BEST, and also the CHEAPEST Automatic Safety Apparatus for Turning Main Engines.

Sole Makers: HICK, HARGREAVES & CO., ENGINEERS, MILLWRIGHTS, AND BOILER MAKERS.

SOHO IRONWORKS, BOLTON. 5199

DE BERGUE'S PATENT IMPROVED RAIL LIFTERS.

THE PATENT RAIL LIFTER.



Entirely supersede the old inconvenient Lever Bars, and effect a great saving in Labour.



The Lever Bar as generally used. Clumsy and Dangerous.

4995

DE BERGUE & CO., LTD., STRANGEWAYS IRON WORKS, MANCHESTER.

JOHN LYSAGHT, Limited,

TRADE MARK. TRADE MARK.

IRON ROOFS & BUILDINGS,

DESIGNS AND ESTIMATES UPON APPLICATION.

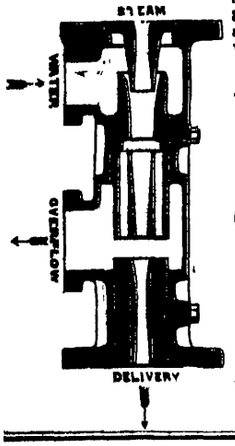
GALVANIZED CORRUGATED AND PLAIN SHEETS.
GALVANIZED STEEL SHEETS FOR WORKING UP.
GALVANIZED WIRE, WIRE NETTING, TANKS, &c.
WROUGHT AND CAST IRON GIRDERS, COLUMNS, &c.

BRISTOL: ST. VINCENT'S GALVANIZED IRON WORKS.
WOLVERHAMPTON: SWAN GARDEN MILLS.
LONDON: 28, GRACECHURCH STREET, E. C. 4068

GRESHAM'S PATENT IMPROVED SELF-ACTING INJECTOR

For Supplying Stationary, Locomotive, Agricultural, or Marine Steam Boilers with Water.

Fig. 1.



The Self-acting Injector possesses the following **great advantages over all other** Injectors:—It is **perfectly** Automatic, and **cannot fail** to work. It will lift its water supply **15 ft.**; and can, when specially ordered, be made for **greater lifts.** It will work with **more ease** and **certainty** with **hot water** than **any** other Injector. If it ceases working from **any cause** (for instance, shortness of water, and consequent admission of air), it will **re-start Automatically** immediately the cause is removed. It will work **equally** well at **any pressure** from 10 lb. to 200 lb. It may be fixed in **any position** above or below the water supply.

The combining and receiving Cones of Fig. 2 can be taken out and cleaned without breaking any pipe joints.

The above and every other class of Injector, Ejector, and Elevator in stock and in progress; also Brass Fittings for Locomotive and other Boilers.

Upwards of **100,000** *of Gresham's Patent Injectors are now in use.*

GRESHAM & CRAVEN,

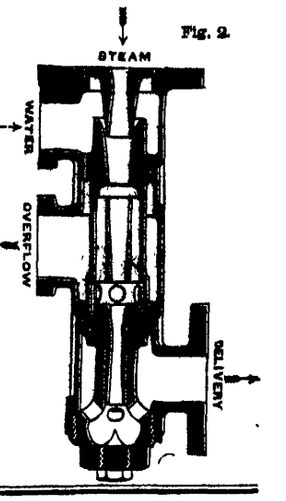
ENGINEERS, PATENTEES, & MANUFACTURERS,

Craven Ironworks, South Hall Street, Ordsal Lane, Manchester.

LONDON OFFICE:
A. L. SACRE, 60, QUEEN VICTORIA STREET, E.C.

AGENTS—Glasgow: WILLIAM LESTER, 58, Renfield Street. Newcastle-on-Tyne: TANGYE BROS., St. Nicholas Buildings. Birmingham: TANGYES LIMITED, Soho. 5039

Fig. 2.



ROOT'S PATENT STEAM BOILER.

NEW MODEL

WITH

STOLLWERCK'S PATENT FEED-WATER PURIFIER.

High Pressure and Large Power with Safety Capacious Water and Steam Space.

—PERFECT CIRCULATION.—

GREAT EFFICIENCY AND ECONOMY.

Sulphates, Carbonates, and other Impurities Intercepted and Readily Removed from Purifier. Generative part of Boiler Continuing Free from Scale.

FOR PRICES AND PARTICULARS APPLY TO

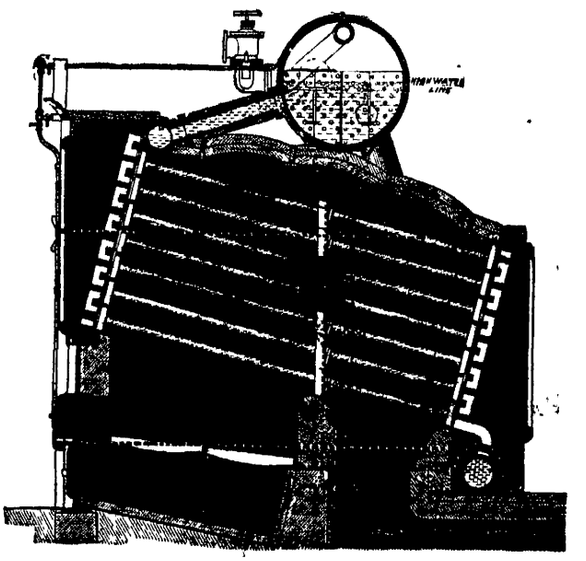
THE PATENT STEAM BOILER CO.

—(ESTABLISHED 1869.)—

HEAD OFFICE AND WORKS: 28, HENEAGE STREET, BIRMINGHAM.

LONDON OFFICE: 11, QUEEN VICTORIA STREET, E.C.

(CONRAD KNAP, REPRESENTATIVE.) 5418

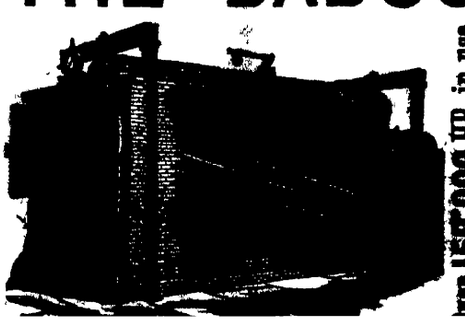


THE BABCOCK AND WILCOX CO.

(NEW YORK & GLASGOW)

PATENT

WATER-TUBE STEAM BOILER.



Over 150,000 H.P. in use.

Safe, Economical (as to space and fuel), and Durable; Having Perfect Water Circulation, and Spacious Steam-room; Easy of Transportation, and perfectly Accessible for Cleaning external and internally.

For Illustrated Circular and full particulars apply to our European Offices,

107, HOPE STREET, GLASGOW, SCOTLAND;

40, CANNON STREET, LONDON, E.C.; and

3, VICTORIA BUILDINGS, DEANSGATE, MANCHESTER.

For the Colonies and New England, apply at No. 2 Central Street, Boston, U.S.A.

TANNETT WALKER & Co.

ENGINEERS, LEEDS,

Makers of the heaviest class of Machinery used in the manufacture of **IRON** and of **STEEL** by the Bessemer and Siemens processes.

COGGING, RAIL & PLATE MILL ENGINES.

Armour Plate and Forging Presses.

STEAM HAMMERS.

Hydraulic Cranes and Capstans. 5963

WORKS: EAST GREENWICH, LONDON S.E.

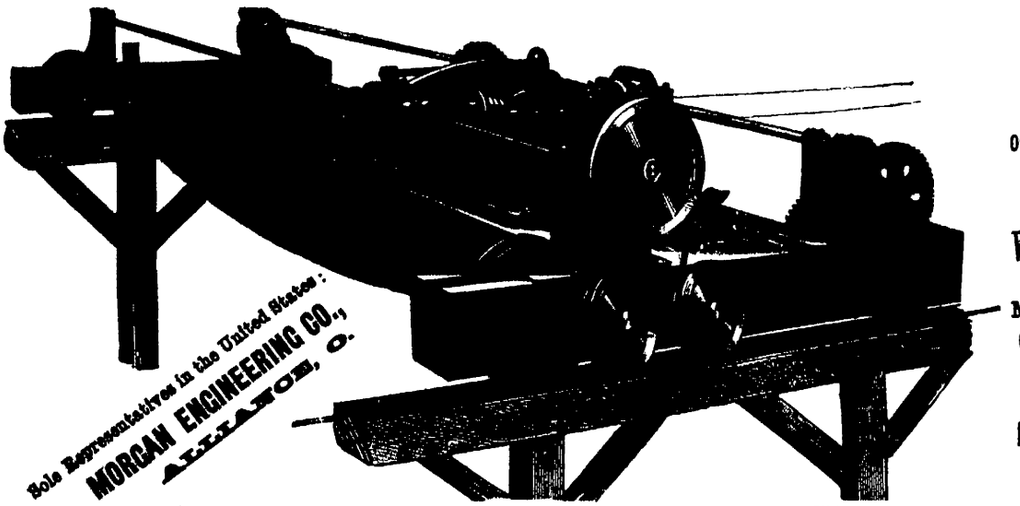
APPLEBY BROTHERS.

CITY OFFICE: 89, CANNON ST., LONDON, E.C.

Cranes, STEAM, HAND, AND HYDRAULIC, FIXED, PORTABLE OR LOCO.

OVERHEAD TRAVELLERS And Lifting Machinery of all descriptions.

Boilers. All types of Land and Marine, and in all sizes.



Sole Representatives in the United States: MORGAN ENGINEERING CO., ALLIANCE, O.

STEAM ENGINES Of all types and powers for Mills, Mines, Water Works, &c.

Winding Gear, PUMPING MACHINERY, Combined or separate.

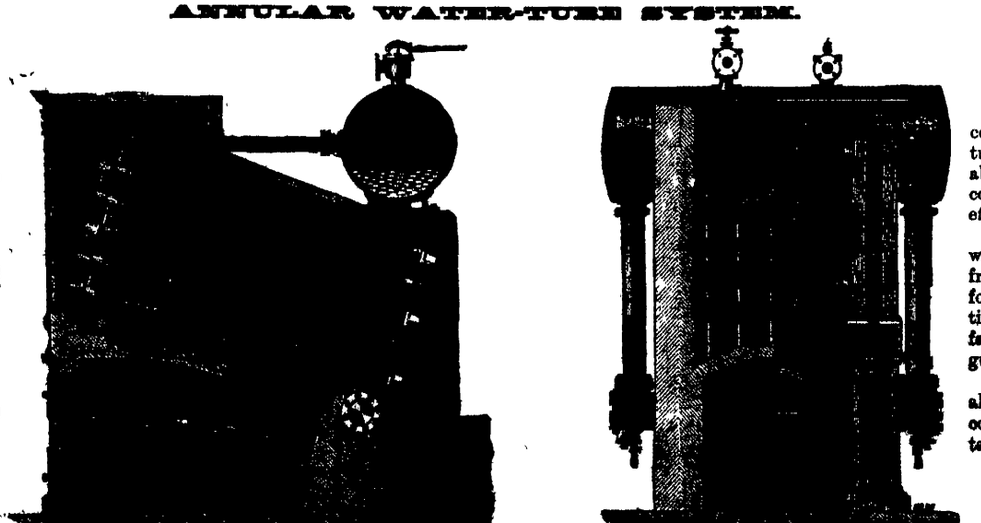
IRON BRIDGES, Iron Roofs and Girder Work of all kinds. 4046

HARDINGHAM's Patent Sectional STEAM BOILER

ANNULAR WATER-TUBE SYSTEM.

—:—

FOR FULL PARTICULARS, Apply to G. G. M. Hardingham Engineer, 191, Fleet Street, LONDON, E.C.



—:—

By this improved construction of Water-tube Boiler, considerable economy in first cost and in working is effected.

Although the waterways are exceptionally free from liability to fouling, the construction affords peculiar facilities for their regular inspection.

The system further allows of extreme compactness being attained.

—:— 4047

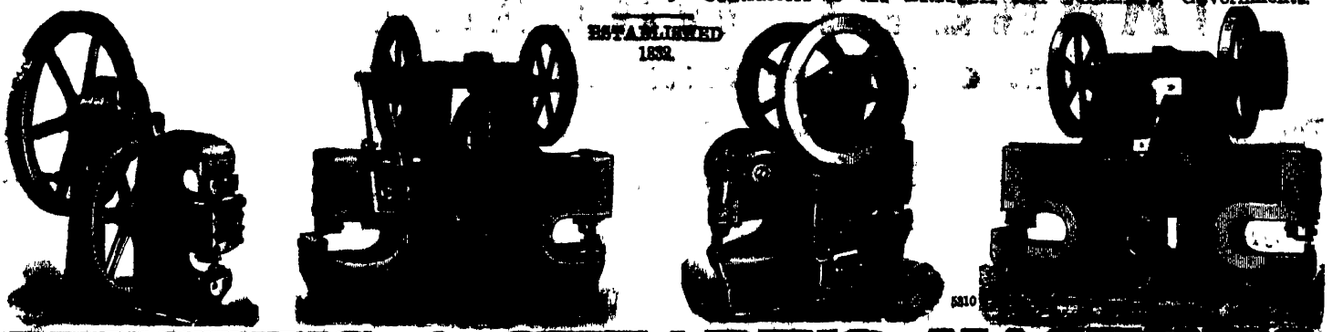
The Boiler represented in the above sketch indicates 110 HP., and occupies a space 11 ft. by 9 ft.

FRANCIS BERRY & SONS, Ironfounders, Engineers, and ToolMakers,

SOWERBY BRIDGE, ENGLAND.

Contractors to the BRITISH and [illegible] Governments.

ESTABLISHED 1832.



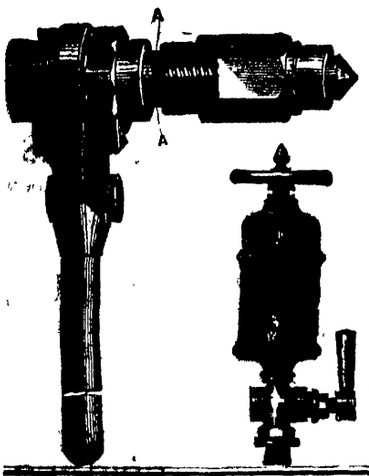
PUNCHING & SHEARING MACHINES.

NETTLEFOLDS LIMITED, BIRMINGHAM,

SOLE MANUFACTURERS OF

WESTON'S STORER'S

PATENT DIFFERENTIAL RATCHET BRACE.—PATENT OPEN TOP SUET LUBRICATOR.



These BRACES, which have been several years before the public, and are MUCH APPRECIATED by them, NETTLEFOLDS have lately CONSIDERABLY IMPROVED by enclosing the SCREW in a SLEEVE (A) which always PROTECTS it from INJURY either from DIRT or BLOWS. This SLEEVE also acts as a GUIDE for the NUT, thus keeping it steady throughout the whole of its traverse, and consequently enabling the drilling to be effected with PERFECT ACCURACY.

The SUET LUBRICATOR has effected a saving of 70 per cent. in the cost of lubricating material used for Nettlefolds' Engines, and has now been fully tested in their works on 15 Cylinders working to 750 horse-power.

Messrs. HICKS, HARGREAVES & Co. write:—"We find the saving in *excess* of that stated in Messrs. Nettlefold & Chamberlain's Report—viz., 70 per cent., and the cylinders to which these Lubricators have been applied are in beautiful condition. We shall adopt them for all our engines."

By this Invention the steam is lubricated before passing to the valves, while the supply of grease is uniform and constant.

SOLD BY THE UNDERMENTIONED AGENTS:—

BIRMINGHAM	Wakeman, C. H., St. Charles St.	SHEFFIELD ..	Wilkes Brothers & Co., Taskar Sons & Co.
LONDON ..	Nettlefold & Sons.	NEWCASTLE-ON-TYNE	Galloway & Co.
LIVERPOOL ..	Sharp & Carline, 24, James Street.	NOTTINGHAM	Manlove, Alliott, Fryer & Co.
MANCHESTER	Edmondsons & Co.	BELFAST	Patterson, R., & Sons.
GLASGOW ..	W. McGeoch & Co., Schaffer & Budenberg.	DERBY	Handyside & Co.
		RUSSIA	Sumner, John M. & Co., Manchester.
EDINBURGH ..	Redpath, Brown & Co., Thos. Scott.	AUSTRIA	Simon, Henry, Manchester. 788
BRISTOL	Weston, J. D., & Son.	GERMANY	Schaffer & Budenberg, Manchester.

OF WHOM PRICED LISTS AND FULL PARTICULARS MAY BE OBTAINED.

BUCKLEY AND TAYLOR,

Engineers, Millwrights, and Ironfounders,

CASTLE IRONWORKS, OLDHAM.

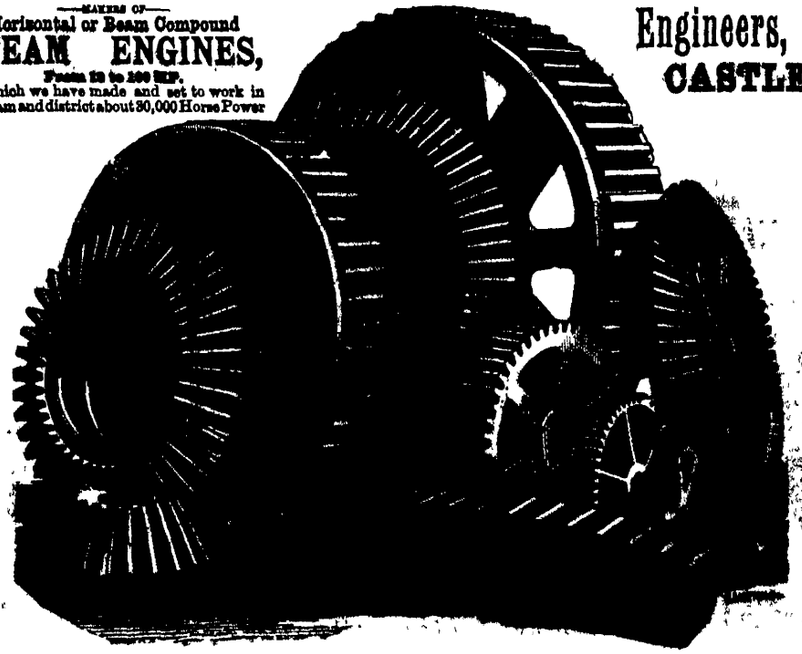
—MAKERS OF—

Horizontal or Beam Compound

STEAM ENGINES,

From 10 to 200 H.P.

Of which we have made and set to work in Oldham and district about 30,000 Horse Power



—MAKERS OF THE—

COMPOUND ENGINES

Driving the Textile Machinery at the Oldham Exhibition.

LANCASHIRE STEAM BOILERS,

Made with the best Machinery, with Holes Drilled or Punched, and Plates Planed.

PATENT ELASTIC SPRING

PINION AND BEVEL WHEELS,

Specially designed, and adapted for heavy work, varying loads, and sudden shocks.

PATENT BEVEL WHEELS,

WITH SEPARATE STEEL RIMS,

Applied in cases where GREAT STRENGTH is required.

MAIN DRIVING DRUMS,

For Spinning Mills up to 30 feet diameter.

[illegible] provided by our Patent Machinery.

[illegible] CO.'S (Sheffield) are

PATENT COMPENSATING PISTONS.

RANSOMES AND RAPIER,

5, WESTMINSTER CHAMBERS,

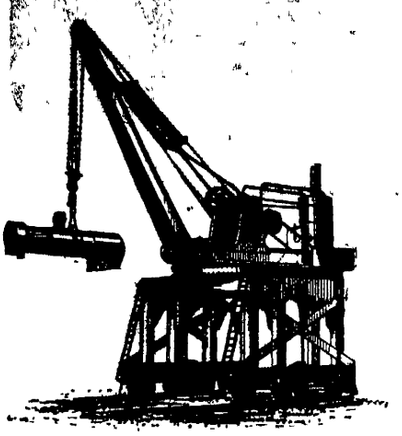
LONDON,

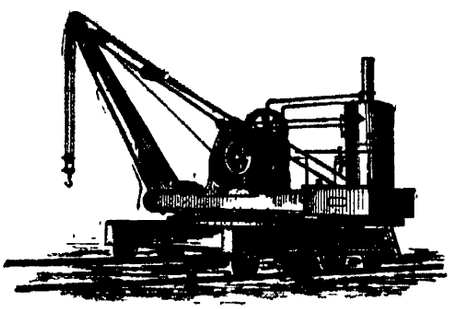
And **WATERSIDE IRONWORKS, IPSWICH,**

— MAKERS OF ALL KINDS OF —

STEAM & HAND CRANES

From 5 Cwt. to 50 Tons Load



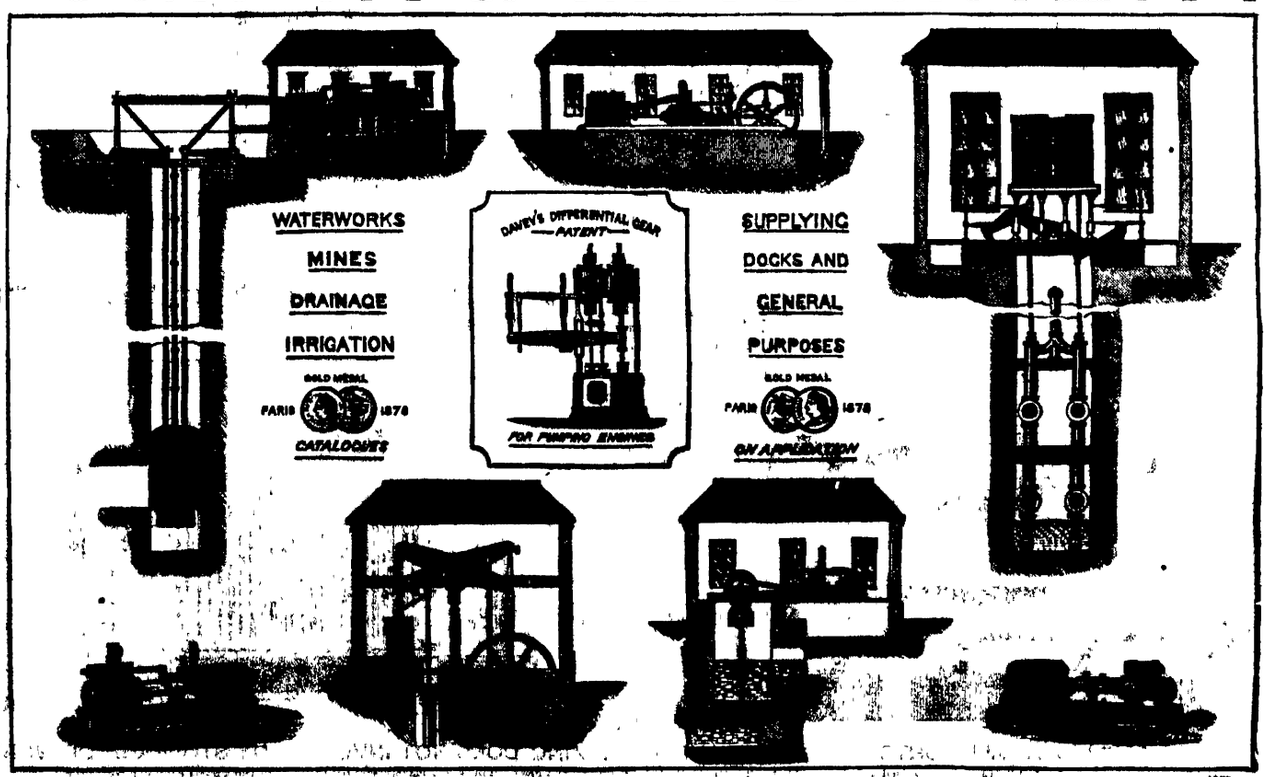




FOR PRICES AND ILLUSTRATIONS APPLY TO 5056

RANSOMES & RAPIER, 5, Westminster Chambers, LONDON, S.W.

PUMPING MACHINERY.



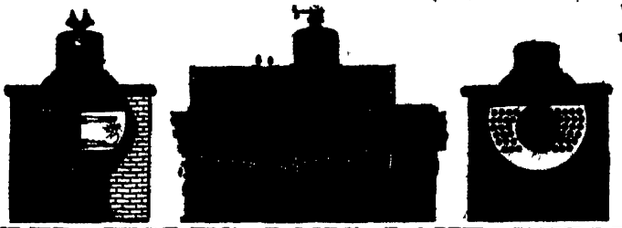
HATHORN, DAVEY & CO., LEEDS. 4973

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

The most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breese, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft.	long,	5ft. 0in.	diameter,	20-horse power.
10ft.	,,	5ft. 6in.	,,	30 ,,
12ft.	,,	6ft. 0in.	,,	40 ,,
13ft.	,,	6ft. 6in.	,,	50 ,,
14ft.	,,	7ft. 0in.	,,	60 ,,
15ft.	,,	7ft. 6in.	,,	70 ,,
16ft.	,,	8ft. 0in.	,,	80 ,,
17ft.	,,	8ft. 0in.	,,	90 ,,
18ft.	,,	8ft. 0in.	,,	100 ,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

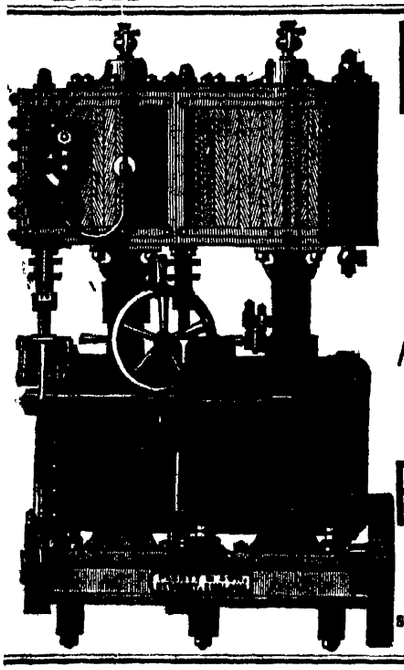
A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5146

BRASS & COPPER TUBES

SEAMLESS & BRAZED, FOR BOILERS, SURFACE CONDENSERS &c
BRASS & COPPER WIRE, SHEETS &c.

4857

BIRMINGHAM BATTERY & METAL CO., BIRMINGHAM.



PLENTY & SON,

EAGLE IRONWORKS,

NEWBURY, BERKS.

MANUFACTURERS TO THE ADMIRALTY.

First Prize, Royal Yacht Club, Cowes.

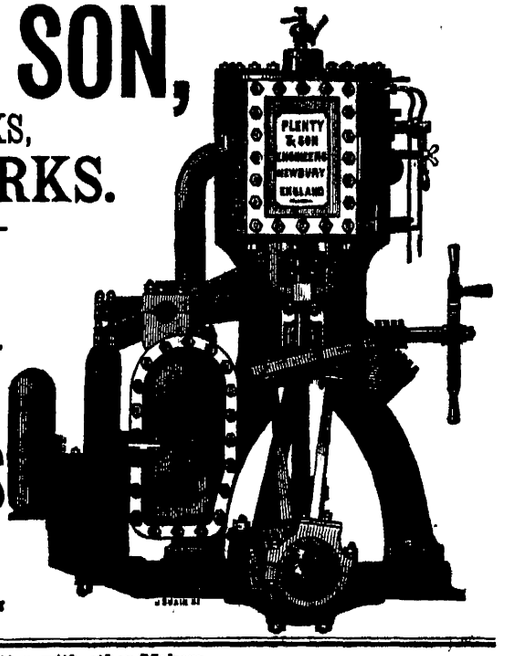
PATENT

ENGINES & BOILERS

FOR

SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &c.

Simple, High-Pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works. 4227

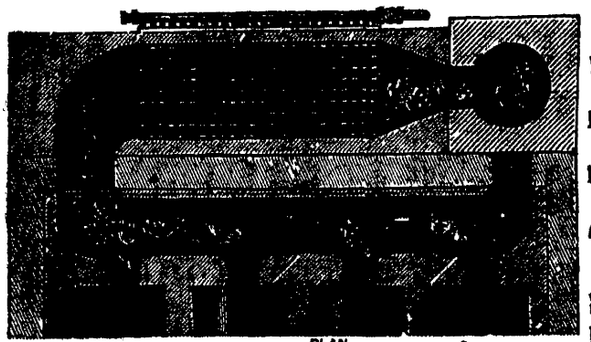


Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(FOR UTILISING THE WASTE HEAT FROM STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION



PLAN.

SPECIAL ADVANTAGES.

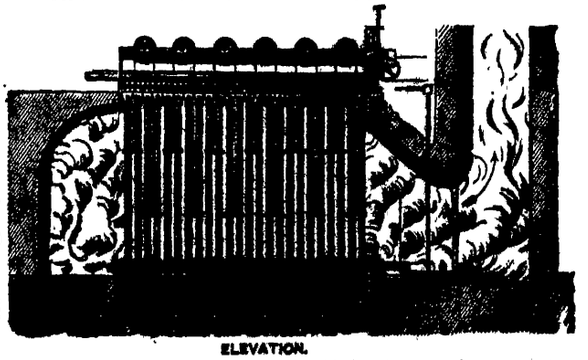
Vertical Pipe Castings. Guaranteed sound and perfectly true.

New Patent Spiral Scrapers. The most effectual removers of soot.

Patent Reversing Gear. Never sticks or gets out of order

ALREADY IN OPERATION TO HUNDREDS OF STEAM BOILERS.

Saves from 20 to 25 per cent. of the fuel.



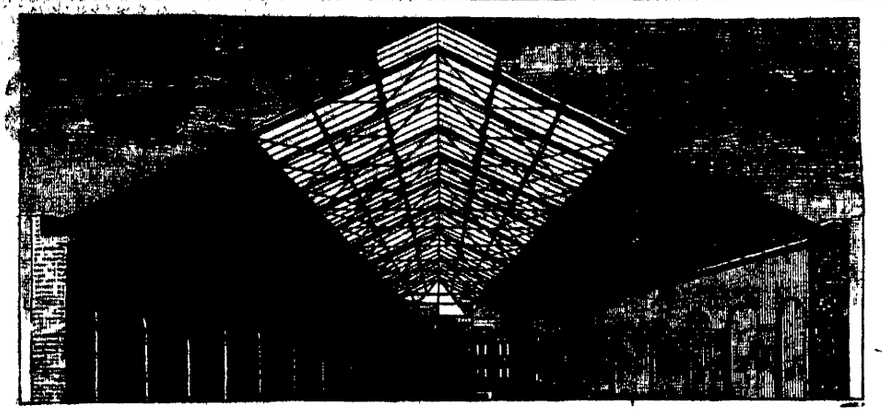
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N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and Abroad.

PRICES, TESTIMONIALS, AND FURTHER PARTICULARS ON APPLICATION TO 4429

ARTHUR LOWCOCK, (PATENTEE, &c. SOLE MAKER) Coleham Foundry, Shrewsbury, England.



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From 1 Cwt. to 50 Tons, for every kind of work,

Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.

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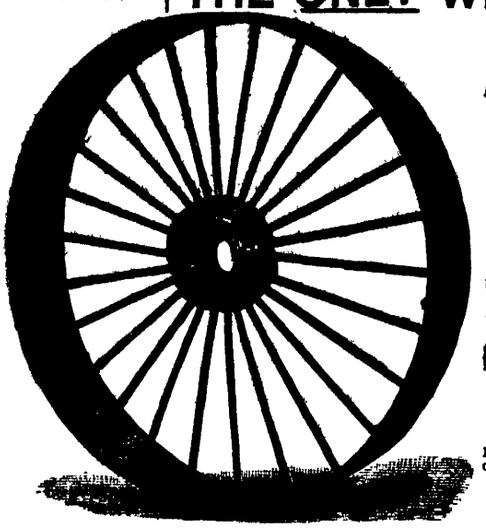
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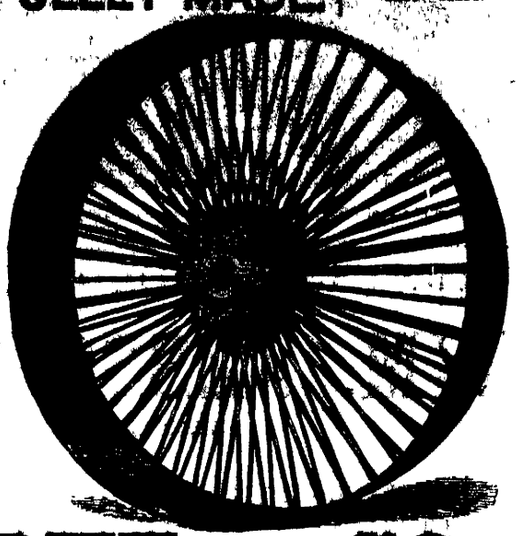
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All Sizes up to 24 feet Diameter.



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The Best Pulley in the World

USED SOLELY FOR

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Messrs. Marshall, Sons and Co., Limited, keep a Stock of our Pulleys at their Depôt, Marshalls' Buildings, 79, Farringdon Road, London, E.C.

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STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,

AND EVERY DESCRIPTION OF SHIP FITTINGS.

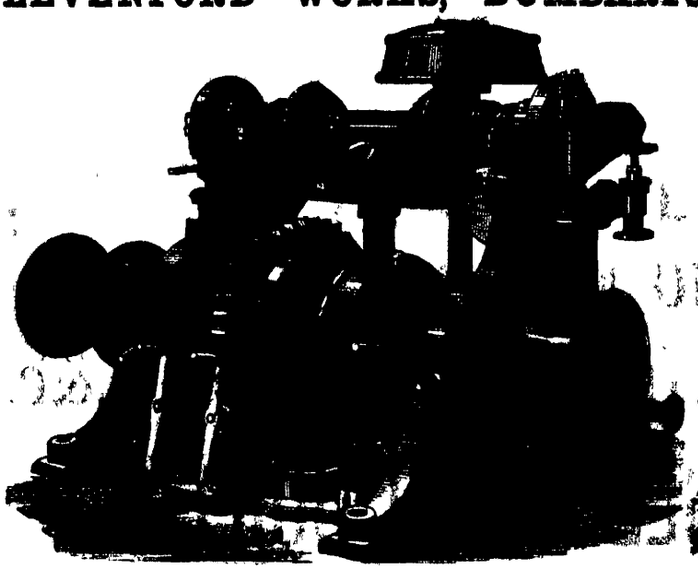
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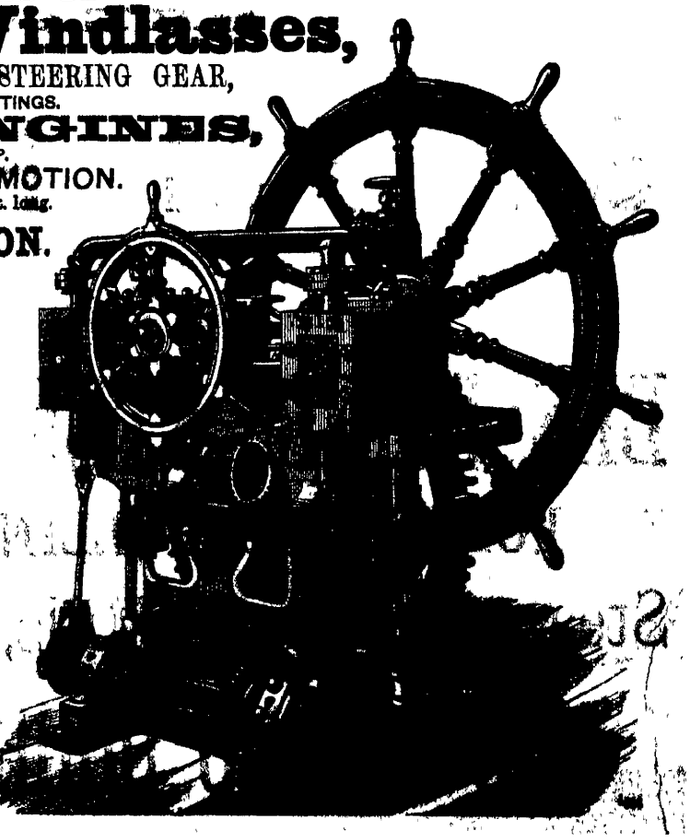
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LAUNCH ENGINES, WITH PATENT VALVE MOTION.

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Only Gold Medal for Gauges at the Paris Exhibition, 1878.

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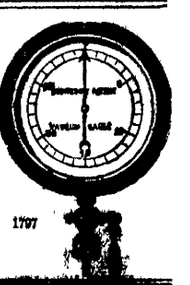
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[Telephone No. 6583] SOLE AGENTS IN LONDON. [Telephone No. 1797

M. BOURDON cautions Persons using Steam Gauges that a large number of very inferior instruments are sold, bearing his name, which are not of his manufacture, a great proportion of them also having a forged Trade Mark.

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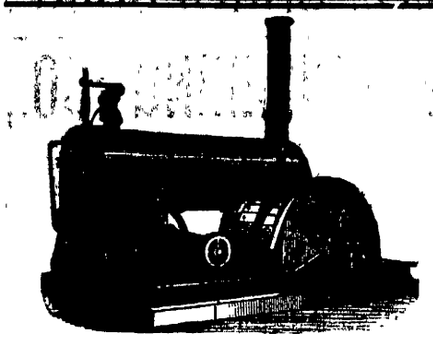
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MANUFACTURERS OF

Steam Cultivating Machinery—Traction Engines—Patent Compound Yorkshire Semi-Portable and Fixed Engines—Semi-Portable Engines—Horizontal High-Speed Stationary Engines—Hauling, Winding, and Pumping Engines—Patent Automatic Expansion Valve Gear and Governor, for ensuring Economy, Regularity, and Safety—Boilers of all types, adapted for every kind of fuel and country—Steel Portable Railway, for Sugar, Cotton, and Indigo Plantations, Contractors' Works, Military Depots, Workshops, Mines, Timber Yards, Agricultural Holdings, &c.—

Locomotives of various gauges.

CALCUTTA EXHIBITION, 1884, FIVE FIRST PRIZES.

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Hanover Agricultural Meeting, 1881—Gold Medal and Diploma of Merit. [Prizes.
Paris Exhibition, 1878—Grand Prix, Gold Medal, and other

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to the [illegible] and Shipping Co., Limited.

Bell's Asbestos Works, Southwark,
"Ruapehu," Royal Albert Docks, 19th May, 1884.

Gentlemen,—I beg to state that your Asbestos Block Packing was used in the high-pressure piston of this ship with the following remarkable results, viz.:—

Miles steaming ..... steaming without renewal.
Steam Pressure ..... Vacuum ..... 26 inches.

My experience does not enable me to speak of it from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,
D. HENDERSON, Chief Engineer, S.S. "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway Co.—Steamship Department, Grimsby, April 10th, 1884.

Dear Sirs,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can unreservedly recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperature, your packing has invariably stood well. I have also used it with complete success when fitted on the top of packing, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for ever during engineer to be more than very highly satisfactory.

Yours truly,
C. H. CLARKE, Sup. Engineer.

Mr. J. Bell.

Department of the Director of Navy Contracts.
Admiralty, Whitehall, 30th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Rhombic core.....square. Rhombic core, ...round.

To Mr. John Bell. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is shown at Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with canvas and rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and others to supply the cheaper manufactures at my list prices, users are requested to see that all packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This valuable adjunct by absorbing the free oxygen that is in the water entirely checks pitting and [illegible] the destructive incrustation so immediately as to prevent its adhering to the plates.

Not only is the [illegible] effected by keeping boilers clean, but the risk of leaving the plates [illegible].

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; 1 in., 60 per cent.; 1½ in., 300 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and saves its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into [illegible]

Sold in drums and [illegible]

BELL'S ASBESTOS YARN & GRAPHITE PACKING, [illegible] with [illegible] friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To Bell's Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the [illegible] pumping engine at the above Colliery, and during that period we have not had [illegible] and find the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,
[illegible] WINTER, Colliery Engineer.



— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "bonus" orders should be sent direct to the undermentioned depôts and not through agents or factors.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION, for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up, adheres to metal and preserves them from rust, prevents the unequal expansion and contraction of boilers exposed to weather, covers in per cent. more surface than any other coating, and is absolutely indestructible. It can be shipped off at any time, requires but 10 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates ..... 152 deg.
Covering ..... 94 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov 26th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly, "W. SANTO CRIMP, C.E., F.G.S."

The Tunnel and Kit Hill Granite Company, Limited, Gunnislake, Tavistock, 6th April, 1884.

Mr John Bell, Southwark, S.E.

Sir,—I have much pleasure in stating that the Asbestos Covering supplied by you to the boiler of our travelling crane at Kit Hill, has [illegible] most remarkable results. Since it has been in use we have saved fully half our coals and [illegible] a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be cut by hand to the form required without puckering, and is especially useful for making joints of manhole and mudhole doors. It is kept in sheets 36 rolls of 100 ft., from ⅛ in. to 2 in. wide, and any thickness from 1 16th in. upwards. Manhole covers can be fitted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against [illegible] these inferior articles at my prices, users are recommended to see that every [illegible] of the Asbestos Tape purchased by them bears the Trade Mark.

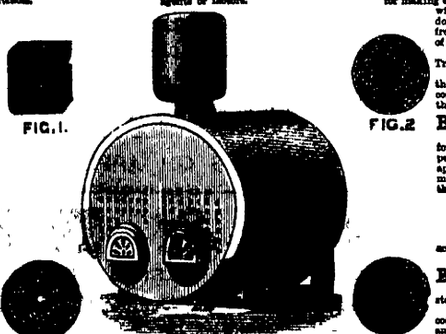


FIG. 1. FIG. 2

FIG. 4. FIG. 5

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to obtain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and ¼ millimetre to 26 millimetres thick.

Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts.
Admiralty, Whitehall, S.W., 17th May, 1884.

Sir,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,
Director of Navy Contracts.

Mr John Bell.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and [illegible] vase by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint, where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valves.

Valves made of this material are very durable, as they are not subject to [illegible]

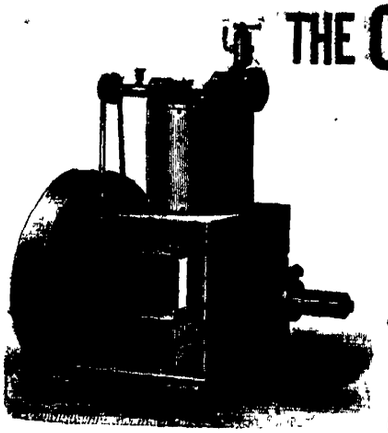
BELL'S ASBESTOS LUBRICANT REGD.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

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OR THE DEPÔTS—

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HIGH SPEED ENGINES,

THE MOST EFFICIENT AND RELIABLE MADE.

Also LIGHT BALANCED PULLEYS, SHAFTING, &c.

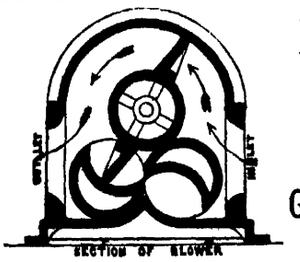
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Baker's Patent Rotary Pressure Blower and Gas Exhauster.



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BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.

—:o:—

HALL'S PATENT STONE BREAKER.

—:o:—

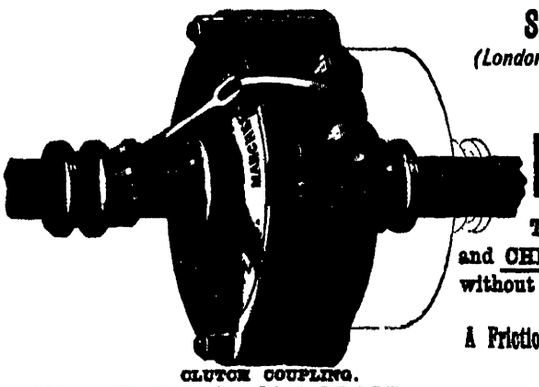
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CLUTCH COUPLING.

— PATENT —

FRICTION CLUTCH.



These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.

LIBERAL TERMS TO THE TRADE. PRICES ON APPLICATION.

CLUTCH AND PULLEY 5200

GOODFELLOW & MATTHEWS,

(LATE S. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

— MAKERS OF —

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

HIGH-CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS.

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 4487

ELECTRIC LIGHT.

Gold Medal Crystal Palace, 1882.

WORKSHOPS, MILLS, DWELLING HOUSES, OUT-DOOR CONTRACTS.

R. E. CROMPTON & CO., Electric Light Engineers,

MANSION HOUSE BUILDINGS, LONDON, and ARC WORKS, CHELMSFORD,

Contractors to H.M. Board of Works, General Post Office, Principal Railway Companies, &c.,

ARE PREPARED TO SUPPLY SETS OF MACHINERY FOR

ELECTRIC LIGHTING EITHER BY ARC OR INCANDESCENT SYSTEM,

AS UNDER:

ARC LIGHTING.

	£	s.	d.
10-light set (including Burgin Dynamo machine, Ten 16-hour, 2,000 candle-power lamps, cable, switch, &c.) packed and delivered free to any railway station in England	330	0	0
6-light set do. do. do. ...	195	0	0
3-light set do. do. do. ...	120	0	0

INCANDESCENT LIGHTING.

	£	s.	d
30-light set (including self-regulating Burgin Dynamo machine, Thirty Swan 20 candle-power lamps, 30 holders, cable, branch wire, cut-outs, plain wall brackets or pendants) packed and delivered free to any railway station in England	100	0	0
75-light set do. do. do. ...	195	0	0
150-light set do. do. do. ...	300	0	0

OTHER PRICES AND LIST ON APPLICATION.

Extract from a Letter from the Manager of the South Wales Tin Plate Works (who have since increased their installation by the addition of both Arc and Incandescent Lamps), with reference to an Installation by R. E. CROMPTON & CO.

"Six months' experience is too short a time to enable me to give anything but an estimate of the cost of Electric Lighting, as some parts of the machines only require renewing once in every two or three years. In fact, as yet the cost of renewals has been almost nothing, except in lamps. I, however, estimate that over a series of years this item of expense will not exceed £60 per annum for 100 lights, exclusive of lamps, and this is confirmed by the reports of others, who say that 10 per cent. upon the cost of the plant will quite cover repairs, and £80 is a great deal in excess of 10 per cent. on the cost of our plant. Taking this sum as the expenditure on repairs, the cost of the Electric Light will be as follows in cases similar to our own, where there is spare steam at night:—

Wages	..	£62	0 0
Lamps	.	90	0 0
Repairs, &c.		60	0 0
Oil and Stores	...	13	0 0
		225	0 0
Less work done by Engineer		41	6 8
		£183	13 4

I deduct the above amount for the work done by the engineer. He has nothing to do except to oil the bearings once or twice during the night, and can turn rolls, screws for the mills, &c., in a lathe driven by the same engine as the Dynamos; in fact, it is an advantage in more ways than one to give him this work to do, as it prevents him from going to sleep and so neglecting oiling the machinery, as well as the saving in wages.

"This cost is for 100 lamps of 17 candle power for a year, using them on an average five nights a week for 14 hours in the winter six months, and nine hours in the summer six months, this gives a total of 2,990 hours, during the whole of which we have 1,700 candle power of light for the sum of £183 13s. 4d.

"What would an equal light cost in Gas at 3s. 9d a 1,000 cubic feet? We cannot calculate on burning less than one cubic foot of Gas per hour for every three candles' power; so to get 1,700 candles power for 2,990 hours, we should burn 1,694,300 cubic feet of Gas, costing £317 14s. 7d. against £183 13s. 4d. for the same light if supplied by the Incandescence Electric system."

4813

SHAFTING

Turned true and bright to Whitworth's Gauges, any length, from 2 in. to 3 in. diameter, 12s. per cwt. at Nottingham. Also Couplings, Pulleys, Plummer Blocks, Hangers, Machine-made Spur, Bevel, and Mitre Wheels, Friction Gearing, &c.

H. HIND & SON, NOTTINGHAM, AND 62, BLACKFRIARS ROAD, LONDON, S.E. 4187

THOMAS TURTON & SONS,

MANUFACTURERS OF RAILWAY SPRINGS AND BUFFERS,

Files and Cast Steel of Superior Quality, Spring Steel, Shear Steel, &c. 4937

SHEAF WORKS, AND SPRING WORKS, SHEFFIELD.

LONDON OFFICES, 90, CANNON STREET, CITY. PARIS DEPOT, 12, RUE DES ARCHIVES. BOSTON, U.S., 40, KILBY STREET.

DANIEL ADAMSON & CO.,

[Established 1851.] **ENGINEERS AND BOILER MAKERS,** [Established 1851.]

DUKINFIELD, NEAR MANCHESTER.

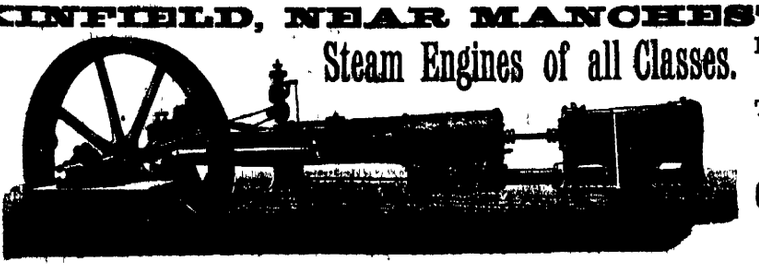
SOLE MAKERS OF

THE WHEELOCK PATENT

Automatic Expansion Engine

Which has gained highest awards in competition with Corliss and other Automatic Expansion Engines.

SULZER PATENT INJECTOR CONDENSER.



Steam Engines of all Classes.

BLOWING ENGINES, AIR COMPRESSORS, BESSEMER PLANT, TESTING MACHINES, PATENT HYDRAULIC JACKS.

GENERAL HYDRAULIC ENGINEERS. 4464

REGISTERED TRADE MARK

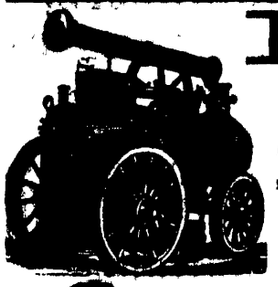
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SOLE MANUFACTURERS UNDER SEVERAL PATENTS 1475

The PHOSPHOR BRONZE COMPANY, Limited, Sumner & Emerson Streets, Southwark, London, S.E.

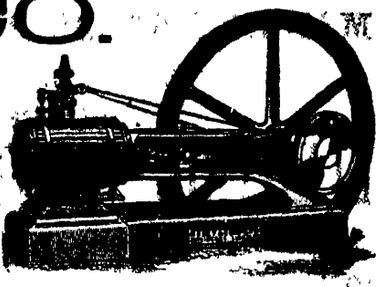
ROBEY & CO.



SUPERIOR PORTABLE ENGINES 2½ to 50 HP.

First PRIZE for PORTABLE ENGINES, Melbourne Exhibition, 1881.

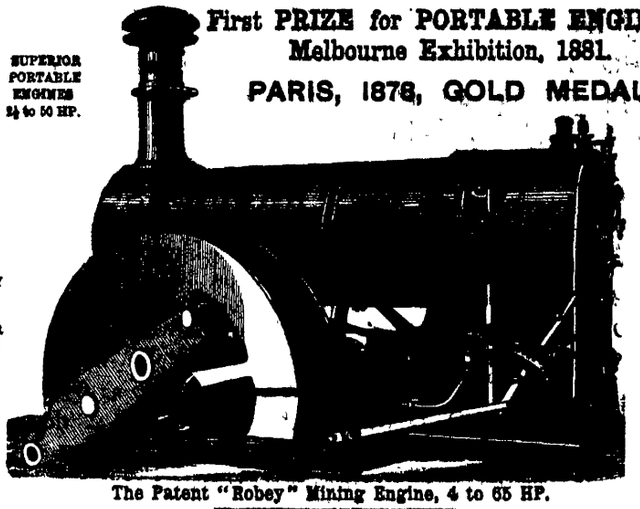
PARIS, 1878, GOLD MEDAL.



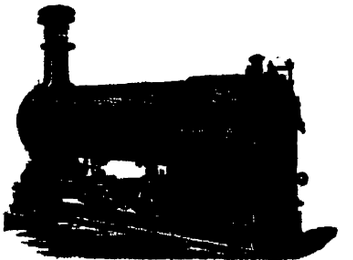
HORIZONTAL FIXED ENGINE, 4 to 60 HP.
☞ References can be given to upwards of 9,000 Engines now at work.



VERTICAL STATIONARY STEAM ENGINE AND BOILER Combined, of all Sizes, from 1½ to 16 HP.



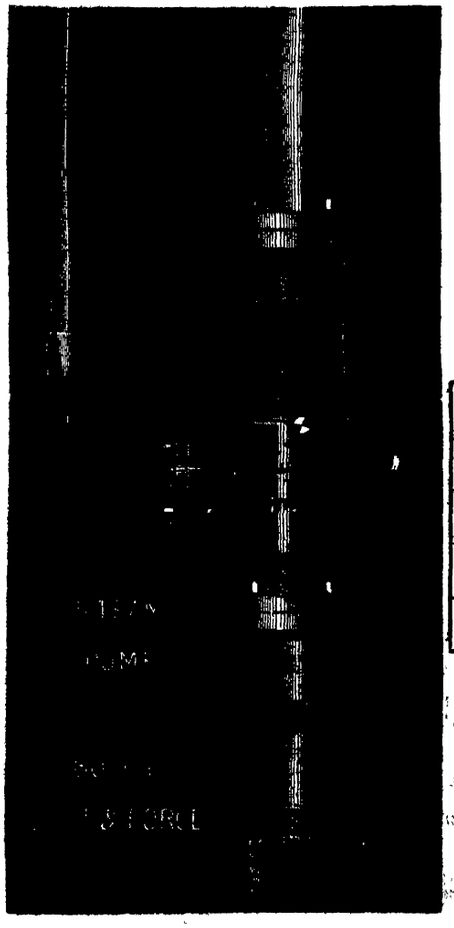
The Patent "Robey" Mining Engine, 4 to 65 HP.



THE IMPROVED ROBEY FIXED ENGINE & LOCOMOTIVE BOILER Combined, 4 to 65 HP., and COMPOUND ROBEY SEMI-FIXED ENGINE. 4381

Prices and full Particulars of the Machinery here illustrated on application to the Manufacturers:

ROBEY & CO., Globe Works, LINCOLN, ENGLAND.



HALL'S PATENT

JETOMETER

NEW Double Lift and Force STEAM PUMP up to 80 ft.

WORKS with 40 per cent. less Steam than any other Jet Pump

INVALUABLE for all Water Raising purposes.

NO moving parts, Oil, Grease, or Attention.

THOROUGHLY reliable under all conditions.

EXTREMELY simple; High-Class Materials; and Low in Price

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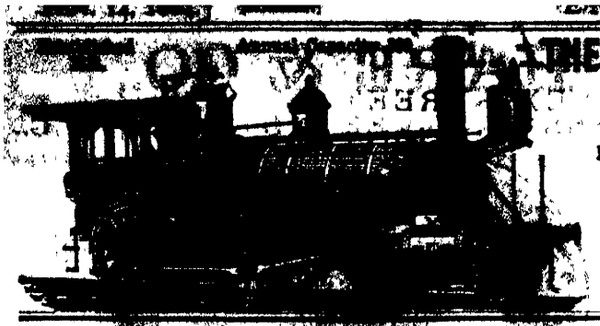
No. and Class	6 A	8 A	10 A	12 A	14 A	16 A	16 B	18 B	20 B	25 B	30 B	35 B	40 B	45 B	5 B
PRICE COMPLETE	£2 10	£3	£3 10	£4 10	£7 10	£9 10	£12	£15	£20	£25	£30	£35	£40	£45	£5
Gals. per hour	300	500	700	1,000	2,000	3,000	3,000	4,000	6,000	8,000	10,000	15,000	20,000	25,000	30,0
Diam. of Steam Jet	3/16 in.	1/4 in.	5/16 in.	3/8 in.	1/2 in.	9/16 in.	9/16 in.	5/8 in.	11/16 in.	13/16 in.	7/8 in.	15/16 in.	1 in.	1 3/16 in.	1 1/4
Delivery and Suction Pipes	1/2 in.	3/4 in.	1 in.	1 1/4 in.	1 1/2 in.	2 in.	2 in.	2 1/2 in.	3 in.	3 1/2 in.	4 in.	4 1/2 in.	5 in.	5 1/2 in.	6 i

Patentees and Sole Makers:

FAIRBURN & HALL

CHIEF OFFICE } 63, ROYAL EXCHANGE, MANCHESTER.

FIRST-CLASS AGENTS WANTED in ALL PARTS of the WORLD.



THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

BUILDERS OF LOCOMOTIVE ENGINES OF ALL GAUGES

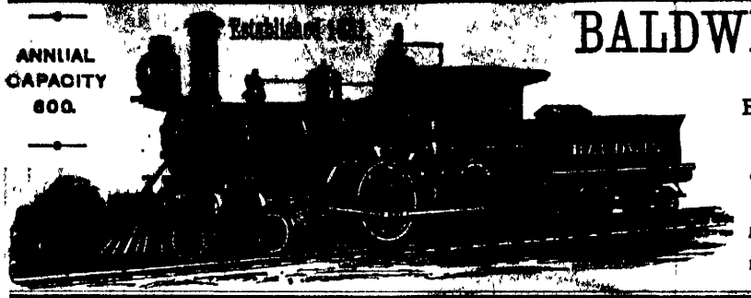
And for every variety of service,

PATERSON, NEW JERSEY.

UNITED STATES OF AMERICA.



6112



ANNUAL CAPACITY 600.

BALDWIN LOCOMOTIVE WORKS,

PHILADELPHIA, U.S.A.

BURNHAM, PARRY, WILLIAMS, & Co., Proprietors.

MANUFACTURERS OF

LOCOMOTIVE ENGINES,

Adapted to every variety of service, and built accurately to standard gauges and templates. Like parts of different engines of same class perfectly interchangeable

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Have designed and constructed one hundred various types of Tank and other Locomotive Engines for upwards of thirty different widths of gauge, adapted where necessary for passing round sharp curves and ascending steep gradients, suitable for any climate, and for burning coal or wood, &c. . also for special duties required by Railway Companies, Contractors, Collieries, Iron Works, and Mines, Brick Works, Quarries, Gas Works, Ship Yards, Docks, Sugar Plantations, &c., &c. They are built accurately to standard gauges and templates in order that like parts of various classes of Engine will fit different Engines of the same type, and so that duplicates can be supplied on the shortest notice. The materials are the best of their respective kinds, and the workmanship cannot be excelled.

MANNING, WARDLE & Co., having designs and models of such a great variety of Engines, are enabled to execute orders for Locomotive Engines adapted to most requirements in a very short time

Locomotive Tank Engines from 9 inches to 15 inches Cylinders on Four or Six Wheels all coupled, always in Stock or in Progress. 2486

SPECIFICATIONS, PHOTOS, AND PRICES, ON APPLICATION.

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MANUFACTURERS OF

HIGH CLASS STEAM ENGINES,

Simple or Compound, with Jet, Surface or Evaporative Condensers, up to 1,000 Indicated Horse Power.

PUMPING MACHINERY

Of the most powerful and economical type, for Water Supply, Irrigation, Docks, Drainage Works, and other purposes, and all Classes of General Engineering Work.

CONSTRUCTIONAL IRON WORK FOR BUILDINGS, &c.

FOR TYPE OF OUR DIRECT-ACTING PUMPING ENGINES, SEE "ENGINEERING," 3rd OCTOBER, 1884. 5375

MEASURES BROS. & CO., SOUTHWARK STREET, LONDON,

Manufacturers of Patent Girders, Rolled Joists in Iron or Steel, Riveted Girders, Fitch Plates, Bulb and Channel Iron, Contractors' Rails, Tee, Angle, and Sash Iron, Bonding Hoops, Bolts, Rivets, Washers, Chequered Flooring Plates, Patent Fire-proof Floors, Cast or Wrought Iron Columns, Stanchions, Tanks, and every description of Builders' Iron-Work,

Have now in their TOWN STOCK 5,000 TONS, and can guarantee prompt delivery at lowest Market Prices.

ESTIMATES, SECTION SHEETS, AND BOOKS FREE ON APPLICATION.

SECTION OF JOISTS.



ANGLES.

2 × 2 × ¼	3½ × 3½ × ⅜
3 × 3 × ⅜	4 × 4 × ⅜
3 × 3 × ½	4 × 4 × ½
4 × 4 × ⅜	5 × 5 × ⅜
4 × 4 × ½	5 × 5 × ½
4 × 4 × ⅝	6 × 6 × ⅜
4 × 4 × ¾	6 × 6 × ½
4 × 4 × 1	7 × 7 × 1

3 × 3 = 10lbs.	4½ × 3 = 12lbs.	7 × 3½ = 14lbs.	9½ × 3½ = 24lbs.	12 × 5 = 42lbs.
3 × 3½ = 8 ,,	5 × 4½ = 23 ,,	7 × 3¾ = 20 ,,	9½ × 4½ = 30 ,,	13 × 6 = 50 ,,
4 × 3½ = 7 ,,	6½ × 3 = 11 ,,	8 × 4 = 28 ,,	10 × 4½ = 32 ,,	14 × 6 = 60 ,,
4 × 3 = 12 ,,	6½ × 3½ = 16 ,,	8 × 5 = 32 ,,	10 × 5 = 35 ,,	15 × 6 = 70 ,,
4½ × 1½ = 8 ,,	6 × 5 = 20 ,,	8 × 6 = 34 ,,	10 × 6 = 56 ,,	15 × 7 = 100 ,,

Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 16". Length, 13 to 30 ft. Thickness, ¼" to 1". 5198

TEES.	CHANNELS.
2½ × 2½	12 × 3
3 × 3	12 × 3½
3½ × 3½	12 × 4
4 × 4	12 × 5
4½ × 4½	14 × 3½
5 × 5	14 × 4
6 × 6	15 × 3½
7 × 7	15 × 4
8 × 8	15 × 5
9 × 9	15 × 6
10 × 10	16 × 3½
12 × 12	16 × 4
14 × 14	16 × 5
15 × 15	16 × 6
1 × 1	18 × 3½
	18 × 4
	18 × 5
	18 × 6





Non-Compression Engine.

GAS ENGINES

FROM 1 MAN TO 100 HP.



Compression Engine.

ALL SIZES ABOVE 2 HP. SELF STARTING. 6120

ATKINSON'S PATENTS.



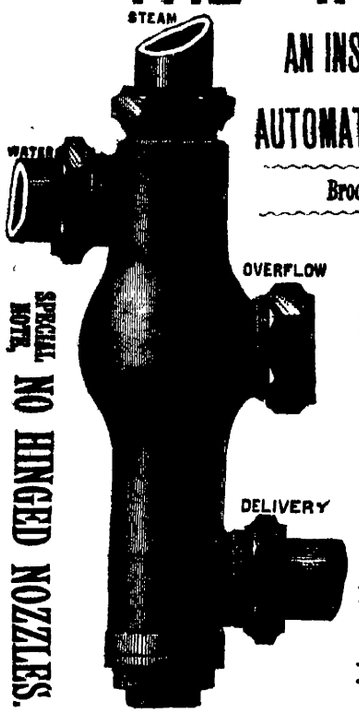
Feed-Water Heater.

FEED-WATER HEATERS.

JOHN HASTIE & CO., GREENOCK, SOLE MAKERS OF THESE HEATERS FOR SCOTLAND.

Sole Makers: BRITISH GAS ENGINE & ENGINEERING COMPANY, Limited, 11, Queen Victoria St., London, E.C.

THE "INFLUX"



SPRING NOT THERE NO HINGED NOZZLES.

AN INSTANTANEOUS STARTING AND AUTOMATIC RESTARTING INJECTOR

Brooke, Holden, & White's Patent.

The only Lifting Injector devoid of Spindles, Levers, Adjustable Internal Parts, or hinged Nozzles which lifts without manipulation and restarts automatically. Instantaneous action on Steam being turned full on. Works equally well lifting up to 12 ft., or as a "non-lifter." Invaluable for Locomotives, Traction Engines, Marine, and other Boilers. Can be seen working on application; or reference will be given as to their perfect reliability.

For Prices, &c., apply to

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ST. SIMON WORKS,

SALFORD,

SOLE MANUFACTURERS.—Also Sole Makers of BORLAND'S 5086

PATENT BOILER DRILL

For Drilling Boiler Shells.

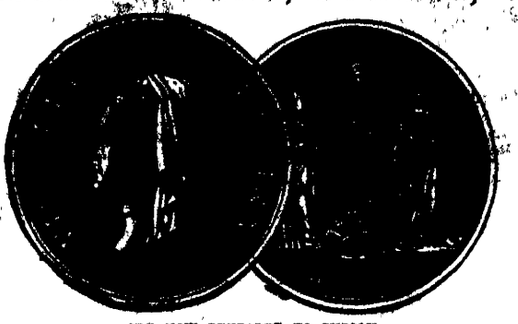
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HARE & CO.,

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PATENT LUBRICATOR AND LUBRICANT

SAVE 90 %. over Liquid Oil.

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UNIVERSALLY APPLICABLE. WORK IN ANY POSITION.

THE LOOSE PULLEY LUBRICATOR.

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TRIER BROS., SOLE LICENSEES AND MANUFACTURERS, 5201

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STEAM FITTINGS, PUMPS, & FILTERPRESSES.



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ENGINEERS,

THETFORD, ENGLAND,

LONDON OFFICE: 123, CANNON STREET, E.C.,

MANUFACTURERS OF

MARINE ENGINES,

COMPOUND

SURFACE

CONDENSING

to 600 I HP.

—

ALSO

BOILERS

For ditto in

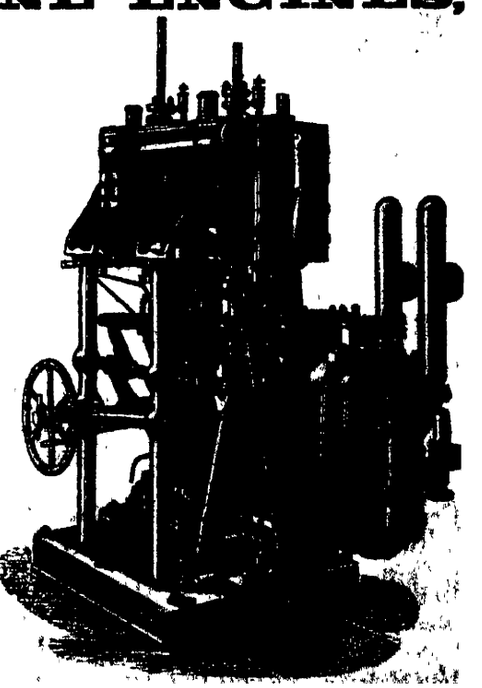
Steel or Iron.

—

PRICES

ON

APPLICATION. 4961



ROBT. HARVEY & CO.,

(Successors to D. Cook & Co.)

Colonial Engineers,

PARK GROVE

IRONWORKS,

GLASGOW,

MAKERS OF

Steam Hammers

For Steel Works, Forges and Coppersmiths,

AND

Shipbuilders' and Boilermakers' Tools,

ALSO

SUGAR MACHINERY

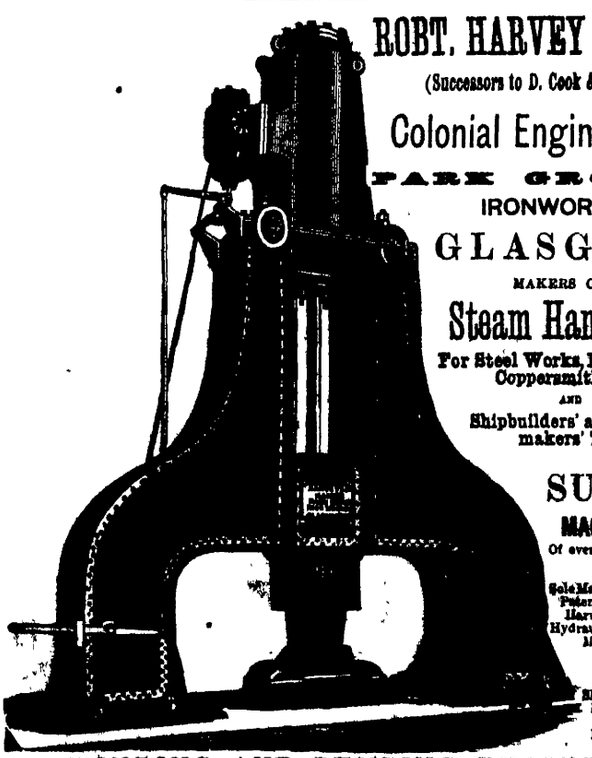
Of every description.

—

Sole Makers of Cook's Patent Steam and Harvey's Patent Hydraulic Riveting Machines.

—

Punching, Shearing, Angle Iron and Bar Cutting MACHINES. 5083

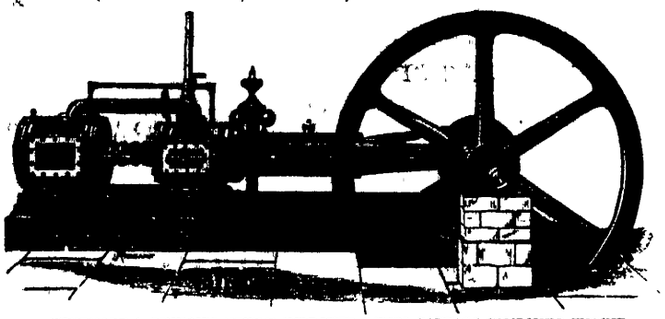


WINDING AND PUMPING ENGINES.

WHITMORE & BINYON,

Millwrights, Engineers, Founders & Boilermakers, Manufacturers of Improved Steam, Water, & Wind Flour Mill Machinery.

28, Mark Lane, London, E.C.—Works: Wickham Market, Suffolk, England.



WHITMORE & BINYON'S NEWLY IMPROVED "FUEL SAVING" COMPOUND ENGINE.

THE Engraving illustrates Messrs. W. & B.'s improved Compound Engine fitted with their New Automatic Cut-off Valve (Low's Patent) as manufactured and exhibited by them at the Royal Agricultural Society, England, meeting at Shrewsbury in 1884 (*vide* ENGINEER and ENGINEERING, of 12th Sept.), so constructed that the Pistons, Rods, and other working parts may be as easily withdrawn or disconnected for examination and repairs as in the simpler Engines

Foundations and Fixing Simple.
A High-class Engine at Moderate Price.
TERMS ARRANGED WITH OTHER MAKERS FOR ROYALTY TO USE PATENT CUT-OFF.
FOR CHEAPNESS, ECONOMY, & EFFICIENCY UNRIVALLED.
STEAM USERS SEND FOR PRICES.
BOILERS OF ALL KINDS. 5877

HORIZONTAL ENGINES Of all Types and Sizes. Compound, Condensing, & Non-Condensing.

MAKERS ALSO OF BEAM ENGINES Up to 50 H.P. Nom. High-pressure & Compound Condensing or Non-Condensing

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BRICK PRESSES AND PATENT DRYING SHEDS For home use & for exportation. apply to the PATENT Brick Machine COMPANY, MIDDLESBRO' 5247

Deals, Battens, Spruce, Flooring,

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Specifications sent on application to 5315

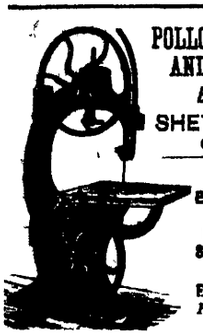
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SPECIALITIES: BAND SAWING MACHINES. PUNCHING AND SHEARING MACHINES STEAM HAMMERS, FUEL ECONOMISERS.

Prices & Lithographs on application. 5176

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STEAM ENGINE INDICATOR.

Sole Manufacturers in Scotland:
HANNAN & BUCHANAN,



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ALSO MAKERS OF
Bourdon's Patent Pressure Vacuum and Compound Gauges, Engine Counters, Engine Telegraphs, Reducing Gear for Indicating Engines, Salinometers, Thermometers, Lever Clocks, &c. 4344

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ENGINEER, Manufacturer of Screwing Apparatus Working and Machine Taps, &c., to Whitworth's Standard Threads and Sizes,

Britannia Works, Ordsall Lane, Salford, MANCHESTER. 5147

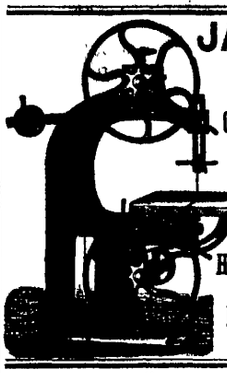
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Circular and Band SAWS,
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GENERAL WOOD WORKING MACHINERY.
Horizontal Steam Engines
LATHES, &c.,
KILMARNOCK.

Illustrated Price List sent free on application



MÜLLER'S ALPHA PATENT GAS-MAKING MACHINE.
Gas produced without fire or heat. For Lighting all places where Coal Gas is unobtainable.
Sizes, 13 to 200 Lights and above.
Prices, 16 GUINEAS upwards.



MÜLLER'S PATENT GAS GENERATOR AND GAS ENGINE COMBINED.
For power in all places where Coal Gas cannot be had.
The Engine makes the Gas by which it is driven.
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Machine Müller à faire le gaz (dite Alpha).
Elle produit le gaz sans feu et sans chaleur. Elle sert à éclairer tous les endroits où l'on n'a pas gaz de charbon.
Types: de 13 à 200 becs et au-dessus.
Prix: à partir de 16 guinées.
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Machine motrice pour tous les endroits où l'on n'a pas gaz de charbon.
La machine produit le gaz qui la met en mouvement.
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Müller's Alpha-Gasherstellungs-Maschine.
Erzeugt Gas ohne Feuer und ohne Hitze. Zum Erleuchten von Orten an denen kein Kohlengas zu haben ist.
Für 13 bis 200 Brenner
Preis: 16 Guineen und darüber.
Müller's Generator und Gas-maschine, vereinigt,
Kraftmaschine für Orte ohne Gas-fabrik.
Die Maschine bereitet das Gas welches sie in Bewegung setzt.
Preisverzeichnisse auf Verlangen zu senden von
H. L. MÜLLER, BIRMINGHAM

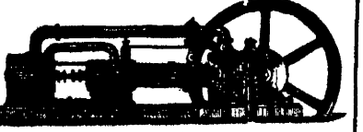
Máquinas de Müller para hacer gas (Alpha).
Produce gas sin fuego ni calor Sirve para alumbrar lugares en que no puede proporcionarse gas de carbon.
Tipos: de 13 á 200 mecheros y más.
Precio: á partir de 16 guineas.
Generador de gas, unido con una máquina de gas, patente de Müller.
Máquina motora para todos los puntos en que no hay gas de carbon.
La máquina produce el gas que la pone en marcha. 6001
Pídanse catálogos ilustrados á
H. L. MULLER, BIRMINGHAM.

HOLBOROW & CO., DUDBRIDGE IRON WORKS, STROUD,

MANUFACTURERS OF IMPROVED
Condensing & Non-Condensing Compound & High-Pressure Expansive Engines.



COUPLED ENGINE.



TANDEM ENGINE.

THE Coupled Engine is fitted with HOLBOROW & Co.'s Invention of DIFFERENTIAL VALVES, enabling either half to work independently should it be necessary through accident or repair, thus virtually making two Engines.

THE Tandem Engine is designed so that pistons can be withdrawn altogether for repairs by simply removing covers; it has no more working joints than ordinary engine, occupies no more space, nor requires more expensive foundations.

A vacuum of 14 lbs. below atmosphere is readily maintained by new SINGLE-ACTING AIR-PUMP AND CONDENSER; while consumption of fuel, as proved by exhaustive trial, does not exceed 2 lbs. per HP. per hour, and piping is above floor.

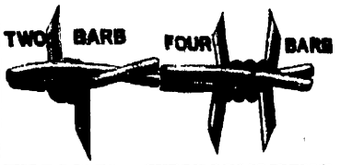
THEIR SIMPLICITY ENABLES VERY LOW PRICES TO BE QUOTED.

"An excellent action of the valves and an unusually good and well maintained vacuum. Exceptionally high vacuum—very great economy—exceptionally good results in economy."—See ENGINEERING, Nov. 18th, 1881, May 27th, 1882, and July 6th, 1883.

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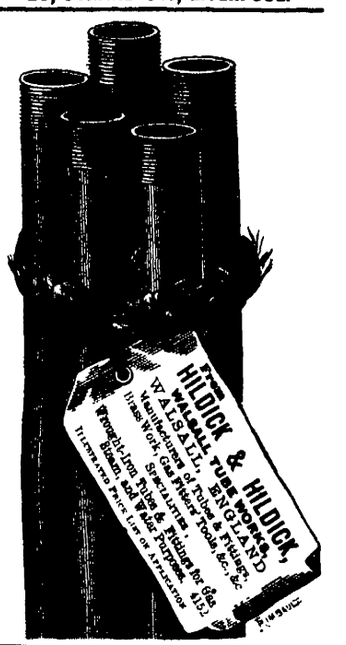


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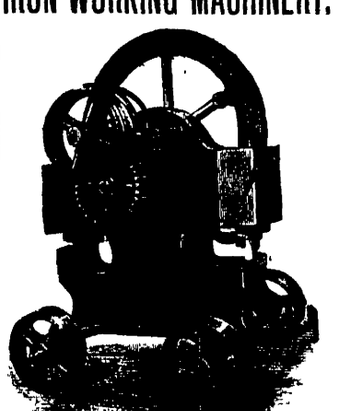


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AND
28, STRAND ST., LIVERPOOL.



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AS ORIGINALLY INTRODUCED BY OUR FIRM.

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BEST FLAX,

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Obtained the Highest Awards, viz., for Steam Hammer, First-Class Certificate and Silver Medal; and for Root's Patent Improved Blower and Engine, another First-Class Certificate and Silver Medal.

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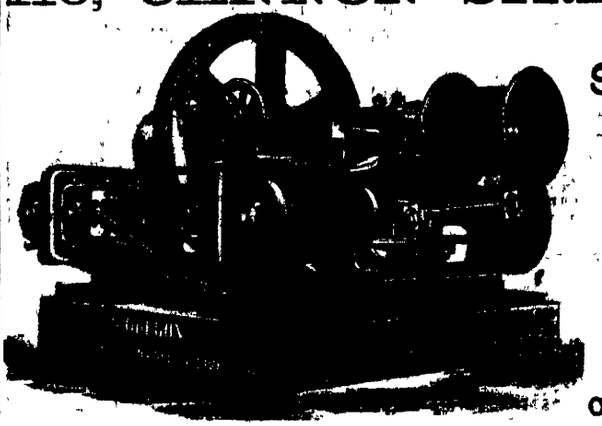
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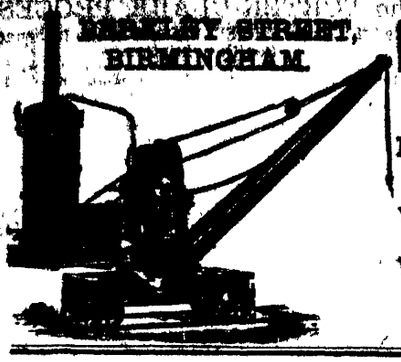
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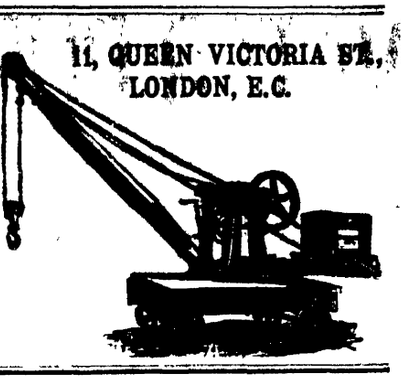


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TORPEDO BOAT for the ITALIAN GOVERNMENT. Official Trial Dec. 13, 1881. SPEED on the Measured Mile 22.46 KNOTS. 5267
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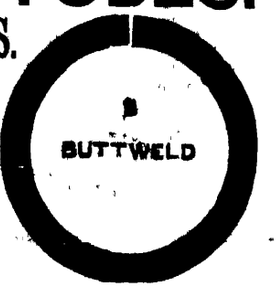
LAPWELDED IRON BOILER TUBES.

BUTTWELDED GAS, STEAM, and WATER TUBES.



DIAGRAM SHOWING LAP AND BUTT WELDS.

These two Engravings, representing sections of Lapwelded Wrought Iron Tube (at A) and Buttwelded (at B) show conclusively the superior strength of Lapweld, which has nearly four times the surface in contact in the Weld over that given in Buttweld.



All Gas, Steam, or Water Tubes over Two-inch size are made Lapwelded by us. 4804

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By this Process the Sulphates and Carbonates of Lime and Magnesia are removed and the water rendered fit for steam users. One Railway Company treats **1,000,000 gallons** of feed water per day by this system 5226

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ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 5400

TEST BAR, Half Actual Size.



HADFIELD'S UNHAMMERED Steel Castings Tested by H.M. Govt., and stood 45 tons per sq. in. tensile strain with 20 p.c. elongation

STEEL CASTINGS

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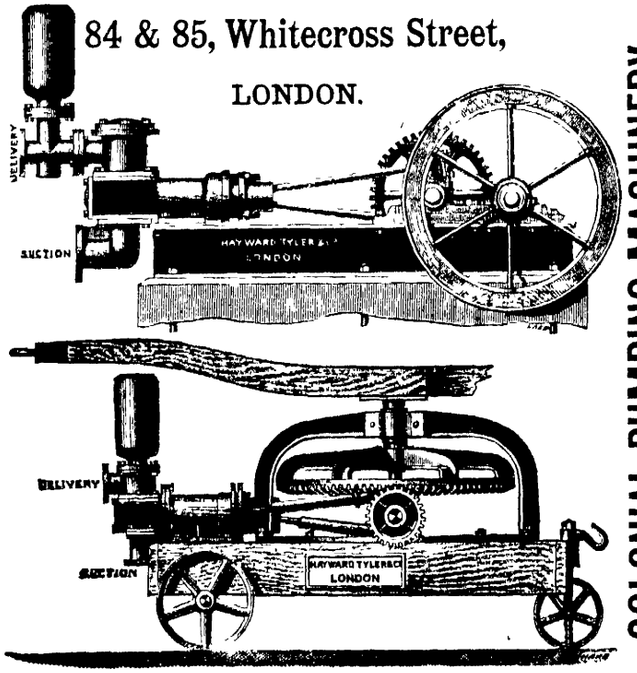
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Every description of Dynamo Machines, Arc and Incandescent Lamps, Electric Light Fittings; Colliery and Railway Signalling Apparatus, Electric Stop Motion for Machinery; Temperature, Pressure, and Water Height Alarms; Electric Bells and Indicators.

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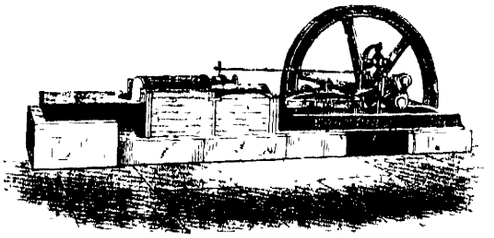
PATENT HORIZONTAL

COMPOUND CONDENSING STEAM ENGINES

FOR MILLING, PUMPING, & OTHER PURPOSES.

The great and well-known economy in fuel of these Engines has been fully proved by very careful trials, particulars of which sent on application (See also "Minutes of Proceedings of the Institution of Civil Engineers," Vol. 66, Session 1880-81 Part IV.)

They have repaid their cost in a short time, are not more complicated than ordinary Condensing Engines, require much less water for condensing, no greater skill to drive, and are as easily accessible for repairs as ordinary Engines



In cases where Boilers are overworked, the adoption of these Engines leads to easy firing, saving of wear and tear, and labour, rendering old Boilers more durable and capable of giving off additional Engine power, thereby saving the cost of new Boilers, where an increase of power is wanted All joints and working parts adjustable.

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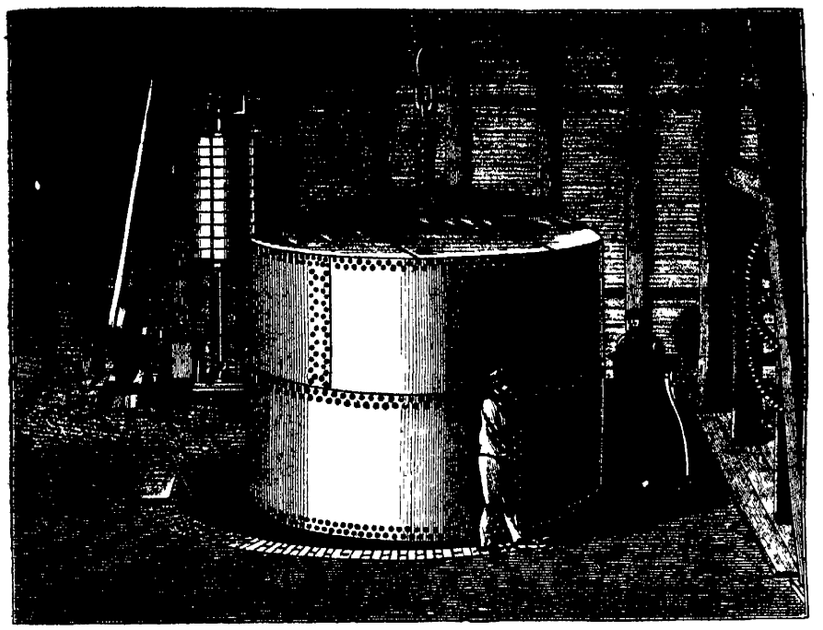
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18, BILLITER STREET, LONDON. And BUTE DOCKS, CARDIFF.

5101

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Punching and Shearing Machines, Plate Bending Rollers, Plate Edge Planing Machines, Beam Bending and Horizontal Punching Machines (with either Single, Double, or without Angle Iron Cutter combined), Keel Plate or Garboard Strake Bending Machines, Plate Straightening Machines, Countersink Drills, and Single-Drill Verticals, &c., &c. 5821

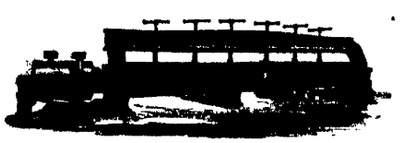
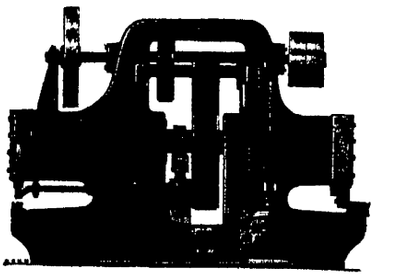


Plate Edge Planing Machine.

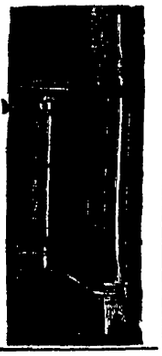
PRICES AND PARTICULARS ON APPLICATION



Punching and Shearing Machine, with Angle Iron Cutter.

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WITHINSHAW'S PATENT
Feed Water HEATER.



The most powerful invented
Great Saving in Boilers, Coals, and Labour.

LARGE HEATING SURFACE

Solid Drawn Brass Tubes.
Free Expansion
No Scurf adheres to the Tubes.

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List on application

BY ROYAL LETTERS PATENT.



MATHER'S
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ARE THE BEST FOR SMALL POWER.
They have large Fly Wheels on which they travel, they are light in draught and are handy

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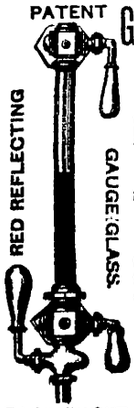
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Manufacturers of
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Guaranteed true to Pattern, of best Qualities, and at Low Rates.
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For Iron, Cast-iron, Copper, &c.

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RED REFLECTING GAUGE GLASS,
Showing through the water a Broad Red Line.

N.B.—All Glasses are of the finest quality, and manufactured expressly to resist extreme pressure.

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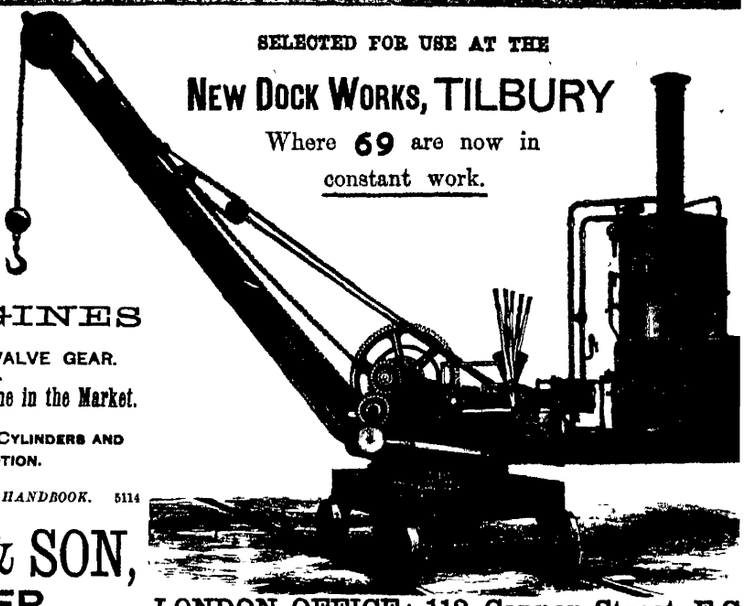
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MILL ENGINES
FITTED WITH
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Cheapest and Most Efficient Crane in the Market.

ALL OUR CRANES HAVE TWO CYLINDERS AND LINK REVERSING MOTION.

SEND FOR ILLUSTRATED HANDBOOK. 5114

SELECTED FOR USE AT THE
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Where 69 are now in constant work.

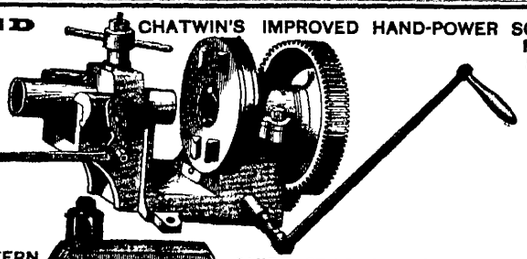


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CLYBURN SPANNER

GAS TUBES SCREWED AT ONCE OVER



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MANUFACTURER OF
STOCKS, DIES, AND TAPS,
PATENT HAND-POWER SCREWING MACHINES. TWIST DRILLS,
STANDARD CYLINDRICAL GAUGES, RIMERS,
CLYBURN, BUDDING, AND OTHER SPANNERS,
RATCHET BRACES, TUBE CUTTERS, TUBE WRENCHES, TUBE VICES,
And General Tools for Engineers, Gas Fitters, &c. 4234

STRAIGHT LIP TWIST DRILL, WITH INCREASE TWIST AND GRINDING LINE.

FUEL ECONOMISER

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BUTTERS BROTHERS, Contractors' Engineers

PERCY CRANE AND ENGINE WORKS, LAMBHILL STREET, PAISLEY ROAD,

MAKERS OF

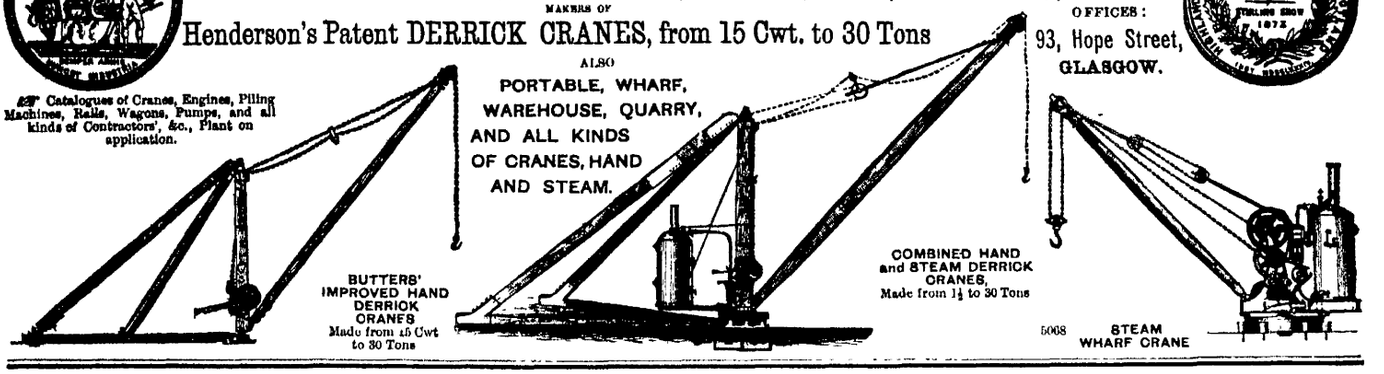
Henderson's Patent DERRICK CRANES, from 15 Cwt. to 30 Tons

ALSO

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BUTTERS' IMPROVED HAND DERRICK CRANES Made from 15 Cwt to 30 Tons

COMBINED HAND and STEAM DERRICK CRANES, Made from 1¼ to 30 Tons

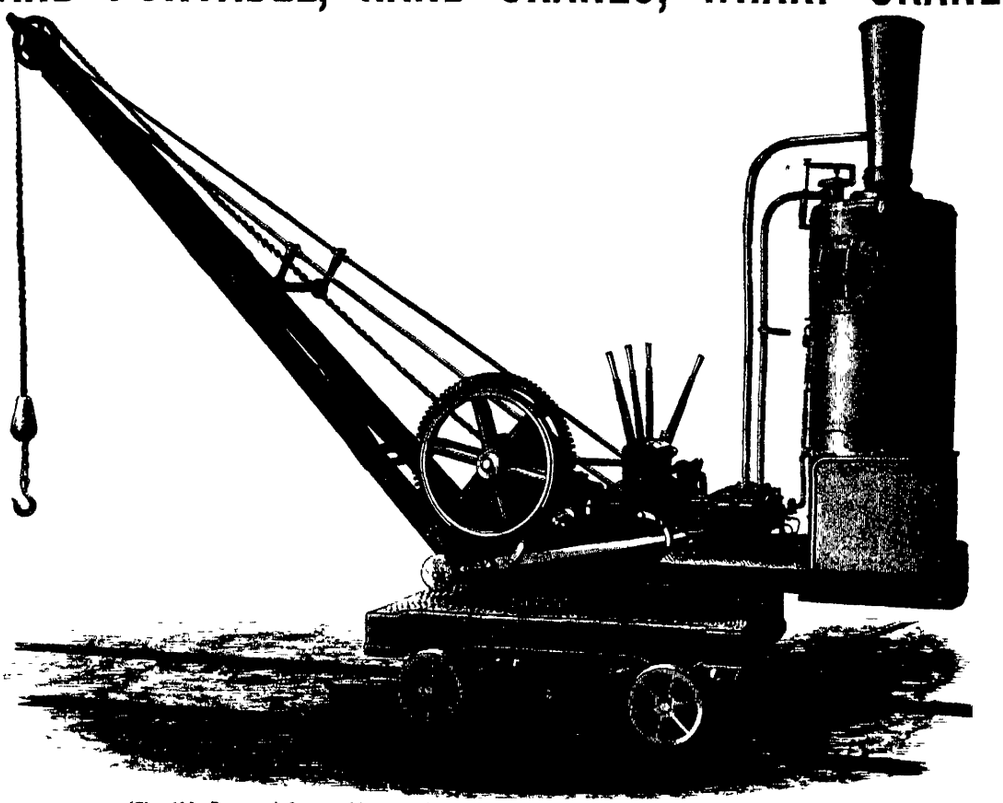
5008 STEAM WHARF CRANE

STOTHERT AND PITT, LIMITED,

ENGINEERS, BATH,

STEAM CRANE MAKERS,

FIXED AND PORTABLE, HAND CRANES, WHARF CRANES, &c.



(Fig. 100, Engraved from a Photograph of Steam Crane with all the latest improvements.)

N.B.—CRANES of this type, for lifting loads of from TWO to TEN Tons, are always kept in Stock, or in a forward state for prompt delivery. 4031

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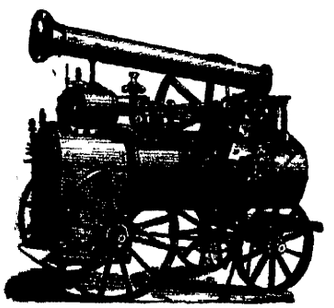
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MANUFACTURERS OF PORTABLE, SEMI-PORTABLE, HORIZONTAL, FIXED, VERTICAL, AND TRACTION ENGINES, THRASHING, CORN GRINDING, SAWING AND TEA PREPARING MACHINERY.



PORTABLE ENGINES, 1½ TO 35 HORSE POWER,

Adapted for all Countries, and constructed to burn Coal, Wood, Straw, Vegetable Matter and Refuse as Fuel.

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A FIRST-CLASS ANTI-CORROSIVE

LUBRICANT.

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Saves 40 per cent. over Tallow. Lasts twice as long as Olive Oil.

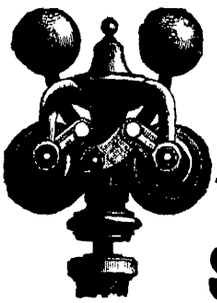
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70 & 71, BISHOPSGATE STREET, LONDON.

Twelve Years in use. See Testimonials.

CANNOT GUM OR CLOG. 4917

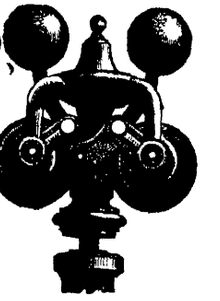


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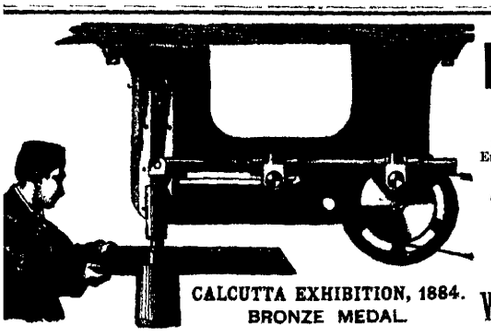




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W. & J. PLAYER, Engineers, LIONEL ST., BIRMINGHAM. VERY LOW PRICES. 5064

IMPORTANT TO USERS OF BELTING.

GANDY v. REDDAWAY AND OTHERS.

Advertisements have been issued and largely circulated in this country and abroad by Mr Maurice Gandy, in which he gives prominence to our name without mentioning the whole of the facts in connection with the above action. It is therefore necessary for us to inform the Users of Belting that the ACTION of

GANDY v. REDDAWAY & CO. and Others was dismissed as regards us, WITH COSTS TO BE PAID BY GANDY to

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REDDAWAY'S PATENT CAMEL HAIR BELTING. | REDDAWAY'S PATENT MACHINE-MADE CANVAS HOSE.

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[Registered at the General Post Office as a Newspaper.

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

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Portland Cement,

manufactured by

Francis and Co.,

5333

The celebrated Nine Elms Brand, established 1810
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Locomotive Tank Engines designed and constructed by MANNING, WARDLE, AND COMPANY, Boyne Engine Works, Leeds 3487
See their Illustrated Advertisement, page 31.

Locomotive Tank Engines, TRAMWAY ENGINES AND CARS
Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough 5206
See Illustrated Advertisement Oct 31, page 11

R. E. Crompton and Co., ELECTRIC LIGHT ENGINEERS,
MANSION HOUSE BUILDINGS, E.C. 5426
See Advertisement last week, page 30

Atkinson's Gas Engines, SELF-STARTING, COMPOUNDED, SIMPLE AND ECONOMICAL.
BRITISH GAS ENGINE AND ENGINEERING CO 11, QUEEN VICTORIA STREET, LONDON
See Advertisement last week, page 41 5341

Over 15,000 "Otto" Engines AT WORK,
Using 25 to 75 % less Gas per Brake HP. than
Any other Engine.

Crossley's Patent Self-Starter, Safest, Best, and Simplest made, may now be applied 5388

Crossley's Patent Twin-Engine Impulse every Revolution. Very Steady in Running
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Crossley Bros. Ld. Manchester.

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Screw Steamers having speeds up to twenty-six miles an hour. Paddle Steamers having draughts down to 6 inches of water. Machinery constructed for boats built abroad. 5384

Steam Launches, fitted with really efficient and accessible tubular boilers. For small steamers, steam lighters, salt flats, &c., these boilers will be found unrivalled.—Apply, COCHRAN and CO, Birkenhead See page 4. 4740

Vosper & Co., Broad Street, PORTSMOUTH
Have FOR SALE, New STEEL STEAM YACHT, 60 ft by 10 ft. 4 in, New WOOD STEAM LAUNCH 40 ft by 7 ft 6 in, and Second hand ditto, 22 ft, by 5 ft 6 in 3551

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G. F. G. Des Vignes, Chertsey, Surrey, Builder of First-class High speed Steel Yachts, Launches, & Torpedo Boats Estab 1869 3794

Miller, Tupp, & Rouse, Steam LAUNCH BUILDERS, HAMMERSMITH, LONDON
Illustrated Price Lists, with Photos., Six Stamps 4547

Worthington Pumping ENGINE COMPANY,
114, QUEEN VICTORIA STREET, LONDON, E C
See Illustrated Advertisement on page 8 5445

John Spencer and Sons, NEWBURN STEEL WORKS, NEWCASTLE-ON-TYNE.
SPRINGS, BUFFERS, STEEL CASTINGS, FORGINGS, TOOL STEEL, FILES SPRING STEEL, &c
SIEMENS STEEL BLOOMS AND BARS 3708
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Johnson & Phillips, Telegraph ENGINEERS, ELECTRICIANS, and CONTRACTORS, 16, Union Court, Old Broad Street, E.C
Works and Wharf at Charlton, S E.
Makers of all Machinery, &c, for the complete equipment of Telegraph Cable Factories and Steamers, Electric Leads, Cables, and Carbons, &c 5360

Steam Cranes.— Coles' Patent
Grab and Bucket Dredgers
HENRY J COLES,
9, SUMNER STREET, SOUTHWARK, LONDON 4827

Steel Hydraulic Cylinders.— HENRY BESSEMER & CO, Limited, SHEFFIELD
See Advertisement, page 35 3627

Stannah's Pendulum Pumps. For Prices see alternate weeks. 3238

Willans' Patent Compound ENGINES, for marine and general purposes Stock sizes from 6 to 150 I HP Special patterns for Electric Lighting.—WILLANS & ROBINSON, Thames Ditton, Surrey 5283

Iron Roofs, Sheds, Buildings, HOUSES Best work, reduced prices Dixon's special CURVED IRON ROOFS are the most economical for spans up to 45 ft. Catalogues, Designs, Estimates, on application ISAAC DIXON, Windsor Ironworks, LIVERPOOL. 4833

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The Landore Siemens-Steel CO, LIMITED,
LANDORE, R S O, SOUTH WALES 4961

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W. T. H. Carrington, 9 and 11, FENCHURCH AVENUE, E.C
Removed from 76, Cheapside, E C. 5095
See Illustrated Advertisement last week, page 12.

A First-Class Lubricant.

"Engelbert's Lubricator."

SEE ADVERTISEMENT LAST WEEK.

Hunter and English, ENGINEERS AND MILLWRIGHTS,
IRON AND BRASS FOUNDERS, BOW, LONDON, E.
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HYDRAULIC MACHINERY.
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HUNTER'S PATENT FLOATING CRANE FOR DOCKS, &c.
STEAM LAUNCH MACHINERY 4955

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EDWIN LEWIS AND SONS, Wolverhampton 4863

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Having Special Stock, Shipments and Repairs executed very rapidly 4938

Tubes. MARINE, LOCO', STEAM, BORING, COLLIERY LARGE TUBES LAP WELDED TO 12in DIAM.
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Mr L W SUTCLIFFE, M E, AGENT 5189

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Steam Hammers (with or without guides) Hand worked or Self acting TOOLS for SHIPBUILDERS & BOILER MAKERS
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Hardingham's Patent Sectional STEAM BOILERS (annular water tube system) Efficiency, economy, accessibility, compactness, safety For full particulars, apply to G G M HARDINGHAM, Engineer, 191, Fleet St, London, E C

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W. & J GALLOWAY & SONS, Manchester, always keep a large stock of "GALLOWAY and "TWO-FLUED" Boilers ready for dispatch 5060

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See Illustrated Advertisement last week, page 24

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Thomas Kell and Son, Litho- graphers, &c, execute every description of Lithography, Chromo lithography, Engraving, and Printing, Engineering, Architectural, and Pictorial Drawing in best manner Paper Drawing, photo lithography, &c —40, King St., Covent Garden, W C 3462

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Thomas Smith,
STEAM CRANE WORKS, OLD FOUNDRY, 4345
RODLEY, NEAR LEEDS
See Illustrated Advertisement last week, page 12

International HEALTH EXHIBITION
PAUL PFLEIDERER'S PATENT
Bread-Making Machinery
In Bakery Section. 5365

London Mutual Boiler In- SURANCE COMPANY, LIMITED Established in 1874 for the INSURANCE and PERIODICAL INSPECTION of all kinds of Land and Marine Boilers throughout the United Kingdom.—For particulars apply to the Secretary 17, Queen Victoria Street, London, E C 5366
The Assured are secured against loss from claims established under the Employers' Liability Act, 1880.

Hathorn, Davey & Co., LEEDS
PUMPING MACHINERY
For Mines, Water Supply, Irrigation, Graving Docks, Drainage of Fens and General Pumping Purposes.
ALSO
HYDRAULIC MACHINERY OF ALL KINDS
The "DOMESTIC" MOTOR
CATALOGUES ON APPLICATION 5356

HIGHEST AWARD, PARIS, 1878
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MANCHESTER 4818

East Ferry Road Engineering WORKS CO, LIMITED, Hydraulic Engineers, Millwall, London, E. Parkes's Patent Portable Hydraulic Cranes, Lifts, and Hoists Duckham's Patent Suspended Weighing Machines. 5124
See Illustrated Advertisement last week, page 14

Dredgers and Excavators.— HIGHEST PRIZE AT TYNEMOUTH
FOR
HYDRAULIC DREDGERS
Bruce and Batho,
9, VICTORIA CHAMBERS, 5349
WESTMINSTER, S W
See Illustrated Advertisement last week, page 29

L. Sterne & Co., Limited. ENGINEERS,
Sole Makers of
Clerk's Patent Self-Starting Gas Engine.
HIGHEST AWARD,
BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881
GOLD MEDAL,
CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifiers, WITH
STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

Emery Wheels, Emery Machines, Spiral Springs.
The Crown Iron Works, GLASGOW.
The Crown Iron Works (Hollinwood), MANCHESTER.
10, Victoria Chambers, WESTMINSTER.
City Office and Show Rooms, 40, CANNON STREET, E.C.
10, Rue Laffitte, PARIS. 3589

Royal Indian Engineering College, Cooper's Hill, Staines The course of study is arranged to fit an engineer for employment in Europe India, or the Colonies Sixty Students will be admitted in September, 1885 For competition the Secretary of State will offer FIFTEEN APPOINTMENTS in the Indian Public Works Department and TWO in the Indian Telegraph Department For particulars apply to the SECRETARY at the College 432

TENDERS.

INDIA OFFICE,
20th November, 1884
INDIAN STATE RAILWAYS.

BY ORDER OF THE SECRETARY OF STATE FOR INDIA IN COUNCIL.

The Director General of Stores for India is prepared to receive

Tenders from such Persons as may be willing to SUPPLY
IRONWORK for BRIDGES
IRONWORK for ROOFING

The Conditions of Contract may be obtained on application to the Director General of Stores, India Office, Westminster, S W, and Tenders are to be left at his Office at any time before Two o'clock p m on Tuesday, the 9th December, 1884, after which no Tender will be received

A ABERCROMBIE JOPP, J 259
Director General of Stores

SOUTH INDIAN RAILWAY COMPANY

The South Indian Railway Company is prepared to receive

Tenders for the Supply of HARDWARE, STEEL TOOLS, METALS, LEATHER BELTING, OILS and COLORS, SUNDRIES and OFFICE FITTINGS comprised in General Stores, STATIONERY and TICKETS

Specifications and Forms of Tender may be obtained on and after the 18th instant, at the Company's Offices Tenders addressed to the Chairman and Directors of the South Indian Railway Company, and marked "Tender for Stores," or "Stationery and Tickets," as the case may be, must be left with the undersigned, not later than Twelve o'clock noon, on Tuesday, the 2nd day of December, 1884

The Company is not bound to accept the lowest or any Tender

A charge of Ten Shillings (which will not be returned) will be made for copies of the respective Specifications By order,

HENRY W NOTMAN, Managing Director
Company's Offices, 65, Gracechurch Street,
London, 17th November, 1884 J 231

GREAT SOUTHERN AND WESTERN RAILWAY COMPANY, IRELAND

TULLOW EXTENSION—TO RAILWAY CONTRACTORS

The Directors of the Great Southern and Western Railway Company are prepared to receive

Tenders for the Construction of the EXTENSION LINE from Baltinglass in the county of Wicklow, to Tullow, in the county of Carlow, a length of about 10 miles 4 furlongs and 8 chains, the whole of which is to be constructed for a single line

The Plans, Sections, Drawings and Specifications may be seen at the Offices of Mr BENJAMIN P FLEMING, C E, No 15 Dawson Street, Dublin, on and after Monday 24th instant

A Copy of the Land Plan, Longitudinal Section, and Specification, will be supplied on payment of Five Guineas, with a Schedule of the Engineers' quantities, which quantities are not guaranteed, but given for the purpose of enabling contractors, who purchase plans &c, to check their own quantities by

Tenders accompanied by estimates enclosed in sealed envelopes marked "Tender for Extension Works," and addressed to the undersigned, must be delivered at the Company's Office, not later than Ten a m, on Friday, the 19th December next

The Directors do not bind themselves to accept the lowest or any Tender, nor will any Tender be received except accompanied by an estimate, both on Forms to be supplied on application to Mr Benjamin P Fleming's Office

FRANCIS R ORMSBY, Secretary
Kingsbridge Terminus, Dublin,
15th November, 1884 J 222

TO BOILERMAKERS AND OTHERS

THE COMMISSIONERS FOR PUBLIC BATHS AND WASHHOUSES in the Parish of St James, Westminster, are prepared to receive

Tenders for Providing and FIXING a NEW CORNISH BOILER of the following description—Internal diameter, 6 ft, length, 20 ft; thickness of plates at bottom of boiler to extent of one third of surface, 9/16 in, and of remainder of plates, 7/16 in, thickness of boiler ends, 9/16 in, strengthened with angle brackets, pitch of rivets, 2 in, diameter of rivets not less than 1 1/8 in, diameter of furnace tube, 2 ft 9 in, thickness of plates, 9/16 in, to be fitted with not less than three Galloway tubes at different angles, water space between bottom of furnace tubes and bottom of boiler not less than 12 in, diameter of steam dome, 2 ft 0 in, height, 3 ft, thickness, 9/16 in, all to be of the best Lowmoor iron and fitted with man and mud hole doors, two safety valves 5 in diameter, loaded to 40 lb per square inch, steam and water gauges, blow off cocks feed valve, steam stop valve, furnace fittings, firebars and damper supplied but not fitted until the setting of boiler, working pressure being 40 lb per square inch The test will be required up to three times that amount All to be of the best workmanship and single riveted Price to include supplying, delivering, fixing and setting boiler, and leaving same fit and ready for immediate use at the Public Baths, 16, Marshall Street, Golden Square, London, and the Tender to state what sum will be allowed for old boilers (No 4 and No 5) to be removed The boiler house may be seen any morning on application to the Superintendent or Engineer

Tenders, under cover, endorsed "Tender for Boiler," to be addressed to the undersigned and delivered at the Offices of the Commissioners, 16, Marshall Street aforesaid, by or before Two o'clock in the afternoon of Wednesday, the 10th day of December, 1884

The Commissioners do not bind themselves to accept

EMPIRE OF BRAZIL

Tenders for Lighting by Gas the City of Rio de Janeiro, will be received at the Brazilian Legation, and at the Consulate General in London, on or before the 28th of February, 1885—For particulars and Specifications, apply to the BRAZILIAN CONSULATES GENERAL in London and Liverpool J 230

NEWLYN PIER

TO CONTRACTORS

The Newlyn Pier and Harbour Commissioners are prepared to receive

Tenders for the Construction of a CONCRETE PIER at NEWLYN, in the County of Cornwall

The Contract, Drawings, and Specifications may be seen and Bills of Quantities obtained at the Office of the Engineer, Mr J C INGLIS, 18, Buckland Terrace, Plymouth

Tenders endorsed "Newlyn Harbour Contract," are to be sent to the Harbour Office, Newlyn, Penzance, not later than 13th December, 1884

The Commissioners do not bind themselves to accept the lowest or any Tender

(Signed),
R TOMAN, Secretary
Dated 15th November, 1884 J 243

TO ENGINEERS AND OTHERS,
TRINITY HOUSE, LONDON,
11th November, 1884

This Corporation being desirous of receiving

Tenders for the Manufacture and Delivery at the Trinity Wharf, Blackwall, of SUNDRY STEEL BUOYS, of stated dimensions and descriptions, Notice is hereby given that the Drawings may be inspected, and Forms of Tender and Specification obtained on application at the Store Department at this house, on any day, between the hours of Ten a m, and Four p m Tenders, sealed and marked outside "Tender for Steel Buoys," must be addressed to the Secretary and delivered at this house on or before Thursday, the 4th December, and no Tender can be entertained that is not made on the Form provided The Corporation does not pledge itself to accept the lowest or any Tender By order,
J INGLIS, Secretary

TO MACHINERY BROKERS, CLOG SOLE MANUFACTURERS, AND TIMBER DEALERS

The Mersey Docks and Harbour Board have a number of WOOD WORKING MACHINES of superior modern quality, consisting of Saws, Clog-sole Making Machines, and Bending Machines, formerly the property of the British Timber Company, Limited, which they are willing to DISPOSE OF

The Machinery will be open for inspection from the 14th to the 26th instant, and Tenders must be sent in to the undersigned, not later than Thursday, the 4th proximo

Forms of Tender, with Conditions of Sale, and Orders to view the Plant can be obtained on application at the Office of the Dock Engineer, Dock Yard, Coburg Dock By order,
EDWARD GITTINS,
Dock Office, Liverpool Secretary
13th November, 1884 J 225

APPOINTMENTS OPEN.

Civil Service Commission - FORTHCOMING EXAMINATION ARCHITECTURAL DRAUGHTSMAN in the Department of the Director of Engineering and Architectural Works in the Admiralty at the Head Office (20 - 32), 24th December

The date specified is the latest at which applications can be received They must be made on Forms to be obtained, with particulars, from the SECRETARY, Civil Service Commission, London, S W J 234

Engineering Foreman.—WANTED, for Six Months, a PERSON accustomed to Cofferdams, Timbering Cuttings, and Brick work None need apply but those who can keep fair record and progress books Applications, stating wages, and accompanied by recent testimonials, to be in not later than Wednesday, the 26th inst—Address, J 242, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W C J 242

Cashier, &c, for Mechanical Establishment in Russia, Englishman, but must know German thoroughly and have had experience in Bookkeeping and general business Salary to commence at £250 to £300 Unexceptionable references required—Address, stating age and qualifications, to C H 666 Messrs DRACONS, Leadenhall St, E C J 250

Junior Draughtsman Wanted in a London Engineer's Office, must have had a shop training Address, stating experience and salary required, to L A, at C H MAY & Co's General Advertising Offices, 78, Gracechurch St, E C J 237

Representative for Spain REQUIRED, by Ibbotson Brothers and Co, Limited, Globe Steel Works, Sheffield a thorough knowledge of the Sheffield Trade and of the Spanish and French languages indispensable—Applications by letter only, addressed to the SECRETARY J 224

Agents Wanted, to push First-class MACHINERY OILS commanding a large and successful sale Liberal commission—Address BOX 201, Post Office, Liverpool 5238

Lists of Berths Vacant or WANTED See "ENGINEERING REVIEW," weekly 1d—E & F N SPON, 16, Charing Cross, London, or of all News Agents. 5378

SITUATIONS WANTED.

Civil Engineer's Draughtsman with a thorough knowledge of bridge and rail

Employment Wanted, by a middle aged man, as Clerk, Timekeepor, or in any place of trust, willing to make himself generally useful Good references,—Address, X Y, care of HARRY WESTCOTT, 28, Budge Row, Cannon Street, London, E C J 229

Wanted, Situation as Assistant Draughtsman or Foreman in Agricultural or Mechanical Engineering Firm, has thorough practical experience, can produce first class testimonials and references, age 26—Address, H B, 7, Hatton Park Road, Wellingborough, Nth Hants J238

London Representative or TRAVELLER—SITUATION WANTED, by Advertiser, aged 35, energetic and experienced in engines, boilers, and general machinery, good connection with engineers, builders, contractors, &c, highest references—Address, H Y, Offices of ENGINEERING, 35 & 36, Bedford Street, London, W C J 249

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Wheatley Kirk, Price, and GOULTY. (Established 1850)
MECHANICAL VALUERS, AUCTIONEERS, AND ARBITRATORS
Albert Chambers, Albert Square, Manchester; and 52, Queen Victoria Street, London, E C.

Engineering Firms of Good REPUTE, open to admit partners or desirous of selling outright, are requested to communicate with the undersigned, who have numbers of clients open for such—WHEATLEY KIRK, PRICE, and GOULTY, 52, Queen Victoria Street, London, E C 4926

Partnerships.—Gentlemen (practical engineers) desirous of entering established Engineering concerns, are invited to communicate with the undersigned, who have numerous bona fide establishments open to admit such References are given and required—WHEATLEY KIRK, PRICE, and GOULTY, 52, Queen Victoria Street, London, E C

To Civil Engineers in practice—The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright
WHEATLEY KIRK, PRICE and GOULTY, 52, Queen Victoria Street, London, E C 5371

WANTED, &c.

Wanted to Purchase, a Quantity of GOOD SECOND-HAND MACHINERY, for the purpose of BRIDGE, GIRDER, and ROOF CONSTRUCTION, such as LEVER PUNCHING and SHEARING MACHINES, PLANING MACHINES, LATHES, RADIAL and other DRILLING MACHINES, STEAM and HYDRAULIC RIVETERS

PORTABLE and FIXED STEAM ENGINES and BOILERS, BENDING ROLLS, OVERHEAD STEAM and HAND TRAVELLERS

ROOFING and COLUMNS for SHEDS

SHAFTING, RIGGERS, and LEVELLING SLABS and BLOCKS, ANGLES, HAMMERS, and other TOOLS, WEIGH BRIDGE and WEIGHING MACHINE, &c, &c

Send full particulars and lowest prices to—
JOSEPH WESTWOOD, 39, Great Tower Street, London, E C J 236

Dredger.—Wanted to Hire for few months, good STEAM LADDER DREDGER, of good capabilities, also, in first rate working order, three or four HOPPER BARGES—Terms and full particulars to JOHN JACKSON, Contractor, 9, Victoria Chambers, Westminster J 240

Seismometer.—Wanted, to HIRE, one for measurement of ground vibrations caused by falling bodies, heavy traffic, &c Full value deposited for security—Address, J HODGSON, General Engineer, Commercial Street, Newport, Mon J 228

Wanted, "Engineering," March 5, April 2 and 16, 1875, and January 14, 1876—Address, W E C MEE, 190, High Street, Portmadoc, North Wales J 252

"Engineering."—Wanted, the Numbers for July 27th, August 3rd, and November 23rd, 1866 Good price given—Address, A B, 62, Loddige's Road, Hackney, London J 258

Lists of Machinery Wanted or on SALE See "ENGINEERING REVIEW," weekly 1d—E & F N SPON, 16, Charing Cross, London, or of all News Agents 5282

FOR SALE.

For Sale, One Pair of Compound Surface Condensing MARINE ENGINES AND BOILER, 130 IHP Nominal 5299
J GILMOUR & CO, Engineers, Glasgow

For Sale, Stone Breaker, size 12 in. by 6 in Weight 2 tons, with Hall's Patent Elastic Steel Connecting Rods—Apply, C E HALL, Standard Iron Works, Washford Road, Sheffield 5346

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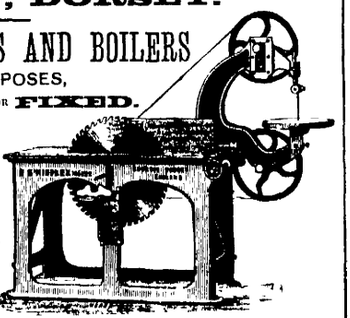
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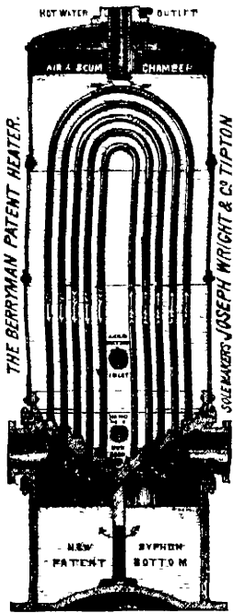
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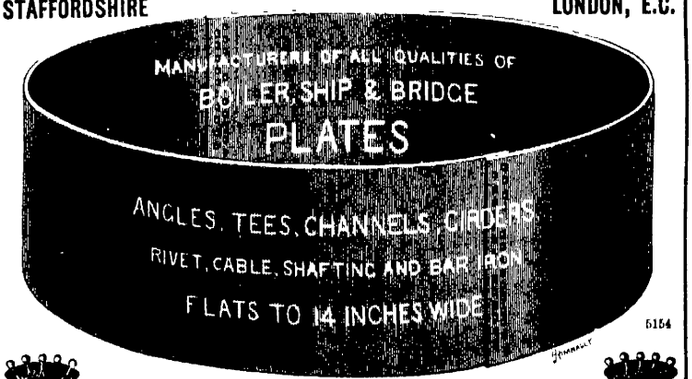
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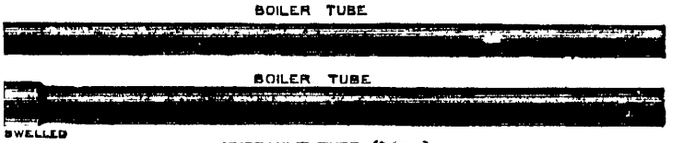
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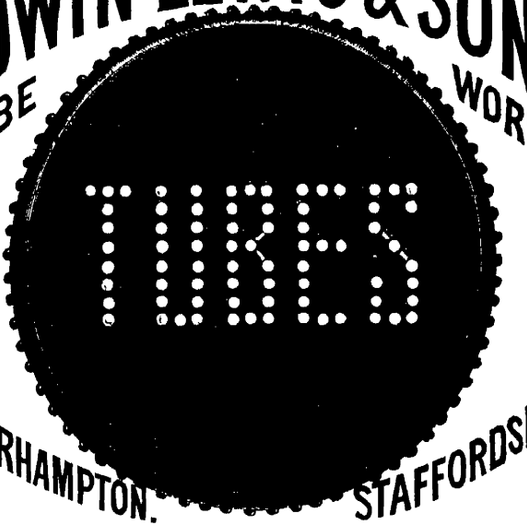
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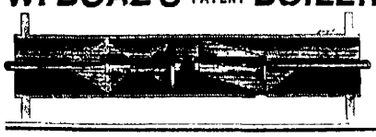
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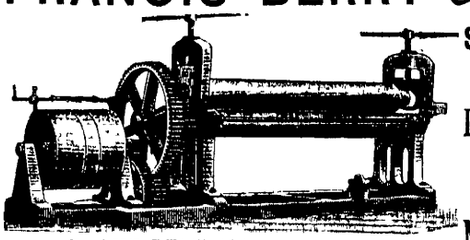


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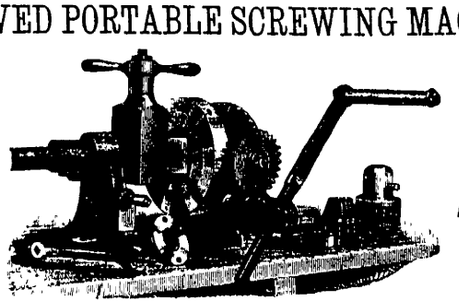
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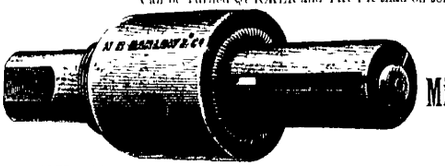
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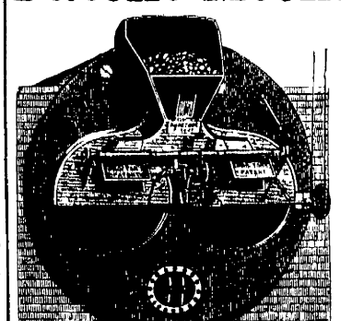
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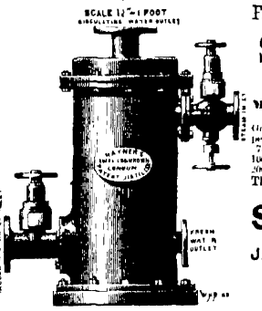
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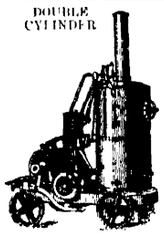
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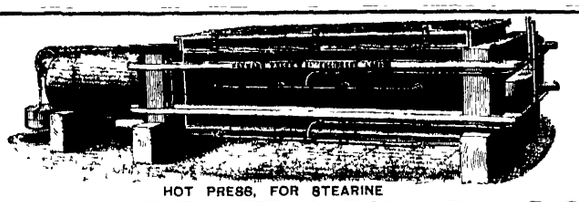
I am, yours faithfully, T A Brock, Secretary

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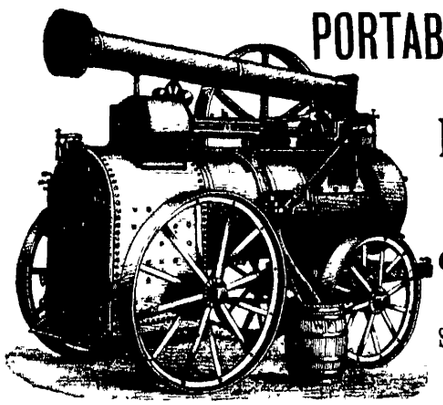


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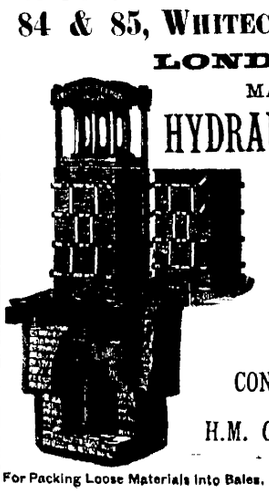
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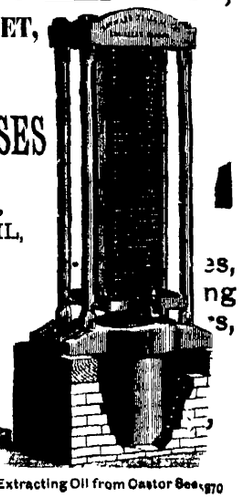
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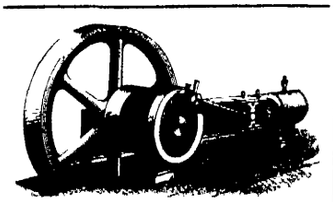
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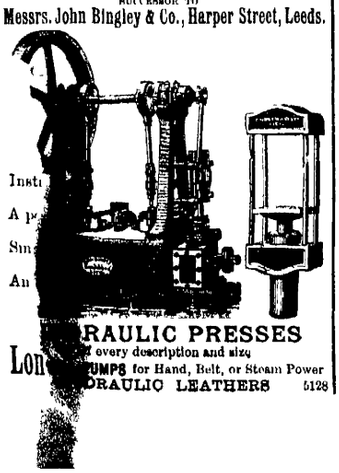
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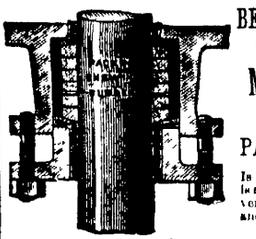
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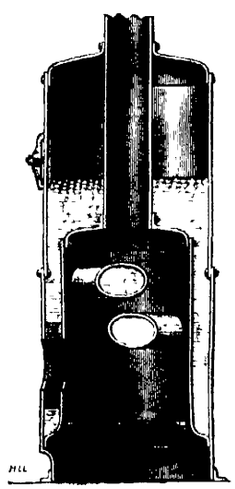
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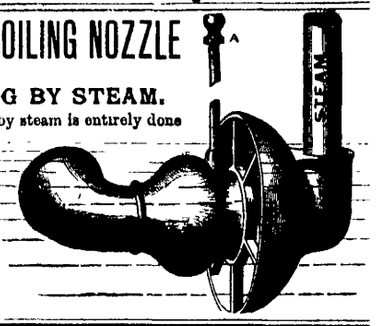
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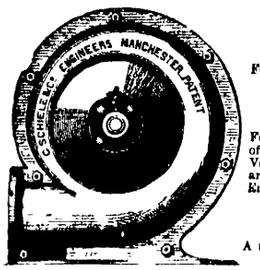
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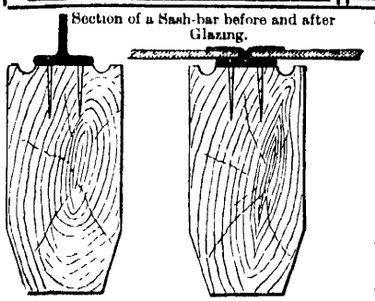
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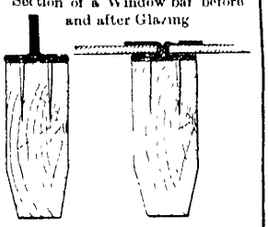
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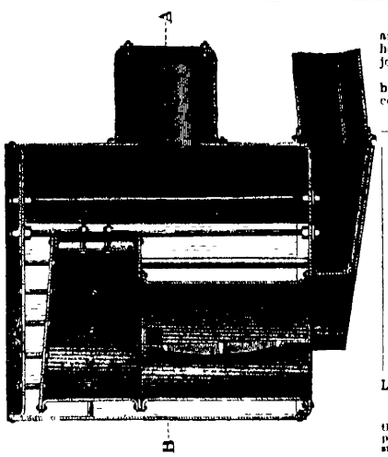
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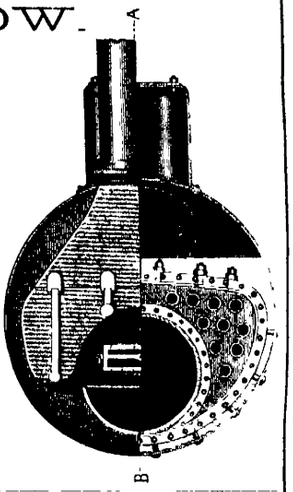
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95	4 6	6 6	2 0	2 0	155	65	£94
80	4 9	7 0	2 3	2 0	174	73	£120
80	5 0	7 0	2 3	2 1	189	78	£134
80	5 6	7 6	2 9	2 4	225	90	£154
80	6 0	7 6	2 9	2 4	265	97	£174
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			Two flues				
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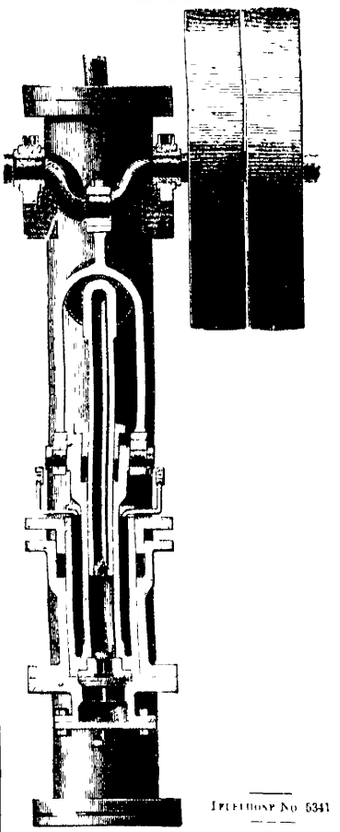
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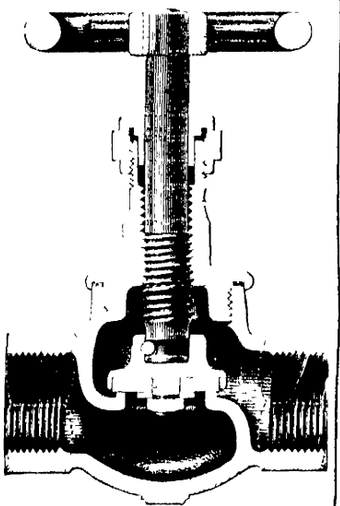
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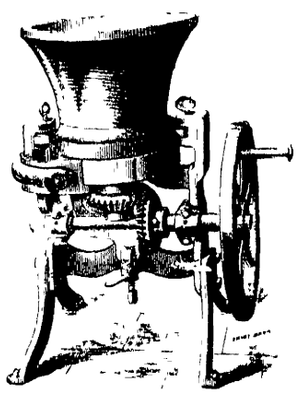
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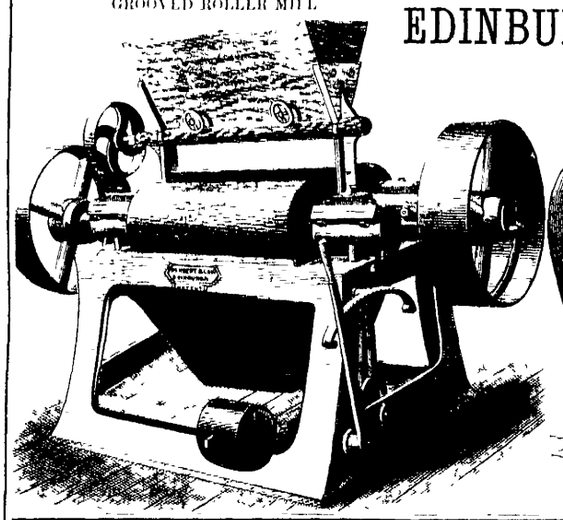
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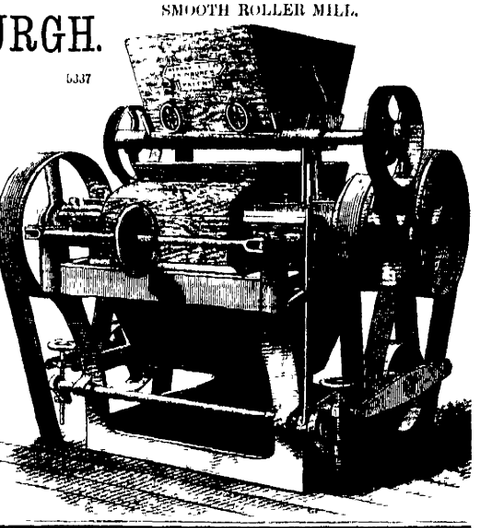
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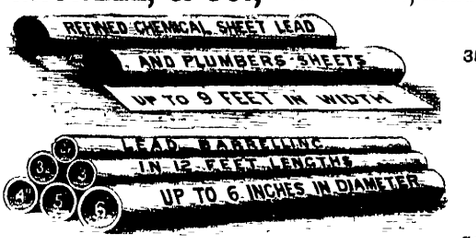
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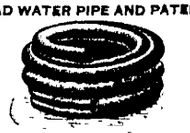
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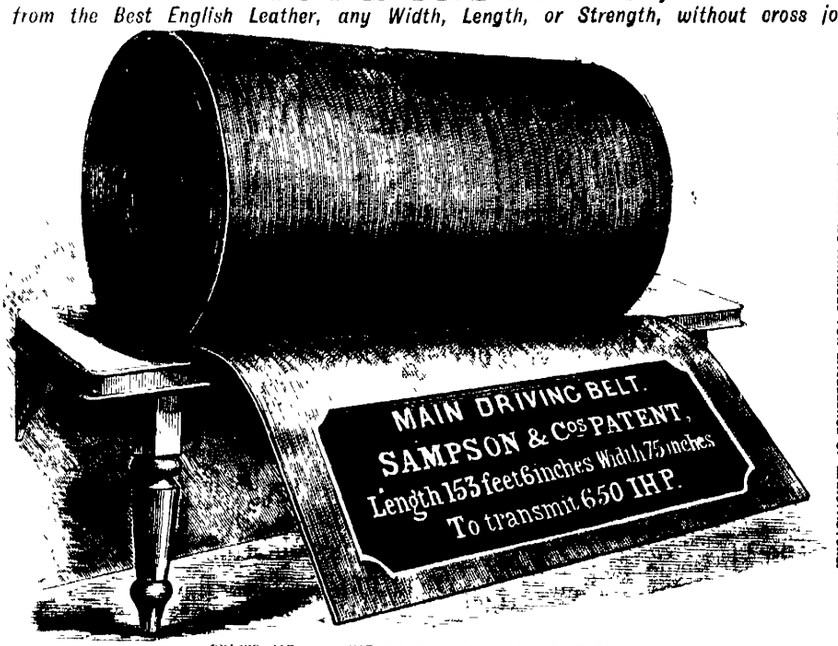
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Distilling (Water) Apparatus.
Chaplin, Alex, & Co. . Glasgow
Normandy, A. . Custom House Station, Victoria Docks, E.
Rose & Duncan . . . Glasgow

Diving Apparatus.
Siebe, Gorman & Co. . 192, Eagle Wharf Road, N

Drawings, Tracings, &c.
Bell, J., & Son . . 40, King Street, Covent Garden
Bremner & Thorpe . 8, Quality Court, E.C
Thorp, John B. . Copthall House, Telegraph St., Moorgate Street, E.C

Dredging Machines.
Grace & Botho . 9, Victoria Chambers, S.W
Coles, M. J . . 89, Sumner Street, S E
Edwards & Symes .. . . Wharf Road, Cubitt Town, E.
Fleming & Ferguson .. Paisley, N.B.
Hanna, Donald & Wilson . Paisley, N.B.
Hayward & English .. Bow, London, E
Hunter, H., & Co. . Paisley, near Glasgow
Priestman Brothers .. . Hull
Rose, Downs & Thompson . Old Foundry, Hull
Stothert & Pitt, Limited .. Bath

Dynamite.
Winter, F . . .. .. 126, London Wall, E.C.

Economisers (Fuel).
Appleby, Robert, & Co . Hatton Court, Ipswich
Green, E., & Son . 54 Ann's Square, Manchester
Hathorn, A. .. .. Colnham Foundry, Shrewsbury
Kilpatrick, Mcnab, & Highgate . Shettlestone, Glasgow

Electric Lighting Plant.
Crompton, R. E., & Co .. .. Arc Works, Chelmsford
Glover, W. T., & Co. . 25, Booth Street, Manchester
Hime, Howard, & Co. . 115 & 116, Palmerston Buildings, London, E.C
Woodhouse & Rawson . 11, Queen Victoria Street, E.C.

Electrical Engineers.
Crompton, R. E., & Co. .. .. Mansion House Buildings, E.C.
Edmunds & Goolden .. .. 9, Victoria Mansions, S.W
Isaacs & Phillips .. .. 14, Union Ct., Old Broad St., E.C
Paterson & Cooper .. .. 76, Little Britain, E.C.
Siemens & Irish .. .. Electric Works, Sunderland
Woodhouse & Rawson .. .. 11, Queen Victoria Street, E.C.

Elevators, Grain, Coal, &c.
Priestman Brothers .. Hull
Rose, Downs & Thompson Old Foundry, Hull

Emery and Emery Cloth.
Acton & Borman . 72, Shoe Lane, E.C
Goldsworthy, T., & Sons . Hulme, Manchester
Oakey, John, & Sons . Wellington Mills, London, S.E.

Emery Wheels.
Selig, Sonnenthal & Co 85, Queen Victoria Street, E.C
Slack's Emery Wheel & Machine Co., Limited . Ardwick, Manchester
Sterne, L., & Co., Limited . Glasgow & London

Engine and Boiler Fittings.
Cran, Jno & Co. . Albert Engine Works, Leith
Dewrance, John, & Co 135, Great Dover Street, S.E.
Foster, Edward & Son . Halifax
Galloway, W. & J., & Sons . Manchester
McCulloch, T., & Sons . Kilmarnock
M'Neil, C., Jr . Kinning Park Ironworks, Glasgow
Melling, Hopkins & Co . Bow, London, E. [gow
Tangyes Limited .. . Cornwall Works, Birmingham
Weir, G. & J . 49, Jamaica Street, Glasgow
Winn, Charles, & Co . Granville Street Birmingham

Engines (Air).
Tyler, H., & Co . 84, Whitecross Street, E.C.

Engines (Blowing).
Adamson, D., & Co . Dukinfield, Manchester
Carrick & Wardale . Gateshead
Daglish, R., & Co . St. Helen's, Lancashire
Davey Brothers, Limited . Sheffield
Galloway, W. & J., & Sons . Manchester
Goodfellow & Matthews . Hyde, near Manchester
McCulloch, T., & Sons . Kilmarnock
Neil, W., & Son . 96 Helen's Junction, Lancashire
Ormerod, Grierson & Co . Hulme, Manchester
Savile Street Foundry and Engineering Co, Limited . Sheffield
Thwaites Brothers . Vulcan Ironworks, Bradford
Walker Brothers . Wigan

Engines (Gas).
Andrew, J. E. H., & Co . Stockport
Barker, T. B., & Co . Scholefield St., Birmingham
British Gas Engine & Engineering Co . 11, Queen Victoria Street, E.C
Crossley Bros., Limited . Manchester
Miller, H. L . Birmingham
Otto, J. C. R. . 30, Queen Victoria Street, E.C.
Sterne, L., & Co Limited . Crown Ironworks, Glasgow
Tangyes Limited . Cornwall Works, Birmingham

Engines (Locomotive).
Appleby Brothers . .. East Greenwich, S.E.
Bagnall, W. G . Stafford
Baldwin Locomotive Works . Philadelphia, U.S.A.
Balmforth, Wm. (Executors of) . Rodley, near Leeds
Black, Hawthorn & Co . Gateshead-on Tyne
Chaplin, A., & Co . Glasgow
Dick, Kerr & Co. . 101 Leadenhall Street, E.C
Falcon Engine & Car Works, Ltd Loughborough
Fowler, J., & Co. . Leeds
Grange Iron Co., Limited . Durham
Hawthorn, R. & W . Newcastle-on Tyne
Hudswell, Clarke & Co . Leeds
Hunslet Engine Co . Leeds
Jessop, J., & Son . Leicester
Kerr, Stuart & Co . 20, Bucklersbury, E.C.
Lewes Engineering Co., Ltd, The . Whitehaven
Manning, Wardle & Co . Boyne Engine Works, Leeds
McCulloch, T., & Sons . Kilmarnock
Peckett, Thomas . Atlas Engine Works, Bristol
Rogers Loco & Machine Works . Paterson, N J., U S A
Walker Brothers . Pagefield Ironworks, Wigan

Engines (Marine).
Appleby Brothers . East Greenwich, S.E.
Burrell, C. & Sons, Limited . Thetford
Cran, John, & Co . Albert Engine Works, Leith
Hanna, Donald & Wilson . Paisley, N.B
Hawthorn, R. & W . Newcastle-on Tyne
Hayes, Ed . Stony Stratford
Hunter & English . Bow, E
Patil, M. & Co . Levenford Works, Dumbarton
Plenty & Son . Eagle Ironworks, Newbury, Berks
Rankin & Blackmore . Greenock
Roger, R., & Co. . Stockton-on-Tees
Rosen, Downs & Thompson . Hull
Rose & Duncan . Whitefield Works, Glasgow
Thornycroft, J. I., & Co . Chiswick, W
Vosper & Co. . Broad Street, Portsmouth
Wilson, Alex & Co . Vauxhall Ironworks, Wandsworth Road, S W
Wilson, H. M . Blyth, Northumberland
Yarrow & Co . Isle of Dogs, London, E

Engines (Portable).
Appleby Brothers .. East Greenwich, S.E.
Barrows & Stewart . Banbury
Belleville, J. & Co . 4 St. Denis, Seine
Clayton & Shuttleworth . Lincoln
Davey, Paxman & Co . Colchester
Farmer, Robey Brown & Co Gainsborough
Foster, W. & Co., Limited . Wellingborough
Garrett, R., & Sons . Leiston Works, Suffolk
Hindley, E. S. . Bourton, Dorset
Hornsby, R., & Sons, Limited . Grantham
Marshall, Sons & Co., Limited . Gainsborough
Mather, G. R. . Wellingborough
Ransomes Sims & Jefferies, Ltd Ipswich
Reading Ironworks Co. Ltd . Reading
Robey & Co . Lincoln
Ruston, Proctor & Co . Sheaf Ironworks, Lincoln
Smedley Brothers . Belper

Engines (Rotary).
Heenan & Froude . Manchester

Engines (Stationary).
Adamson, D. & Co . Dukinfield, Manchester
Appleby Brothers . East Greenwich, S.E.
Aitken, McNeil & Co . Helen Street, Govan, Glasgow
Allen & Macclellan . Sentinel Works, Glasgow
Barr, James . Kilmarnock
Barrows & Stewart . Banbury
Beckwith, E., & Co. . Sunderland
Brotherhood, P . Belvedere Road, Westminster Bridge S E
Buckley and Taylor .. Castle Ironworks, Oldham
Burnsted, F. D . Holmesford, Staffs.
Carrick & Wardale . Gateshead
Chaplin, Alex, & Co . Cranston Hill Engine Works, Glasgow
Clayton & Shuttleworth . Lincoln
Coalbrookdale Co., Limited . Coalbrookdale, Shropshire
Cochrane, J . Barrhead
Coles, H. J . Sumner Street, S.E.
Coley, Henry . Mansion House Chambers, 11, Queen Victoria Street, E.C
Copeland, J., & Co . Dobbie's Loan, Glasgow
Craig, A. F., & Co. . Paisley, N B
Daglish, R., & Co . St. Helen's, Lancashire
Davey, Paxman & Co . Colchester
Davy Brothers, Limited . Sheffield
Denkin, B., & Co. .. .. Barnoudsey, S E.
Douglas & Grant .. .. Dunnikier Foundry, Kirkcaldy, N B
Drysdale & Co . .. .. Bon Accord Engine Works, Glasgow
Farmer, Jas., & Sons .. .. Salford, Manchester
Farmer, Robey, Brown & Co. . Trent Foundry, Gainsborough
Foster, W., & Co., Limited .. Lincoln
Fowler, J., & Co . .. .. Leeds
Galloway, W. & J., & Sons .. Manchester
Garrett, R., & Sons . Leiston Works, Suffolk
Goodfellow & Matthews . Hyde, near Manchester
Grange Iron Co. Limited .. Durham
Hanson, Wm. .. .. Quebec Works, Bradford
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Hathorn, Davey & Co. .. .. Leeds

Engines (Stationary).—Continued.
Heenan & Froude . . Manchester
Herbert & Law .. .. Edinburgh
Hick, Hargreaves & Co .. . Soho Ironworks, Bolton
Hindley, E. S. . .. .. Bourton, Dorset
Holborow & Co . Dodbridge Ironworks, Stroud
Hornsby, R., & Sons, Limited Grantham
Hunter & English . Bow, E
Iron Foundry & Engineering Co Newport, Monmouthshire
Jessop, J., & Son .. Leicester
Lowes Engineering Co., Ltd., The Whitehaven
Machinery & Hardware Co., Ltd 147, Queen Victoria Street, E.C
Manlove, Alliott, Fryer & Co .. Nottingham
Marshall, Sons & Co, Limited . Gainsborough
McCulloch, T., & Sons . Kilmarnock
Moreland, Richard, & Son . 3, Old Street, E.C.
Musgrave, J., & Sons . Bolton
Neill, Wm., & Son. . 96, Helen's Junction, Lancashire
New, D., & Co .. . 18, Devonshire Chambers, E.C
Norman, J. & Co .. .. Aigburth Engine Works, Glasgow
Ormerod, Grierson & Co. . Hulme, Manchester
Paul, M., & Co. . Dumbarton
Peckett, Thomas . .. Atlas Engine Works, Bristol
Piggott, T., & Co. . Springhill, Birmingham
Ransomes, Sims & Jefferies, Ltd. Ipswich
Robey & Co .. . . Lincoln
Roger, R., & Co . Stockton-on-Tees
Rose, Downs & Thompson . Old Foundry, Hull
Russell, Geo., & Co . Motherwell, near Glasgow
Ruston, Proctor & Co . Sheaf Ironworks, Lincoln
Savile Street Foundry and Engineering Co, Limited . Sheffield
Shanks, Alexander, & Son . Dens Ironworks, Arbroath
Smedley Brothers . Eagle Ironworks, Belper
Tangyes Limited . Cornwall Works, Birmingham
Taylor & Challen . Birmingham
Tyler, H., & Co . 84 & 85, Upper Whitecross Street, E.C
Walker Brothers . Pagefield Ironworks, Wigan
Walker, T., & Co . Leeds
Whitmore & Binyon . 98, Mark Lane, E.C
Williams & Robinson . Thames Ditton, Surrey
Wilson, Alex., & Co . Vauxhall Ironworks, Wandsworth Road, S.W

Engines (Traction).
Aveling & Porter . Rochester
Burrell, C., & Sons, Limited Thetford
Clayton & Shuttleworth Lincoln
Foster, Wm., & Co., Limited Lincoln
Fowler, John, & Co Leeds
Marshall, Sons & Co Gainsborough
Reading Ironworks Co., Ltd. Reading

Engravers, Mechanical, &c.
Hare & Co 31, Essex Street, Strand
Rimbault, J. H 30, Maiden Lane, W.C

Excavators.
Bruce & Batho . 9, Victoria Chambers, Westminster, S W
Chaplin, Alex., & Co Glasgow
Fleming & Ferguson Paisley, N B
Priestman Brothers 51, Queen Victoria Street, E.C
Rose, Downs & Thompson Hull
Ruston, Proctor & Co Sheaf Ironworks, Lincoln
Schram Richard, & Co 9, Northumberland Street, W C

Fans and Blowers.
Allday, Wm., Sons, & Co . Birmingham
Capell, R. A
Donald, J., & Sons 42, Cadogan Street, Glasgow
Donkin, B., & Co . Bermondsey, S E.
Drysdale & Co . Bon Accord Engine Works, Glasgow
Grange Iron Co., Limited Durham
McCulloch, T., & Sons Kilmarnock
Savile Street Foundry and Engineering Co, Limited . Sheffield
Selig, Sonnenthal & Co 85, Queen Victoria Street, E.C.
Schiels, C., & Co . 2 Clarence Buildings, Manchester
Thwaites Brothers . Vulcan Ironworks, Bradford
Union Engineering Co Booth Street, Manchester
Walker Brothers Wigan

Feed-Water Heaters.
British Gas Engine & Engineering Co 11, Queen Victoria Street, E.C
Savile Street Foundry and Engineering Co, Limited . Sheffield
Sterne, L., & Co., Limited . Crown Ironworks, Glasgow
Tangyes Limited . Cornwall Works, Birmingham
Taylor & Challen . Derwent Foundry, Birmingham
Wright, Jos., & Co. Tipton, Staffordshire

Fencing.
Dennis, W. F., & Co 101, Leadenhall Street, E.C

Files and File Sharpening Apparatus.
Bedford, J., & Sons . Lion Works, Sheffield
Jowitt, T., & Sons Sheffield
Tilghman Patent Sand Blast Co., Sheffield

Filtering Apparatus.
Halliday, J., & Co .. . Water Street, Newtown, Manchester
Fulsometer Engineering Co .. Nine Elms, S W.

Filter Presses.
Klein, Schanzlin, & Becker . Frankenthal (Rheinpfalz), Germany

Firebars.
Patent Diagonal Rocking Firebar Co. . .. 290, Gresham House, E.C.

Fire Clay Goods.
Farnley Iron Co Farnley, near Leeds
Glenboig Union Fire Clay Co, The Glasgow
Kershaw & Pole . 2, Fen Court, Fenchurch St., E.C
Lowood, J. Grayson, & Co. . 80, Attercliffe Road, Sheffield

Fire Engines.
Morris, John .. Salford, Manchester
Rose, W., & Co . Deansgate, Manchester
Worthington Pumping Engine Co. 114, Queen Victoria Street, E.C.

Floor Cloth Machinery.
Farmer, Jas., & Sons Salford, Manchester
Landale, James .. . Kirkcaldy, N B.
Summers, T. & W Gloucester

Forges (Portable).
Thwaites Brothers .. Vulcan Ironworks, Bradford

Forgings (Iron and Steel).
Askham Bros. & Wilson, Ltd. . Sheffield
Beardmore, J. & W Glasgow
Bessemer, Henry, & Co., Limited Sheffield
Brown, Bailey, Dixon & Co. Sheffield
Clarke's Crank Co . Lincoln
Glasgow Hydraulic Forge Co Sentinel Works, Polmadie, Glasgow
Goodfellow & Matthews Hyde, near Manchester
Hill & Smith . Brierley Hill Ironworks, near Dudley
Ibbotson Brothers & Co., Ltd.. Sheffield
Jackson, P. R., & Co. . . Salford Rolling Mills, Manchester
Jessop, Wm., & Sons . Sheffield [ter
Kirkstall Forge Co . Near Leeds
Landore Siemens Steel Co . Landore, South Wales
Leeds Forge Co., Limited . Leeds
Mersey Forge, Limited, The Liverpool
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury
Osborne, S., & Co . Sheffield
Savile Street Foundry and Engineering Co., Limited.. . Sheffield
Spencer, J., & Son. . Newcastle-on-Tyne
Staffordshire Wheel & Axle Co., Limited . . Springhill, Birmingham
Stanners Close's Steel Co . Wednesbury, via Darlington
Steel Co. of Scotland, The .. Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Furnace Fittings.
Galloway, W. & J., & Sons .. Manchester
Martin, W. A. & Co. .. .. Pocock Street, S.E.

Galvanised Iron.
Hill & Smith . .. . Tipton, Staffordshire
Lysaght, John, Limited .. .. Bristol
Marswood & Co. . .. Soho, Birmingham

Gas Exhausters.
Donkin, B., & Co. .. Bermondsey, S.E.
Kirsting Brothers .. .. .. 17, Lancaster Avenue, Manchester
Owens, S., & Co . . Whitefriars Street, E.C.
Savile Street Foundry and Engineering Co., Limited, .. Sheffield

Gas Works (Plant for).
Dowson Economic Gas Co., Ltd., 4, Great Queen Street, Westminster S.W.
Grange Iron Co., Limited .. Durham
Hanna, Donald & Wilson . Paisley, N.B.
Horton, J. & W . .. Ince Works, Ennetwick, Manchester
Jenson, C., Son, & Co .. . Darlington [mingham
Miller, H. L. . Birmingham
Piggott, Thos., & Co. .. .. Springhill, Birmingham

Gauge Glasses.
Martin, Guilbert . .. .. 1 & 2, Falcon Street, E.C.
Mouriett, John .. .. .. Nth. Brit. Glass Works, Perth
Tomey & Sons . . Tay Glass Works, Perth, N.B
Tomey, Jos., & Sons . . Manor Glass Works, Aston, Birmingham

Gauges (Pressure).
Dewrance & Co .. .. 135, Great Dover Street, S.E.
Negretti & Zambra . .. Holborn Viaduct, E.C
Salter, Geo., & Co . . West Bromwich
Schaffer & Budenberg . 1, Southgate, Manchester

Gearing.—(See Wheels, Geared.)

Girders.
Ashbury Railway Carriage & Iron Co., Limited . Openshaw, Manchester
Davies Bros. & Co. . .. Crown Ironworks, Wolverhampton
De Bergue & Co., Limited Manchester
Goodwin, James, & Co Motherwell, N B
Jenson, C., Son & Co Darlington
Lea Foundry & Engineering Co Newport, Monmouthshire
Lowes Engineering Co., Ltd., The Whitehaven
Lysaght, John, Limited Bristol
McCulloch, T., & Sons .. .. Kilmarnock
Measures, Bros. & Co Southwark St., S E.
Moreland, Richard, & Son .. 3, Old Street, E.C

Glass Machinery (Plate)
Daglish, R., & Co . St. Helen's, Lancashire
Musgrave, J., & Sons . Bolton

Glazing.
Braby & Son . .. 356, Euston Road, London
Grover & Co., Limited . Britannia Works, Wharf Rd ,N

Governors (Engine).
Blair, George . 32 Queen Street, Glasgow
Duncan Bros (Talbot Electric) 22, Queen Victoria Street, E.C.
McCulloch, T., & Sons Kilmarnock
Murdoch, Wm., & Co . 90, Hope Street, Glasgow
Schaffer & Budenberg . Manchester
Tangyes Limited . Cornwall Works, Birmingham
Whitley Partners . Hunslet Road, Leeds

Grindstones.
Robson, Robert . . 21, Grainger Street, West, Newcastle-on Tyne

Gunpowder Machinery.
Hall, J. & E Dartford, Kent
Hastie, J., & Co . . Kilblain Engine Works, Greenock.
Savile Street Foundry and Engineering Co., Limited . Sheffield
Taylor & Challen . . Birmingham

Hammers (Hydraulic).
Anderson & Gallway .. Cremorne Works, Lot's Road, Chelsea, S.W.
Fielding & Platt . . Gloucester
Twyddell, E. H. .. .. 14, Delahay Street, S.W

Hammers (Power).
Player, W. & J .. . Lionel Street, Birmingham
Thwaites Brothers . Vulcan Ironworks, Bradford

Hammers (Steam).—(See Steam Hammers.)

Heating Apparatus.
Kirting Brothers . .. .. 17, Lancaster Avenue, Manchester
Thames Bank Iron Co, The Upper Ground Street, S.E.

Hematite Pig Iron.
West Cumberland Iron & Steel Co .. .. Workington, Cumberland

Heating Machinery.
Appleby Brothers . .. East Greenwich, S.E.
Balmforth Wm. (Executors of) Rodley, near Leeds
Carrick & Ritchie . .. Edinburgh
Chaplin, Alex., & Co .. .. Cranston Hill Engine Works Glasgow
Coles, H. J . .. .. Sumner Street, S E.
Cowans, Sheldon & Co., Limited St. Nicholas Works, Carlisle
Craig, A. F., & Co . Paisley, N B.
Crowley, John, & Co. .. .. Sheffield
Drysdale & Co .. .. .. Bon Accord Engine Works, Glasgow
Gibbins, R. C., & Co .. Berkley Street, Birmingham
Glover, Walter T., & Co . 25, Booth Street, Manchester
Hunter & English . Bow, E.
Jessop, J., & Son .. .. Leicester
Melville, W. M Kirkcaldy
Pickering, John. .. .. Stockton-on-Tees
Selig, Sonnenthal & Co .. 85, Queen Victoria Street, E.C
Shanks, Alexander, & Son . Dens Ironworks, Arbroath
Tangyes Limited . .. Cornwall Works, Birmingham
Thomas, T., & Sons .. Cardiff
Waygood, R., & Co .. .. Nevington Works, Falmouth Street, S.E.

Hoops for Boiler Fines.
Bolton Iron & Steel Co. .. .. Bolton
Bowling Iron Co., Limited .. Bradford

Hose Pipes.
Morris, John .. .. .. Salford, Manchester
Richards & Co .. .. .. Aberdeen
Rose, W., & Co. .. .. .. Deansgate, Manchester
Worthington Pumping Engine Co. 114, Queen Victoria Street, E.C

Hydraulic Machinery.
Adamson, D., & Co. .. .. Dukinfield, Manchester
Anderson & Gallway .. .. Cremorne Works, Lot's Road, Chelsea, S.W.
Berry, Henry .. .. .. Croydon Works, Hunslet, Leeds
Coles, H. J. . .. .. 89, Sumner Street, S.E.
Cowans, Sheldon & Co., Limited St. Nicholas Works, Carlisle
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Dudgeon, Richard .. .. .. 114, Fenchurch Street, E.C.
Fielding & Platt .. .. .. Gloucester
Hathorn, Davey & Co .. .. Leeds
Middleton, Robert .. .. .. Shepcote Foundry, Leeds
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Rennebottom, J .. .. .. Hunslet, Leeds
Rose, Downs & Thompson .. .. Old Foundry, Hull
Tangyes Limited .. .. Cornwall Works, Birmingham
Twyddell, E. H. .. .. .. 14, Delahay Street, S.W.
Williams, W. L. .. .. .. 2, Westminster Chambers, S.W.

Hydraulic Presses.

Anderson & Gallway .. Cremorne Works, Lot's Road, Chelsea, S W
Bessemer, Henry, & Co., Limited Sheffield [Chelsea, S.W
Cowish & Wardale Gateshead-on-Tyne
Coles, H. J. .. .. 89, Sumner St., Southwark, S.E.
Copeland, J. & Co. Dobbie's Loan, Glasgow
Drysdale & Co. .. Bon Accord Engine Works, Glasgow
Fielding & Platt .. Gloucester [Glasgow
Middleton, Robert .. Sheepscar Foundry, Leeds.
Norman, John, & Co .. Keppochill Engine Works, Glasgow
Rose, Downs & Thompson .. Old Foundry, Hull
Stothert & Pitt, Limited .. Bath
Tangyes Limited .. .. Cornwall Works, Birmingham
Tweddell, R. H. .. 14, Delahay Street, S W
Tyler, H., & Co. .. .. 84, Upper Whitecross St., E.C

Hydraulic Rams.

Blake, John .. .. Accrington, Lancashire

Hydrokinetor.

Weir, G. & J. .. .. 49, Jamaica Street, Glasgow

Ice Making Machines.

Pigott, T., & Co. .. .. Springhill, Birmingham

India Rubber Goods.

Anans, Geo., & Co. Newcastle-on-Tyne
Harburg India Rubber Comb Co. 128, London Wall, E.C
India Rubber, Gutta Percha & Telegraph Works Co., Limited Silvertown, Essex
Maclellan, George, & Co. Glasgow Rubber Works, Glasgow
North British Rubber Co, Ltd Edinburgh
Star Rubber Co., The .. . 151, West Regent St., Glasgow

Indicators (Steam Engine).

Hannan & Buchanan . 75, Robertson Street, Glasgow
Taits & Carlton (Stroudley's Speed) 63, Queen Victoria Street, E.C.

Injectors.

Donald, J., & Son . 42, Cadogan Street, Glasgow
Fairburn & Hall .. .. 68 Royal Exchange, Manchester
Gresham & Craven Manchester
Hancock Inspirator Co . 108, Upper Thames St., E C
Holden & Brooke .. 8t, Simon Works, Salford
Körting Brothers .. 17 Lancaster Avenue, Manchester
Madan, C S. 21, Mansfield Chambers, St. Anne's Square, Manchester
Manlove, Alliott, Fryer & Co Nottingham
Patent Exhaust Steam Injector Co., Limited 4, St. Ann s Square, Manchester
Schaffer & Budenburg . 8t Mary Street, Manchester

Insurance Companies.

Employers' Liability Assurance Corporation, Limited 84 & 85, King William Street, E C
London Mutual Boiler Insurance Co, Limited .. 17, Queen Victoria Street, E C

Iron and Steel Works (Plant for).

Adamson, D., & Co. Dukinfield, Manchester
Davey, Bros., Limited Sheffield
Galloway, W. & J., & Sons Manchester
Goodwin, James, & Co Ardrossan N B
McCulloch, T., & Sons Kilmarnock
Tweedales Bros. Bradford
Walker Bros. Wigan
Walker, T., & Co Leeds
Whitwell, W (Stoves) Stockton-on Tees

Iron Buildings.

Davies Brothers & Co . Crown Iron Works, Wolverhampton
Davies, M H Grange Rd., Bermondsey S.E.
Dixon, J. Windsor Ironworks, Liverpool
Lysaght, John, Limited . Bristol
Macfarlane, Walter, & Co Possil Park, Glasgow
Morewood & Co Soho, Birmingham
Morton, F., & Co., Limited Naylor St Ironworks, Liverpool

Iron Joists (Rolled).

Measures Bros & Co . Southwark Street, S E
Shelton Bar Iron Co . Stoke-on Trent, and Cannon Street, London, E.C

Iron Merchants.

Beeston, John, & Son 40e, St. Mary s Gate, Derby

Jacks (Lifting).

Dudgeon, Richard 114, Fenchurch Street, E C
Gibbins, R. C., & Co Berkley St. Birmingham
Pickering, John Stockton-on-Tees
Selig, Sonnenthal & Co . 85, Queen Victoria Street, E.C
Shirlaw, A., & Co. Berkley Street, Birmingham
Tangyes Limited Cornwall Works, Birmingham

Keys and Pins.

Smith, H Ford Seddon St., Salford, Manchester

Lamps.

Barnett & Foster . 35a, Eagle Wharf Road, N
Wells, A. C., & Co. . Withy Grove, Manchester

Launches and Yachts.

Burnet, L., & Co .. .. Govan, Glasgow
Chaplin, Alex., & Co .. Cranston Hill Engine Works, Birkenhead [Glasgow
Cochran & Co. .
Cran, J. & Co . . Albert Engine Works, Leith
Dos Vignes, G F G . Chertsey
Edwards & Symes Wharf Rd., Cubitt Town, E.
Forrestt & Son . Limehouse, E.
Manns, Donald & Wilson Paisley, N B.
Hayes, Ed . . Stony Stratford
Kerr, Stuart & Co . 20, Bucklersbury, E C
Miller, Tupp & Bouse Middle Mall, Hammersmith
Paul, M. & Co . . Levenford Works, Dumbarton
Rose & Duncan . . Whitefield Works, Glasgow
Thornycroft, J. I., & Co Chiswick, W
Vosper & Co . Broad Street, Portsmouth
Yarrow & Co Poplar, E.

Laundry Machines.

Manlove, Alliott, Fryer & Co, Nottingham

Lead Refiners and Merchants.

Holman, Rogers, Michell & Co St. Helen's, Lancashire

Leather Machinery.

Drysdale & Co .. .. .. Bon Accord Engine Works,
Stothert & Pitt, Limited . Bath [Glasgow

Lifts.

Coles, H. J .. .. 89, Sumner Street, S E.
Drysdale & Co . . Bon Accord Engine Works, Glasgow
Gibbins, R. C., & Co. .. Berkley St, Birmingham
Hanson, W . .. Bradford
Hunter & English . .. Bow, E.
Pickering, John. .. Stockton-on Tees
Thomas, T., & Sons . Cardiff
Waygood, E., & Co. . Falmouth Road, S.E.

Linoleum Machinery.—(See Floor Cloth Machinery.)

Lithographers.

Kell, Thos., & Son.. . 40 King Street, Covent Garden, W.C.

Locomotive Details.

Storey, L., & Sons .. . Knott Mill, Manchester

Locomotive Engines.—(See Engines, Locomotive.)

Lubricants and Oils.

Bell, J. .. .. .. Asbestos Works, Southwark, S E
Blyth's American Lubricating Cream .. .. 23, Brunswick St., Liverpool
Bradford, J., & Sons .. .. Liverpool
Crane, P. Muir, & Co., ... Bank Street, Manchester
Engelhart & Co. . 70 & 71, Bishopsgate St., E.C.
Fleming, A. B., & Co., Limited 15, Whitefriars Street, E.C.
Price's Patent Candle Co., Ltd. Battersea, S.W
Rowland & Co. .. .. .. 7, Idol Lane, E.C.
Wilson, J. Veitch, & Co. .. Glasgow

Lubricators.

Blake, J . . Accrington, Lancashire
Dewrance & Co. .. .. 123, Great Dover Street, S.E.
Foster, Edward, & Son .. Halifax
Körting Brothers . .. 17, Lancaster Avenue, Man
Nettlefolds, Limited . Birmingham [chester
Tyler Brothers . .. 19, Gt. George St., Westminster
Whitehouse & Co . . Tipton Hall Chain Works, Staffordshire

Machine Tools.

Anderson & Gallway . . Cremorne Works, Lot s Road, Chelsea, S W
Archdale, Jas., & Co. .. Leeds.an Street, Birmingham
Askham Bros. & Wilson, Ltd. .. Sheffield
Asquith, W . . Highrood Well Works, Halifax
Barlow, E. B., & Co. Cornbrook Works, Manchester
Beckwith, R., & Co. Sunderland
Berry, F., & Sons Oaklerdale Ironworks, Sowerby Bridge
Berry, H. . .. Croggon Works, Hunslet, Leeds
Booth, Geo, & Co . Halifax
Butterfield, F. & J., & Co. . Keighley, Yorkshire
Cameron, John .. Oldfield Road Ironworks, Salford
Churchill, C., & Co Cross Street, Finsbury, E.C.
Cowley, John, & Son . Hyde, near Manchester
Craig & Donald Johnstone, near Glasgow
Davis & Primrose Rhea Ironworks, Bangor Road, Leith, N B
De Bergue & Co, Limited Manchester
Dron & Lawson Cranston Hill Tool Works, Glasgow
Earnshaw, A., & Co Crown Works, Booth Town, Halifax
Fielding & Platt Gloucester
Galloway, W. & J., & Sons Manchester
Hargens Limited .. .. Albion Ironworks, Aberdeen
Harvey, Robert, & Co Park Grove Ironworks, Glasgow
Heap, Joshua, & Co., Limited Ashton-under Lyne
Kendall & Gent Victoria Works, Manchester
Laing, J., & Sons Johnstone, N B.
Lee & Hunt . . Arkwright Works, Manchester
London Bros Rothwell Street, Glasgow
Machinery & Hardware Co, Ltd 147 Queen Victoria Street, E.C
McArthur, A., & Son Johnston N B
Muir Wm., & Co. Sherbourne Street, Manchester
New, D., & Co . 15, Devonshire Chambers, E.C
Pitt Bros . . Yorkshire Machine Tool Works, Liversedge
Pollock, Macnab, & Highgate Shettlestone, Glasgow
Rushworth & Co . Keworthy Bridge, Yorkshire
Scott Bros West Mount Ironworks, Halifax
Scriven & Co. . Leeds Old Foundry, Marsh Lane, Leeds
Selig, Sonnenthal & Co. 85, Queen Victoria Street, E.C.
Shepherd, Hill & Co Leeds
Shirlaw, A., & Co Suffolk Works, Birmingham
Smith & Coventry Orchell Lane, Salford, Manchester
Smith & Willshaw Halifax
Tangyes Machine Tool Co., Ltd. Soho, Birmingham
Tweddell, R. H . . 14, Delahay Street, S W
Widdowson J H Ordsall Lane, Salford
Winn, Charles, & Co. .. Granville Street, Birmingham

Maize Dressing Machinery.

Copeland, J., & Co Dobbie's Loan, Glasgow
Norman, John, & Co. Keppochill Engine Works, Glasgow

Mathematical Instruments. Makers.

Archbutt, J. & W. E. .. Westminster Bridge Road, Lambeth, S W
Negretti & Zambra Holborn Viaduct E C
Stanley, W. F . . Great Turnstile, Holborn, W C

Mattresses (Spring).

Morris, John . Salford, Manchester

Metals (Phosphor, Alloys, &c.).

Billington & Newton Longport, Staffordshire
Cockshott & Jowett 142, Thornton Road, Bradford
Dick, Alex. 110, Cannon Street, E.C
Evans, James, & Co. .. Gaythorn, Manchester
Hughes, J. & J Woodcock Street, Birmingham
Phosphor Bronze Co., Limited . Sumner Street, S.E.

Meters.

Manchester Water Meter Co, Limited . Ardwick, Manchester
Worthington Pumping Engine Co 114 Queen Victoria Street, E.C

Mill Gearing, Shafting, &c.

Askham Bros. & Wilson, Ltd Sheffield
Bessemer, Henry, & Co., Limited Sheffield
Bodley, Bros., & Co Exeter
Brown, Bayley, Dixon & Co Sheffield
Buckley & Taylor Castle Ironworks, Oldham
Forsyth, Miller & Co Mile End, Glasgow
Goodfellow & Matthews Hyde, near Manchester
Hawthorn, R & W Newcastle-on Tyne
Hick, Hargreaves & Co Soho Ironworks, Bolton
Mind, H., & Co Nottingham
Jackson, P. R., & Co. Salford Rolling Mills, Salford
Kirkstall Forge Co Leeds
McCulloch, T., & Sons . Kilmarnock
Musgrave, John, & Sons Bolton
Savile Street Foundry and Engineering Co, Limited . Sheffield
Smith, Parfrey & Hitchings Buckingham Palace Rd., S W
Staffordshire Wheel & Axle Co Spring Hill, Birmingham
Taylor & Challen Derwent Foundry, Birmingham
Whitmore & Binyon 28, Mark Lane, E C.
Yates & Co. . Sheaf Works, Hunslet Road, Leeds

Mill Machinery (Flour, Corn, and Rice).

Clayton & Shuttleworth Lincoln
Copeland, J., & Co. . Dobbie Loan, Glasgow
Herbert & Law . Edinburgh
Hunter & English Bow, E
Landale, James Kirkcaldy N B
Marshall, Sons & Co., Limited Gainsborough
McCulloch, T., & Son Kilmarnock
Norman, J., & Co Keppochill Engine Works,
Ransomes, Head, & Jefferies Ipswich [Glasgow
Ruston, Proctor, & Co Lincoln
Whitmore & Binyon . 28, Mark Lane, E C

Mills (Paint, Oil, Mortar, &c.).

Butters Brothers Lambhill Street, Glasgow
Follows & Bate, Limited (Paint) Manchester
Rose, Downs, & Thompson Hull
Selig, Sonnenthal & Co . 85, Queen Victoria Street, E.C
Spencer & Co Malkeham, Wilts
Wilson, John H., & Co. . Sandhills, Liverpool

Mining Machinery.

Askham Bros. & Wilson, Ltd. .. Sheffield
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Clay Cross Co. Clay Cross, near Chesterfield
Daglish, R. & Co St. Helens, Lanc
Hadborn, Davey & Co. . Leeds
Jordan, T. B., Son & Commans 62, Gracechurch Street, E.C.
McCulloch, T., & Sons . Kilmarnock
Neey & Co. .. .. Lincoln
Ruston, Proctor & Co. . Lincoln
Schram, Richard, & Co. . 9, Northumberland St., W C
Tangyes Limited . Cornwall Works, Birmingham
Walker, Bros. . Wigan

Moulding Machines.

Whittaker, Wm., & Co .. Oldham

Non-Conducting Compositions.

Anderson, D., & Son, Limited Lagan Felt Works Belfast
Bell, J. .. Asbestos Works, South wark, S E
Haskin, A., & Co . 31, Lime Street, E C
Keenan, M Armagh Works, Tredegar Wks. N Bow, E
Leroy, F., & Co. . . . Gray Street, Commercial Rd., E

Nuts (Finished).

Mercer, Ed. . .. Hollinwood, Manchester

Oils.—(See Lubricants.)

Oil Cans.

Kaye, Jos., & Co. . .. Bank Works, Kirkstall, Leeds

Oil Distilling Plant.

Copeland, J., & Co Dobbie's Loan, Glasgow
Norman, John, & Co. Keppochill Engine Works, Glasgow

Oil Mill Machinery.

Pigott, Thos., & Co Birmingham
Rose, Downs & Thompson Old Foundry, Hull
Rowlandson, W 122, Boundary St., Liverpool
Tangyes Limited .. Cornwall Works, Birmingham

Packing (Engine).

Beldam Packing & Rubber Co 77, Gracechurch Street, E.C
Bell, John . Asbestos Works, Southwark
Binney & Son . Catherine St., City Road, E.C.
Lindsay, R. B., & Co Plantation Quay (West) Glasgow
Mead, P. M., & Co. 223b, Kennington Road, S E
Turk & Co., Limited 116, Cannon Street, E.C
United Asbestos Co., Ltd., The 161, Queen Victoria Street, E.C

Paints.

Bagnoine & Co 7 Idol Lane, Great Tower St.
United Asbestos Co, Limited 161, Queen Victoria Street, E.C.

Paper.

Hodgkinson & Co .

Paper Making Machinery.

Donkin, B., & Co Bermondsey, S E
Douglas & Grant Kirkcaldy, N B

Patent Agents.

Alexander, E P. .. 36, Southampton Buildings, W C
Allison, Brothers . 52 Chancery Lane, W C.
Brewer & Jenson .. 53, Chancery Lane, W C
Brookes, Wm. 55 & 56, Chancery Lane, W C
Craven, T E., & Son 24, Victoria Chambers, South Parade, Leeds
Harris & Mills 23, Southampton Buildings, W C
Horn & Son 172, Strand, W C
Inventors Patent Right Association, Limited 21, Cockspur Street, S W
Phillips & Leigh 22, Southampton Buildings, Chancery Lane, W C
Redfern, G F .. 4, South Street, Finsbury, E.C
Rogers, F M 21 Finsbury Pavement, E C
Thompson & Boult 6 Lord Street, Liverpool
Thomson, W. B., M., & Co 95, Buchanan Street, Glasgow
Vaughan & Son 57, Chancery Lane, W C
Wise, W Lloyd . .. 46, Lincoln s Inn Fields, W C

Patterns.

Ormerod, Grierson & Co Manchester

Permanent Way.

Askham Bros. & Wilson, Ltd. Sheffield
Dick, Kerr & Co 101, Leadenhall Street, E.C
Hartley & Arnoux Brothers Stoke-on-Trent
Ince Foundry & Engineering Co. Newport, Monmouthshire
Kerr, Stuart & Co 20 Bucklersbury, E.C
Railway Sleeper Supply Co, The 17 Gracechurch St. London
Thomson & Browning 3, Victoria Street, E C

Pig Iron Breakers.

Evans, J., & Co Trumpet Street, Manchester

Pile Drivers.

Gibbins, R. C., & Co Berkley Street, Birmingham

Piles.

Goodwin, James, & Co. Ardrossan, N B
Le Grand & Sutcliff . 100, Bunhill Row, E.C.

Pipe Founders.

Clay Cross Co Clay Cross, near Chesterfield
Ince Foundry & Engineering Co Newport, Monmouthshire

Pipe (Drain) Making Machinery.

Clayton, Howlett & Venables Harrow Road, W

Pipes (Sanitary).

Doulton & Co. Lambeth, S E
Farnley Iron Co., Limited Farnley, near Leeds
Glenboig Union Fire Clay Co, The Glasgow

Pistons and Piston Rings.

Atkins & Co. . Special Tool Works, Stanley Street, Sheffield
Bates, Timothy, & Co Sowerby Bridge
Jackson, P. R., & Co Salford Rolling Mills, Manchester
Lockwood & Carlisle Eagle Foundry, Park, Sheffield

Plates (Iron and Steel).

Beardmore, J. & W Glasgow
Brown, Bayley, Dixon & Co Sheffield
Jessop, Wm., & Sons, Limited Sheffield
Landore Siemens-Steel Co, The Landore, South Wales
Leeds Forge Co., Limited Leeds
Shelton Bar Iron Co Stoke-on Trent, and Cannon Street, London, E C
Steel Co of Scotland, Limited Glasgow
West Cumberland Iron & Steel Co, Limited Workington

Portable Engines.—(See Engines, Portable.)

Portable Railways.—(See Railways, Portable.)

Pottery and Encaustic Tile Machinery.

Bodley Brothers & Co Exeter
Boulton, W Burslem, Staffordshire

Presses (Hydraulic).—(See Hydraulic Presses.)

Printing Machinery for Textile Fabrics.

Farmer, Jas., & Sons . Salford

Propellers.

Jackson, P. R., & Co . Salford Rolling Mills, Manchester
Ross & Duncan Glasgow [ter
Savile Street Foundry and Engineering Co, Limited Sheffield

Pulley Blocks.

Crowley, John, & Co Sheffield
Pickering John Stockton-on Tees
Selig, Sonnenthal & Co 85, Queen Victoria Street, E.C
Tangyes Limited Birmingham
Thomson, Wm Kinning Park, Glasgow

Pulleys (Cast Iron).

Bagshaw, J. & Sons . Batley, Yorkshire
Bodley Brothers & Co. Exeter
Buckley & Taylor Castle Iron Works, Oldham
Crowley, Geo Cleckheaton, Yorkshire
Goodfellow & Matthews . .. Hyde, near Manchester
Harper & Co. Albion Ironworks Aberdeen
Jackson, P. R., & Co Salford Rolling Mill, Manchester
Ormerod, Grierson & Co Hulme, Manchester
Reading Ironworks Co. . Reading
Rowlandson, W . 122, Boundary St., Liverpool
Taylor & Challen . .. Derwent Foundry, Birmingham
Yates, J & Co. . .. Munslet, near Leeds

Pulleys (Wrought Iron).

Bagshaw, J. & Sons .. Batley
Crowley, G . . Albion Machine Works, Cheaton
Hall, J. & E. . . Dartford Ironworks, Kent
Rodwell, Clark & Co. Railway Foundry, Leeds
Okes, J C B .. 39, Queen Victoria Street,
Pickering, John. .. . Stockton-on Tees
Reading Ironworks Co, Ltd. Reading

Pumps and Pumping Machinery.

Allen, W H., & Co York Street, Lambeth, S E
Anderson & Gallway Cremorne Works, Lot's Chelsea, S W
Blundell G T, & Co. Limehouse, London
Cameron, John . Old Field Rd Ironworks, Sa
Carrick & Wardle .. .. Gateshead
Chaplin, A., & Co. Glasgow
Clay Cross Co Clay Cross, near Chesterfi
Coalbrookdale Co, Limited Coalbrookdale, Shropshire
Cochrane, Jno Barrhead
Coles, H J Sumner Street, S.E.
Craig, A F, & Co. Paisley, N B
Daglish, R & Co. St. Helen's, Lancashire
Drysdale & Co. Bon Accord Engine W Glasgow
Evans, Jos., & Sons .. Wolverhampton
Fairburn & Hall 63, Royal Exchange, Manch
Fielding & Platt Gloucester
Grange Iron Co, Limited Durham
Manns, Donald & Wilson Paisley
Hanson, Wm Bradford
Harvey, Robert, & Co Park Grove Ironworks, Gla
Hathorn, Davey & Co. Leeds
Hatton, J Coventry
Hett, C L. Ancholme Foundry, Brigg
Hunter & English Bow, E
Isler C & Co 98, Southwark Street, S E
Klein, Schanzlin, & Becker Frankenthal (Rheinpfalz) many
Le Grand & Sutcliff 100, Bunhill Row, E.C
Loudon, Bros. Bothwell Street, Glasgow
Lowes Engineering Co., Ltd., The Whitehaven
Mather & Platt . . Manchester
McCulloch, T., & Sons . Kilmarnock
Moreland, Richard, & Son 3, Old Street, E.C
Neill, W., & Son St. Helen s Junction, Lanca
New, D., & Co 15 Devonshire Chambers,
Okes, J C B. 39, Queen Victoria Street,
Owens, S., & Co Whitefriars Street, E.C
Pearn, Frank, & Co Manchester
Pigott, Thos. & Co Birmingham
Pulsometer Engineering Co, Ltd. Nine Elms, S W
Ramsbottom, Jno. Seymor Road, Leeds
Ruston, Proctor, & Co Shead Ironworks, Lincoln
Seattle Street Foundry and Engineering Co, Limited Sheffield
Selig, Sonnenthal & Co 85, Queen Victoria Street,
Shanks, Alexander, & Son Dens Ironworks, Arbroath
Simpson & Co Pimlico, London
Stannah, J 20, Southwark Bridge Rd, Bath
Stothert & Pitt, Limited Bath
Tangyes Limited . Cornwall Works, Birming
Taylor & Challen Birmingham
Thwaites Brothers . Vulcan Ironworks, Bradfo
Tweddell, R. H 14, Delahay Street, S W
Tyler, H., & Co 84, Upper Whitecross St.,
Westinghouse Brake Co, Ltd. York Road, King s Cross,
Wilson, Alex., & Co Vauxhall Ironworks, Wworth Road, S W
Wilson, John H., & Co Sandhills, Liverpool
Worthington Pumping Engine Co 114, Queen Victoria Street

Pumps (Centrifugal).

Allen, W H., & Co. York St Works, Lambeth
Drysdale & Co Bon Accord Engine W Glasgow
Evans, J., & Sons Wolverhampton
Hathorn, Davey & Co. Leeds
Hett, C L. Whitehaven
Lowes Engineering Co., Ltd., The Whitehaven
New, D., & Co 15 Devonshire Chambers
Owens, S., & Co Whitefriars Street, E.C
Ruston, Proctor & Co Lincoln
Simpson & Co Pimlico, London
Tangyes Limited . Cornwall Works, Birmin

Pumps (Donkey).

Cameron John Oldfield Rd. Ironworks,
Chaplin, Alex. & Co . . Cranston Hill Engine Glasgow
Coalbrookdale Co, Limited Coalbrookdale Staffordsl
Cochrane, John Barrhead, N B.
Coles, H J 89, Sumner St., Southwark
Hanson, W Queen's Works, Bradford
Hathorn, Davey & Co. Leeds
Hatton, J Coventry
London Brothers Bell Street, Glasgow
Lowes Engineering Co., Ltd., The Whitehaven
McCulloch, T., & Sons Kilmarnock
New, D & Co . . 15, Devonshire Chambers
Okes, J C B. 39, Queen Victoria Street
Owens, S., & Co Whitefriars Street, E.C
Roger, R & Co Stockton-on Tees
Stannah, J 29 Southwark Bridge Rd
Tangyes Limited Cornwall Works, Birming
Wilson, Alex., & Co Vauxhall Ironworks, Wworth Road, S W
Wilson, John H., & Co Sandhills Liverpool

Punching and Shearing Machines.

Anderson & Gallwey Cremorne Works, Lot s Chelsea, S W
Beckwith, R. & Co Sunderland
Berry F & Sons . Calderdale Ironworks, Sa
Fielding & Platt Gloucester
Tweddell, R. H .. . 14, Delahay Street, S W

Railway Agents.

Oldham Brothers 110, Cannon Street, E.C

Railway and Contractors' Plant.

Askham Bros. & Wilson, Ltd Sheffield
Beeston, John & Son 40e St Mary s Gate, De
Brown Bayley, Dixon & Co Sheffield
Chaplin, Alex., & Co Cranston Hill Engine Glasgow
Darlington Steel & Iron Co., Ltd. 5, Victoria St., Westm S.W
Dick, Kerr & Co 101, Leadenhall Street,
Goodwin, Jas., & Co Ardrossan, N B
Hadfield s Steel Foundry Co Attercliffe, Sheffield
Hartley & Arnoux Brothers Stoke-on Trent
Janson, C., Son & Co. Darlington
Ince Foundry & Engineering Co Newport, Monmouthshi
Ransomes & Rapier 3 Westminster Chamber
Thomson & Browning 3, Victoria St., Westm
Wood, C . . Tees Ironworks, Middlesbrough Tees

Railways (Portable).

Bagnall, W G Stafford
Dick, Kerr & Co 101 Leadenhall Street,
Fowler, J., & Co Leeds
Hartley & Arnoux Brothers Stoke-on Trent
Kerr, Stuart & Co. 20 Bucklersbury, E.C.
Wood, C . Tees Ironworks, Middlesbrough Tees

Rail Benders.

Bodmer & Jones Deadwood House, Londo

Rail Lifters.

De Bergue & Co, Limited Manchester

Rails (Steel or Iron).

Askham Bros. & Wilson, Ltd Sheffield
Beeston, J., & Son . 40a, St. Mary's Gate, D
Brown Bayley, Dixon, & Co, Ltd. Sheffield
Darlington Steel & Iron Co, Ltd 5, Victoria St., Westm
Hartley & Arnoux Brothers Stoke-on Trent
Shelton Bar Iron Co. Stoke-on Trent, and Street, London, E.C.
Steel Co of Scotland, Limited . Glasgow
West Cumberland Iron & Steel Co. Workington, Cumberla

Reducing Valves.
Ranson, Wm . Quebec Works, Bradford

Refrigerating Machinery.
Copeland J , & Co . Dobbie's Loan, Glasgow
Douglas & Grant . Dunnikier Foundry, Kirkcaldy, N B
Hall, J & E. . Dartford Ironworks, Kent

Rice Dressing Machinery.
Copeland, J., & Co. . Dobbie's Loan, Glasgow
Douglas & Grant . Kirkcaldy, N B
Hunter & English . Bow, E
Landale, James .. . Kirkcaldy, N B
McCulloch, T , & Sons . Kilmarnock
Norman, John, & Co .. Keppochill Engine Works, Glasgow
Sands, Harold . Popham Street, Nottingham
Struthers & Co . 96, Buchanan St , Glasgow

Rivets.—*(See Bolts, Rivets &c)*

Rivetting Machines.
Anderson & Gallway . Cremorne Works, Lots Road, Chelsea S W
Berry Henry . . Croydon Works, Hunslet, Leeds
De Bergue & Co , Limited . Manchester
Drysdale & Co . Bon Accord Engine Works, Glasgow
Fielding & Platt . Gloucester
Gilmar, W F , & Co . Quayside, Newcastle-on Tyne
Harvey, Robert, & Co . Park Grove Ironworks, Glasgow
Higginson & Co . Mersey Street Liverpool
Naw, D , & Co . 15, Devonshire Chambers, E.C
Tweddell, R H . 14, Delahay Street, S W

Rock Drills.
Glover & Mobson . St. James s Road, S E
Hartley & Arnoux Brothers . Stoke-on Trent
Jordan, T B Son, & Commans . 22, Gracechurch St , E C
Schram, Richard, & Co . 9 Northumberland Street W C

Rolling Mills.—*(See Iron & Steel Works, Plant for)*

Rolls (Chilled and Grain).
Perry, Thomas, & Son . Highfield Works, Bilston

Roofs (Iron, Steel and Zinc).
Ashbury Railway Carriage & Iron Co , Limited . Openshaw, Manchester
Davies, Bros , & Co . Crown Ironworks, Wolverhampton
Davies, M H . Grange Road, Bermondsey, S E.
De Bergue, & Co , Limited . Manchester
Dixon, Isaac . Windsor Ironworks, Liverpool
Goodwin, Jas , & Co . Motherwell, N B.
Hanna, Donald & Wilson . Paisley, N B
Mill & Smith . Tipton Staffordshire
Ranson, C , Son & Co . Darlington
Jsca Foundry & Engineering Co . Newport, Monmouthshire
Lewon Engineering Co , Ltd ,The . Whitehaven
Lysaght, J , Limited . St. Vincent Works, Bristol
McCulloch, T , & Sons . Kilmarnock
Morewood & Co . Woodford Ironworks, Soho Birmingham
Morton Francis & Co . Naylor St. Ironworks, Liverpool
Walker Brothers . Wigan

Rope Driving Gear.
Goodfellow & Matthews . Hyde, near Manchester
McCulloch, T , & Sons . Kilmarnock

Ropes (Wire).—*(See Wire Ropes)*

Rustless Iron.
The Bower-Barff Rustless Iron Co , Limited . 23 Queen Victoria Street, E.C

Sanitary Appliances.
Boulton & Co. . Lambeth S E
Winn, Charles, & Co . Granville Street, Birmingham

Shafting.
Bagshaw, J & Sons . Batley, near Leeds
Bessemer, Henry, & Co , Limited . Sheffield
Brown, Bayley, Dixon & Co. . Sheffield
Goodfellow & Matthews . Hyde near Manchester
Harper & Co . Albion Ironworks, Aberdeen
Hick, Hargreaves & Co . Soho Ironworks, Bolton
Hind, H , & Son . Nottingham
Jackson, F. R , & Co . Salford Rolling Mills Manchester
Kirkstall Forge Co . Leeds
McCulloch T & Sons . Kilmarnock
Naw, D , & Co. .. 15 Devonshire Chambers, E.C
Taylor & Challen .. Derwent Foundry, Birmingham
Yates, J , & Co . SheafWorks Hunslet Rd , Leeds

Ship Builders.
Aberoorn Shipbuilding Co . Abbey Works, Paisley, N B
Alley & Macleilan . Glasgow
Ross & Duncan . Glasgow
Simons, W , & Co . Renfrew
Yarrow & Co . Isle of Dogs, E.

Slide Valves.
Thom J . S.Storey Sq , Barrow in Furness

Smiths' Fires.
Thwaites Brothers . Vulcan Ironworks, Bradford

Soda Water Machinery.
Barnett & Foster . 23a, Eagle Wharf Road, N

Speed Indicators.
Selig Sonnenthal & Co . 85 Queen Victoria Street E C
Tuite & Carlton . 83, Queen Victoria Street, E C

Springs.
Ibbotson Brothers & Co Limited . Sheffield
Osborn, Samuel, & Co . Sheffield
Salter, George, & Co . West Bromwich
Spencer, J , & Sons . Newburn Steel Works, Newcastle on Tyne
Sterne L , & Co , Limited . Crown Ironworks, Glasgow
Turton, Thos. & Sons . . Sheaf Works, Sheffield

Steam Hammers.
Booth, Geo , & Co . Halifax
Cochrane, John . Barrhead
Davis & Primrose . . Ritza Ironworks, Bangor Road, Leith, N B
Dary Brothers, Limited . Sheffield
Dudgeon, Richard . 114, Fenchurch Street, E.C
Harvey, Robert, & Co . Park Grove Ironworks, Glasgow
Massey, B & S . Manchester
Musgrave, J , & Sons . Bolton
Pollock, Mannab, & Highgate . Shettleston, Glasgow
Rushworth & Co . Sowerby Bridge, Yorkshire
Savile Street Foundry and Engineering Co , Limited . Sheffield
Thwaites Brothers . Vulcan Ironworks, Bradford
Walker Brothers . Pagefield Ironworks, Wigan
Walker, T , & Co . Leeds

Steam Traps.
Blake, J . Accrington Lancashire
Ranson, W . Quebec Works, Bradford
Lancaster & Tonge . Pendleton, Manchester
Vaughan & Son . West Gorton, Manchester

Steel Makers.
Ashbam Bros. & Wilson, Ltd . Sheffield
Beardmore, J & W . Parkhead Ironworks Glasgow
Bessemer, H , & Co , Limited . Sheffield
Bolton Iron & Steel Co . Bolton
Brown, Bayley, Dixon & Co . Sheffield
Hadfield s Steel Foundry Co . Attercliffe Sheffield
Howell & Co . Sheffield
Ibbotson Bros , & Co , Limited . Sheffield
Jackson, F R., & Co . Salford Rolling Mills, Manchester
Jessop, W , & Sons, Limited . Sheffield
Landore Siemens Steel Co , Ltd . Landore, South Wales
Leeds Forge Co Limited . Leeds
Marsden, Francis . Slavonia Works, Sheffield
Osborn S , & Co . Sheffield
Stanners Close s Steel Co . Wolsingham near Darlington
Steel Co of Scotland, The . 180 Hope Street, Glasgow
Tangyes Limited . Cornwall Works, Birmingham
Turton, T , & Sons . Sheaf Works, Sheffield
West Cumberland Iron and Steel Co . Workington, Cumberland

Steel and Iron Works (Plant for).—*(See Iron and Steel Works)*

Steering Gear.
Donkin & Nichol . Newcastle-on Tyne
Grange Iron Co , Limited . Durham
Lynn, John, & Co . Sunderland
Paul M , & Co . Levenford Works, Dumbarton
Piggott, T , & Co . Springhill, Birmingham
Wilson, J H., & Co. . Sandhills Liverpool

Stokers (Mechanical).
Hodgkinson & Co , Limited . Manchester
Proctor J . Burnley, Lancashire

Stone Breakers.
Baxter, W H , & Co . Albion Street, Leeds
Brinjes & Goodwin . Whitechapel E
Goodwin, Jas , & Co . Motherwell, near Glasgow
Savile Street Foundry & Engineering Co , Limited . Sheffield

Stone Dressing Machinery.
Harper & Co . Albion Ironworks, Aberdeen
Norman John & Co. . Keppochill Engine Works, Glasgow

Stone Merchants.
Endcliffe Co The . 114a Queen Victoria St , E C

Sugar Machinery.
Aitken McNeil & Co . Helen Street, Govan, Glasgow
Clayton, Howlett & Venables . Harrow Road, W
Copeland, J & Co . Dobbie s Loan Glasgow
Davis & Primrose . Ritza Ironworks, Bangor Road, Leith
Harvey, Robert, & Co . Park Grove Ironworks, Glasgow
Landale, James . Kirkcaldy, N B
Manlove, Alliott, Fryer & Co . Nottingham
Norman, John, & Co . Keppochill Engine Works, Glasgow
Piggott, T , & Co . Springhill, Birmingham
Sands, Harold . Popham Street, Nottingham
Struthers & Co . 96, Buchanan St Glasgow

Surface Plates.
Okes, J C R . 39, Queen Victoria Street, E C
Richards G , & Co . Atlantic Works, Broadheath, near Manchester

Tanks.
Bellamy, John . Byng Street, Millwall, E.
Copeland, J , & Co . Dobbie s Loan, Glasgow
Davies Bros & Co. . Crown Ironworks, Wolverhampton
Hanna, Donald & Wilson . Paisley N B
McCulloch, T , & Sons . Kilmarnock
Morewood & Co . Soho, Birmingham
Norman, John, & Co. . Keppochill Engine Works, Glasgow

Tanners and Curriers.
Hepburn & Gale, Limited . Long Lane, Southwark S E
McIntosh, Peter, & Sons . 129a, Stockwell St., Glasgow
Norris, S E & Co . High Street, Shadwell, E
Webb & Son . Slowmarket
White John, & Sons . Bingley, Yorkshire
Wilcock, Mark . . Bowerdy Bridge

Tea Dressing Machinery.
Copeland J , & Co . Dobbie's Loan, Glasgow
Marshall, Sons & Co , Limited . Gainsborough
Struthers & Co .. 96, Buchanan St , Glasgow

Telegraphs (Engine and Steering).
Chadburn & Son . Lord Street, Liverpool

Telegraph Wire and Cables.
Glover, W T , & Co . 25, Booth Street Manchester

Timber Merchants.
Bruce Geo . 11, Leadenhall Street E.C
Keen, J. . 264, Waterloo Bridge Road, S.E

Tools (Hand and Small).
Bedford, J , & Sons .. Lion Works, Sheffield
Chatwin, Thos. . Gt. Tindal St., Birmingham
Churchill, C., & Co . 21, Cross Street, Finsbury, E.C.
Cowley, John, & Son .. Hyde, near Manchester
Gibb, James, & Co . 23, St. Mary Axe, E.C
Heap, Joshua, & Co , Limited . Ashton-under-Lyne
Ibbotson Brothers & Co., Limited . Sheffield
Jowitt, Thos., & Sons . Sheffield
Nettlefolds, Limited . Birmingham
Richards, George, & Co. . . 12, City Road, Manchester
Selig, Sonnenthal & Co. . . 85, Queen Victoria Street, E.C.
Shirlaw, A , & Co. . . Suffolk Works, Birmingham
Smith & Coventry . . Ordsall Lane, Salford, Manchester
Widdowson, J H. .. Ordsall Lane, Manchester

Torpedo Boats.
Hanna, Donald & Wilson . Paisley
Thornycroft, J I , & Co . Chiswick, W.
Yarrow & Co. .. Isle of Dogs, E.

Tramways and Tramway Plant.
Askham Bros. & Wilson, Ltd. . Sheffield
Carrington, W T H. (Wire) . 9 & 11, Fenchurch Street, E.C
Dick, Kerr & Co . 101, Leadenhall Street, E.C.
Hadfield's Steel Foundry Co . Attercliffe, Sheffield
Hartley & Arnoux Brothers . Stoke-on Trent
Kerr, Stuart & Co . 20, Bucklesbury, E C
Savile Street Foundry and Engineering Co , Limited . Sheffield

Tube Cleaners.
Boss, W . . 29, West India Dock Road

Tube Expanders.
Dron & Lawson . . Cranstonhill Tool Works, Glasgow
Dudgeon, Richd . 114, Fenchurch Street, E C
Gibb, James, & Co, . 23, St. Mary Axe, E.C
Selig, Sonnenthal & Co . 85, Queen Victoria Street, E.C
Thomson, Wm . Kinning Park, Glasgow

Tube Making Machinery.
Farmer, Jas , & Sons . Salford, Manchester

Tube Wells.
Isler, C , & Co . 88, Southwark Street, S.E.
Le Grand & Sutcliff . 100, Bunhill Row, E.C

Tubes (Brass).
Birmingham Battery & Metal Co . Birmingham
Munts s Metal Co., Limited . Trench Walls, nr Birmingham

Tubes (Iron and Steel).
Aird, Jos. . Tipton, Staffordshire
Birmingham Battery & Metal Co. . Birmingham
Caledonian Tube Co . Cambridge, near Glasgow
Cralends Cold Drawn Seamless Steel Tube Co., The . Ledsam Street, Birmingham
Donald, J , & Son . 62, Cadogan Street, Glasgow
Eadie, J , & Sons . Clydesdale Tube Works, Ruthergien, near Glasgow
Farmar, Jas , & Sons . Salford
Galloway, W & J , & Sons . Manchester
Hildick & Hildick . Tube Works, Walsall
Howell & Co . Brook Steel Works, Sheffield
Lane, Howard, & Co . 115 & 116, Palmerston Buildings, London E C
Lewis, E, & Sons . Wolverhampton
Lloyd & Lloyd . Birmingham
Marshall, J , & Sons . Glasgow
Mothee, Jas & Co . Cambridge, N H
Russell, Ias , & Sons . Crown Tube Works, Wednesbury
Skidmore, H P . Wednesbury
Spencer, John . 5, Queen Street Place, Cannon Street, E.C
Spencer, J E. & S . Clyde Tube Works, Cambridge
Stewart, A & J . Ickinield Port Rd., Birmingham
Weldless Steel Tube Co

Turbines.
Donkin, B , & Co . Bermondsey, S E
Hanna, Donald & Wilson . Paisley, N B
Hett, C J, . Ancholme Foundry Brigg
King, H J H. . Stroud, Gloucestershire
McKenzie, Thos , & Sons, Ltd . 16, Holborn Viaduct, E C
Schram, Richard, & Co . 9,Northumberland Street, W C
Stothert & Pitt, Limited . Bath

Turnstiles.
Isler C , & Co . 88, Southwark Street, S E.
Le Grand & Sutcliff . 100, Bunhill Row, E.C

Tuyeres.
Newlove, R R , & Co (Water) . Nottingham

Tyres (Railway).
Bessemer H & Co , Limited . Sheffield
Brown, Bailey, Dixon, & Co . Sheffield
Landore Siemens-Steel Co , Ltd. . Landore, South Wales
Leeds Forge Co., Limited . Leeds

Valuers, Engineering.
Kirk, W , Price & Goulty . 32 Queen Victoria Street, E.C

Valves (Gas, Water, &c.).
Alley & Macleilan .. Glasgow
Dewrance, J , & Co , . 126, Great Dover Street, S E.
Donkin, B., & Co . Bermondsey, S E
Duncan Brothers . 33, Queen Victoria Street, E C
Foster, Edward, & Son . Halifax
Hanna, Donald & Wilson . Paisley, N B
Hanson, Wm . Quebec Works, Bradford
Hartley & Sugden, Limited . Halifax
Hunter & English . Bow, London, E.
Owens, S , & Co . Whitefriars Street, E.C
Rhodes, H . 240, Bow Road, E.
Walker, Bros. . Pagefield Ironworks, Wigan

Valves, Safety.
Adams, Thos. (Executors of) . West Gorton, Manchester
Blake, J .. Accrington, Lancashire

Ventilators.
Boyle, R., & Son . 64, Holborn Viaduct, E.C

Vices.
Crampton Brothers .. .. 58, West Bar Green, Sheffield.
Mackrair, W. M. .. . . Sheaf Island Works, Sheffield

Vulcanite.
Winter, F .. .. 138, London Wall, E.C.

Wagon (Railway) Builders.
Ashbury Railway Carriage & Iron Co , Limited . Openshaw, Manchester
Bagnall, W C . Stafford
Falcon Engine & Car Works, Ltd . Loughborough
Metropolitan Railway Carriage & Wagon Co , Limited. . Saltley Works, Birmingham
Midland Railway Carriage and Wagon Co. Limited . Abbey Works, Shrewsbury

Wagons (Tip).
Dick, Kerr & Co, . 101, Leadenhall Street, E.C
Hartley & Arnoux Brothers . Stoke-on Trent

Water Closets.
Winn, Charles, & Co . Granville Street, Birmingham

Water Meters.
Manchester Water Meter Co , Ltd. . Tipping Street, Ardwick, Manchester
Worthington Pumping Engine Co. . 114, Queen Victoria Street, E.C.

Water Purifying Apparatus.
Porter, John Henderson . 1 & 2, Tudor Street, E.C.

Water Wheels.
Aitken, McNeil & Co . Helen Street, Govan, Glasgow
Bodley Brothers & Co .. Exeter
Copeland, J , & Co . Dobbie s Loan, Glasgow
Hett, C J, . Brigg
King, H J H . Stroud, Gloucestershire
Norman, John, & Co. . Keppochill Engine Works, Glasgow
Stothert & Pitt, Limited . Bath

Weighing Machines.
East Ferry Road Engineering Works Co., Limited . Millwall, E.
Hodgson & Stead . Regent Road, Manchester
Ranson, Chas., Son & Co , . Darlington
Pooley, Henry, & Son . Albion Foundry, Liverpool
Salter, G , & Co . West Bromwich
Scott, Jas , & Son . 10, Tibb Lane, Cross Street, Manchester

Well Engineers.
Isler, C , & Co . . 88, Southwark St , London, S E
Le Grand & Sutcliff . 100, Bunhill Row, E.C

Wheels (Geared).
Bodley Brothers & Co . Exeter
Buckley & Taylor . Castle Ironworks, Oldham
Forsyth, Miller & Co . Mile End, Glasgow
Goodfellow & Matthews . Hyde, near Manchester
Haddfield s Steel Foundry Co . Attercliffe, Sheffield
Harper & Co . Albion Ironworks, Aberdeen
Hawthorn, R. & W . Newcastle-on Tyne
Hind, H., & Son . Nottingham
Jackson, F R., & Co . Salford Rolling Mills, Manchester
Manlove, Alliott, Fryer, & Co . Nottingham
McCulloch T , & Sons . Kilmarnock
Musgrave, J , & Sons, Limited . Bolton
Ormerod, Grierson & Co . Hulme Manchester
Parry, Thomas & Son . Highfields Works, Bilston
Rowlandson, W . 132, Boundary St., Liverpool
Smith, Parfrey & Hitchings . Buckingham Palace Rd , S W
Staffordshire Wheel & Axle Co . Springhill, Birmingham

Wheels (Railway).
Ashbury Railway Carriage and Iron Co., Limited . Openshaw, Manchester
Metropolitan Railway Carriage and Wagon Co . Saltley, Birmingham
Midland Railway Carriage and Wagon Co , Limited . Abbey Works Shrewsbury
Staffordshire Wheel & Axle Co , Limited . Springhill, Birmingham

Wheels (Road) and Axles.
Smith, Parfrey & Hitchings .. Buckingham Palace Rd., S W

Whistles (Signal).
Cran, J , & Co. .. Leith

Winches, Steam.—*(See Cranes)*

Wire and Wire Rope Makers.
Birmingham Battery & Metal Co . Birmingham
Bullivant & Co. .. .. .. 72, Mark Lane, London, E C
Cradock, Geo , & Co . Wakefield
Daniels, W F , & Co . 101, Leadenhall Street, E.C
Glover, W T & Co . 25, Booth Street, Manchester
Lane, Howard, & Co . 115 & 116, Palmerston Buildings, London, E.C
Warrington Wire Rope Co . 1d, Gores Plassas, Liverpool

Wire Making Machinery.
Crossley, Geo . Cleckheaton, Yorkshire
Farmer, Jas., & Sons .. Salford, Manchester

Wire Working Machinery.
Farmer, Jas., & Sons . Salford, Manchester

Wire Tramways.
Carrington, W T H . . 9 & 11, Fenchurch Avenue, E.C

Wood Working Machine Makers.
Barr, James . . Kilmarnock
Blake, J . Accrington, Lancashire
Carrick & Ritchie . Waverley Engineering Works, Edinburgh
Hindley, H S . Bourton, Dorset
Marshall, Sons, & Co , Limited . Gainsborough
M'Dowall, John, & Sons . Johnstone, near Glasgow
Massons, A , & Co . Stanley Works, Chelsea
Richards, G , & Co . Atlantic Works, Broadheath, near Manchester
Sands, Harold . Popham Street, Nottingham
Worsam, Samuel, & Co . King's Road. Chelsea, S W

GUN FACTORIES IN FRANCE.

It will be remembered that in the spring of last year a Board of distinguished American artillerists under the presidency of Commodore Simpson, U.S.N., was sent to Europe to gather information respecting existing gun factories, with a view to the establishment in America of manufactories of steel ordnance wherewith to supply the needs of the United States army and navy. The report of the board's visit to England, France, and Russia was published during this summer, and a supplement to the report has now been issued by Lieutenant Jaques, U.S.N., in vol. x. of the Proceedings of the United States Naval Institute, which contains a mass of information of great interest, accompanied with excellent plans and views of the chief places inspected, and altogether furnishes a valuable account of the methods of steel production and gun manufacture carried on in the various countries visited.

In England the Board were permitted to make a minute inspection of the Elswick Works and of the Royal Gun Factories at Woolwich, and further visited most of the important steel works in the country. Passing to France, Lieutenant Jaques deals in considerable detail with the leading steel and ordnance establishments. The great development recently given to the factories engaged in the construction of ordnance in France gives much interest to this portion of the Board's report.

The private companies which manufacture ordnance for the Government are given as follows :

Steel Manufactories producing Steel up to Tubes for 16 cm. Guns.—Jacob Holtz and Co., Unieux, Loire, Marrel Frères, Rive de Gier, Loire ; Société des Aciéries et Forges, Firminy, Loire ; Compagnie des Forges et Aciéries, St. Étienne.

Steel Manufactories producing Steel up to Tubes for 42 cm. Guns.—Henri Schneider and Co., Le Creusôt ; Aciérie de la Marine, St. Chamond.

Private Companies having Gunmaking Plant.—Henri Schneider and Co., Le Creusôt ; Cail and Co., Paris ; Soc. des Forges et Chantiers, Havre, Compagnie de Fives-Lille, Fives-Lille ; Soc. An. de Constructions Navales, Havre ; Aciérie de la Marine, St. Chamond.

Government manufactories for the army comprise the Fonderie de Canons at Bourges, where steel guns of 9 cm., 15 cm., 19 cm., and 24 cm. are made ; the Ateliers de Construction at Tarbes in the Hautes Pyrenées, where steel guns of 9 cm. and 12 cm. are constructed, as well as siege and field gun-carriages ; and the Ateliers de Construction at Puteaux, near Paris, at which place all the steel mountain and field-guns of 8 cm. are made, also siege guns of 12 cm., and Hotchkiss revolving cannon. Gun-carriages, limbers, &c., are made at Government shops at Vernon, Avignon, and Angers.

The artillery establishment at Bourges contains foundry, gun-shops, laboratory, test-rooms, and proof ground. All are well equipped, and the shops well placed and lighted. The steam hammer has a tup of four tons. The parts of the guns are received from Le Creusôt, St. Chamond, and St. Étienne, rough-bored, turned, and tempered, and are machined and assembled here ; 1300 men are actively employed.

The foundry at Ruelle, near Angoulême, has become the principal, if not the only, establishment for the manufacture of the larger guns required for the navy and coast defence. That at Nevers is no longer used, its machinery having been transferred to Ruelle. Three circumstances, Lieutenant Jaques adds, have contributed to the selection of Ruelle—the hydraulic power continuously supplied by the River Touvre, whose waters neither dry up, overflow, nor freeze ; the proximity of special ores producing iron possessing extreme resistance to the action of powder-gas, and the charcoal supplied by the neighbouring forests.

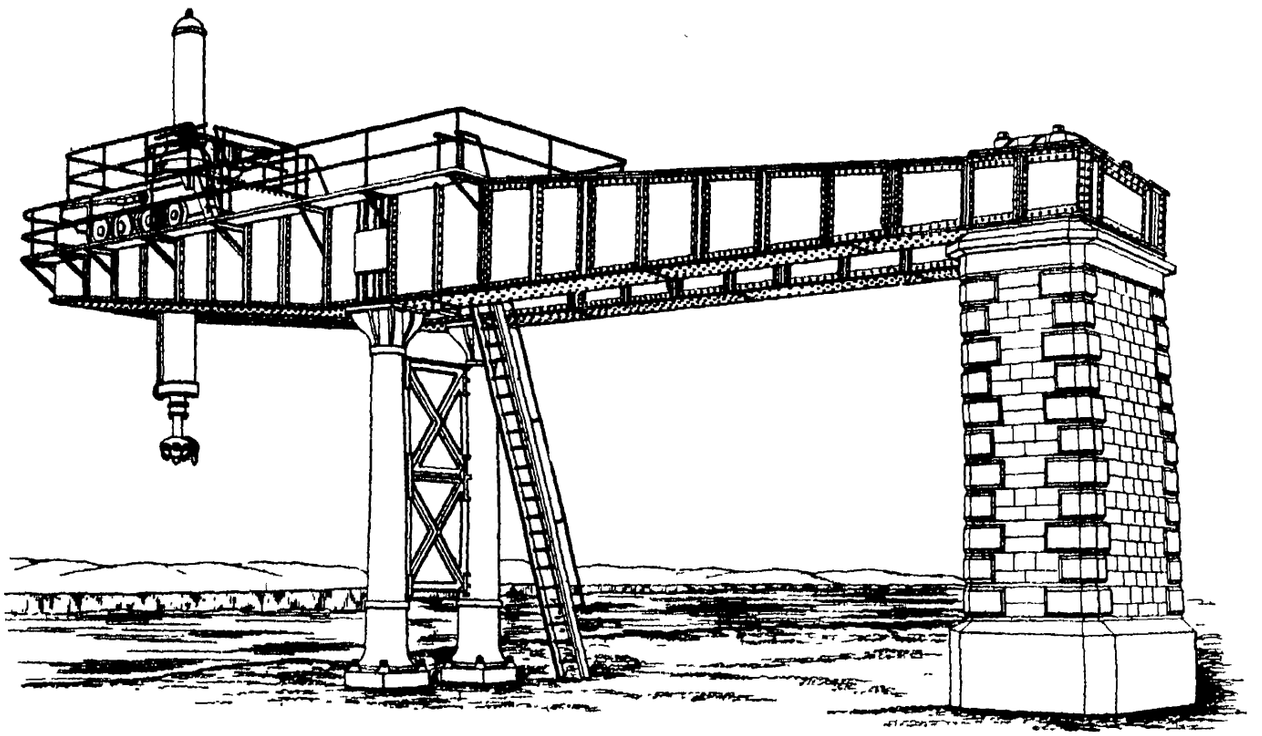


FIG. 1. 100-TON CRANE AT THE RUELLE GUN FACTORY.

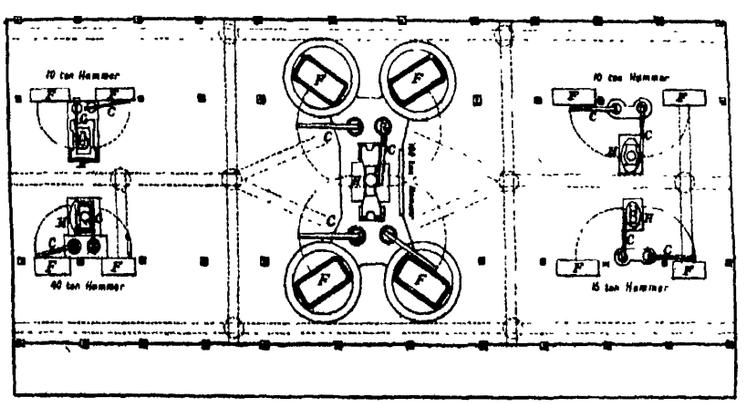


FIG. 2. PLAN OF STEAM HAMMER SHOPS, &C., CREUSÔT.

At the Ruelle foundry all the constructive force of the marine artillery has been concentrated and all the largest guns are made The report of the Foundry Board states that it has the most remarkable collection of tools of the age, designed for guns of 34 cm. and upwards, and having a capacity of handling guns of 160 tons in weight and 60 ft. in length The shop in which these tools are placed is about 450 ft. in length and 131 ft in width, having a height of 85 ft at the centre peak of the roof. At one end is the shrinking pit, in which the gun tube is placed upright to receive the hoops The bottom of this pit is 85 ft. below the floor. It is excavated in a rectangular form, and is divided into four stories, contracting in area as each lower level is reached. At each level the opening can be floored over to accommodate the work of hooping any length of tube. The heating furnaces are on th first level below the floor. The tools already in at the time of the Board's visit were the fol- g, but there is stated to be room for fully a dozen more of similar character. Two turning lathes capable of turning guns 15 m. long. These can be increased in length 10 m Three boring and one rifling machine for ditto. Two smaller boring machines with adjustable connections for turning. Two other machines for breech details, &c. Two movable cranes, one of 100 tons and one of 30 tons.

The 100-ton crane, of which we annex an illustration, Fig. 1, for the transfer of heav barges, was constructed at Fives-Lille in ___

Lieutenant Jaques remarks that the steel works of Marrel Frères at Rive de Gier are well equipped for the manufacture of steel shafting, machinery,

and gun tubes up to 17 cm. There are four steam hammers with tups of from 10 to 25 tons; all are double-acting and have a stroke of 8 ft. The gun tubes are of open-hearth steel, tempered in oil. "After tempering they are bored to the close dimensions required by the French contracts, in many instances to $\frac{3}{1000}$ of a millimetre (.000117 in.) of the finished size." The report of the Board adds, "For tubes and hoops, however, for large guns requiring massive forgings, the supply is limited to the works of St. Chamond and Le Creusôt."

La Compagnie des Hauts-Fourneaux, Forges et Aciéries de la Marine et des Chemins de fer à St. Chamond, is described by Lieut. Jaques as an immense establishment, with a capital of twenty millions of francs, and very extensive shops containing excellent tools. Some very fine turning lathes by Jouffroy, at Vienna, are noticed The forge contains three large hammers with tups of 10, 35, and 80 tons. The largest was constructed at the works at a cost variously estimated from one to two millions of francs. It is double-acting, with a stroke of 18 ft Steam is not used above. The foundation is rock, covered with wood and 800 tons of iron castings, the largest of which weighed 130 tons. Three 28-ton and two 12-ton Pernot furnaces give a capacity for casting an ingot of 100 tons. The Board state that the ingots cast at St. Chamond for the 42 cm. 75-ton gun are of 75 tons weight The tube, after rough boring and turning, weighs about 35 tons. The tempering pit is a large excavation 15 metres deep. At one extremity is the furnace where the tube is placed erect and heated. At the other is a cylindrical excavation reaching to 15 metres below the floor of the pit, where is placed the tank containing 100 tons of colza oil into which the tube when heated is lowered rapidly.

At Le Creusôt,* which are the most important steel works in France, 15,000 men are employed. It comprises coal mines, smelting furnaces foundries, forges, steel works, and construction shops. Advantageously situated in the centre of France, closely connected by rail with the Burgundy and Bourbon districts, united by a private railway to the central canal, which is about 10 kilos. distant, and which gives easy access to the Loire, Saône, and Rhone, it is by its rail and waterways in communication with the Atlantic and Mediterranean, and with all parts of France. About 1867 the Siemens-Martin furnace was introduced and the Bessemer soon followed, accompanied by the fabrication of steel rails and soft steel for the construction of ships as well as material for cannons, to the development and improvement of which Le Creusôt has largely contributed. In 1873 the fabrication of steel tyres was undertaken, and for the manufacture of shafts for large marine engines, and of the parts of guns of great weight, the 80-ton hammer was erected in 1876 and completed in 1877. With this hammer was forged the armour-plates tried at Spezia, and in 1878, plates weighing 65 tons and cast ingots of 120 tons were produced

Under the administration of Messrs Schneider, besides the establishment proper, the company possesses a shipyard and bridge construction shops at Chalons sur Saône, and numerous coal and iron mines, covering 2857 acres, 1048 of which are occupied by buildings and works of various descriptions.

In 1880-81, to meet the production there were consumed 621,000 tons of coal, 200,000 tons of coke, 517,000 tons of ore, 3,600,000 cubic metres of water, 2,800,000 cubic metres of gas. The working capacity of the establishment was 700,000 tons of coal, 200,000 tons of pig iron, 160,000 tons of wrought iron and steel, 30,000 tons of constructed material, represented by bridges, river steamers, marine and stationary engines, locomotives, iron and steel rails, wrought iron and steel for commercial purposes, armour-plates, cannon and gun-carriages.

There are thirteen smelting furnaces, several covered with brick, but the more recently constructed have metal covers of the Scotch type. They are conveniently fed from a platform 38 ft. high and 550 yards long The powerful blowing engines are arranged in three groups. The first comprises three horizontal engines of high speed, the second four vertical direct-acting engines of 200 horse-power each, the third two vertical engines of 250 horse-power each, with air cylinder above the steam; the draught is produced by two chimneys, one of brick, 246 ft. high, the other of iron, 278 ft. high.

The coke employed for fuel is all made at the works from bituminous coal found in the basin of the Loire, mixed with the anthracite of Le Creusôt. The carbonisation is effected in 190 Belgian and thirteen Appolt ovens of eighteen compartments each, and the daily production is about 520 tons of a very dense and glutinous coke, which contains very little sulphur, and explains in part the excellence of the Creusôt irons.

The steel works are represented by three groups of Bessemer converters, seven Siemens furnaces, and two rotary Pernot furnaces. The cranes and engines of the Bessemer plant are actuated by two engines of 40 horse-power each. Two engines developing 2000 horse-power provide the blast. The Siemens furnaces each contain 18 tons, and the Board witnessed the casting of a 45-ton ingot, which was effected in twenty-three minutes.

The most striking feature at Le Creusôt is stated to be the forge, where is assembled an array of steam hammers comprising one 100-ton hammer with a fall of 5 metres, one 40-ton hammer with a fall of 3 metres, one 15-ton hammer with a fall of 3 metres, two 10-ton hammers with a fall of 2½ metres, and one 8-ton hammer with a fall of 2½ metres.

The forge is situated near the steel works, and covers an area of thirty acres. It extends over a distance of more than 550 yards, and comprises steam and hand forges with their accessories, puddling furnaces, a central court for convenience of communication, and rolls for shaping the ingots. The bays that contain these rolls are 330 yards long and 100 yards wide On the right is placed a long line of reverberatory furnaces. In the centre there are twenty rolls run by fifteen engines of over 6000 horse-power. The flywheel of one of these engines is 33 ft. in diameter, and its weight nearly 60 tons. The steam required for these engines is furnished by vertical boilers, and is generated by the surplus heat of the reverberatory furnaces. The reservoir that feeds them and further supplies the forge has a capacity of 300,000 cubic metres. In addition to the installation of steam hammers, there are smaller ones in the bays on each side of the central building. In Fig. 2, on the preceding page, H H are the hammers, F F the furnaces, and C C the cranes.

The construction shops are 1640 ft. long, with an average width of 490 ft, and contain iron and bronze furnaces, hand forges, brassery, steam and other mechanical cranes, hydraulic rivetters and presses, twenty-seven small steam hammers, boring, turning, planing, and adjusting departments, and also include sections set apart for the manufacture of cannon, where the forged parts are machined and assembled. They contain lathes of all sorts capable of making guns up to 100 tons. The hoops for guns are manufactured from solid ingots, those for guns up to 24 cm. are rolled like railway tyres, those for larger calibres being forged on a mandrel. The mode of manufacture is thus described.

By casting the steel in moulds of suitable dimensions, solid cylinders are obtained which are flattened into discs under a hammer. Whilst still warm they are placed under a second hammer, whose face is terminated by a mandrel so placed as to punch in the centre a cylindrical hole. The hoops are then rolled in the tyre rolling machine. Usually the hoops are rough drawn and finished in the rolling machine, but sometimes they are finished under the hammer. During this last operation they are mounted upon an iron mandrel attached to the anvil. Jackets of large size are also manufactured. These are made from solid ingots which are forged and then bored out. The tempering pit is, as at St. Chamond, 15 metres deep, with a furnace at one end and a tank with 100 tons of oil at the other. One side of the upright furnace is constructed as a door made to turn on its hinges. When the tube is raised to the right temperature it is seized by the travelling crane, the door is swung open, and the tube is at once taken to the tank in which it is immersed. All tubes are soaked in oil a second time, but at a temperature below that to which they were raised at the first immersion. This process constitutes the annealing after tempering.

In their report the Board state that the Terrenoire Company have largely produced steel for projectiles and hoops for guns, though the metal has not proved suitable for the inner tubes for large guns. The company claims a speciality in producing steel without blowholes, which requires no subsequent working under the hammer. The Terrenoire steel is produced in Siemens furnaces, and is soft and malleable. Special attention is now being given to the manufacture of large castings, and the best methods of tempering and annealing. Hoops for guns of an interior diameter of 56 cm. are being made.

The following description of the process of casting employed, is taken from the report of the Foundry Board.

In general terms the object of greatest importance in this process is to keep down oxidation in the bath from the commencement of the operation. For this purpose the furnace must be kept as hot as possible, with a good solid body of flame, but there must be only just enough air admitted to produce thorough combustion.

The process requires an initial bath of pig iron, containing 6 to 8 per cent. of manganese. Spiegeleisen is the most convenient form for introducing it, but as a spiegel with precisely this percentage may not be at hand, the bath may be formed by taking a richer spiegel and diluting it with a proper proportion of ordinary pig containing no manganese. The greater part of the bath should be of pig poor in carbon, particularly when highly carbonised materials are to be dissolved. The weight of the initial bath should generally be about 11 per cent. of the whole.

When the bath is completely melted, the refining materials are successively added in small quantities. These are pre-heated and dropped at the deepest part of the hearth in front of the doors. Pre-heating is employed not only to keep the furnace hot, but to save oxidation. The materials used at this period of the operation are chosen with reference to the quality required in the finished product For projectiles the Terrenoire Company generally use Bessemer ingot and rail ends with sinking heads from previous projectile charges. These are all high in carbon, and contain some manganese. The proportion of refining materials to the whole charge averages 78 per cent. As soon as one charge is melted another is added until all are fused, when a series of tests commence. The final additions consist of a special pig (11 per cent of the whole charge) containing 4½ per cent. of silicon and 3½ per cent. of manganese, and also a little ferro-manganese containing 50 or 60 per cent. of manganese. A part of these ingredients is taken up by reaction, which prevents the formation of blowholes, the remainder is left in the metal to impart to it the physical qualities required.

The special pig is charged hot. While it is melting, a marked change takes place in the bath, which up to that time has bubbled about as much as in the ordinary pig and scrap operation. It becomes gradually more and more quiet until its surface is smooth and scarcely broken by small and widely scattered bubbles. When the special pig is nearly all melted, the ferro-manganese is thrown in hot. The casting takes place immediately. The metal runs into the mould without splashing, and no escape of gas is noticeable. Spiegeleisen is used for the initial bath, because the manganese it contains being the most oxidisable of all the material present, will remove oxygen that may be present in the bath, and will intercept oxygen that may tend to enter it, so that the more manganese there is in the slag the less oxygen there will be in the metal below. By testing the slag frequently there is constantly present a delicate test of the oxidation of the bath. If this precaution were not taken and the oxygen were allowed to go on accumulating in the bath, it would be impossible to tell how much there is of it present when the final additions of silicon and manganese are made, and how much of these substances would be removed in taking up this oxygen. Therefore oxygen must be kept out, so that the whole of the ingredients finally added shall be left to perform their work.

The success which has thus far attended the development of the manufacture indicates a useful future for the process. The persevering efforts of the Terrenoire Company prove their confidence in the principle involved. Further experience may justify the use of the metal more generally for guns, and if it can be made hard enough, it may be used for the inner tubes. It will require exhaustive experiments to induce artillerists to accept in all cases the simply cast metal as a substitute for that forged under a hammer or press, but if its ability to

* For a general plan of the works at Le Creusôt, we refer our readers to page 275 of our twenty-sixth volume.

stand all tests is demonstrated, it will open a way to great economy in manufacture.

With regard to the advantages gained by tempering gun steel, much mooted also in England, Lieut. Jaques says that whilst nearly all authorities in France are in favour of tempering, there are still diverse opinions as to its hardening effect, and as to the best system to be employed in the operation.

Mr. Harmet, chief engineer of the steel works of St. Etienne, argues that the usual method of plunging the tubes entirely in oil, which causes the cooling to commence simultaneously on the outer and inner surfaces, creates three different zones of cooling in the thickness of the metal, the centre one of which begins to contract only when the two outer ones are already set The tensions of the metal consequently vary towards a line in the middle of its thickness, instead of being concentric with the axis of the tube. Mr. Harmet proposes to obtain this latter result by filling the tube with water and applying none to the exterior.

In England the late Sir W. Siemens shared these views, and proposed to temper the solid cast-steel gun he designed, by applying gas to the outside and water to the bore.

Judging by the very full and detailed information which it will be seen was freely given to the Board at the establishments visited, the appreciation they express of the courtesy with which they were received was certainly well deserved, though it is a matter of doubt whether information obtained in this manner, much of it of great importance, should properly have been made public to the world at large.

Mr. Krupp has cause to congratulate himself that he was not in this instance induced to relax his stringent rule respecting inspection of his works. Some fine fencing took place between the Board and Mr. Krupp on the subject, but it can hardly be doubted that he exercised a wise discretion in offering to exhibit the performances of his guns to the Board without permitting an inspection of the processes and details of their construction.

Anxious to avoid a blank page in their report with respect to the doings of the great "cannon king," a portion of a recent report by the American consul at Crefeld is inserted, but that document contains nothing that has not already been made public by Mr. Krupp himself, and no further light is thrown on the mysteries of the Essen processes of steel manufacture and ordnance construction.

In fact it may be questioned whether the free exhibition of our industrial processes to foreigners is a wise proceeding, and whether it would not have been better to have displayed some of the reserve maintained by Mr. Krupp. Though duly invested with the dignity of a presidential precept, the Board was nothing less than a manufacturing committee sent to gather information for the benefit of American industries, and most of the firms they visited showed an unwonted liberality in affording them almost unrestricted facilities.

How the information acquired is to be made use of can be seen from the designs of guns, given in Lieutenant Jaques's work, emanating from the Bureau of Ordnance, and intended for manufacture in the States. These are, in their leading features, copies of recent English guns. If somewhat inclined to doubt the realisation of Lieutenant Jaques's patriotic anticipations that American guns will become the standards for comparison for all nations, we can at all events congratulate the Board with having taken the best means of laying a sound foundation for their future operations.

From the abstract Lieutenant Jaques gives of the discussion in the Senate on the report of the Board it may be doubted whether the large appropriations demanded for the construction of an ordnance factory and the manufacture of a number of guns will be granted. American legislators have always shown a strong disinclination to embark on the heavy outlays inseparable from establishments adequate to carry out the comprehensive schemes of national defence which have been pressed upon them, and it is consequently not improbable that the interesting addition to the literature of the subject due to Lieutenant Jaques will be the chief result of their labours.

TEAK.

(*Concluded from page 460*).

There is very much interest connected with the getting of the timber and its transmission to market. The first operation is to ring or girdle the tree, for if cut green it is too heavy to be floated down the rivers. It is generally thought that the best time for girdling the tree is after the fall of the leaf, when the circulation of the sap is at its lowest ebb. The girdler goes into the forest with his "dah" (a kind of long knife like an attenuated chopper used by a butcher), and with it or with a small axe he chips through the bark and sapwood all round, a short distance above the ground, taking great care, if he is a good workman, to excise every part of the sapwood out of each fluting and hollow of the tree; for if he leaves the least bit of the sapwood intact the tree will live on—though it be in a half-hearted way—and when actually cut down it will not float. Amongst the many points to which the girdler must give special attention in his selection of trees to be felled, none is of more importance than the size of the tree, because to girdle undersized trees would be unprofitable, and would destroy the succession. It is seldom worth while to work out a tree that is less than 6 ft. in girth, or say about 100 years old. By way of identifying the work as his own, the girdler hammers or cuts his own special mark, and if the girdling operation has been thoroughly done the tree is practically, if not absolutely, dead in the course of a few weeks, while in from two to three years, it has become sufficiently seasoned to float. It is this long course of preparation, necessitated by the requirements of river carriage, that insures that thorough seasoning of the wood which is so remarkable an advantage in its use Then come the feller and his mate with their small Burmese axes with which they attack the tree, generally above the buttresses, which sometimes extend as much as 12 ft. up from the ground, so that the fellers have to erect a stage to work on. The cuts are arranged so that the tree may fall with the least chance of injury either to itself or its neighbours of its own tribe. This is often a matter of difficulty. Steady hewing for half or three quarters of an hour is generally sufficient to bring down a tree of 6 ft girth, and the crash of its falling resounds far and near over the hills. The tree is next trimmed of its branches, and "logged" into one or two logs, according to its size and position, for if the ground be hilly, or the spot far from the water, or the creek narrow and crooked, a very long or a very heavy log may be unmanageable

As must readily be supposed, the difficulties which attend the bringing of very long logs from the forests to the shipping ports are enormous, owing to the system of transit, which it is necessary to have recourse to. In the transit of teak from the forests, man finds a most valuable assistant in the elephant, and there are few more interesting sights in the animal world than the working of a well-trained elephant, so wonderful are the intelligence and skill with which he will adapt his great and yet not clumsy strength to the manipulation—at the mills—alike of a square two tons in weight and of a long board half an inch in thickness, which the slightest jar would break; but it is in taking the logs from the forest to the stream that the elephant is invaluable as a beast of burden. After the tree has been felled the animal comes upon the scene with his mahout and attendant, and the dragging chains having been attached to the log, it at once starts on its journey to the water If the log be heavy, and the ground rough, the air is filled with the shrill trumpetings and loud roars of the overtasked elephant, in which case the work is often eased by rollers which are shifted from time to time; and in an old forest the work is frequently facilitated by the comparative smoothness that has gradually been imparted to the dragging track Of course, the time occupied in reaching the water varies much according to the distance and nature of the ground; for, while in newly-opened forests, where the timber is close to the water, an elephant will drag a number of logs in one day, in old forests the distance may be even ten or more miles, in which case an elephant will probably drag not more than thirty logs in a season No dragging is done after February till the rains burst in June, as the elephant is easily exhausted by labour in the hot months When the logs have arrived at the creek bed they are arranged side by side, care being taken to keep them from the neighbourhood of any heaps of drift and rubbish, lest the forest fires catching these extend to the logs, and a mark is hammered on each log by the elephant driver to identify it as dragged by him. There the logs lie till the first rises of the water float them off, but though they have been floated, their troubles are not necessarily over. Often the creeks are rocky or sandy, generally crooked, frequently with precipitous beds, and at times again so shallow that with high water the logs get over the banks. In the great majority of cases, therefore, the journey of the logs to the main stream has to be helped by the elephants Where the creek debouches into the main river, and if the latter be large enough to admit of the rafts floating, there is often a thittaga or boom, formed either of twisted canes, or of logs chained together, to prevent the timber drifting out into the main river The rafting is generally done at the thittaga or boom, where there is one. Taken out one by one into the main stream the logs are made into rafts, according to the size of the river, and thence they are floated down to Rangoon or Moulmein, the journey taking many months in the case of rafts from the upper waters of the Irrawaddy. On the nature of the stream depends, of course, the point at which the rafting is done, the rule being to do it as high up as possible Owing to the occurrence of numerous rapids on the Salween, rafting on that river is impossible above a place called Kyodan, which is only 80 miles above Moulmein, and at that point a great rope of canes is stretched across the river just below the last rapid. In order to form the raft, the logs are tied together by canes, or by ropes made from the inner bark of a tree called "shaw," and the construction is strengthened by means of cross-pieces of wood. At the ends there are rowing places, as cross rowing has to be resorted to so as to keep the rafts in the current. At night the rafts are moored by long canes or "shaw" ropes, often 150 ft. to 200 ft. in length. Huts are built on the rafts in which the raftsmen and their families live during their often long journey; and the rafts are despatched in batches under the care of a head man who is held responsible for them Until within the last few years rafts coming down the Sittang were exposed, in the lower part of that river, to the danger of meeting a dangerous "bore" which at spring tides runs with a lofty crest and roar heard for many miles, up the wide mouth of that stream, and many thousands of logs drifted irrecoverably out to the Gulf of Martaban Now, however, there is a canal which takes off higher up the Sittang and gets rid of that danger When they arrive at Rangoon or Moulmein the raftsmen are paid the balance due to them over and above the advance made at starting, and the logs are taken charge of by the owners, who stow them at Rangoon on land belonging to themselves or rented, and at Moulmein in a depôt kept by Government, who issue warrants on which the banks will grant advances

From the depôts the logs are taken as wanted to the sawmills, which of late years have largely supplanted the old hand-labour sawpits At these mills the timber is cut up into various classes of squares suitable for the European and Indian markets, and into scantlings As imported into this country the timber usually comes (1), in squares measuring 23 ft. and upwards in length, (2) in squares ranging from 15 ft to 23 ft in length, which are generally termed "short girthy," on account of their short length and very large sides; (3) in planks principally taken off the sides of the logs in being manufactured into squares, and which are thus produced much cheaper than if taken direct from the squares After conversion the squares and planks or scantlings are piled to await shipment Until lately all the moving of the timber in the yards was done by elephants trained for the purpose, but of late years owing to the enhanced cost of elephants—a good "tusker" now costing as much as 350*l* or 400*l*—their liability to disease, and their inability to work at certain seasons, the tendency has been to substitute mechanical appliances and coolies, for elephant labour

Teak is admittedly by far the most suitable timber known for use in works of construction Being very hard, having a fine grain, unaffected by high temperatures, by dryness, or moisture, susceptible of a very fine polish, and possessing an aromatic oil which preserves iron, a most important advantage, it is greatly prized by shipbuilders, who are, indeed, the principal consumers of it in this country. It is also being employed somewhat extensively in the construction of railway carriages. The following figures showing the exports of teak from Burmah, and the consumption in this country prove how extensively it is used. The total exports from Burmah during recent years may be roughly stated at from 120,000 to 160,000 loads, two-thirds of which found a

THE HOSPITAL SHIP "CASTALIA;" LANDING STAGE AND PONTOON.

MR ADAM MILLER, ENGINEER, LONDON.

(*For Notice, see Page 470.*)

Fig 1.

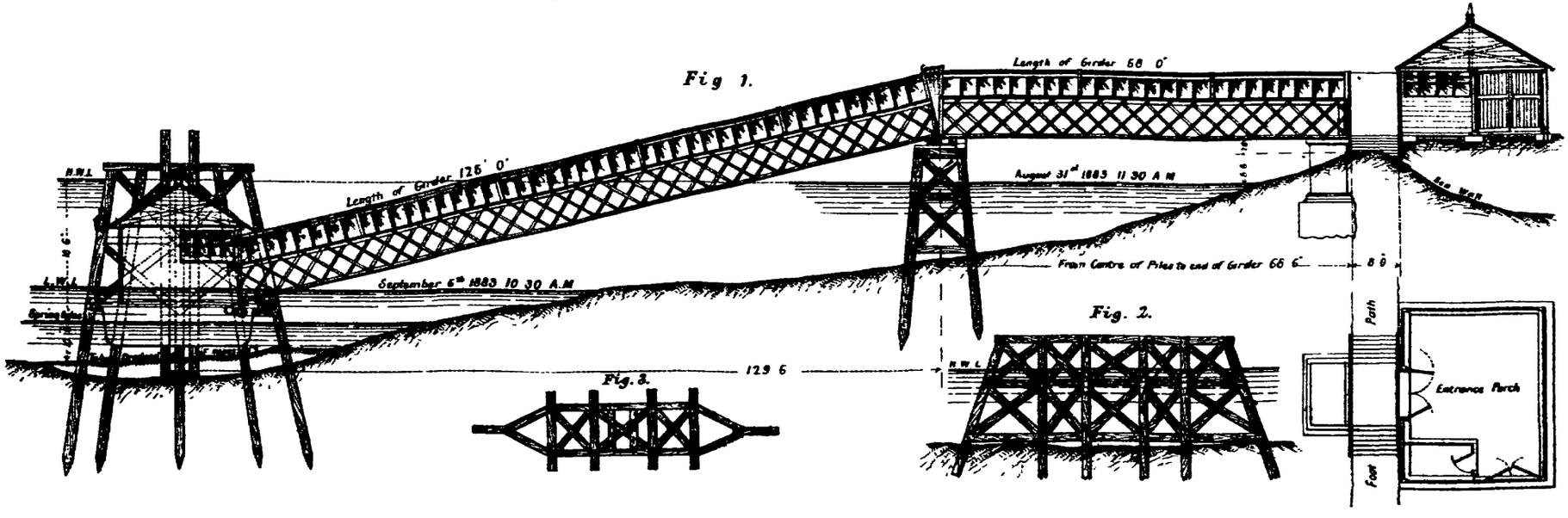


Fig. 2.

Fig. 3.

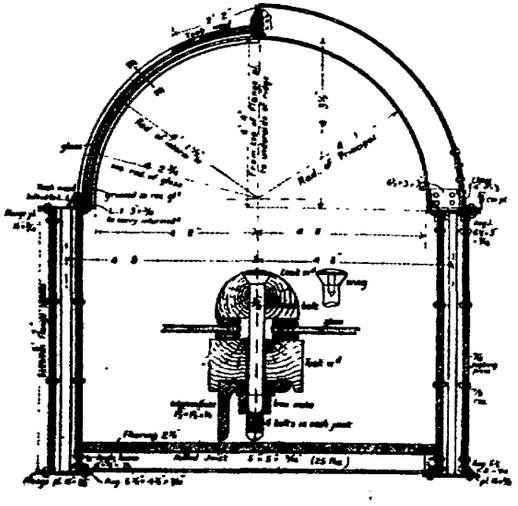


Fig 7

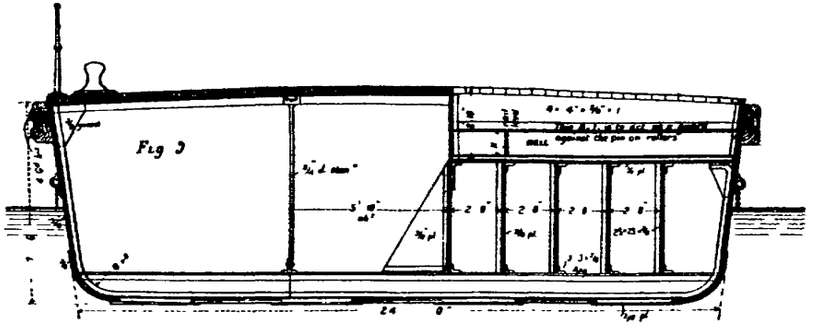
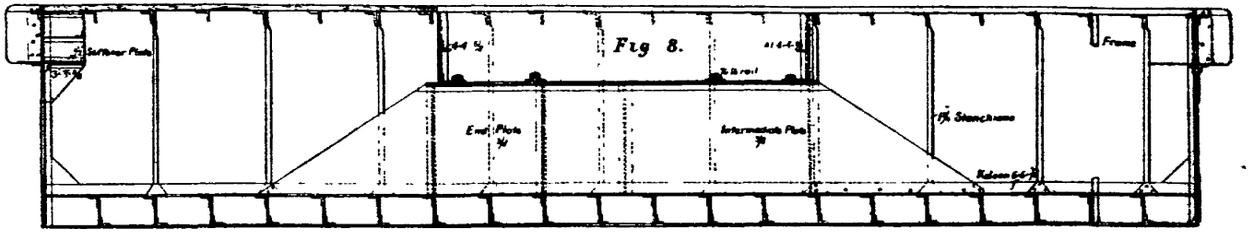


Fig 8.



THE HOSPITAL SHIP "CASTALIA."

MR. ADAM MILLER, ENGINEER, LONDON.

(*For Notice, see Page 470.*)

Fig. 4.

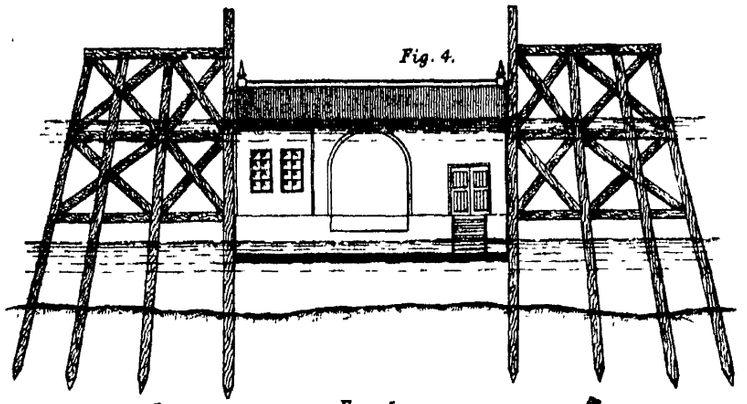


Fig 5

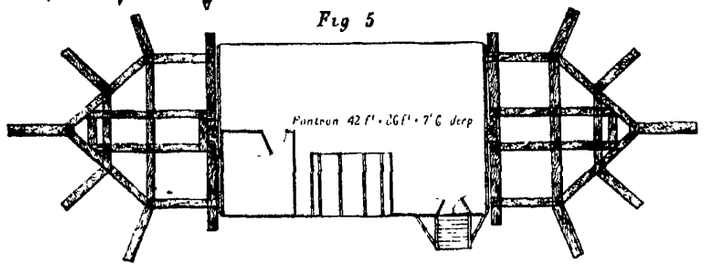
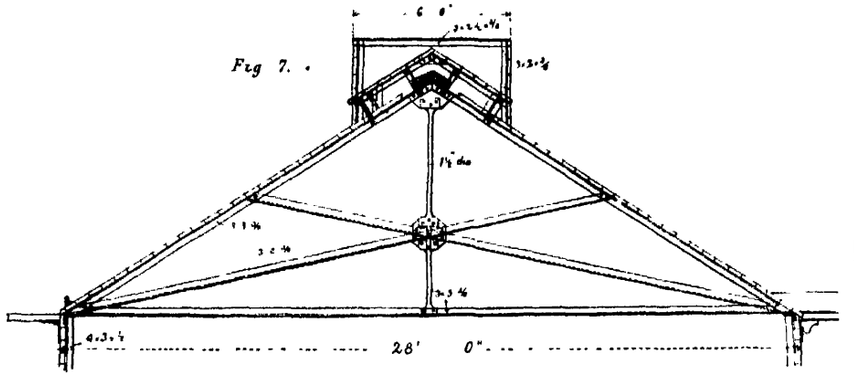


Fig 7.



market in India. Of that enormous quantity of timber the imports into the United Kingdom in the years mentioned were as follows.

			Loads.
April 1, 1874, till March 31,		1875	42,868
,, 1875	,,	1876	60,612
,, 1876	,,	1877	45,108
,, 1877	,,	1878	56,939
,, 1878	,,	1879	37,413
,, 1879	,,	1880	38,620
,, 1880	,,	1881	65,626

These figures show an average of 49,598 loads over a period of seven years. The great increase in the year 1880-81 was caused by the large demand in the United Kingdom for the timber for shipbuilding purposes, it being freely obtained from the Forest Department, and the lessees of the different forests. The Clyde lays claim to being the largest consumer of this valuable timber, the imports to it alone averaging, from 1876 till 1883, 11,916 loads per annum, or close upon 24 per cent. of an average year's exports from Burmah to this country. During that period the largest quantity imported in one year into the Clyde was 16,994 loads, and the smallest quantity was 5133 loads. The Thames ranks next to the Clyde as regards the imports of teak from Burmah, the quantity being an average of 8340 loads per annum. The Mersey, the Tyne, the Wear, and the Government dockyards are the other principal consumers of teak wood, each of which will receive from 3000 to 5000 loads in the course of a busy year. This large supply of teak from Burmah to this country has not been more, of late years, than has been required. This is accounted for by the briskness of the shipbuilding industry during the same period having caused a more than ordinary demand for the material, although it has not yet overtaxed the resources of the teak merchants.

By many persons the price of teak is considered to be an obstacle to its more general use. No doubt its cost is greatly increased by the expense of bringing it long distances from the forests, by the difficulties of transit, and by the heavy rates of insurance for cargoes carried by wooden vessels, which are those most suitable to the trade. The average price obtained for it in this country is about 5s. 3d. per cubic foot, but during times of great depression in the shipbuilding industry, it has been as low as 3s. 8d. per cubic foot, while in seasons of great briskness it has touched 6s 4d. per cubic foot for timber of average size and quality.

In recent years teak has been imported into this country from Bankok in Siam, but the shipments have not met with much favour from shipbuilders on account of the wood being much more brittle than the Burmah timber, while it possesses the "heartshake" in a very marked degree, is full of beeholes, is earthy in grain, and does not, to the same extent, contain the essential oil which contributes so largely to the value of Burmah teak. To a future generation it may be valuable in the event of the Burmah forests failing to meet the requirements of the time; but while the other is to be had in such quantities as at present, it is not likely to be in great demand, unless the Bankok shipments can be improved.

Teak may be regarded as the most important timber with which the Forest Department of India has to deal, and in Burmah the forests under its administration at present, cover an area of from 3500 to 4000 square miles. The attention of the Conservancy officers is devoted to the protection of trees which have not yet reached maturity, and no girdling is permitted in the tracks over which they have authority, until the permission of the officer in charge has been obtained. Much care is also devoted by them to the maintenance of these forests, when cleared, as teak-bearing districts.

In the Indian Section of the Forestry Exhibition there are shown specimens of timber which more or less approach teak in its numerous excellent qualities. The most valuable timber after teak is that obtained from the *Lagerströma flos-reginæ*. It grows in Sylhet, Cachar, Chittagong, and Burmah, and is used in shipbuilding and for boats and canoes, and in all kinds of construction. In Southern India it is used for building purposes, and in Ceylon for casks The *Fragræa fragrans*, an evergreen tree of Burmah, yields a hard wood which is brown, close-grained, and beautifully mottled. It is very durable, and is not liable to the attacks of the teredo or seaworm. As one of the most important of the reserved trees of Burmah, especially in Tavoy, its wood is used for house-building, for bridge and wharf piles, for boats' anchors, and for other purposes. Another timber known as "sal," which is obtained from the sal tree (*Shorea robusta*), when it has once been thoroughly seasoned, stands almost without a rival as a timber for strength, elasticity, and durability, all of which it retains without being sensibly affected for a great length of time. This timber is most extensively used in Northern India, being in constant request for piles, beams, planking, and railing of bridges, for beams and the door and window posts of houses, for gun-carriages, the bodies of carts, and above all for railway sleepers, the yearly consumption of which for such purposes reaches some lakhs of cubic feet The ironwood tree of Pegu and Arracan (*Xylia dolabriformis*) yields a timber which is used for boat-building and for agricultural implements in Burmah; also for carts and tool handles. In Southern India it is used for railway sleepers, posts, boatbuilding, and carts; and in Burmah and Bengal it has been extensively employed for telegraph posts, for which it has answered well. Its weight is about 65 lb. per cubic foot. Lastly, we may mention the wood of the sissoo, which is very durable, seasons well, and does not warp or slip. For the felloes and naves of wheels and carved work of every description, for the framings of carriages and similar work, it is said to be unsurpassed by any other wood, owing to its fine seasoning and standing qualities. Unfortunately the supply of this valuable timber is comparatively small

CABLE TRAMWAYS.

By J. Bucknall-Smith.

(*Continued from page 445.*)

Mr. Hallidie did not allow his project for establishing cable tramway communication in San Francisco to repose, but ultimately succeeded in interesting some friends in the matter, and in obtaining a practical trial. For some time, however, he met with more obstacles than encouragement, and in fact the scheme was somewhat ridiculed, and regarded as being visionary and impracticable.

Ultimately, however, he succeeded in obtaining the co-operation of Messrs. Britton, Davis, and Moffit, who supplied the required funds. The franchise for the line was then acquired from a Mr. Brooks, who originally intended to attempt some cable haulage schemes in the city The public was also invited to assist, and a prospectus inviting subscriptions was issued and dated June, 1872. The result was an absolute failure. Some property owners in the neighbourhood of the projected line made promises, as numerous as vague, regarding future assistance, if the scheme succeeded, but anything like definite encouragement, in the event of a success, took more the form of a gratuitous sum than an investment. California-street was the first proposed site for a trial, but the route ultimately selected for this experimental line was Clay-street, a busy central street in the city of San Francisco, only 49 ft. wide between the houses.

The highest part of the line was to be about 300 ft. above the level of the lower or Kearny-street

terminus, and its entire horizontal length was 2800 ft., or about 5600 ft of single line. The transverse intersecting streets, which occurred about every 412 ft, were at right angles, and cut the grades of Clay-street with level crossings The steepest gradient on the line was about 1 in 6. The preparation of the necessary plans and details, as also the superintendence of the construction of this inaugural cable tramway, were carried out by a Mr. W. Eppelsheimer, who from that time has been much associated with the introduction and development of the cable system generally.

The proposals contained in the original prospectus were that the line should run between Kearny and Jones-streets. The hours of traffic were to be from 7 A.M to 11 P M., the rate travelled being from five to six miles per hour, the trip thus occupying about six minutes Horses were to be attached to the cars upon their arrival at the summit of the hill, where an extension was to be worked by a horse system. The promoters stated that they considered a ten-minute service of cars would be sufficient at first, and further mentioned that it was hardly to be expected that the line would pay upon the proposed investment of capital, but that the ultimate benefit would rest with the property owners and residents upon the hill A guarantee of 45,000 dols (about 9000*l*.) was invited as being necessary, before the construction of the line could be commenced. The projectors undertook to have the line built and opened for traffic within six months

Mr W. Eppelsheimer supplemented this prospectus with an able report, giving a detailed estimate for the work proposed, accompanied by some valuable notes regarding the probable traffic

The total cost of the scheme was estimated at 100,000 dols. (about 20,000*l*.) including the entire track, tube, steel wire rope, engines, tension appliances, pulleys, rolling stock, grippers, twenty horses, buildings and tools, &c A detailed account of the actual expenditure incurred will be given later on, but at present it will suffice to state that the construction and equipment was within the above estimate The monthly running expenses of the road, with adequate allowances for depreciation, wear and tear, &c., were estimated in the said report at about 3000 dols, about 600*l*. Ultimately a donation of about 40,000 dols. was subscribed by the interested property holders in support of the line.

The population of San Francisco was then about 180,000, and the proportion that travelled daily by different tramways in the city amounted to about 29 per cent The number of inhabitants that resided in the district of the proposed Clay-street line, was estimated at about 12,000, and by reasonable deductions from the average workings of the other tramway companies over level ground, it was to be fairly expected that the daily transport of passengers would exceed 3300, which at 5 cent fares (2½d.) would produce a daily revenue or gross profit of about 165 dols, or 33*l*., or, say, about 230*l*. per week, or 920*l* per month, which would leave a net profit of 320*l*. per month, after the allowances for working expenses, interest, and depreciation. Assuming the receipts to have given a profit of only 200*l*. per month, then the line would have paid 12 per cent. interest upon the estimated capital required, but Mr. Eppelsheimer's figures worked out in support of a probable return of over 30 per cent. Facts since prove that this estimate has been attained, and indeed exceeded, the line having at times earned over 35 per cent. upon the capital expended, minus the above mentioned donation. The rapidity with which this line was subsequently constructed is worthy of remark, and reflects great credit on all concerned. The terms of the franchise only allowed two months for the completion of the entire work; the ground was broken early on the 2nd day of June, 1873, and the first trial trip made on the line by the first day of the August following. It must not be imagined that the promoters were permitted to place any rough or inefficient system of public traction in the streets of this city. On the contrary, considerable strictness and vigilance were exercised with regard to the construction, operation, and fares. The plans submitted to the authorities were to comply with the following conditions, viz That the road should not present more impediment to ordinary traffic than the usual and existing horse lines; that the rope should be arranged and operated below the street surface in such a manner as to in no way interfere with vehicular or foot traffic, that the cars could be promptly started, stopped, or controlled upon any part of the line; that no engine or motor should be used on or under the street that could frighten horses or endanger lives. The speed of travelling was not to be less than three or more than eight miles per hour Further, the single passenger fares for the entire distance were not to exceed 5 cents.

Embarking upon such a restricted and more or less speculative undertaking, it was obviously of prime importance to carry out this experimental line at as low a cost as possibly consistent with adequate efficiency. In fact, the line was chiefly for demonstrative purposes, and little thought was bestowed upon its ornamental aspect. It will therefore be readily understood that some features of the construction bore somewhat primitive aspects; as, for example, the wooden offices and engine-house, with its metal chimney shaft, &c.—in fact, wood was liberally used throughout the whole work. Before more minutely describing the construction and operation of the Clay-street cable road, we will pause to briefly narrate some interesting particulars connected with its public opening

It was about 4 o'clock A M. on the morning of the 1st of August, 1873, that the first trial trip was run upon the Clay-street line. The morning was dull and foggy, consequently the rails were slippery from the atmospheric moisture. The haulage rope or cable was set in motion by the stationary engine, and appeared to run satisfactorily through the slotted track tube in which it was mounted on suitable pulleys. A "dummy" or independent carriage to which the cable gripping apparatus, brake gear, and other mechanical operating and controlling mechanism was attached, was then brought out, and the "gripper" duly lowered into the cable tube Ropes were next attached to the frame of the "dummy" in order to safely test the action and efficiency of the brakes upon such a severe incline The result was, that they were found to be inadequate to the requirements. The probability of the cars precipitously rushing down this declivitous line, if the grippers should happen to slip upon the moving cable, was not remote, although at this early hour there were no vehicles, horses or foot passengers to collide with in such event. The above-mentioned deficiency was far from conducive to confidence, and the driver deputed to take the first car down succumbed to cogent scepticism regarding the reliability of the scheme and his personal safety. However, the trial trip had to be made, so that Messrs. Hallidie and Eppelsheimer at once succeeded to the charge of the "dummy car," accompanied by some of their financial co-operatives and employés. Subsequently the descending trip was performed with safety and comfort and without any interruptions. On the way down, stoppages at the crossing streets were tried by releasing and regaining the underground travelling cable with satisfactory results. At the lower terminus the "dummy" was reversed and the up trip tried with similar success. A further trial was made at about 3 o'clock in the afternoon with a dummy and ordinary car connected, when the down trip was effected with similar satisfaction, but a slight hitch took place on the up or return journey owing to some slight derangement of the cable gripping appliance and the interruptions occasioned by the enormous concourse of people that had assembled to witness the experiments. The first disorder was soon remedied and the trip resumed, but the public continued to persistently besiege the cars, and the "dummy" was taken possession of by some sixty persons who crowded into and about it in order to get a free ride at their own risk

About half way up the hill, or between Stockton and Mason-streets, where there is a severe change in the grade, the crowded cars came to a standstill owing to the slipping of the freshly tarred cable upon the driving drum or pulley in the engine room. However, this difficulty was speedily neutralised by the administration of some sawdust and a slight increase in the tension of the cable, and the trip was then satisfactorily completed.

As in all new devices or schemes, there were numerous small alterations and adjustments necessary before the road worked thoroughly well.

It was soon, however, apparent that this small experimental line was an unquestionable success, and would be, probably, the pioneer of many other similar schemes. The line with its extension has now been in successful mechanical and financial operation for upwards of eleven years.

(To be continued).

THE HOSPITAL SHIP "CASTALIA."

In our issue of October 31st we published illustrations of the hospital ship Castalia, and of her tender, the Maltese Cross. We now give several engravings of the Longreach Pier by which the patients embark and disembark. Fig. 1 (page 468) gives a general elevation of the pier and landing stage; Figs. 2 and 3 show the stack of piles between the fixed and moving portions; Figs. 4 and 5 (page 469) show the pontoon and the house on it; Fig. 6 is a cross-section of the pier; Fig. 7 is a similar view of the roof of the porch; Fig. 8 is a longitudinal section of the pontoon; and Fig. 9 is a cross-section. The pier is 193 ft. in length over all; the moving portion being 125 ft., and the fixed part 68 ft. in length. It is lined throughout with yellow pine, and roofed with glass. The moving portion rests at one end on a pontoon, which rises and falls with the tide; the other end is fixed to a stack of piles by a joint bolted to each of the girders, and also to the piles. The fixed portion of the pier is also bolted to the same joint, thus making the connection of the moving and fixed parts. Ambulances can be taken through the pier, and there is a porch at each end. The work has been designed by Mr. Adam Miller, of Riches-court Lime-street, London.

METALLURGICAL NOTES.

Electrolytic Extraction of Copper.

Engineering and Mining Journal states that at the works at Oker, in Germany, there are in operation five machines, C_t, by Siemens and Halske, of Berlin, each machine being connected to twelve depositing baths. Each machine is driven by water-power of four to five horse-power, and deposits about 300 kilos. of copper per day. At the North German Refining Works, in Hamburg, six Gramme machines (No. 1), and one Wohlwill machine, are working, precipitating 2500 kilos. of copper per day. Hilarion Roux, at Marseilles, works with a No. 1 Gramme machine connected with 40 baths giving 900 square metres of anode surface: the cathodes being 5 cm from the anodes, and 0.5 mm. thick. The machine makes 850 revolutions per minute, consumes 240 kilos. of coal per day, and deposits 250 kilos of refined copper, with 8 volts 30 amperes. It is understood that in this country the electrolytic process of working copper is coming more and more into favour, especially for argentiferous copper materials, and that recently in the Swansea neighbourhood new plants have been erected, and old ones extended. But details of the mode of working, and results obtained, have so far not transpired, beyond vague generalities.

Analyses of Slags.

In an article in the *School of Mines Quarterly*, Dr. Iles states that he finds that slags which are not usually decomposed by acids alone, and which therefore require to be fused with alkali in order to prepare them for analysis, may in many cases be rendered easily soluble in acid by taking the sample from the still liquid slag in a special manner. His remarks apply more particularly to slags produced in lead smelting, but he believes that the same result would be obtained with other slags. If a pot of newly-drawn slag be examined immediately after cooling, it will be seen that on the outside, where the slag has cooled rapidly, in contact with the iron slag-pot, there is a thin layer of glassy and brittle slag. This glassy portion is often found to be easily decomposed by acids, while the inner portion of the slag, cooled slowly, resists acids and has to be decomposed by fusion. In taking samples for analysis, for the regulation of the furnace mixtures, &c., Dr Isles now proceeds by taking a steel bar, and either plunging this into the liquid slag in the slag-pot, or holding it in the stream of slag as it issues from the slag spout of the furnace, in each case withdrawing the bar and plunging it into cold water as soon as a thin crust of slag adheres to it. This rapid cooling of the slag, which has so marked an influence on its resistance to acids, does not seem to affect its chemical composition at all, and certainly not as regards the main constituents, the determination of which is usually the object of analysis. Slags containing up to 42 per cent. of silica have always been found to be entirely decomposed by hydrochloric acid after this treatment, and so much trouble and delay is saved.

A New Metallurgical Process.

The *Mining and Scientific Press* of San Francisco describes, under the heading of "A New Metallurgical Process," a method practised by Mr. Edward Probert, of Eureka, Nevada, for extracting the silver and gold contained in arsenide of iron, or speiss. The method consists of treating the molten speiss with lead, or litharge, or both, and so obtaining argentiferous and auriferous lead, leaving the speiss more or less free from the precious metals originally contained in it. So far as this method is concerned, it is difficult to see how any claim can be made for it is a "New Metallurgical Process." It is, on the contrary, a very old one indeed, as applied to copper mattes, and practised at many places. It is fully treated of in

various works on metallurgy, and Percy proposes for it the name of "Lead Soaking Process" as an English equivalent of the German name "Eintranke Process." Lead alone is usually employed, but lead and litharge together have been used. Neither is the method new as regards its application to arsenide of iron, or speise, as this has been desilverised formerly by adding lead to the molten speise and rabbling and agitating together, as proposed by Mr. Probert. The novelty of Mr. Probert's invention seems to consist in the manner in which he proposes to obtain sufficient agitation and mixing of the speise and lead, so as to enable the latter to take up the silver and gold. He taps the liquid speise into iron pots, which have a lining largely composed of limestone, dolomite, or other carbonate decomposed at high temperature, such decomposition of carbonates by the heat of the speise causing carbon dioxide, or carbonic acid, to be given off with ebulliton, and steady agitation of the liquid contents of the pot. As usually practised, the lead has been brought into contact with the matte, or speise, in the tapping-hole of a furnace, or, as in so desilverising speise at Freiberg, the lead has been added to the material under treatment, in a special small reverberatory furnace, the agitation in such case being obtained by stirring.

The "Bessemerising" of Copper Mattes.

It is probably well known to most of our readers, that attempts have frequently been made to apply the Bessemer process to the working of copper ores. It will be in their recollection that, a few years ago, Mr. Holway proposed to revolutionise the Spanish pyrites industry by applying the method direct to the pyrites, and producing sulphur and rich copper mattes. A great stir was made at the time, the proposal was most powerfully supported, and success predicted for it on very high authority. But, nevertheless, it was a failure, and has been completely abandoned, having won no laurels beyond those with which it was prematurely crowned at the outset. These attempts of Mr. Holway were not the first made in that direction, if we leave aside the special question of pyrites very rich in sulphur, and regard only the concentration of copper. In Russia, and elsewhere, trials were made to operate on copper mattes, but without any practical success. It appears to have been left for the French metallurgist, Mambés, to get the proposed method to work on a really practical scale, and this he has done after many experiments and failures, commencing about 1880; the results of which have appeared from time to time in various papers dealing with metallurgical subjects, one of the most complete accounts having been by Professor Gruner in the "Annales des Mines" last year. One of the main difficulties found was, that in converting copper matte direct into metallic copper (impure "black copper)," the ordinary construction of converter, with vertical blast holes, was useless. However well the operation went on during the earlier stages, it came to grief as soon as any metallic copper was separated, owing to the metal which settled to the bottom at once congealing, and closing the blast openings, stopping the process, and blocking up the converter. This was remedied by having converters with blast holes at some distance from the bottom, arranged horizontally round the converter. The separated copper sinks at once below the level of these, and not being cooled by the blast, remains fluid till the close of the operation. No difficulty was found in converting Rieber mattes direct into copper containing about 1½ per cent. impurity, to be refined in the ordinary way. But with poorer mattes carrying only some 30 per cent of copper, the large amount of iron to be slagged off caused much trouble with the linings of the converters, which consist of three parts quartz and one part fireclay. This lining was rapidly corroded away, so that very few operations could be made with one lining. This difficulty has been got over by adding quartz-sand to the charge, and by not carrying out the conversion of poorer mattes to metallic copper at one operation. The latest notice of the process, which seems to be in regular work now, is in an account appearing last week in *Berg und Hüttenmänische Zeitung* of a visit paid to the works by H. von Jossa, of St. Petersburg. The ores worked are of the most variable nature, the percentage of copper ranging from 4 to 23, and the amount and kind of impurity contained being equally diverse. They are being smelted down in cupolas with a height of 5 metres and diameter at tuyeres of 1 metre. There are three tuyeres of 7 cm. diameter, delivering blast of pressure equal to 20 cm. of water. The usual smelting mixture is in the proportion of 500 kilos. ore, 50 kilos. limestone, 70 kilos. coke, with more or less slags from the converters. Each furnace puts through per twenty-four hours 20 tons of ores and 3 tons of converter slags, and produces 4 tons copper matte, of 30 per cent. copper. This matte, after remelting, is run into the converters in charges of about 1 ton, and a blast of pressure equal to 35 cm. mercury is turned on. The course of the operation is described as follows: At first the flame is quite short, pale yellow, with white smoke. After two or three minutes, the flame gets longer and clearer, the smoke more dense, white or yellowish. Ebullition is heard in the converter As iron and zinc are oxidised, the smoke gets clearer and the flame gets greenish in colour. The operation is over in twenty five to thirty minutes. The product of this operation is called "matte blanche," and contains 75 to 77 per cent copper, as distinguished from the "matte bronze," or original matte, with 30 to 35 per cent. copper. Matte and slag are turned out together into a cast-iron receiving vessel It is not stated whether this is lined, but it must be assumed that it is, or the matte would soon destroy the iron The slag soon separates, and is removed from the top, the matte is returned to the converter, and another blow of fifteen to twenty minutes converts it into metallic copper, with between 1 and 2 per cent. impurity It is again to be assumed—though the article does not say so—that the "matte blanche" remains liquid, and is returned to the converter without any remelting. During the final blow there is very little smoke, short yellow and green flame, and low temperature. The slags from the first blow carry 1 to 2 per cent copper; those from the final blow carrying 2 to 3 per cent They are added to the charge in the ore smelting, and so cleared of the copper contained. When Gruner's description of the process appeared in 1883, the monthly production of copper by its means was 85 to 100 tons, the supply of ores being very irregular, and many of them being extremely impure. The consumption of fuel per ton of copper (refined copper ready for market) was given as 5 tons of coal. Water power was used for the blast, but for purposes of comparison it was taken that an engine doing the work would require coal at the rate of 1 ton per ton of copper produced, taking the monthly production at 100 tons of copper Also coke used was reckoned into its equivalent of coal, for comparison with English copper-smelting, the total being as above To work ores of the same class and assay by the ordinary English process would require 13 to 16 tons of coal per ton of copper produced. Wages are also claimed to be very much less for this process than for the ordinary smelting methods. It seems quite beyond question that M Mambés has long since passed from the stage of experiment into that of commercial success, and in spite of the conservative feelings which seem to cling to nearly all branches of metallurgy, it may be expected that his methods will be copied in many places, and notably in those where fuel is scarce In this connection it does not seem easy to understand why it should not be arranged to run the first make direct from the ore furnace (copper or reverberatory as the case may be) into the converters, and so save cost of special remelting. As regards economy, the method seems triumphant. There is another very important question connected with it, which still requires more proof and consideration, and that is, whether the impurities are as completely removed from copper by the new plan as by the ordinary reverberatory copper smelting Very experienced English smelters lay great stress on the removal of deleterious matter by the several calcinations and smeltings of the process used in this country, and would require very strong proof of the production of any equally pure copper by a rapid and direct method before they adopt it. But if the electrolytic refining of impure copper comes more and more into use, this objection to Mambés' process, even if now valid, would fall away. It may be predicted that the process will recommend itself strongly for the working of argentiferous copper ores, giving rapidly and cheaply an impure copper containing the silver of the ore, such copper to be refined and desilverised by electrolysis.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, November 1, 1884

From recently tabulated returns by the American Iron and Steel Association, it appears that there are at present 675 blast furnaces with 16 in process of erection. The productive capacity in net tons of the completed blast furnaces is 9,300,000 tons, an increase of 1,300,000 tons in capacity during the past two years The capacity of the bituminous furnaces in net tons is 4,850,000 tons, an increase of 725,000 tons within two years The annual capacity of the anthracite furnaces is 3,175,000 tons, an increase of 425,000 tons in two years. The annual capacity of the charcoal furnaces is 1,275,000 tons, or 50,000 tons more than two years ago. There are 434 complete rolling mills and steel works, or 34 more than two years ago, and four works building. Of these mills 71 make rails The rolling mill capacity for iron and steel is 7,600,000 tons There are 5265 puddling furnaces, 2782 heating furnaces, 1555 trains of rolls. There are 81 nail factories, having 5695 nail machines; two new nail works are being built, which will operate 67 machines There are 21 completed Bessemer works and one now being built There are 46 completed Bessemer converters and three being built. The annual capacity in ingots is 2,490,000 tons. There are 35 completed open-hearth steel works with a capacity of 550,000 tons, having 58 completed furnaces. There are 41 crucible steel works with 3594 melting pots, having an annual capacity of 115,000 tons. There are 70 forges making 75,000 tons of blooms and billets, and 53 bloomeries making 70,000 tons of blooms. The iron trade is extremely dull, prices are weak, and there are no indications of any early revival. Steel rails are selling in small lots at 28 dols. in Pennsylvania, and makers are willing to take large orders at 27 dols An estimate of the cost of railmaking in Western Pennsylvania is given at 26.83 dols, and Eastern Pennsylvania about 1 dol less per ton The bar mills are working to about one half their capacity. Increasing quantities of southern iron are finding markets in New England. The advantage is 50 cents to 1 dol. per ton, over Lehigh irons The volume of general business has not increased. The importations of gold are noted, the volume of money in eastern centres is abundant, and bank reserves are increasing Vanderbilt is about dropping the New Jersey Central, over which there has been such a contest in the courts for a long time, he finds it to heavy to carry The Baltimore and Ohio Company having been defeated in their injunction to compel the Pennsylvania Company to carry their cars from Philadelphia to New York, will take steps to push railway construction on their independent line as rapidly as circumstances will permit.

Philadelphia, November 7, 1884

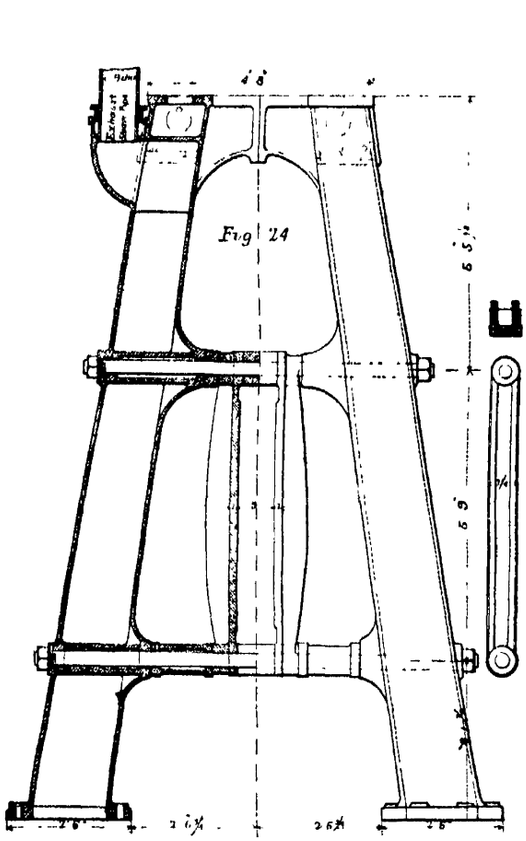
At this writing, great agitation exists in the public mind over the Presidential election, and the probable change of administration, to one which will favour lower revenue duties The manufacturing interests of the States have expended money liberally, but owing to the partial depression which has existed for a year or more throughout the country, only about one half as much money was subscribed and paid in for political purposes as was paid in four years ago The leading manufacturers of this city are apprehensive that the depression will continue for some time to come, and that railroad building will not grow to very large dimensions until late next spring Steel rails are selling to day at 28 dols. in small lots Large lots could be had at 27 dols to 27 50 dols; old rails would sell at 17.50 dols, but small lots are bringing 18 dols to 18 50 dols In Bessemer pig there is no movement at 19 dols at tidewater; 10 per cent spiegel at 23 dols, and 20 per cent at 26 dols, are quiet Imported Bessemer nail blooms are quoted at 32 dols Domestic slabs 1 dol. to 3 dols. higher, foreign blooms are in moderate request Steel nails are gaining ground, and are now selling as low as iron nails. Merchant iron, plate tank structural, and sheet iron, are moving in very small lots at prices heretofore quoted Stocks of metals at New York are as follows Tin plates, 36,639 boxes; pig lead, 335,446 boxes, spelter, 121 tons, sheet zinc, 28,053 lb, scrap zinc, 13,490 lb; old copper, 6863 lb., Swedish iron, 2951 tons, iron wire rods, 553 tons, steel wire rods, 58,915 tons; old rails, 1135 tons, scrap iron and steel, 1690 tons The demand for foreign material is very light A good deal of iron from the Southern States is crowding its way into northern markets, but latterly there has been a falling off The probabilities point to an increasing production of pig iron on account of the small stocks in first and second hands. Sales of steel rails during the past week foot up about 15,000 tons so far as can be ascertained. The coal trade is sluggish. The anthracite production will foot up about 28,000,000 tons this year, or 300,000 tons less than last year. The soft coals of Maryland and Pennsylvania are finding increasing favour in New England markets. The textile manufacturers in New England have still further restricted production, and within the past three week the manufacturers have restricted largely, and will keep their looms idle until the market conditions change radically Political agitations are overshadowing all other interests for the present, but the war of rates between the trunk lines continues. The Pennsylvania is the only one which refuses.

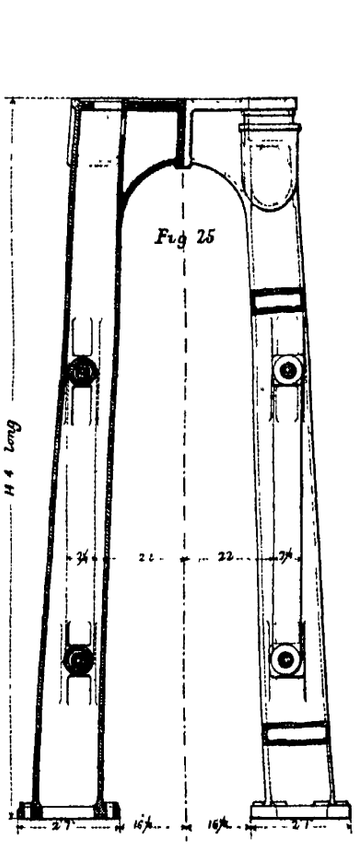
The Fraser River Bridge.—In our account of the Fraser River Bridge on the Canadian Pacific Railway in our issue of September 5, we omitted to mention that it was designed by Mr. C. C Schneider, the late chief engineer of the Niagara cantilever bridge

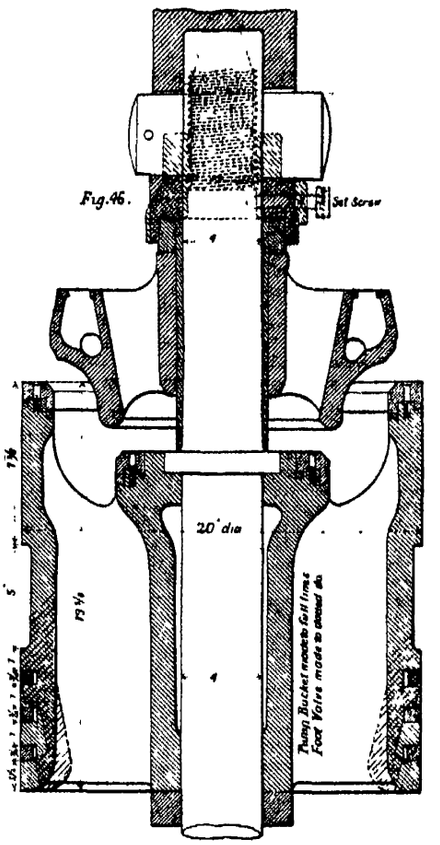
Glasgow Engineers' Association.—At a meeting of the Association held on the 13th inst., in the Christian Institute—the president in the chair—the discussion on the crossover communication on the River Clyde was resumed. Mr. T. F. Thomson advocated a traversing bridge, slightly above quay-level, and Mr. A. J. W. Watkins a high-level bridge, with hydraulic lifts at the quays, in addition to the inclined approaches. Mr. Thomson proposed to cross the river in five spans, the centre span consisting of two cantilever traversing girders, the machinery for working which would be concealed under the quays. The bridge allowed for passenger, street, and railway traffic. Mr. Watkins considered a high-level suspension bridge with stiffening girders the most suitable, as owing to the rise on the river bar on either side the approaches would be comparatively short. This bridge would also allow for railway communication between Stobcross Depôt Terminus quay and the new Cessnock Docks, while the hydraulic lifts would accommodate the transportation of goods between the quays.

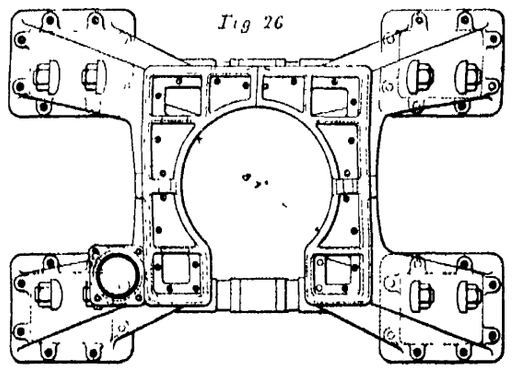
DETAILS OF COMPOUND PUMPING ENGINE; EASTBOURNE WATER WORKS.

CONSTRUCTED BY MESSRS. MORELAND AND SON, ENGINEERS, LONDON.









In our issue of October 3 we gave a two-page engraving of the pumping engine at the Eastbourne Water Works, and again, on October 24, we did the same, with additional views on page 384. This week we conclude the illustrations and add the following descriptions of the engines and their performance.

Messrs. Moreland and Son, Old-street, London, constructed two sets of pumping machinery for these works, in the years 1869 and 1876. By the year 1881, however, the town had increased to such an extent that neither the yield of the wells nor the pumping was adequate to supply the demand. Under these circumstances Mr. G. A. Wallis, engineer-in chief of the water works, decided to sink a new well in the hope of finding an additional supply. After careful examination it was decided to sink the new well in a site removed about one quarter of a mile from the old works. In plan the well is oval, measuring 26 ft. by 18 ft.; it was sunk to a total depth of 65 ft. under the original ground line, the strata passed being 2 ft. or 3 ft. of soil, under which were 27 ft. of chalk, and then 35 ft. of green sandstone. A heading was also driven to connect the new with the old wells. The yield of water surpassed all expectations, being about 5,000,000 gallons per twenty-four hours.

The pumping engines supplied previously were of the inverted cylinder, direct-acting, rotative type. The steam cylinders were 29 in. in diameter; the pumps were of the bucket and plunger type, with working barrels 17 in. in diameter, the stroke of engines and pumps being 30 in. The wells were 105 ft. deep. The performance of these engines had been so satisfactory, and the repairs required of so slight a nature, that it was not only determined to remove them to the new well, but it was also considered advisable to construct the new and more powerful engine on the same general principles, but with this variation, that whereas the old engines had single cylinders, the new engine was to have compound cylinders on the tandem principle. As the steam pressure at the new station was fixed at 80 lb, the working parts of the old engines, designed for a pressure of 55 lb only, would not have been sufficiently strong, it was therefore decided to compound these cylinders also on the tandem principle, so that full advantage could be taken to expand the steam without increasing the initial strain. In fact these engines are not now subjected to a greater strain when expanding eight times with a steam pressure of 80 lb. than with the previous expansion of about twice with 50 lb. pressure of steam. Each pumping engine was to be entirely independent, so that in the event of the breakage of a crankshaft only one would be disabled.

These works have now been completed for some time. The new engine, designed in 1880, was set to work in 1882, and the old engines were compounded and set to work shortly afterwards. The works were formally opened on the 30th of June, 1883, by their Royal Highnesses the Prince and Princess of Wales.

The capacity of the present pumping plant is as under: One independent compound engine capable of raising 1,620,000 gallons per 24 hours at 25 revolutions per minute under a head of 400 ft., and two independent compound pumping engines, each capable of raising 1,080,000 gallons per 24 hours at 30 revolutions per minute under a head of 400 ft. The larger engine, or No. 1, exerts about 160 indicated horse-power, and the two smaller engines, Nos. 2 and 3, each 106 indicated horse-power. About two-fifths of the whole quantity of water is pumped under the maximum head of 400 ft., the remainder against an average head of 200 ft.

There is yet space for a fourth engine similar to No. 1, which it is intended to employ exclusively for low-service work, and which will therefore be fitted with a pump of double the above capacity. The present pumping power is not sufficient to lower the water in the well enough to admit of access to the bucket and suction valve from below; the suction valves are therefore made small enough to be withdrawn from the pump top through the rising main; the waterway through the valves is thus comparatively limited, otherwise the engines could be run much faster. No. 1 engine indeed works exceedingly well at 27 revolutions per minute, equal to 180 ft. pump speed, but where, as in ordinary service engines, large valves can be applied, its normal speed would be 35 revolutions per minute.

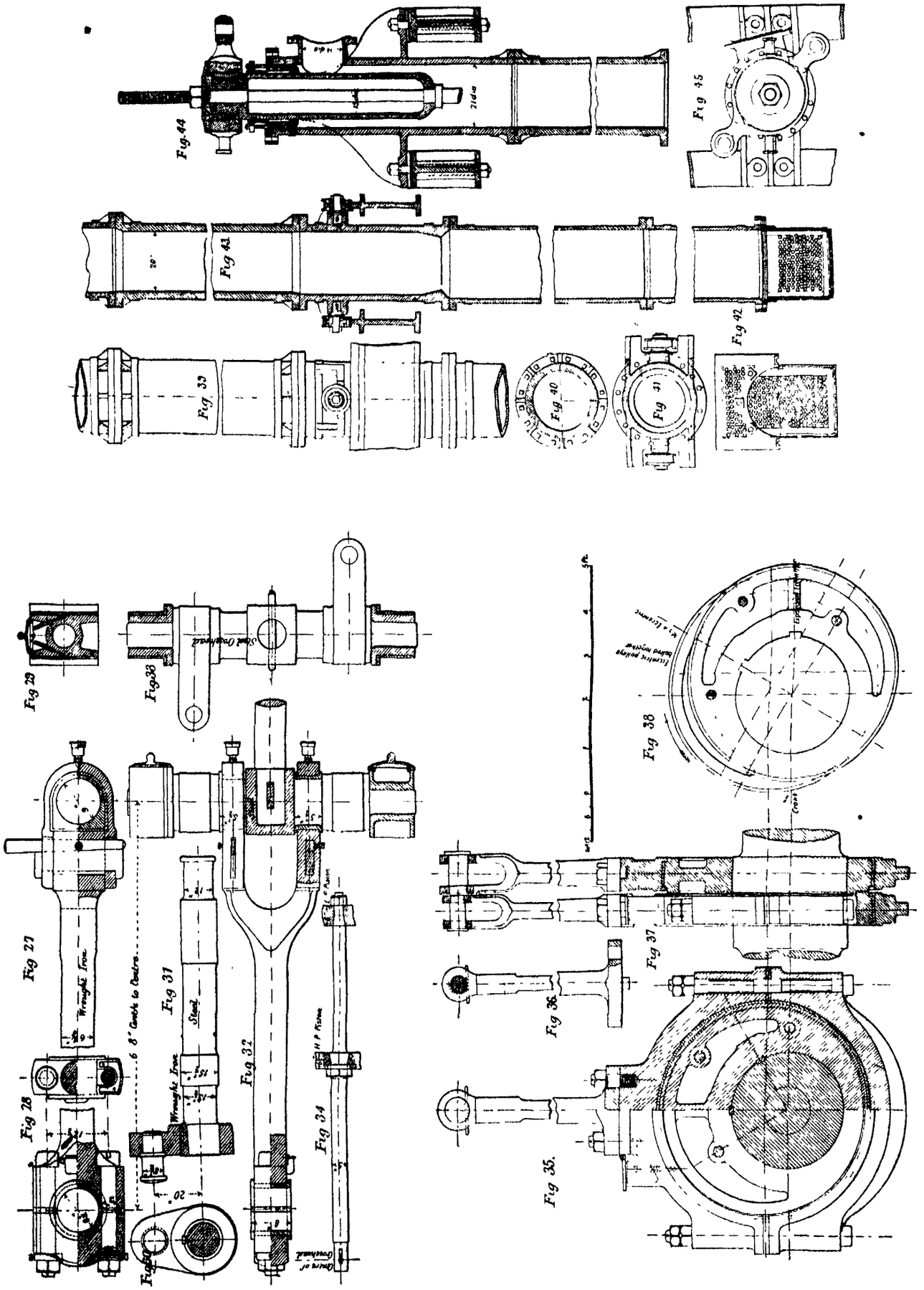
Referring to the illustrations, of which Figs. 1 and 2 will be found in our issue of October 3, Figs. 3 to 23 in that of October 24, and the remainder on the present and opposite pages, it will be [illegible] pumps are supported by heavy cast-iron girders, which rest on the brickwork of the well (Figs. 1 and 2); on these girders are erected substantial columns, 15 in. in diameter, cross-braced together, and supporting the engines above by means of a second set of cross girders. This system of support to the engines was preferred to brickwork, it being considered of primary importance that the pump-room should not only be perfectly open and accessible, [illegible] also as well lighted and as pleasant as the [illegible]ne-room, and not, as is usually the case, a confined, dark, dirty, and sometimes greasy hole in the foundations. The result is perfectly satisfactory, and well repays the small additional expense.

The engine-house, from the designs of Mr. G. A. Wallis and Mr. E. H. Currie, architect to His Grace the Duke of Devonshire, is a model of what such should be—it is at once a thoroughly substantial and elegant structure—for a height of 6 ft. from the floor, the walls are lined with glazed tiles of a dark chocolate colour, which give a very pleasing and clean appearance. The roof principals are of iron, the purlins and boarding of varnished pitch pine. With the exception of the space immediately round the engines (which is of wrought-iron chequered plate), the floor of the engine-room is formed of rubbed York paving, supported by rolled girders. The floor of the pump-room, with the exception of the well-covering of chequered plates, is formed with brick on edge laid in cement.

The general design of the boiler-house and coal store (Fig. 4, page 384), is similar to that of the engine-room; in each case the floors are paved with brick. The boilers, three in number, are of the Lancashire type, 7 ft. in diameter, 25 ft. in length; each has two furnaces 33 in. in diameter. The safety valves are loaded to 80 lb. per square inch, but the boilers are of sufficient strength for a pressure of 100 lb. per square inch. It will not be necessary therefore to reduce the working pressure for many years to come on account

DETAILS OF COMPOUND PUMPING ENGINE; EASTBOURNE WATER WORKS.

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of deterioration. The furnaces are of steel, welded and fitted with Adamson flange seams and Galloway tubes. The rivet holes were drilled in position after the plates were bent The total heating surface of each boiler is 807 square feet, the firegrates are 4 ft. long, and the firegrate area to each boiler is 22 square feet.

A feed-water heater is placed in the main flue, its scrapers are driven by a small horizontal engine fixed in the pump room; this also is employed when necessary, to charge the air vessels by means of an air-charging pump wrought from the piston rod. The air charging pumps fitted to the engines are only used to supply loss in the ordinary course of pumping The whole of the engine-house and pump-room is commanded by a 10 ton travelling crane.

A pair of 5 in. safety valves loaded to 180 lb per square inch are fitted between each of the pumps and air vessels, and in the event of any mismanagement of the main cocks, would discharge the whole of the water from the pumps back into the well. A governor is also fitted to each engine, which, however, does not come into action until a speed greater than the maximum working speed has been reached. In the event of the not unheard of accident of the bursting of a main, the engines would still be under control, although the attendant was not at hand to check them In actual work all regulation of speed is effected by the expansion gear alone, full boiler pressure being always admitted to the high-pressure cylinders

Before proceeding in detail to describe No. 1 engine, it may be well to state what special advantages are claimed for this class of engine as applied to pumping when compared with a beam engine, they are:

1 The pressure of the steam is transmitted directly to the pump piston or plunger, without the intervention of a beam

2 The number of the working parts and the weight of the engine are both considerably diminished.

3. The first cost is about 30 per cent. less, and the cost of maintenance is sensibly reduced.

4. A large saving in the cost of the buildings and foundations.

Direct-acting vertical engines up to 100 indicated horse power are best balanced by the flywheel; above that power, and as in No. 1 engine, it is desirable to get a light balance which can also be utilised for working the auxiliary pump.

As previously stated, this engine is compound, vertical, rotative, and direct-acting, placed directly over the well. The cylinders are inverted and arranged tandem fashion, but without the usual space for two stuffing-boxes between them In place of these a form of metallic packing is introduced which enables the cylinders to be directly bolted to each other. The advantages of the arrangement are (1) Reduced height of the engine; (2) a saving of one stuffing-box, (3) a reduction in friction, (4) an entire absence of air leakage into the low-pressure cylinder

The packing consists of two cast iron split rings, bored slightly smaller than the piston rod, and fitted up in exactly the same manner as an ordinary piston, with springs behind. The results have been most satisfactory, as after two years' constant use the piston-rod was found to be perfectly smooth, and no adjustments whatever were required.

The sizes of the cylinders are as under

	in.
High-pressure cylinder, diameter ..	20
Low " " "	38½
Stroke	40

On the upper end of the high-pressure cylinder is cast a strongly-ribbed sole plate (Figs 5 and 6) 8 in. deep and 4 ft. 6 in. square, to which the upper and low pressure cylinder is bolted, and which itself rests, and is securely bolted to, the engine frames

The bodies and external covers of the cylinders are steam-jacketted; the condensed water drains back into the boilers. The working barrels are cast separately of hard, close-grained metal, and fixed into their seats by hydraulic pressure; this method of construction is at once simple, and makes a thoroughly steam-tight job. The valve faces are cast of special metal and pinned on to the cylinders. Each cylinder is fitted with expansion valves (Figs. 5, 10, 11 and 12) capable of being independently adjusted whilst the engine is running. The main valves of both cylinders are actuated by one eccentric, and the expansion valves by another eccentric (Figs 35 to 38). The communication between the high-pressure exhaust passage and low-pressure valve chest is effected by two copper pipes, 4½ in. bore (Fig. 6). The exhaust branch to condenser is 10 in. bore. The cylinder covers and valve chest doors are polished, the bodies of the cylinders and the valve chests are lagged with sheet iron secured with polished brass bands; all the spaces underneath the lagging are packed with hair felt The pistons are hollow, and are fitted with Prior's packing rings, these give excellent results, and have as yet required no adjustment. Either piston can be removed or the packing adjusted by taking off the corresponding cylinder cover. The piston-rod, of Bessemer steel, is 5 in. in diameter between the cylinders, and 6½ in. in diameter at its lower part; the nuts securing the pistons to the rod are gun-metal. The valve spindles (Figs 14 to 20) are of Bessemer steel, and are fitted with adjustable slipper guides, which are bolted to the high-pressure valve chest (Fig 6). The spindles are so arranged that the valves of either cylinder can be removed without interfering with those of the other cylinder. The expansion spindle (Fig, 15) is fitted with a screwed joint to allow either of the two portions to be rotated independently. Indicator pipes and cocks, and a full set of drain and starting cocks, are fitted to each cylinder, these being arranged to be all operated from the lower platform.

The general design of the bedplate and framing is clearly shown in Figs. 1 and 2. The bedplate, of box section, is 10 ft. 9 in. long and 7 ft. 6 in. wide; it is formed with a circular trough (Fig 21) at the bottom which effectually catches all oil or dirt that would fall into the pump room, and also serves to support the girders for the pump rods. The crankshaft bearing is cast with the bedplate, the bottom brass is octagonal and the top brass is square; the cap is of polished wrought iron held down by two bolts 3½ in in diameter. The bottom of the bedplate is planed and adapted to rest in the cast-iron girders which carry it.

The standards (Figs. 24 and 25) are also of box section; one of them is utilised as the exhaust passage to the condenser, and they are all bolted together at their upper ends. The guide bars are fixed to the frames by means of three turned bolts, 3½ in. in diameter, fitted with nuts on the outside of the standards. The guide bars, 7½ in wide, are double ribbed; brass oil-catchers are fitted under the guides

The crosshead (Fig. 32) of Bessemer steel is 9 in. in diameter at the journals, and has two horns forged solid with it to take hold of the pump rods. The connecting rod of best scrap iron, 7 ft. 6 in. centres, is forked at its upper end to embrace the crosshead. The lower end head is of the marine type. The crankshaft (Figs. 30 and 31) is of Bessemer steel with journals 13½ in. in diameter. The diameter at the flywheel boss is 14½ in. The crank is of forged scrap iron, and is bored out to 15½ in., and shrunk on and keyed on the shaft. The crank-pin, of Bessemer steel, is 8½ in. in diameter and 8 in. long, and is shrunk into the eye of the crank and rivetted over.

The eccentric rods (Figs. 35 to 38) are of scrap iron; the eccentrics are 4½ in. wide, and two eccentric blocks are bolted together by three bolts, and secured to the crankshaft by long keys. A loose gun-metal lever, free to revolve, is fitted between the block and strap of each eccentric.

The rods connecting the engine and pump cross heads are of Bessemer steel 4 in. in diameter. All the working parts and the pump rods are finished bright.

The flywheel is 15 tons weight, 15 ft 7 in. in diameter, and is made in eight segments, which are planed and put together by wrought-iron dowels and keys. The centre is bored out and turned for polished wrought-iron hoops 5 in. deep and 3 in. thick, which are shrunk on the eye of the wheel in position.

The engine, as well as its platforms, is quite independent of the walls of the building. The lower platform is carried by cantilevers from the framing, and the upper platform by means of two light cast-iron girders bolted to the baseplate between the cylinders. The covering of the platforms is formed of wrought-iron chequered plates, and the handrails and standards are all finished bright. The whole of the gear necessary for starting or regulating the engine is controlled from the lower platform.

(To be continued.)

TREVITHICK'S ENGINE AT CREWE.

A few weeks ago, when dealing with the visit made to Crewe by the members of the Iron and Steel Institute during the Chester meeting, we mentioned (*vide* page 310 *ante*) the old high-pressure engine of Richard Trevithick, which, thanks to Mr. Webb, has been rescued from a scrap heap in South Wales, and re-erected at the Crewe Works. We this week give on page 476 engravings of this engine, which have been prepared from photographs kindly furnished to us by Mr Webb, and which will clearly show its design.

As we mentioned in our former notice the boiler bears a name-plate with the words "No. 14, Hazeldine and Co., *Bridgnorth*," and it is evidently one of the patterns which Trevithick was having made by Hazeldine and Co., about the year 1804. The shell of the boiler is of cast iron, and the cylinder, which is vertical, is cast in one with it, the back end of the boiler and the barrel being in one piece as shown. At the front end the barrel has a flange by means of which it is bolted to the front plate, the plate having attached to it the furnace and return flue, which are of wrought iron. The front plate has also cast on it a manhole mouthpiece to which the manhole cover is bolted. In the case of the engine at Crewe, the chimney, firehole door, and front of flue had to be renewed by Mr. Webb, these parts having been broken up before the engine came into his possession.

The piston rod is attached to a long cast iron cross-head, from which two bent connecting rods extend downwards, the one to a crank, and the other to a crank-pin inserted in the flywheel. The connecting rods now on this engine were supplied by Mr. Webb, the original ones—which they have been made to resemble as closely as possible—having been broken up. In the Crewe engine as it now exists it is not quite clear how the power was taken off from the crankshaft, but from the particulars of similar engines recorded in the "Life of Richard Trevithick,"* it appears that a small spur pinion was in some cases fixed on the crankshaft, and in others a spurwheel, with a crank-pin inserted in it, took the place of the crank at the end of the shaft opposite to that carrying the flywheel. In the Crewe engine the flywheel, it will be noticed, is provided with a balanceweight.

The admission of the steam to and its release from the cylinder, is effected by a four-way cock provided with a lever, which is actuated by a tappet rod attached to the crosshead, as seen on the back view of the engine. To the crosshead is also coupled a lever having its fulcrum on a bracket attached to the boiler, this lever serving to work the feed pump. Unfortunately the original pump of the Crewe engine was smashed, but Mr. Webb has fitted one up to show the arrangement. A notable feature in the engine is that it is provided with a feed heater through which the water is forced by the pump on its way to the boiler. The heater consists of a cast-iron pipe through which passes the exhaust pipe leading from the cylinder to the chimney, the water circulating through the annular space between the two pipes.

Altogether the Trevithick engine at Crewe is a relic of the very highest interest, and it is most fortunate that it has come into Mr. Webb's hands and has thus been rescued from destruction. No one, bearing in mind the date at which it was built, can examine this engine without having an increased respect for the talents of Richard Trevithick, a man to whom we owe so much and whose labours have as yet met with such scant recognition.†

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The warrant market was more steady last Thursday, thus showing that confidence was being restored. From Thursday of the previous week nothing but cash transactions had been recorded. Prices opened at 2½d. per ton under those current at Wednesday's close, but they improved, and closed 1½d. higher per ton than on the previous day. Transactions were reported on forenoon 'Change at 43s. up to 43s. 3d. cash, also at 43s. 1d. to 43s. 3d one month, the close being sellers at 43s 2½d cash, and 43s. 4d. one month, and buyers offering ½d. per ton less. Business was done in the afternoon at 43s. 2d. to 43s. 4d. cash, the market closing with sellers at 43s. 4d. cash, and buyers at 43s. 3½d. Friday's market was very quiet in the morning, but holders were very firm, and in the afternoon prices were advanced to the extent of 5d. per ton; the close, however, was only 2½d. per ton over that of the previous day. During the forenoon the cash transactions ranged from 43s. 4d. to 43s. 6d., and the close was sellers at 43s. 6d. cash, and buyers at ½d. per ton under. Iron changed hands in the afternoon at 43s. 7d. up to 43s. 9d. cash, also at 43s. 8½d. to 43s. 10d. one month, and the close was sellers at 43s. 6½d. cash and 43s. 8d. one month, and buyers offering ½d. per ton less. The market was weak on Monday, and prices experienced a decline of 6½d. per ton. There seemed to be a withdrawal of the late pressure put upon the market by the holders of warrants, and it was expected that business would be conducted with less recklessness for some time to come. Business opened at 43s. 4d. (being 2½d. down) to 43s. 2d. and 43s. 3d. cash, the close of the forenoon market being sellers at 43s. 2½d. and buyers at 43s. 2d. cash, and in the afternoon the quotations were 43s. 2d. down to 42s. 10½d. and back to 43s. cash, the market closing with sellers at 43s. cash and 43s. 2d. one month, and buyers offering ½d. per ton lower. Yesterday's market opened weak, and at a decline of 1½d. per ton, but recovered, and closed as on the previous day. In the morning there were transactions at 42s. 10½d. up to 43s. cash, also at 43s. to 43s. 1½d. one month, and sellers at the close were wanting the last-named quotations, with buyers near. In the afternoon the quotations ranged from 43s. 1d. to 43s. cash, and at the close of the market 43s. was the nominal cash price. A renewed upward tendency in prices was shown to-day, the forenoon quotations ranging from 43s. to 43s. 5d. cash, the close being buyers at 43s. 5d. cash and sellers at 43s. 5½d. In the afternoon the range of prices was from 43s. 4d. to 43s. 6d. cash, and towards the close of the market there were sellers at 43s. 6d. cash and buyers at 43s. 5½d. It cannot be said that there is much change to report in the position of the market so far as warrants are concerned, which seem to remain under the control of those who have of

* "Life of Richard Trevithick, with an Account of His Inventions." By Francis Trevithick. London and New York: E. and F. N. Spon.

† It may not be out of place here to remind our readers that the subscription list for the Trevithick Memorial Scholarship—a fund of which Mr. Henry Chapman, 113, Victoria-street, London, S.W., is the honorary secretary—is not yet closed. The object of this subscription, namely, the establishment of an engineering scholarship to commemorate the labours of Richard Trevithick, is a most meritorious one and deserves every support.

the popular notion is regarding the effect of turning the feed into a boiler which has been allowed to get short of water and become overheated, the Manchester Steam Users' Association has for some time been conducting an extensive series of experiments with a full-sized Lancashire boiler under various conditions. The results of the tests, we believe, fully confirm the opinions held by boiler engineers, and prove that the ideas entertained by the general public with regard thereto are quite fallacious. We understand these experiments are now completed, and we shall look forward with considerable interest to the publication of Mr. Fletcher's official report thereon.

THE RAILWAY ACCIDENT AT NORTH WOOTTON.

The report of the Government inspector on this accident has now been issued, and the remarkable features attending it, which we have already alluded to (see page 251 *ante*), are fully borne out by General Hutchinson. As the disaster at Penistone will be famous for the sacrifice of life owing to the failure of a vacuum brake, so will this accident on the Lynn and Hunstanton line be remarkable for the lives saved by the Westinghouse brake. The circumstances are peculiar, and as they illustrate very opportunely some crucial points with regard to the merits of different systems of brakes, it is of importance again to call public attention to the facts

The Lynn, Hunstanton, and West Norfolk Railway is a single line worked by the Great Eastern Railway Company. On the 3rd of September the 4.45 P.M. passenger train, consisting of a tank engine running chimney first, and seven vehicles, left Lynn for Hunstanton, and when running from forty to fifty miles an hour between North Wootton and Wolferton Stations, at a point about 4¼ miles from Lynn Station, the engine and all the vehicles left the rails and came to rest in about 90 yards from the first mark of a wheel having mounted a rail. The engine turned over on its right side on the edge of a ditch on the right side of the line, and with its chimney still towards Wolferton; the first vehicle, a carriage truck, remained still attached to the engine, and was turned over on its left side with its trailing end towards Wolferton; the second vehicle, a horse-box, was turned over on its left side across the left rail about opposite the front of the engine, its front and rear couplings having both given way; the third and fourth vehicles, a third-class and composite carriage, were on their left side still coupled together, but the composite separated by a short interval from the vehicle in the rear; the fifth, sixth, and seventh vehicles, a third-class composite and brake van, were on their wheels coupled together and astride of the left rail. The engine was but little damaged, as well as the carriage truck and horse-box, though the leading wheels of the horse-box were carried from under it. The front end of the first third-class carriage was knocked in. In the composite next it, the body was lifted off the frame, and the floor pierced by a rail; the third-class carriage next had its front end damaged, and the two remaining vehicles were practically uninjured. In the permanent way, 15 rails were broken and 7 bent, 142 chairs were broken and 72 sleepers damaged. Although the two third-class carriages were full, and the two composites partly full, there being about 150 passengers in the train, only six complaints of slight injury have been received, and the guard states that at the time no one appeared hurt, while the servants of the company escaped without a scratch.

That such wonderfully little damage resulted, either to passengers or stock, is due entirely to the powerful and instantaneous action of the Westinghouse brake, as well as to the system upon which its automatic action is carried out. The five rear vehicles had come in from Wisbech attached to an engine fitted with the brake, but the engine which took the train on from Lynn was not so fitted. With any other brake in the country, either automatic or non-automatic, the train would consequently have been from that point deprived of any controlling agency, since they have no means of storing power independent of the engine. The Westinghouse brake, on the other hand, admits of the pressure being retained on the carriages for use by the guard, or for automatic application in case of a train breaking into two, and on this occasion the train left Lynn with a pressure of 50 lb. in the reservoirs on the carriages. It is entirely due, as we have said, to this singular and important advantage that there was no loss of life to deplore in the case before us. In the ordinary case, where an engine and train were fitted throughout with a brake, the driver would have applied it so soon as the engine left the rails, and if non automatic, the brake would come off almost immediately as it did at Penistone, when twenty-four people were killed and sixty-four injured. At North Wootton, of course the driver had no control over the train, but it appears from the evidence of the guard that he was sitting on the raised seat at the back of the van with his hand resting on the tap of the air brake. The sudden jerk when the engine left the rails, he stated, "threw me forward into the body of the van, and my hand must have opened the tap as I fell forward, as on recovering myself I found that the brake had gone on, and the gauge had gone down to zero." The couplings parted between the second and third carriages, so that even if the guard had not thus unintentionally applied the brake, it would have been put on automatically by the separation of the vehicles. General Hutchinson's conclusion is to the effect that the accident must "be attributed to the dangerous oscillation of a tank engine having been attained when running at a higher speed than it is safe for such engines to attain, and that having reached to between forty and fifty miles an hour, from some cause that cannot clearly be ascertained, the right leading wheel of the engine mounted a right-hand rail, and thus led to the whole train running off the line." The inspector adds, "It was a fortunate thing that the five rear carriages of the seven vehicles composing the train were fitted with the Westinghouse brake, and that the compressed air had been left in the reservoirs under these carriages after their arrival from Wisbech." The position and condition of the vehicles after the accident, as already described, is a matter of importance as evidencing what would have been the result if a quick-acting brake had not been at hand. The fact that the overturned engine, carriage truck, and horse-box were lying across the line in front, that some of the ends of the carriages were knocked in, and the body of one lifted off its frame, with the floor pierced by a rail, all point to the conclusion that it was a very near thing indeed, and that the loss of even two or three seconds in the application of the brakes, meant all the difference between life and death to many of the passengers.

There can be no doubt that it is only by the combination of the good qualities which so pre-eminently distinguish the Westinghouse brake, that lives can be saved in emergencies like those at Penistone, Downton, and North Wootton, as well as many other places. It is mere begging the question to plead, as is done for other brake systems, that something short of the best is good enough. Some may be good enough until put to the test, but when the emergency arises with that dreadful suddenness which characterises all our worst accidents, nothing but the application of a great force instantaneously brought into action can avail to prevent or mitigate disaster, and the time cannot be far distant when the railway companies will be brought to see the matter in the same light.

STEEL PROJECTILES.

About a month ago we learned that during practice at Cronstadt on September 26, an 8-in. breech-loading howitzer burst explosively, severely injuring a large number of the detachment working the gun. This howitzer was constructed at the Government factory at Perm, and formed one of a number of similar weapons destined for arming the coast defences. It was made of steel, with steel hoops, and fired a projectile of 200 lb. with 30 lb. of powder.

This disaster shows that liability to accident is not the unique characteristic of British guns, as a section of our critics would have us believe. When a projectile broke up on a recent occasion in the bore of a 100-ton gun at Gibraltar, there was no lack of announcements of the failure of another English gun, and one writer at least of some pretensions to knowledge of artillery matters, without waiting to hear the whole facts, indulged in a jeremiad on the subject of British ordnance in general. It will, we suppose, be of small interest to these gentlemen to learn that the official examination of the gun has declared the injuries to be unimportant and easily repairable on the spot. Until steel projectiles are generally adopted, an occasional break-up of a cast-iron shell in the bore of a gun may be anticipated, but that our guns should support the unusually heavy strain thereby produced with only slight injuries to the grooves where the broken pieces of the projectile struck, must be considered as a satisfactory demonstration of their general excellence of construction, apart from the question of their design.

It is certainly curious that as yet so little has been done in England towards providing a projectile for our heavy modern guns which is able to utilise a high proportion of the enormous power developed. It is characteristically inconsistent to re-arm our fleet with guns of greatly increased power, and yet leave them the old description of projectiles made of relatively weak and brittle cast iron, which have proved themselves very much inferior to steel shell, of which several foreign powers have already acquired a supply for use with their armour piercing guns. Of what use can it be to add largely to the energy developed in the projectile if the material of which it is made remains inherently weak, and consequently incapable of transmitting the stored-up work to the plate attacked? The excellent results obtained recently with the 100-ton breechloading gun fired against compound and steel targets at Spezia were in great measure due to the admirable steel shell used, manufactured by Krupp. What the special process of manufacture of these projectiles may be, is not known, and the secret is jealously guarded, but the results obtained with them have shown extraordinary hardness combined with great tenacity. Much of this may be due to the excellence of the material used, but it is probable that their unusual power of withstanding the vibration induced by impact against steel and steel-faced armour, is due to special tempering, to which it is known Mr. Krupp has devoted great attention.

One advantageous feature of these shells is that their heads are solid and not furnished with separate points or tips as is the case with some English projectiles of the same material. Whatever advantages may be gained by the use of a specially hard point loosely fixed to the front end of shell in favouring the manufacture and tempering as well as the subsequent penetration of the apex, is unquestionably lost in the diminished capability of the shell as a whole to withstand the enormous vibrating and crushing strain of penetration, and the tendency of the point itself to wedge or split open the body of the projectile.

One great objection to the introduction of steel shell is their cost, but that sooner or later they will have to be employed is inevitable, unless we wish to see our cast-iron projectiles shivering harmlessly against the armour of our opponents, whilst their steel shells are playing havoc with ours.

Russia, Germany, Italy, and France are providing themselves with a large supply of these projectiles, and we cannot afford to be left behind It is also probable that when our manufacturers turn their attention to the subject it will be found possible to considerably reduce the present price of manufacture, as it is known that Mr. Krupp has succeeded in producing steel shell at a comparatively low figure.

ELECTRIC LIGHTING AT THE INTERNATIONAL HEALTH EXHIBITION.

No. XII.

Concluding Notice.

We must now draw this series of articles to a close. It is not professed that they constitute a complete description of the many apparatus which figured in the nightly illumination, such an account would be as wearisome as a thrice-told tale. All that has been attempted has been to call attention to matters which have the merit of novelty, and have come into existence since the last Exhibition allowed a comparison to be made between the numerous systems before the public. In some cases we have travelled beyond the limits of the actual exhibit, and have taken advantage of the occasion to give particulars of apparatus of later date than that sent to South Kensington, which had already been in place several months before the publication of our first notice. By thus overstepping a little the boundaries to which our object was limited by its title, we have been able to present our readers with an account, which is practically complete, of current electric lighting in this country.

Two important firms, Messrs. Siemens Brothers and Co., Limited, and Messrs. R. E. Crompton and Co., were not professedly exhibiting, but

both lent apparatus which was used in the illumination of the fountain and grounds. Attention was called to them in a previous article, but so much interest was excited by the performance of the Siemens machines, that a few additional details will be interesting. The lamps in the South Gallery were fed by two alternate-current machines of the type W_{11}, each of which supplied 550 Swan lamps of 20 candle-power, arranged four in series. The intensity of the current was 175 ampères, and the electromotive force 200 volts. These generators are of the usual Siemens pattern, except that the armatures are wound with ribbon instead of wire conductor, a practice which has already been in use by the firm for more than a year. They attract no special attention until they are compared with other machines of similar power, when their great simplicity and lightness are immediately recognised. Although they absorbed more than 50 horse-power, they did not require heavy foundations or elaborate baseplates, but were fastened down to the floor just as if they had nothing to do but drive a few arc lamps. In each case the electro-magnets were excited by a D_7 dynamo, and the speed of rotation was between 1100 and 1200 per minute. The chief interest, however, centred on the large dynamo of the B_2 type used in the illumination of the fountains. It produced a current of 420 ampères, with an electromotive force of 70 volts, and fed a number of arc lamps arranged in multiple arc, besides filling a "general utility" part on other occasions, when it was pressed into service to make up for the deficiencies of other generators. In construction it is simply an enlarged Siemens direct-current dynamo with the wire wrapping of the armature replaced by rectangular conductors. The original Hefner-Alteneck design appears to need no modification, and the larger the scale upon which it is carried out, the more successful are the results. There were also in the Exhibition several other Siemens machines of the usual patterns, generating both direct and alternate currents.

The Pilsen-Joel Electric Light Company, of Telegraph-street, Moorgate-street, E.C., showed a number of Pilsen arc lamps and Gatehouse incandescence lamps. The Pilsen lamp has now assumed even a simpler form that it had originally, and appears to be as free from mechanical complication as it is possible to conceive that an arc can be. The means of regulation consists of a compound coil, formed of a bobbin of coarse wire in the main circuit, overlaid with a wrapping of fine wire, in a shunt circuit round the arc. Within this coil there works a conical core of such a configuration that the influence of the coil upon it is the same in whatever position it stands. To the lower end of this core the carbon-holder is attached. When the carbon is long the core passes through the coil and projects beyond it on the upper side, and as the carbon wastes, the core descends under the action of gravity. The effect of the coarse coil is to raise the core, and that of the fine coil to depress it, and it is upon the difference of the two actions that the feed depends, as is well understood. This lamp requires a current of eight ampères and 46 volts and gives a light of 2000 nominal candles. The current is generated by a modification of the Schuckert dynamo, the original of the Victoria and the Gülcher generators As now manufactured by the Pilsen Company, the flat disc which forms the core of the armature is composed of a ribbon of iron wound in a volute form with a layer of cloth between the adjacent convolutions. This ring is wound directly upon the hub and is not attached thereto after the coiling of the conductors is completed, as has been formerly the practice. The hub is of gun-metal, and has arms ending in forks, in which the iron ribbon is laid. The sections of conductor wound on this core are separated from one another by soft iron shoes or wedges insulated from the rest of the iron in the core, and it is claimed that the use of these separate pieces increases the efficiency of the machine The company also showed a very simple form of ammeter devised by Mr. Dunston, one of their engineers. Two flattened coils of wire are mounted upon the same axial line, and between them is arranged a vertical spindle carrying a needle or armature, and an index. Within each of the coils there is a soft iron core having a hollow curved end struck from a centre near the centre of the vertical spindle. The influence of the coils, within which the needle or armature enters, and the attraction of the cores together, tend to rotate the spindle in opposition to the power of a spring. By giving the faces of the cores a suitable form the deflections can be rendered equal for equal increments of current. The instrument can be ordinarily made to show variations of a tenth of an ampère, and is very dead beat.

The Gatehouse lamps, which were situated in the East Central Gallery, were fed by current from two machines exhibited by Messrs. Elphinstone and Vincent, of 16, Bedford-row, Holborn, W.C. Each machine gave a current of 240 ampères with an electromotive force of 90 volts, and weighed 30 cwt. only. The alterations which have been effected since last year principally refer to structural details. The four, six, or eight brushes that were then used have been replaced by a single pair, the equipotential segments of the commutator being connected internally as we lately explained in reference to the Victoria machine, when our remarks gave rise to a correspondence as to whom belonged the honour of the invention. The Elphinstone-Vincent dynamos are usually made with six poles, but unlike all other machines in the market, each pole of the external field is reinforced by a stationary pole within the armature. This latter consists of a long hollow cylinder of non-magnetic material, mounted upon a disc at each end. Each disc has a boss bored out to run on the spindle which carries the internal magnets; upon one boss the driving pulley is mounted, and on the other the commutator. The method of winding is as follows: A hank of insulated wire is coiled on a mould of such a form that it assumes a rectangular shape, and it is then transferred to the non-magnetic core The hank may consist of one coil only, or it may be composed of two, or four, laid one over the other, according to the nature of the current required. When it is laid upon the core it embraces between the two sides of the rectangle an angular distance equal to the distance from pole to pole; in a four-pole machine 90 deg, and in a six-pole machine 60 deg. A second coil is laid by the side of the first, one of its longer sides falling within the area, circumscribed by the first, and the other falling outside. A third and a fourth coil follow, and so on, until the whole cylinder is covered by groups of conductors running longitudinally, each occupying an independent strip. But it is not possible that the ends of the rectangles should be arranged so conveniently; as they have to pass over one another, since every hank lies partly within and partly without other hanks. When the first hank is put in place its ends lie on a part of the cylinder beyond the field-magnets, and follow its curvature. The ends of the next hank lie partly on the cylinder, and partly on the previous hank, and so on. A longitudinal section of the completed armature, therefore, cuts the ends of three or four coils laid one above the other.

It is necessary that the coils should not only be arranged in proper sequence electrically, but also that they should produce together a perfectly balanced armature. To show how this is accomplished we will describe the winding of a four-pole machine, having twelve hanks on the armature, each hank comprising two coils. Let the coils be numbered 1 to 24, Nos. 1 and 13, 2 and 14, &c., forming together each one hank, and further let the two ends of each coil be distinguished thus, 1 and 1*, 2 and 2*, 3 and 3*, and so on. The surface of the cylinder is divided into 24 equal portions, since each of the twelve hanks occupies two portions. Coils Nos. 1 and 13 occupy the first and seventh portions; coils Nos. 2 and 14, instead of being laid in the second and eighth portions, are turned in the opposite direction, to the second and twentieth; Nos. 3 and 15 occupy the third and ninth; Nos 4 and 16 the fourth and twenty-second; Nos. 5 and 17 the fifth and eleventh; Nos. 6 and 18 the sixth and twenty-fourth. This accounts for one-half of the coils, and occupies one-half of the cylinder. The others maintain the symmetry, Nos. 7 and 19 occupying the thirteenth and nineteenth spaces; Nos. 8 and 20 the fourteenth and eighth; Nos. 9 and 21 the fifteenth and twenty-first, and so on. The connections to the commutator are equally simple. Distinguishing its segments by the same numbers as the spaces on the cylinders, we find the ends 1 and 2* on No. 1 segment; 2 and 3* on No. 2; 3 and 4* on No. 3; 4 and 5* on No. 4; 5 and 6* on No. 5; 6 and 13 on No. 6; 13* and 14 on No. 7; 14* and 15 on No. 8; 15* and 16 on No. 9; 16* and 17 on No. 10; 17* and 18 on No. 11; 18* and 7* on No. 12; 7 and 8* on No. 13; 8 and 9* on No. 14; 9 and 10* on No. 15; 10 and 11* on No. 16; 11 and 12* on No. 17; 12 and 19 on No. 18; 19* and 20 on No. 19; and so on. It will thus be seen that the system of connections is perfectly simple, and can be readily understood whatever is the number of poles. The hanks are bound on to the cylinder by a wrapping of phosphor-bronze wire, and the ends are secured by phosphor-bronze clips.

The magnets are shunt-wound or compound according to circumstances. Before the latter form of winding was devised, Messrs. Elphinstone and Vincent obtained self-regulation over a wide range by causing the magnets to become saturated with a small current. By this device they could turn out 80 per cent. of the lamps with safety. The machines are made in all sizes from 5 to 500 lamps, and of course can be made much larger when required. The comparatively great diameter of the armature allows of a high peripheral speed with a moderate rate of rotation, and permits of a moderate internal resistance being obtained with wire of manageable diameter by coupling the coils in parallel arc.

Messrs. Parker and Elwell, of Wolverhampton, furnished the current for lighting the lamps in Mr. Taylor Smith's artistic fittings. Their apparatus consisted of a dynamo and twenty-four Planté cells. The Parker-Elwell dynamo has a Gramme or Pacinotti armature of very considerable length, constituting in fact a hollow cylinder rather than a ring. The machine is thoroughly well made, and gives excellent results. The secondary battery is distinguished from the Faure and the Sellon batteries, by being made of metallic lead only. The plates are soaked in dilute nitric acid until they acquire a spongy texture, and are then rapidly "formed" under the influence of a current. By this method of manufacture, which was patented in this country independently by Messrs. Parker and Elwell, and by M. Planté, the difficulty arising from the peeling of the oxide is avoided.

Mr Killingworth Hedges supplied a number of fusible safety plugs for use in different parts of the Exhibition. In them the usual lead wire is replaced by a strip of foil of a peculiar alloy, inclosed between plates of mica. For large currents two or more strips of foil are used according to the section required. The use of the mica is to retain the foil in place, and prevent it from being scattered in hot particles when it is fused Mr. Hedges makes his cut-outs in several different forms, specially arranged to facilitate the insertion of a new bridge when one has given way.

The Jablochkoff Company, of the Albert Embankment, made a fine display of their lights. The South Central Gallery, the Central Avenue, and parts of the East and West Central Galleries, were illuminated by their candles in a most satisfactory manner. The use of two candles in one lantern, and of Trotter's glass, secured an exceedingly uniform effect. The generators were of the customary type.

The whole of the power for the combined installation was supplied by Messrs. Davey, Paxman, and Co., of Colchester, whose exhibit included six engines and eleven boilers. Two of the engines were large double-cylinder horizontal coupled engines with heavy flywheels of 12 ft. diameter. Two were compound engines of the receiver type, one with and the other without a boiler on the same bedplate. One was a double-cylinder semi-portable engine and the sixth a double-cylinder semi-fixed engine. All the boilers were made of steel and of the locomotive type. The power given out by all the engines when worked simultaneously, as they were night after night during the period of the Exhibition, was about 1280 indicated horse-power, and the average consumption of coal, including that required for getting up steam, was 3926 lb. per hour, or about 3.07 lb. per indicated horse-power per hour. On several occasions trials with the compound engines alone gave an average consumption of coal of 2.2 lb. per indicated horse-power per hour. These figures show a very high degree of economy, especially when it is considered that the engines had no condensers, and that the quantity of coal expended in lighting up the fires is large in proportion to the coal consumed during the time the engines were at work, which time was about four hours every night on an average. All the engines were fitted with Paxman's patent automatic expansion gear in connection with adjustable governors, by which the number of revolutions made per minute by the engines kept practically constant, and only showed a variation of 1 per cent. On two occasions the large driving band on one of the coupled engines broke, when the engine was transmitting about 300 horse-power; but the

ELECTRIC LIGHTING OF H.M.S. "COLOSSUS."

THE ANGLO-AMERICAN BRUSH ELECTRIC LIGHT ASSOCIATION, LIMITED, LONDON.

(*For Description, see Page* 482.)



FIG. 1.

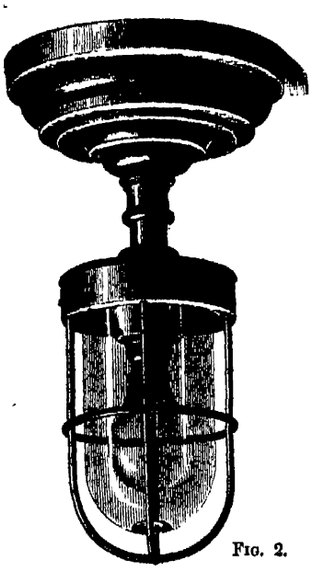


FIG. 2.

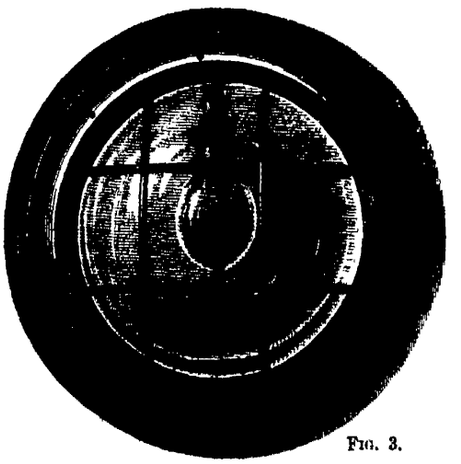


FIG. 3.

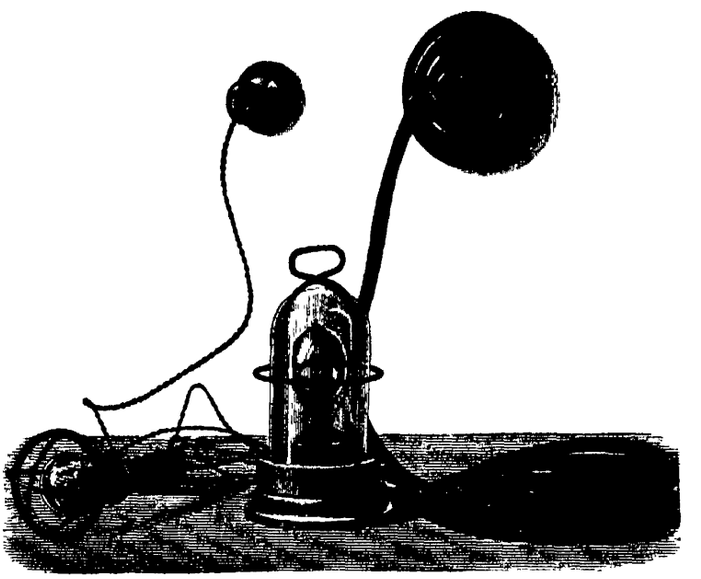


FIG. 4.

governor at once took charge of the engine, w immediately resumed its normal speed. The ... gines have been at work night after night during the Exhibition without any stoppages or alterations being necessary. The work required being rather more than was anticipated, some of the boilers had to be provided with an injector in addition to the donkey pumps, which did not prove to be quite suffi-

NOTES.

MAGNESIUM SEARCH LIGHTS.

THE electric light when used for searching purposes is subject to the drawback that in misty weather its rays fail to penetrate the atmosphere so well as ordinary oil or gaslights. Magnesium light is not open to the same objection, and is likely to be used for search purposes in preference to the arc light as at present supplied. The purer the magnesium the better the light, and very pure magnesium can now be prepared by the electrolytic process of Grätzel, who recently exhibited in Berlin a ball of pure magnesium 15 centimetres in diameter. Ordinary magnesium contains a proportion of potassium, and tends to oxidise in the air, but the pure metal retains its silvery lustre.

DETERMINING THE LEGAL STANDARD OF LIGHT.

Dr. Werner Siemens has recently pointed out a practical way of producing the light adopted by the Paris International Electrical Congress as the standard of light. Platinum at the point of solidification readily takes up foreign substances which change the point in question; hence Dr. Siemens prefers to determine the light given out by the platinum at its melting point, which with pure platinum is about the same as in the other case. The platinum surface in the form of a thin sheet or foil, is inclosed in a metallic case provided with a hole 0.1 square centimetre in section; the hole being just in front of the foil. The sides of the hole are conical and the foil completely closes it up all round. A current of electricity is sent through the foil until it fuses; and at the instant of melting a quantity of light equal to 0.1 of the legal standard is emitted by the hole. By suitably graduating the electric current, the melting point of the platinum can be delayed until all is prepared to make the comparison with another light. Experiments show that the light emitted from the opening is about 1½ times the British standard candle.

HENRY LARTIGUE.

We learn with much regret of the death of M. Henri Lartigue, Director of the Société Générale des Telephones, at Paris, on the 19th inst., at the age of fifty-six, and after a long illness, which had left no hope of his recovery. The chief portion of M. Lartigue's career was filled with the company of the Northern Railway of France, and it was in the capacity he there occupied that he developed the ingenious and inventive qualities which led him to devise a large number of electrical apparatus applied to railway working. Among these we may mention the electric semaphore, invented by him jointly with MM. Tesse and Prudhomme, an automatic whistle, a level crossing indicator, a c ling apparatus for switches, &c. When the Générale des Telephones was incorporated at Paris, by the amalgamation of the several independent companies, M Lartigue was elected its manager, and he by his tact, business qualities, and technical knowledge, contributed largely to the success of the enterprise The death of M. Lartigue, who was a member of the Consulting Committee of French Railways, will be long felt as a loss to the scientific world

THE SYNCHRONOUS MULTIPLEX TELEGRAPH.

The new telegraph system of Mr. Patrick Delany, of New York, has been successfully tried between Boston and Providence, R.I., United States, over a No. 6 galvanised iron wire line. In this system, it may be remembered, the transmitting discs or rotary contact makers at both ends of the line, are kept in synchronous rotation by means of tuning forks which transmit tuned electrical impulses along the line. The system has been worked out so well by the inventor that during the recent trial a single wire was made to transmit six different messages at the rate of forty words per minute each message. Again, twelve different messages or "circuits" were kept going at the rate of twenty words per minute; and by a different arrangement the single wire was made to correspond to seventy-two distinct circuits, each working at the rate of from two to three words per minute. The distance between Boston and Providence is about fifty miles, but this was practically doubled, by introducing a return wire, and the speed of transmission was about the same. One advantage claimed for the system is that a small group of cities at each end of the single line may all telegraph over the latter by their own special circuit, just as though they each had their own special wire.

ELECTRIC TRANSPORT OF POWER.

The water power of the River Suze, at Bienne, in Switzerland, has been utilised for watchmaking by means of turbines and dynamos The concessionaires have their plant at Boujeon, where there is a cascade and waterfall in a gorge of the river. At present only two turbines are installed, the larger being driven by the cascade. It is a Girard turbine capable of supplying 180 horse-power The power is communicated to the dynamos by means of belts. There is space for four dynamos in the shed which has been erected. The receiving dynamo is 1250 metres distant, and serves for two workshops requiring between 6 and 18 horse-power. It is essential for the watchmaking work done that the speed of the receiver should be uniform, and compound wound dynamos have been found the best for the purpose. The conductor connecting the two dynamos is aerial, and consists of two wires 7 millimetres diameter,

each carried upon posts and telegraph insulators. The generating dynamo runs at 500 turns per minute, and gives an electromotive force of 350 volts; the receiver runs at 400 turns, and with an electromotive force of 300 volts. These machines are the H_2 type of Thury dynamo, and their industrial efficiency is more than 70 per cent. One novelty of the installation is the introduction of lightning protectors at the ends of the line, a very necessary precaution, since the apparatus has been fused several times by lightning during the past summer. The installation is one of the successful, practical, and economic examples of the transport of power by electricity.

On Slag.

Herr Ledebur, a German chemist, has made some interesting experiments on slag from which we select the following deductions He finds that the richer a pig iron is in carbon, silicon, and manganese, and the higher the temperature of the furnace, the less iron goes into the slag. Again, the lower the temperature of the furnace the more manganese goes into the slag. If the temperature be higher and the fuel applied more than is required to reduce all the manganese in the charge, silicon is reduced. Grey pig is formed when the quantity of manganese present is not sufficient to prevent the formation of graphite induced by the silicon; in presence of much manganese a silicon-iron-manganese alloy is formed. Owing to the high temperature in the Bessemer process the affinity of carbon for oxygen is considerably increased as compared with the puddling process. While carbon is present in the bath the quantity of iron in the slag will be less than in puddling furnace slag; when the carbon has disappeared the slag is still poorer in iron, owing to the action of the iron in the slag of the converter lining. Continued blowing after the carbon is removed also increases the iron in the slag; but if, on the other hand, the burning of certain substances, such as phosphorus in the basic process, raises the final temperature, and increases the quantity of slag, the proportion of iron is reduced thereby. In the Siemens-Martin process the temperature is high and the furnace lining is silicious, so that the slag must contain more silica and less iron than in the older refining processes for producing wrought iron. On the whole these slags range between the same limits as the Bessemer slags do. We may add that M L. Garnier has advantageously applied blast furnace slags to vines as a preventive of phylloxera. The sulphur they contain is believed to be the remedy.

THE LIGHTING OF THE "COLOSSUS."

Since the Brush Company has turned its attention to incandescence lighting it has been fortunate in securing the lion's share of the Admiralty orders, and has justified the choice of the authorities by the erection of some first class installations on shipboard. In the Victoria dynamo* it possesses a machine which is eminently adapted for marine use, because from the comparatively large diameter of the armature a great peripheral speed is obtained at a slow rate of rotation, and hence direct driving can be adopted without the engines being pressed unduly. The use of four or six poles is also another advantage, and very greatly increases the output of the generator without adding to its size or complexity. These two features, combined with first-class workmanship and the minimum of sparking, recommend the Victoria machine for all kinds of work, and particularly for use in places where space is valuable, and where a breakdown may be almost a matter of life and death. In naval warfare the great engine of defence against torpedo attack is vigilance, but in the dark it is exercised at such great disadvantage when the most important sense of sight is almost inoperative, that the odds turn in favour of the enemy, unless the whole area about the ship be incessantly patrolled by guard boats, a practice which exceeds in weariness and exposure the detested sentry-go of the garrison soldier. The electric light, however, restores to the look-out the faculty of vision and he can sweep the sea, often for miles, with the certainty of detecting anything larger than a wherry. It is, therefore, most important that the means of defence, which vies in utility with other portions of the armament apparently much more formidable, should be secure against all chance of breakdown, as it is matter of universal experience that if a hitch occurs it always happens at the most critical moment. In the Colossus, the latest and most complete Brush installation afloat, there are three dynamos each driven by an independent engine, and as long as one of them is intact, it will maintain either one or two search lights. There are three Mangin projectors on board the ship, two forward and one aft, and any of them can be connected to either of the generators at will. All the machines have their magnets compound wound, as they are also used for incandescence lighting, and they are found to answer extremely well for the hand lamps of the regulators, which, of course, are liable to irregularities in the feed from inattention or unskilfulness on the part of the attendant. If the arc becomes excessively long the excitation of the shunt coil maintains the electromotive force, which would rapidly drop in a series wound machine, and if the arc breaks and has to be re-established, the influence of the series coils aids the process, which is sometimes difficult in a shunt-wound machine.

Of the three machines, one is designed to feed the search lights, one to illuminate the interior of the ship, and one to be held in readiness to replace either of the others. Six circuits proceed from the engine-room; two lead to the projectors, one to the citadel, one to the engine and boiler-rooms, one to the officers' quarters, and the last is the fighting circuit. Each dynamo is capable of feeding 200 lamps of 20 candle-power each, and gives a current with an electromotive force of 80 volts. Many of the lamps, however, are only of 10 candle-power, these being used for the mess tables, officers' quarters, and for general illumination. The deck is lighted by two yard arm reflectors, each containing eight lamps of 40 candle-power with flexible leads, which allow them to be suspended at any point. The connections for these are made at a terminal box on the superstructure. The whole of the lamps and globes are protected from the concussion caused by the fire of the large guns by the spring arrangement described at page 255 *ante*. Those in the cabins and state-rooms are inclosed in lamps illustrated in Fig. 1 (page 481), while the lamps exposed to rough usage are protected by gratings, as shown in Figs. 2 and 3, the former being intended for attachment to a bulkhead, and the latter to the deck above. In many parts of the ship sockets are provided to which flexible conductors can be attached, and thus the lamp can be moved about over a considerable area (Fig. 4).

The application of the electric light to every one of Her Majesty's vessels of war cannot be long delayed now The navies of foreign powers will be accompanied by a cloud of torpedo boats, and in the event of war, their moral effect against ships not perfectly equipped against their attacks, will be far more formidable than their power for evil would warrant. The stage of experiment as regards generators and lamp has passed, and there can be no excuse for further delay on that score. One point, however, still remains for improvement. The projector offers a good mark for a shot, and a very slight injury would be fatal to it. It is difficult to see how this is to be avoided except by the use of reflectors, a method which entails a large loss of illuminative power. Something, at any rate, might be done by means of shields to lessen the area exposed, and to render the position of the attendant less perilous. Of course there is little fear of shots fired from a torpedo boat, but if two vessels engage in a duel at night the one who could extinguish her adversary's light would have a great advantage, as the machine guns of her antagonist would then be fired entirely at random, and many operations could be safely attempted which would be instantly repressed or defeated if they could be seen.

* See Engineering, page 255 *ante*.

A NEW PROCESS FOR COLOUR PRINTING.

The perfect reproduction of paintings, or even of nature herself, in all the brightness and beauty of original colour, has long been the object of inventive genius, and the rapid strides which photography has made of late have materially increased the chances of ultimate success. By means of photography we can readily reproduce all outlines and shades of objects or pictures, but a photographic print has but one colour, and, therefore, necessarily often conveys a wrong impression where colour predominates in the picture. An ideal way of reproducing various tints and shades would be to stop out, by interposing coloured transparent plates, all rays except those of one colour, prepare a printing surface from this negative, roll this up with ink of as near the colour wanted as it is possible to produce, and then proceed to the rest, printing one above the other, until by the blending thus obtained a picture like the original is produced. This, as we have said, would be an ideal method; in reality difficulties, at present insurmountable, are in the way, and therefore something less perfect but based on this line of working, must, be considered satisfactory. The Universal Printing Company, of 280, High Holborn, have recently introduced a process called after its inventor, the Hoeschotype, for the photographic reproduction of coloured pictures, which as far we can judge, seems capable of producing excellent results at a comparatively reasonable cost. The inventor has fixed at the outset upon only five colours to be used in his process, yellow, red, blue, grey, and black; these five form the base of a large key map of tints, each one divided into five grades, containing, so to speak, respectively one, two, three, four, and five-fifths of any of these colours. In combining these tints by printing two or more above each other, a large variety of over 1600 shades are produced; the colours must of course be transparent for this purpose.

To reproduce a picture, for instance a portrait, the painted original is at first photographed and copies printed. One of these copies is now taken in hand by an artist, who by means of his colour scale ascertains for each spot in the picture the amount of yellow contained, and he covers that particular spot with an equivalent shade of grey, painting out with white at the same time all those parts of the photographic print which in the picture are to contain no yellow. This process finished, a negative is produced from this painted sheet, and a print taken on sensitised gelatine mounted upon plate glass. It will be understood that this gelatine print only represents a picture of those parts in which the artist wishes yellow to appear, and in different degrees of density. In other words, after this gelatine is washed, and rolled up with yellow transparent pigment, an impression can be taken from it on paper. In a similar manner gelatine printing surfaces are prepared of the rest of the colours, red, blue, grey, and finally black; they are all printed one above the other on one sheet in perfect register, and the result is a reproduction of the original coloured picture, as near as the skill of the artist who prepared the copies for the coloured plates, and the perfection of pigments will admit. There cannot be any doubt that tedious though this process appears, and depending as it does on the skill of an artist, the result is admirable, and we have seen excellent specimens of this work, and have moreover examined the working of the process. The glass plates carrying the gelatine film are placed upon the bed of what appears a well-built litho. press. The ink used is very stiff, and the inking operation performed in the usual way by rollers, is repeated twice for every one impression to insure perfect distribution. The sheets are laid on to exact register, and printing by power is performed at the rate of about 100 copies per hour. The presses are capable of printing up to 25 in. by 35 in. in colour, and if smaller subjects are worked two or more can be placed on one plate. Ink and paper are of course important items; in the former, shades must never vary, since otherwise the artist's tedious work would not be faithfully produced, and in the latter a certain texture and sizing are, we understand, most essential, but the finished pictures can be given any desirable texture by rolling. We have seen amongst numerous other specimens at the offices of the company in High Holborn, a reproduction of Mr. Alma Tadema's Pandora, the picture which made him a member of the Society of Painters in Water Colours, and we were told by the secretary that so much pleased was the severe critic with the reproduction, that he gave permission for its publication.

ELECTRIC LIGHTING NOTES.

Electric Light at Hartlepool.

The Central Marine Engineering Works Company, of Hartlepool, have purchased a Brush machine and sixteen lamps from Messrs. Gray and Gladstone, of the same town, and the Hammond Electric Light Company are erecting the apparatus.

The Electric Light Act.

Yesterday an influential deputation representing all the principal electric lighting companies met Mr. Chamberlain at the Board of Trade, to lay before him a statement of the effect which the Electric Light Act had produced upon the progress of their enterprise, and to suggest alterations. The following three points were those to which the speakers addressed themselves principally; the first and third relating to matters provided for by the Act itself, and the second to the terms of the provisional orders. 1. In the opinion of the deputation, the rights given to the local authorities to purchase compulsorily electric lighting undertakings within their districts upon the terms set forth in Section 27 of the Electric Lighting Act, are such as prohibit any supply of electric light to the public; and such clause should be repealed. 2. In the provisional orders granted by the Board of Trade under the Act, the provisions as to the compulsory laying down of mains should be omitted; and the undertakers should have full power to decide as to the position and extent of the mains to be laid down by them. The right to compel the undertakers to supply them with the electric light should be confined to consumers willing to take a minimum supply per annum. 3. The undertakers should be permitted to supply otherwise than by meter, and in such cases the purposes to which electricity is applied by the consumers should be matter for agreement between them and the undertakers. The interview was not concluded in time for us to give the results in this issue,

and we shall deal with the matter at length next week.

ST. ENOCH'S STATION, GLASGOW.

Messrs. Anderson and Munro, electric light engineers, Glasgow, have for some time been engaged in fitting up afresh, and on a more extensive and complete scale, the electric lighting arrangements of St. Enoch Station, which is the terminus of the Glasgow and South-Western Railway in that city. If we mistake not, this station was amongst the very first in the United Kingdom to be lighted by electricity; and at least three different firms have had contracts for "running the lights." Whatever want of success may, from time to time, have attended the St. Enoch installation, has been due in great measure to the prime motor, which also drove the laundry machinery and did other work in the large hotel connected with the station. It is now several months since the last contract terminated, and before fresh tenders were taken in for continuing the electric lighting of the station, it was resolved by the directors of the railway company to erect a fresh engine and boiler-house. The new arrangements, which are now being carried out under the advice of Mr. Watson, one of the directors, will include the use of three dynamo machines, 34 Brush arc lamps, and between 200 and 300 incandescence lamps. Two of the machines will each provide current for 17 Brush lamps, and the other will be a Victoria 300-light dynamo. In the station proper there are to be 32 arc lamps in four lines of eight each, and the remaining two will light the booking hall. The incandescence lamps will be chiefly employed in lighting the principal floor of the hotel, in which gas has hitherto been exclusively used.

MUIR *v.* STOCKMAN.

On Wednesday, the 12th, inst., Lord Fraser, sitting as the Lord Ordinary in the Court of Session, Edinburgh, gave judgment in an interesting and somewhat peculiar case arising out of an electric lighting contract formerly noticed in ENGINEERING. The action was raised by Mr. William Campbell Muir, proprietor of the estate of Inistrynich, Argyleshire; and the claims against the defender, Mr. B. P. Stockman, civil engineer, London, arose out of the contract in which he undertook to fit up an installation necessary to light up the pursuer's house with electric incandescence lamps. In a previous action, as may be remembered, Mr Stockman obtained a decree against Mr. Muir for the amount of the contract, which was some 319*l.*; and the action now under notice was brought by the last-named gentleman to recover 28*l.* for the board and lodging of the defender and his son Frank while they were engaged in fitting up the installation; for 28*l* in consideration of 444 hours' service of a skilled plumber paid by Mr. Muir; and for 100*l.*, as the amount necessary for the repair of certain damage done by the defender in ascertaining in what respects the installation was imperfect. The Lord Ordinary found that the hospitality received by the defender and his son was not given as if it were to be paid for, and that Frank Stockman was treated as a guest in the pursuer's house. He, therefore, disallowed the claim make in respect of board and lodging, as also the claim for the services of the plumber, holding that it had not been proved that the defender was not entitled to those services at the expense of the pursuer. His lordship, however, found that the defender was liable in payment of the sum of 3*l.* 10*s.* 2*d.* for solder and lead used in connection with the contract work, and of the sum of 15*l.*, being the amount estimated by an expert as sufficient for the repair of the damage complained of by the pursuer as having been done to certain electric apparatus by the defender in the month of October, 1883. Beyond these amounts his lordship assoiled the defender, and found neither party entitled to expenses.

TRIAL TRIPS AND LAUNCHES.

THE s.s. Musgrave, recently built by Messrs. Alexander Jack and Co., Seacombe, had her official trial on Tuesday, the 11th inst. This vessel has been built and specially fitted out for the pilot and lighthouse service of the Queensland Government. She is 125 ft. long by 22 ft. 6 in. beam, and 12 ft. moulded depth; her engines, by Messrs. James Jack and Co., have cylinders 23 in. and 45 in. in diameter by 2 ft. 6 in. stroke, the working pressure being 90 lb. The boilers, two in number, are of steel, and are specially designed for burning Australian coal. The full speed trial extended over a distance of twenty-nine miles, and notwithstanding the boisterous weather a speed of about 11¼ knots per hour was maintained throughout. The trials were superintended by Mr. G. Gemmell Dick, executive engineer to the Queensland Government.

On the 13th inst., Messrs. William Denny and Brothers, Dumbarton, launched a steel-built screw steamer named the Tanpo, of Dunedin, for the Union Steamship Company of New Zealand (Limited). She measures 200 ft. by 32 ft. by 16 ft. 3 in., and is a vessel of 765 tons gross register. She will be fitted with refrigerating chambers for conveying fresh meat from port to port in New Zealand. Messrs. Denny and Co. are supplying the vessel with a pair of compound engines of the usual type of 600 horse-power indicated. The Tanpo is a sister ship to the Ohau which was launched by the same builders about a month ago.

Messrs. David J. Dunlop and Co. launched, on November 13, from their shipbuilding and engineering works at Port-Glasgow, an iron screw steamer named the Chalhuin, and of the following dimensions Length between perpendiculars, 124 ft. 6 in.; breadth moulded, 22 ft.; depth of hold, 10 ft., and 300 tons B.M. The Chalhuin has been built to the order of Messrs. Lloyd, Lowe, and Co., of London, for Messrs. Kendall and Co., of Valparaiso. The vessel will be fitted with compound-surface condensing engines, the high-pressure cylinder being 18 in. in diameter, the low-pressure 35 in., and the length of stroke 24 in. The boiler and machinery will be capable of exerting 300 indicated horse-power, which will propel the vessel at a speed of 10 knots per hour when loaded.

The screw steamer Bisagno, a vessel of about 3000 tons gross, and measuring 230 ft. by 37 ft. by 27½ ft., built by Messrs. Burrell and Co., Dumbarton, and engined by Messrs. Duncan Stewart and Co., Glasgow, had her official trial trip on the Firth of Clyde on Friday, the 14th inst., prior to being taken over by her owners, the Societa Italiana di Trasporti Marittimi Raggio, of Genoa. Like her sister ship, the Borineda, also built by Messrs. Burrell and Co., she is to do duty between Genoa and the River Plate. On the trial trip her engines developed fully 1400 horse-power, and the mean speed attained was 11¼ knots per hour.

On Saturday, November 15, Messrs. Scott and Co., Greenock, launched a very handsomely modelled steam yacht, a vessel of 126 tons register, and 169 tons Thames yacht measurement. She was entirely completed on the stocks, and launched with steam up. Her engines are of 200 horse-power indicated, the cylinders being 15 in. and 28 in in diameter, respectively, with piston stroke of 21 in. The yacht, which is schooner-rigged, has been built to the order of Mr C. Randall, of London, who intends proceeding on a long cruise in foreign waters.

A steamer named the Bulldog, built for the Town Council of Bristol, arrived in Cumberland Basin from Chepstow on Tuesday. She was built from the designs of Mr. J. W. Girdlestone, Bristol Dock engineer, by Messrs Finch, of Chepstow. She is 90 ft long and 20 ft. beam, with a draught forward of 5 ft. 6 in, and aft of 6 ft. 6 in. She is constructed of Landore steel of great strength, with a Barlow rail running round her. Her special purpose is that of a salvage tug, but she will be also employed in river improvement and general dock work. The vessel is divided into several compartments between the five water-tight bulkheads. In the stern are the engines—two tandem compound, of 12 in and 24 in. cylinders, and having a stroke of 18 in.—which work the twin screw propellers. The collective force of the engines is 350 horse power indicated. In advance of the engines are two boilers, having Fox's corrugated furnaces, and steel tubes, the pressure at which they are to be worked being 120 lb These are placed side by side, and owing to special circumstances, the two chimneys are athwart ship. A crane, driven by steam, and a centrifugal pump, occupy part of the space of the fore part of the vessel. The crane will be capable of lifting from five to ten tons, and the pump will discharge from 6000 to 10,000 gallons of water per minute, according to the height it has to be lifted. Next the bow is a powerful capstan worked by two separate engines with rotary cylinders, and a long length of steel rope will be kept on board to be used in case of need.

There was launched on November 18 from the Whitehaven Shipbuilding Company's yard, Whitehaven, a steel screw steamer measuring 234 ft. by 32 ft. by 22 ft. This vessel has been built to the order of Messrs. Dunsmuir and Jackson, Govan, Glasgow, for Haji Cassim Joosub, Bombay, for the pilgrim trade. She will be fitted by Messrs. Dunsmuir and Jackson with compound engines of 900 indicated horse-power, having steel boilers with brass tubes working at a pressure of 90 lb.

On Wednesday the 19th inst., Messrs. John Elder and Co. launched from their shipbuilding yard at Fairfield, Govan, a steel screw steamer named the Rimutaka, for the New Zealand Shipping Company, of London, for their direct service from London to New Zealand. This steamer is a sister to the s.s. Kaikoura, launched by the same firm on the 8th of September. The vessel is divided into eight watertight compartments, five of which are carried up to the spar deck. She is built of steel, and her principal dimensions are as follows Length between perpendiculars, 420 ft.; length over all, 451 ft.; depth, 33 ft. 4 in, with a gross tonnage of about 4500 tons. The engines, which will indicate about 4000 horse-power, have two inverted cylinders, one high-pressure 46 in., and one low-pressure 88 in. in diameter, each having a stroke of 4 ft. 9 in. The propeller blades are of bronze. Steam is supplied by three cylindrical double-ended multitubular boilers of steel, to be worked to 110 lb. pressure per square inch, having in all eighteen of Fox's patent corrugated furnaces.

ROYAL INDIAN ENGINEERING COLLEGE.

TO THE EDITOR OF ENGINEERING

SIR,—There is an advertisement in your issue of last week (November 14) headed as above, but stating that the course of study is arranged to fit an engineer for employment in Europe, India, or the Colonies. Further, that sixty students will be admitted in September, 1885, and that for competition the Secretary of State will offer fifteen appointments in the Indian Public Works Department and two in the Indian Telegraph Department. Now precisely the same advertisement is appearing in the Bristol papers, and therefore, presumably, in the local papers throughout the whole country. Were it not for this fact I should not address this letter to you, but I feel it to be my duty to the local college with which I am for the time connected, to make an attempt to point out to what this enterprise is clearly tending, in what position the Government stands with regard to it, and to humbly offer a suggestion or two.

When the project was formed for establishing the Cooper's Hill College about the year 1870, it was said to be distinctly with the object of providing trained engineers for the Indian Civil Service Even then the Government of India wrote to the Duke of Argyll, as Secretary of State for India (*vide* ENGINEERING, vol. xxxii., page 488). "We consider the success of such a college to be a matter of very great uncertainty, that it must be regarded entirely as an experiment, and that we have great doubts that any real necessity exists for its immediate establishment," and further on "the Institution (*i.e.*, the proposed Indian Engineering College) in short would, in our judgment, be distinctly condemned if it could not be conducted on what would be an entirely self-supporting basis." In addition to this, the Institution of Civil Engineers addressed to the Duke of Argyll a vigorous protest against the proposed establishment of the college Yet in spite of this the scheme was carried into operation, and moreover was specially maintained, until about two years ago by the Indian Government (*vide* second report of the Royal Commissioners on Technical Education, vol. i., p. 413), though each young man sent out to India cost no less than 321*l.* to educate

The project in its original form has signally failed, and now mark the result. The number of the students having fallen off to an alarming extent, notwithstanding the fact that the staff consisted of, and still consists of, men of the very highest rank both as teachers and men of science, and who might be safely trusted to make the system of education all that could be desired, the college was, rather more than two years ago, thrown open to students training for the engineering profession generally. It was therefore by this course placed on exactly the same footing as any other engineering college, but with two important exceptions.

1. That the Cooper's Hill College is supported by the tax payer.

2. That very heavy inducements are offered as prizes to students to enter, in the shape of Government appointments (this year seventeen in number)

In spite of this the number of students was a short time ago only two-thirds of that which could be received, and in order to increase the number, or even maintain it, an extensive and likewise expensive system of advertisements is necessary nearly a year in advance. Meanwhile, the investment of capital goes on A mechanical laboratory costing 2000*l.* has just been instituted, other laboratories doubled in size, and a handsome room for drawing constructed, and the Government committed to a greater extent each year to support the establishment.

Now what in plain English is the real state of the case? It appears to be this.

1 Local engineering schools supported by private effort are quite competent to supply engineering education of the highest kind, and, indeed, threaten to raise the supply above the demand.

2. Yet the supporters of those colleges are taxed to maintain a far more expensive rival system, not only of education, but of advertisement, that must result in taking students from their colleges, and in the end inflict certain injury to them in such an obviously unequal struggle

3. There is, moreover, no logical reason that can be adduced why Government should train engineers for private employment any more than members of any other profession. Yet, since only 17 appointments are offered for 1885, this is what is done for 70 per cent. of the 60 students who are to enter Cooper's Hill in that year.

4. I therefore venture to suggest the following way out of the awkward dilemma in which such an anomalous state of things must place a right minded and honourable body of men like those in authority.

Reduce at once the scale on which the Royal *Indian* Engineering College is maintained (making, of course, suitable compensation to those of the staff temporarily inconvenienced by this change) so as to provide for no more than the 17 candidates required for the Indian Civil Service, allowing a small margin perhaps in case of accidents. Then throw open the appointments for competition to *all* engineers with proper limits as to age, &c., and let the examinations be of as strict and searching a nature as can be reasonably devised If there be not an abundant supply of first-rate men who can successfully compete with those trained at Cooper's Hill, then by all means maintain the system (*i.e* let the Indian Government do so); but if, on the other hand, there should be such supply, then the right thing to be done is obvious and need not be suggested by

Yours truly,

H. S. HELE SHAW.

University College, Bristol, Nov. 17, 1884.

WORKING MILITARY RAILWAYS.

TO THE EDITOR OF ENGINEERING.

SIR,—When a railway has to be hastily constructed for war purposes, and when moreover it is carried along a route the topography of which is but little known, it is generally most difficult to obtain suitable watering places. This was much felt during the early portion of the Abyssinian war, and it is said to have formed the main reason for not advancing this summer on Khartoum by the Suakim-Berber route. It appears to me that the difficulty can be avoided by mounting hot air engines as

locomotives. High-pressue hot-air engines have now been brought to great perfection, and although the difficulty of lubricating their cylinders will always obtain, and may always prevent their employment commercially to any important extent, still their endurance is ample for a campaign of many months' duration, and their modulus for the coal burnt is so good as to form another argument in favour of their employment for war purposes, and especially for railways across countries in which both water and fuel are scarce.

Sir, your o
J. T. Bu
Gosport, November 17, 1884.

SEISMOMETER.

To the Editor of Engineering.

Sir,—I am in want of an instrument for the
ment of vibrations of the ground arising from shocks caused by the falling of heavy bodies, heavy goods traffic, &c. I believe such instruments are called Seismometers and are too expensive for me to buy for the short time I should require to use it. I therefore wish to hire one, and will deposit its full value as security. If you could assist me by the insertion of this letter, I should be obliged. Yours, faithfully,

John Hodgson.

118, Commercial-street, Newport, Mor
November 17, 188

AWARDS FOR VENTILATORS AT THE HEALTH EXHIBITION.

To the Editor of Engineering.

Sir,—With reference to the inconsiderate letter from Robert Boyle and Son, in your issue of last week, I may state that the writers are in error in at least three points with which I was concerned as testing engineer to the Jury 10:

1. They were *not* excluded from the testing rooms.
2. They were invited by me, in a letter dated the 9th September last, for the Jury 10, to send their ventilator for testing, in the same terms in which other invitations were issued. I hold their acknowledgment of receipt of that letter of invitation dated September 12, in which they state that they cannot comply with my request.
3. "The bottoms of the pipes attached to the ventilators" were *not* inside the "tube," as they call it, which was 10 ft. in length, not 8 ft. They were outside, and completely isolated from the action of the current.

November 17, 1884.

PRESSURE OR VACUUM BRAKES?

To the Editor of Engineering.

Sir,—Your correspondent, "Dux," page 452, has rendered very valuable service by the extremely lucid and
cise way in which he has directed attention to the alt
ground upon w
brakes must in future be fought.

trials, nine years ago, that after the experiments with the brakes, the unanimous opinion was strongly in fa of the automatic system. Advocates of the "vacuum" remarked that "they could soon make their brake automatic," but this does not seem to have been quite such an easy matter, for we find that the Vacuum Brake Company has fought against, and resisted to the utmost of its power, the adoption of automatic brakes, and the well-known conditions of the Board of Trade. Railway companies have been induced to fit no fewer than 1138 engines and 6658 vehicles with the inefficient simple vacuum brake, and now, since the Penistone disaster, the Vacuum Company admits that it has been in the wrong, and that "an automatic brake is desirable."

It is indeed to be regretted that this company did not make such an important discovery nine years ago at Newark, as it would have saved hundreds of lives and thousands of pounds. The brake question now is, undoubtedly, as stated by "Dux," between pressure and vacuum.

A table was recently given in *The Field* by Mr. Kiernan, to prove that the vacuum brake, with its large cylinders, is as powerful as the small ones used in the Westinghouse system, and of course the readers are expected to consider the two brakes as of equal efficiency.

Every brake, from the simple lever on a coal wagon to the best continuous system, is of equal power when full "on," that is, they can *all*, if necessary, skid the wheels of a train. The question, therefore, is not one of power, but of time required to bring that power into efficient action. Every engine-driver knows the efficiency which resulted from the increase of steam pressure in the locomotive engine; why then should not the same rule apply to brakes?

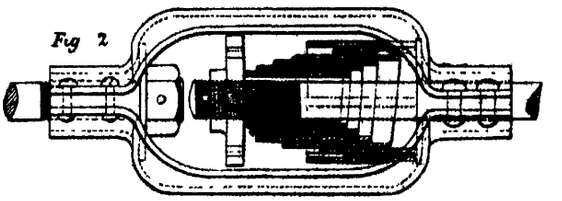
Advocates of vacuum brakes imply, and wish the public to believe, that a force of 12 lb. will act as well as one of 60 lb., but no one can accept such an absurd conclusion. The fatal defect in vacuum brakes (both automatic and non-automatic) always has been, and always must be, *slowness of action*. To make the low pressure of 12 lb. capable of
ing the required power, the areas of the cyli
be made fully six times as large to do the
work as the high pressure of 70
80 lb.; but the all-important point is that every in
increases the cubical contents of the apparatus,
greater quantity of air has consequently to be moved to apply and release the brakes, hence slow action *must* follow. The advocates of vacuum brakes boast about the power they can get with their large cylinders, but they very carefully avoid giving the enormously increased size and cubical contents of the apparatus and the amount of air which has to be moved to fill and empty these large cylinders. Having frequently noted the time required to bring pressure and vacuum brakes into full operation, there can be no doubt that vacuum brakes are slow in action. An express train running at sixty miles an hour passes over 88 ft. per second, therefore if a disaster occur to such a train, the telescoping and fatal consequences are all over long before a *slowly-acting* brake can even begin to exercise any retarding power. On the other hand, the pressure brake, by means of the triple valve, the high-pressure and
ll pipes and cylinders is capable of being applied as
rly instantaneously as possible, therefore it acts, and
kes its power felt, by retarding and holding back the
ns of trains, thus avoiding "telescoping" and
. For these reasons, and these alone, I have
advo
s on account of their instantanec
saving powers.

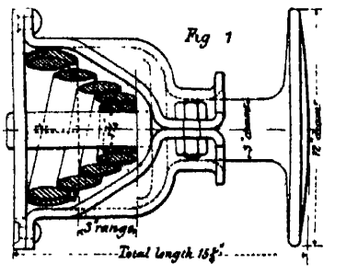
I am, Sir, yours faithfully,

Clement E. Stretton, Hon. Mem. A.S.R.S.

40, Saxe-Coburg-street, Leicester, Nov. 17, 1884.

HEPBURN'S BUFFER AND DRAWBAR.





The annexed illustrations represent new forms of buffers and drawbars devised by Mr. R. H. Hepburn, of Palace Chambers, Victoria-street, West-
r. Their distinguishing peculiarity is that they are formed entirely of iron or steel, and that the springs are open to observation, and can be readily replaced with a very small expenditure of time and trouble. Commencing with the buffer (Fig. 1) it will be seen that the case is made of two steel plates, stamped into form and permanently rivetted to the baseplate. The two parts are joined together by a pair of bolts, and when these latter are removed, the two parts can be sprung sufficiently wide apart to allow the collar on the ram to pass through. This collar, which is shown in dotted lines, is of oval shape, so that it does not require a very wide separation of the two parts of the case to allow it to be withdrawn. Beyond this collar is a loose washer which bears against the spring, and is of sufficiently large diameter to obtain a bearing on the successive coils as they are compressed. The last coil is hooped with a stop ring, which prevents it being strained beyond the determined amount, and thus greatly adds to its life. Should a spring become broken its renewal is a very simple affair, as when the ram is withdrawn a new spring can be slipped in from the side through the opening in the

In such a buffer designed for use on wagons, the weight of the spring is 16½ lb., its resisting power 4½ tons, and when driven home 8¾ tons.

In the drawbars (Figs. 2 and 3) the draw cradles are made from steel bars, cut into suitable lengths. Each bar is corrugated and drawn down at the ends to receive steel bushes, flanged on the inside to form a base for the spring, and winged at the sides to receive the rivets. It will be noticed that the whole pull or strain is upon the solid metal and not on the fastenings. The principal parts are formed by machinery by one operation and are made up with great rapidity. The cradles are light and of very considerable stability and strength, and having no welded corners the risk of breakage is much removed, smithwork being almost altogether dispensed with.

Wagons with through drawbars coupled together by
cradles and strong springs, with a good margin of range, must have a longer life than wagons with disconnected drawbars and simply a cup and spring washer, which spring is usually of short range. The crosspiece on which the couplings are fixed frequently breaks, and oftentimes a breakage of the headstock follows. With the through system, the pull and strain passes from end to end of train, and is divisible among as many wagons as go to make up the train. Thus wagons with connected drawbars are practically free from jerks and shocks.

Mr. Hepburn informs us that when locomotive superintendent of the Llanelly Railway, now part of the Great Western, he prolonged the use of a great number of 6-ton wagons by a careful revision of the drawbars upon the through system, and although the wagons were light and of obsolete pattern, and ran with the now heavy type of coal wagon, there was a very considerable diminution in repairs and renewals of crosspieces and headstocks.

We understand these buffers and drawbars have been largely specified for some important railways now in hand. Their simplicity should recommend them, and should lead to their extensive adoption.

The makers and sole licensees are Messrs. John Spencer and Sons, whose agent in London is Mr. J. Campbell Evans, Parliament Mansions, Victoria-street, Westminster.

Messrs. Marshall, Sons, and Co., Limited.—This well-known firm have recently supplemented their works
on, these pre-
situated at 79, Farringdon-road, and comprising, besides extensive offices and show-rooms, a workshop for the execution of repairs, &c., and store rooms for engines and machinery which they let out on hire.

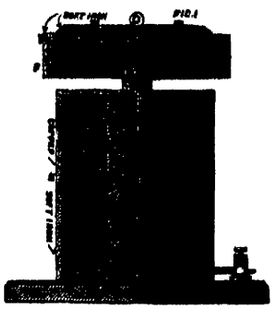
twelfth annual issue of this handy work is now published, and fully maintains the reputation gained by those which preceded it. In addition to the ordinary contents of an almanack, it contains short histories of eminent engineers and their works, racy tales brimful of "shop," capital receipts and workshop dodges, and useful articles
-cutting, chains, materials, and
a machinist in Manchester, and his book has a well-deserved popularity with the mechanics of the district.

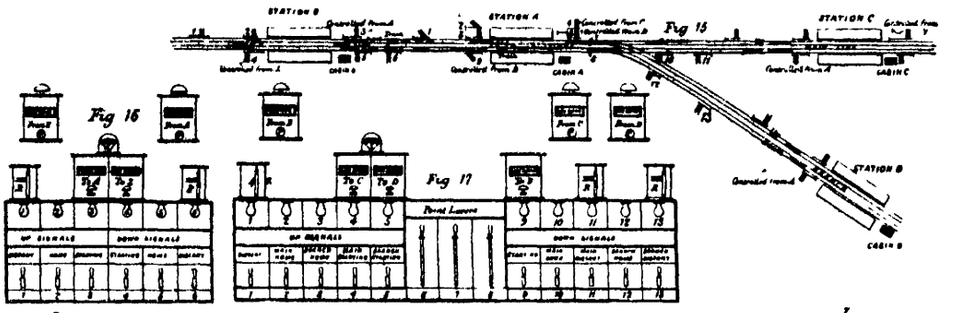
Gas at Nottingham.—The Gas Committee of the Nottingham Town Council report that they have appointed Mr. L. T. Wright as general manager. The appointment has proved satisfactory. During the past year, gas has been manufactured at a cost of 1½ per thousand less than hitherto, and this notwithstanding an increase in the cost of coal of about 6d. per ton. The amount of gas consumed from the 25th of March, 1883, to the 25th of March, 1884, was 1,163,225,500 cubic feet. The committee advise that a further reduction of 2d. per thousand cubic feet should be made in the price of gas.

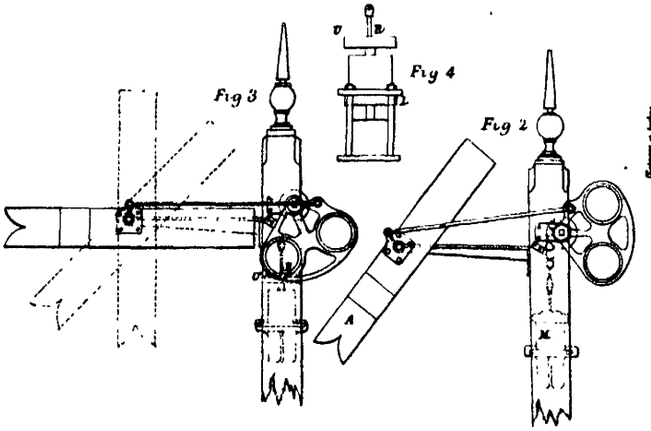
Society of Arts.—In addition to the usual courses of Lectures, the Society of Arts announces a course
to be delivered under the Howard Trust, the subject being "The Conversion of Heat into Useful Work," and the lecturer, Mr. William Anderson. The first lecture of the course will be delivered on Thursday, the 27th inst., and of the six lectures of which the course consists, three will be delivered before Christmas, and three after it. The following is the syllabus of the first three: Lecture I., November 27.—Introduction; the laws of motion; potential and kinetic energy; laws of impact. Lecture II., December 4.—Oscillation, vibration, wave motion, pulsation in liquids and fluids; the luminiferous ether; porosity of matter, ultimate structure of matter; heat the consequence of molecular motion; transparency; diathermancy; specific heat; unit of heat; latent heat; absolute zero of temperature. Lecture III., December 11.—Molecular theory of gases; laws of volume, pressure, and temperature; isothermal and adiabatic lines of permanent gases and of vapours; Joule's equivalent;
doctrines of Carnot; the limits of efficiency of heat engi

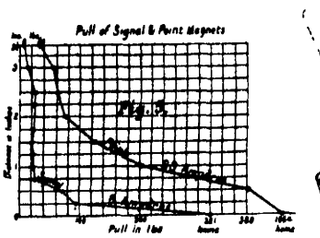
The Australasian Mail Service.—Considerable discussion has taken place of late with reference to the Australian and New Zealand mail service *vid* San Francisco. The New South Wales Government has given notice of withdrawal, but as the company which performs the service is pledged to the New Zealand Government to carry it on till November, 1885, there is no necessity for haste in making other arrangements. At present the mails are landed in Auckland in 38 or 39 days from London, but the service could be considerably expedited. In all probability it will be arranged to maintain the San Francisco monthly service, and by giving a subsidy to the direct steamers to have a monthly mail service from them, the mails to be delivered in the southern part of New Zealand within 45 days.

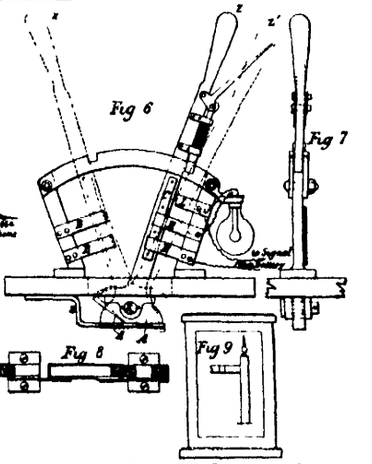
WORKING RAILWAY SIGNALS BY ELECTRICITY.

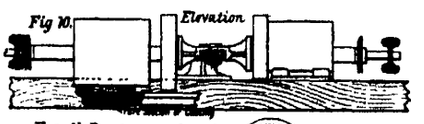


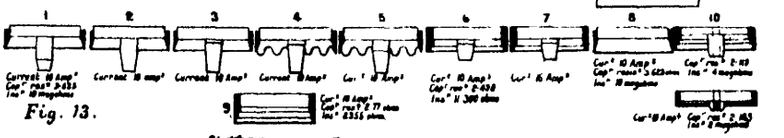


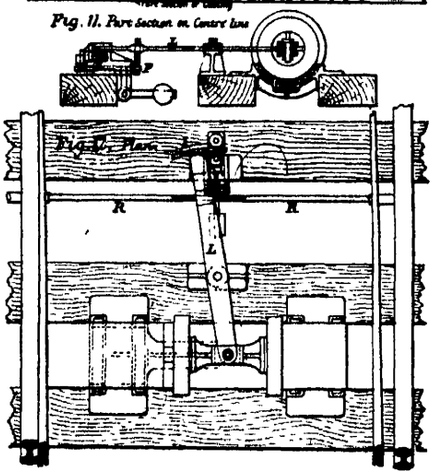


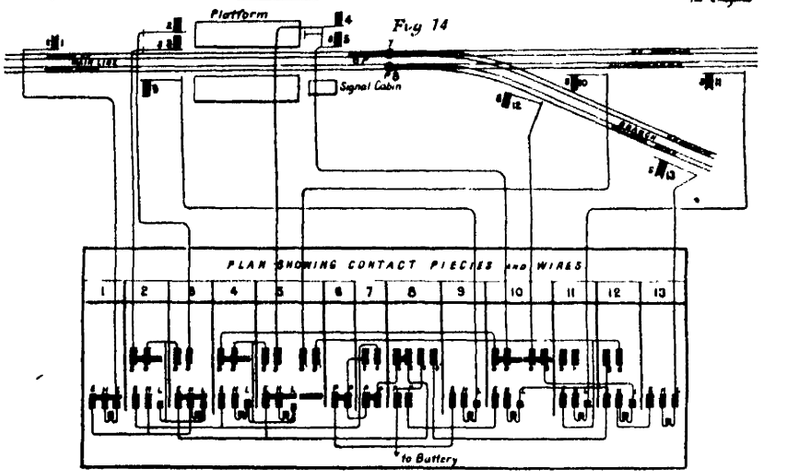












WORKING RAILWAY SIGNALS BY ELECTRICITY.

*On the Application of Electro-Magnets to the Working of Railway Signals and Points.**

By Mr. ILLIUS A. TIMMIS, of London.

THE object of the present paper is to describe a new, powerful, and economical electro-magnet, capable of exerting its pull in a manner suitable for convenient application to the mechanical working of railway signals and points. Its main features are its great power, which is exerted through a long range, and is under perfect control; and its economy, both in exerting the initial pull which effects the mechanical movement required, and also in retaining the moving parts after the desired movement has been effected.

The rapid growth of railway systems and their consequent complexity, have rendered urgent the application of electricity for the working of railway signals and points, and for checking the work done by signalmen and pointsmen. Though much has been accomplished in this direction both in this country and elsewhere, there has hitherto been always one initial want; namely, an electro-magnet, which, with a low average current and a small electro-motive force, shall give a powerful, long, and well-balanced attractive pole. A range of pull of only ½ in., which has hitherto been the practical limit with electro-magnets, is evidently not long enough to be of use for heavy mechanical work, such as pulling signal arms over or throwing machinery in and out of gear; and although the range can be increased by multiplying gear up to 2 in. or 3 in., yet the increased current then required for making the attraction powerful enough at the initial ½ in. distance, is so enormous that two difficulties present themselves which are almost insuperable; firstly, the expense; and, secondly, the destructive violence of the final impact, in consequence of the attraction increasing inversely as the square of the distance of the armature from the magnet, and for part of the stroke inversely as the cube.

In the ordinary form of the electro-magnet, a core or bar of soft iron, wrapped round with a coil of wire or tape, and bent into the shape of a horseshoe, attracts to its poles a plain armature, and by some natural law, as yet unsolved, the working pull of such a magnet practically ceases, as already stated, when a distance of only ½ in. between the magnet and the armature is exceeded. In the electro-magnet of tubular form, thence called a sole oid, a hollow core or tubular bobbin of brass is wrapped round with wire or tape; and a central rod of soft iron, sliding lengthways inside it, forms the armature, which is drawn or sucked longitudinally into the core by the attraction of the bobbin coil, until it reaches a central position in relation to the magnetic field; in this position the attraction is symmetrical in all directions, and is therefore neutralised. Although a considerable length of attractive pull can be got with such a magnet, the current of electricity required to give any strong initial pull is so excessive that its cost is prohibitory; moreover, it is clear that the holding power falls to zero when the armature reaches its central position longitudinally. In order to obtain adhesive power, or what is called a "retaining" pull, the internal sliding rod or armature is made shorter than the length of the hollow bobbin, and is capped at

* Paper read before the Institution of Mechanical Engineers at the Nottingham meeting.

one end with a disc of soft iron, which, coming in contact with that end of the bobbin, thereby prevents the armature rod from reaching its central or neutral position within the bobbin, and leaves a corresponding reserve of holding power against the end of the bobbin.

Currie Long Pull Magnet.—In the long-pull electro-magnet, shown in Fig. 1, page 485, which is the invention of Mr. Stanley Currie, the principle adopted is a combination of the horseshoe magnet and solenoid, with additions; but the construction is so materially modified as to give far greater power and efficiency, and the magnetic attraction is more evenly distributed over a longer range, while the initial pull is stronger and acts at a greater distance than in any other electro magnet of the same weight and with the same current. The range already attained in practice is 3½ in., and can be increased.

The bobbin B, here shown standing upright on one end, is made with a tubular core C of soft iron; and the coil of wire wound around it is surrounded by an outer casing of soft iron B of the same weight as the core, with a soft iron baseplate at the bottom of the bobbin, connecting the core with the outer casing; a brass plate covers the bobbin at the top. The copper wire used in the coil is No. 18 Birmingham wire gauge, or 0.048 in. thick. The armature consists of three portions, each one playing its part in the work to be done. The central stalk A of soft iron is rather shorter than its own range of motion; and is encased in a brass tube, which is prolonged below it so as to form a guide, fitting within the bobbin core. The soft iron cap or disc D, fastened in the top of the central stalk, is slightly larger in diameter than the outer casing of the bobbin B. It is made by preference of two or more thicknesses of flat plate, to assist in demagnetisation; but it must be thick enough to prevent saturation with any working current. Round the edge of the disc runs a cylindrical rim or flange F projecting downwards; it is so shaped as to suit the attraction required, and it comes within the range of attraction of the outer casing of the bobbin when the lower end of the central stalk has entered within the core. When the rim in turn has done its duty, the disc D comes within range of attraction of both outer casing and inner core.

Uniformity of Pull.—So long as the central stalk or armature rod is altogether out of the bobbin core, the attraction upon it continues to be inversely as the square of its distance from the bobbin; but as soon as the end of the iron rod enters within the orifice of the core, the force of attraction becomes lost upon so much of its length as is inside the core. The same diminution in attractive force holds good in regard to the flanged rim of the armature disc, as soon as its lower edge passes below the upper edge of the bobbin. The force of attraction varies also directly as the mass of the body attracted. Advantage is therefore taken of these two principles in combination, to regulate or adjust the effective attraction in such a way as to obtain some sort of approximation towards uniformity of pull throughout the 3½ in range of stroke of the armature. This is accomplished by tapering in the manner shown in Fig. 1 the lower end of the armature stalk A and also of the flanged rim F, according to the desired adjustment of the attractive force; in addition to which the thickness of the armature disc D and the distance that its flanged rim F projects downwards, as well as the thickness of the rim, can also be varied; and in some cases, moreover, as in some of the examples shown in Fig. 13, the bottom edge of the flange is made of a serrated or wavy form, so as to prevent the pull from suddenly increasing as the disc nears the bobbin. The result is that, when the strength of the pull on the armature stalk and flanged rim is decreasing, owing to their having both of them reached and passed the position of maximum attraction, the pull on the disc is increasing as it nears the magnet head. In this way, and in combination with a counterweight acting at a suitably varying leverage, an approximately equal pull is obtained through a considerable range, and violence of contact in the closing of the disc upon the magnet is avoided. By suitably adjusting the several proportions of the various parts, the pull can be so greatly varied both in force and range that it can be adapted to meet almost any requirements.

Double Length of Pull.—A double length of pull is readily obtained by the simple tandem combination shown in Fig. 4 Here a pair of single magnets on the foregoing principle, arranged at a fixed distance apart, have their armature guide-rod R in common; the lower armature disc L is made fast upon the rod, while the upper disc U bears against a shoulder upon it. The range of the lower disc being nearly double that of the upper, the first half of the pull is given by the upper; and by the time the upper disc U has closed upon its own bobbin, it has brought the lower disc L within the attractive range of the lower magnet, by which the second half of the pull is then given, the armature rod R now sliding free through the upper disc U. This arrangement is suitable for working signal arms that are required to stand at the three positions of danger, caution, and line clear, as shown in Figs. 2 and 3.

Railway Signals.—In the application of the electro magnets to railway signals, the ordinary signal posts and arms are utilised; but it is advisable that the bearings and working parts should be made as true as practicable, because, though friction is not so material when the work is done by manual labour, it is of the utmost importance that it should be reduced to a minimum where electricity is the motive power. As there are no complicated parts, and the movements are all simple, and direct, there is no difficulty on this point.

In Figs. 2 and 3 is shown the application of a single magnet to an ordinary signal arm intended to stand in only the two positions of danger and line clear. The magnet M is fixed upright on a bracket at the back of the post, and a chain from its armature pulls upon a quadrant arc centred on a horizontal spindle above it. The quadrant carries a lever and counterweight acting in opposition to the pull of the magnet; and also an arm which is connected by a rod with a bell-crank centred at the side of the post. Another rod connects the bell-crank with the semaphore and spectacle. When the magnet is out of action, the semaphore is held up at danger by the weight of the spectacle, in conjunction with the counterweight on the quadrant lever, which then comes against a stop. In this position all the parts are locked, in consequence of the quadrant arm being then on its dead centre; that is, the quadrant arm and bell-crank are so arranged that the direction of the rod connecting them passes then through the centre on which the quadrant turns. For yet greater security of locking, it is preferable indeed to let the connecting rod be even a trifle beyond the dead centre, so that any pull upon the bell-crank, from wind pressure or accumulation of snow on the semaphore, shall hold the counterweight lever still more firmly against its stop. The locking is thus done mechanically, and is independent of the magnet. On bringing the magnet into action by a current from the signal-box, the pull of the armature rotates the quadrant arc, raising the counterweight and spectacle, and lowering the semaphore; in this position the semaphore is retained so long as the electric current is continued. On the cessation of the current, the semaphore is automatically raised again to danger, and locked there mechanically without the use of extraneous catches, which is a most important feature.

In Fig. 3 is shown the application of the double magnet or tandem arrangement to a balanced semaphore centred at mid-length. Here the pair of magnets are fixed on one side of the post, and the quadrant arc on which they exert their pull is fixed on the spectacle spindle. A rod connects the spectacle with a crank on the semaphore, and the weight of the spectacle brings the semaphore to the horizontal position of danger, in which it is locked mechanically as before, by the connecting rod being then on its dead centre. An electric current sent to the upper magnet pulls the semaphore to an angle of 45 deg. for caution; and a second current sent to the lower magnet pulls it vertical for line clear. In either position it is held by the spectacle acting as a counterweight against the retaining pull of the magnet.

Electric Current.—Under ordinary circumstances a current of 3 ampères is amply sufficient to pull the armature down upon the magnet, and so actuate the semaphore; but to guard against wind pressure, dust, rust, and wear of rubbing parts, a current of 5 ampères is provided. In addition a reserve current of as much as 15 ampères is kept in store at the signal-box, and is at the immediate command of the signalman in any emergency. From the lower line in the diagram shown in Fig. 5, it will be seen that with 5 ampères an initial pull is given of 8 lb., at a distance or range of 3½ in.; which is more than double what is required to work any signal arm properly fitted; and the home pull is 321 lb.

If the same strength of current were necessary to hold signals down as to pull them down, the use of a continuous current would be prohibited by its cost. But a current of only 0.1 ampère is more than sufficient to hold a signal down, and it is found that a continuous current of 5 ampères for moving the signal, and of 0.1 ampère for retaining it, yields an economical result. Accordingly when the armature has finished its stroke and moved the signal, it is made to switch in automatically a resistance coil which reduces the maximum or moving current of 5 ampères to the minimum or retaining current of 0.1 ampère. The resistance coil can take the form of an incandescent lamp, which then serves as an indicator or tell-tale in the signal-box, as shown in Figs. 6 to 9

In excess of the greatest possible requirements, it may be assumed that the whole time during which each signal is needed to be held down to show line clear, is 12 hours out of every 24; and that the number of times each signal has to be lowered in the 24 hours is 150; and that the time occupied in each lowering is two seconds. Assuming also 10 ampères instead of 5 as the moving current, and 0.2 ampère instead of 0.1 as the retaining current, then 150 lowerings × 2 seconds × 10 ampères = 3000 ampère-seconds or 0.8 ampère-hour; and a retaining current of 0.2 ampère for 12 hours = 2.4 ampère-hours; the total is therefore 3.2 ampère-hours of current C per signal per 24 hours. The resistance R being taken at 5 ohms, the electromotive force E is equal to C × R = 3.2 × 5 = 16; and assuming 746 watts = 1 HP., the horse-power is equal to C × E ÷ 746 = 3.2 × 16 ÷ 746 = 0.07 HP. The cost of providing a current of such power by means of a secondary battery, according to well-recognised electrical data, would be only 0.4d.; while the current actually used being only about one-third of that provided, and the real time less than one-half, the true cost would be less than one farthing per signal arm per day.

The foregoing remarks respecting the electric current employed to actuate the magnets apply to the use of secondary batteries; and the results obtained from these accumulators of electrical power are very satisfactory and economical. In certain cases, however, it may be preferred to use a primary battery, such as the Lalande oxide of copper battery, the working of which is very easy and reliable. The constant and economical current it gives can be used not only for actuating the magnets, but also for lighting the lamps on the signal posts and at the points. With a primary battery the reduction of the current from a moving to a retaining current cannot be effected in the same way as with a secondary battery, by switching a resistance in; but the same levers and switches are still available for switching out the large battery which gives the stronger moving current for lowering the signals, and switching in a smaller battery, of smaller cells and with greater internal resistance, which gives the weaker retaining current for holding the signals down.

Railway Points.—In Figs. 10, 11, and 12 are shown the magnets and gearing for working a pair of railway points; these magnets are practically of the same construction as for working signals, but are of larger size, and are wound with copper tape instead of wire in order that they take a maximum current with a minimum of resistance. With a current of 23 ampères and an electromotive force of 40 volts, the force of the pull is as shown by the upper line in Fig. 5, commencing with an initial pull of 33 lb. at 3½ in. distance, and increasing to 64 lb. at 3 in., and to a home pull of 1064 lb. As will be seen from the diagram, the points are pulled over and held in either position by the sliding rod R, which is worked by the lever L, and is locked by the locking bolt P. The slot in the rod R is made ½ in. longer than the width of the lever L working in it, so that the first ½ in. of travel of the lever withdraws the locking bolt P by means of the incline I on the extremity of the lever, before the lever acts upon the sliding rod R.

Where a pair of points are actuated by a signal, the locking bolt P—in conjunction with the armature of the magnet which pulls the points over into the position corresponding with the signal down when for line clear—completes the circuit which enables the signalman to lower the signal. The signal is checked by its automatic repeater in the signal-box. The other point magnet completes with the locking bolt the circuit which works a repeater in the signal-box.

Advantages.—The advantages of working signals and points by this system are that their distance from the signal-box is immaterial, inasmuch as the electric working gets rid of all the mechanical difficulties which arise from excessive expansion and contraction of lever wires and from the severe pull required to work them through long distances

Signals.—It is only during the continuance of the electric current that the signal can be held at caution or line clear; its normal position is at danger, to which it returns automatically on the cessation of the current, or if anything goes wrong; and in this position it is locked by simple mechanical means, and not by any electric agency whatever. Each signal is worked by its own magnet, and has a repeater or tell-tale in the signal-box in the shape of a small arm R, Fig. 10, which shows the position of the signal arm. If it is desired, the repeater is arranged to show the exact travel of the magnet armature working the signal that is, if the armature stops half way, the repeater arm would stop in the same position; in fact any arrangement that may be desired can easily be effected. At the instant of contact between the armature and the magnet, there is a momentary cessation of the main current; and the tell-tale arm indicates this by falling back a little from its extreme position. This affords another infallible check as to the correct working of the magnet. The reduction of the current from a moving to a retaining pull takes place automatically at the moment of the armature reaching the magnet.

Points.—The advantages in working points by these electro-magnets are as great as in the case of signals. Either can be worked at any distance from the signal cabin. There is no need for a cabin to be put up, or a stand of levers, to work any special set of points and signals; any number of points and signals can be worked from a small cabin, and can be locked and interlocked with absolute certainty. They can be so arranged that, if any wrong lever is moved by the signalman in arranging any combination, an alarm bell is rung in the cabin, and the signals already lowered go back to danger; the mechanical and electrical parts being so arranged as to provide a perfect check, without the intervention of manual labour or the will of the signalman.

Application to Railway Junctions.—In Figs. 14, 15, 16, and 17 is given an illustration of the application of this electric system to working the signals and points of an ordinary junction where there is a double line of way both on the main line and on the branch. The signal-box is here divided, as regards the electrical connections, levers, and switches, into thirteen divisions, 1 to 13.

Suppose an up main line train is required to be turned into the branch, Fig. 14, it will be necessary to work the points P 6, and the three signals on the up main line, namely, the distant signal S 1, the home signal S 3, and the station signal S 5. The lever of the points P 6 is first pulled over in division 6 of the signal-box, whereby an electric connection is made between 6 and 7, the up-branch points being thus set right for, the up train to pass into the branch. The down-branch point-lever 8 must be back or in its normal position, in order to let the current pass through to division 3 for lowering the home signal S 3. As soon as the signal lever is pulled over and the signal lowered, the current can pass on to 1 for enabling the distant signal S 1 to be lowered. Last of all the current can pass to 5, lowering the signal station S 5.

Suppose another case of a train approaching the junction on the down branch, to pass upon the down main line; the home and distant down-branch signals S 12 and S 13 will have to be lowered. The points P 8 must first be in their normal position, and their lever 8 must be back, before the electric current from the battery can pass through 8 to 12, and thence to 10 for lowering the home signal S 12, and afterwards to 13 for lowering the distant signal S 13. It is now impossible to lower the home and distant signals S 10 and S 11 of the down main line; because the current for working these signals is prevented from passing, by the act of pulling forwards the lever that belongs to the home signal S 12 of the down branch.

For station to station signalling, Fig. 15, the transmitter and receiver instruments are used in somewhat the same way as in ordinary railway working. The continuous current used makes the working very simple and easy and reliable. The signals and points are actuated by a main current; and this is checked and controlled by a subsidiary current, which works the transmitter and receiver instruments. A train travelling along any section of line

protects itself by passing over contact levers or treadles T, both on entering and on leaving the section; the depression of the treadles by the deflection of the rail breaks the current which holds the signal arms down, and sets them free to fly up to danger automatically.

MODERN AGRICULTURAL IMPLEMENTS.*

By D. Pidgeon.

Forty-three years ago, when the Royal Agricultural Society of England first tabulated their machinery exhibits, the number of agricultural implements at Liverpool in 1841 did not much exceed 300, while, at the present time, every Royal Show brings forward more than 5000 farm implements of various kinds.

These figures sufficiently indicate the extraordinary growth and development of agricultural engineering, while they demonstrate the extent of the field which has to be reviewed, or, more properly speaking, glanced at, in the course of this short paper. Those who may desire to add some details to a sketch necessarily consisting entirely of outlines, are referred to a paper on "Recent Improvements in Agricultural Machinery" which the author had the honour of bringing before the Society of Arts during the session of 1883, and of which this communication is only a digest.

It is, indeed, quite a formidable matter merely to classify the farm machinery of the present day, which may, however, be conveniently divided as follows:

Class I.—Prime movers.
" II.—Tillage implements.
" III.—Sowing machinery.
" IV.—Harvesting machinery.
" V.—Farm machinery.
" VI.—Food preparing machines.
" VII.—Milling machinery.
" VIII.—Dairy appliances.
" IX.—Poultry farm appliances.

To these headings there might be added implements for the reclamation and drainage of land; machinery for preserving crops, including fan-drying apparatus and ensilage; the manufacture of manures and cattle foods; the irrigation of land; the processes of hop-drying and malting; the retting, breaking, and scutching of flax; the preparation of beet sugars and spirits; mechanical forestry; sheep-shearing and homestead tools.

Class I. *Prime Movers.*—The first portable engine ever shown at a Royal Agricultural Society's meeting was exhibited at Liverpool in 1841. Forty years later, 240 engines appeared at the Derby Show, and these motors are now produced by thousands every year. Most of them are single-slide engines with a fixed rate of expansion, although makers always exhibit, and sometimes supply portable engines fitted with variable expansion valves controlled by the governor.

Compound engines were first introduced on the farm by Messrs. Garrett and Co. in 1880, and, being extremely economical coal-burners, are likely to come into extended use. For it is well known that the "racing" engines, as they are called, having variable expansion gear, to which so many well-deserved honours have been adjudged by the Royal Agricultural Society of England, are not those which manufacturers recommend to farmers. They are too delicate to be advantageously handled by labourers, and single-valve engines are accordingly sold instead, because experience has proved that these do best and fare best in the field. If the introduction of the compound engine, already so successful in the factory, the mine, and the steamship, enable the farmer to realise an economy of which, at present, he only reads in the reports of judges, it is sure of a cordial welcome.

Self-moving engines, now in very general use, have been greatly improved during recent years in three important particulars. In 1870, Messrs. Aveling and Porter prolonged the side plates of the firebox upwards, forming these into brackets for carrying the bearings of the crank and countershafts, and thus relieving the boiler from all undue local strains. Previously to 1878, again, the gearing of self-moving engines had always been placed outside the crank brackets, but in that year, for the first time, Messrs. Aveling and Porter succeeded in bringing all the wheels and pinions between the bearings, and the driving and side wheels close up to the side plate brackets. By this arrangement the engine became immensely strengthened, its wear and tear correspondingly reduced, its width lessened, and its general compactness increased. If to these two important improvements be added the use of steel instead of iron in all the axles and gearing, the chief advances in these engines may be said to have been summarised.

The straw-burning engine, which was a novelty ten years ago, is now largely used in countries where coal is dear and the climate dry enough to permit of grain being thrashed very soon after it has been harvested. Straw-burning is accomplished by fitting a feed-box and pair of rollers to the furnace door of an ordinary portable engine. The feed rollers are driven by a strap from the crankshaft, and they force straw into the furnace in a thin fan-shaped stream. The fuel is thus held in suspension, so to speak, for a short time, allowing the separated stalks to become immersed in the flames, while provision is made for the ingress of large volumes of atmospheric air.

The calorific value of straw is as 1 to 3½ compared with coal, or, taking the relative local values of coal and straw into consideration, the use of the former would cost three and a half times more than the latter in countries like Russia and Hungary. In England, on the other hand, coal is the cheaper fuel by 5 to 1, partly because of its own low price, and partly because of the high price of straw.

Class II. *Tillage Implements.*—The plough is older than human history, yet thousands of years have not exhausted the possibilities of its improvement. It is only fifteen years ago that the introduction of the double-furrow Pirie plough seemed to threaten a revolution in the ancient practice of ploughing. Double-furrow ploughs are, it is true, no novelty. They were described 200 years ago by a writer in Cromwell's time. Arthur Young gave a drawing of one in his "Tour to the North," published in 1771, and Lord Somerville took out a patent for such a plough in 1802. A Leicestershire plough-wright, named Hanford, followed with a double-furrow plough, having adjustable beams for changing the width of the furrows, and these implements were generally popular in the early part of the present century.

But they all ultimately died, and the subject slept until Pirie's plough appeared in 1868. This well-known implement consists of two plough bodies carried on a framework of wrought iron, supported on three wheels, of which two, having V-shaped tyres, run in the furrows, and one on the land. The leading furrow wheel is steered by a lever, and plough handles are dispensed with. The pith of the invention consists in mounting the furrow wheels on inclined axes in such a way as to bring their tread into the angle of the furrow usually occupied by the slade. The last is dispensed with, and the plough, therefore, rolls instead of sliding forward, the draught being correspondingly diminished, and two furrows being traced almost as easily as one by the common plough. The objection to Pirie's plough was the want of proper means for raising and turning in at the headlands, but a device was introduced by Messrs. Ransomes in 1870, which rendered it possible to raise a double plough and turn it in at land's end without undue effort on the part of the ploughman. The plough is provided, about the centre of its length, with a through axle, cranked at each end and carrying a pair of travelling wheels. When in work, the cranked axle is in such a position that its wheels are off the ground, but on releasing the catch which holds it thus, the wheels take the ground, and the onward movement of the horses rolls them under the plough, raising it at the same time, until the cranks become vertical, when they come against a stop and the implement rides about like a cart. Messrs. Howard accomplish the same end by means of a brake, which the ploughman can apply to one of the plough wheels at will, utilising the energy thus obtained from the horses through suitable levers for lifting the plough body.

Turnwrest, or one-way, ploughs are made on four different plans. First, the mould board turns over from left to right, and *vice versâ*, as in the American hill-side plough. Second, one or more plough bodies revolve on a horizontal axis forming the beam, one set standing vertically while the other set is at work. Third, two or more right and left-hand ploughs are balanced, as in the steam plough, and used in the same manner. The fourth and last plan, which was patented by Mr. Muriston in 1876, is the only one that calls for special notice. Mr. Muriston places two ordinary plough bodies back to back, and supports them on a central wheel, which, as in Pirie's implement, acts the part of slade, and upon which the two plough bodies balance. The beam and handles are pivotted to a vertical stud rising from the centre of the plough frame, and can be swung round horizontally, while the plough bodies themselves remain stationary and looking in opposite directions. Catches, under the control of the ploughman, are provided to fix the beam and handles in the proper position for ploughing either way, and when the implement has arrived at the end of a furrow, the horses, in the act of turning, bring these into line for the return journey.

The limits of time forbid any attempt to review the gigantic subject of steam tillage, of which, however, a few words must be said. With regard to the motive power, it is now acknowledged that this should be applied as directly as possible to the work, and it has been found more economical to use two engines, notwithstanding their greater first cost, rather than change the direction of motion in the hauling rope. But Fisken's clever plan of transmitting the power by means of a light rope running at a high velocity is still successfully applied, especially in hilly districts.

As to the cultivating implements, it may be said generally that since the Fisken and Fowler patents of 1855 and 1856 expired, plough makers have adopted the see-saw movement of the latter in preference to the balance of the former patentee. The old Fowler plough, though greatly improved in detail since its introduction, still remains the same in principle as that which was first exhibited at Chelmsford in 1856, and has become the type of all succeeding balance ploughs of value.

The turning cultivator, originally contrived by Smith, of Wolston, has been greatly improved by Fowler and Co. and Barford. By the former this implement is now raised and turned at the headland by the pull of the tail rope on its coming into action, for hauling; while the latter has applied cams and ratchets, very ingeniously, to the lifting of these apparently unwieldy implements.

The self-moving anchors of Fowler, Howard, and Barford are mechanical contrivances of great merit, and factors of much importance in the system under which the plough travels backwards and forwards between a single engine and an anchorage. The anchor, which was formerly shifted laterally, after every bout, by hand, is now moved by the hauling rope itself, the ploughman being able to control its movements from his seat on the plough.

Class III. *Sowing Machinery.*—A good drill should sow uniformly the same quantity of seed, whether travelling on level ground, along the side of a hill, or up and down hill. It should adapt itself, not only to all kinds of seeds, but to all conditions of such seeds. The regulation of the quantity to be sown per acre, the shape of the coulters, and the steerage of the machine, are all matters of importance, but even sowing is the most important of all.

Cup-delivery drills are now in almost universal use throughout England and the Continent. Theoretically speaking, cups should be perfectly regular in their delivery, whether on level or hilly land; for if they are alike in capacity, and are all set at exactly the same angle to the diameter of the cup-wheel, they cannot fail to discharge exactly the same amount of seed with every revolution of the wheel spindle. Again, if the hopper into which the discharge takes place has a sufficiently wide mouth, and is set quite close to the cup-wheel, every seed must be thrown into it from the cups, even on the steepest hill-sides, whether moving along or up and down hill. Practically, however, it is a difficult matter in this class of work for the maker to set every cup rightly, and every hopper almost in contact with the cup-wheel, while the stems of seed-cups are so easily bent, and the tin hoppers so easily misplaced in working, that very regular seeding is a thing most difficult of attainment.

There was shown at Derby, in 1881, the McSherry "force-feed" drill, which is in common use throughout America. The McSherry feed is simplicity itself. The bottom of a hopper, containing seed, is closed by a small, spirally grooved roller which, revolving as the machine advances, supplies the seed in a regular stream to the coulter. The speed of the roller is constant, so that change wheels are avoided, and the amount of seed sown is regulated by sliding the feed roll laterally, and thus exposing more or less length of the feeding grooves. A "follower," or blank portion of the roll, closes the aperture in the hopper, which this movement would otherwise occasion.

So far as regularity of delivery is concerned, the McSherry feed is perfect. Its discharge does not vary more than 10 ounces per acre, whereas the best cup drills vary from 7 lb. to 40 lb. an acre; but the grooved roller of the McSherry drill is not so well adapted for sowing a variety of seeds as are cups.

Messrs. Murray, of Banff, introduced in 1880 a new potato planter, the invention of Mr. Ferguson, which requires a moment's notice. This machine consists of two large iron hoppers, containing the eyes, mounted on two travelling wheels, from whose axis an endless chain of cups passes up through each hopper, each cup taking up a "set" as it passes through. The sets, travelling with the chain, are carried down a spout, whence they are discharged into the furrow.

Class IV. *Harvesting Machinery.*—More patents have been obtained for improvements in reapers and mowers than for any other farm implement. Between two and three thousand have been taken out in England, and nearly double that number in America, while the degree of perfection to which these difficult machines have now arrived, is very great.

The improvements of mowers since their first introduction has consisted in lightening the dead weight and moving parts of the machine; in perfecting the cutting apparatus so that clogging is impossible under all conditions of crop and soil; in the substitution of iron for wood in the framing, and in housing the gearing. In all these respects the mowing machine has been for some years a perfect tool, and recent improvements are so much mere matters of detail that they do not require special notice.

The case is different in regard to the reaping machine. This implement must not only cut, but must deliver the grain, and the problem of how best to deal with wheat, oats, barley, and beans, long crops and short crops, wet and dry, standing and laid, is one that still engages the close attention of many clever inventors.

Although swathe delivery was the rule in all the early machines, the question of self-acting delivery in sheaf was not entirely neglected. In America, Mr Seymour, of Brockport, introduced a reciprocating rake in 1851, and the machine made a favourable appearance on light English crops. In 1862, Messrs. Samuelson and Co., of Banbury, introduced the Dorsey reaper, an American invention, which being greatly improved by this firm, laid the foundation of all the modern self-rakers. Neither the Dorsey machine or its predecessors, however, sized the sheaf, but threw the grain off at regular intervals without reference to variations in the weight of the crop. In 1869, the Johnstone Harvester Company, of Brockport, U.S., introduced a "controllable" self-raker, but this machine was not suitable for English crops, although the principle of sizing the sheaf was correct, and in the course of a few years English manufacturers were compelled to adopt either the Johnstone switch, or some equivalent of this device, for placing the rakes under the control of the driver.

The idea of a sheaf-binding reaper is by no means new. In 1847 Jacob Mann, of Clinton, Ohio, patented a machine having endless bands, which carried the cut grain into a receptacle, where it was bound by hand. In 1851 Watson and Renwick, of Chicago, brought out a sheaf-binder, which, in effect, was exactly like the string binder of to-day. It failed from the mechanical defects in the delicate tying apparatus, but it led to binding by hand upon the machine, a practice long successfully employed in America, and which only gave way there before the introduction of the self-raker.

The first sheaf-binder ever seen in Europe was exhibited by Walter A. Wood and Co., at Vienna, in 1873. It bound the sheaf with wire, and this class of machine was made on a large scale in the States by Wood and other American manufacturers, between 1875 and 1878. Before the end of that time, an outcry had been raised against wire, both by farmers and millers, and the Johnstone Harvester Company began experimenting with twine binders, their first machine of this kind being shown at Bristol in 1878.

Numerous as the schemers are, however, who have since then attacked the problem, only two successful string binders are yet before the public, viz., the Wood and Appleby machines, both of American origin.

* Paper read before Section G of the British Association at Montreal.

It is quite beyond the scope of this paper to describe in detail so complicated a machine as the self-binding reaper, but it may be said, generally, that the cut grain is carried, in the first place, across the platform and then over the drive wheel by means of endless webs. Here the stream of grain falls down an incline, until its passage is stopped by a bar standing vertically across its path. Against this bar the grain is "packed" until a bundle big enough for a sheaf is formed. Then the bar, which is arranged to give way under a certain pressure, moves, and, in doing so, puts into gear a "binder," a curved arm which comes up from below, and, after passing the binding string round the bundle, leaves its end in the grasp of the "knotter." Finally, this clever device first ties and then cuts the twine band, leaving the sheaf free to be kicked off the machine by a pair of levers provided for that purpose. The latest improvement in binders enables the driver to carry the bound sheaves on the machine, and to drop them at will so as to leave a clear road for the harvest wagon between the rows of sheaves.

While the chief interest of harvesting implements centres in reaping machines, it must be remarked that haymakers have been much improved of late years by Ransomes, Howard, Nicholson, and Jeffery and Blackstone. The first-named makers have introduced a tedder which knocks the grass out of the swathe by means of a fast back action, thus throwing the crop up behind the machine instead of over it, as usual. This method of tossing is sufficient for light crops and does no damage to the hay. The last firm have added a hood to the old Ashby machine, which partially incloses the forks, and prevents clogging in windy weather.

Horse rakes, once a rough class of implements, are now admirably made tools. The teeth are constructed of steel, and their form has received great attention with the object of collecting large loads, while giving a loose, light discharge. They are also made adjustable, so as to lightly skim, or closely rake the ground at pleasure. By the adoption of a balanced rocking frame, locked when at work, and free when being raised, the effort of lifting has been reduced to a minimum, while seats have been added, together with an automatic delivery under the control of the driver.

Stacking machines are now universally employed in the harvest field, and are of two kinds. First, the "horse pitchfork," which takes the hay from the wagon, and deposits it on the rick; and second, the straw elevator, driven by a small horse-gear. In the latter machine the hay or sheaves are thrown from the wagon into a hopper, whence they are raised to the top of the stack by means of endless chains furnished with rake teeth, and capable of elevation as the rick grows in height.

Class V. *Barn Machinery* — The modern thrashing machine is the outcome of forty years of experiment; the survival of the fittest results obtained from a long series of trials and errors, combined in a complex piece of mechanism, whose many functions have been correlated with an extraordinary diversity of conditions by the labours of a generation of mechanics.

Thrashing machines are classified as double blast, or finishing, and single blast, or non-finishing machines. The operations performed by the former of these are

1. Separation of the grain from the ear and straw.
2. Separation of the grain from cavings, chobs, and chaff.
3. Separation of the grain from dirt and seeds
4. Separation of the grain into different qualities.

So far as the first two of these functions are concerned, the finishing machine has been but little changed for a long period. It is in regard to operations Nos. 3 and 4 that improvements have been most numerous and important. A few years ago there were no machines which could finish for market unless the crop was in fair condition, but perfect samples are now obtained from grain, no matter how foul or unpromising its condition.

A cleaning and sizing machine, called the "second dresser," has been incorporated with the original thrashing machine. It consists of sieves and a second blast so arranged that any dust, dirt, seeds, and chaff not extracted in the first dressing are cast out, while uncleaned grain is returned to the riddles, and passed a second, or even a third time through the machine. Meanwhile, such grain as has been thoroughly cleaned falls into a revolving screen of three different meshes, whence it is discharged, either as first, second, or third quality, into sacks ready for market. The single-blast machine has no second dresser, and does not finish for market, but only for the granary.

By an Act of Parliament, passed in 1878, for the prevention of accidents in thrashing machines, makers are now obliged to protect the mouth of every thrashing machine with such a guard as effectually fences off the drum from the possibility of any one falling into it while at work. Previously to this, however, in 1874, the R.A.S.E. had offered prizes for drum guards, and in 1871, Mr. Wilder patented a safety feed, which has since been adopted by several eminent makers. This apparatus is, in effect, a small straw shaker, which delivers into the drum mouth, and is fed by an attendant, who himself stands in a place of safety. Above the shaker hangs a spiked rake, under whose teeth nothing thicker than a layer of grain can possibly pass.

Messrs. Marshall's "feeder" consists of a spiked barrel, fed from an inclined board. Beneath the latter three saw-toothed discs revolve, and the board itself is suspended by springs in such a manner that the weight of the sheaf depresses it sufficiently to allow the discs to protrude and cut the band. The loosened sheaf is then carried forward by the spiked barrel until it reaches a line of oscillating forks, by which it is spread out evenly just before entering the concave.

Drum guards proper are now very numerous, and the subjects of many patents, but they all depend on one of two principles. Some makers think, with Messrs. Robey and Garrett, that there is no danger of accident to the feeder so long as he is in his box; and it is only when he is out of it that there is any possibility of his falling into the drum. Their guard consists simply of a cover, which always remains closed over the mouth of the machine until the feeder gets into his place, when his weight depresses the bottom of the box a little, giving movement to suitable levers, and opening the mouth of the machine. Others arrange matters in such a way that if any undue pressure comes, either upon the feeding board, or a curved hood which half covers the drum opening, the latter is instantly closed by a self-acting shutter or flap.

The use of an elevator for carrying the straw as it issues from the shakers to the top of the straw-rick has long been universal, but in 1879 Messrs. Naldor and Naldor exhibited a thrashing machine and straw elevator combined, thereby taking a step in advance of the old system. The Naldor elevator is an integral part of the machine, swinging around a pivot like a crane, and delivering the straw in any direction, while it is arranged to pack easily and snugly on top of the thrasher when travelling.

In the interesting comparative museum of ancient and modern implements, which the R.A.S.E. brought together at Kilburn in 1879, there might have been seen a dressing machine, made by Henry Cooch, of Harlestone, which had been in use for 79 years, and was still a serviceable tool. Venerable as it was, however, this machine bore a strong family likeness to the latest dressing machine by the same maker, which the judges had chosen as the representative of modern practice, and there is, indeed, little to be said about improvements in connection with this class of implements. But in 1867, Mr. Childs introduced into America a very successful machine known as the "Aspirator," wherein the fan blast of the ordinary winnower is replaced by an exhaust acting in conjunction with riddles for the cleansing and separation of grain. Since that time great improvements have been made in exhaust dressing machines, chiefly, however, in connection with milling.

In 1876, Messrs. Walworth and Co., of Bradford, introduced a machine for cleaning grain and seeds, in which riddles are dispensed with and separation takes place according to specific gravity alone. The grain is allowed to drop vertically through a chamber, from which air is exhausted by the action of the fan. In its fall, it is arrested six times by as many inclined shelves, beneath each of whose lower edges a current of air is rushing in to fill up the partial vacuum created by the fan. Six times, therefore, the grain is weighed in a delicate air balance, the result being its perfect separation into several samples, each of the same specific gravity. This machine will not, of course, do the same kind of work as that performed by riddles, for some very small seeds are as heavy as wheat or barley grains, and must be taken out by sieves.

(*To be continued.*)

NOTES FROM THE SOUTH-WEST.

Cyfarthfa.—Contrary to general expectation a portion of these works is about to be closed, it is to be hoped only temporarily. In the upper forge—the portion referred to—there are sixteen puddling furnaces, and all these are to be stopped.

Newport.—Business in steam coal continues quiet, and some collieries have not been working full time. Prices have remained without alteration. A fair demand exists for house coal. No improvement is reported in the manufactured iron and kindred trades, and this week's shipments of iron have amounted to only 609 tons, despatched to Rio Grande do Sul. Iron ore has remained dull. The Slipway Company has completed a new fitting shop next to the Waterloo Wharf. The Usk Shipbuilding Company is stated to be about to extend its works. Last week's coal clearances amounted to 60,429 tons. From Bilbao there were received 10,020 tons of iron ore, and 6200 tons came to hand from other sources.

The Bute Docks.—A provisional agreement providing for the amalgamation of the Bute Docks and the Taff Vale Railway Company, was on Thursday signed, on behalf of Lord Bute and Lord Bute's trustees, by Mr. W. T. Lewis, and on behalf of the Taff Vale Railway Company by Mr. George Fisher. A Bill will be applied for in the forthcoming session of Parliament to give legal validity to the arrangement. By the arrangement entered into between Mr. Lewis and Mr. Fisher, Lord Bute will hold a very large interest in the combined undertaking. The amalgamation Bill involves the great Welsh struggle in the impending session of Parliament.

Shot Firing in Mines.—In the House of Commons on Thursday night, Mr. Burt asked the Home Secretary if he had appointed, or would appoint, some competent person to represent the Home Office at the coroner's inquiry into the cause of a recent fatal explosion at Pochin Colliery, near Tredegar. Sir W. Harcourt said it was intended to send a representative of the department to the inquiry. He might say, for the information of gentlemen in the House interested in mining matters, that he had that day received a letter from the inspector, in which that gentleman said that, although they had been unable to examine fully into the subject, in his opinion the explosion was the result of shot firing. Upon the general question of shot firing Sir W. Harcourt has written to Lord Aberdare: "In consultation with Mr. Wales, I find he will have no difficulty in selecting a test case by which to try the efficiency of the present rule. This, I consider, should be done before making any change in the rule as it now stands. He will, therefore, be instructed to take some case of a fiery mine, in which shots are now fired without removing any of the men, in a manner which is, in his judgment, dangerous. It will then appear whether the practical difficulties which he anticipates in enforcing the rules really exist. Until then, the proposed new rule will be suspended. You are at liberty to communicate the decision to the parties interested. I hope you will consider this a satisfactory solution of the matter, and that you will recognise in it my desire, whilst discharging the responsibility cast upon me, to [meet the wishes of the masters and the men employed in the important industry of the coal workings in South Wales."

Cardiff.—Last week the coal clearances showed a more satisfactory total. In steam coal, however, there is practically no change to report, a quiet tone still continues to be displayed, and the demand is rather less active. The demand for small steam coal has improved. The patent fuel market is in a satisfactory state. There is no improvement in the iron ore trade. Last week's clearances comprised 134,241 tons of coal, 7813 tons of patent fuel, 1063 tons of iron, and 2760 tons of coke. From Bilbao there arrived 3000 tons of iron ore and 709 tons came to hand from other sources.

The "Great Eastern" (s.s.).—The fitting out of this leviathan vessel has commenced in real earnest. As far as possible, the work has been given to local contractors. This will be acceptable to Milford Haven, which has of late suffered grievously in consequence of the stoppage of the dock works. It is estimated that it will take about six months to get the Great Eastern ready for her trip to the New World, where moored in the Mississippi she will be used as a floating hotel.

Pontypridd, Caerphilly, and Newport Railway.—This line affords a direct communication between the Rhondda Valley and Newport. The number of mineral trains passing through Caerphilly Junction is often twenty per day. Additional signal boxes and apparatus have been completed, and the whole line is now in complete working order.

Important Coal Contract.—A contract for the supply of steam coal to the Pacific Steam Navigation Company, of Liverpool, for which tenders were recently invited, has been taken by Mr. S. James, for the Marquis of Bute's Bute Merthyr Collieries. The quantity contracted for exceeds 20,000 tons.

Rhondda and Swansea Bay Railway.—Messrs. Struvé, Taylor, Eaton, and Rice, Briton Ferry, have obtained a contract for the segments, &c., for the tunnel of this railway under the Neath.

The Usk.—Mr. J. A. Macfarlane has been engaged by the Newport Harbour Commissioners on the recommendation of Mr. M'Connochie, to make a survey and cross sections of the River Usk, 803 ft. apart, for a sum of 300*l.*, the commissioners providing him with two boats and seven men, and all other necessary appliances for carrying out the work, which is to be completed in three months.

Barry Dock and Railways.—On Friday, Lord Windsor cut the first sod in connection with this undertaking. The ceremony took place on the mainland, a promontory known as Castle Land Point. Mr. T. A. Walker, the contractor, commenced the proceedings by presenting Lord Windsor with a barrow and shovel, made of polished oak, and elaborately decorated with ornamental silver. The barrow bore the following inscription. "This barrow was used at the cutting of the first sod of the Barry Dock and Railways by the Right. Hon. Lord Windsor, chairman of the company, on Friday, November 14, 1884. John Wolfe Barry, Thomas Foster Brown, H. Marc Brunel, engineers. Thomas A. Walker, contractor." The shovel bore a similar inscription, and the arms of Cardiff and Lord Windsor, as also did the barrow. Lord Windsor, amid cheers, turned the first sod and wheeled the barrow down a gangway to the edge of the cliff, where he tipped it over. Mr. Davies Davies and Mr. Wolfe Barry, amid laughter and cheers, also loaded an ordinary barrow. Mr. Wolfe Barry then made a few remarks explanatory of the undertaking. He said they were then at the beginning of the inclosed dam of the Barry Dock, and that the sods which had just been turned had begun a dam which would go out in nearly a straight line to the Mark Rock, from where a neck would run between the point and the point of the island into the docks. Behind the entrance there would be a basin of 8½ acres, and behind that again a dock of 40 acres. Immediately to the left to the eastward, there would be a timber pond of 15 acres. That, shortly, was the enterprise known as the Barry Docks. The docks would be approached by a railway which would come from Hafod on the north side, and the coal tips would be arranged on the same side and on the south side of the dock. The north and the south sides of the dock would be united by two railways, which would run parallel across the dam on the east and the west sides, so that coal could be shipped on the north side as well as the south side of the docks. The width of the docks would be 600 ft., the length 1100 yards, and the width of the entrance 80 ft. The depth of water at the entrance would be 2 ft. more than either the Roath Basin or Penarth Dock.

Great Western Railway.—The Great Western Railway Company will apply to Parliament next session for powers to construct a line commencing at Bandkey by a junction with the Devon and Somerset Railway, and terminating at Tawstock by a junction with the North Devon section of the London and South-Western Railway; to construct a railway commencing at Barnstaple by a junction with the Devon and Somerset Railway, and terminating also at Barnstaple by a junction with the Ilfracombe section of the London and South-Western Railway; to construct a railway commencing at Neath by a junction with the South Wales section of the Great Western Railway and terminating at Cadoxton-juxta-Neath by a junction with the Swansea and Neath section

of the Great Western Railway; to widen a bridge carrying the Great Western Railway over the Avon about 117½ miles from Paddington; and to convert into an open cutting a tunnel at Brislington.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

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Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act

SHIPS.

627. J. Lees, South Town, Suffolk, and J. S. Lees, Oldham. Applying a Tubular Formation in the Construction of Ships and Boats. [6d. 6 *Figs.*] January 4, 1884.—These are made with two or more tubular or trough-shaped portions arranged longitudinally or fore-and-aft, and parallel to each other, to form the floating base or substructure of the ship, and rigidly united by means of plates or girders placed on edge to resist transverse and longitudinal strains or stresses (*Accepted October* 17, 1884).

1139. W. P. Thompson, Dundee. Construction of Iron, Steel, and Composite Ships. [6d. 4 *Figs.*] January 10, 1884.—The frames are constructed of channel iron or steel in lieu of the ordinary combination of angle frames and reverse frames. The beams are also formed of channel iron in lieu of the ordinary bulb plate and two angle irons The kelsons are made of channel, I, or "Z ore" shaped sections of iron or steel. The objects are to dispense with part of the riveting, and to perform the remainder by machinery. (*Accepted October* 7, 1884).

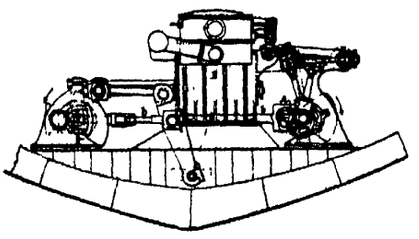
PROPELLING SHIPS.

2551. T Phillips, Aberdare, Glamorgan. Construction of Paddle-Wheels for Steamships. [6d. 2 *Figs.*] February 1, 1884.—The paddles or blades are arranged around a disc or plate placed intermediately between rims or flat rings by which the paddles are bordered at each side, the rim nearest the ship being of larger diameter than an intermediate rim which is of larger diameter than the outside rim, so as to thrust away floating objects, the paddles being either of the fixed or feathering type. (*Accepted October* 10, 1884).

2627. S. Ballisn, Paris. Propelling Ships. [6d. 2 *Figs.*] February 2, 1884.—A pump in the hold of the ship is so combined with tubes that water is drawn in from the front of the vessel and ejected at the back The tubes are arranged in such manner that at different points of their lengths they can be made to communicate, by means of small tubes opened or closed at will, with the hold (*Accepted September* 19, 1884).

2909. J. Whiteley, Leeds. Reducing the Frictional Resistance of Ships and Propellers. [2d.] February 9, 1884.—Air and animal, vegetable, or mineral oils are forced by a suitable pump through pipes to the respective positions where the greatest frictional force and other impediments, such as barnacle life, exist. (*Sealed May* 16, 1884).

10,372. W. R. Lake, London. (*E. Bauduin, Pola, Austria*). **Coupling and Driving of the Shafts of Twin Screw Vessels.** [8d. 3 *Figs.*] July 19, 1884.—The object is to couple and drive the shafts of twin screw vessels with a single set of engines without wheel gearing or additional rods or levers. Referring to the illustration, the cylinders B are placed horizontally athwartship. The leading high-pressure cylinder is provided with two connecting rods b b¹. The connecting rod b is double, and is



connected with two cranks and drives the starboard crankshaft A, the other rod b¹ is single, and actuates the port crankshaft A. The rods of the other cylinders are connected respectively with cranks on the two shafts, the cranks on each shaft being at right angles. The pistons of the two cylinders are thus independent of each other, and can follow the motion imparted to the crankshafts by the leading cylinder. The fulcrum of the side levers is arranged as clearly shown below the cylinders. (*Accepted September* 12, 1884).

SHIPS' FITTINGS

2286. J. Linklater and W. P. Mears, Tynemouth. Deck Seats. [6d. 3 *Figs.*] January 2, 1884.—A twin boat or raft formed of two parallel square or quadrangular tubes floating on the angle is employed for making deck seats. These tubes are connected by hinged thwarts so as to form deck seats with back rests capable of being opened out to form a life raft. (*Accepted October* 10, 1884).

11,551. C. D. Abel, London. (*J. F. Belleville, Paris*). **Marine Steam Boilers.** [1s. 2d. 13 *Figs.*] September 1, 1884.—This relates to the construction of the class of marine steam boilers known as the "Belleville" boiler. As shown in the drawing annexed to this specification, six boilers are arranged back to back in the longitudinal axis of the vessel with the stokeholes to port and to starboard. The group is formed of six distinct compartments, each constructed of sheet and angle iron for the ashpit, the tube chamber and the smokebox, and of firebrick wall secured together for the furnace chamber. Each compartment contains a distinct boiler composed of a variable number of tubular elements. The boilers have no communication except through the smoke flues and main feed and steam pipes, the boilers consist of four principal parts: 1. The casing including the base of brickwork surrounding the ashpits, the facia plates and the crosspieces situated at the inner angles of the boilers and forming the framework of the casing; the partitions or panels that separate the ends of tubes and form the tube chambers, and the casings that forms the smoke flues and base of the uptake. 2. The ashpit with its doors, the furnace with its fagade and doors, the furnace grates, the brickwork surrounding the furnaces and separating them from each other, the tube chambers and their doors 3 The steam producing elements formed into a group for each boiler, the feed pipes, the steam separators, the draining tubes, and the ejector recipients. 4. The feed apparatus and steam supply pipes (*Accepted October* 3, 1884).

11,962. R. Meager, London, Mariner's Compasses. [6d. 1 *Fig.*] September 3, 1884.—The compass card instead of being made circular is made of polygonal form with the sixteen principal points of the compass at the angular points. The card is divided by a transverse band separating the northern from the southern divisions. (*Accepted October* 3, 1884)

12,562. J. Linklater and W. P. Mears, Tynemouth Drag Anchors. [2d.]. January 2, 1884.—A piece of canvas is attached by its upper margin to one end of the buoy or raft athwartships. A metal rod is attached to the opposite margin A rod passes from each end of this last rod to the corresponding side or gunwale of the buoy or raft, and is hinged to it. (*Accepted October* 14, 1884).

RAISING SUNKEN VESSELS

825 W P. Thompson, London. (*R W. Doherty, Liverpool, now at sea*). **Raising Sunken Vessels and Apparatus therefor.** [6d. 2 *Figs.*] January 7, 1884.—Inflatable bags formed approximately to correspond with the vacant spaces in the vessel are inserted in the spaces and inflated by means of an air-pumping apparatus on a pontoon or other vessel and pipes connected with the nozzles of the bags, each nozzle being provided with a stop cock. (*Sealed September* 30, 1884).

BOATS

456. C. F. Woosnam, Southend, Essex. Rowlocks. [6d 3 *Figs.*] January 2, 1884.—The rowlock resembles a fork with a stem, able to turn on a hinge or pivot arranged crosswise of a frame chamber in the side of the boat A swivel is provided between the fork and the pivot or hinge. When in use the fork is turned up on the pivot, so that the bifurcated portion is above the top of the chamber, in which position it is retained by a cover of the chamber. (*Accepted October* 10, 1884).

574. Hon. O. G. Lambart, Southend. Life-Saving Raft or Apparatus. [6d. 8 *Figs.*] January 3, 1884.—This comprises a flat framework preferably of oval form, having a large rectangular opening formed through it at the centre, and carrying at its two ends air-tight cases serving as floats. The central opening is fitted with a jointed cage or basket capable of opening and hanging downwards whichever side up the raft may happen to be floating The outside of the framework is surrounded with slabs of cork A provision locker is provided at each end of the rectangular opening. (*Accepted October* 17, 1884)

GRAPNELS.

2296. H. C Chester, Noank, Conn., U.S.A. Grapnels. [4d. 2 *Figs.*] May 28, 1884.—The object is to permit a grapnel to be folded up into small compass when not required for use All the arms or flukes are hinged to the shank and a slide is mounted on the shank and receives the tips of the folded arms or rests on the unfolded arms. A locking pin secures the slide in either position. (*Sealed September* 26, 1884)

PERMANENT WAY OF RAILWAYS.

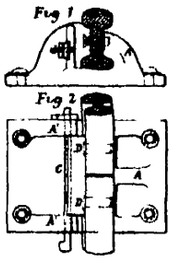
81 E. H Lake, London. (*R W. Taylor, Richmond, Virg., U S A.*) **Journal Boxes or Bearings** [6d. 1 *Fig.*] January 1, 1884.—Mica is formed or cut to the desired shape, secured together by a clamp, placed in a suitable mould and brass, iron, or other material cast around it except at one side After removing the bearing from the mould, the clamp is removed and the mica side is concaved to receive the axle or shaft, (*Accepted October* 3, 1884).

166. G F. L. Meakin, Kingston-on-Thames. Constructing and Fixing the Heads of Tramway and Railway Rails. [4d 2 *Figs.*] January 1, 1884.—The heads are held in jaws formed in bars cast or rolled to shape, the lower parts of the heads being made to fit projections or recesses in the jaw. The head is formed in two pieces forming the sides of the rail and secured by a wedge piece forming the bottom of the groove of the rail. (*Accepted September* 12, 1884).

665. R. D. Sanders, Norwood, Lennie, N.B. Railway Keys. [4d. 10 *Figs.*] January 4, 1884.—A thin strip of metal somewhat longer than the key is placed in a longitudinal groove in the chair. The strip of metal is split at both ends, one part at each and being bent inwards over the key and the other part outwards round

the side of the chair. A number of holes are drilled transversely through the key and plugs of hard wood inserted The illustrations show the wooden key A retained in place by the split ends B of the metal strip, the key and plate being shown separately in Figs. 2 and 3. *a a* are hard wooden plugs inserted in transverse holes in the key. (*Sealed November* 6, 1884).

883. J. Cook, Glasgow, and D. Atkinson, Wednesbury. Permanent Way of Railways and Tramways. [6d. 4 *Figs.*] January 8, 1884.—The chair shown in Figs. 1 and 2 is specially adapted for use in lieu of fishplates to secure the rails at their end joints. The chair is cast with a broad jaw A to fit the rail on one side and with a pair of brackets A¹, which rise vertically from its base at the opposite side of the rail. A cushion fitted between these brackets and the rail, is shaped to fit the web and lower flange of the rail and is kept in place by means of a tapered key C passing through a slot in each of the brackets and bearing on the back of the cushion. A split pin prevents the key from shaking out. When applied to secure the end joints of rails, pins D are formed on the cushion and pass through the web of the rail



into the jaw A to prevent the rails creeping out of the chair (*Sealed November* 11, 1884).

1722. O. Imray, London (*J. Chater, Seetarampore, Bengal*) **Railway Sleeper and Chair Combined.** [4d. 7 *Figs.*] January 18, 1884.—A pair of jaws holding the rail are fixed in recesses in the sleeper by a tie bar passed through them and secured by keys Referring to the illustration, the sleeper S, preferably ribbed underneath, is formed with recesses to re-

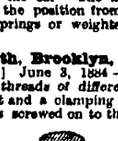


ceive two jaws J, and with a slot for the tie-bar T The two jaws are interchangeable, and have in their outer faces recesses to receive cushions of elastic material The jaws may also rest on elastic cushions U The outer jaw J is secured by a wedge W The inner jaw J is secured by the tie-bar T, and the keys K driven into slots in the tie-bar (*Accepted October* 7, 1884).

2661 C D. Abel, London. (*F Westmeyer, St Johann-on Saar*) **Raising Rails on the Permanent Way.** [4d 3 *Figs.*] February 20, 1884.—A framing is embedded in the permanent way immediately beneath the rail to be raised, and carries a horizontal shaft on which are two eccentrics connected to each other at different points of the periphery by rods The shaft is rotated by worm gearing, one or other of the rods bearing against the underside of the rail so as to lift it. (*Accepted September* 10, 1884).

5121. A. and M. F. Bonzano, Phœnixville, Penn., U.S.A. Arresting Locomotives and Cars. [6d 9 *Figs.*] March 19, 1884.—A lever is pivotted to lugs on a shoe free to slide on the rail and has two arms, one vertical and the other horizontal, connected by a web A toe on the lever bears on the shoe, and the horizontal arm of the lever is above a block resting on the rail and sliding with the shoe and lever, being loosely confined between a projection on the lever and the end of a slot in the shoe When the locomotive or car strikes the vertical arm of the lever, it, with the shoe, will yield and slide on the rail, exerting at the same time such pressure on the rail through the medium of the block as to arrest the car The arresting devices may be made self restoring to the position from which they have been moved by means of springs or weights (*Accepted October* 10, 1884)

8544. E. C. Smith, Brooklyn, N Y., U.S A. Nut-Locks. [4d. 3 *Figs.*] June 3, 1884.—The screw bolt is provided with two screw threads of different pitch, and on which screw respectively a nut and a clamping plate Referring to the illustration, the nut A is screwed on to the bolt *d* in the ordinary



manner, and the plate s forced up against it being screwed on the reversely threaded portion of the bolt. A projecting point *j* on the plate is then bent down on to the side of the nut. The threads may be of different pitch, and both have the same direction. (*Sealed September* 19, 1884).

12,057 T G. Hardie, Burnley, S. B. Depree, Old Trafford, and M. Willes, Burnley, Lanc. Railway Joint Supports and Railway Chairs. [4d. 4 *Figs.*] September 5, 1884.—The two chairs are connected together at a convenient distance apart by means of a strengthening web bolted to or cast in one with the chairs The fish-joint of the rail rests on the strengthening web (*Accepted October* 10, 1884).

TRAMWAYS.

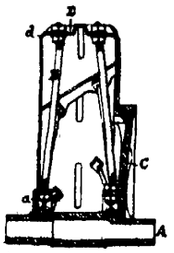
23. O. Imray, London. (*T. A, Appleing, Calcutta*). **Rope Carrying Gear and Suspended Tramways.** [4d. 3 *Figs.*] January 1, 1884.—The pulleys or wheels are made in two parts, each having the shape of a frustrum of a cone and mounted on separate axes in the same line, with their smaller faces presented towards each other, the suspending connection passing between these faces. When the rope travels it runs in the V-shaped groove formed by the surfaces of the two parts, and the direct suspender passes through the space left between the two half pulleys (*Accepted October* 17, 1884).

946. C. D Norton, London. Cleansing and Sanding Tramway Roads. [6d. 6 *Figs.*] January 2, 1884.—Two wheels extending on either side beyond the rails are mounted on a transverse shaft, which supports loosely a shoe or scoop, to which is attached a plough extending slightly in front of the shoe. The shoe drops into the groove automatically Revolving brushes are also mounted on the shaft and fit into the scoop, sweeping the refuse matter into a compartment provided for it. The sand box is of triangular form, and has fitted in the opening at its bottom a spiked roller which can be raised and lowered as desired. The axle being smaller than the roller allows the sand to drop over the roller clear of the axle on to the rail. (*Accepted October* 17, 1884).

WHEELS.

11,187. D. M. Osborne, Auburn, New York, U.S.A Traction Wheels. [6d. 6 *Figs.*] August 12, 1884.—This consists in a sectional wheel constructed with a cast metal hub or centre, with a sectional metal rim and with radial metallic spokes, the ends of which are secured in the rim and hub respectively The hub is constructed with flanges or ears to receive the spokes, and with a gear-wheel or geared rim to impart motion to the mechanism of the machine. Referring to the illustration, the hub A is cast in a

tubular form, and provided at or near its ends with encircling flanges *a*, the outer edges of which are extended laterally inward to receive the inner ends of the spokes B. The wheel or rim C provided with gear teeth is cast integral with the hub. The rim D is constructed in numerous sections joined end to end, each section being of the full width of the face of the wheel, and pro



vided with a series of holes to receive the spokes, and with a hub or flange to overlap the inner face of the next section and with inwardly turned flanges *d* The spokes are secured by nuts. (*Accepted September* 12, 1884).

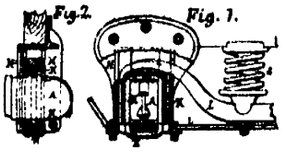
RAILWAY ROLLING STOCK.

654. W. Boucher, Newnham, Gloucester Buffers for Railway Wagons, &c. [6d. 4 *Figs.*] *January* 4, 1884.—A ram works in a cylinder, and its back end is fitted with studs working in grooves passing from end to end of the cylinder Two flat keys pass across the grooves near the front end of the cylinder, and serve to prevent the rams extending too far out The spring for bearing the compression is constructed of steel of an angular section, or of india-rubber. (*Sealed October* 28, 1884).

913. H. Parks, Northwich, Cheshire. Safety Truss and Axle Protector for Railway Rolling Stock. [6d. 5 *Figs.*] January 8, 1884.—A truss provided with circular grooves is fixed on to the centre of the axle. The ends of tubes surrounding the axle fit into these grooves, the other ends fitting in similar grooves in the boxes of the wheels. Strengthening bolts pass through snugs formed upon the truss, and through snugs on the box of each wheel, being securely fastened by nuts. The spaces between the axles and tubes are filled with red lead and oakum, or other non-corrosive substance. (*Accepted October* 3, 1884).

10,710 J Tordoff, Leeds. Buffer Boxes for Dead-stops and Vehicles of Railways, &c. [4d. 5 *Figs.*] July 29, 1884.—The buffer boxes are produced by stamping, striking, or pressing a heated metallic plate successively by means of a series of punches and dies of varying form until the plate is caused to assume the desired configuration with a flange thereon, and removing the superfluous part from the smaller end (*Sealed October* 31, 1884).

10,918. W. S. G Baker, Baltimore, Maryland, U.S.A. Car Axles, Boxes, &c [4d 5 *Figs.*] January 22, 1884.—This refers to Specification 1918 of 1884. The axle box A plays between the jaws of a depending pedestal H rigidly bolted to the framing of the car and stayed by braces. A link E is suspended from the top of the axle box A and sustains the step I provided with a suitable seat for the link on its under face and notched at each end for the reception of the upright sides of the link A ∩-shaped spring frame K straddles the axle box and suspending link and rests upon the ends of the step I, its arms, as

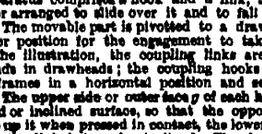


well as the step I, fitting in vertical grooves in the jaws of the pedestal The frame K is acted upon by the spring beam L, the opposite end of which is supported upon another axle box The car body is mounted in the usual manner upon the springs S A brace rod I extends from one axle box to the other. The car axle box, as will be seen, can move laterally so as to give ample play to prevent jerks in passing curves, the vertical movement of the block I and the spring frame K accommodating this action. The car body may be mounted on springs bearing on the upper face of the frame K. (*Sealed November* 4, 1884).

12,947. C. Steiger, London. Moving Railway, &c., Wagons, Vessels, &c. [4d. 6 *Figs.*] September 5, 1884.—Stationary engines are employed to drive racks, by means of pinions or wheels. The rack is composed of a number of sections having together a length greater than the distance between two stations at which it is driven These racks are employed to move railway wagons, vessels, &c. (*Accepted October* 14, 1884).

RAILWAY CAR COUPLINGS.

498. E. Richmond, Leicester. Coupling Railway and other Vehicles. [6d. 3 *Figs.*] January 3, 1884.—The coupling apparatus comprises a hook and a link, the one fixed and the other arranged to slide over it and to fall into its place by gravity. The movable part is pivotted to a drawhead, and is held in proper position for the engagement to take place. Referring to the illustration, the coupling links are pivotted at their rear ends in drawheads; the coupling hooks *e* are secured to the end frames in a horizontal position and secured to the draw rods. The upper side or outer face *g* of each hook is formed with a curved or inclined surface, so that the opposite link may slide or glide up it when pressed in contact, the lower side *h* of the outer end of the link being also inclined. The drawheads supporting the links are provided on each side with projections *i*

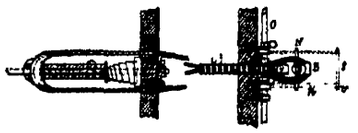


above the rear ends of the links and with projections *j* below their ends. The projections limit the upward and downward movements respectively of the link. The rear ends of the links are formed with flat surfaces, so that they strike the top and bottom projections at the same moment, thereby reducing the strain on the drawbar to a minimum. The vehicles are uncoupled by means of rods *k* supported in suitable bearings, and having their inner ends cranked and partly extending under the link. By means of levers the rods are rotated to raise the links. An iron guard *s* is suspended from the bottom or sides of the front end of each link, and the projecting crank end of the rod *k* passes through the guard, and the rod *k* being fixed in the position shown in dotted lines prevents accidental uncoupling. Cords, chains, or ropes may be employed for uncoupling. (*Sealed May* 30, 1884).

2697. J. and G. Gaskell, Pemberton, Lanc. Couplings for Railway Rolling Stock. [6d. 1 *Fig.*] February 9, 1884.—The draw hook shank is formed with a beak projecting from its upper surface backward into the buffer plate The draw hook has an abutment preventing its shank going too far into the buffer plate. The link is applied between the beak and shank before the draw hook is fixed in place, and the draw hook is then screwed up till the abutment comes firmly against the buffer plate and till the beak enters the buffer plate. (*Accepted October* 3, 1884).

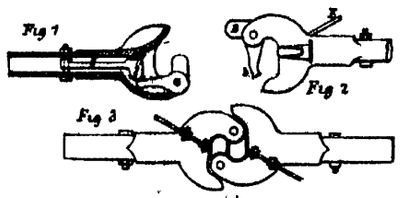
2947. F. F. A. Brandt, Belleville, Ill., U.S.A. Car Couplings. [4d. 4 *Figs.*] June 20, 1884.—A doubly slotted drawhead is employed, one slot having a hook pivotted therein to engage with the opposing drawhead, which latter is also provided with a hook to engage with the other slot of the former. The hooks can be raised from the sides or tops of the carriages by bars supported by straps and connected to the hooks by chains passing through eyes in the drawbar or by rods secured to the hooks and supported by straps. (*Sealed September* 23, 1884).

9236. R. C. Bayer, Newport. Coupling Apparatus for Railway Vehicles. [8d. 9 *Figs.*] June 21, 1884.—The vehicles are coupled together with iron or steel wire rope formed into double loops at the ends of the vehicles, into which the loops upon the adjacent vehicles to be coupled pass, the coupling being secured by means of a pin or bolt having arms to prevent it falling through the loop, and being lowered into and raised from the loops by means of horned links worked from the sides. The ropes at the other end or under the vehicles are passed round properly formed headpieces sliding upon a central bolt, and retained in place by means of a spring and worked by a ratchet and pinion, or projected backwards and forwards by means of a screw coupling bolt worked by a train of bevelled wheels under the centre of the vehicle. The illustration shows one modification of the apparatus. The operation of coupling is as follows The bar S of the link R is turned on its joint at U, so as to be parallel with the arm of the



link, and the link is raised to its highest position, the horizontal arm N of a bolt being prevented from sliding down the link by means of projections. The horizontal bar of a vertical T-shaped piece takes between projections on the link R, and its lower end rests in the hollow of an inclined bracket V, and is retained in position by a small chain. The loop B of the adjacent vehicle is forced outwards by moving the bar O horizontally (when the link R will be free to turn on it) and rotating it, causing the rack C^2, through which the rope passes to be moved outwards, and the bar O is then moved back to engage with the link R, and, by means of the bar S fixed in the position shown in dotted lines, the loop is adjusted vertically to take into the loop on the first vehicle. This loop comes in contact with the end of the T-iron which is raised clear of the link, which drops with its bolt N by gravity, and the coupling is completed. Slight modifications are described. (*Sealed October* 21, 1884).

11,156. H. H. Lake, London. (*E H. Janney, Alexandria, Virg., U.S.A.*) **Coupling Apparatus for Railway Vehicles** [4d. 6 *Figs.*] August 11, 1884.—This relates to that class of coupling apparatus in which the drawhead is provided with a rotating hook nose. Fig. 1 is a plan with the rotary hook nose in open position Fig 2 is a horizontal sectional view of one of the couplings, and Fig. 3 is a plan of two united coupligns reversed The rotary hook nose B is provided with a special bearing face *b*. The locking block C is pivotted on a shaft extend-



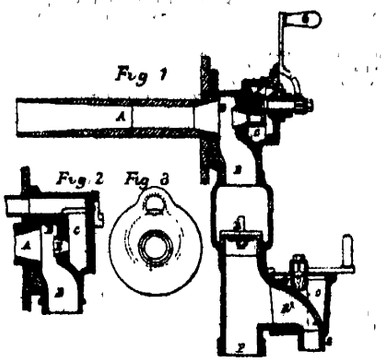
ing across the drawhead and is forced to its normal position by a spring The operation is as follows: One or both of the couplings being in the open position as shown in Fig 2, the drawheads are brought together, the rear end *b* of the hook nose B swings in beneath the free end of the locking block C, and raising it against the resistance of the spring passes in behind one of the side bearings of the head portions of the locking block, as shown in Fig. 1, the position of the parts when coupled being shown in Fig. 3. (*Accepted Octobe* 7, 1884).

RAILWAY BRAKES.

6122. H. J. Haddan, London. (*H. Wad, St. Louis, U.S.A.*) **Railroad Car Brake.** [1s. 9d. 21 *Figs.*] April 8, 1884.—The locomotive cover is connected with an air filter connected with the air pump used for supplying air for operating the car brakes. The filter consists of two wire screens, the face between which is filled with fibrous material. The ports of the brake cylinder opening to the external air are also provided with filters. The electrical conductors for operating the valves of the air brakes are supported and protected inside the air conduits. These valves connect the interior of the cylinder alternately with the main pipe and with the external air. The leading wires of each car terminate at the hose couplings and are automatically connected from car to car simultaneously with the coupling of the hose. An automatic regulating valve is arranged to close the communication between the cylinder and the external air, when the pressure in the cylinder falls to a predetermined point after the electro-magnetic valve has opened the port to the external air. The valves, electro-magnetic appliances for operating the valves, the gearing for connecting the electrical conductors, the air Westcott brake cylinders, &c. are fully illustrated and described. (*Sealed November* 25, 1884).

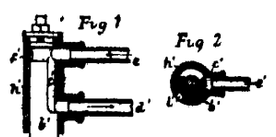
1004. S. Carlton, Clifton House, Wilts. Vacuum and Steam Brake Apparatus for Railway Trains. [6d. 3 *Figs.*] January 9, 1884.—This refers to apparatus of the kind described in Specification 2606 of 1882. A disc valve having two apertures is employed to control the admission of steam to the ejector, the smaller suitable for high-pressure steam and the larger for low-pressure steam. This relates also to the steam and discharge cones of the injector and to the valves of the apparatus.

Referring to the illustrations, the air and steam chambers, B and C, are separated by a partition, into which is screwed the steam cone E in the same axial line as the discharging cone A. The disc valve F (Fig. 1) having the two apertures, large and small, rotated against the face of E and is actuated by a lever G. Steam from the boiler is admitted into the chamber C; as shown in Fig. 2, the steam enters at the back. The check valve L is hinged to a diaphragm. The air inlet valve chamber O communicates with the train pipe P, and is provided with a tapering plug Q having two passages, the one communicating with the train pipe and the other to the reservoir by the branch S. The plug has also a passage R^2 by which the train pipe can be connected to the reser



voir, as shown in Fig. 1. By means of another passage the reservoir can be placed in communication with the atmosphere. The plug Q is kept in position by a spring, as shown, and is rotated by the handle. The chamber O is partially closed by a perforated cap. It will thus be seen that, according to the position of the lever U (1) the ejector is exhausting the train pipe and reservoir, or (2) the train pipe only, (3) air is admitted to the train pipe only, or (4) to the reservoir and train pipe. (*Accepted October* 10, 1884).

10,788. H. H. Lake, London. (*C. E. Mark, Flint, Mich., U.S.A.*) **Controlling the Passage of Air or other Fluid in Railway Brake Apparatus.** [4d. 5 *Figs.*] August 2, 1884.—This consists chiefly in providing a stop-cock or plug valve in the hose connections and in connecting the valve with the levers employed to actuate the car couplings that they will also actuate the valve. Referring to the illustration, the plug b^1 is arranged on the crankshaft M and rotates with it. A recess a^1 in the plug is of sufficient length to communicate with the ports



d^1 and e^1, and at one end with the annular recess f^1. The plug is surrounded by the shell A', which has the two ports d^1 and e^1, and an exhaust port c^1 leading to the atmosphere As shown in Fig. 1, the air or steam from the pipe extending from the locomotive passes by the port e^1, recess a^1, and port d^1 to the brake pipe of the system; when the plug is turned so that it closes the port d^1, the air entering the port e^1 will escape by the port c^1. The crankshaft M, as will readily be seen, when turned to engage or disengage the vehicles, controls also the passage of the air or other fluid to the brake system. (*Sealed November* 4, 1884).

SIGNALLING APPARATUS.

12,259. W. Fox, Leeds, and A. Gladhill, Batley. Fog Signalling. [4d. 5 *Figs.*] July 19, 1884.—A chain passes over a toothed or pitch wheel arranged on a vertical axis in a box. The upper side of each link is provided with a platform receiving the detonating charge. After each explosion the chain is caused by the signalman to travel a sufficient distance to bring another link on to the rail for another explosion, the detonating case being cut off or withdrawn from the platform (*Sealed October* 21, 1884).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

ISTHMUS OF CORINTH CANAL.—The works of this canal are proceeding regularly. The canal is expected indeed to be completed within the contract time.

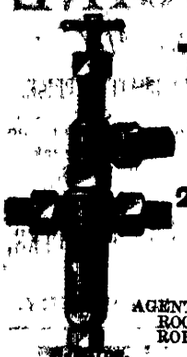
RAILWAYS IN NEW SOUTH WALES.—The New South Wales Acting-Minister for Works (the Hon. G. E. Dibbs) is desirous of having about thirty miles of a railway from Narrandera to Jerilderie, opened for traffic in time for the approaching wool season, with the right to use the remaining portion of the line. The opening of thirty miles of this railway will offer great advantages to the wool growers in that part of New South Wales, and will probably be the means of attracting to Sydney a large quantity of wool, which, without railway communication with Narrandera, would be taken to Melbourne *viâ* Deniliquin, along the Deniliquin and Moama Railway, or by way of the Murray, to other points of communication with the Victorian railways. The railway to Jerilderie has so far progressed towards completion that the rails have been laid the whole of the way, and all that is now required to be done, is the finishing work which follows the laying of the rails. The Engineer-in-Chief for Railways left Sydney recently for Gosford, to inspect railway works in progress there in connection with the Homebush and Waratah line.

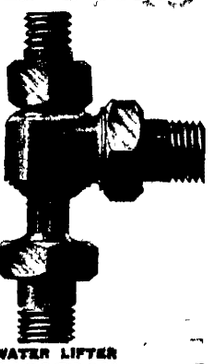
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5130 WATER LIFTER

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BROTHERHOOD'S PATENT



FLEXIBLE COUPLING

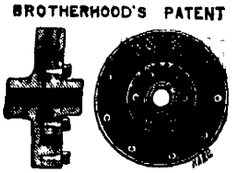
PETER BROTHERHOOD,

MECHANICAL ENGINEER,

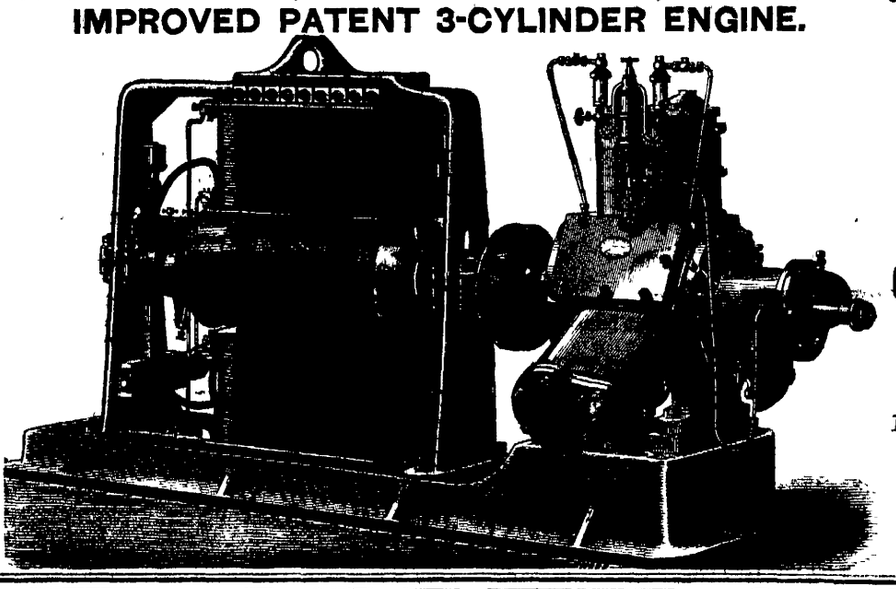
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FOR DRIVING

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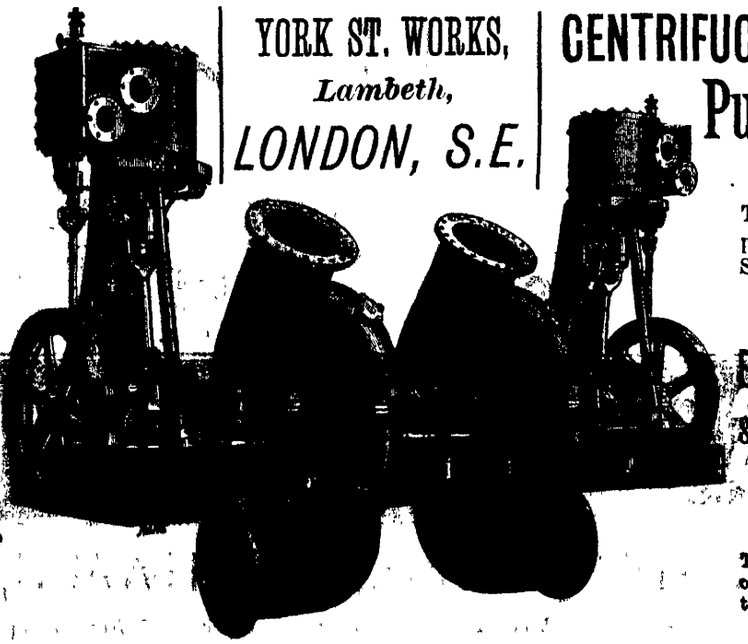
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Of these Pumps and Pumping Engines have been fitted on the Swiftest and Largest Steamers afloat, sailing in all parts of the World.



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This engraving represents a pair supplied to the magnificent S.S. "Umbria," the latest addition to the Cunard Line.

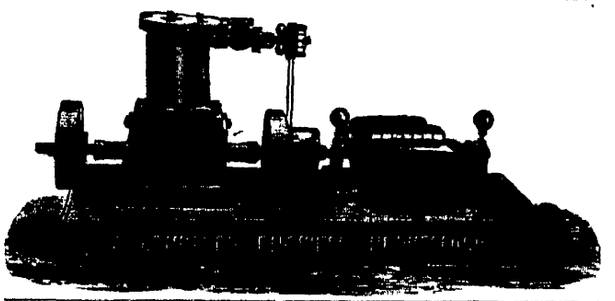
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SINGLE OR DOUBLE. SILENT & STEADY.

SPECIAL TOOLS having been made for these ENGINES they are MODERATE in PRICE.

1200 REVOLUTIONS per Minute. Perfect System of Lubrication—no handoiling, no attention. Half-pint of Oil is sufficient for Two Days' Supply. Forged Steel Crank and Phosphor-Bronze Working Parts throughout. MADE IN FOUR SIZES.

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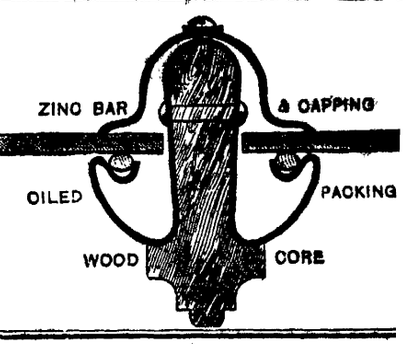
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BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

Bell's Asbestos Works, Southwark S.S. "Rnapehu," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

16,000 miles continuous steaming without renewal.

Steam Pressure 110 lbs. | Vacuum 26 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 27 days 22 hours, being the fastest run from New Zealand on record

Yours obediently,

D. HENDERSON, Chief Engineer, S.S. "Rnapehu"

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department,

Grimsby, April 19th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory

Yours truly,

Mr J. Bell. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts.

Admiralty, Whitehall, 26th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to sample submitted.

Elastic core .....square. | Elastic core . . . .round

To Mr. John Bell. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1 lb in think of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 60 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To Bell's Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

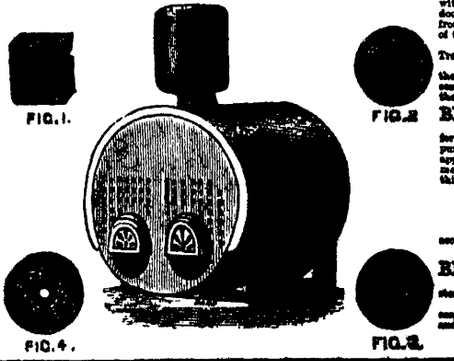
I am, dear Sirs, yours faithfully,

THOMAS WINTER, Colliery Engineer.



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The goods of this name are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depôts and not through agents or factors.



BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to the and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; ec 80 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after w years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only t mixed with water to the consistency required for use.

A Horizontal Boiler, 27 ft. 6 in. long, 15-HP., gave the following results:—

Temperature on Plates . . . . 157 deg.

Covering . . . . 84 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 l steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 20th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel the using your covering.—Yours truly, "W. SANTO CRIMP, C.E., F.G.S.

The Tamar and Kit Hill Granite Company, Limited,

Gunnislake, Tavistock, 5th April,

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the bo our travelling crane at Kit Hill has yielded most remarkable results. Since it has been in u have saved fully half our coals, and have effected a great saving in the time it takes to get up s which is often a matter of great importance to us. I should add that the crane runs on high pre and is fully exposed to all weathers. I have formed the highest opinion of your Asbestos as now this purpose, and as you are aware, have had another boiler similarly covered, though it has since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W. J. CHALK, Assoc. M. Inst, C.E., Engineer and Mana

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TA AND SHEETING,

for making every class of Steam and Water Joints. It and Se bent by hand to the form re without puckering, and is especially useful in making joints of manhole and mu doors. It is kept in stock in rolls of 100 ft., from ⅛ in. to 3 in. wide, and any thic from 1 16th in. upwards. Manhole covers can be fitted many times before the of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and cuts about half Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to themselves against being supplied with these inferior articles at any price, users recommended to see that every 10 ft. length of the Asbestos Tape purchased by them the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBES MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughne purity, and is absolutely free from the injurious ingredients frequently used to ob appearance of finish, regardless of the real utility of the material. Made in measuring about 40 in. square, from 1-64th in. to 1 in., and 1 millimetre to 25 milli thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts.

Admiralty, Whitehall, S.W., 10th May,

Sir,—I have to inform you that your tender for Asbestos Millboard has accepted.

JOHN COLLETT,

Mr John Bell. Director of Navy Contr

BELL'S ASBESTOS EXPANSION SHEETING, Pa

This Sheeting is another combination of Asbestos with India-rubber, giving steam most the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an coating of vulcanized Asbestos Cloth, thus producing an unequalled joint where ste and concussion render other packings inadmissible.

This material is admirably suited to steam pipe joints and every class of valve. Valves made of this material are very durable, as they are not subject to decay

BELL'S "ASBESTOS LUBRICANT"

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.

OR THE DEPOTS—

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF.

CLASS A.



LOCO. PATTERN, SINGLE LEVER.

THE HANCOCK

INSPIRATOR

ONLY GOLD MEDAL, Paris, 1878. FIRST AWARD, Sydney, 1879.

60,000 IN USE.

THE DONKEY PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND RELIABLY.

No Adjustment.

Draws Water at 140°.

All Sizes lift water 25 ft.

Delivers to Boiler up to 212°.

ESTIMATES FOR FIXING COMPLETE with Guarantee to start in good working order, and all information on application to—



Feeds through Heaters.

Can be used as a Pump only.

No Valves or Wearing Parts.

Can be examined instantly.

THE HANCOCK INSPIRATOR CO., 108, Upper Thames St., London, E.C.

CLASS C.



STATIONARY PATTERN. 5115

Henry Bessemer and Co., Limited,

Manufacturers of Cast Steel,

SHEFFIELD.

FORGINGS

In Steel of any size.—Quotations given either for uses or finished complete.

STEEL CASTINGS

Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0.30 per cent. carbon, and to bear a tensile strain of 34 tons to the square inch.

TYRES AND AXLES.



SOFT CAST STEEL

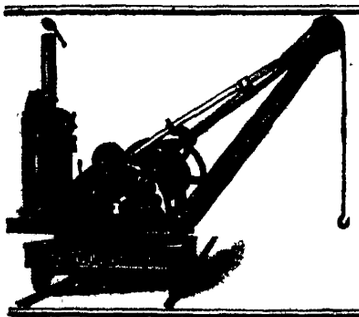
In bars and rods, for general use in Engineering Works.

BLOOMS, BILLETS, & SLABS

Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,

Of superior quality. 5137



EXORS. OF WM. BALMFORTH,

RODLEY, NEAR LEEDS.

MANUFACTURERS OF

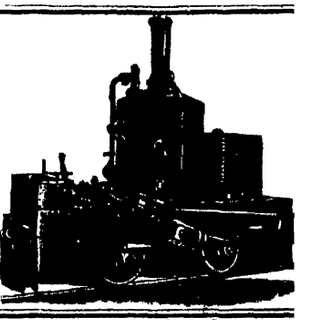
LOCO. STEAM CRANES, CONTRACTORS' LOCOS.,

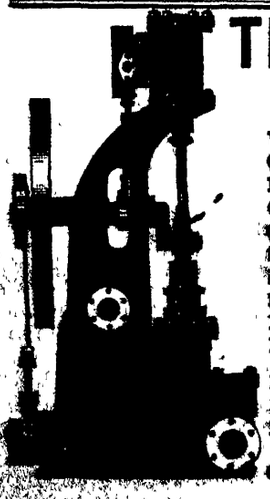
TRAVELLERS, HOIST S,

AND ALL KINDS OF LIFTING MACHINERY.

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes.

4097





THE PUMPS

COALBROOKDALE CO., LTD.

MAKERS OF

DIRECT-ACTING

AND OTHER

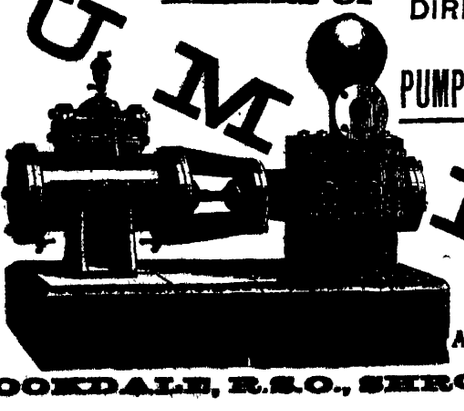
PUMPING MACHINERY

SIMPLE & COMPOUND

FOR

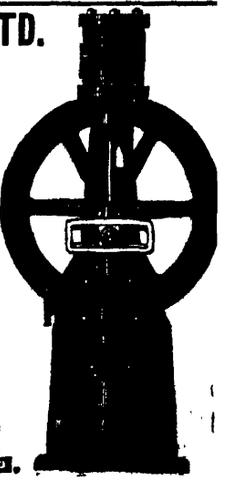
WATERWORKS.
COLLIERIES.
BREWERIES.
QUARRIES.
CHEMICAL WORKS.
SEWAGE WORKS.
POTTERIES.
STEAM SHIPS.
IRRIGATIONS.
DRAINAGE.

BOILER FEEDERS.
FIRE ENGINES.
HYDRAULIC PUMPS



FOR

ALL PURPOSES.



5120

COALBROOKDALE, R.S.O., SHROPSHIRE.

S. OWENS & CO.

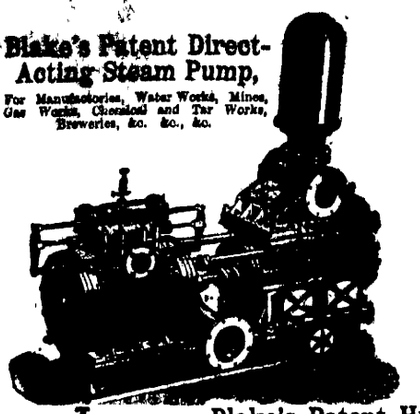
HYDRAULIC AND GENERAL ENGINEERS, WHITEFRIARS STREET, LONDON.

SOLE LICENSEES AND MANUFACTURERS FOR GREAT BRITAIN OF

BLAKE'S Patent DIRECT-ACTING STEAM PUMP.

Blake's Patent Direct-Acting Steam Pump,

For Manufactories, Water Works, Mines, Gas Works, Chemical and Tar Works, Breweries, &c. &c., &c.



More than 16,000 in Use.



Blake's Patent Direct-Acting Steam Pump and Vertical Boiler Combined.

Blake's Patent Direct-Acting Compound High and Low Pressure Steam Pump.

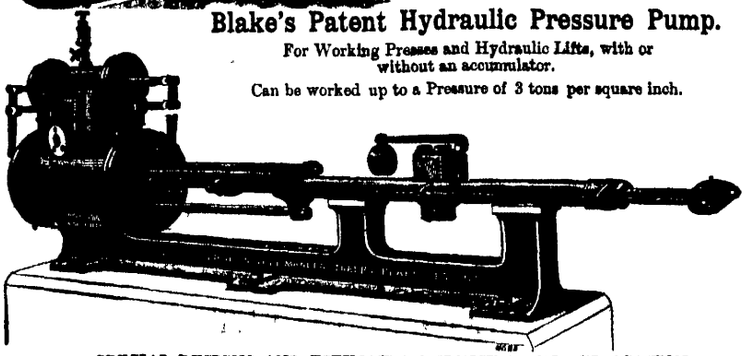
With combined or independent Condensing Gear, the greatest economy in consumption of coal, for Water Works, Irrigation Works, Drainage of Mines, &c.



Blake's Patent Hydraulic Pressure Pump.

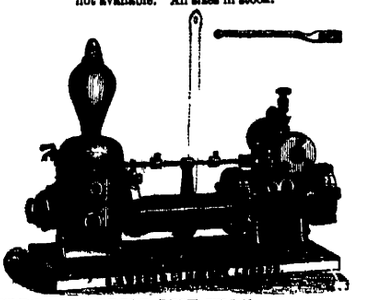
For Working Presses and Hydraulic Lifts, with or without an accumulator.

Can be worked up to a Pressure of 3 tons per square inch.



Blake's Patent Boiler Feeder.

Fitted with hand power lever, for use when steam is not available. All sizes in stock.



SPECIAL DESIGNS AND ESTIMATES FURNISHED ON APPLICATION. DESCRIPTIVE PAMPHLET AND PRICE LIST FREE. 5003

Mr. William Knowles' Patent Automatic Supplementary Governor,

FOR SECURING AND MAINTAINING AUTOMATICALLY ALMOST PERFECT ACCURACY OF SPEED IN STEAM ENGINES UNDER VARYING LOADS AND STEAM PRESSURES.

HICK, HARGREAVES & CO., Sole Makers and Licensers,

SOHO IRONWORKS, BOLTON. 5100

RICHARD DUDGEON,

114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF HIS

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, &c.



THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "DUDGEON'S ROLLER TUBE EXPANDERS," R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only are stamped as under:—

R. DUDGEON, N.Y., Patd. Feb. 5th, 1867, on the Guide-ring of each Tool, WITHOUT WHICH NONE ARE GENUINE.

These can be obtained at R. Dudgeon's English Depôt, 114, Fenchurch Street. Whereas counterfeits of these Expanders have been offered by [illegible] as R. Dudgeon's, and R. Dudgeon, after [illegible] regret that evidence bearing his strong circumstantial and [illegible] this be manly or right, to assert the identity of what is made by himself, by which [illegible] is asserted or felt.

R. Dudgeon [illegible] the opportunity of returning thanks for past favours, either by ordered or recommendation, and it being his [illegible] the Quality and Workmanship of [illegible] the Expander, [illegible] consequence of the same

CATALOGUES AND PRICE LISTS ON APPLICATION TO R. DUDGEON, 24 COLUMBIA STREET, NEW YORK, U.S.

ROOT'S PATENT STEAM BOILER

SPECIALLY SUITABLE FOR VERY HIGH PRESSURE & EXPORT.

Sizes up to 100 HP. Nominal, and when required in small light pieces for Mule Transport or special positions.

Easily Erected by Unskilled Labour.

BOILERS WORKING ALL OVER THE WORLD.

— REFERENCES TO MANY EMINENT FIRMS. —

FOR PRICES AND PARTICULARS APPLY TO

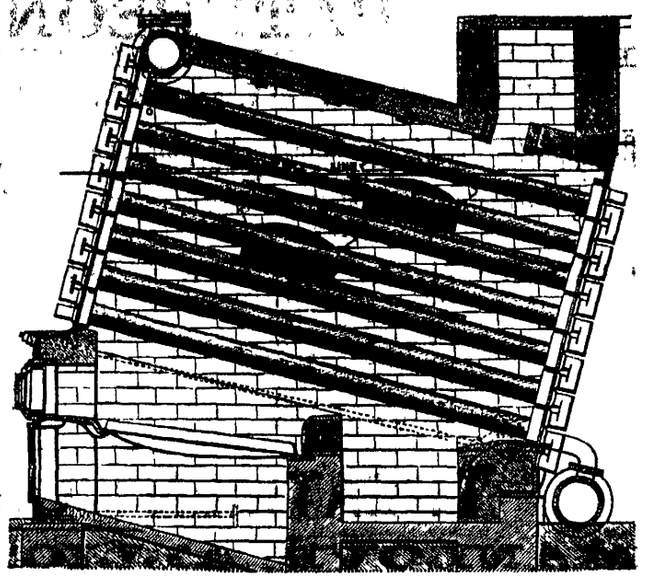
THE PATENT STEAM BOILER CO.

(ESTABLISHED 1860.)

HEAD OFFICE AND WORKS: 28, HENEAGE ST., BIRMINGHAM.

LONDON OFFICE: 11, QUEEN VICTORIA ST., E.C. 5418

CONRAD KNAP, REPRESENTATIVE.



15 PRIZE MEDALS.] THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED, [15 PRIZE MEDALS.

4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1862, 1



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD, 5400

100 TO 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

Crossley's Patent TWIN-ENGINES. Impulse every revolution. The steadiest running Gas Engine yet made.

THE "OTTO." GOLD MEDAL at Crystal Palace, & HIGHEST AWARD at Paris Electrical Exhibitions.



New Patent SELF-STARTER. Best, Safest, and Simplest made, may now be applied.

CROSSLEY'S NEW VERTICAL ENGINE, Requiring little floor space.

¼ TO 100 HP. IND. MANY IMPROVEMENTS. OVER 15,000 IN USE.

LONDON: 24, POULTRY, E.C.

GAS ENGINE

GLASGOW: 58, UNION STREET

5382

CHEAP GAS FOR MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·3 lb. per ind. H. P. per hour.

DOWSON GAS COMPANY, Ltd., 3, Great Queen St., Westminster, S.W.

4888

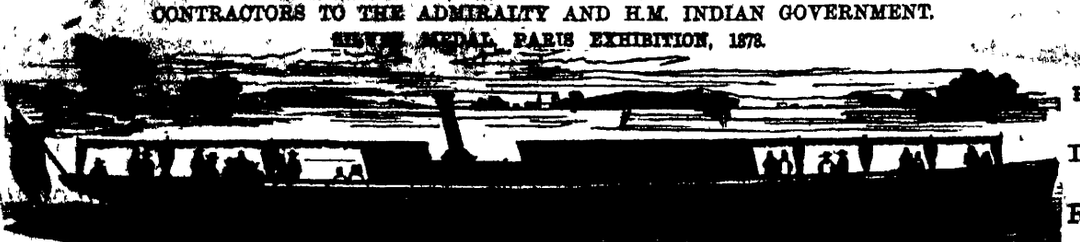
EDWARDS & SYMES,

Shipbuilders and Engineers, Wharf Road, Cubitt Town, London, E.,

CONTRACTORS TO THE ADMIRALTY AND H.M. INDIAN GOVERNMENT.

SILVER MEDAL, PARIS EXHIBITION, 1878.

BUILDERS of all classes of STEAM and SAILING VESSELS, TORPEDO LAUNCHES, YACHTS, TUGS, LAUNCHES,



DREDGERS, Hopper Barges FLOATING DOCKS GIRDERS, ROOFS, &c.

YACHTS and LAUNCHES for Sea or River service, up to 150 feet in length, built of Steel, Wood or Iron. Speeds up to 22 miles an hour. Draught of water down to 6 inches for shallow Rivers. 996

PATERSON & COOPER,

ELECTRIC LIGHT ENGINEERS AND CONTRACTORS,

76, LITTLE BRITAIN, LONDON. Steam Factory: POWNALL ROAD, DALSTON.

Complete Sets of Electric Lighting Machinery and Fittings for Lighting Hotels, Public Buildings, Factories, Mills, Ships, &c., &c.

ESTIMATES FOR INSTALLATIONS FREE OF CHARGE. EXPERIENCED MEN SENT TO ALL PARTS OF THE COUNTRY.

Licensees of the "Clarke and Bowman" Arc Lamp, and of Joel's Storage Batteries.

PATERSON & COOPER'S DIRECT CURRENT "PHŒNIX" DYNAMOS.

No. 1.—For	16	20 candle-power Lamps,	or	2	Small Arcs,	or	1	Large Arc			£36
No. 2.— „	30	„	„	3	„	„	2	„	„		54
No. 3.— „	75	„	„	7	„	„	4	„	„		80
No. 4.— „	120	„	„	12	„	„	7	„	„		120
No. 5.— „	200	„	„	24	„	„	14	„	„		180
No. 6.— „	300	„	„	...	...	...	...	...			250
No. 7.— „	500	„	„	...	...	...	...	...			400

TREATMENT OF TOWNS REFUSE.

MANLOVE, ALLIOTT, FRYER, AND CO.,

Works: NOTTINGHAM & ROUEN. London Offices: 50, QUEEN VICTORIA STREET, E.C.,

SOLE MAKERS OF

Machinery & Apparatus for treatment of Towns Refuse by Fryer's Patent Methods, "PURIFICATION by FIRE."

MINERAL MATTER.—Cinders and other rubbish are destroyed by means of the Patent DESTRUCTOR. The residue, ground with lime, is made into an excellent Mortar, and sold freely at a profit. The steam power is furnished by the waste heat from the destructor. VEGETABLE MATTER.—The Sweepings of Markets and Paved Streets, Paper, Straw, Garbage, &c., are converted by means of the Patent CARBONISER into Charcoal, which is used for removing offensive odours from privies, drains, and infected places; it is scattered over offensive material when transported on Carts or Railway Trucks. A layer of Charcoal should be placed in every newly-opened grave. ANIMAL MATTER.—"Pail contents," slaughter-house refuse, and the contents of urinals, are reduced by the Patent CONCRETOR and Patent DRYERS to a most valuable inodorous manure, a powder resembling guano, readily sold at from £5 to £9 per ton

These three processes may be combined or used separately. They offer the most effectual and the most profitable means known for the disposal of refuse. Every product is valuable, no nuisance is created, stores are accumulated, no residue is left, and the spread of infectious diseases prevented.

Some of the more important cities and towns have already adopted FRYER'S method to a greater or less extent. Among others may be enumerated CITY OF LONDON, LEEDS, BIRMINGHAM, MANCHESTER, ROCHDALE, STAFFORD, NOTTINGHAM, HECKMONDWIKE, DERBY, BLACKBURN, BURY, BRADFORD, WARRINGTON, BOLTON and HULL.

SOLE MAKERS OF WASHINGTON LYON'S PATENT DISINFECTOR,

Patent Carboniser, Destructor, Concretor, Firman's Dryer, Harescough's Dryer, Double Effect Dryer, Odour Tight Sanitary Cart, Cinder Screen, Pail-Washing Apparatus; Improved Charcoal Closets.

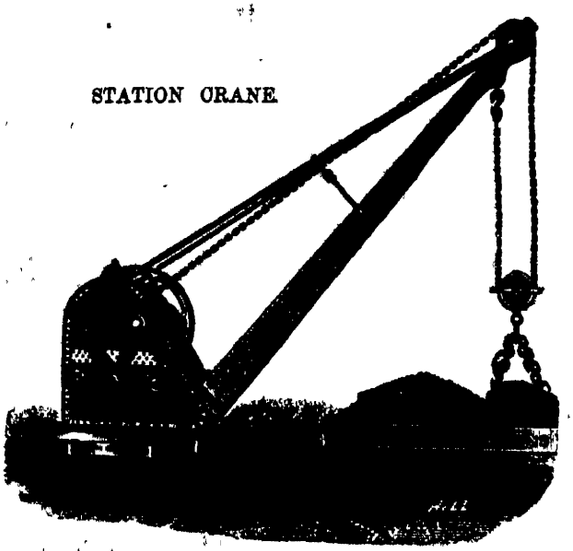
SEE FUTURE ADVERTISEMENTS. 5076

COWANS, SHELDON & CO., LTD.

ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.

STATION CRANE.



STEAM ACCIDENT CRANE.



TURNTABLES, CRANES, MASTING SHEERS, AND TRAVERSERS OF EVERY DESCRIPTION

STEAM, HAND, OR HYDRAULIC POWER.

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

The most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel. 3. Greater Heating Surface. 4. Decidedly cheaper. 5. Easy to Easily Cleaned. 6. Most Durable. 7. Accessible for Repairs without Disturbing the other Parts. 8. Great Economy in Boiler Space. 9. Will Burn either Tan, Breeze, Small Coal, or Sawdust. 10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft.	long,	5ft. 0in.	diameter,	20-horse power.
10ft.	,,	5ft. 6in.	,,	30 ,,
12ft.	,,	6ft. 0in.	,,	40 ,,
13ft.	,,	6ft. 6in.	,,	50 ,,
14ft.	,,	7ft. 0in.	,,	60 ,,
15ft.	,,	7ft. 6in.	,,	70 ,,
16ft.	,,	8ft. 0in.	,,	80 ,,
17ft.	,,	8ft. 0in.	,,	90 ,,
18ft.	,,	8ft. 0in.	,,	100 ,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

W. NEILL & SON,

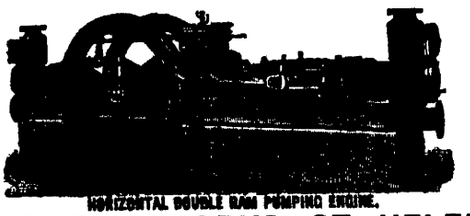
ENGINEERS, IRON & BRASS FOUNDERS, BOILER MAKERS, &c.

MANUFACTURERS OF

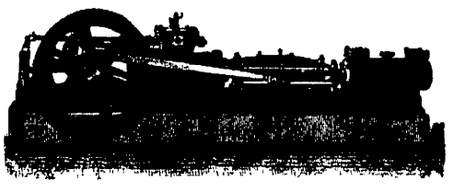
PUMPING ENGINES, BLOWING ENGINES, STEAM ENGINES, AIR COMPRESSORS, and VACUUM PUMPS.



DOUBLE RAM PILLAR PUMPING ENGINE.



HORIZONTAL DOUBLE RAM PUMPING ENGINE.



BLOWING ENGINE AND AIR COMPRESSOR. 4358

BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.

JESSOP'S CRANES

For Particulars see last Week's "ENGINEERING," or WRITE FOR HANDBOOK.

J. JESSOP & SON, LEICESTER. 5118

Or 113, CANNON STREET, LONDON.

JAMES GOODWIN & Co.,

Ironfounders, Bridge Builders, Engineers, & Boiler Makers,

MOTHERWELL NEAR GLASGOW.

MAKERS OF *Cast Iron Chairs, Cast Iron Sleepers,* COLUMNS, TANKS, *Ingot Moulds, and General Castings.*



VIADUCT AT HIGH BLANTYRE, CALEDONIAN RAILWAY. LENGTH, 780 FEET. ERECTED 1882.

SOLE MAKERS OF HOPE'S PATENT Stone Breakers.

—:o:—

Foundries also at Ardrossan, Ayrshire, AND Johnstone, Renfrewshire.

5274

MAKERS OF IRON ROOFING AND GENERAL STRUCTURAL WORK.

THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

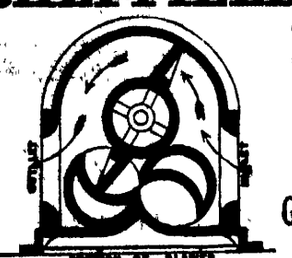
Baker's Patent Rotary Pressure Blower and Gas Exhauster.

—:o:—

BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

—:o:—

HALL'S PATENT STONE BREAKER.

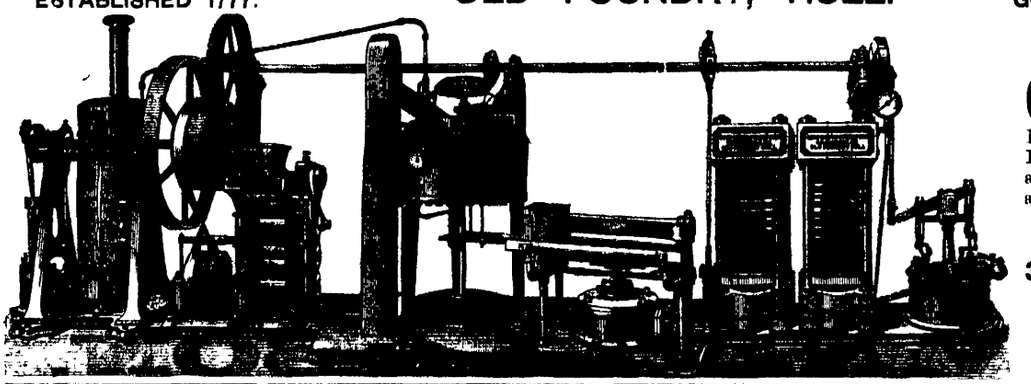
—:o:—

General Machinery of Every Description.

London Office and Exhibition Rooms, 58, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4888

ROSE, DOWNS & THOMPSON

ESTABLISHED 1777. OLD FOUNDRY, HULL. GOLD MEDAL, CALCUTTA.



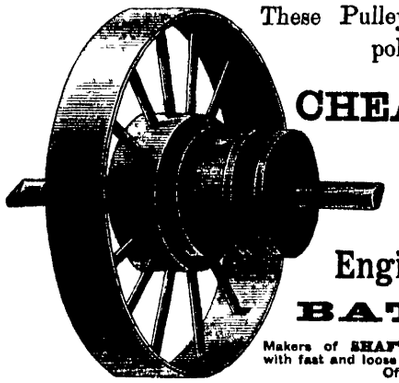
MAKERS OF THE
ANGLO-AMERICAN
OIL-MILL MACHINERY

For crushing Linseed, Cotton Seed Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent. in labour and power, and 2 to 4 per cent. in Oil (See *Engineer*, May 6, 1881, and Nov. 23, 1883.)

300,000 TONS OF OIL SEEDS
PER ANNUM,
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These Pulleys are **TURNED IN A LATHE,** and not polished on a Grindstone like those generally sold.

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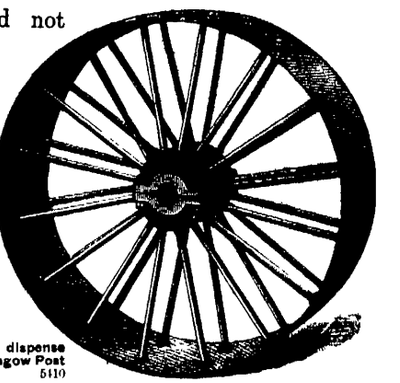
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Makers of **SHAFTING** and **FRICTION PULLEYS** for Electric Lighting Machinery, which dispense with fast and loose Pulleys one Pulley answers for both. In use at L. & N. W. Railway, Nine Elms, Glasgow Post Office, King's Cross Station, and all principal Factories home and abroad. 5110

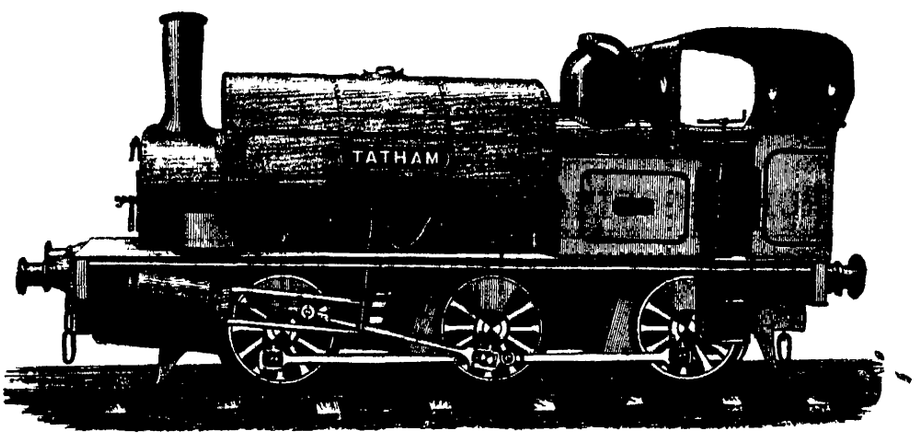


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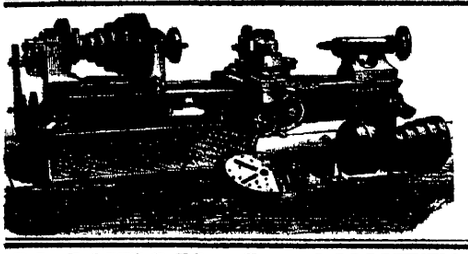
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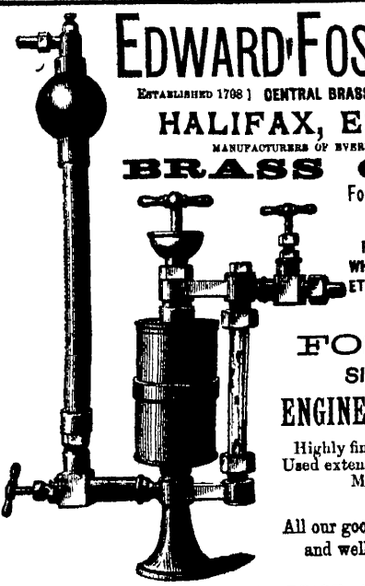
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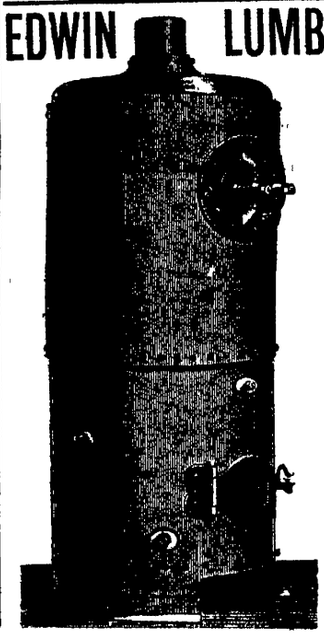
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PATENT VERTICAL
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ADVANTAGES:
Compactness, Durability, Economical, Accessible, Cheap in First Cost, Suitable for all uses, and adapted for Export.
VARIOUS SIZED BOILERS
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BIRMINGHAM SHOW, BINGLEY HALL, November [illegible] to December [illegible], STAND [illegible]
SMITHFIELD SHOW, AGRICULTURAL HALL, December [illegible] to [illegible], STAND [illegible]

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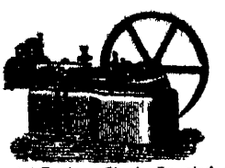
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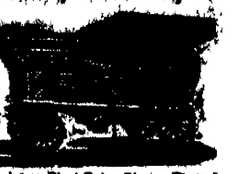
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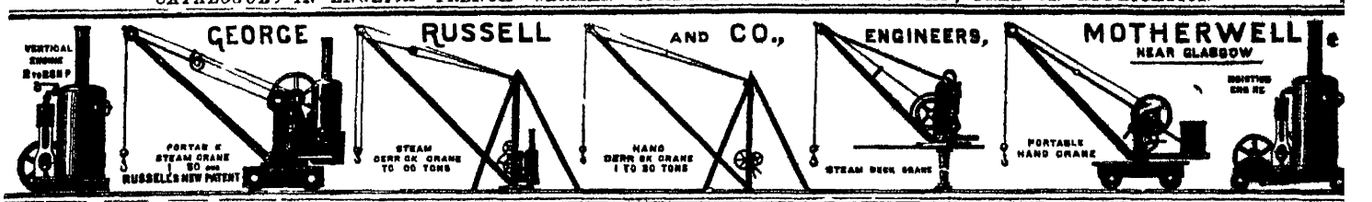


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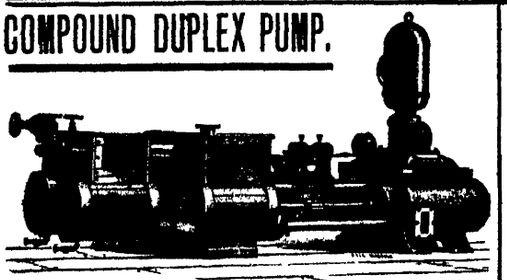
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12 inch and 18 inch Cylinders 10 inch Plungers.

DUPLEX COMPOUND PUMPS are specially desirable where the duty is constant or where great economy is important. They take one third less steam than a high pressure pump and the saving is still greater when a condenser can be applied The slide valves are the simple ones used in all ordinary engines

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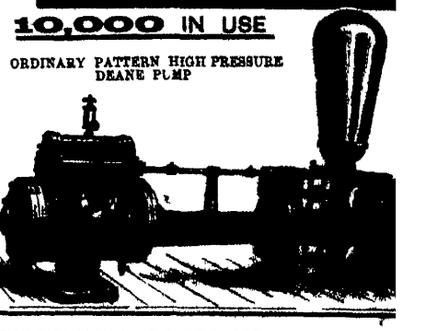
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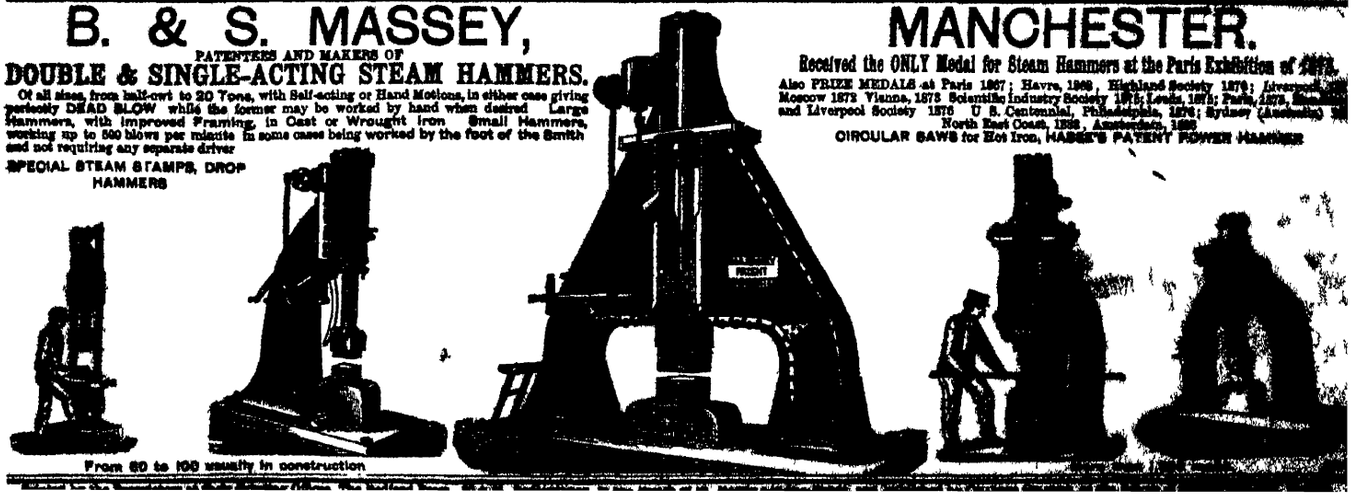
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Of all sizes, from half-cwt to 20 Tons, with Self-acting or Hand Motions, in either case giving perfectly DEAD BLOW while the former may be worked by hand when desired Large Hammers, with improved Framing, in Cast or Wrought Iron Small Hammers, working up to 500 blows per minute in some cases being worked by the foot of the Smith and not requiring any separate driver

SPECIAL STEAM STAMPS, DROP HAMMERS



From 60 to 100 usually in construction

MANCHESTER.

Received the ONLY Medal for Steam Hammers at the Paris Exhibition of 1878.

Also PRIZE MEDALS at Paris 1867; Havre, 1868, Highland Society 1870; Liverpool, [illegible] Moscow 1872 Vienna, 1873 Scientific Industry Society 1875; Leeds, 1875; Paris, 1878, Manchester and Liverpool Society 1876 U S. Centennial, Philadelphia, 1876; Sydney (Australia) [illegible] North East Coast, 1868, Amsterdam, 1869

CIRCULAR SAWS for Hot Iron, MASSEY'S PATENT POWER HAMMER

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H MAW AND JAMES DREDGE

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VOL XXXVIII—No 987] *LONDON FRIDAY NOVEMBER 28 1884* [PRICE 6d BY POST 6½d

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Worthington Pumping ENGINE COMPANY 114, QUEEN VICTORIA STREET LONDON E.C See Illustrated Advertisement on page 7 5445

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John M Dowall & Sons JOHNSTONE NEAR GLASGOW FOR WOOD WORKING MACHINERY INTERNATIONAL EXHIBITION SYDNEY 1879-80 — Only FIRST Award granted to European Exhibitors. INTERNATIONAL FORESTRY EXHIBITION EDINBURGH 1884 — 5020 Highest Award GOLD MEDAL (1st CLASS) London Agent—J B GUTHRIE 0 Bishopsgate Within

Okes Pumping Machinery Of all Kinds 5054

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Field's Patent Boilers and TUBES LEWIS OLRICK & CO London 5046 See Illustrated Advertisement, page 27

George Russell & Co, ENGINEERS and BOILERMAKERS, ALPHA STEAM CRANE and ENGINE WORKS MOTHERWELL, near GLASGOW SILVER MEDAL, PARIS 1867 4921

Steam Hammers — Massey's Patent Hammers RECEIVED THE *ONLY* PRIZE MEDAL PARIS 1878. More than 1500 made. Drop Hammers Hames Patent Power Hammer B. & S MASSEY MANCHESTER 4926

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Locomotive Tank Engines designed and constructed by MANNING WARDLE, AND COMPANY Boyne Engine Works Leeds. See their Illustrated Advertisement, page 39

Locomotive Tank Engines TRAMWAY ENGINES AND CARS Built by THE FALCON ENGINE and CAR WORKS Limited Loughborough. See Illustrated Advertisement page 9

The Patent Corliss Engine And PATENT CORLISS GEAR ENGINE, special improvements by DOUGLAS and GRANT Dunnikier Foundry Kirkcaldy N B These engines are made Horizontal or Beam Condensing, Non condensing and Compound Also makers of Rice Jute and Paper Mills and General Engineers. Machinery shipped or trucked direct from the premises.

John Cochrane Engineer BARRHEAD N B Advertises his STEAM ENGINES STEAM HAMMERS STEAM PUMPS &c in this Paper every Fortnight Catalogues &c on application

Steel Hydraulic Cylinders, HENRY BESSEMER & CO Limited SHEFFIELD See Advertisement last week page 35

Tweddell's Hydraulic Riveting Machine

14 DELAHAY STREET WESTMINSTER, LONDON S W See Illustrated Advertisement last week page

L Sterne & Co, Limited ENGINEERS Sole Makers of Clerk's Patent Self Starting Gas Engine HIGHEST AWARD BRITISH SECTION ELECTRICAL EXHIBITION PARIS 1881 GOLD MEDAL, CRYSTAL PALACE ELECTRICAL EXHIBITION LONDON 1882.

Strong's Patent Feed water Heaters and Purifiers WITH STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS

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The Crown Iron Works GLASGOW

The Crown Iron Works (Holinwood) MANCHESTER.

10 Victoria Chambers WESTMINSTER

City Office and Show Rooms, 40 CANNON STREET E C

10 Rue Laffitte PARIS.

Royal Indian Engineering College, Cooper's Hill Station. The course of study is arranged to fit an engineer for employment in Europe, India, or the Colonies. Sixty students will be admitted in September 1885. For competition the Secretary of State will offer FIFTEEN APPOINTMENTS in the Indian Public Works Department and TWO in the Indian Telegraph Department. For particulars apply to the SECRETARY at the College. 5432

Society of Engineers.—The next ORDINARY MEETING of this Society will be held on MONDAY next, December 1st, at the Town Hall, Caxton Street, Westminster, S.W., when a Paper will be read by Mr. A. C. Ewart, on "The Flow-pipe Blast Furnace."
The Chair will be taken at half-past Seven o'clock.
CHARLES J. LIGHT,
6, Westminster Chambers, S.W. Secretary. J 295

TENDERS

INDIA OFFICE,
24th November, 1884.
INDIAN STATE RAILWAYS.

BY ORDER OF THE SECRETARY OF STATE FOR INDIA IN COUNCIL.

The Director General of Stores for India is prepared to receive

Tenders from such Persons as may be willing to SUPPLY LAMINATED ELLIPTIC AND COIL NEST SPRINGS FOR CARRIAGES AND WAGONS.
The Conditions of Contract may be obtained on application to the Director General of Stores, India Office, Westminster, S.W., and Tenders are to be left at his Office at any time before Two o'clock p.m. on Tuesday the 9th December next, after which no Tender will be received.
A. ABERCROMBIE HOPE, J 292
Director General of Stores.

FOR THE ULEABORG LINE OF THE FINLAND STATE RAILWAYS.
(Now under construction.)

The Building Commission are prepared to receive

Tenders for Supply of Fifteen (15) LOCOMOTIVES (Mogul Pattern) and TENDERS (five of which are to be delivered at the Port of Hangö, before the end of July, 1885, five more at the same place within the ensuing year, and the remainder at the Port of Uleaborg, before the end of July, 1886).
Sealed Tenders, addressed to "The Uleaborg Railway Building Commission, Helsingfors, Finland," and marked "Tender for supply of Locomotives and Tenders," are to be sent in not later than Twelve o'clock at noon on Monday, the 22nd of December, 1884.
Specifications, Drawings and Forms of Tender may be obtained at the Office of the said Building Commission at Helsingfors.
By order, G. E. FELLMAN,
Helsingfors, November 12th, 1884. J 69

DARLASTON URBAN SANITARY AUTHORITY.

SEWERAGE WORKS. CONTRACT No. 3.

TO CONTRACTORS AND OTHERS.

The Local Board of Darlaston acting as the Urban Sanitary Authority, invite

Tenders for the Construction of TEN MILES or thereabouts of 18 in., 15 in., 12 in., 10 in., and 9 in. FARTHENWARE and CAST IRON PIPE SEWERS, together with all necessary Manholes, Flushing Chambers and Ventilating Shafts; also the CONSTRUCTION of Engine and Boiler House, Cottage, Tanks, Filter Beds, Drains, Carriers, Roads, Fencing, Chambers, and other works as shown.
The Plans, Specification and Detail Drawings can be inspected at the Offices of the Engineer, Mr. EDWARD PERCHARD, 2, Storey's Gate, Westminster, or 57, Waterloo Street, Birmingham, from whom Bills of Quantities, Forms of Tender and other particulars can be obtained on payment of One Guinea.
Sealed Tenders, properly endorsed, to be delivered to the undersigned, on or before the 18th day of December, 1884.
The Local Board do not bind themselves to accept the lowest or any Tenders sent in.
By order,
JOSEPH CORBETT, Clerk to the Local Board.
Darlaston, 24th November, 1884. J 264

GREAT SOUTHERN AND WESTERN RAILWAY COMPANY, IRELAND.

TULLOW EXTENSION TO RAILWAY CONTRACTORS.

The Directors of the Great Southern and Western Railway Company are prepared to receive

Tenders for the Construction of the EXTENSION LINE from Baltinglass in the County of Wicklow to Tullow, in the County of Carlow, a length of about 10 miles 4 furlongs and 8 chains, the whole of which is to be constructed for a single line.
The Plans, Sections, Drawings and Specifications may be seen at the Offices of Mr. BENJAMIN P. LEMMAN, C.E., No. 5, Dawson Street, Dublin, on and after Monday 24th instant.
A Copy of the Land Plan, Longitudinal Section, and Specification will be supplied on payment of Five Guineas, with a Schedule of the Engineer's quantities which quantities are not guaranteed, but given for the purpose of enabling contractors, who purchase plans &c., to check their own quantities.
Tenders accompanied by estimates enclosed in sealed envelopes, marked "Tender for Extension Works," and addressed to the undersigned, must be delivered at the Company's Office, not later than Ten a.m., on Friday, the 10th December next.
The Directors do not bind themselves to accept the lowest or any Tender, nor will any Tender be received except accompanied by an estimate, both on Forms to be supplied on application to Mr. Benjamin P. Lemman's Office.
FRANCIS B. ORMSBY, Secretary.
Kingsbridge Terminus, Dublin,
16th November, 1884. J 272

EMPIRE OF BRAZIL.

Tenders for Lighting by Gas the City of Loanda, Angola, will be received at the Brazilian Legation, and at the Consulate-General in London, on or before the 28th of February, 1885.
For particulars and Specifications, apply to the BRAZILIAN CONSULATE-GENERAL in London and Liverpool. J 230

TO ENGINEERS AND OTHERS.
TRINITY HOUSE, LONDON.
14th November, 1884.

The Corporation being desirous of receiving

Tenders for the Manufacture and Delivery at the Trinity Wharf, Blackwall, of SUNDRY STEEL BUOYS of stated dimensions and descriptions. Notice is hereby given that the Drawings may be inspected, and Forms of Tender and Specification obtained on application at the Store Department of the House, on any day, between the hours of Ten a.m. and Four p.m. Tenders, sealed and marked outside "Tender for Steel Buoys," must be addressed to the Secretary, and delivered at this House on or before Thursday, the 4th December, and no Tender can be entertained that is not made on the Form provided. The Corporation does not pledge itself to accept the lowest or any Tender. By order, J 291
J. INGLIS, Secretary.

NEWLYN PIER.

TO CONTRACTORS.

The Newlyn Pier and Harbour Commissioners are prepared to receive

Tenders for the Construction of a CONCRETE PIER at NEWLYN, in the County of Cornwall.
The Contract Drawings, and Specifications may be seen, and Bill of Quantities obtained at the Office of the Engineer, Mr. T. C. Inglis, 1, Buckland Terrace, Plymouth.
Tenders endorsed "Newlyn Harbour Contract," are to be sent to the Harbour Office, Newlyn, Penzance, not later than 18th December, 1884.
The Commissioners do not bind themselves to accept the lowest or any Tender.
(Signed) R. TOMAN, Secretary.
Dated 15th November, 1884. J 247

APPOINTMENTS OPEN.

Civil Service Commission FOR THE FORTHCOMING EXAMINATION. ARCHITECTURAL DRAUGHTSMAN in the Department of the Director of Engineering and Architectural Works in the Admiralty at the Head Office (Nos. 5-52), 24th December.
The date specified is the latest at which applications can be received. They must be made on Forms to be obtained with particulars, from the SECRETARY, Civil Service Commission, London, S.W. J 251

TO CIVIL ENGINEERS.

THE HIGHWAYS COMMITTEE FOR THE WESTERN DIVISION OF THE COUNTY OF SUSSEX are desirous of receiving

Applications for the Appointment to the office of West Sussex COUNTY SURVEYOR. Candidates must be Members of the Institution of Civil Engineers. The duties will be—
1. To survey, personally, every county bridge (in number at present, 43), including the roads over the same, and so much of the approaches thereto as are liable to be repaired by the Rapes in which the bridges are respectively situate once a year between Christmas and Lady Day and to attend the Easter Quarter Session for the said Western Division and make a written report to such session as to the condition of every county bridge, and to state in such report the date when every such bridge was surveyed;
2. To survey, personally, and make a special report upon any county bridge if called upon to do so by the Bridge Committee within whose jurisdiction such bridge is situate;
3. To survey, personally, any culvert or bridge, not being a county bridge, if called upon to do so by the Justices of the Petty Sessional Division within whose jurisdiction such culvert or bridge is situate, and report to such justices on the state of such culvert or bridge;
4. To survey, personally, any police station or other county building if called upon to do so by the Justices of the Petty Sessional Division in which such station or other building is situate, and report upon the state thereof either to the Justices or the Constabulary Committee as he shall be directed.
The County Surveyor will receive, annually, a retaining fee of Fifty Guineas, which shall cover the annual surveys and reports mentioned under Duty No. 1 and also any surveys and reports mentioned under Duties Nos. 2, 3 and 4, but for every special attendance required by the Justices, or the Bridge Committee, whether at any bridge or at Petty Sessions, he shall be paid One Guinea and a half, to cover his expenses. He will also be paid a commission of five per cent. on all contracts entered into by the county over £20, which are subjected by the county to his control or supervision, such percentage to include and cover the preparation of plans and specifications and superintendence of the work, and anything connected therewith which would be usually included in the five per cent. paid as remuneration for his services to an architect or surveyor.
Candidates are requested to send in their applications, accompanied by testimonials of recent date, indorsed "Application for appointment of West Sussex County Surveyor," on or before Thursday, the 11th day of December 1884 to THOMAS BLIFORD,
Horsham, Clerk to the Committee.
22nd November, 1884. Horsham.

Wanted, for a Jewish Trade School in the East an experienced MECHANIC to give instructions in the various branches of wood and metal work, including carpentry, joinery, wood and metal turning, locksmith's work, and forging.
He will also be required to keep in order the steam engine and other machinery.
Preference given to an unmarried man, and to one who can teach linear drawing. Salary £200 per annum, and passage money.
Apply by letter, stating age, qualifications and references, to the SECRETARY of the Anglo Jewish Association, 100, Sutherland Gardens, W. J 293

Wanted to Engage, on Liberal Salary, a young energetic BUSINESS or TECHNICAL MAN (or one combining both capabilities), who has been already connected for many years in works for the making of Transportable Steel Rails. Knowledge of the German language desired.—Applications, stating full particulars as to previous occupations in every Branch, and enclosing copies of testimonials, should be sent to J. S., 5915, care of Rudolf Mosse (Paul Ollendorff), 28, Rue de Richelieu, Paris. J 266

Wanted, by a Firm of Hydraulic and General Engineers in London, an ASSISTANT DRAUGHTSMAN, used to general work; one who has had experience in the shops preferred.
Apply, stating age, experience, and salary required, to J. 276, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. J 276

Millwright, accustomed to Pattern making, WANTED in small country shop. Permanent job for first class man.—State wages and send testimonials to TANNER BROS., Lath Hard Iron Works, Rochester. J 277

Agents Wanted, to push First-class MACHINERY OILS commanding a large and successful sale. Liberal commission. Address BOX 201, Post Office, Liverpool. 5233

Lists of Berths Vacant or WANTED. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London, or of all News Agents. 5373

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An Engineer, having Office in London, wishes to UNDERTAKE the AGENCY for a Firm of Engineers. Address J. 251, Offices of ENGINEERING, Bedford Street, Strand. J 280

An Engineer, at present in London, and going to an important industrial centre in Scotland, WISHES TO REPRESENT MANUFACTURERS in the sale of MACHINERY, SPECIALTIES, or any other commodity.—Address, J. 271, Offices of ENGINEERING, Strand 35, Bedford Street, Strand, London, W.C. J 271

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To Civil Engineers in practice —The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright.
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Wanted, a quantity of Steel RAILS 60 to 70 lbs per yard, also a 3 HP HORIZONTAL ENGINE, in exchange for a pair of Horizontal Engines in excellent condition, cylinders 10 in. and 22 in., 36 in. stroke, fly spur wheel, 12 ft. diameter, weighing about 8 tons. Can be seen at work. Address, GEORGE CRADOCK & CO., Rope Works, Wakefield. J 281

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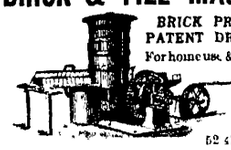
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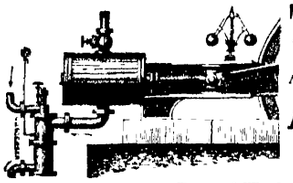
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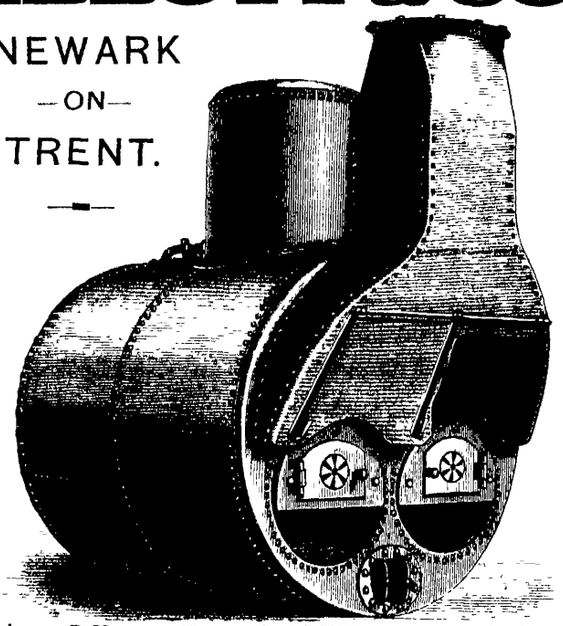
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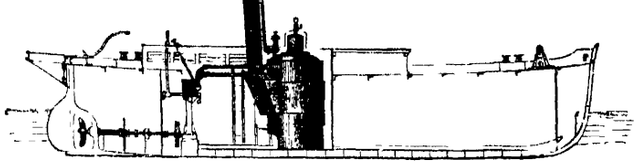
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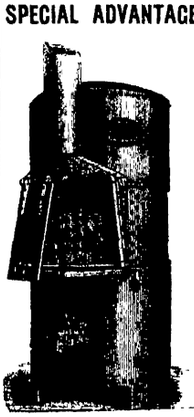
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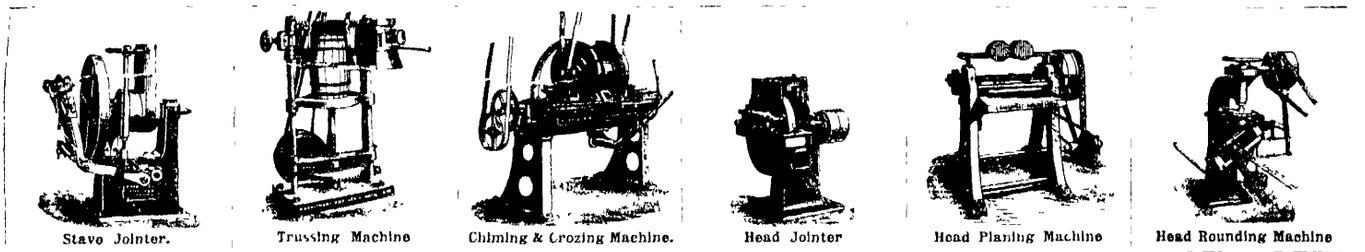
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For COLLIERIES, STEEL WORKS, &c., and as supplied to HER MAJESTY'S GOVERNMENT for INDIA

WALKERS' PATENT GUIBAL VENTILATING FANS,

For Mines, Collieries, Tunnels, Sewers, &c. Diameters from the smallest size up to 50ft. With Simple or Compound Condensing Engines

MAKERS OF THE GUIBAL, SCHIELE (his latest Patent), AND WADDLE FANS

LOCOMOTIVES. STEAM HAMMERS, Patterns up to 20 tons. FORGE and ROLLING MILL PLANT. WINDING, HAULING, and PUMPING ENGINES. IMPROVED FEED PUMPS for BOILERS.

STEAM CAPSTANS, Patterns for lifting up to 60 tons. OVERHEAD TRAVELLERS AND OTHER CRANES

HORIZONTAL AND VERTICAL, STATIONARY, AND LOCOMOTIVE BOILERS.

Iron and Steel Forgings Horizontal and Vertical Engines, Condensing and Non-Condensing Roofs, Girders, Bridges, Pit Cages, &c., and all kinds of Iron and Steel Work

---

WALKERS' Patent, as adapted to Bessemer Blowing Engines, is now in successful operation at the following Steel Works, and is about to be applied to other Engines for similar purposes :—

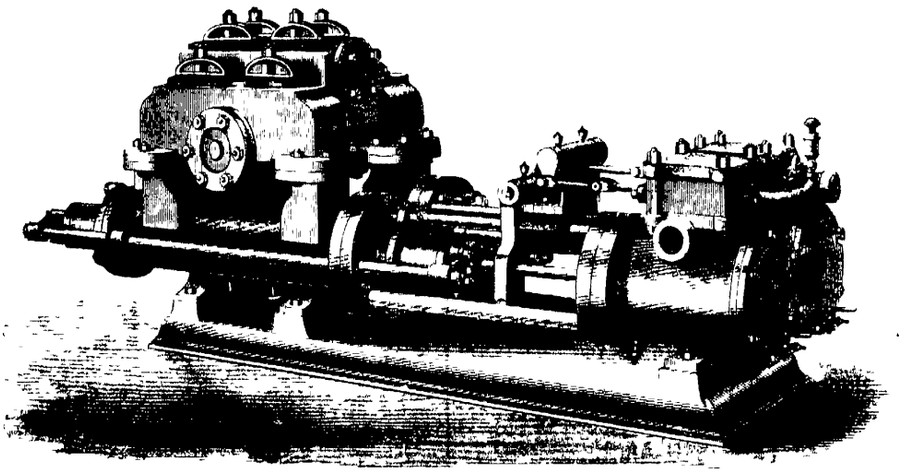
Messrs. BOLCKOW, VAUGHAN and CO., Eston, Middlesbro'.
,, The DOWLAIS IRON CO., Dowlais.
,, CHARLES CAMMELL and CO., Cyclops Works, Sheffield.
,, The DARLINGTON IRON and STEEL CO., Darlington.
,, The WEARDALE IRON and STEEL CO., near Durham.
,, The NORTH-EASTERN STEEL CO., Middlesbro'.

And to nearly 200 other Engines for a variety of purposes throughout the country.

The advantages afforded by the application of the Patented Valves to Bessemer Engines, are a greater endurance than has yet been attained by valves worked automatically (eccentrics, &c, for the valves not being required), and an almost perfect expulsion of the whole of the compressed air from the cylinders. 4109

WORTHINGTON PUMPING ENGINE CO.,

114, QUEEN VICTORIA STREET, London, E.C.



THE WORTHINGTON PRESSURE PUMP

HAVING EXTERNAL ADJUSTABLE PACKING.

— ESPECIALLY ADAPTED FOR HYDRAULIC CRANES AND HOISTS, OIL PIPE LINES, AND COTTON AND HYDRAULIC PRESSES —

Built to withstand any Pressure up to 4000 lbs to the Square Inch

ADOPTED BY ALL THE BESSEMER STEEL WORKS OF THE UNITED STATES

CATALOGUES AND ESTIMATES ON APPLICATION 340

HALL'S Patent AUTOMATIC INJECTORS

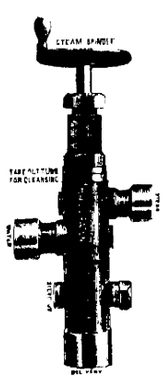
AND WATER ELEVATORS.

ENGINEERS, STEAM USERS, AND EXPORTERS

Will find these High Class Boiler Feeders the only thoroughly reliable ever sent into the Market for supplying all classes of Steam Boilers with Water, from 2 lbs. to 200 lbs.

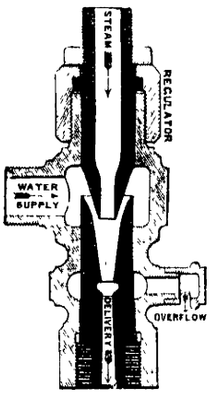
Our D L. Class, No 2, lifts 10 ft (set from 20 lbs to 150 lbs) ONE MOTION ONLY SIMPLY TURN ON STEAM

Lifting
D. L. CLASS.



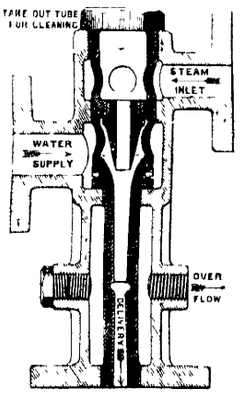
TRACTION.

Forcing
O CLASS



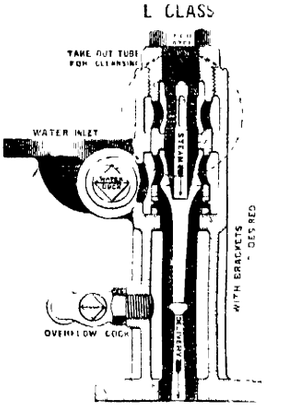
STATIONARY.

Forcing
S S CLASS



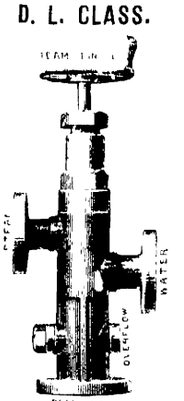
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Forcing
L CLASS



LOCOMOTIVE

Lifting
D. L. CLASS.



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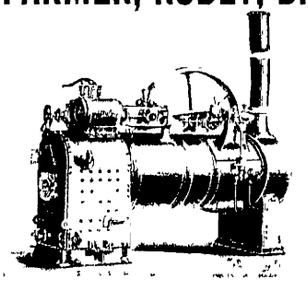
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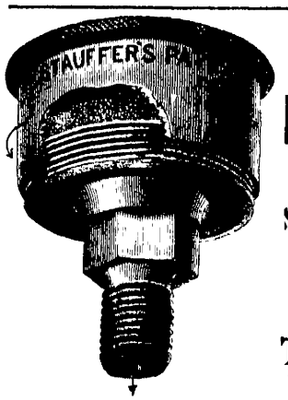
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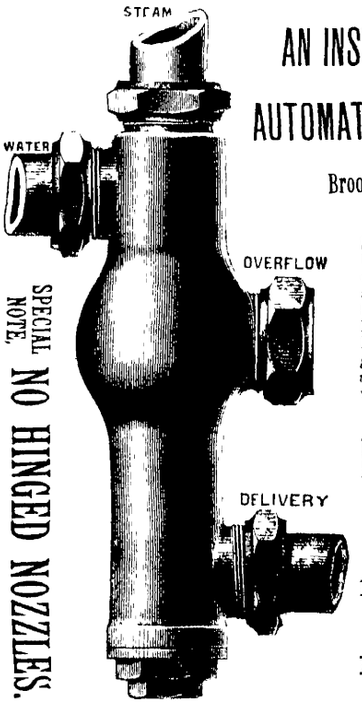
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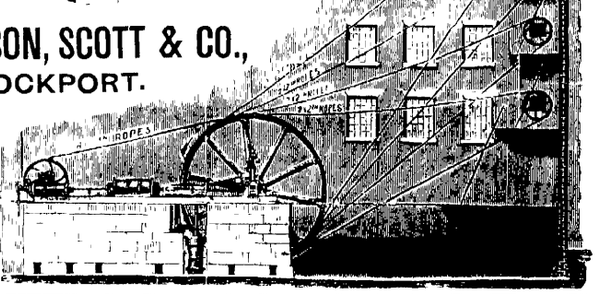
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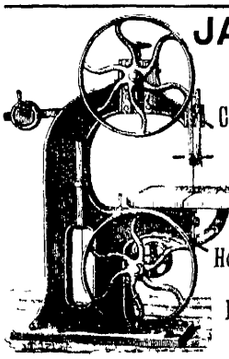
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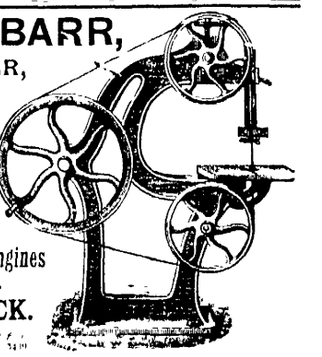
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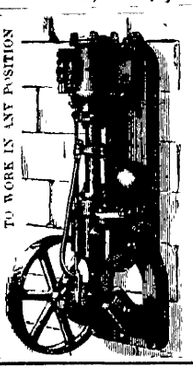
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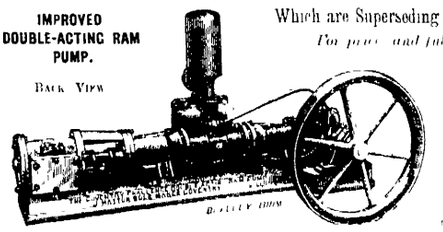
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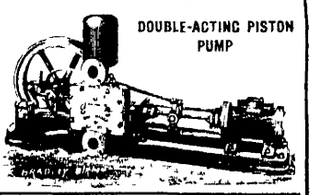
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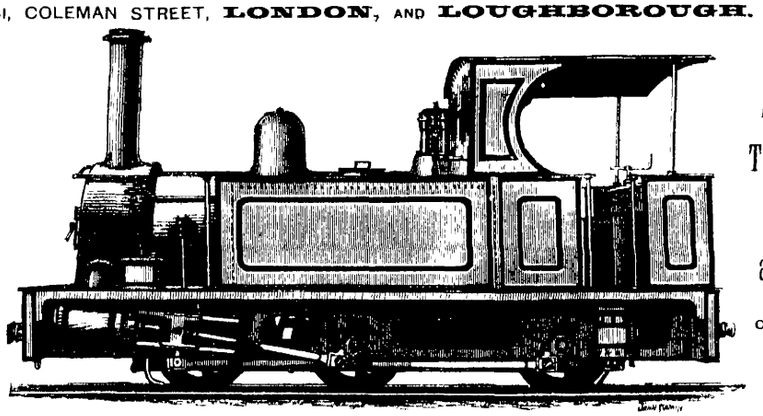
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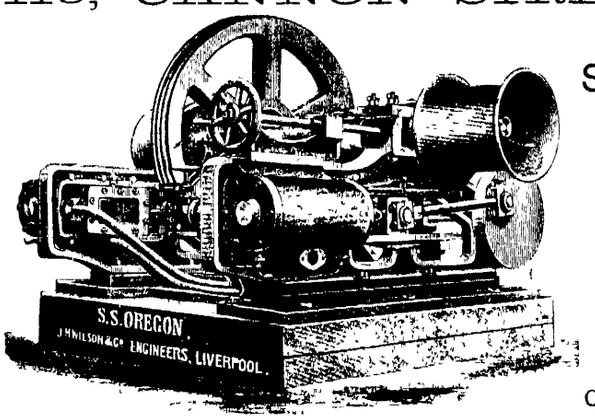
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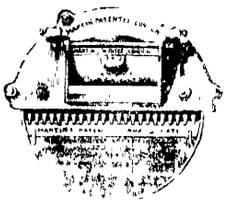
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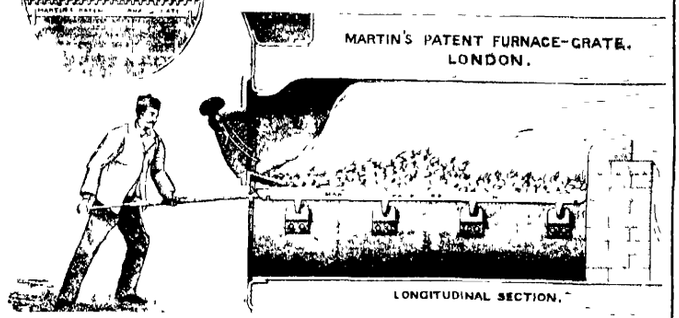
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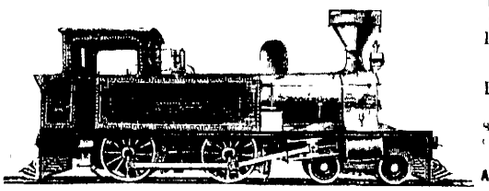
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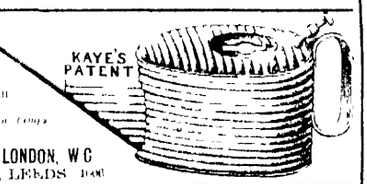
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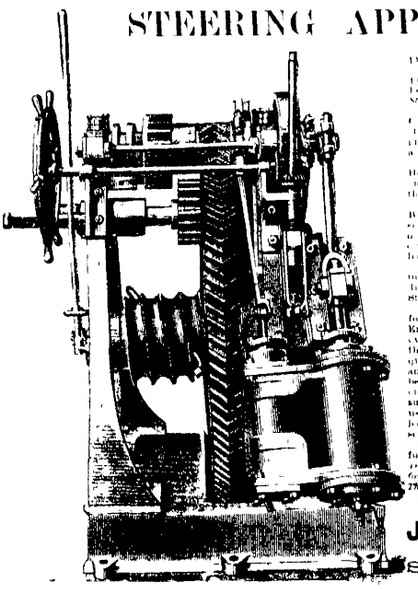
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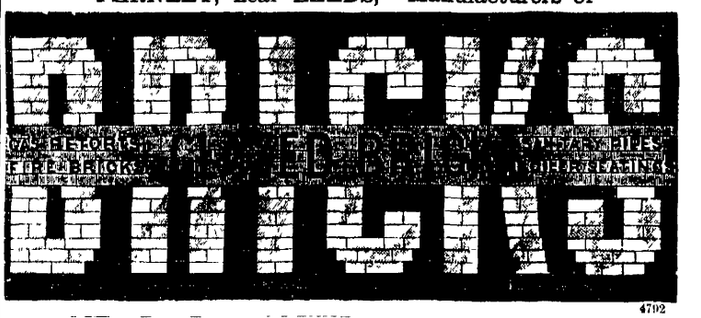
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ARROL'S PATENT PORTABLE HYDRAULIC RIVETTING MACHINES,

FOR

Land and Marine

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WAGON

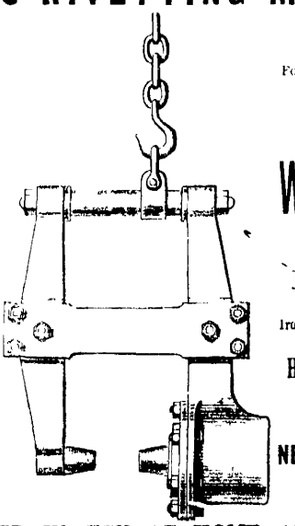
Undercarriages,

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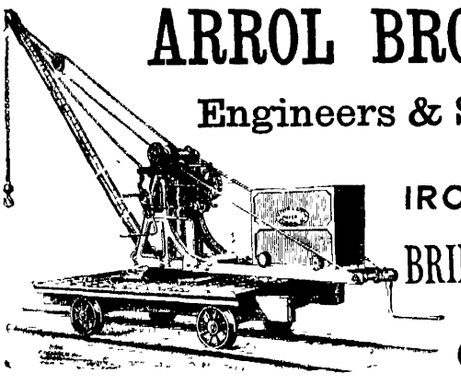
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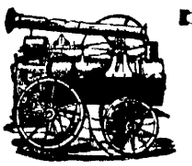
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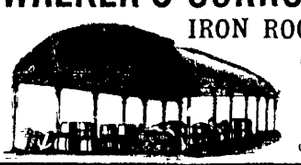
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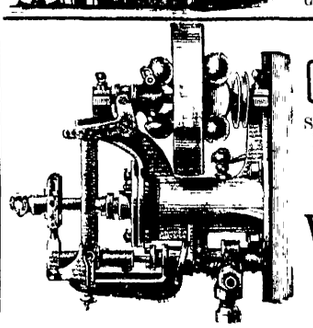
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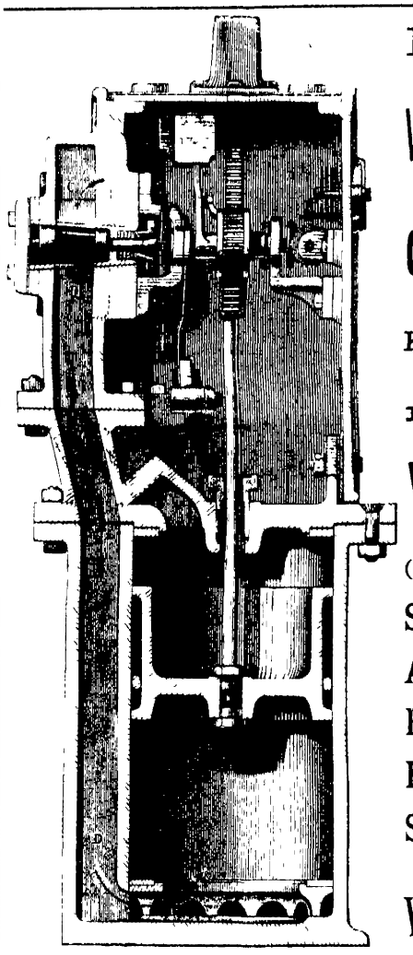
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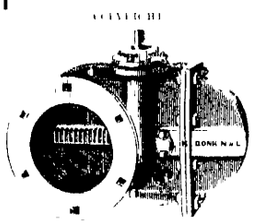
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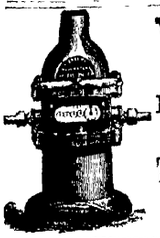
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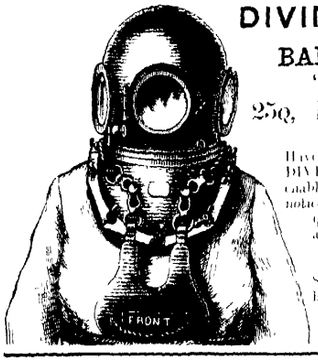
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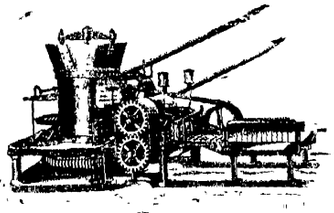
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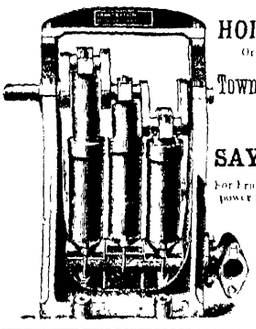
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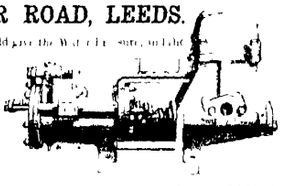


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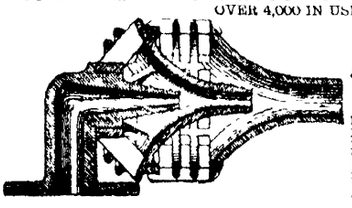


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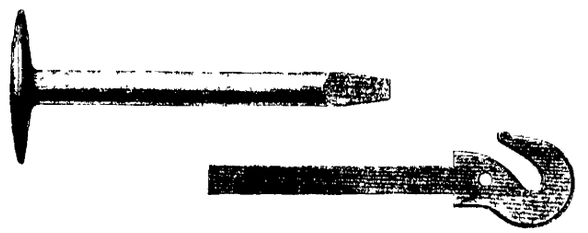


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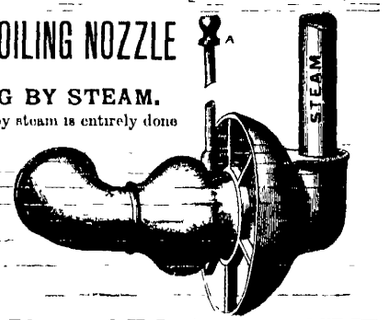
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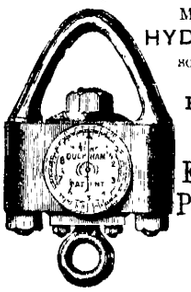
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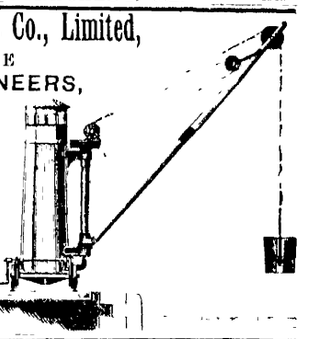
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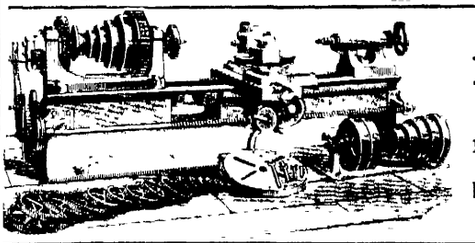
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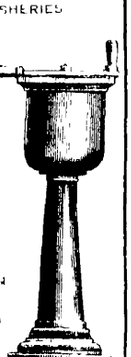
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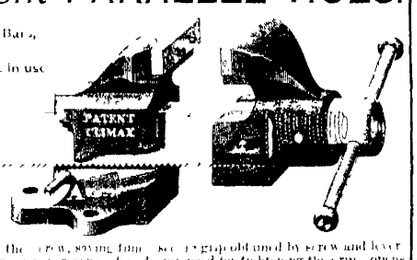


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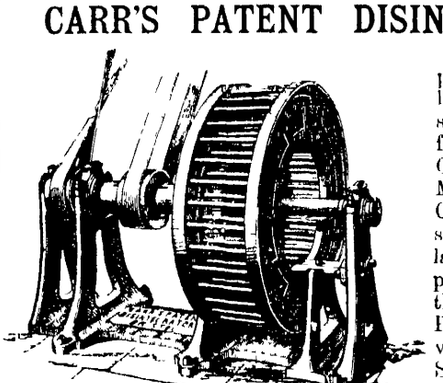
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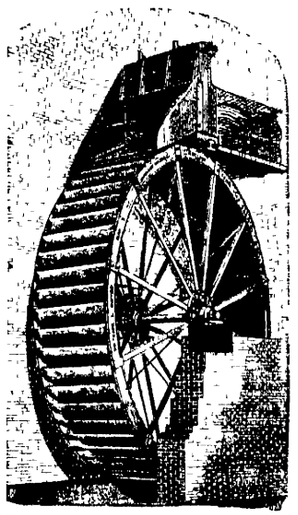
A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee, 2523

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Of the best and most modern construction, in cast or wrought Iron, or of Wood calculated to utilise the maximum power available from the stream or source of supply

W. & B. have patterns of large and strong wheels for the heaviest work, and also of lighter useful wheels of all forms, widths, and diameters, from which any requirement may be promptly met 477

Prices and full particulars on application

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PLANING, SLOTTING, SHAPING, BORING, DRILLING, AND SCREWING MACHINES.

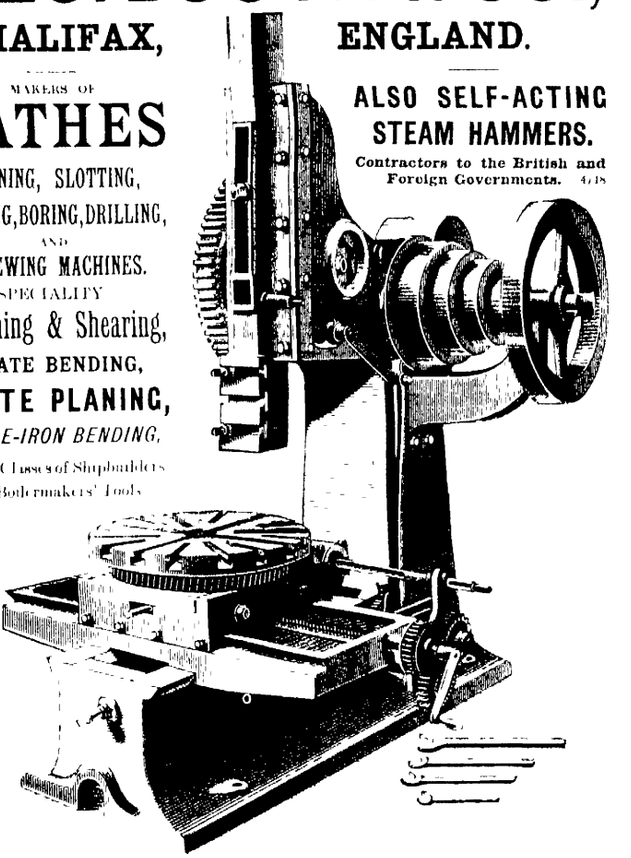
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ALSO SELF-ACTING STEAM HAMMERS.

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Draughtsmen & Engravers on Wood

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ESTIMATES ON APPLICATION

SLAG WOOL *Loose* and SILICATE CLOTH *Felted.*

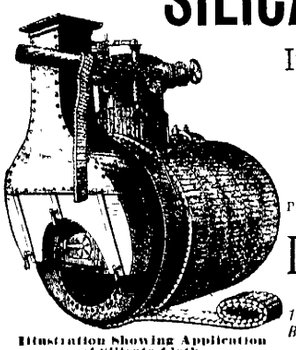


Illustration Showing Application of Silicate Cloth

Incombustible.
Best Non-conductor Extant.
Easily Applied.
Removable.
Re-applicable.

PRICES, ESTIMATES, AND FULL INSTRUCTIONS FREE ON APPLICATION TO

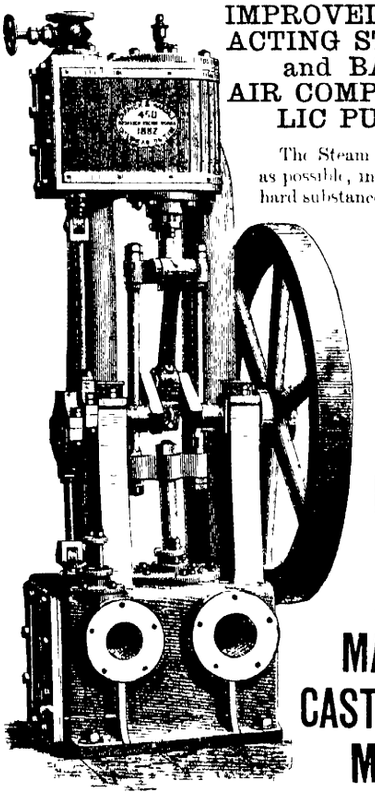
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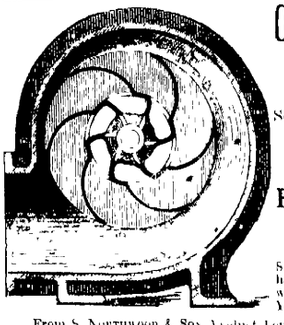


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The Steam Pumps as illustrated are, as nearly as possible, incapable of being choked, save with hard substances, and in working it has been found that shavings, waste, corn, small coals, &c., pass easily through which renders them eminently suitable for ballast pumps for ships

They are largely used in Chemical Works, Breweries, &c. where ordinary lifting valve pumps are readily choked, and by Railway Companies for supplying water at watering stations

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CAPELL Double-Power FAN

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THE MOST POWERFUL YET MADE

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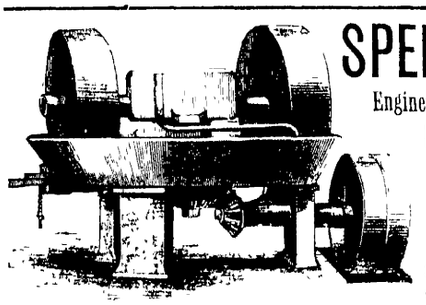
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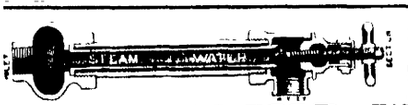
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Unvarying

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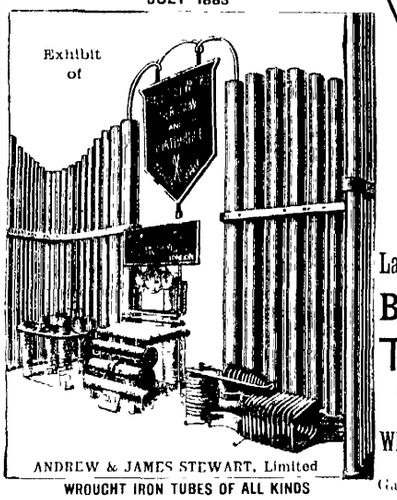
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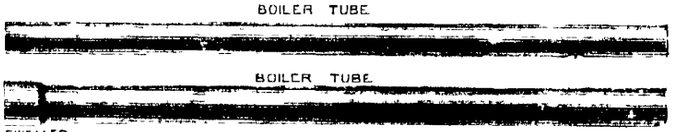
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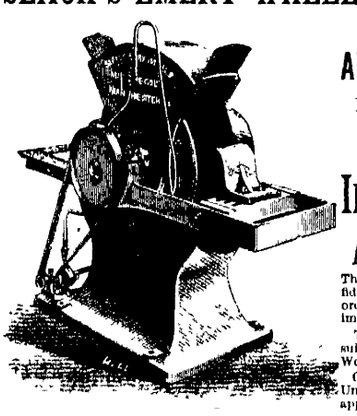
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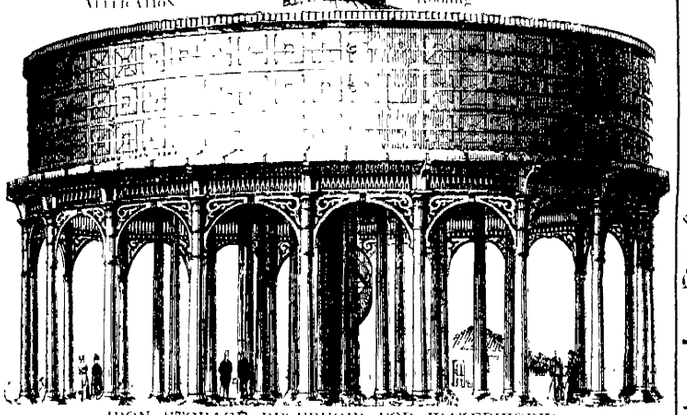
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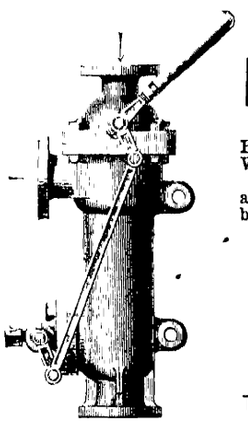


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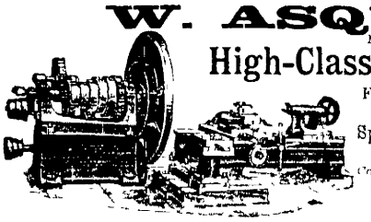
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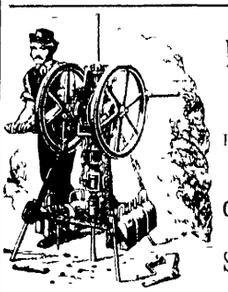


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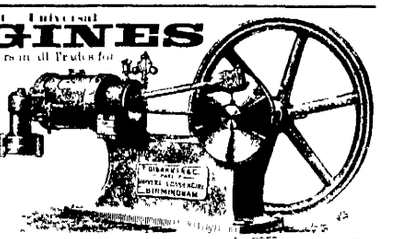
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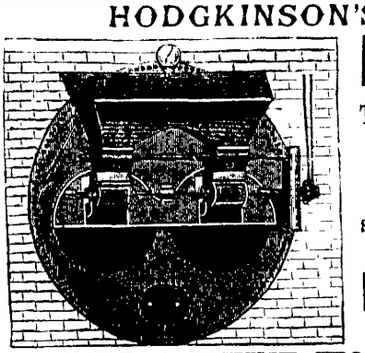
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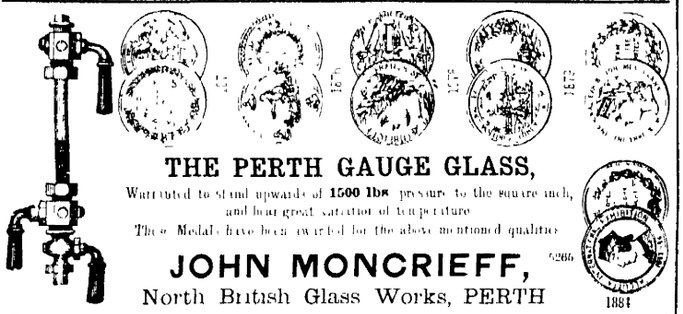
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(See Illustrated Advertisement November 7th, page 41)



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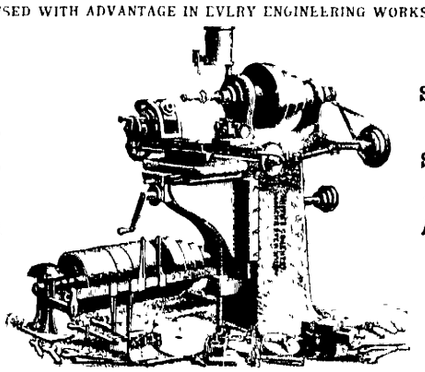
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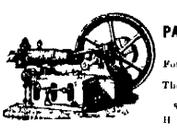
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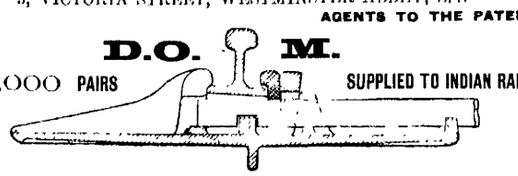
(*Vide* "Minutes of Proceedings of the Institution of Civil Engineers," Nov., 1881, Vol. LXVII., p. 87)

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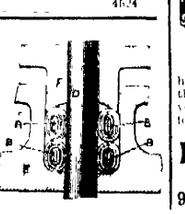
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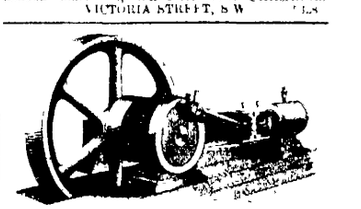
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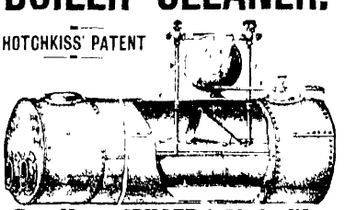
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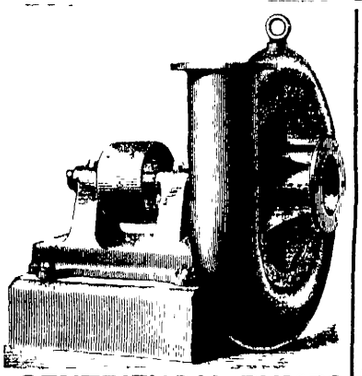
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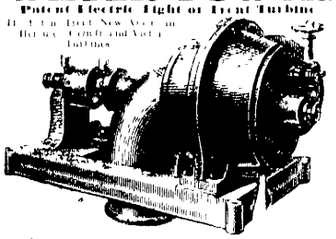
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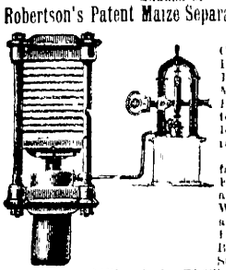
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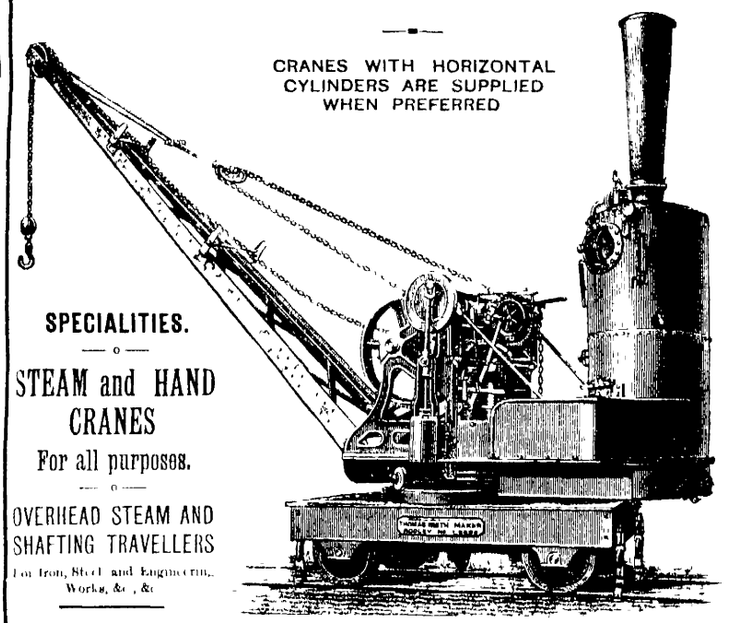
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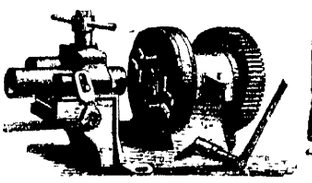


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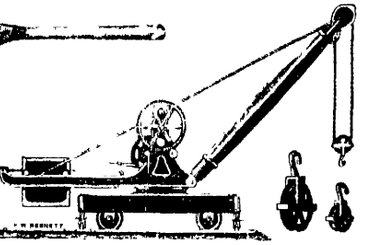












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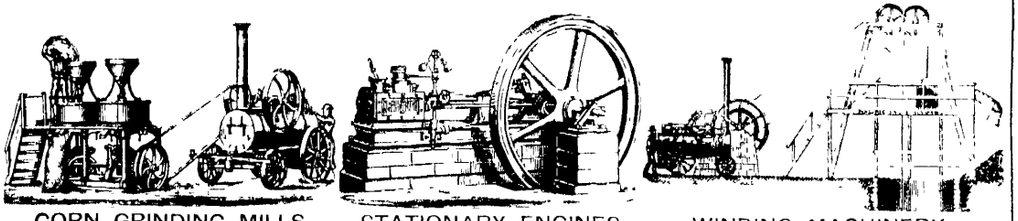
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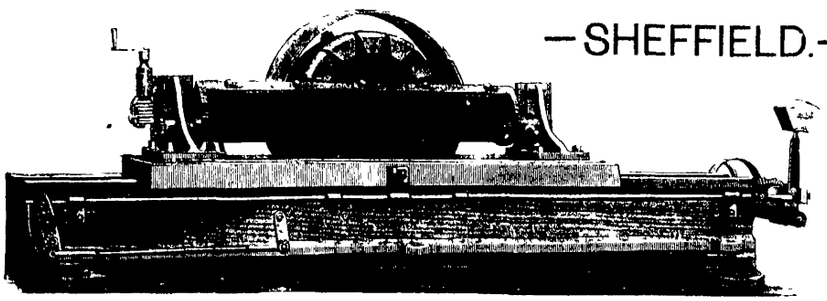


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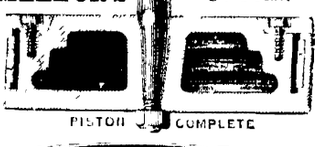


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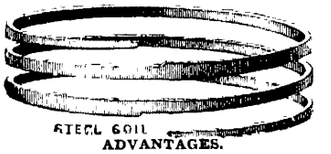
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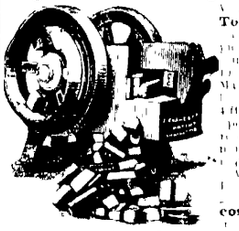
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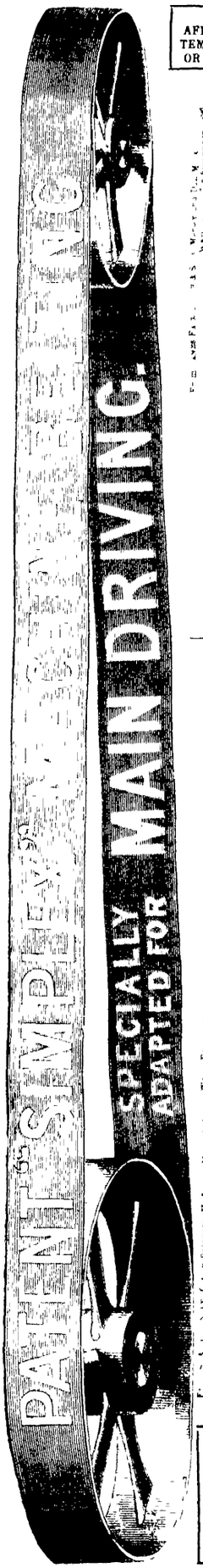
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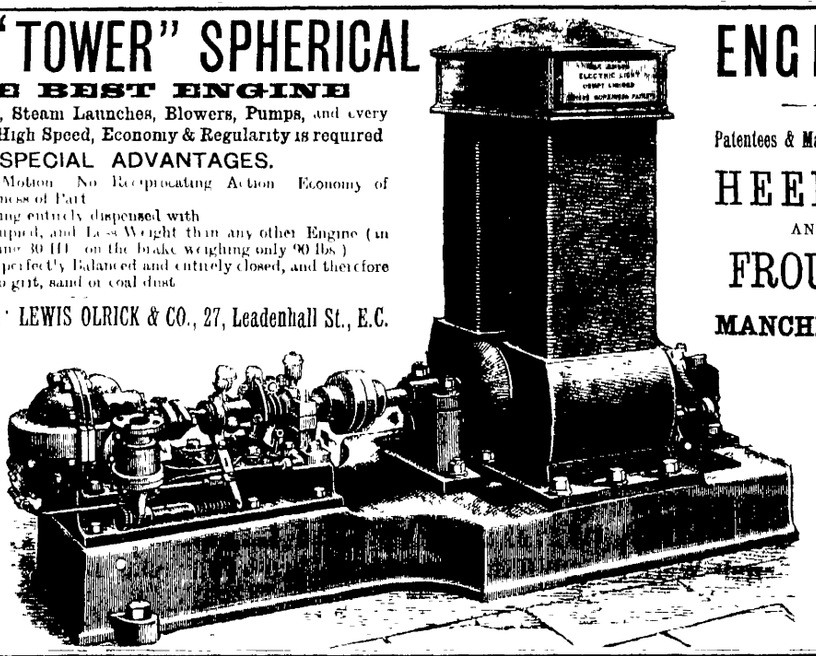
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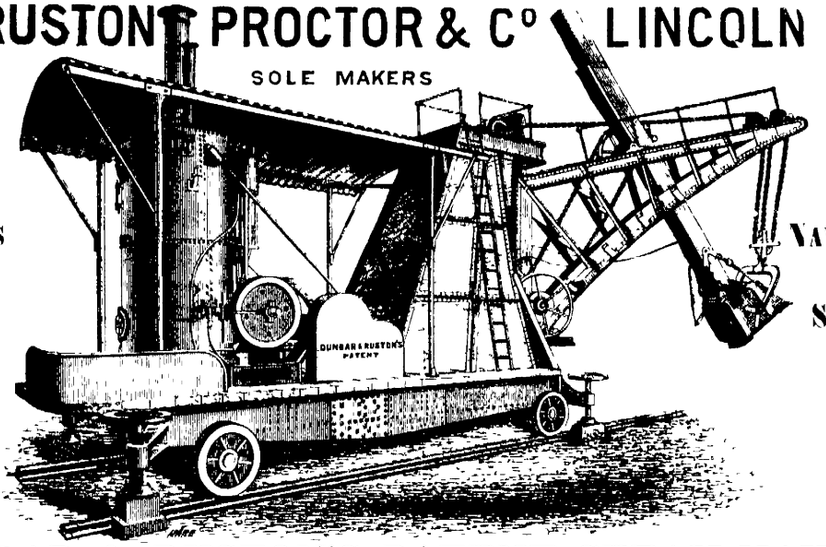
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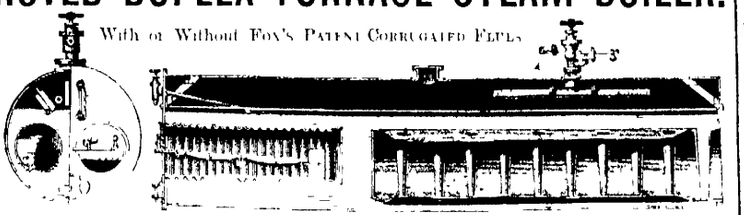
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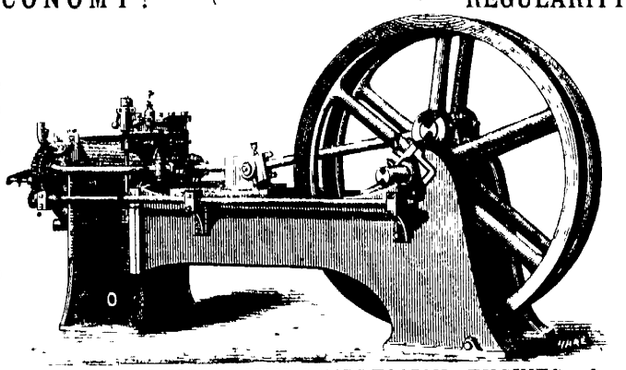
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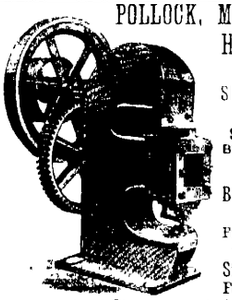
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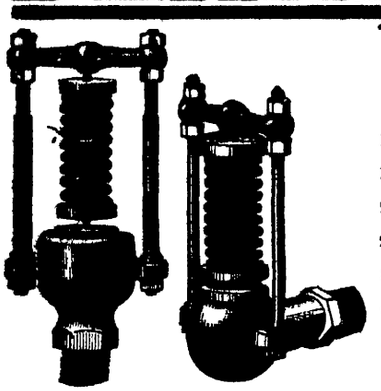
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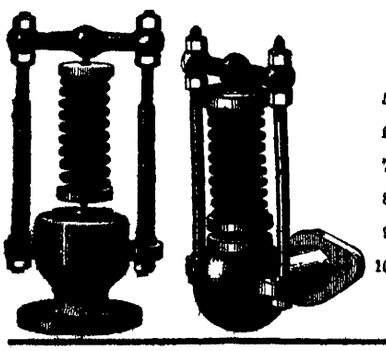
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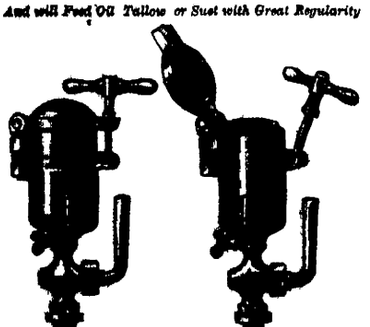
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No 7	ditto, ditto 5 in by 7½ in ditto, ditto	6	6	0
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We are dear Sir yours very truly,

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We are, yours truly,

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Yours truly,

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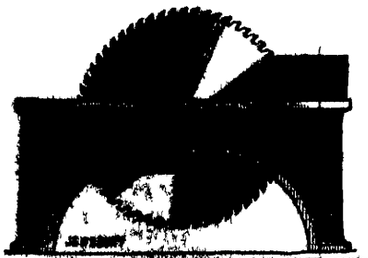
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" 5	" 1½-inch "	4	0	0
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3,	"	"		19	15	0
4,				25	10	0
5				30	0	0
6,				37	15	0

JOHN BLAKE, Engineer, ACCRINGTON, LANCASHIRE.

LITERATURE.

Electricity in Theory and Practice. By LIEUT. BRADLEY A. FISKE, U.S.N. New York: D. Van Nostrand. London: E. & F. and N. Spon.

THIS book is written with the object of forming a connecting link between the many works written on the theory of electricity and those written on its practical applications. The author states in his preface that practical men find great difficulty in mastering this subject, because they have to study the theory of electricity from books devoted wholly to theory, and the practical applications from those devoted wholly to practice, and he endeavours in the present work to remove this difficulty, by considering the theory of electricity in connection with its practical applications. The book opens, after an elaborate table of contents, with a chapter on magnetism, in which only the leading facts and phenomena are touched upon, and then the author proceeds to the consideration of frictional electricity. There is nothing novel in the treatment of this part of the subject; we notice the customary engravings of the various machines, better executed than is ordinarily the case, and a very well-written description of the Holtz machine. The idea of potential, which is usually so incomprehensible to students, is very lucidly explained, and the chapter on voltaic batteries is extremely full and complete. The discussion of Ohm's law in the following chapter leads us to the consideration of quantitative measurements, and this is followed by an explanation of the practical units in which currents are measured, and examples illustrating their use, and showing how the current varies according to the grouping of the cells.

Electro-magnetism is very clearly dealt with in chapter eight, and the convention of magnetic lines of force is rendered very easy of comprehension by excellent diagrams. An account of electrical measurements is preceded by a description of the sine and tangent galvanometers, and we must point out, that in his discussion of the principle of the sine galvanometer, Mr. Fiske has made use of ambiguous terms, which would probably leave a wrong impression on the mind of the student. He refers to the couple, tending to pull back a deflected magnetic needle into the meridian, as being measured by the product of the earth's magnetic force, the strength of one pole and the distance between them, whereas he should have been careful to point out that it is the horizontal component only of the earth's magnetic force that enters into the couple. It is a defect in the chapter on magnetism that there is so little information in it on the subject of the earth's magnetism. Several forms of ampère-meters and voltmeters are excellently described in this chapter, and the manner in which the engravings are executed is beyond all praise. The account of telegraphy in the following chapter gives a description of all the systems of working commonly in use and is a most interesting and instructive article.

The chapter on the electric light possesses no particularly novel feature, and we are somewhat disappointed in not finding some practical information on the subject of installations and methods of working.

Electric machines receive a fuller treatment than is to be found in most text-books; there is a splendid folded engraving of the Weston machine, and also smaller ones of the Brush and Siemens machines. This chapter also contains a discussion of the characteristic curves of dynamos, which is a valuable addition. These curves, first suggested by Dr. Hopkinson, offer a graphic representation of the relations of the strength of current to the electromotive force, and therefore to the magnetisation of the magnets. Under the heading of electric distribution of power, the author discusses the problem of transmission of power in the form of electric currents, and gives a series of tables taken from the *Electrical Review*, London, showing the amount of horse-power lost per thousand yards, in conductors of different sizes, with currents of different strengths. There is also a full account of the various systems of electric distribution, by which power may be distributed with a comparison of their relative advantages and disadvantages. This chapter may be considered as the principal feature of the book, for in it the author departs from the ordinary routine of the text-book, and applies the theory which has been studied in the previous chapters to the consideration of problems of a more practical nature.

The book concludes with an account of electric railways, in which the two systems for propelling cars by electricity, viz., firstly, by a storage battery carried by the car, and secondly, by a conductor which transmits the electrical energy to the motor, are dealt with. The difficulties that arose in the solution of the problem of applying electricity to locomotion, and the way in which they were surmounted, are fully explained, and the student is thus made conversant with all that is at present known on the subject. As a scientific text-book this work is sure to find considerable favour amongst students and teachers; the reasoning is at all times clear and explicit, and the general arrangement of the book leaves little to be desired. To the student who is desirous of becoming an electrical engineer, it will be [a 'most valuable assistance,' as it goes beyond the point at which most books leave off, and shows how theory is applied in practice. We have already had occasion to note the excellent engravings with which the book is illustrated, and we will only add further that it is got up in a manner which we regret to say is seldom seen in this country.

Facts and Figures Concerning the Manufacture of Coke and the Collection of Bye-Products by the Simon-Carvès Process. By J. R. BRECKON, Sunderland.

The author of this pamphlet is the agent in Durham and Northumberland for the Simon-Carvès process of coking coal and recovering the bye-products. His utterances, therefore, are those of an avowed partisan, and must be received with the caution which necessarily attaches to the statements of interested persons. Mr. Breckon evidently feels the difficulty of his position, for two-thirds of his volume are occupied by extracts from the writings of others, principally from papers read before various societies, and in the remaining portion he constantly appeals for corroboration to statements made by well-known ironmasters and coke-makers. A stronger piece of evidence than the opinion of any individual person of the utility of the Simon-Carvès process, is the fact that licenses for 350 ovens have been given in this country, and that there are 370 ovens at work, or, in course of construction, in France. During the coming winter three additional establishments on this system will be in operation, of which the first is already started. These are at the works of (1) the Bearpark Coal and Coke Company, near Durham; (2) the Altham Colliery Company, near Accrington; and (3) the Bignall Hill Colliery, Newcastle, Staffordshire. The last license given in France has been taken by the Western Railway, who are establishing 80 ovens on this system at Rouen, the necessary coal coming up the Seine from England. The coke is required for the locomotives on the suburban lines around Paris, where the use of coal is forbidden. These ovens are designed to carbonise 200 tons of coal per day of 24 hours, or at the rate of 900 tons of coal per annum per each oven.

Mr. Breckon gives an estimate of the advantage of 50 ovens on the new system over beehive ovens. Taking the yield at 77.03 per cent. for the former and 60 per cent. for the latter, and estimating the tar at threepence per gallon, and the ammonia liquor at a penny per gallon, he finds that for a given amount of coal (43,680 tons) the Simon-Carvès ovens will bring to the proprietor 10,227*l.* more than the beehive oven, rent, interest, and depreciation not being reckoned in either case. The first cost of the new ovens would be 9700*l.*, so that the saving represents 107 per cent. of the capital, and offers an ample margin for all extra expenses, if there be any. Putting the matter in another way, it would pay a manufacturer using the new method, as well if he sold his product at 1s. 9d. per ton, as if he obtained 8s. 6d. with the old style of working.

The latest improvement in the Simon-Carvès ovens consists in the use of a regenerator to heat the air before it enters into combustion with the gases in the flues. This regenerator is not subject to an alternate action, but is merely an air conduit built in the terminal flue and receiving heat through the walls from the escaping gases. The effect of the introduction of hot air, in place of cold, is to shorten the coking process from about 70 hours to 48, and thus to greatly increase the output of the plant and to render it able to deal with coal of a less bituminous nature. In France excellent coke is being made from small coals which do not contain more than 20 per cent. of volatile matters, and slack direct from the washer can be put into the ovens perfectly wet, and a gain in ammonia is found to result from the process.

The appendix contains reprints, more or less complete, from Mr. Simon's paper, read before the Iron and Steel Institute in 1880; from Mr. Robert Dixon's paper, read before the same body in 1883; from Mr. Watson Smith's paper, read before the British Association, Section B, in 1883; and from a paper read by the same author before the Society of Chemical Industry in Liverpool, in 1883. The volume thus reproduces all that has been laid before the public on this most interesting and promising subject, and although the author views the matter in a very rosy light, his work will be of considerable assistance to those who are making inquiries in the subject with which he deals. In conclusion we must commend Mr. Breckon's good taste in not allowing trade rivalry to lead him into making comparisons between other systems and his own.

BOOKS RECEIVED.

Brickwork. A Practical Treatise embodying the General and Higher Principles of Bricklaying, Cutting, and Setting. By F. WALKER. Illustrated by Ninety-one Woodcuts. London: Crosby Lockwood and Co. [Price 1s. 6d.]

Exercises in Electrical and Magnetic Measurement. By R. E. DAY, M.A. New Edition. London: Longmans, Green, and Co.

Annual Report of the Chief Engineer of the Philadelphia Water Department for the Year 1883. Philadelphia.

The Patentee's Manual; being a Treatise on the Law and Practice of Letters Patent. By JAMES JOHNSON and J. HENRY JOHNSON. Fifth Edition, thoroughly revised, incorporating the Patent Act of 1883. London: Longmans, Green, and Co., Stevens and Co

United States Commission of Fish and Fisheries. Part IX. *Report of the Commission for 1881. A. Inquiry into the Decrease of Food Fishes. B The Propagation of Food Fishes in the Waters of the United States.* Washington: Government Printing Office.

THE ATTOCK BRIDGE

THE bridge which we illustrate on pages 492 and 493, as well as by a two-page engraving in the present issue,* and page 448 of our issue of November 14, was built to carry the Punjaub Northern State Railway, and the trunk road between Lahore and Peshawar, across the river Indus on the north-west frontier of India. This railway, consisting of a main line of 279 miles and several branches, was constructed for purely military purposes, and had been many years in hand, but was only about one-third completed when the late Afghan war broke out. Orders were then issued to complete this line at any cost; work was started over the unfinished portions late in 1879, and the line was opened for traffic up to the River Indus on the 1st January, 1881, and beyond the Indus the following year, but the bridge over the river, together with the heavy cuttings and tunnels in its approaches, were not opened until the 24th May, 1883.

The River Indus.—At Attock the Indus has already traversed a distance of in round numbers 900 miles (much of the upper lengths are unexplored, being outside British territory, therefore the exact length is unknown) The area drained is estimated at 120,000 square miles, or almost exactly the same area as the British Isles.

About 30 miles above Attock the river leaves the main ranges of the Himalayas and spreads out into a wide shallow bed, the average width being about two miles, to be again contracted by the ranges of hills which cross its course at Attock itself and further south. Through these latter ranges it winds its course for over 90 miles, the bed being sometimes narrowed to a width of a little over 100 yards and seldom exceeding 400 yards, until it finally debouches into the plains at Kala Bagh, the highest point to which the Lower Indus is navigable by steamers.

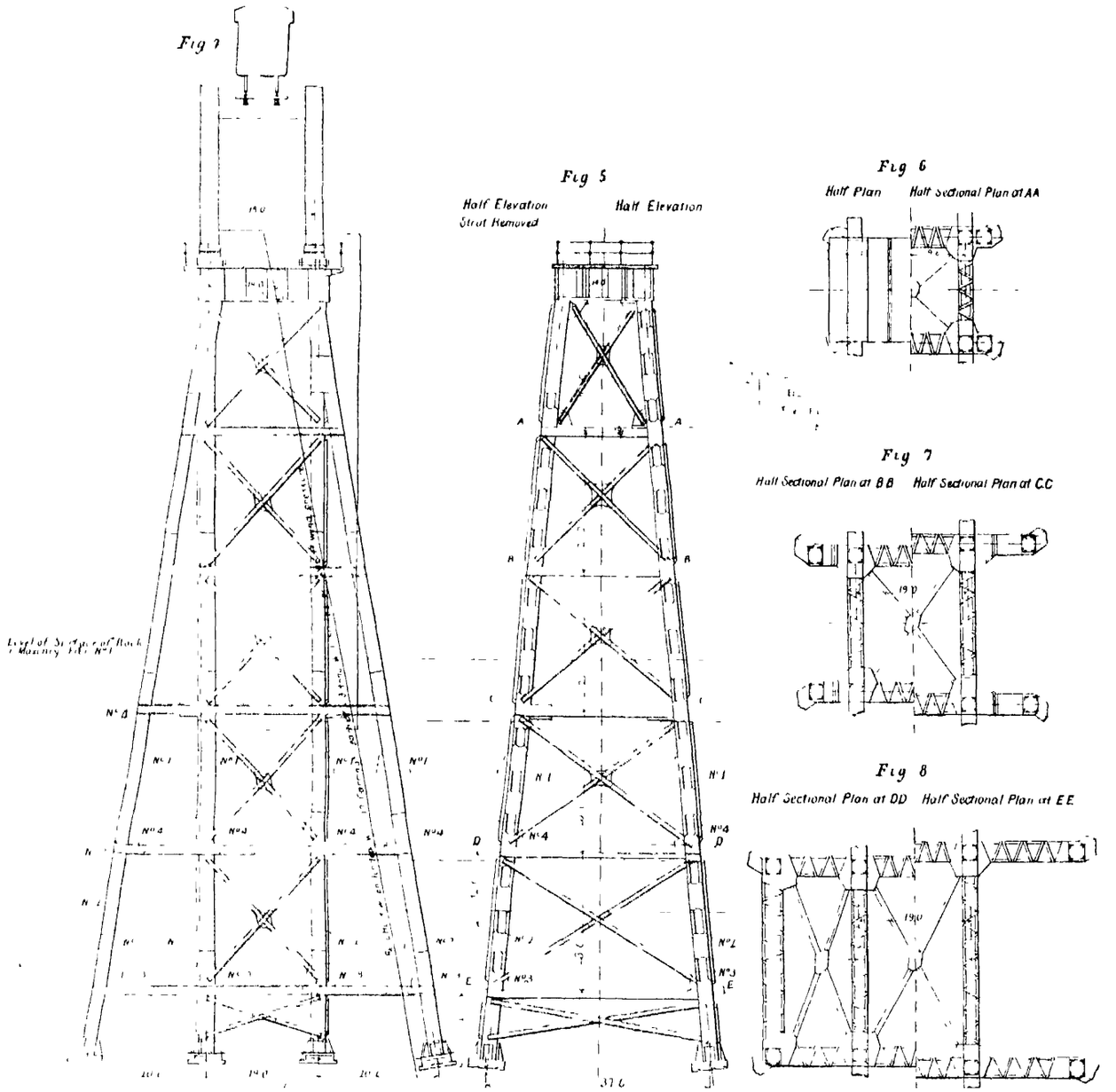
The comparatively flat plain north-east of Attock, locally called the Chuch, and which extends westwards up the valley of the Cabul River to Peshawar, shows evident signs of having once been the bed of a great lake fed by the Indus from the north-east, and by the Cabul River from the west, the outlet being a river on the line of the present Indus below Attock, whose bed was at first at a considerably higher level, but was cut down in the course of ages to its existing position.

As a rule the river is at its lowest from November until the early days of March; during this season the greatest depth of water in the contracted parts of the channel is about 30 ft., and of course less in wider places. There are three different causes which produce floods in the Indus. First, the melting of the snows in the Himalayas as the summer advances; this usually leads to a gradual

* See also the two-page engraving in ENGINEERING, November 14.

BRIDGE OVER THE RIVER INDUS, AT ATTOCK.

MR F. L. O'CALLAGHAN, ENGINEER IN-CHIEF.



increase of depth, beginning in March and continuing until an extra depth of about 20 ft is reached by the end of May Second, the monsoon rains in June, July, and August, these in the upper reaches of the Indus are not so regular as in districts near the sea coast, but the highest floods produced by them generally occur in July, and have been known to rise as much as 70 ft above low-water level Third, abnormal floods have been caused by land slips, which impounded some of the large tributaries until an immense quantity of water had collected, which bursting these temporary barriers swept all before it, and caused sudden and unexpected floods in the main river It is known that the heavy flood in February, 1858, which rose to a height of 70 ft. at Attock, and seriously damaged the cantonment of Nowshera in the Peshawar Valley, was due to a landslip in the Shyok River in the northern part of the Cashmere country, and it is probable that the great flood of 1841, which rose 101 ft above low water at Attock, was due to a similar cause Twice during the construction of the railway bridge the engineers received warnings from the British Resident at the Cashmere Court of landslips having blocked the Shyok, but fortunately in each case the impediment disappeared gradually without causing a flood

During sudden and heavy floods the open plains of the Chuch and Peshawar Valley above Attock have a most valuable effect in acting as a regulator Their combined extent is about 30 miles by 5 miles, and this area in extraordinary floods reduces the depth and velocity in the gorge below

The Attock Bridge In designing a bridge to carry a railway across the Indus at Attock the highest probable flood level had to be carefully considered, allowing for the action of the regulator above referred to, a height of 15 ft above the level of the great flood of 1841 was deemed sufficient for the underside of the girders, and at this level the bottom booms were fixed

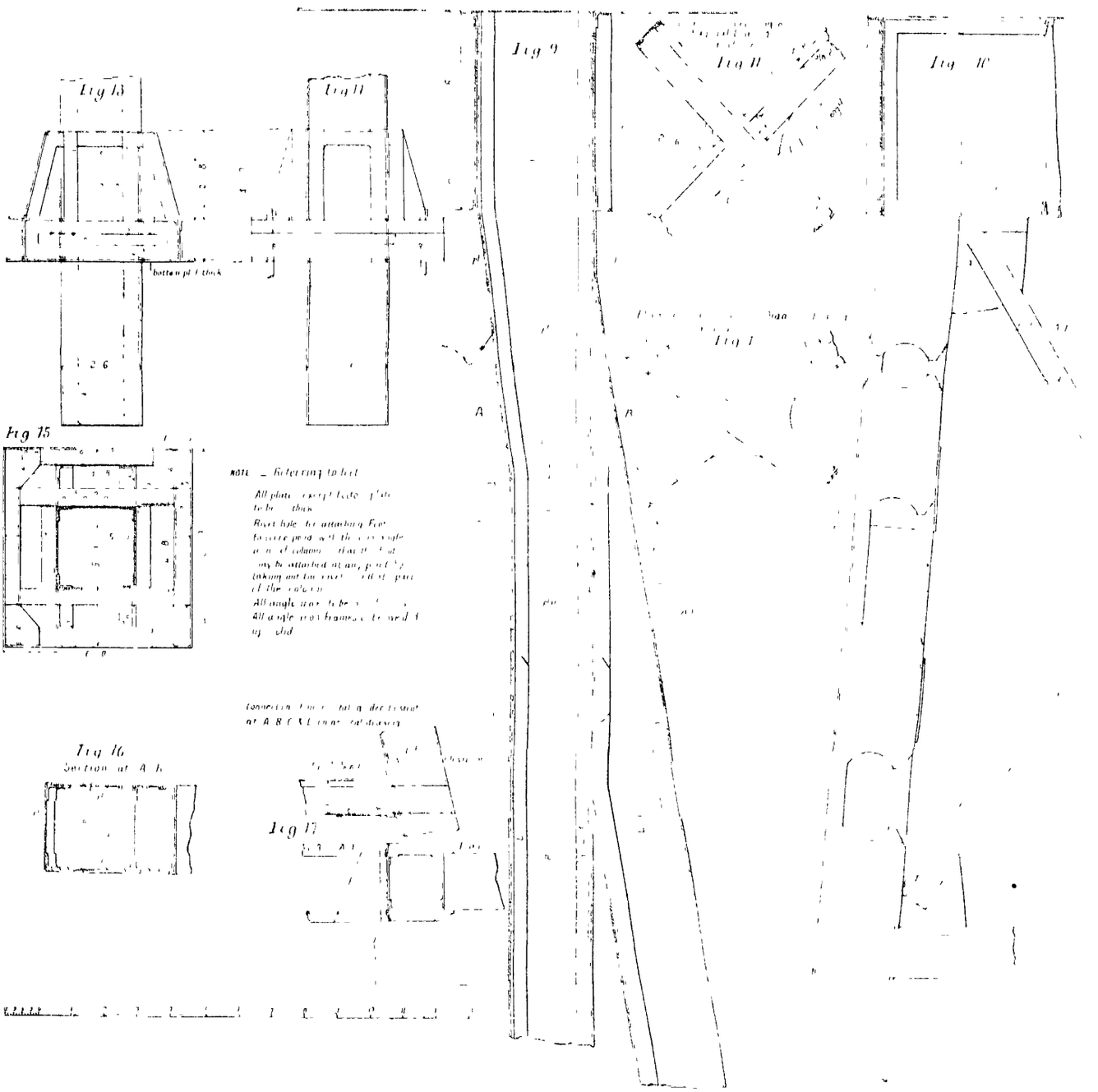
Another contingency had also to be provided for, which is the liability of the district to earthquakes Slight shocks are of frequent occurrence, the direction of the seismic wave being as a rule east and west Provision was also made for the bridge carrying a cart road as well as a railway, the traffic on the trunk road having hitherto been dependent on a ferry in the flood seasons Orders for the construction of this work were issued in October, 1879, but before a detailed design could be prepared the exact position for the bridge had to be fixed on

The Site – Surveys had been made near Attock on several occasions with the view of bridging the Indus Originally the bridge was intended for the trunk road to Peshawar, when the proposal was for a suspension bridge, but when railway extension to the frontier was determined on a more detailed examination was undertaken

Above Attock no practicable site exists, for a long distance the river, as before stated, averages about two miles in width, the surveys were, therefore, confined to the gorge at and below the Sikh fort, which for centuries dominated the crossing The examination of the river ended in three sites being left to choose between, and, on somewhat detailed estimates being prepared, the position now occupied by the bridge, about two miles below the fort, was selected At this point the width of the top surface of the water at its lowest is under 600 ft, and the channel is divided into nearly two equal parts by a rocky shoal near its centre. Above low-water level, and extending some distance beyond the line of the highest recorded flood, the rock surface is perfectly bare, being swept clean by the water when it rises and also by the wind The left-hand channel is the deepest, and here below water the surface is bare, but the right-hand channel always has a sandy bottom, the current being considerably less

BRIDGE OVER THE RIVER INDUS, AT ATTOCK

MR F L O'CALLAGHAN, ENGINEER IN CHIEF



Eventually a bridge of five spans, three being 0 ft and two 300 ft in the clear, was decided on, l contracts for the pier and girder work were let England Fig 4 (see ENGINEERING, November) shows the general elevation of the bridge and section of crossing Wrought iron was chosen the best material for the piers owing to the acity of good sound building stone, and to the bility to extra heavy vibrations from earthquakes *Foundations*.—By the adoption of 300 ft spans the dry season stream any difficulty with the ndations of all but one of the piers was avoided e exact position of the bridge and the size of the ns were not however finally decided on until the ry end of January, 1880, far too late in the season allow of an effectual effort being made to secure e one wet foundation, besides which no plant was llected or shelter for the engineers or workmen ady, every available man being at the time engaged in the effort to get a railway of some kind laid r the movement of troops

The surface of the rock at the site of the centre pier being, for the most part, exposed to the action of a strong current, was swept clean, except for the micaceous sand which lodged in the crevasses timber therefore could not be used to form a coffer dam The foundation was secured by inclosing the space required with a wall made of Portland cement concrete In the absence of driving plant a commencement was made by filling small cotton cloth bags with fine concrete and setting them by hand, the native divers first clearing the sand from the hollows in the rock, and then laying the bags in place A small portion of the wall was thus built in February, 1880, as an experiment, but the early rise of the river that season from the melting of the snows put an end to the work before much progress was made During the time which elapsed until the river was again low enough to allow of work being carried on for this foundation, quarters for the staff were built, workshops were erected [illegible] constructed, a bazaar for the supply of food arranged for, and roads, practicable for pack animals, were constructed from Attock The line for the permanent railway from Campbellpore Station, nine miles distant, was laid out, and the works on it started directly those on the other portions were so far complete as to make labourers available Quarries for stone for the abutments and masonry works on the approaches were opened, and generally every possible preparation was made for the vigorous prosecution of the works

The contracts for the ironwork were given out on the condition that the piers were to be completed in time to insure delivery in India by November, 1880, and the girders during the same month The piers were given to one firm and the girders to another, but while the latter were delivered in due course and portions arrived at the site of the work as early as October, 1880, the firm entrusted with the work for the piers failed to complete them in time, and delivery was not given until a year later than originally promised

In December, 1880, work was reco

the foundations for the centre pier. The small portion of the concrete wall already constructed was found to have been destroyed by the river during the flood season, therefore a commencement had to be made *de novo*. The outline of the space to be inclosed was irregular in plan, being determined by the configuration of the rocky shoal, and extended some distance up stream beyond the actual requirements of the pier, to a point where a larger peak of rock than usual projected above water level (see Fig. 3).

Some of the extra space thus enclosed was required for the foundations of a concrete outwater subsequently built to protect the pier from floating matter, and the remainder was most useful as a platform to store materials and to work from.

The wall was completed, and the space inclosed was divided into ten compartments by cross-walls before the end of the working season; but, owing to the non-arrival of the ironwork for the piers, no steps were taken for emptying the foundation.

The method adopted for constructing this wall, in the absence of proper diving apparatus and plant, was as follows: Barges were moored just outside the line of the portion of wall being operated on, and as much as possible of the fine micaceous sand which in places covered the rock was removed by a spoon dredge, and then the surface was re-cleared by hand. This of necessity was a slow process, and the work was but imperfectly done by the native divers, who, of course, could not remain very long under water. The intense cold of the snow-fed river was also against them. When the rock was reported clear, bags capable of holding 1¼ cubic feet were about two-thirds filled with Portland cement concrete, and were laid on the rock and rammed into the cavities, and by means of the same kind of work this wall was gradually built up to water level. Above water level the wall was continued for a height of 5 ft., being built of rubble stone set in mortar composed of one part of "kunkur" lime and two parts of "soorkee" (crushed bricks). This lime was sufficiently hydraulic to stand the action of water after a day or two. The material for the piers having at last come to hand, work on the foundation was resumed directly the water was low enough.

In the latter part of November, 1881, pumps were got to work, and some of the compartments were emptied. It was then found that the surface of the rock was not so sound as had been supposed, being honeycombed and cut up by small fissures which it had been impossible for the native divers, working without diving apparatus, to close up with the cement concrete. The influx of water through these holes and fissures was too great to allow of the cells for the shoes of the pier standards being sunk into the rock. It was then determined to discontinue pumping altogether and diving dresses having in the mean time been procured, the compartments into which the dam had been divided were cleared of all sand and loose matter. When quite empty of all but water, each compartment was in turn filled up with cement concrete which was allowed to set for three or four days, then a cell was cut down through it to the surface of the rock and continued into the rock until found sound and perfectly solid. In two cases, after excavating a few feet into the rock, small passages communicating with the river outside were cut into, when the process had to be repeated over again. The cells were cut 7 ft. square at top, or just a little larger than the shoes of the columns, and somewhat wider at the bottom. When all the eight cells were completed to the full depth required to insure a sound base, the bottom pieces of the column were cut to the necessary length, the shoes were rivetted on, and each was lowered into its cell and placed approximately at the proper level and position horizontally, resting on hardwood wedges. The next lengths were then bolted to them, and two tiers of horizontal braces with the intermediate cross braces were fixed in place with bolts. The whole base of the pier was now slightly raised by traversing screwjacks and brought exactly into position both horizontally and vertically. Fine Portland cement concrete was carefully rammed under the shoes, also inside and around them, and the cells around the columns, and also under them, were filled with the same class of concrete up to the level of the top of the dam wall. This completed the foundation work of No. 3 pier, and the others were treated in a similar manner; there being, however, no water to contend with, they were set without difficulty of any kind.

(To be continued.)

MINERAL WATER MACHINERY AT THE HEALTH EXHIBITION.—No. II.

Messrs. Barnett and Foster, of Eagle Wharf-road, N., had a complete mineral water factory in miniature in full operation during the Exhibition. Perhaps the chief point of interest in this exhibit, however, was the application of a mineral water machine to the bottling of beer. On page 496 we give a general view (Fig. 1) of a machine used for this purpose. The beer is placed in one of the large cylinders shown, each of which is capable of holding one barrel. Air is then exhausted from the cylinder by means of the pump beneath. When the air has all been exhausted, carbonic acid gas is forced in by the same pump, until it reaches a pressure of 20 lb. to the square inch, when bottling may be proceeded with. The two cylinders are worked alternately, so that time may not be lost in charging. The conversion of the pump, from a vacuum to a force pump, is simply effected by means of two-way cocks which convert the suction into the delivery branches, and *vice versâ*.

The effect of forcing carbonic acid gas into the liquor is the same as if the beer were allowed to remain a long time in bottle, excepting that there is no thick deposit when the gas is introduced mechanically, as is the case when it is generated in the usual way by fermentation. In the mechanical process, too, the beer is fit to drink immediately it has been bottled, a point of considerable importance from a commercial point of view. The corking and bottling machine used in connection with the above apparatus is shown in Fig. 2 on page 497, and is of a new design recently patented by Mr. Foster.

With this machine a screw stopper, larger than the outside part of the neck of the bottle, can be used, a great advantage, as a firm hold can be obtained for unscrewing by hand. The first operation in filling a bottle, the apparatus having been previously connected up by two pipes to the aerating machine, is to lower the handle C and place a stopper into the open connection above the space marked B. The stopper, which is of lignum vitæ, is of the screw class, and has a flat head, which, as we have said, overhangs the neck of the bottle. On the lower part a thread is cut, and there is a corresponding thread in the inside of the neck of the bottle. The stopper, when placed in the machine, is jammed into a cone clutch on the lower end of the vertical spindle, terminating at G. The lever C is then allowed to resume its former position, and the spindle, together with the stopper, is drawn upwards out of the way. The neck of the bottle is then inserted at B, the bottom of the bottle resting on the stand shown, which is adjustable, as to height, by means of the thumbscrew H. It is now requisite to make connection between the bottle and the cylinder containing the beer under pressure, and this is done in a very ingenious manner. The part of the apparatus above B, into which the neck of the bottle is thrust consists of a cylinder in the walls of which there is an annular space cast. The inner wall of the cylinder, so formed, is cut away for a short distance all round, so that there is an annular opening from the interior of the cylinder leading into the space mentioned. This opening, however, is stopped by a flat ring of india-rubber, which is really a short length of india rubber tube, and which is firmly attached to the casting forming the cylinder. The annular space referred to, which is, of course, at the back of the india-rubber, can be put under hydrostatic pressure by means of a small hydraulic pump shown at A, and which is worked by the foot lever D. The neck of the bottle having been placed in the cylinder, the pressure is applied, and the india-rubber ring is forced against the neck of the bottle just below the top collar. The two pipes referred to, which connect with the aërating cylinders, lead into the space above the india-rubber ring, and it is obvious therefore that a connection is made between the machine and the bottle, if the cocks by which the connecting pipes are controlled are open, so that the beer or other liquor can be conveyed from one to the other. The reason that there are two connecting pipes is to prevent frothing or "fobbing," as it is generally called, in bottling. The beer being under a pressure of 20 lb. or so above that of the atmosphere, and the bottle being subject only to the atmospheric pressure, a violent rush of liquor to the bottle would take place as soon as the connection was made by opening the cock, so that the bottle would contain nothing but froth. In order to prevent this the second pipe leads to the space above the beer in the aërating cylinder, and by opening a cock the bottle is first put under the same pressure as that in the cylinder. The beer will then flow easily down by its own gravity and no frothing will take place. Having filled the bottle it remains to screw the stopper in. This is done by means of the handle G, the turning of which rotates the vertical spindle. The latter works through a stuffing-box into the chamber in which the neck of the bottle is placed, as already explained. It will be remembered that the stopper is held by a clutch, which is in the shape of a cone, on the end of this spindle. By means of the lever C the whole is lowered until the stopper touches the mouth of the bottle, when a few turns of the handle G cause it to enter into the neck and screw it firmly home. The operation is then complete and the pressure forcing inwards the india-rubber ring can be released, and the bottle removed to make way for another. In the engraving, E is the lever of the filling valve and F a snifting valve used in bottling mineral waters.

This machinery enables light beers, which are not fit to undergo the ordinary fermentation process, to be bottled. Creating a vacuum above the beer has the effect of removing the atmospheric air contained in the liquor, which does so much towards making bottled beer often taste flat and insipid. At the same time a considerable quantity of the alcohol is also removed. Beer bottled in this way is more sparkling than usual, on account of the large amount of carbonic acid gas it contains and the absence of atmospheric air. It is said, also, that persons of weak digestion who cannot take ordinary beer can drink this with impunity.

Messrs. Barnett and Foster were also manufacturing aërated waters on their stand. For this purpose they had one of the "Niagara" machines, with bottling machines connected for filling syphons, corked bottles, and various descriptions of patent bottles. The principal novelty in the Niagara machine is the condenser, in which the agitation is not carried on by mechanism, but by the rising of gas through the water and the falling of the water in a finely diffused spray through the gas. Fig. 4 shows the action. The water and gas are pumped together at A into the space between the inner and outer casing as shown, and a certain amount of gas is there absorbed, as it forces its way through the water to pass to the central space. At D there is a perforated diaphragm through which the partially charged water falls, taking up a further quantity of carbonic acid gas whilst dropping to the bottom of the cylinder, where it is drawn off at B fully charged. The pressure is shown by a gauge communicating with the interior at C, and a gauge glass is provided for showing the height of the liquor in the apparatus, so that the rate at which it is drawn off may be regulated.

In Fig. 3, page 497, we give an illustration showing a general view of a new design of aërated water machine which this firm has recently introduced. The principal novelty consists in the arrangement of the two cylinders, the general principle being similar to that already described.

In the Exhibition one gas-producing plant served to supply gas for both the mineral water and beer apparatus. To provide against the chance of the gasholder bell collapsing in the event of all the gas being exhausted through accident or carelessness, a special provision is made. A metal case similar to that of a dial pressure indicator is provided and is fitted with a prepared diaphragm, which will break at pressure less than that which would collapse the bell. An electric bell is also fixed which begins ringing directly the bell falls below a certain point, so that there is always warning of a failure of gas. In the machinery exhibited, however, these precautions were not absolutely necessary, as the production of gas was automatically carried on, the agitator in the generator being driven from the shafting above, whilst the acid-feeding arrangement was controlled by a line and spring hung upon the acid tap. In this way the rising and falling of the bell caused the proper amount of acid to be admitted to the generator as required to make up for the gas drawn off.

There were several other machines at work on this stand, in addition to which a number of neatly got-up machines were exhibited not working. Large quantities of beer and aërated waters were bottled and manufactured in the Exhibition, and these were sent out in the

NOTES FROM THE UNITED STATES.

(From our own Correspondent.)

Philadelphia, November 14, 1884.

Encouraging evidences of an improvement in the iron trade are presented in all the leading markets. A few good transactions have been closed; no general improvement is probable; buyers everywhere have kept out of the market for several weeks, and are now in absolute need of material, and hence are imparting a little activity to the market by their purchases. Special interest is being taken in southern pig iron, both in New York and Chicago, as well as here. Contracts for 4000 or 5000 tons of Alabama iron have been made, at 16 dols. to 16.25 dols., delivered at tidewater ports. Inside quotations for forge irons from the Lehigh Valley, at tidewater, are 15 dols. to 17 dols., according to quality. There is a difference of 50 cents to 1 dol. per ton in favour of southern irons, and if this should continue, it would not be surprising for the New England and Middle States markets to absorb upwards of 100,000 tons of southern iron during the next thirty to sixty days, under contract. On November 1, 88 anthracite furnaces were blowing, with a weekly capacity of 23,049 tons; 135 were idle, with a weekly capacity of 31,150 tons; 86 bituminous and coke furnaces were blowing, with a capacity of 43,940 tons, and 136 idle, with a capacity of 48,992 tons per week. Chicago pig-iron dealers are negotiating for foundry and forge iron from the south, and heavy sales are reported. There is some contradiction as to the amount of business done in southern pig iron, but there is, to say the least, a decided improvement in the demand for it. At New York a 4000-ton lot of standard American iron sold. Nails are in active demand at 2 dols. to 2.10 dols. for iron, with 15 cents more for steel nails. One more mill has started to making steel nails. Merchant bar is weak at 1.75 cents. Demand for structural and plate iron is extremely dull. Rails are selling at 28 dols. to 29 dols. in small lots. It is probable that 27 dols. to 27.50 dols. would be accepted for large lots, late delivery. Building activity continues throughout the larger cities. The coal trade is active, but competition is very sharp. In this city two-thirds of the rolling mill capacity is idle, and the textile capacity is in about the same condition, although it is difficult to arrive at exact results. The financial situation is sound, and money is abundant. There is an average of thirty to thirty-five failures per day throughout the country. All kinds of staple products are very low. There is an improvement in the volume of exchanges this week as compared to last, and with the expected settlement of the Presidential question, it is probable that there will be a general improvement in business.

METALLURGICAL NOTES.

Distillation of Quicksilver in Vacuo.

Dr. F. Gutzkow, of San Francisco, read a paper recently before the Technical Society of the Pacific Coast, strongly urging the advantages of distilling off quicksilver under diminished atmospheric pressure, as applied to the retorting of amalgam obtained in treating silver and gold ores. A report of the paper, with detailed description and drawing of the apparatus proposed by Dr. Gutzkow, appears in *The Engineering and Mining Journal* of November 1st. A steam pressure of 60 lb. is used to produce a vacuum of 16 in. of mercury, and the vapour of quicksilver from the retort being rapidly removed under the suction so caused, the operation can be conducted much more rapidly at lower temperature, and without the usual risks to the health of the workmen caused by escape of mercurial vapour. The bulk of the quicksilver condenses in the Liebig cooler, which is a usual part of the retorting plant, and the remainder is drawn through the tubes and water-box of the apparatus in such a manner as to completely condense there, efficient arrangements being made to prevent the possibility of any back suction of water into the retort if the vacuum should be suddenly destroyed. Dr. Gutzkow points out how very specially necessary is the rapid removal of quicksilver vapour during distillation. The tension of this vapour does not rapidly increase with a slight rise of temperature as with steam, but a considerably greater amount of heat above the boiling point is required before it will escape with energy from a closed vessel, and even then it will move slowly. Quicksilver will as little evaporate in an atmosphere saturated with its own vapour, as will any other liquid, and hence much time and great heat are required to drive it out from the amalgam and out of the retort. This is stated to be daily proved in the working of retorts, by the fact that on opening them the silver is found to have been melted in contact with the iron, showing the great heat used, and yet quicksilver is still present in the cooler portions. Dr. Gutzkow considers it desirable to draw attention also to the advantages that might be derived by applying distillation *in vacuo* to other processes, in which it has not yet been utilised, and instances the distillation of coal oil. A somewhat similar process of extracting quicksilver vapour from [illegible] has been cited also by Mr. Stetefeld in discussing Dr. Gutzkow, considers the apparatus used not to have been effective, and gives his reasons for objecting to it. The reply by Mr. Stetefeld is given appended to the notice in *The Engineering and Mining Journal*, and the whole matter will be of interest to those concerned in amalgamation of ores.

Examination of Coke.

In *Stahl und Eisen* Dr. W. Thörner gives an account of a rapid and simple method he has adopted for determining the specific gravity of coke, and also the relative volumes of coke-substance and pore-spaces in any given sample. No novelty is claimed for the principles involved in the method, which is, however, recommended as very rapid and easy, and when proper care is taken, quite satisfactory as to accuracy. A fair average sample of the coke is carefully taken, and then of this sample two separate portions are prepared, one being reduced to fine powder, and the other being taken in small pieces of about 10 mm. diameter. The powder may be called No. 1 and the small pieces No. 2. Equal weights, say, 25 to 50 grammes of each portion, are then weighed off, and that from No. 2 is placed in a beaker and covered over with alcohol, benzole, or other suitable fluid, the object of which is to completely moisten and permeate the coke as speedily as possible. Alcohol, though not as rapid in its action as benzole or one or two other fluids, is finally recommended as quite efficient, and cheaper and pleasanter to work with. The beaker is placed on a water bath, and the alcohol made to boil for a few minutes, after which the beaker is placed aside to cool down to 15 deg. Cent. By this treatment the coke is completely moistened, and all its pore-spaces are filled up by the alcohol. The apparatus which is used for measuring volumes consists of a small flask of a capacity of about 100 cub. cm., rather tall and narrow, and not too thin in the glass, the neck of which is continued in a glass tube of 12 to 13 mm. bore, long enough to contain 100 cub. cm., and graduated from the bottom upwards in centimetres and tenths of centimetres. This apparatus is filled with alcohol (or other fluid used) up to a point a little above the zero on the scale of the tube, a cork is inserted to prevent evaporation, and the flask and tube then immersed in water in a glass cylinder, the water being kept as nearly at a temperature of 15 deg. Cent. as possible. In a few minutes the height of the fluid in the tube is read off on the scale as accurately as possible. If a piece of black paper is held behind the tube, and all readings are made on the lowest point of the meniscus, $\frac{1}{10}$ cm can be accurately measured. The weighed sample of powdered coke, No. 1, is now carefully introduced into the fluid in the tube by means of a funnel; the funnel is cleared of all adherent particles, and after the cork is again inserted the apparatus is gently shaken till all coke powder settles in the fluid. After again cooling the apparatus to 15 deg. C., the height of the column in the tube is read off as before. The difference between the two readings of course gives the volume of the powdered coke-substance, free from pores, and by dividing the weight of coke used, in grammes, by the number of cubic centimetres displaced, we get the specific gravity. Thus if we took 25 grammes coke and we found that it displaced 13.9 cub. cm. of the fluid, we should have $\frac{25.0}{13.9} = 1.80$ specific gravity of coke substance. The sample of coke in small pieces, No. 2, is now removed from the beaker in which it has been covered with fluid, on to a funnel, allowed to drain for a few seconds till all excess of fluid is removed, and is then carefully transferred to the apparatus. If too large a quantity of coke powder was used in the first determination, then the flask and tube must be cleaned out and newly filled with fluid as at first; but if not too much was used, there will be room for the second measurement without so re-filling. In either case the displacement caused by sample No. 2 is carefully read off, with the same precautions as before, and as the pore-spaces of the coke were fully filled up by the fluid in the beaker, we now get the volume of coke plus pore-spaces, and from this again the specific gravity of the actual coke in question. Thus, taking 25 grammes as before, and finding a displacement of 28.75 cub. cm. we have 0.87 as specific gravity of coke plus pore-space. We thus arrive at the proportion of volumes, in the coke under examination, of coke-substance proper and of pore-space:

25 grammes coke + pores	= 28.75	cubic cm.
25 " coke-powder	= 13.9	"
25 " contain pores	= 14.85	"

Or taken on 100 grammes of coke, the coke-substance would occupy 55.60 cub. cm., the pore-space would occupy 59.40 cub. cm., giving a total volume of 115 cub. cm.; and one cube metre of the coke would weigh 869.6 kilogrammes. For the above tests there are required only two weighings (exact to 0.01 grammes) and three readings of the tube, which can all be done in half an hour.

The Moffet Jumbo Roaster.

We propose shortly to discuss some of the difficulties attendant on the working of mixed lead, zinc, silver ores. According to some American newspapers, all such difficulties have been quite wiped out by the process adopted by a Mr. Moffet, whose new plant is known as the "Moffet smelter," or also, facetiously, as the "Jumbo roaster." The *Mining and Scientific Press*, of San Francisco, reproduces and comments upon some of the statements which have appeared, and which are certainly rather amusing. Thus, the *Tribune Republican* of Denver, predicting the overthrow of other works in competition with the "Moffet-Jumbo roaster" establishment, says that "the Jumbo roaster works beat upon the ores that are worst for other smelters," and "no such thing as refractory ores are known or recognised by the Gunnison-Jumbo Works," after which little statement it is not surprising to find that the paper in question considers that "the only hope for the valley establishments lies in the chance that Mr. Moffet will not press the limit of his wonderful invention by erecting a plant large enough to treat all the ores of the State and adjoining territories." The *Gothic Record* writes in the same enthusiastic strain, and tells us that "since smelting became a great industry, it has been considered an impossibility to successfully treat heavy black-jack zinc ore in any known furnace, without using an immense quantity of free lead ores as fluxes," but that after years of study Mr. Moffet "has at last demonstrated that the heavy zinc minerals can be easily and cheaply reduced, and every iota of silver saved." The wonderful process in question has been working upon ores containing only 8 per cent. of lead, and over 30 per cent. of zinc, which will be admitted to be a sufficiently severe material to deal with. Then follows the only description of the process which we have so far come across, and we consider this worthy to be reproduced. "Instead of the old, slow labour and costly method of roasting, the Jumbo does its work cheaply and rapidly. It is apparently only a cast-iron open fireplace, surrounded by a water jacket. The ore and a little coal are thrown in and fired. A number of heavy air blasts are turned on, which soon fire the sulphur in the ore, creating an intense heat that soon melts the mineral into a wax. The melted mass is forked into a tank of water, where it granulates into a soft mass of oxided ore. As the melted truck is moved from the fireplace, more ore and coal are added, and as the great heat, generated by the coal and sulphur, very soon does the work, the cost of roasting is only a small amount. Over the fireplace there is an immense suction air pipe, that grabs every particle of the fumes and gases, fully 50 per cent. of the lead, and all of the zinc and sulphur being converted into gas and mineral fumes. These are forced through a long tunnel that connects with a houseful of long sacks, into which all the mineral smoke collects in the form of a fine white dust, the sulphur gas passing off through the fibre of the sacks. The zinc that remains with the lead and silver in the fine dust has its refractory nature so changed that it, with the lead, makes an excellent flux. It is mixed with the roasted ore, a little lime and iron added, and the result is a clean lead bullion, containing every particle of gold and silver ever in the ore." This is something like a metallurgical process! The "houseful of long sacks" must be a very striking arrangement, and anybody who has had experience of smelting "mixed" ores will be disposed to admire the wonderful action of a process that can make of oxidised zinc products "an excellent flux" Judging from these descriptions it is to be feared that the "Jumbo roaster" will disappoint its enthusiastic admirers when accounts come to be made up, and that it will soon, to quote the *Engineering and Mining Journal* of New York, "adorn the classic scrap-piles."

German Locomotive Building.—We learn that an Esslingen house has secured a contract at Elberfeld for eleven goods engines. The contract price is stated to be 1675*l.* per engine.

Brick Machinery in Queensland.—The *Brisbane Courier*, of September 27, contains an account of the proceedings at the formal opening of the works of the Queensland Brick and Tilemaking Company, Limited, near Brisbane. The brickmaking industry had, says our contemporary, been previously carried on in the colony under conditions which seriously impeded its progress. Now, however, they are to be manufactured in a style hitherto unknown in the colony, and on the most approved scientific principles. The machinery selected was the plastic brick machine of Messrs. Bennett and Sayer, of Derby, which has been fitted up in a shed measuring 56 ft. by 80 ft. The machine was invoiced to turn out 15,000 bricks per day of eight hours; but, on being tested, it was found capable of manufacturing 16,000. The *Courier* adds that great care was exercised in the selection of the machinery. Ten tons of the clay were sent to England and distributed amongst the principal makers of brick-manufacturing machinery, and Mr. De Winton and Mr. H. C. Stanley, after visiting the establishments of the various firms, at length decided in favour of the machinery of Messrs. Bennett and Sayer. Mr. S. Betteridge, an experienced Staffordshire man, had been sent over as working foreman. Most of the speakers at the opening referred to the extremely satisfactory manner in which the machinery is doing its work.

SECONDARY BATTERIES.

To the Editor of Engineering

Sir,—In the report upon the electric light at the "Healtheries," which appeared in your last issue, you refer to the exhibit of Messrs. Parker and Elwell in the following terms

"The secondary battery is distinguished from the Fauré and the Sellon batteries, by being made of metallic lead only. The plates are soaked in dilute nitric acid until they acquire a spongy texture, and are then rapidly 'formed' under the influence of a current. By this method of manufacture, which was patented in this country independently by Messrs Parker and Elwell, and by M. Planté, the difficulty arising from the peeling of the oxide is avoided."

As accumulators of electrical energy are destined to play so important a part in the future, an accurate knowledge of their early history is a desirable matter of importance, and I therefore venture to ask you to place on record, for the information of those of your readers who may be interested, the subjoined extracts, one from my patent specification of September 10, 1881, the other from that of Messrs. Parker and Elwell of August 4, 1882. I would also mention that I called attention to the same matter in connection with M. Gaston Planté's patent of July 11, 1882, in a letter to the *Electrical Review* of September 16 of that year, immediately after the paper by M. Gaston Planté (which appeared in the *Comptes Rendus* of the French Academy of Science in August, 1882) was seen by me

It is not my intention here to enter into questions of patent law, nor into the merits of the various types of secondary batteries (upon which I may, if permitted, have something to say on another occasion). I would merely now remark, in respect to the chemical *process or means described and claimed* by M Gaston Planté and Messrs Parker and Elwell in their respective patents, that such action by the acids on lead has been a matter of common knowledge since the early days of chemical science, and that their employment is the readiest means which any ordinary laboratory lad would adopt if told to bring a piece of lead to the condition specified by me.

Sellon's, September 10, 1881.	*Parker and Elwell's, August* 4, 1882.
"The plates of lead may also be *roughened* on one or both sides by means of . . . *any chemical process* . . . in such a manner that to a suitable depth on each side of the plate a *spongy layer or projecting points or surfaces* are produced, which are either *suitable for retaining* the material hereafter to be made active or for *obtaining a more rapid formation of the plates* if used without such packing."	"The lead electrodes . . . are prepared in order to *facilitate their development* under the action of the electric current, by placing them in a dilute solution of sulphuric and nitric acids. The nitric acid oxidises and dissolves some of the lead and causes a *roughening, corroding, or honeycombing of the surface, whereby the plate is made capable of having formed upon it, and retaining when so formed*, a larger proportion of peroxide of lead during the action of the battery than if the plate were employed with its surface in the originally *smooth condition*"

I am, Sir, your obedient servant,

John S. Sellon

The Hall, Sydenham, November 21, 1884

AWARDS FOR VENTILATORS AT THE HEALTH EXHIBITION

To the Editor of Engineering.

Sir,—In reply to Mr Clark's letter re the above, which appears in your current issue, we have only to repeat that we were not invited to send our air pump ventilator, which is the only exhaust ventilator we either manufacture or sell, for the purpose of being tested, nor were we notified that tests were being made with exhaust ventilators, we, as already stated, not being even aware that such tests were instituted until after they were completed and the awards made. Under these circumstances it seems rather superfluous for Mr Clark to say that we were not excluded from the testing, seeing that we—why we cannot understand, though we mean to find out—were left in entire ignorance of the existence of such tests. Mr. Clark states that we were invited in proper form to send our ventilator to be tested, and also that he holds a letter from us declining to comply with his request. As this is really a matter of not only private but public interest, we now call upon Mr. Clark to publish the letter referred to, so that your readers may be enabled to judge between us, and that we may have the opportunity of showing how we have been treated.

With respect to our error in the length of the testing tube, stating that it was 8 ft., whereas Mr. Clark informs us it was 10 ft long, this additional length instead of improving the position shows all the more conclusively that the mode of testing was a farce, and we are prepared to argue this point with Mr. Clark either as a question of science or practice, or as both, and to prove the correctness of our assertions, which we make as practical men of extended experience From the accounts we have since read of the experiments and the manner in which they were conducted, we much fear that they will have the effect of bringing sanitary science into discredit with the public, and do it almost as great an injury as the notorious "Kew experiments," which is greatly to be regretted, as it retards and hampers the efforts which earnest and practical men are now making to popularise the cause amongst the people. We derive the information from a credible source that the shafts of the ventilators tested were inside the tube, but as Mr Clark affirms, and we have no knowledge of ourselves to the contrary that such was not the case, we will concede the point, which does not affect materially the method of testing the ventilators.

Mr. Clark stigmatises our letter as "inconsiderate." If stating that we will not allow this matter to drop until we have *sifted* it to the *bottom* and discovered the individual or individuals really to blame, is "inconsiderate," then we admit the impeachment; or if our remark that the experiments in question are a reflection on the intelligence of the nineteenth century may be called "inconsiderate," then we again admit the impeachment.

We presume we may look upon Mr Clark's letter as a final reply, so far as the jury are concerned, to our letter of protest addressed to Sir Philip Cunliffe-Owen in his capacity as official representative of the jury, the receipt of which that gentleman duly acknowledged; we herewith enclose a copy of four letters to Sir P. Cunliffe-Owen for your perusal.

We are, yours truly,

Robert Boyle and Son.

Queen Anne's-buildings, 64, Holborn Viaduct, London, E.C., November 4, 1884.

THE BOARD OF TRADE AND ELECTRIC LIGHTING.

To the Editor of Engineering.

Sir,—Mr. Chamberlain's reply to the deputation of the 20th inst., encourages discussion upon the terms of the option of purchase under sec. 27 of the Electric Lighting Act, 1882. That there is to be an option seems a foregone conclusion. To take the discussion out of the region of pure speculation, I shall take a somewhat parallel case in actual experience.

Thirty years ago, the financial practicability of railway enterprise in India was purely hypothetical. Experimentally and tentatively some progress had been made. So early as 1849, the East India Railway Company, had been incorporated by Act of the Imperial Parliament, and an experimental line was soon afterwards made by aid of a subvention from Government, then that of the East India Company. The public, however, were not easily to be convinced that railway works could be successfully maintained under the climatic and physical conditions of the country, and what is still more to the point, the problem still awaited solution, how far the natives could make use of the accommodation to be provided. The Indian Government were desirous of attracting private capital to the enterprise, but for this it was necessary not only to confer a monopoly of powers, but to give a substantial pecuniary guarantee. In consenting to this sacrifice the Government were far-seeing enough to reserve to themselves an option of purchase, but the terms were carefully considered so as to be fair and not repellent to inventors.

The final contract of the Indian Government with the East Indian Railway Company was made in 1854. The Government guaranteed a minimum dividend of 5*l.* per cent.; surplus profits over that amount in any year were to be shared, one-half to go towards recouping the Government for their outlay on the guarantee, and the other half to increase the dividend. And there was to be an option of purchase by the Government, to be exercised by notice to be given within six months after the expiration of

MINERAL WATER MACHINERY; HEALTH EXHIBITION.

CONSTRUCTED BY MESSRS. BARNETT AND FOSTER, ENGINEERS, LONDON.

(*For Description, see Page* 494).

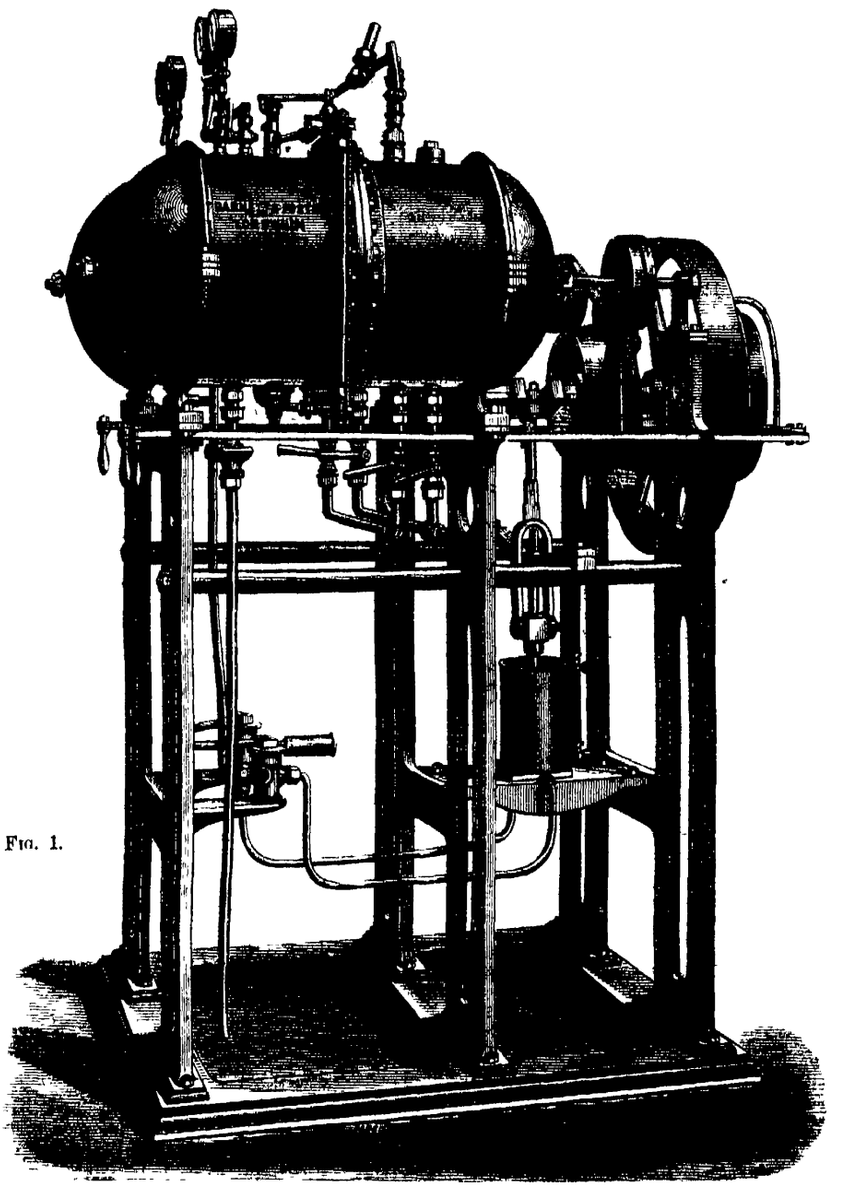


Fig. 1.

MINERAL WATER MACHINERY AT THE HEALTH EXHIBITION.

CONSTRUCTED BY MESSRS. BARNETT AND FOSTER, ENGINEERS, LONDON.

(*For Description, see Page* 494.)

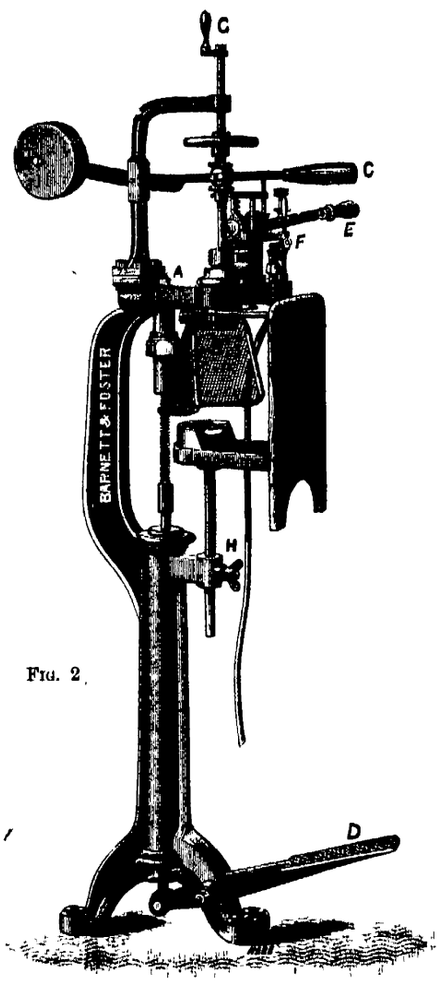


FIG. 2.

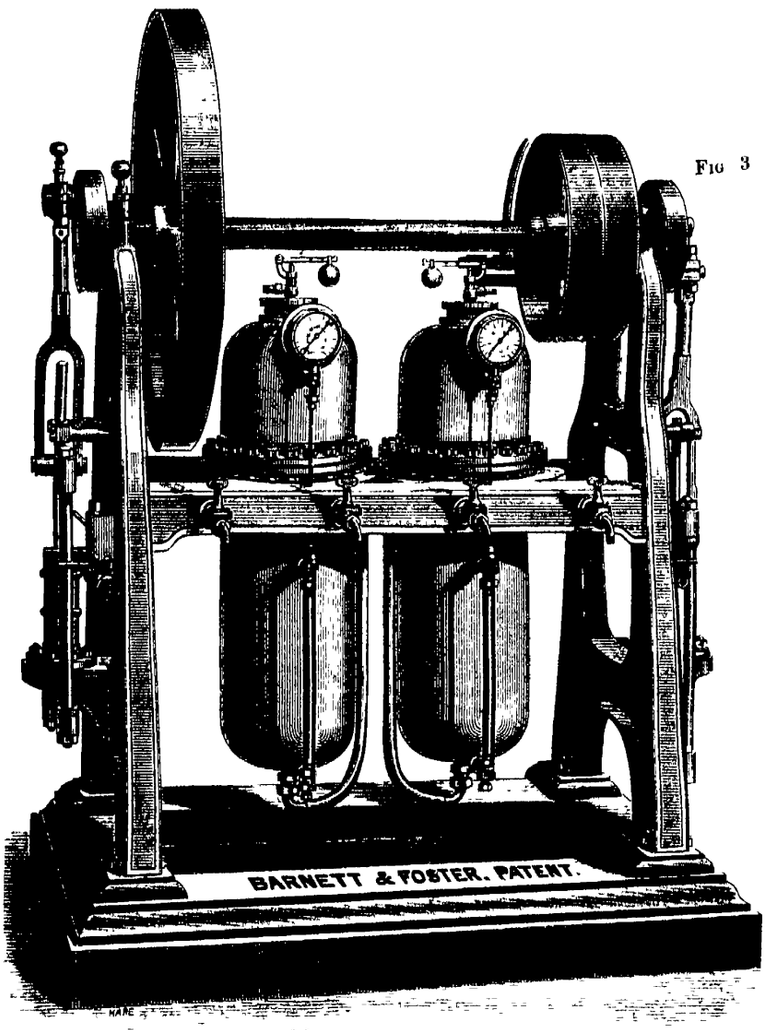


FIG 3

twenty-five years, or within six months after the expiration of fifty years, the purchase money to be "a sum equal to the full amount of the value of all the shares and capital stock in the company calculated *according to the mean market value in London of such shares or stock during the three years immediately preceding* the expiration of the said period of twenty-five years, or the said period of fifty years, as the case might be."

The terms of the contract, as settled in 1854, were the basis of the great undertaking of the East Indian Railway, and it may be said of the railway system in India. For identical terms were embodied in the Government contracts with all the railway companies in the earlier undertakings in India.

To return to the East Indian Railway Company. The capital was subscribed on the strength of the contract of 1854; and the undertaking carried out. After some years the profits were found frequently to exceed the guaranteed amount, so that, after dividing the surplus with the Government according to the arrangement, a dividend of ½, 1, or even 2 per cent. over the guaranteed 5 per cent. was paid to the shareholder. The stock improved steadily, and, as the time came near for exercising the option, stood at about 25 per cent. premium. At this time a momentary panic was caused by a letter to the *Times* calling attention to the existence of the option. But when those concerned had time to look into the matter, the terms of the clause were found to have been adjusted with such fairness and forethought, that prices quickly resumed the usual quotations. Indeed, when the Government (the Secretary of State under the powers of the Act of 1858) decided to exercise the option, the only effect on the market was a slight rise of the stock owing to certain fresh advantages conceded by the Government to holders in order to secure the success of the large financial operation required for meeting the purchase money. The new arrangement (which is confirmed by an Act of the Imperial Parliament, 43 and 44 Vict., cap. cevi.) took effect from January 1, 1880; and the Government acquired at the price of 25 per cent. premium—perhaps at an expenditure including the amount expended under the guarantee of 50 per cent. in all over the original cost—an undertaking of proved

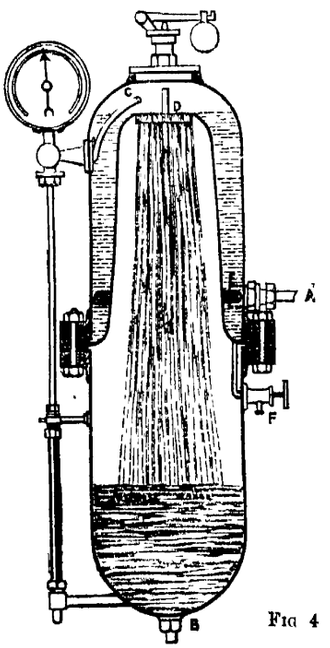


FIG 4

and increasing value, with the accumulated fruits of experience and successful management, in every respect a remunerative purchase. Indeed, so important was the success attributed to the private management, that under the new arrangement, the company retains a certain interest in the success of the undertaking, which continues to be carried on by the directors of the company on behalf of the Government.

A similar option has been lately exercised in the case of the Eastern Bengal Railway, by notice given in 1883, and under an arrangement confirmed by an Act of the Imperial Parliament in 1884. In some other cases the Government have not found it expedient to exercise the option, and perhaps there are cases, but these are exceptional, in which it is never likely to be exercised. Even where the railway has been, financially, a comparative failure, the public advantage has doubtless been a fair compensation for the loss on the Government guarantee. Such a case, however, only illustrates the fairness of the terms of the option under which the Government has acquired the undertakings which have proved successful.

In the case of electric lighting there is no question of guarantee. All that is asked is that undertakers for lighting on a large scale shall have the necessary powers, and consequently what may be called a quasi monopoly. In the case of the Indian railways, the option was part of the consideration for the pecuniary guarantee. The analogy does not indeed justify *any* condition of an option in the case of electric lighting. But assuming that the principle of Clause 27 is unalterable, and the option of purchase a *sine quâ non*, the history of Indian railways extending over the whole period up to and for some years beyond the actual exercise of the option, is a precedent showing the terms on which such an option can be made consistent not only with the encouragement of private enterprise, but also (what is a point of some importance) with steadiness in the market value of the property affected.

That the Indian Government, in new railway undertakings, can and does impose harder terms, is only an illustration of the difference between a new and untried enterprise, and an undertaking on which the profits can be estimated by matured experience. This difference at once disposes of the supposed analogy between electric lighting

and gas and water supply. There is the further difference in the case of water companies, that their concessions involve not only a monopoly strictly so called, but the extensive appropriation of natural resources. False and misapplied analogies, indeed, pervade the whole existing legislation upon electric lighting.

I am, Sir, yours faithfully,
R. CAMPBELL.

13, Old square, Lincoln's Inn, November 24, 1884

PRESSURE OR VACUUM BRAKES?

TO THE EDITOR OF ENGINEERING.

SIR,—I have been watching with much interest the controversy *re* Westinghouse and vacuum automatic brakes, and as one who has had some experience with both systems, I shall be obliged if you will spare me room for a few remarks.

Neither the Westinghouse nor the vacuum automatic brake can be deemed to have reached the limit of attainable perfection, in either principles of action or suitability of material, and I wish to point out that the practical effect of the compulsory adoption of a type which so many correspondents have advocated, would be to stereotype the existing form, defects and all.

Supposing the question of brakes at its present stage were to be brought under Parliamentary legislation, and railway companies were forced to adopt one particular kind, it would be necessary to specify, not only the general form, but also every detail connected with it, to prevent complications affecting interchangeability.

Locomotive superintendents would not care to take upon themselves the responsibility of urging any deviation from the standard type, since it would necessarily involve an application, through their directors, to the Board of Trade for sanction to introduce the improvement, and the directors, happy in this responsibility having been taken off their shoulders, would, most certainly, refuse to court the responsibility of introducing any improvement, however advantageous.

Railway companies in being sued for damages on account of any accident occurring through the failure of the brake, which had been imposed upon them against their desire, would certainly refuse to accept any responsibility for the consequences of the failure of its action Let the public hesitate before clamouring for legislative interference; I would ask it whether, if for any reason control had been invested in the Board of Trade over the manufacture of bicycles and tricycles, those machines would have attained their present perfection of material and construction, under a system of hard and fast rules and regulations? This instance of the value and effect of competitive effort is apparent to every one, as is the want of it in our ships and guns.

The public may rest assured that as long as there remains a reasonable chance of brake patents being tried, adopted, and paid for, so long improvements will continue to be made. But on the other hand, with a standard type in use, an inventor will be practically debarred from experimenting, and when in addition to his other difficulties, after the birth of his invention, he has to stand up, encounter, and overcome the ogre of red tape, it will happen that inventions relating to brake improvements will simply not be born.

Considerations of this kind have, no doubt, prevented the Board of Trade from asking for powers to impose any brake upon the railway companies. Their course has been a wise one, and I am at a loss which to admire most, the clear grasp of the requirements which they evinced in framing their conditions, or the astuteness they have shown in their subsequent policy of non interference. Scientifically and theoretically it will be admitted that pressure and a vacuum are susceptible of the same degree and efficiency of control. But as the case stands at present we have not discovered the best methods This is a question of time, not of possibilities

I am, Sir, your obedient servant,
E. R. CALTHROP,
Assistant Locomotive Superintendent, Great Indian Peninsula Railway Company.

India, November 6, 1884.

INSPECTION OF BOILERS.

TO THE EDITOR OF ENGINEERING.

SIR,—I think sufficient time has elapsed since inspection of boilers was taken up by the Board of Trade, by the insuring companies, and by the Steam Users' Association of Manchester, to inquire into the practical results, that is to say, have the systems of examination prevented explosions? This I take to have been the practical object in view; broadly speaking, there can be no doubt that many serious accidents have been averted by all. The Board of Trade's examinations of marine boilers have not entirely prevented explosions, many occurring to boilers under their care. The same may be said of nearly all the insuring companies (here I speak of companies having the experience of ten years or more). The Manchester Steam Users' Association, on the contrary, has never experienced one explosion, or accident to person, in connection with a guaranteed boiler. That the *system* of inspection has contributed much towards attaining this satisfactory result is apparent, because one of the insuring companies which has had eleven years' experience, and follows the same system of inspection as the Steam Users' Association, has had the same satisfactory result. I mean the Yorkshire Boiler Insurance and Steam Users' Association, Limited, of Bradford. Another reason may have had to do with it, in both cases, *i.e.*, the Steam Users' Association and the Yorkshire Insuring Company, have only a moderate number of boilers under their care (from 2000 to 4000), whilst the less successful companies have had the care of much larger numbers, unless perhaps in the most recent case at Bilston. Whether the system of inspection or the limited number of boilers, has contributed most towards attaining the object may be an open question for discussion, but there is evidence sufficient to prove that the system of inspection adopted by the old insuring companies has been directly responsible for serious blunders.

I should have been pleased to explain the successful system, but am afraid I have already trespassed too much on your valuable space

Yours most respectively,
ROGER SMITH.

14, Westfield-crescent, Bradford, November 22, 1884.

TRIAL TRIPS AND LAUNCHES.

THE London and Glasgow Shipbuilding and Engineering Company, on Wednesday, the 19th inst., launched from their shipyard at Govan an iron screw steamer of about 3000 tons gross register for the "Shire" Line of Messrs. Jenkins and Co, London. She is named the Glamorganshire, and measures 340 ft. by 40 ft. by 26 ft. 6 in. The builders are supplying the engines.

On the following day, Messrs. Barclay, Curle, and Co, Whiteinch, Glasgow, launched the Middlesex, a three-masted iron sailing ship of 1730 tons net register. She measures 255 ft. by 38 ft. 9 in. by 23 ft. 6 in., and has been constructed to the order of Messrs. George Marshall and Sons, London.

On the same day Messrs. Russell and Co, Port Glasgow and Greenock, launched from their Carbsdyke shipyard a beautifully modelled iron sailing ship of 1500 tons register. She was named the Port Chalmers, and measures 250 ft by 38 ft. by 23 ft. She has been built for the "Port" Line of iron sailing ships owned by Messrs. Crawford and Rowatt, Glasgow, and is to take up her berth immediately for Melbourne.

Also on the same day a run was made with the steam launch Man Hla, owned by Messrs. Bullock Brothers and Co, of Rangoon. She is of composite build, having galvanised steel framing and teak planking sheathed with yellow metal below the water-line. The driving mechanism is a single cylinder engine, the cylinder being of 8 in. diameter, with 9 in stroke. It is fitted with Bremme valve gear. The boiler is of steel, with a working pressure of 120 lb per square inch. The propeller is of brass, and of Duncan's hook form. A steady speed of nearly ten miles an hour was maintained The Man Hla is 43 ft long over all by 8 ft. 6 in. beam, and was built and engined by Messrs. Ross and Duncan, Whitefield Works, Glasgow.

On Saturday, November 22, the screw steamer Bisogno, with 3250 tons on board, had another trial trip on the Firth of Clyde; from the Cloch Light to Cumbrae and back she maintained a speed of 10½ knots per hour, which was considered highly satisfactory. She was built by Messrs. Burrell and Son, Dumbarton, and engined by Messrs. Duncan Stewart and Co., Glasgow, her owners being the Societa Italiana di Trasporti Marittimi, Raggio and Co, of Genoa, and she is to sail between Genoa and the River Plate.

NOTES FROM THE SOUTH-WEST.

The Dowlais Works.—A new lathe is being put up near the Lower Works. It cost something like 5000*l*. Where the lathe used to be placed additional steel works are to be erected

South Wales Institute of Engineers.—A meeting of this Institute was held on Thursday at Cardiff. Mr. J. Colquhoun presided. Mr. A. Steer read a paper on "Miners' Safety Lamps as compared with the Morgan Lamp" All the best known lamps were subjected to a series of experiments by Mr. Morgan's apparatus for testing at various velocities, and the opinions expressed by Mr. Steer were fully borne out. With the exception of the "Morgan" no lamp has as yet been found to withstand this apparatus The "Davy," "Clanny," "Mueseler," "Harsant," &c., cause explosions in a space of time rarely exceeding five seconds, while the "Morgan" lamp has been placed in every conceivable position in relation to the apparatus without failing The large flame of the "Morgan" lamp, which is little if anything short of a sperm candle, is to be particularly noticed. A paper by the chairman on "Hot Blast Stoves" gave rise to a comparison of the relative merits of Whitwell and Cowper stoves. Several members expressed an opinion that the day of iron stoves has gone by, and that in a very short time nothing but brick stoves would be in general use. The consideration of a paper "On an Improved Type of Vertical Boiler," by Mr. Marcus Moxham, was postponed until the next meeting, owing to the unavoidable absence of the author. A paper "On Endless Rope Haulage, as adopted at the Clifton Colliery, Nottingham," by Mr. Hart Huxham, F.G.S., gave rise to a considerable discussion Mr. Huxham explained that, under ordinary circumstances, a rope would last from nine to about sixteen months; but the one which had been experimented upon at the Clifton Colliery had been in use since 1879, and still appeared little the worse for wear. He had received a letter from Mr. H. Fisher, one of the most practical colliery engineers in the Midland district, stating that there was every prospect that the rope would last three years longer, making eight years altogether. The discussion was adjourned.

The Severn Tunnel and the Avonmouth Dock.—A meeting has been held at the offices of the Bristol Chamber of Commerce for the purpose of promoting a proposal for the construction of a short line to connect the Severn Tunnel with the Avonmouth Dock. The line, if carried out, would be between five and six miles in length, and would cost about 55,000*l*. A resolution was passed to the effect that it was essential to the interests of Bristol that the line should be made, so that the docks should be brought into connection with the South Wales coalfields. In the discussion which took place it was urged that the line should be made by the Great Western Company. A provisional committee was appointed to promote a Bill in the ensuing session of Parliament for the construction of the line.

The Cwmpennar Collieries.—Mr. Phillips, late of Blaenavon, has been appointed manager of these collieries in the room of Mr. D. Williams, who left not long since to undertake similar duties at Dowlais.

Tramways in the West.—Notice has been given of an intended application to Parliament for a Bill to authorise an extension of the Weston-super-Mare street tramways, and also for a steam tramway and carriage road, thence to Clevedon in a nearly direct line over a bridge to be constructed over the tidal part of the Yeo. The Parliamentary notice includes the continuance of the tramway from Clevedon through Walton and Weston to Portishead, and it provides for connections with railways, sidings to quarries, works, &c.

New Steamer at Cardiff.—The screw steamer Sparkle has been loading a cargo of coal in the Roath Basin, Cardiff, for Aden. She is a fine vessel of 2324 tons net register, and is the latest addition to the fleet of vessels owned by Messrs. H. Briggs, Sons, and Co, of Hull, which have frequently of late years loaded at Cardiff.

Cardiff.—The steam coal trade has been rather easier; at the same time last week's clearances were of a satisfactory nature. Business in the patent fuel trade has also been fairly good. The demand for house coal has been rather easier. Last week's clearances comprised 141,289 tons of coal, 1270 tons of patent fuel, and 390 tons of iron. From Bilbao there arrived 8007 tons of iron ore

Newport.—The steam coal market is considered to have slightly improved. Some shippers have been well employed, and prices have been, if anything, slightly firmer. The manufactured iron trade has remained in much the same state. Last week's iron exports amounted to 970 tons, this total being made up by shipments to Ceara, Rio Grande, and Alexandria. Last week's coal clearances were 39,350 tons. From Bilbao there arrived 9010 tons of iron ore and 1450 tons came to hand from other sources.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the market was unchanged and the feeling was very quiet. No 3 g.m.b. f.o.b Tees was again offered at 36s 3d. per ton prompt delivery, and for delivery over a few months 36s. 6d. was asked. The volume of fresh business is not large. It is satisfactory to notice that shipments continue on a fair scale, being 61,900 tons this month against 66,000 tons last month, and 84,500 tons at the corresponding time last year. The manufactured iron trade remains dull, although a few orders for steamers have been recently placed in the North of England. This will tend to send more work to the rolling mills where short time has been the order of the day. Ship plates are quoted 5*l*. and angles 4*l*. 12s. 6d. less 2½ per cent. at works. Hematite pig iron is a shade firmer at 45s. for Nos. 1, 2, and 3 f.o.b. west coast ports.

Wages in the Iron Trade.—The court of arbitration for fixing the wages in the North of England manufactured iron trade has been held in Newcastle. A good deal was said about the depression of trade and the necessity for a reduction of 5 per cent in wages. On the other hand, the operatives argued that their wages were lower than they had ever been before, and if they were further reduced many men in the north would be unable to live and maintain their families. As the masters claim a reduction of 5 per cent., and the men ask for a like amount advance, it is the general opinion that the arbitrator will leave wages as they are, in the hope that trade cannot be worse than it is at present, and may soon be a little better.

The Steel Trade.—Most of the steel works are fairly well occupied just now. There is, however, a great deal of difference on the score of profit made at the respective establishments, some firms having many advantages over others. What everybody in the Cleveland district desires to see, is the introduction of the smaller branches of the steel trade. There is still very considerable distress amongst the industrial classes in the northern towns owing to the general depression in trade. Relief committees exist in most of the towns.

The Coal and Coke Trades.—There is a steady demand for all kinds of fuel, and prices are unaltered.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Communication between Goole and York.—It is stated that the imperfect railway communication between Goole and York is, at the instance of Mr. Creyke, M.P., who has been in communication with Mr. Dent Dent, the chairman of the North-Eastern Railway Company, again engaging the attention of the general manager of the company. Though it is felt that the prospects of railway traffic just now are not very bright or encouraging for the construction of such a branch railway, or even of a junction, as would facilitate communication between York and Goole, it is admitted by the company that

Goole is a growing port, which should have greater facilities than it now enjoys.

The Electric Light at Cleethorpes.—We believe that the directors of the Manchester, Sheffield, and Lincolnshire Railway Company have under consideration the project of taking over the electric light at Cleethorpes for the purpose of lighting their new promenade.

The Parkgate Iron Company.—The directors of this company have declared an interim dividend of 1*l.* 10*s.* per share, free of income tax, for the six months ended September 30, being 10*s.* less than in the corresponding period of last year. They regret that only a part of the plant has been employed during the past six months, and a moderate amount of work executed at extremely low prices.

John Brown and Co., Limited.—The directors of John Brown and Co., Limited, Atlas Steel and Iron Works, Sheffield, at a meeting held on Friday, decided to pay, on December 23 next, an interim dividend of 2*l.* per share (less income tax) on the ordinary shares of the company. The shares are 100*l.* each, on which 75*l.* is paid up.

Alfreton Water Works.—During the past week some further testing of the land adjoining the Lindway reservoir of the Alfreton Water Works has been made with a view to the enlargement of the storage area. By consent of the owners of land on both sides of the work, testing has been done outside the land in the possession of the sanitary authority. The result of the trial was to confirm the opinion of the probability of the proposed enlargement being comparatively inexpensive.

New Local Railways.—It is proposed by the Manchester, Sheffield, and Lincolnshire Railway Company to construct a new railway in the West Riding. The line will commence in the parish of Treeton, near Kineton Park Station, and terminate in the parish of Chesterfield "in a field belonging, or reputed to belong to the Duke of Devonshire, and in the occupation of Enoch Goodwin." The terminus will be about the centre of the fence which divides that field from Brewery-street. The parishes and townships which the line will traverse are Treeton, Ulley, Brampton-en-le Morthen, Aston-with-Aughton, Todwell, Thorpe-Salvin, Wales, Harthill-with-Woodall, otherwise Harthill, Killamarsh, Beighton, Eckington, Renishaw, Stareley, Brimington, Whittington, Tapton, Newbold, Dunston, and Chesterfield.

Failure of the Rotherham Water Supply.—The Rotherham corporation have restricted the supply of water to the town to one hour per day. They now purpose to obtain water at Dalton, which will give an additional daily supply of 350,000 gallons. Towards this movement a deputation has proceeded to London to consult Mr Mansergh, the engineer to the waterworks. It is feared unless more expedition is decided upon, the trade of the town and the health of the inhabitants will be seriously affected, as at the present time there is a good deal of fever and measles in some parts of the borough.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The warrant market was very strong last Thursday forenoon, and prices at one time touched 44*s.* cash, but in the afternoon the early gain was lost, and prices closed as on the previous day. Transactions were reported in the morning at from 43*s.* 7*d.* up to 44*s.* cash, also at 43*s.* 6½*d.* up to 44*s.* 1*d.* one month fixed, the market closing with sellers at 44*s.* cash and 44*s.* 2*d.* one month, and buyers near. In the afternoon business was done at 43*s.* 10*d.* down to 43*s.* 9*d.* cash, and the close was sellers at 43*s.* 7*d.* cash, with buyers at 43*s.* 6*d.* Saturday's market was dull in the morning, and cash prices declined to 43*s.* 4*d.*, subsequently, however, there was a recovery, and prices at the close were ½*d.* per ton over those ruling at the close on the previous day. On the whole there was an advance of 1½*d.* per ton, and the fluctuations over the week extended to 1*s.* 1½*d.* per ton. There were transactions during the forenoon at 43*s.* 5*d.*, 43*s.* 4*d.*, and up to 43*s.* 6½*d.* cash, and at the close sellers were asking the top price, and buyers offered ½*d.* per ton under. Business was reported in the afternoon at 43*s.* 7*d.*, 43*s.* 6½*d.*, and up to 43*s.* 7½*d.* cash, the close being buyers at the last-named price, and sellers near. The warrant market was dull on Monday, chiefly in consequence of discouraging reports just received from New York regarding the condition of the iron trade in America, and prices declined 4*d.* per ton. Business was transacted during the forenoon at 43*s.* 6*d.* cash, sellers remaining at that price, and buyers at 1*d.* per ton less. Transactions were reported in the afternoon at 43*s.* 6*d.* up to 43*s.* 7½*d.*, and down to 43*s.* 3½*d.* cash, with sellers at the close at 43*s.* 3½*d.* cash, and 43*s.* 5*d.* one month, and buyers near. Yesterday's warrant market was a little uncertain, but the closing prices were the same as those of the previous day. The forenoon rates ranged from 43*s.* 2*d.* to 43*s.* 4*d.*, and back to 43*s.* 2½*d.* cash, the close being sellers at 43*s.* 3*d.*, and buyers offering ½*d.* per ton lower; and in the afternoon the prices were 43*s.* 3*d.*, 43*s.* 2½*d.*, and 43*s.* 3*d.* cash, and 43*s.* 4½*d.* and 43*s.* 5*d.* one month, and at the close there were buyers at 43*s.* 3*d.* cash, and 43*s.* 5*d.* one month, with sellers at ½*d.* per ton higher. Business was done this forenoon at 43*s.* 3*d.* to 43*s.* 5*d.*, and back to 43*s.* 4*d.* cash, with sellers at the close asking 43*s.* 4*d.* cash, and 43*s.* 6*d.* one month, and buyers at ½*d.* per ton less. There was an easier market in the afternoon, and transactions took place at 43*s.* 3½*d.* down to 43*s.* 2½*d.* cash. The market is in a restless and unsettled condition, while an air of suspicion seems to pervade the trade, owing to the uncertainty amongst the operators as to the course that the trade is likely to take in the immediate future, that being in great measure attributable to the oversold state of the accounts. Sharp fluctuations in prices have been the rule in the market over most of the past week. On account of the want of confidence that prevails a very little buying creates a smart rise in prices, and a very little selling is attended with a considerable fall; and the state of the trade is such that dealers incline more to sell than to buy. The public continue to hold aloof, and consequently business is confined to members of the trade, who, as a rule, only buy to cover oversales. The outlook as regards the legitimate demand does not improve, and very few fresh orders are being received from America or the Continent, or other places abroad, or from consumers at home. Shipping iron remains somewhat steady, and prices are almost unchanged, though in the case of some brands slight concessions are being made. The number of blast furnaces in actual operation remains at 95, as at last report, the number blowing a year ago being 101. There is some talk as to the likelihood of some more being blown out, but nothing of definite character is known on the subject by the outside public. Last week's shipments of pig iron from all Scottish ports amounted to 6935 tons, as against 6078 tons in the preceding week, and 9617 tons in the corresponding week of last year. They include 894 tons to the United States, 100 tons to Canada, 100 tons to South America, 170 tons to France, 1400 tons to Italy, 914 tons to Germany, 100 tons to Russia, 480 tons to Holland, 280 tons to Belgium, and lesser quantities to other countries. The stock of pig iron in the public warrant stores stood at 579,863 tons yesterday afternoon, as compared with 579,925 tons yesterday week, showing a decrease for the week of 62 tons.

First Voyage of the "Umbria."—The new Cunard liner Umbria, recently built and equipped by Messrs John Elder and Co., has to-day completed her first round voyage to and from New York. She left that port at 9 a.m. this day week, and passed Brow Head at 5 50 this morning, thus making her homeward passage, from land to land, in 6 days 10 hours 20 minutes. It is evident that she is destined to become of even greater swiftness than the Alaska and the Oregon. Mr A. D. Pryce Douglas, the engineer manager to Messrs John Elder and Co., went out to New York with the Umbria.

The Edinburgh Suburban Railway.—Though the cross over bridge at the Waverley Station and some other engineering work is not yet finished, it was definitely arranged yesterday that the Edinburgh Suburban Railway should be open for passenger traffic on the date originally fixed, the 1st of December. Goods trains have been travelling over the line since the 1st of November to the great relief of the traffic at the Waverley Station. The passenger time table, which has been arranged, provides for a tram running every hour of the day each way, so that practically a half hourly service from morning till night will be given. The trains will call at all the stations on the line, seven in number, and these trains from Edinburgh by the "outer circle" will have fair connections throughout the day with trains to and from Glasgow. Forty minutes are allowed for the round, and with a margin of twenty minutes in the hour to spare, it is anticipated that there should be no delay in the starting of these circular trains. The two trains will be made up of first and third class carriages and will be fitted with the latest improvements. This service bids fair to become highly popular amongst the residents of the southern suburbs.

Trade at Kirkcaldy.—The engineering trade at Kirkcaldy is still dull. At two of the foundries, however, a considerable number of hands are at work, while at another an order has just been received for the construction of a lot of sugar mill machinery. There is a prospect of the Whytebank Engine Works being re-opened soon, and likewise the shipbuilding yard at Kinghorn—negotiations with that object in view being, it is reported, now almost completed. The premises just mentioned belonged to the firm of Messrs. John Key and Sons, whose bankruptcy took place some time ago.

Expected Admiralty Order for the Clyde.—It is stated that at the least two designs for warships have been forwarded from Clyde shipbuilding firms to the Lords of the Admiralty for inspection, in the hope that the Government may see fit to place some orders for such vessels in this great centre of the shipbuilding industry. One of the designs is said to be for a sort of combination of the type of the Nelson and Northampton (built, respectively, by Messrs Elder and Co. and Messrs. R. Napier and Sons), and that of the Esmeralda (recently built by Sir William Armstrong, Mitchell, and Co.), about 450 ft. long, with enormous engines to work up to something like 15,000 horse-power. The other is understood to be of the Leander and Phaeton type (lately constructed for the Admiralty by Messrs Napier and Sons), having steaming power sufficient to give a speed of 20 knots per hour, and to carry a large number of light guns.

Wick Harbour.—The Wick Harbour Board have all but completed arrangements with the Public Works Loan Commissioners for a loan of 50,000*l.*, to aid in carrying out a scheme of harbour improvement and extension. The latest phase in the negotiations was the presentation of a draft bond to be signed by the members of the Board, in which they were asked to give personal security for the sum of 100,000*l.*, that the money so obtained would be applied to the construction of the works shown on plans which had been approved of by the Board of Trade. Being a movable body, the members demurred to become personally responsible for the application of so large a sum of money, in the expenditure of which they might have no voice. This view of the matter was placed before the Loan Commissioners, who agreed to restrict the bond to 14,000*l.*, as security for the first instalment of the loan, which is to be 7000*l.* At a special meeting on Saturday, the members of the Harbour Board present with one exception, consented to sign the bond on the conditions submitted by the solicitor of the Loan Commissioners. It was at the same time decided to accept the offer of Messrs Fleming and Ferguson, Paisley, to construct a dredger at a cost of 7900*l.*

FOREIGN AND COLONIAL NOTES.

New Zealand Railways.—There has been a good deal of discussion of late with reference to the route of the New Zealand North Island Railway, which is to connect Auckland with Wellington. Two routes have been proposed. Both routes run together for about fifty miles, from Te Awamutu, the present terminus of the line from Auckland. One, which is known as the central route, passes by the western side of Lake Taupo, and joins the line to Wellington at Marton. The other takes a westerly direction, and joins the Taranaki line at Stratford, at the back of Mount Egmont. On both routes the land is said to be of excellent quality. There is no doubt that the construction of this trunk railway through the North Island is one great work which lies before the colony at present.

Bridge Building on the Baltimore and Ohio Railroad.—A bridge now building over the Brandywine on the outskirts of Wilmington, for the Philadelphia branch of the Baltimore and Ohio Railroad, will be a structure of great strength. There are five massive piers, three of which will be 82 ft. high. The other two will have a height of 40 ft. At the base they are each 37 ft. 7½ in. long, and have a uniform width of 14 ft. 7½ in. At the top they are 32 ft. long, including the coping, and 8 ft. wide. In each pier there are four through stones 10 ft. long. The other blocks are also huge. The ironwork will be 26 ft. above the stone coping. The longest span will be 164 ft. The entire length of the bridge will be 874 ft.

Elevators for the Canadian Pacific Railway.—The Montreal Terminal Company, which will build some elevators for the Canadian Pacific Railway, will have a capital of 500,000 dols., on which the Canadian Pacific Company guarantees an interest of 7 per cent. per annum. The Canadian Pacific Company will also buy the elevators after ten years at 5 per cent. advance on the cost. Two elevators will be ready by next spring.

Locomotives on the Northern Pacific Railroad.—At the close of June, this year, the Northern Pacific Railroad Company owned 391 locomotives, as compared with 289 at the close of June, 1883, 158 at the close of June, 1882, and 104 at the close of June, 1881. The length of line in operation upon the system at the close of June, 1884, was 2547 miles, as compared with 1701 miles at the close of June, 1883, 1296 miles at the close of June, 1882, and 754 miles at the close of June, 1881.

Gas at Paris.—The revenue of the Parisian Company for Lighting and Heating by Gas amounted in the first nine months of this year to 1,953,690*l.*, showing an increase of 23,305*l.*, or 1·21 per cent., as compared with the corresponding period of 1883.

Spanish Locomotive Building.—A locomotive built at Valence has just been brought into use at Spain. Hitherto all the locomotives required in Spain have been imported.

German Railways.—Prince Bismarck has prepared a project to be laid before the Reichstag in its coming session for the purchase, by the German Empire, of all the railways now owned by the different federal governments, and for the centralisation of the administration thereof in Berlin. It is stated that the governments of Bavaria, Wurtemburg, and Saxony oppose this scheme.

Artesian Wells in New South Wales.—An artesian flow of water has been met with by a New South Wales Government boring party, near Breakfast Creek, a locality about six miles up the Nepean from the railway crossing. The engineer has reported to the superintendent of drills, that since the date of his last report about the water struck in the bore, the stream ceased to flow higher than the surface, but recently, at a depth of 305 ft. it started to flow again, rising 5 ft. above the surface and flowing at the rate of 100 gallons per hour.

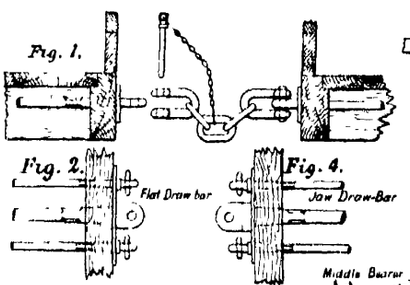
Melbourne Harbour Trust.—Some questions having been asked in the Legislative Assembly of Victoria as to the expenditure of the Melbourne Harbour Trust for plant, &c., outside of the colony, that body has prepared a return showing that the amount which has been spent on plant, &c., in England, is 122,524*l.*, while the Trust spent for plant in the colony 140,896*l.*, for work 387,564*l.*, and for timber 51,536*l.*

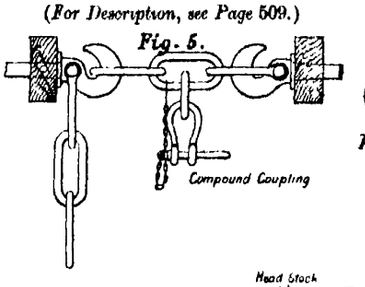
THE BOSTON ELECTRICAL EXHIBITION.—An Electrical Exhibition will be held in Boston, U.S.A., in the fair building of the Massachusetts Charitable Mechanics' Association, from November 24 to January 3.

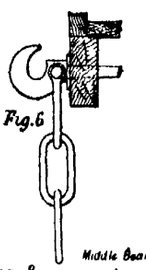
MESSRS MERRYWEATHER AND SONS' WORKS.—During the past week a trial has taken place at the works of Messrs. Merryweather and Sons, of two of the most powerful steam fire engines in the world, constructed for the corporation of Liverpool. Steam was raised in the boiler of No. 1 engine (which indicates 100 horse power) in 9½ minutes, and the steamer was tested for its fire-extinguishing powers. A jet was thrown 300 ft. with great force, the engine being capable of working twelve streams simultaneously. A satisfactory trial has also been made of one of the fifteen steam tramway locomotives now being constructed for the North London Tramways. These engines have cylinders 7½ in. in diameter by 12 in. stroke, and are each capable of drawing three loaded cars at a speed of eight miles per hour, and at a working cost of 30 per cent. less than horse-power. It is expected that the whole of these engines will be running in the course of the next two months.

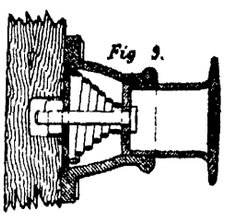
THE MINERAL WAGONS OF SOUTH WALES.

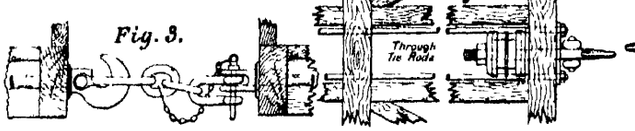
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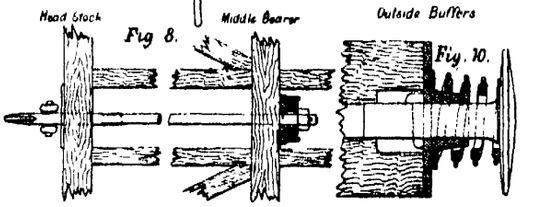
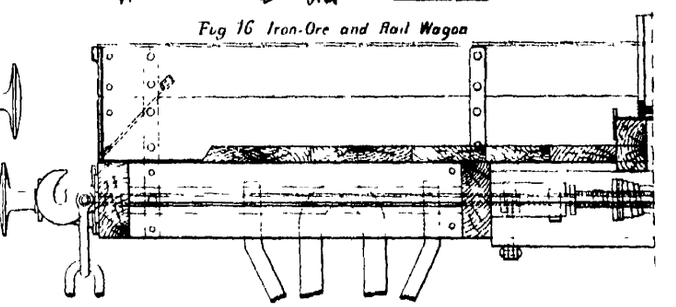
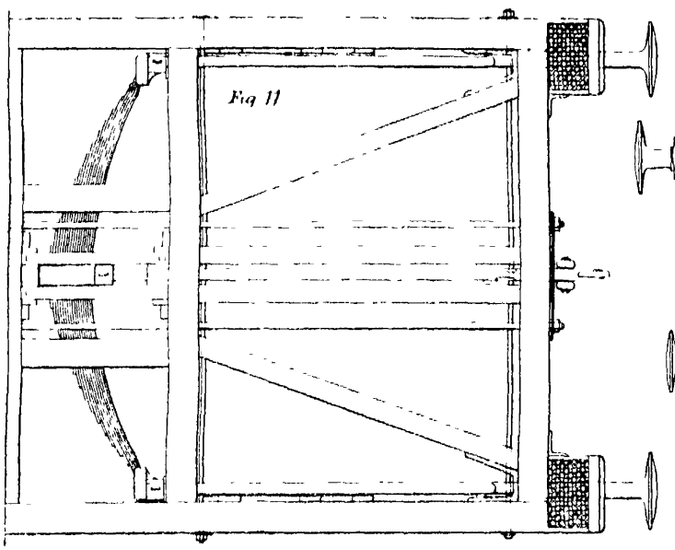
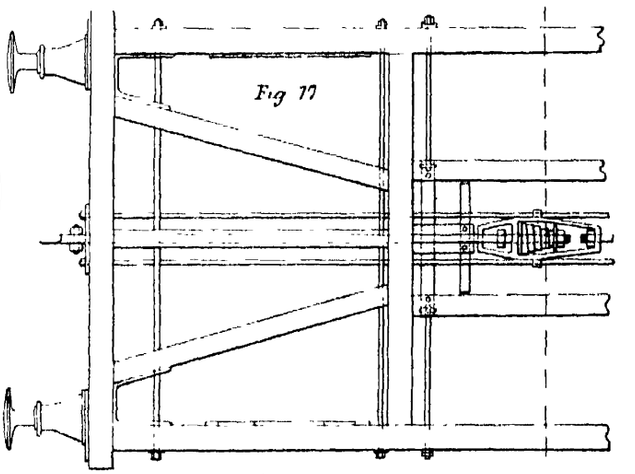
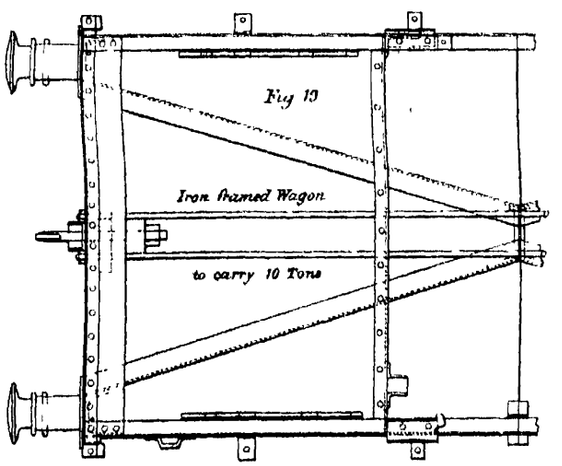


Fig 16 Iron-Ore and Rail Wagon









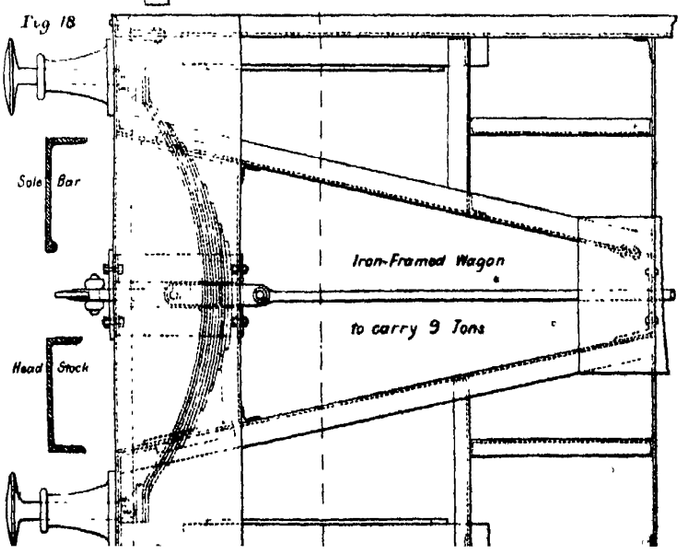


Fig 20

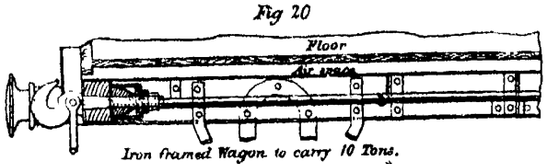
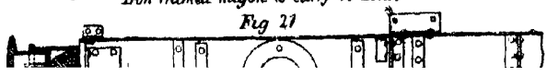
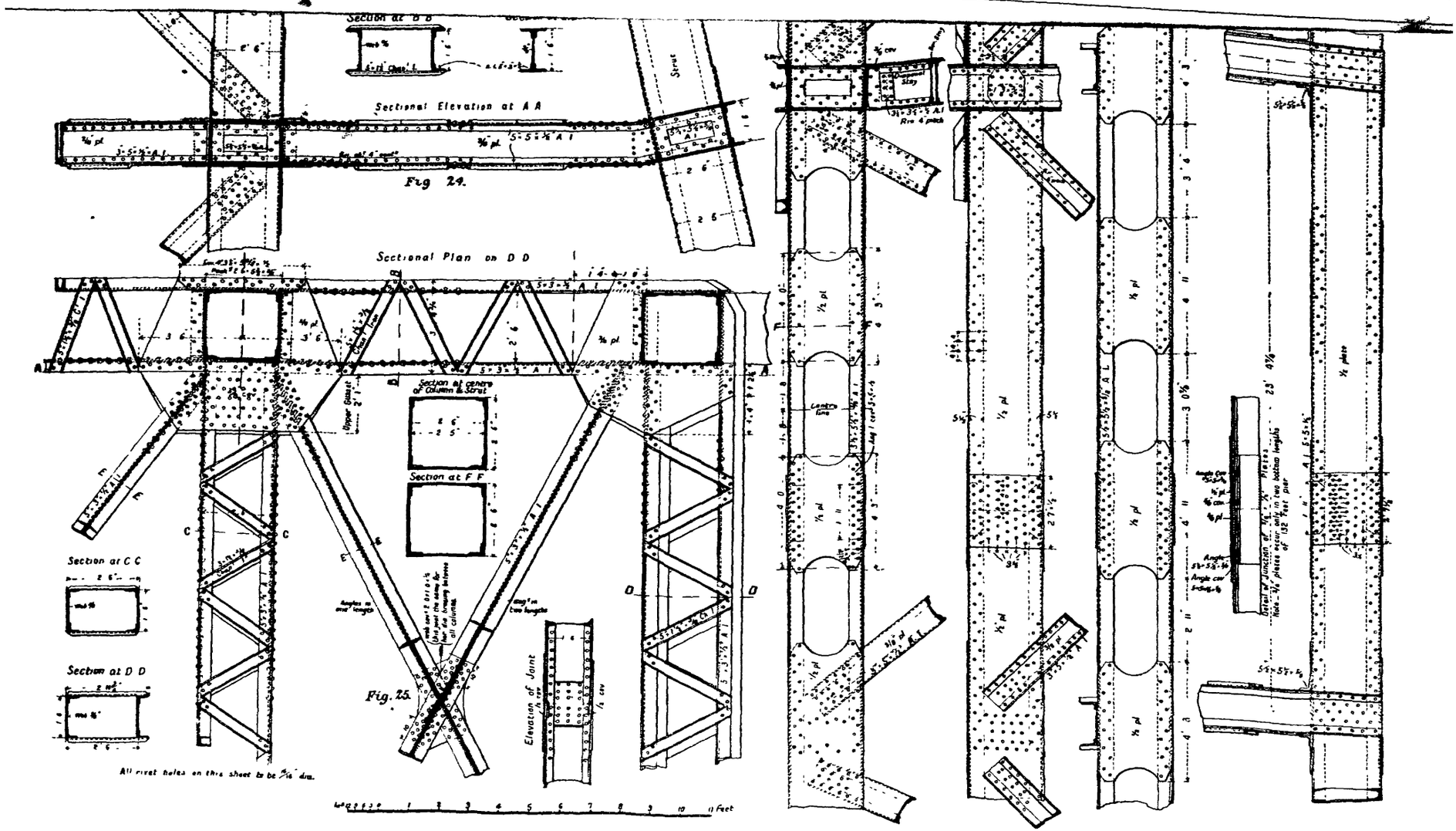


Fig 21




Section at B B
Sectional Elevation at A A
Fig 24.
Sectional Plan on D D
Section at centre of Column & Strut
Section at F F
Section at C C
Section at D D
Fig. 25.
Elevation of Joint
All rivet holes on this sheet to be ¾" dia.
Detail of Junction of ½" & ⅝" Plates
Note - ½" plates over ends in two bottom lengths of 102 feet pier
Centre line
Strut
Upper Chord
Lower Chord
Angles on one length
Angles on two lengths
Rivs 4 pitch
11 Feet

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NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS—Ordinary meeting, Tuesday, December 2nd, at 8 p m. Papers to be read with a view to discussion "The Working of Tramways by Steam," by the Hon R. C. Parsons, B.A., B C E, M Inst C E "The Sydney Steam Tramways," by W Shellshear, Assoc. M Inst C E.—Students' meeting, Friday, December 5th, at 7 30 p m Paper to be read and discussed: "Trigonometrical Surveying," by Harley H Dalrymple Hay, Stud. Inst C E. Mr Henry Law, M. Inst. C E, in the chair.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, 7, Westminster Chambers.—Wednesday, December 3rd, at 7 30 p m. Address of the President, Mr Thomas Cole

ENGINEERING.

FRIDAY, NOVEMBER 28, 1884.

MULTIPLE BOILER EXPLOSIONS.

THAT several boilers in a group should suddenly burst and fly off together without a moment's warning is to say the least of it rather startling, and to many minds doubtless appears somewhat mysterious. Like most other mysteries, however, the phenomena in question resolve themselves into very simple elements when the facts of the case come to be carefully analysed, and the recent boiler explosion at Bilston, to which we briefly referred in our issue of the 14th inst, and further particulars of which will be found in another column, offers no exception to the rule in this respect. In fact it may be taken as a very typical case of what usually occurs in such disasters. In this case three plain egg ended boilers in a range of ten set side by side exploded to all appearances simultaneously and scattered their fragments all around.

It is easy to understand that to the untrained observer who judges only from general results, the fact that the boilers were almost new, that no wasting of the plates was visible, and that at the time of the explosion the boilers which burst were working in conjunction with five others alongside which remained unmjured, may present itself as a puzzle by no means easy to solve. To the trained expert, however, accustomed to investigate such phenomena, the disaster did not present much difficulty of explanation, and was comparatively easy to diagnose.

A careful examination of the fragments revealed the fact that in one boiler, and in one only, was there a longitudinal rent, while to the skilled eye it was at once apparent that the plates at this part had been very severely overheated, and on plotting the position of the rent it was found that it had occurred just at the part which would be overheated in the event of the level of the water in the boiler getting too low Further consideration showed that it was not probable the shortness of water had been brought about by evaporation in the ordinary way in consequence of the attendant neglecting his feed supply, but that the level had been in all probability lowered very rapidly from some cause or other, and the evidence of Mr Marten and Mr Ramsey at the inquest showed, we think, that the most probable explanation of the loss of water was that the leakage had occurred at a defective joint in the blow-out pipe

The fact that a portion of the blow-out pipe on this boiler was made of wrought iron, while those of the other two were of cast iron, enabled it to be identified as the middle boiler of the three which had burst. The evidence, therefore, showed clearly that in the case of No 2 boiler at least, the explosion was due to the water level in the boiler getting too low, whereby the plates had become overheated to so great an extent that they were rendered too weak to withstand the ordinary working pressure The question then arises, What caused the explosion of boilers Nos 1 and 3? An examination showed there were no signs of shortness of water in either of them, nor had they failed longitudinally In each case the rents occurred at the ring seams, the boiler on the left being divided into two fragments, and that on the right into three. The explanation suggested by the scientific witnesses at the inquest was that boilers No 1 and No. 3 were burst in consequence of the violent shock to which they were subjected on the explosion of boiler No 2 The reasons which make this explanation conclusive will we think be more evident if we briefly consider the strains to which such boilers as the ones in question are liable in ordinary work.

Although the plain cylindrical externally fired boiler doubtless possesses some advantages over the internally fired one of the ordinary Lancashire or Cornish type generally used—such for instance as simplicity of construction, and consequent lower first cost, increased grate surface whereby inferior quality of fuel may be burnt, greater facility for cleaning out, and the ease with which it may be taken down a pit and built up underground—still it would be idle to deny that it has not counterbalancing disadvantages, and is called upon to bear strains in ordinary work from which the internally fired Lancashire or Cornish boiler is free. The action of the fire, for instance, in heating the lower half af the shell while the upper half is only heated to the temperature of the steam, leads, in the first place, to severe straining, and causes the ends to curl upwards. This action is much aggravated when the water with which the boiler is fed is of a dirty or sedimentary character, as the mud or scale naturally settles on the bottom at the very part on which the flames play with the greatest intensity Again, when the feed water is introduced it falls to the bottom on account of its greater specific gravity, and cools a strip of plating from end to end, causing it to contract This contraction is resisted by the portions of plating along each side, which are not cooled, so that a shearing action is set up whereby a heavy strain is thrown upon the ring seams of rivets, and we have frequently known boilers of this class to explode in consequence of a sudden steam rip starting at the ring seams of rivets in this way

Bearing these facts in mind, therefore, all mystery in connection with the Bilston explosions vanishes, and it is easy to understand how the shock consequent on the bursting of No. 2 boiler from shortness of water should have so severely strained the adjoining boilers on each side of it that they exploded in turn. A reference to the plan of the exploded boilers, which we give on page 504, will show that the circumferential rents in the two outside boilers occurred at the part which would be called upon to bear the greatest effect of the blow consequent on the bursting of the middle one. There would in reality be two, if not three, explosions, but the interval of time between each would be so short that they would appear to be simultaneous rather than successive

The explosion at Bilston is not the first instance in which several boilers have burst together, though happily the occurrence of these disasters is somewhat rare. From the printed reports of the chief engineer of the Manchester Steam Users' Association, it appears that this is the tenth compound boiler explosion which has been recorded in the United Kingdom since the year 1862 The last occasion on which a disaster of this kind occurred was in March, 1879, when six boilers, all of the plain egg-ended externally fired class, went off together In that case one of the boilers was ripped into a great number of pieces, which were scattered around in all directions, while each of the other five were only divided into two or three pieces at the ring seams of rivets, and the fragments were simply shot fore and aft. Investigation showed that in the case of the boiler which was torn into a great number of pieces the outlet for the steam had been plugged, in consequence of which the pressure had gone on accumulating until the shell gave way, the shock consequent on the explosion being so violent that the five other boilers set alongside also gave way. Another very similar explosion to this occurred at St Helen's in 1872, when three boilers of the plain egg-ended type failed in consequence of the outlet of one of them being stopped with a wooden plug On looking over the list of these compound explosions given in Mr Fletcher's reports, it appears that in no less than six out of the ten cases recorded the boilers were of the plain cylindrical type fired externally, a fact which would seem to show that boilers of this class possess elements of danger that are hardly shared by those of the internally-fired description. Had the boilers at Bilston, for instance, been of the Lancashire or Cornish type, the occurrence of shortness of water would in all probability not have involved anything more serious than a collapsed furnace crown The damage would have been confined exclusively to the boiler in question, and would certainly not have resulted in the bursting of two others alongside

We may just add in conclusion that the Bilston explosion enforces still more upon steam users the importance in dealing with steam boilers of carefully considering every detail in their design and equipment The shortness of water was in all probability due to leakage at the joints of the blow-out pipe, which was concealed and bound fast, instead of being open, and free to move with the boiler, while the disastrous consequences would have been averted had the boiler been furnished with a reliable fitting for giving warning in the event of the water level falling too low With the high pressures now in vogue a steam boiler cannot be too well equipped to begin with, nor too vigilantly watched when set to work

THE ELECTRIC LIGHTING COMPANIES.

JUST two years ago the electric lighting companies were besieging the Board of Trade for provisional orders, and were dividing the country among themselves, much as the Israelitish band under Joshua parcelled out the promised land before they set foot in it. Every large town which was not defended by a too powerful municipality, was awarded to one or other of the companies, while London, with its many centres, was more or less equitably divided among several of the principal. The process was not without its expense, but at a time when investments at 4 per cent. were most difficult to find, it was considered worth while to risk a good deal to obtain possession of a monopoly.

And, in spite of all sophistical disguises, the possession of a provisional order does confer a monopoly; it gives the holder the right to use the ratepayer's streets in which to lay his mains, and unless he flagrantly abuses his privileges, it defends his possessions against all competition. The very eagerness which companies displayed in obtaining these rights, and the alacrity with which they spent their slender stock of cash for the purpose, showed the great value that was attached to them by the applicants. And yet, after two years, there has been nothing effected, except the erection of an insignificant installation at Colchester. The schemes all ended in wind, and nothing more, for the walls of the modern Jericho do not fall before the blasts of rams'-horns, however energetically they may be blown. The struggle for existence which besets the early years of every new movement cannot be carried on energetically without ample resources, and those which were at one time fairly abundant, had been foolishly squandered in the case of the electric light. Millions had been obtained and divided between sanguine inventors and astute promoters, and when the time for action came it found the companies without capital and the public without confidence, and nothing could be done.

After a long pause the electric lighting interests are again bestirring themselves, and, as we mentioned last week, they have had an interview with Mr Chamberlain to try and get from him a modification of the conditions under which district lighting must be carried out. As matters now stand, the municipal authorities have the option of buying the entire plant and business of a district lighting company at the end of twenty-one years, or at the end of any succeeding term of seven years, at its net valuation, free of all compensation for goodwill, compulsory purchase, and the like. The companies argue, with great show of justice, that this entirely ties their hands, that the public will not risk their money upon such terms, and that a most promising industry is thus being strangled by Act of Parliament. In their interview with the President of the Board of Trade they met with as favourable a reception as they had any reason to expect. Mr Chamberlain was firm upon the point that no enduring monopoly should be created, but in other respects he showed a conciliatory attitude. He said "He would admit at once that if they were to discuss the methods, they were fairly open to reconsideration. He should say that in the 27th clause the object of the Committee was that, while the community should be enabled to resume this monopoly at any moment after the twenty-one years, it should do so on terms which would, at all events, fairly recoup the undertakers for all legitimate outlay. It might be that the terms of that clause did not carry out that object, and if the deputation were of that opinion, he could only say that, if they would draw up such a modification of the clause as in their opinion would satisfy those conditions, he would take care that it had the fullest consideration. But he was bound to say frankly that he could not give any support whatever to a plain proposal that the whole of that clause should be repealed. He did not think the local authorities of the country would assent to any proposition of that kind, and he could not think that Parliament, which had shown itself hostile to the creation of those great monopolies, would allow a new one in the case of electric lighting, unguarded by any such limitations as those which they had sought to impose. Some kind of limitation they must take to be an absolute necessity, and the only question to consider was whether the limitation imposed was a limitation which unfairly restricted the progress of the industry, and which, therefore, might be properly altered as to its details."

It thus remains for the companies to make a proposition that will be fair both for them and the public. They have reason to be thankful for the delay which the Act has imposed upon them, for if their hands had not been tied the financing of patent rights would long ago have been succeeded by the financing of provisional orders, and the stigma attached to electric lighting shares would, if possible, have been deepened. Many of the companies have seemed to think that the public might be eventually induced to come to their aid under the existing arrangement, and so they have asked for extension of time and kept the orders alive as long as possible. Now that this has come to an end they attribute their non-success to the influence of legislation. We very much doubt, however, whether they have yet struck the chief reason. Money in plenty would be forthcoming, if only the public could be assured that scientists and engineers were agreed as to the practicability of establishing on a sound basis some of the systems which have been introduced during the last two or three years, whereas it is an open secret amongst investors that great differences of opinion exist, and that experts who have most fully considered the matter are convinced of the utter impossibility of making any one of the present schemes a success, either commercially or otherwise.

The electric light companies are in far too great a hurry to bring their wares to market, and seek to organise great schemes when they have never tried small ones. It is difficult to point to more than very few installations of 1000 lights, and yet they complain that circumstances will not permit them to fling themselves headlong into projects requiring 100,000 lights. It is to be hoped that Mr. Chamberlain will not accede to any alteration of the 21st clause that will open the doors to another rush of speculation. It may be that the infant industry is badly repressed, but the early precocity which it displayed quite justifies strong measures. The community can live happily for another five years without district lighting, and at the end of that time there will be a great store of experience accumulated to work upon. The demands of private users will have caused the construction of dynamos of large size, and the elaboration of a system of canalisation, which will serve as the basis for a wider distribution. By that time, also, the cost of the electric light will be settled definitely, and perhaps, also, it may have been reduced. As long as it is double the price of gas, as at present, it can only be the luxury of the rich.

The deputation called Mr Chamberlain's attention to two other of their grievances, the first being that they are obliged to lay mains all over their districts, and to supply all who ask, and the second that they must charge solely by meter. Both these might well be modified for a term at least. The difficulty of earning a profit will, on the most favourable assumptions, be sufficiently great without the unnecessary expense of laying mains in all the back streets, and as for the meter, such a thing does not exist, and therefore some other methods of arriving at a fair price must be devised.

OUR IRONCLAD NAVY.

The state of our ironclad navy, its efficiency and its strength, as compared to that of other nations, especially of France, has been ably discussed for some time past, and the theories on naval tactics held by our most experienced naval officers, have been published in connection with the above subject. It has been the custom to estimate this relative strength by making tables, in which the thickness of armour and the number and weight of guns, are the sole test, accordingly, we usually find one of our ships bracketted with one, somewhat similar in this respect, belonging to France or Italy, or perhaps some other power, the result proving invariably that our Navy is not sufficient either in respect of armour and guns, or in number of ships. According to these tables all our best vessels entered in our Navy List are available in the hour of need, and might be sent to the Mediterranean at a short notice. Is this a fair way of estimating? We always have several of these vessels on our foreign stations, usually as flagships, and so far from being available at home in the event of a war, they would be insufficient to protect our colonies, and other ironclads would have to be sent out to assist them, thus further reducing the number of vessels available for home service. Nor is any account taken of the vessels lying in our dockyards, which have been dismantled and are awaiting their turn for being rendered fit for service; when all these deductions are taken into account, it would be found that we could not add more than five or six ironclads to the existing Channel and Mediterranean squadrons combined. This then should be taken as the available strength of our Navy, and what is it when compared to that of France? Our coastguard vessels are, for the most part, old and obsolete, but they would not be available, even if they were ever so good, for our harbours and shipping would require protection. It therefore appears that our Navy is very defective in numerical strength, and the lists and tables alluded to above prove that it is equally unsatisfactory in respect of armour and guns.

There is another source of weakness which is still more serious, which is seldom alluded to. It is the low rate of speed under steam of all our heavy modern ironclads, which will, in future wars, take the place of the old line-of-battle ships. Nothing need be said about the earlier ironclads with thin armour and small guns, for although their speed is still more defective, they are obsolete, and would have little influence in deciding the fate of a naval war. All the hard fighting will be at first between fleets composed of the heaviest ironclads, and the destruction of one or other of the fleets will practically settle the matter as to the supremacy of the sea.

So far, the relative strength of fleets has been considered under two heads alone, viz.: numerical strength of first-class fighting ships, which our Navy list shows to be in our favour, but whether actually so or not, in the event of a war, when only *available* ships are taken into account, is quite another matter; and, secondly, the relative strength, taking ship for ship, and considering only the armour and guns as a test of strength; in this latter comparison we are at a great disadvantage. The element of speed has never been properly considered, but it is indeed most important, and should never have been overlooked, yet in this respect we are completely at the mercy of our enemies. With respect to cruisers, whether ironclad or not, all parties agree that speed is a most important element in the construction and design of the vessels, it is absolutely necessary in order to overtake the fast merchant vessels and cruisers of an enemy, and naval officers consider it so important in "single combats" that they are willing to forego a certain amount of "handiness;" why then so totally ignore speed in the heavy ironclads?

No person who has any knowledge of our own vessels and those of our foreign neighbours will hesitate as to our inferiority as regards the speed of our heavy ironclads. Some may quote the Alexandra, with her sixteen knots, but she is a nondescript kind of vessel with what is now considered too thin armour for fleet actions, and small broadside guns, besides a mass of rigging, yet she is unnecessarily heavy for a cruisor; she is, in fact, hardly the type of vessel under consideration, whether or not she can steam sixteen knots. The Devastation is rather the class of vessel by which great naval battles will be settled in future, with heavy armour and few heavy guns, whether they are mounted in turrets or barbette being a matter of constructive detail. She may be said to have been the first of the class, and her speed of about twelve knots on the measured mile, with the best hand-picked coal and firemen procurable, has not been exceeded by her successors, although some have fallen far short of this. Nevertheless, in spite of this speed, which about equals the cruising capabilities of many foreign vessels of this class, and is far exceeded by others, eminent naval officers propound theories on naval tactics on the supposition that we are able to compel an engagement with an enemy whenever we please, and on such terms, too, as may seem most desirable for us, without in the least taking the inclination of our enemies into consideration. And what may seem still more extraordinary, they propose all sorts of defensive armour against torpedoes, which will still further reduce the speed of our vessels, and at the same time advocate the construction of vessels to suit one particular system of *attacking* our enemies, quite forgetting that they will attack us in our weakest part or leave us alone; and we must fight them as *they* please, or not at all.

To illustrate some of these theories, some papers recently published in a contemporary may fairly be taken. First of all the "ram" is considered the most powerful weapon, and the fleet is arranged in various ways, in order to make this most available for offence. "End-on" ramming is advocated, and in order to do this most effectively it is proposed to build vessels with most powerful rams, to a certain extent sacrificing the efficiency of other parts. Now suppose that two vessels are opposed to each other, and that ours has one of these most powerful rams, the commander of the other ship will not be such a fool as to run his nose against it, thus entailing his own certain destruction, when he is able, by his superior speed, to take any position he pleases; he would rather avoid being rammed and attack some weaker part of our vessel, or not fight at all, should he deem that the chances of success are not in his favour. Next, suppose that the enemy has as powerful a ram as ours, and both

vessels were to attempt end-on ramming, which is highly improbable. In the first place his superior speed will give him an immense advantage, for if the two vessels are equally strong and heavy the faster vessel will necessarily destroy the other; next, suppose the speed of both vessels equal, both vessels would have their bows crushed in and their fore compartments filled, whether the spurs entered their opponent's bows or not, and both vessels would be so strained by the force of the collision as to be unfit for further service, even if they did not sink. On the whole no certain advantage would necessarily accrue to either party, and therefore it is not at all probable that two captains would be willing to risk the destruction of their own vessels on these terms, and without the consent of both parties end-on ramming is impossible.

As to manœuvring a fleet in order to enable the vessels composing it to ram the bows of the opposing ships at an obtuse angle, it may be done with advantage on paper, but nowhere else, for on consideration it is evident that a true and exact knowledge of the speed of all the vessels is indispensable to insure success, where the difference of two or three seconds, represented by a few feet, makes the difference between ramming and being rammed; in other words, between defeat and victory; besides, the smoke from a few guns would greatly enhance the difficulty.

These theories, like most others propounded, take it for granted that both admirals commanding the fleets hold the same views as to "naval tactics," which is highly improbable; or that our fleet is able to compel an action on the terms which suit us best; for this superior speed is indispensable. But the superior speed is with the enemy, and instead of making theories as to how we will attack them, we had better consider the best defence.

Some may say, suppose both fleets intend to decide the day by a great naval battle; even then the admiral with the faster vessels will have a great advantage by being able to refuse to fight at a disadvantage, by waiting for a more favourable opportunity, which his superior speed will enable him to do, whilst the slower fleet must fight when attacked, for no escape is possible. There is another contingency far more probable, viz, that it will not suit the enemy to risk everything in one great battle, in which case our fleet has not speed enough to overtake the enemy, and compel a general action.

Imagine, for instance, a war with Italy. This country has a few old broadside ships, which need not be considered. Soon five or six of their new type of ironclad will be completed, with a speed of from fourteen to eighteen knots, and 21 in. steel armour, with four 100 ton guns each, besides in some instances a few broadside guns of lesser calibre. The only vessel we have that would be a match for any one of them is the Inflexible, and even she, with all her complication of machinery, would not have a shadow of chance against two of them. In such a case our Mediterranean fleet would have to keep together for mutual protection, lest they should fall in with these powerful vessels, when escape would be impossible, having neither speed to run away, nor being a match for fighting; the result would be that our boasted Mediterranean fleet would command a little piece of water extending no further than the range of its guns. On the other hand, the Italian ships might disperse without the least anxiety as to the result, for we have no vessel that could overtake them and then fight them when caught, yet they could catch any of our vessels with ease and destroy them in detail. As for the Inflexible, she might well, in such a war, be classed with Malta and Gibralter, and so far as destroying the enemy's ships is concerned, would be as useless, for they would keep out of her way, while a ten-knot ship, however handy, cannot overtake another that steams fourteen.

It is most important that something be done to remedy this glaring defect in our Navy; it is very easy to say that building an enormous ship is like carrying top many eggs in one basket, or some may say they cost too much money; but if, without considerable additions, our existing navy is useless, all the money hitherto spent is wasted to no purpose. As to expense, the Inflexible cost nearly a million and a half, with all her absurd complication of machinery, and for the same money two vessels like the Duilio, but with more speed, might have been built, if only the Admiralty could be taught to construct vessels in the only way that private firms can do business, well and at a reasonable cost.

When the Italian Government commenced the Duilio, which was intended to carry 100-ton guns, at a time when the heaviest gun in our Navy did not exceed 35 tons, the constructive department of our Admiralty tried to convince the public that the new vessel must necessarily be a failure, but the public would not be convinced, so after the vessel had been successfully launched, without upsetting, as had been predicted, it became known that the Inflexible was to be built, but since the Duilio had been condemned as too long and unwieldy, our new ship was to be very short, broad, and "handy." The result is well known; our ship, built at an enormous cost, was so short, and turned so easily, that she could not be induced to go straight, and after a short trial was altered on account of this defect, at a cost of nearly two knots speed. Next, the Duilio had not all the latest improvements, and is nothing but a very serviceable ship; so our ship is converted into a kind of museum for new mechanical inventions, and, with all her forty-five engines, required a quarter of an hour for loading her guns at the bombardment of the forts at Alexandria She is not by any means the only ship in our Navy which cannot steer; at the present time there are unpleasant questions being asked about the steering of the Ajax and Agamemnon.

There is no doubt we require more ships, and of a better class than those we have now What is the use of converting our first ironclads, the Northumberland, &c, at a cost of more than a hundred thousand pounds each, when after the conversion the vessels are no better than before? Three of these underwent the nominal improvements of having their 6½-ton guns replaced by half the number of 12-ton guns, which entailed an alteration to all the fittings as well as the ports. And what the better are they? Their guns and armour were not deemed sufficient to enable them to cope with a small modern ironclad, and, after the alteration, they are just in the same position, and nearly four hundred thousand pounds have been wasted

Foreigners can get ships built in England as good and cheaper than can be done in our large naval establishments, and at the same time the builders make fair profits, but they do not waste money on useless alterations, they decide what should be done, and do it; and the foremen and others have to obey orders and work to the designs supplied to them by competent persons. There has been plenty of experience in building ironclads, and it *is possible* to prepare drawings of a good type of vessel, copies of which should be sent to each of our dockyards, with an order to build one or more, and have them completed by a fixed date, and no excuse should be taken if this time is exceeded The drawing offices might well be used for preparing drawings for the guidance of the foremen and men, instead of merely making drawings of what has been completed, after a host of alterations, at enormous cost. If the constructive department is unable to prepare suitable working drawings, the sooner it is abolished the better, and private firms or foreigners will readily supply all that is necessary.

These alterations to old ships refer not only to improvements, as they are called, respecting armour and guns; but of late torpedoes have made their appearance, and are destined to play a prominent part in the naval warfare of the future, and there is a tendency to adopt all kinds of inventions for the protection of our ships, little regard being paid to the serious consequences they will entail in other respects. In the contemporary before alluded to, a plan has been proposed for protecting our ships by means of steel rods screwed into their sides, sufficiently strong to support a network of smaller rods, which shall surround the vessel, and extend a few feet under water, this apparatus, it is computed, will not reduce the speed of our already too slow ships, more than two or three knots per hour; this sounds quite feasible, at the same time it is quite delightful to conceive the idea of our ironclad fleet, dressed up in petticoats, sitting in state in the middle of the Mediterranean, waiting patiently for the enemy to attack it, the admiral's face wearing a placid smile of content as he watches a few of our vessels being burnt in the distance, and thinks what a thrashing he will give those wretched foreign cruisers—when he catches them. But this is too serious a subject to laugh at, something must be done, and that at once. Foreigners have fully appreciated the importance of these abominable submarine machines; they have already large numbers of excellent torpedo boats and are rapidly increasing the number Yet our Admiralty every year promises to buy a considerable number of these boats, of which we have very few, and when the end of the year comes, they have some very good excuse for having done nothing.

What sense is there in putting our ironclads into crinolines, and thereby sacrificing what little efficiency the ships may possess by reducing their speed, when the right course is to meet the attack of torpedo boats by other boats of a similar class. Torpedo boats have been made to take long voyages which they have performed successfully, and there is no difficulty in constructing a larger class of boat, capable of carrying sufficient canvas to keep steerage way on her, and with engine-power sufficient to propel her at 25 knots an hour, on an emergency, besides carrying a few machine guns for use against other torpedo boats This class of boat might accompany a fleet, and would be invaluable for protecting it; they might also be used to cruise about alone, and would prove most destructive to an enemy's shipping, as they would be quite capable of capturing any merchant vessel, and could run away from any armed ship they might chance to fall in with during the day, and at night follow it and attack it, if a favourable occasion offered They would also be invaluable for watching and following an enemy's fleet, by keeping it just in sight during the day, and at night coming as close as prudent The principal difficulty would be to carry sufficient coal, but very little is consumed when steaming slowly, and canvas might well be used on many occasions, with banked fires; of course the boats could always procure coal from a friendly ship, for which reason they would have no difficulty in accompanying a fleet These boats should only be a supplement to the existing class of boat, of which we want many more

If the money devoted to alterations of some old and useless ship were used for the construction of ten or fifteen such vessels, there would be no need for the uneasiness at present felt on account of an enemy's torpedoes. If an excellent design is required it is only necessary to let each of the best torpedo boat builders in this country have an order to make one, at a specified price, say 15,000*l* or 20,000*l*, with a guarantee that there shall be a fair trial between the boats, and that the builder of that which proves itself most satisfactory in every respect, shall immediately receive an order for ten more, similar to that tested, and at the same price There should be no restrictions as to the size of the boats, nor to any of the details of construction, beyond limiting the proportions of torpedo tubes, so as to suit our standard size of torpedo, and firing the kind of machine gun which shall have proved most efficient, and which is adopted in the service This course would lead to keen competition between the builders, and there is no doubt that we should soon obtain the best description of boat, which the existing knowledge on the subject can procure The experiment would not cost much, for all the boats would be serviceable, although not in equal degrees No doubt there would be very strong feeling expressed by the builders at the time of the contest, each man thinking his own the best, but a committee of arbitration might be appointed which would be fair to all parties. The importance of torpedo boats has become too serious by endangering the very existance of our Navy, to be hushed up by theories on naval tactics, nor will the public be satisfied with the waste of more money in the construction of such absurdities as the Polyphemus. The Admiralty must face the matter, and, although it may go sorely against the grain, they will be compelled to take some steps towards remedying the many glaring defects, which, most undoubtedly do exist in our Navy, both as regards the small number and weakness of ironclads which are available, their inability as to speed to compete with foreign ships of the same class, and also our great deficiency in torpedo boats The country has lost already confidence in the administration of our Navy and dockyards, and unless some great improvement be made, it will be compelled to try whether it will not be possible to manage matters better, with some other system.

AN ELECTRICALLY LIGHTED TRAIN.

The London, Brighton, and South Coast Railway Company have three electrically lighted trains running on their lines, and a fourth is nearly ready to be put into service. It will be remem-

THE BILSTON BOILER EXPLOSION.

(For Description, see opposite Page.)

Fig 1.

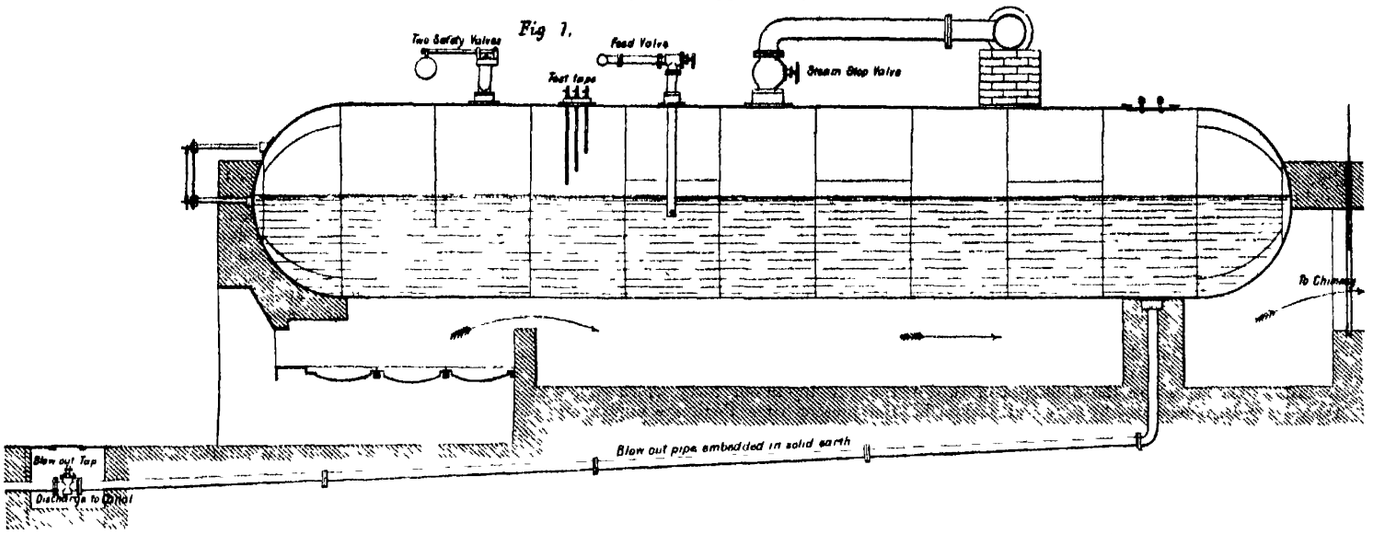


Fig 2

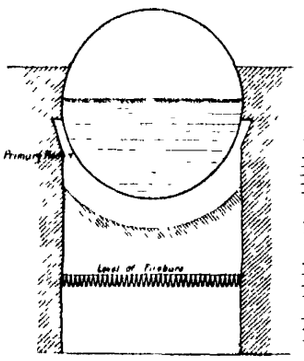
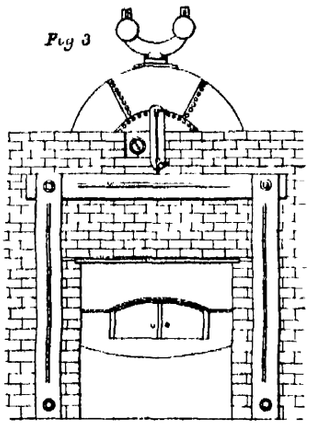
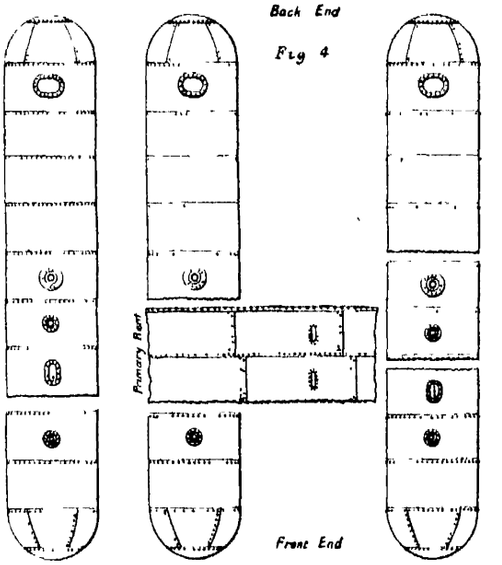


Fig 3



Back End

Fig 4



bered that this company was the first to make trial of the electric light, and that nearly two years ago the Pullman express was fitted with secondary batteries Since that time the subject has been pursued until a really practical system has been evolved. In the present trains the current is generated in the van without the use of an auxiliary engine, and sufficient storage power is provided to supply light during stoppages, temporary breakdowns, and the like. No attendant is required, and beyond the ordinary inspection and care which all machinery demands, there is no trouble involved in the arrangement. The dynamo is dri—— by bands from pulleys on the axle to the van countershaft under the floor serving to give the required increase of speed Leather link belts are employed, there being two from the axle to the shaft, and one from the shaft to the dynamo. It is, however, intended in future to use two for this latter purposes, and then the arrangement will be practically free from danger of breakdown from the failure of the bands. The dynamo feeds into a secondary battery, of the Faure-Sellon-Volkmar type, of 22 cells, and from this the conductors are led down the roof of the carriages to supply the lamps, of which there are 36, of 16 candle-power each. By means of a switch in the van these lamps can be turned on in the daytime upon entering a tunnel and extinguished on leaving it. The cells weigh one hundredweight each, and the rest of the plant brings the total weight to a ton and a half. So far there is nothing noticeable in the arrangement, except the good mechanical style in which it is carried out. The general idea of a dynamo driven from the axle and used in conjunction with an accumulator, was started very soon after the Faure battery appeared, but the schemes were defective because they made no provision for reversing the brushes when the train moved backwards, and did not prevent the battery discharging through the dynamo at low speeds. These two points have been successfully attacked by Mr Stroudley and Mr. Houghton on the Brighton trains There are two sets of brushes on the dynamo, the arrangement being much the same as that used in the electric launches. These brushes are manipulated by a lever connected to an armature under the influence of the field magnets Supposing the train to have been running in one direction the armature will be drawn towards one field magnet, and will hold the "forward" brushes against the commutator. Immediately the train is backed the polarity of the magnets will be reversed, the armature will be attracted to the opposite magnet, and instantly will draw off the first set of brushes and apply the second The brushes are of the Brush type, like oak graining combs, and do not suffer from a slight reverse motion of the commutator. The apparatus for making and breaking the connection between the dynamo and the battery, is entirely mechanical and wonderfully simple. A screw pump, driven by a band from the dynamo shaft, works in a reservoir of mercury From this reservoir there rise two tubes, also partly filled with mercury. The action of the pump is to draw the liquid out of one tube and force it up the other, the difference of the two heights depending upon the speed of the screw. One of the poles of the dynamo is connected to the mercury, and one of the poles of the battery is likewise connected to an insulated terminal in the rising main of the pump. This terminal is fixed at such a height that when the train attains its average speed, twenty miles an hour for a suburban train, and more for an express, the dynamo and the battery are connected. The gearing between the generator and the axle is so designed that at this speed the electromotive force of the current is greater than that of the battery. With this exceedingly ingenious arrangement, which works equally well whichever way the train runs, the circuit is made and broken with the most constant regularity, and all chance of waste of current is avoided. The van is provided with a Stroudley speed indicator, which shows the exact rate at which it is travelling, and forms a check upon the regulator. One train has already been running eleven months, during which time it has made 2352 trips, equal to 27,322 miles, so that the system may be said to have quite passed the experimental stage. Of course it is not of universal application. The train cannot conveniently be broken up, but for made-up trains it seems to fulfil all the essential conditions. The illumination is most ample, far better than the most careful oil or gas lighting, the dynamo runs without supervision, and the expenditure of power is not great. A current of 40 ampères and 44 volts represents about 2¼ electrical horse-power, or say 4 indicated horse-power, and besides this there is only interest, depreciation, and renewal of lamps to provide for. We doubt whether these items will not be greater than the cost of the present oil and gas lighting, but it is quite certain that on competing lines the brilliancy and comfort of the electric light will attract sufficient passengers to cover the deficit many

EXHIBITS AT THE PHILADELPHIA ELECTRICAL EXHIBITION.

(*For Description, see Page 507.*)

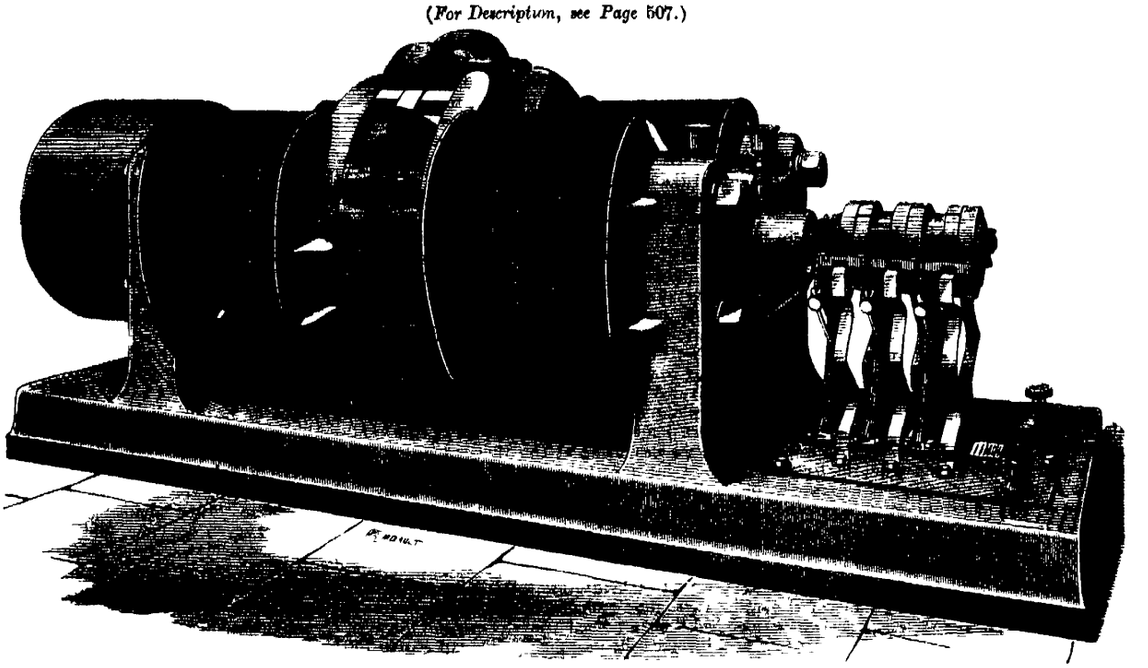


FIG. 1. BRUSH DYNAMO FOR SIXTY-FIVE ARC LAMPS.

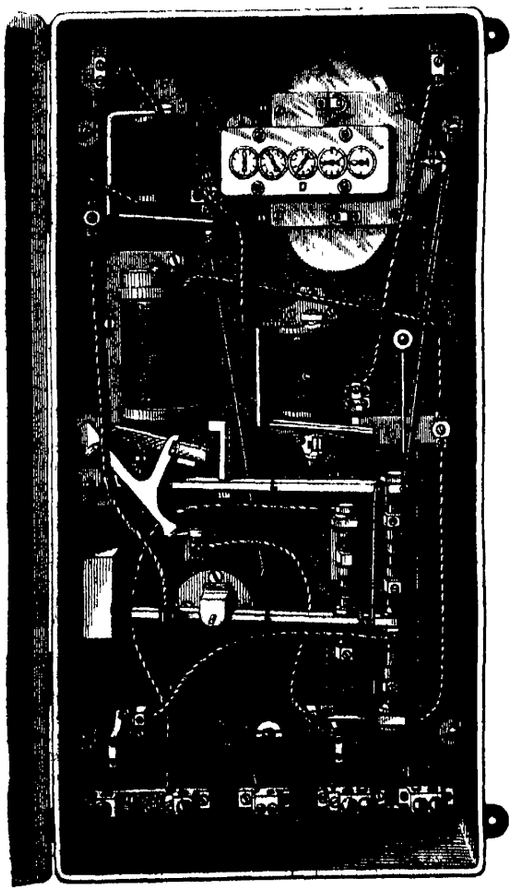


FIG. 4. THE BRUSH SECONDARY BATTERY MANIPULATOR.

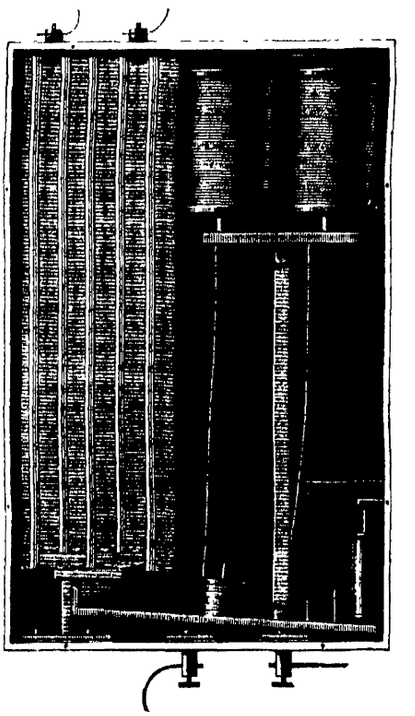


FIG. 2. BRUSH CURRENT REGULATOR.

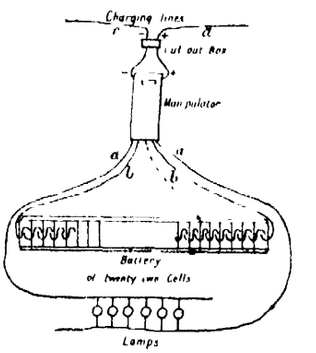


FIG. 3.

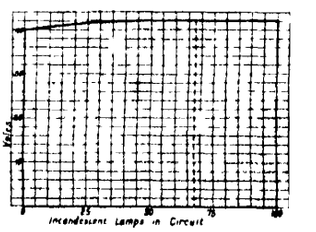


FIG. 4.

times over. In conclusion, we may add that the contractors are the Railway Electrical Contractors, Limited, of 4, Great Winchester-street, London, E.C.

THE BILSTON BOILER EXPLOSION

IN our issue of the 14th inst. (*vide* page 456 *ante*) we briefly described the disastrous boiler explosion which occurred on the 5th inst. at the works of the Staffordshire Steel and Ingot Iron Company, Limited, Spring Vale, near Bilston, and as this explosion has excited more than ordinary interest on account of its unusually destructive character, and the fact that three boilers blew up together, we now propose to give further particulars regarding it.

The boilers, as stated in our former notice, were each of the plain cylindrical egg-ended class, fired externally, and measured 34 ft. 6 in. in length by 6 ft in diameter and ½ in in thickness, the working pressure being 80 lb. on the inch. They formed part of a range of ten made by Messrs. Piggott and Co., of Birmingham, and were only set to work in May last. A reference to the engravings on page 504 Figs. 1 to 4, will at once convey an idea of the general construction as well as the method of set

ting adopted Fig. 1 gives a longitudinal section of the boiler, showing the disposition of the various fittings with which the boiler was equipped as well as the arrangement of the blow-out pipes. Figs. 2 and 3 give respectively a front elevation and cross-section showing the arrangement of the brickwork flue and also the position of the longitudinal primary rent in No. 2 boiler, while Fig. 4 shows the manner in which the boilers failed. The distances to which the various fragments were thrown, as well as the direction of flight, were fully described in our previous notice.

It will be remembered that we stated the explosion was unquestionably due to overheating through shortness of water, but we refrained from expressing any opinion as to how this was brought about from a desire not to prejudice the inquiry by the coroner, which was then pending. The evidence brought out at the inquest has fully confirmed the view we then ventured to express regarding the cause of the explosion, and also the suspicions we entertained as to the manner in which the shortness of water was caused.

It will be seen, on reference to Fig. 2, that the blow-out pipes were badly arranged. There was a horizontal length of about 35 ft. between the blow-off cock and the boiler, this portion was buried in the earth, while the vertical pipe connecting this length to the boiler was encased in a pillar of brickwork The arrangement was most unsatisfactory and ought never to have been adopted. The pipes, instead of being elastic and free to shift with the boiler, were bound fast, so that the slightest movement on the part of the shell due to expansion or contraction was certain to lead to straining of the blow-out pipe, more especially at the part near its connection with the boiler, and trouble appears to have been experienced more or less from this cause ever since the boilers were laid down, failures of the joints or fractures of the pipes having been of frequent occurrence.

At the adjourned inquest held on Thursday the 20th inst., William Davies, the engineer, in charge of the boilers on the evening of the disaster, stated that he noticed the glass water-gauge of No 2 boiler about fifteen minutes before the explosion, and the water then stood at a level of about 3 in in the glass. He then had occasion to assist one of the stokers to clean his fires. They had cleaned the fire of No. 5 boiler and just commenced cleaning that of No. 4, when the explosion occurred. It was no new thing for the joints of the blow-out pipes to give way or for the pipe itself to break; in fact, there were two boilers laid off at the time from this very cause, one gave way on the Monday night and the second on the Wednesday, a short time before he came on duty. That was why they only had eight boilers on, and were so hard pressed to keep steam up. If a joint failed near the back end of the boiler it could not be heard, and it might be three or four hours before the leakage would find its way through the firebridge and make itself evident to the stoker in charge, unless the leakage were very great and was made apparent by the rapid way in which the water was lowered in the gauge-glass. He added that the greater part of his time was occupied in making the joints of the blow-out pipes or replacing broken ones In fact, he generally expected to find a broken joint every time he went on duty, and the first thing he generally did was to walk to the front of the boilers to inquire. He had known as many as four or five joints or pipes fail in one week. He could only account for the explosion by supposing that during the time he was helping the man to clean his fires the blow-out pipe in No. 2 had failed, and lowered the water level in the boiler very rapidly.

Mr. Lewis George Fitzmaurice, the secretary and manager to the steel works, stated that he had examined the fragments of the exploded boilers, and from the appearance of the plates came to the conclusion that one boiler had been short of water, and that this had caused the explosion He could not account for the water getting low in one boiler and not in the others, unless the boiler had been neglected. Judging from the position of the rent he was of opinion that the water level in the boiler had been lowered rapidly from some accidental cause, and not simply by evaporation in consequence of the attendant neglecting his feed supply. This sudden loss of water might be due to the springing of a leak, or from the fracture of a blow-out pipe, but he could find no evidence to support this. Or the leakage might have been due to the blow-out tap not being properly shut. He accounted for the repeated failing of the joints of the blow-out pipes by the jar which would be thrown upon them by the sudden shutting of the cock. In answer to a question by the jury, he stated that he thought that if the blow-out pipe had broken the leakage would have been at once apparent to those in charge. On the other hand, if the cock had been left open the water might have escaped into the canal unnoticed. He believed that was the way in which the water was lost. Had it been lost in any other way he thought the leakage must have been at once observed.

Mr. E. B. Marten, C.E., the chief engineer to the Midland Boiler Inspection Company, who examined the boilers at the request of the coroner, and accompanied his report with an admirable model of the exploded boilers, showing the manner in which they had failed, stated that the explosion originated with No. 2 boiler, which had torn across two rings of plates at the left-hand side just beyond the firebridge, owing to the softening of the iron through shortness of water, the blow inflicted upon boilers No. 1 and No. 3, in consequence of the explosion being so violent that they exploded also; No. 3 being divided into two fragments at a ring seam of rivets, while No. 1, which received the hardest blow, was divided into three fragments, the rents in this case also being at the ring seams. In the course of his report he stated that plain cylindrical boilers fired externally had to bear the strains caused by the difference between the expansion of the highly heated underside and that of the cooler top, and most of the boilers engaged at the works bore evidence of these strains in a considerable degree. With regard to the fittings of the exploded boilers, the blow-out pipe had been arranged conveniently for the men, but it involved the long pipe being exposed to the full pressure of the steam, while as the pipe was firmly fixed in the brickwork the slightest movement in the boiler would inevitably strain the upright pipe or the joints next the boiler. The joint of No. 2 boiler had evidently leaked considerably, a portion of the joint being blown out. There was no means of ascertaining what the precise pressure was at the time, but he thought the ordinary working pressure was ample to account for the destruction that occurred. To work boilers of this class at a pressure of 80 lb on the inch, the fittings ought to have been of first-rate quality, and the men in charge of the works seemed hardly to have realised the contingencies which they ought to have provided against The immediate cause of the accident was doubtless the softening of the plates from overheating through shortness of water. The marks of overheating pointed to a sudden lowering of the water most probably due to the failure of the insecurely repaired blow-out pipe. He pointed out that the boiler was not fitted with any appliance for giving warning when the water level was too low, and stated that if it had been fitted with a reliable float and whistle, warning would have been given in time to prevent the overheating and consequent explosion. In answer to the coroner, Mr. Marten said he thought the defective blow-out pipe was in itself quite sufficient to account for the escape of the water, and in reply to a further question by the jury, added that the leakage might go on without giving any evidence at the front of the boiler for a long time, pointing out that as the escaping water would have a temperature corresponding to that of the steam in the boiler at the time, a large part of it would be instantly flashed into steam and drawn up the chimney, while a great deal would be evaporated by the escaping hot gases as well as by the brickwork forming the floor and sides of the flue. With regard to the quality of the iron of which the boiler was made, he stated that tests of the plates showed that it was not of first-rate quality. The tensile strength was about the average, viz, 20 tons per square inch, but the iron was wanting in ductility, the reduction of area of the test strips at the point of fracture being only from about 3 per cent. to 8 per cent. At this point the inquest was adjourned to Tuesday, the 25th inst.

At the subsequent inquiry on Tuesday last, Mr. Marten was cross-examined by Mr. Alfred Hickman, the chairman of the directors of the Steel Company, with a view to show that the amount of water which had got out of the boiler could not possibly have escaped at the defective joints in the blow-out pipe during the interval that elapsed between the glass water gauge being observed by the attendant and the explosion occurring, and that the only way in which the water could possibly have escaped was through the blow-out tap. Mr. Marten stated that if it could be proved that the blow-out tap was open at the time, he should have concluded it had escaped that way, but he found the blow-out tap shut, and was informed it was found shut after the explosion. Further, if the blow-out tap was open, he thought those in front of the boiler would have heard the escaping water. This opinion of Mr. Marten's was subsequently corroborated by John Simmonds, the boiler attendant, who stated, on being recalled, that if a blow-out tap were left open or partially open, they could at once tell, as the escaping water, which was led into the canal situated a few yards in front of the boilers, made a loud bubbling noise.

Mr. James Ramsey, engineer surveyor to the Board of Trade, stated that he had made an investigation into the cause of the explosion, and agreed generally with Mr. Marten that the explosion was due to overheating, in consequence of shortness of water, and that the water in the boiler had been lost suddenly. How the water escaped was a matter of conjecture, but judging from the appearance of the joint of the blow-out pipe it was probable it had escaped there. After the explosion he had the horizontal length of blow-out pipes remaining in the ground tested by hydraulic pressure, but the pressure could not be got higher than from 20 lb. to 60 lb. per square inch, as the water leaked out of the joints as fast as it could be pumped in. He examined the blow-out pipes of the other seven boilers in the range which had not burst, and found several of them defective; No. 7 was leaking at a joint, so also was No. 8, while the pipe of No 6 was broken. He thought the form of the boiler as a vessel for resisting internal pressure could not be objected to, and that the type of boiler was mainly objectionable from the strains it was liable to when in work and fed with sedimentary water, as the deposit naturally settled on the bottom of the boiler and prevented the water getting to the plates at the part which was subjected to the greatest amount of heat. He thought internally fired boilers would perhaps be better, but it would have been well if the feed water had been more thoroughly purified before it was introduced into the boilers.

Subsequently the coroner summed up, and the jury, after two hours' deliberation, returned a verdict to the effect that "The deceased persons lost their lives by the explosion of boilers at the Spring Vale Works of the Staffordshire Steel and Ingot Iron Company. That such explosion was caused by No. 2 boiler being overheated through shortness of water; that such shortness of water in No. 2 boiler arose from a leakage in the blow-off pipe joint and cock, the result of accidental causes, and not from the negligence of the engineer in charge," and recommended that "The blow-off pipes should be arranged so that they could be more readily seen, and that additional boilers should be provided by the company for the more efficient working of the engines and the supply of steam."

It will be seen from the evidence that there was a concurrence of opinion amongst the witnesses that the water in the boiler was lost very quickly and was not due simply to evaporation in consequence of the attendant neglecting the feed supply, and from a consideration of the facts of the case, we think there can be little doubt that the shortness of water was caused in the way suggested by Mr. Marten and Mr. Ramsey, viz., by leakage at the defective joints of the blow-out pipe. All the evidence supports this view.

With regard to the suggestion of the owners of the works, that the water was lost in consequence of the blow-out tap being inadvertently left open, we may point out that the evidence on this point is problematical, and nothing was offered in support of it, while proof for or against could have been readily obtained, as an examination of the blow-out tap after the explosion would at once have shown whether it had been left open or not. No evidence, however, on this point was vouchsafed. On the other hand, the evidence of Mr. Marten and Mr. Ramsey regarding the defective joints is positive, and does not admit of question.

The boiler was insured in the Mutual Boiler Insurance Company, Manchester, and we presume had been inspected by them, but no evidence was adduced as to whether the attention of the steel company had been called to the defective arrangement of the blow-out pipes in their reports. Whether this were so or not, however, it must have been apparent from the frequent stoppages of the boilers that there was something radically wrong. The blow-

out pipes had given warning again and again, and to our mind the explosion must be classed as a disaster which might have been and would have been prevented, if the boiler had been properly arranged and adequately equipped, while it is a further illustration of the calamitous consequences which may spring from the neglect of very simple precautions. Had the blow out pipes been arranged as they ought to have been, or had the boiler been furnished with a suitable provision for giving warning in the event of shortness of water, we feel confident it would not have been our painful duty to record the explosion in question, with its attendant destruction of property and loss of life

THE PHILADELPHIA ELECTRICAL EXHIBITION.—No. VIII.

By C. J. H. Woodbury, Boston.

The Brush System.

The commercial results of the Brush system exceeds that of any arc lighting system, the present output being claimed at 24,000 lamps, which comprises certainly more than half of the arc lamps in use in America.

The Brush lighting system was not exploited by a new company formed for the purpose of vending electric light plants and treasury stock, but the merits of Mr. Brush's preliminary inventions being recognised by the Telegraph Supply Company at Cleveland, Ohio, the works, administration, and financial organisation of that corporation were devoted to this department of electrical business. Thus at an early day this corporation was better equipped for commercial affairs than their competitors whose companies were newly organised for a new business. The Brush system is so well known that the description of their large exhibit will be limited to those features of interest which are of recent origin. Mr. C. F Brush, the inventor, has continually added improvements of a nature which increase the practical value of the system The Brush dynamo was the first of the class producing the high tension currents, and is particularly adapted for feasible operations on long circuits, with smaller losses on account of the resistance; one lighting circuit at Pittsburg, Pa., being twenty-five miles in length, several in other cities of twenty miles, and numerous ones of about fifteen miles.

At the Exhibition, the large dynamo (Fig. 1, page 505), sustaining sixty-five arc lights on the circuit, was worthy of notice, not merely as being the highest tension continuous current dynamo ever built, but because this result is obtained by the introduction of a new armature on a dynamo of forty-light capacity. The new armature is the same in the winding on the bobbins and the general outline of the ring as in the old armature. It will be remembered that the core of the Brush armature formerly in use consisted of a soft cast-iron ring scored by concentric and radial grooves for the purpose of localising the magnetism in the ring and restraining the production of Foucault currents In the present armature the cast-iron ring is replaced by iron plates covered by japan, and secured together by bolts extending through the ring in a radial direction. It is necessary to surround these bolts by an insulation, because if they had an electrical communication with each other, each pair would form a single coil on the armature and generate an electric current which could not be conducted elsewhere, and would therefore be converted into heat, with results destructive to the armature.

The core of this laminated armature retains so little residual magnetism that it reverses its polarity *more readily than a ring of cast iron*, and also permits a higher speed of rotation, because the diminution of the torsion of lines of magnetic force prevents the armature from carrying the polarity of one magnet beyond the poles of the other one at high velocities. The first cause allows the production of a higher electromotive force by each revolution of the armature, and this alone increases the capacity of a forty-light dynamo to fifty lights at the same speed, while the second cause permits a higher speed of rotation, which will still further increase the electromotive force to supply a circuit of sixty-five lamps—about 3500 volts.

On some of the new armatures insulated copper tape replaces the wire formerly used in winding the bobbins. On the shaft of the armature is a circular switch, which will connect each pair of bobbins on the armature in parallelism, and with the addition of moving another switch, which throws the field coils in parallelism, the dynamo machine is in a moment converted from producing a ten-ampère current for arc lighting, into a twenty-ampère current for charging secondary batteries, or any other purpose requiring such heavy currents of lower tension.

The Brush dynamos are governed to constant current to conform to a variable number of lamps in a circuit, by a regulator which shunts a proper amount of current through the field coils.

The current regulator shown in Fig. 2 on page 505, is contained in a large iron case, and placed in any locality convenient to the dynamo. At the left-hand side of the box, the four piles of pieces of carbon form one long series of resistances to the current which enters at one of the binding posts, passes down the first pile then up the second, down the third, and up the fourth to the other binding post. This resistance is in multiple with the field coils, and is a variable resistance diminishing with the pressure, forcing the pieces of carbon into better contact.

The electro-magnets are in the main circuit, which connects by the lower binding posts. Any increase of current causes them to draw the armature and by means of the lever compress the carbon resistance so that more of the current passes through them and correspondingly diminishes the current passing through the field coils, and weakens the field magnets accordingly. A decrease of resistance in the main circuit produces a reverse effect, and the field is strengthened A dashpot checks abrupt movements of the magnets, and the regulator can be adjusted by weights on the lever attached to the armature The range of work of this regulator will permit the sixty five light dynamo to maintain any number of lamps in the circuit from the maximum capacity of the dynamo, down to ten lamps, without readjustment

The secondary batteries of this company form an object of especial interest, both on account of the general confidence in the ability of Mr Brush to surmount the difficulties which have prevented the application of secondary batteries to practical operation for the many purposes where such batteries can be used, and also the recent decisions awarding him the priority on his claims The Brush secondary battery consists of twenty-one cells filled with dilute sulphuric acid, each of them containing three lead plates 16 in square The middle (oxygen) plate is positive, and the two adjacent plates (hydrogen) are negative, as regards *the charging current; in discharging, the secondary* current is of opposite polarity The plates are pierced with rectangular cells, whose superficial area is fifty-six times the cross-section of the plates. Wood standards keep the plates about $\frac{1}{4}$ in from each other It is contemplated to replace the lead lined wood cells with those made of pottery. The formation is electrolytically formed, as in the Planté battery. The resistance of a cell is 06 ohm, and the tension 1.95 volts for each cell, although when in operation the electromotive force diminishes to 1.88 volts A battery supplies a secondary current of 52 ampères to forty Swan lamps. The resistance of the Swan lamps is about 30 ohms hot, and 57 cold. The manipulator forms the salient feature in this system of secondary batteries.

This ingenious mechanism performs a wide range of functions, one of which is to switch the high tension charging current in the face of the heavier current of opposite polarity, ready to discharge from the battery against the current from the dynamo

A second essential is to furnish data necessary to estimate the amount of energy supplied to the battery. A third feature of great importance in the satisfactory operation of the battery limits the *discharge of the secondary current to that portion* which is of uniform electromotive force, which comprises about 25 per cent. of the total amount of energy stored in the battery.

A complete description of the manipulator would exceed the limits of this article, but its general features will be considered. Fig. 3 shows the outline of the connections, the charging current entering at the upper portion of the manipulator on the conductors *c d*, and leads to the battery by the wires *b b*; the secondary current returns through these same conductors and passes to the incandescent lamps by the leads *a a* Fig 6 illustrates the mechanism of this apparatus.

If the dynamo is not in operation, the manipulator is automatically disconnected from the main circuit, but the magnet A, whose coil is in the main circuit, switches in the current, by raising its armature whenever the dynamo furnishes an electric current. If the battery requires any further supply of electricity, the electro-magnet B raises its armature, which in turn lifts the pair of levers L L and breaks the circuit in rapid succession at the three points E E E, turning the current into the battery. The contact points are made of carbon rod such as is used in arc lamps, and are uninjured by the small spark formed. When the switch is opened the rod *g*, leading to the clockwork D, is raised and starts the movement which registers the number of hours that the switch is open. The tension and current on the charging circuit being known and constant quantities, the duration of its use furnishes the remainder of the data necessary to compute the amount of electricity used by the battery. Whenever the battery is fully charged, the electromotive force of the secondary current suddenly increases The electro-magnet C is wound to high resistance, and its coil is in the secondary circuit from the battery Whenever this rise of electromotive force becomes enough to permit the current to charge the magnet C, it attracts its armature, and short-circuits the magnet B, which closes the switch E, shutting the charging current from the battery, and stopping the registering clock. If the battery connections become faulty, producing an excessive secondary current, the resistance coil H which is in the secondary circuit, grows warm, and chars the thread I, until it breaks and short-circuits the magnet B, by moving the armature of the magnet C Each of these electrical and mechanical parts are provided with adjustments, which confine their operation within specified limits. A portion of the current from six cells proves sufficient for these operations in the manipulator, because the action of all the cells is practically identical The current from two of these batteries was used to supply Swan incandescence lamps, and two electromotors, one of which drove a plating dynamo, this latter operation forming a long chain of the conversion of energy from one form to another 1 The combustion of fuel in the furnace 2 The generation of steam in the boiler 3 The conversion of the steam into work by the engine 4 The conversion of work into electricity by the dynamo 5 The conversion of electricity into chemical action by the secondary battery 6 The reconversion of chemical energy into electricity by the same battery 7 The conversion of the secondary current into work by the dynamo motor 8 The conversion of the work of the *motor into electricity by the plating dynamo* 9. The conversion of the electricity from the plater into chemical action at the plating bath, where silver was deposited upon articles of Britannia metal Although enough conversions to satisfy a hallelujah brother of the Salvation Army were made, it is feared that the toll demanded at each change of state of energy is sufficient in the aggregate to prevent the conversion of any one to this long chain of processes as a commercial method of silver plating. It would probably be necessary to levy upon the finished ware in part payment for plating the goods.

The new low tension Brush dynamo for incandescence lighting is built on the same general plan of construction, but the masses of iron in the field magnets and the armature core are greater than in the arc-lighting dynamos The coils are double wound, partially in shunt and partially in series, and the dynamo is self-regulating, in a manner which will cause the incandescence lamps within the capacity of the machine to give equal illumination, and permit the lamps to be turned in or out of circuit at will, without the interposition of any mechanical regulator at the dynamo The *dynamo does not accomplish this result by generating* electricity of constant electromotive force and current which is inversely proportional to the resistance of the external circuit It shou d be remembered that when a dynamo is performing a great amount of work, there is a slight decrease in the speed, not merely owing to any possible diminution of the speed of the engine, but the "creep" of the belt upon the driven pulleys; also that, as the greater number of incandescence lamps are in circuit, the resistance is not decreased proportionately, but the addition of the resistance of the greater length of leads makes the net reduction of resistance somewhat less than that which is merely due to the interposition of lamps in multiple arc. For these reasons this dynamo is proportioned to generate a current of slightly increased tension as the lamps are added to the circuit, while the current is proportional to the number of lamps.

The practical result is a close approximation to the above, the tension increasing until two-thirds of the incandescence lamps are in circuit, when it remains nearly constant during the addition of the remaining one-third, the maximum increment of the electromotive force being about 5 per cent. Fig. 4 represents this in a graphical manner.

The Swan incandescence lamps on the circuits of this machine were used to illuminate rooms furnished to represent the interior of a residence, also the weaving room of a gingham mill.

This exhibit also contained dynamos and lamps for special purposes requiring a more powerful light than the ordinary standard arc light, also in this connection were focussing lamps for headlights of steamers, and for naval search purposes.

NOTES.

A New Brush Armature.

In order to obtain more lightness, coolness, and efficiency from the armature of the Brush dynamo, the American makers have introduced a core built up of iron riband instead of the old solid cast-iron core. A long band or riband of iron .0625 in. thick is wound round a circular frame, and at intervals between each turn crosspieces of the same thickness are inserted to separate the convolutions admitting air, and at the same time projecting on each side so as to form the V-shaped projections which hold the coils in place and separate them from each other. About forty-five turns of the band are laid on. The new form is said to enable the machine to supply fifty arcs instead of the forty obtained from the older form at the same speed, namely 750 revolutions per minute.

The Human Walk.

M. Marey, the well-known French physiologist, who has studied the march of French soldiers by means of the odograph, has been making further experiments in this direction. The most practical deduction from his earlier experiments was that low heels have a very favourable influence on the pace at which a person can walk. He has now found that the rhythm of the step has an important influence on the speed. The rhythm was studied by means of an electric bell actuated by a pendulum of variable length, to enable the subject to keep exact time; and the distance travelled was recorded on the odograph by electric signals sent along a wire at every 50 metres traversed. M. Marey finds that the length of the step increases little until 65 steps per minute are taken; it then increases until 75 steps are taken, and afterwards decreases as a higher rhythm is reached. The speed of travel increases with the acceleration of the rhythm up to 85 steps per minute, then decreases at higher rhythms.

Rectification of Coins by Electrolysis.

Herr J. Müller, a mining engineer in Germany, has applied electrolysis to the rectification of light coins. The practice obtains of reducing the weight of over-heavy coins by dissolving off some of the metal with acid, but in Germany, at least, no attempt has hitherto been made to add metal to the coin by electro-deposition in order to bring it up to its proper weight. Herr Müller's plan consists in cleansing the light pieces and using them as cathodes; the anode being formed of a band of gold or silver according to the kind of coin treated. With silver coins the electrolyte is formed of fifteen grammes of chloride of silver freshly precipitated in a saturated solution of cyanide of potassium, to which enough water has been added to make a litre of solution. Two Leclanché cells formed the source of current. It was first established that 100 milligrammes of silver would be deposited in an hour with this arrangement; accordingly the pieces were exposed for a longer or shorter time to the bath in order to make up their deficiences. The method answers well for small losses of weight, because the metal added in that case does not deface the characters on the coin.

Railway Progress in New South Wales.

On the 29th of September, 1855, a railway from Sydney to Parramatta was opened for traffic, and since that time railway construction has proceeded rapidly in New South Wales, until there are now over 1600 miles of railways in operation in the colony, about 300 miles in course of construction, and proposed extensions representing over 1400 miles under the consideration of the Colonial Parliament. The total expenditure on railways opened and in course of construction at the end of 1883 was 19,188,464*l.*, of which there was expended in 1883 2,411,822*l.* The gross earnings from all sources last year were 1,931,464*l.*, being an increase over 1882 of 232,602*l.*, a sum which would have been 100,000*l.* more but for a reduction which was made in rates. The working expenses of the year amounted to 1,177,788*l.* The distance run by trains was 1,086,134 miles in excess of 1882. If the rates for 1883 had been maintained at the level at which they were in 1882 the revenue from the railways would have been 2,079,278*l.*; and, but for an increase of wages, the expenditure would have been 34,000*l.* less. There were added to the rolling stock last year 28 locomotives, and 275 passenger and 797 goods vehicles. In the number of trains run there was an increase of 11.65 per cent.; in the miles travelled by trains an increase of 22.39 per cent.; in the number of passengers carried, an increase of 14.33 per cent.; in the earnings from coaching traffic an increase of 12.38 per cent.; in the number of live stock an increase of 28.95 per cent.; in the carriage of minerals an increase of 7.02 per cent.; in the carriage of wool an increase of 125,088 bales, or 53.20 per cent.; in the carriage of general merchandise an increase of 91,637 tons, or 12.63 per cent.; and in the earnings from goods traffic an increase of 158,675*l.*, or 14.28 per cent.

The Improvement of the Mississippi.

Mr. Huntington has submitted his project for improving the navigation of the Mississippi and its tributaries to General Comstock, the chairman of the committee for considering all questions relating to the waters of the Mississippi. Mr. Huntington points out that from Cairo to the mouth of the Red River, the Mississippi's bed is considerably above the level of the waters of the Gulf, and that it is in the second part of this space that the inundations are the most frequent. From the Red River to the Eads jetties the river runs in a deeper channel, rising again as it nears the Passes. In former times the Mississippi had three natural outlets, the Atchafayala, the Manchac, and the Planquemines, which formed a first delta. The Atchafayala closed up, and the others are now closed also, so that the river is deprived of its natural delta, and this is the cause of the changes in its bed and of the inundations which have caused so much damage. There are points, says Mr. Huntington, at which the formation of fresh outlets would favour rather than slacken the pace of the stream, and he suggests the formation of an outlet just below New Orleans, and this outlet, two miles wide, would reduce the depth of the stream by two-thirds at flood time, and by a third of the altitude attained at the mouth of the Red River. Mr. Huntington would make little change in the system of levels as at present existing between the Red River and the jetties, the Government merely exercising a supervision over them. The main work which he proposes to do, is higher up the stream, as he urges the formation of new levées from the mouth of the Red River to that of the Arkansas, a distance of 330 miles, these levées being built behind those already made. Moreover, the levée to be made at the junction of the St. François River would start from President Island, near Memphis, to the Ozark Mountains, near Commerce (Missouri). Mr. Huntington also suggests the formation of reservoirs near the sources of the tributaries of the Mississippi, the Red River, the Arkansas, the White River, the Missouri, and especially the Ohio, so as to regulate their course and check the drainage. Mr. Huntington estimates the total cost of the enterprise at 100,000,000 dols., which, he says, "is not too heavy a price to pay for giving complete security to the largest and richest valley in the world, for doubling and even trebling its prosperity, for giving fresh life to the only large port in the southern portion of the United States between Norfolk and the mouth of the Rio Grande, and to the real outlet of the whole valley, and of the west into the Gulf of Mexico." Mr. Huntington is therefore convinced that the Federal Legislature will not hesitate to vote this sum, the more so as no further expenditure would be required, for the ten or eleven thousand miles of levées which he proposes to form might, he says, be leased to the different railway companies, which would become interested in keeping them in good order.

NOTES FROM PARIS.

By H. Vivarez.

The Societe Generale des Telephones.

In our last issue we referred to the death of the distinguished director of the Société Générale des Telephones, M. H. Lartigue. The company has not yet officially appointed his successor, but has instructed one of its chief officers to act. This is M. Richard, who was manager of the important factory at Bezons, where all the conductors used by the company were produced. M. Richard, whose ability and experience are so well known, will therefore be the general director of the company, and there can be no doubt that the selection is a wise and in all respects a suitable one.

The Transmission of Electricity.

Public electric lighting and electrical transmission are more than ever the questions of the day, and last week, at the suggestion of M. Cochery, the President of the Republic, issued a decree creating a commission which will report on the best measures to adopt in fixing the conditions to be complied with in the interests of public safety, for the installation of conductors for the distribution of high currents. This commission, presided over by M. Cochery, consists of MM. Hervé-Mangon, Jamin, Alphand, Delmas, Gariel Sartiaux, Mascart, Mille, Marquis de Braza, Jousselin, Guillaume, Bergon, Blavier, Georges Cochery, Cael, and Raynaud. It held its first meeting on the 19th inst., and agreed upon the following programme for the work: 1. To consider the precautions that should be taken when conductors are laid in the sewers or otherwise underground, above or along buildings, &c., and for their introduction and fixing within houses. 2. To prepare a list of conditions to be complied with on the part of contractors having charge of the installation of conductors intended for the transmission of power or light. 3. To ascertain the natures of wires, cables, and methods of insulation which should be preferably employed in such installations. 4. To determine the resistance offered by the wires according to their sections, to the resistance of the current. 5. To fix the maximum current to be transmitted through conductors. 6. To recommend the best instruments for measuring the force of the current transmitted, and to determine a practical mode of control. 7. To suggest the necessary precautions to be taken by workmen when repairing conductors, so that they may not be exposed to danger. A sub-commission, presided over by M. Jamin, perpetual secretary of the Academie des Sciences, will be entrusted with preparing the resolutions that will be submitted to the commission for discussion.

Electric Lighting in Paris.

The death of M. Vaucorbeil, late director of the Grand Opera of Paris, and the approaching election of his successor at the National Academy of Music, will bring about the discussion of a large number of questions interest, one of the more important of which will specially affect the immediate future of electric lighting in Paris. The work of illuminating the Grand Opera by electricity has been eagerly sought for, since several years, by the various electric lighting companies, and has been looked upon as the central point of departure for various proposed combinations for public lighting of different adjacent quarters from one great power station. Some months ago the Edison Company proposed a general scheme to provide for lighting the Opera, and an extensive area around the central station, which was to be placed in the Rue Caumartin. The number of lamps to be supplied by this station was estimated at 22,000, distributed among private houses, cafés, clubs, &c., which are numerous in this part of Paris. Of the total number, 6000 were to be used in the Opera. The central station was to contain engines of 2500 horse-power, provided with steam by a group of Belleville boilers and fourteen dynamos, as well as ample secondary battery capacity. This extensive scheme, the cost of which was estimated at 2½ millions of francs, has made no substantial progress, and has indeed been laid aside to await the arrival of better times. It is anticipated that the new combinations that will result from a change in the direction of the Opera, will probably bring with them fresh obstacles to the realisation of the plan. On the one hand, a reaction in favour of strict economy as regards the administration has set in. The death of M. Vaucorbeil has revealed a considerable deficit in the working expenses, a deficit that results from the enormous charges of all kinds, and which the liberal public support accorded to the management, and the heavy subsidy granted by the State, were powerless to overcome. It seems probable, therefore, that any electric lighting scheme will be adjourned indefinitely along with several others that would involve expenditure. It is moreover stated that under the new direction, the Ville de Paris will accord a subvention in relation to the supply of gas, which will be furnished at a reduced price. If this be so, a long and uncertain period will doubtless elapse before we hear of another project for lighting the Opera, and the wealthy quarter around it, the only one in Paris probably where an installation of such a kind could have been undertaken with any reasonable hope of success.

The Society of Engineers.—The next ordinary meeting of the Society of Engineers will be held on Monday next, December 1, at the Town Hall, Caxton-street, Westminster, when a paper will be read by Mr. A. C. Engert, on "The Blow-Pipe Flame Furnace,' the chair will be taken at half-past seven o'clock.

THE ADELAIDE SAND MIXER.

The annexed illustrations represent a very efficient machine for mixing and grinding moulding sand for foundry purposes. The arrangement and mode of working are so evident from the engravings as to render any description almost unnecessary. The vertical shaft, which is mounted within the frame of the machine, carries at its upper end a horizontal disc, in which are bolted a number of upright pins arranged in five concentric rows. The upper ends of these pins pass only just clear of the top plate of the mixer, in which is a central opening to receive the mouth of a hopper, into which the sand is fed. Around the edge of this top plate, and secured by an iron band, is a rubber apron, which hangs down below the top of the frame to which the upper plate above mentioned is secured by bolts. The action of the machine

Fig 1.

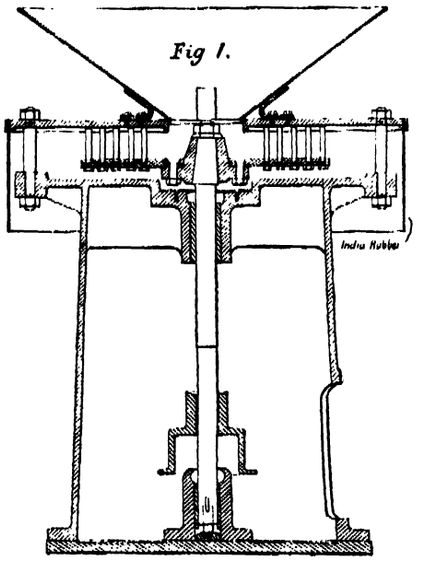
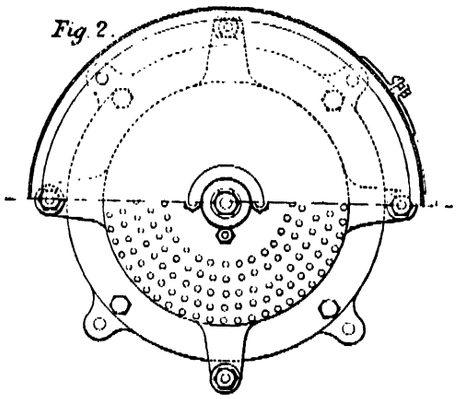


Fig 2.



is evident; the sand is fed in through the hopper upon the mixing plate, which is kept revolving at a high speed, being driven by the pulley on the lower end of the shaft. The centrifugal action throws the sand violently against the series of concentric pins, and thoroughly breaks it up and mixes it, before it escapes over the edge of the machine, where it strikes against the india-rubber apron and falls to the ground. This sand mixer is a German invention (Schütze's patent), and is made in this country by Messrs. T. B. Jordan, Son, and Commans, of 52, Gracechurch-street, E.C. It is already largely in use on the Continent, and is rapidly finding favour in this country. When driven with an energy of three horse-power, it will supply a sufficient quantity of thoroughly mixed sand per hour for about forty moulders.

ON THE MINERAL WAGONS OF SOUTH WALES.*

By Mr. Alfred Slater, of Gloucester.

It is about thirty years since a paper was read before this Institution concerning mineral wagons. During this period the changes that have been made are in the increased carrying capacity, and consequently in the strength and form of the details, rather than in the general design. Mineral wagons form such an important part of the railway system that it seems surprising they have not received more attention; the explanation probably is that they are almost invariably constructed of timber, and therefore appear to call for less consideration on the part of mechanical engineers, in regard either to their construction or to the machinery for producing them. Renewed interest, however, is now attaching to this subject, owing to the construction of iron vehicles for India and other places abroad, and also to the action of some of the English railway companies, who are again constructing carriages and wagons with iron and steel underframes, with a view to economy in the cost of maintenance.

In the present paper the author does not purpose making more than a passing reference to iron wagons or to those with iron underframes, but to treat of private owners' wagons more particularly; because in no other similar area in the kingdom are there so many wagons owned by the traders as in the South Wales district. In the Midland counties and in the North there have always been a considerable number of private owners; but they are becoming fewer, or owning fewer wagons, in consequence of some of the northern railways having become the owners of most of the mineral wagons working upon their systems; a policy more recently adopted by the Midland Railway Company, who are largely buying up the wagons working upon their line.

In South Wales there are various types of wagons, the following being a list of the more important: Coal wagons to carry 10, 8, 7, 6½, and 6 tons; coke wagons to carry 8 tons; and iron ore wagons and rail wagons to carry 10 tons, the two last being usually combined. The coal wagons, which are by far the most numerous, may be divided into two types, namely, those built to pass the inspection of the Taff Vale Railway, and those intended to work upon the Great Western and other trunk lines.

Table No. I.—*Proportion between Paying Load and Dead Weight.*

Taff Vale Railway Regulations.	Capacity of Coal Wagon.	Nominal Load.	Maximum Tare.	Paying Load per Ton of Tare.
	cub. ft.	tons.	tons.	tons.
Nov. 29, 1867	205 to 210	6	3.50	1.714
	240 to 245	8	3.75	2.133
	Not named	10	4.00	2.500
		Average	.. ..	2.116
Aug. 5, 1875.	240 to 245	8	3.85	2.078
	300 to 305	10	4.90*	2.041
		Average	.. ..	2.059
Nov. 12, 1883.	254	8	4.30	1.860
	347	10	5.25†	1.905
		Average	.. ..	1.883

* If with laminated springs at both ends, 0.20 ton extra.
† If with laminated springs at both ends, 0.25 ton extra.

The adoption of some kind of proportion between the paying load and the tare or dead weight of the wagons, has had to give way before the still more important principle of making every part strong enough to stand the heavy strains of ordinary traffic, and the still more damaging strains encountered in shunting. In proof of the statement that the proportion between paying load and dead weight is not now regarded in the same light as formerly, the figures in the above Table, No. I., are taken from the Taff Vale Railway regulations, in which the maximum limit assigned for the tare or dead weight of the coal wagon was as here shown.

It will be observed that not only have the wagons increased in cubic capacity and in dead weight, but that 6-ton wagons have gone out of the list and 10-ton wagons have come in. It is true that 10-ton wagons are mentioned in the regulations of 1867; but no particulars for construction are given. Certain it is that a wagon to carry 10 tons of coal with a tare of only 4 tons would not be made of sufficient strength to stand the work required of it.

The Table No. II., on the next page, gives the sizes generally adopted for the principal parts of coal wagons of different tonnages as now and as formerly built to work in this district. The sizes here given, and the explanatory remarks which follow, may be taken as representing general practice; it would be impossible to describe all the forms and sizes that are to be seen in the district. A comparison of columns 3 and 5 will show a considerable increase in the strength of the 8-ton wagon as built to work upon the Taff Vale Railway; while from the line of "capacity per ton," it will be observed that no fixed rule exists as to the space to be allowed per ton of coal to be carried.

Body.—There should be as few projections as possible inside the wagons, so as not to interfere with the rapid discharge of the coal. Angle-iron is frequently put on the top boards, and is a decided improvement, as it strengthens the body considerably, protects the top boards from injury, and adapts the wagon better for carrying pit-wood, which is of such a form and is so loaded as to strain the body very much. The sides and ends are usually of red deal, but spruce is sometimes used. Each side is connected with the frame by iron knees, of which there are two in the larger wagons and one in the smaller; the knees are 2½ in. × 1½ in., and the foot about 15 in. or 18 in. long, is bolted to the middle bearer. If there is an end door, a knee is attached to the headstock, and to this knee the end door is hinged at the top and fastened near the bottom. In the smaller and older wagons, instead of the knees inside there were simply straight iron stanchions 2½ in. × ⅝ in., placed outside the body, and bolted to the side of the sole-bars. The sides and ends are connected together by an iron corner plate ⅞ in. thick, extending from top to bottom, and 7 in. along each. To prevent the body from swaying to and fro, two iron bars 2½ in. × ⅝ in. are bolted diagonally to each sole-bar and along the side boards. The fast end is attached to the headstock by two upright stanchions of oak 5 in. × 4½ in.; or angle iron 2½ in. × 2½ in. is sometimes used.

Floor.—Every coal wagon, with but few exceptions, has an end door or tip for shipping, and a door in each side. Various methods of fastening the doors are adopted. The coal wagons used in the North of England have hopper-shaped bodies; that is, the sides and ends slope inwards towards the bottom, and the coal falls out of the bottom of the wagon into the ship; they thus differ materially from the wagons used in South Wales, although there are a few wagons in this district which are similarly constructed, for use at certain iron works.

Floor.—In some instances the floor is made of sheet iron, which enables the coal to pass more quickly out of the wagon when being tipped; but unless of a good thickness, sheet iron is not sufficiently stiff, and buckles up, cutting off the bolts intended to hold it down to the frame, and thus freeing itself and occasionally going into the ship along with the coal. Spruce 2½ in. thick is very generally employed; but oak 1¼ in. thick, being more durable than deal, has been used with advantage, and being hard it soon becomes almost as smooth as iron. Wood floors are best laid transversely to the length of the wagon, that is, at right angles to the sole-bars. If laid longitudinally they are apt to break away from the nails, and to shoot out with the coal when the wagon is being tipped.

Framing.—All private wagons in the South Wales district, with but few exceptions, are constructed with oak frames. Some fifteen years ago, the author's firm constructed a number of wagons with the sole-bars of I iron, 9¼ in. deep by 3¼ in. broad and ⅝ in. thick in the web; these bars have still many years of life left in them, though the remainder of the frame, which was of oak, has had to be replaced. Before the demand for coal wagons became so great and the competition so keen, the underframes were constructed of English oak; but now the purchaser is often content to have foreign oak. Indeed English oak could not always be procured in sufficient quantity to keep pace with the demand. The life of the wagon is not much reduced in consequence of this change, provided sound timber be used; for after all no timber can long stand the excessively rough work to which coal wagons are subjected, no other kind of rolling stock meeting with such rough usage.

Draw Gear.—In former years the Taff Vale draw gear was of what is known as the "flat" type. One end of the wagon being devoid of hook and chain, the drawbar had its extremity flattened out in plan into an eye, as shown in Figs. 1 and 2, page 500, to which the drawchain of the next wagon was coupled by an open link with a pin dropped vertically through the eye. In 1872 new wagons were constructed with ordinary coupling at one end, as in Fig 6, and with a compound coupling at the other end, as shown in Fig. 5, for enabling them to be coupled either to the "flat" type or to the ordinary. But the present regulations of that and other railways require all wagons to be constructed with the ordinary hook and chain at each end, as shown in Fig. 6; and wagons fitted with other types of coupling are being altered. Side chains have also been dispensed with. Some of the other lines bringing coal down to the different docks had special couplings, one form of which is shown in Fig. 3. Under the Taff Vale present regulations the drawbar pulls from the headstocks, which are connected by long tie-rods, and thus form a continuous drawbar, as in Fig. 7; but the usual practice is to draw from the middle bearer, as shown in Fig. 8. Under this arrangement the strain on the middle bearer is very severe, for it has to stand both the brunt of the pulling and also the bulk of the weight of the load; it is therefore sometimes made 6 in. thick in the 10-ton wagons. The spring placed upon the drawbar is frequently only a single ring of india-rubber, 1½ in. or 2 in. thick, as shown in Fig. 8.

Buffers.—As regards the buffing arrangements, the underframes of mineral wagons are of three principal kinds; first, those with dead buffers at each end; second, those with spring buffers at one end and dead buffers at the other; and, third, those with spring buffers at each end. As a general rule private owners will not incur the expense of spring buffers, not even at one end, unless they are compelled to do so. Where adopted, the spring buffers are usually of the "outside" type, Fig. 9, page 500, formerly known as Brown's, the spring being contained within the casing of the buffer, and the whole situated outside the headstock of the underframe. They were usually if not always of cast iron, but this material is not suitable for the work; consequently wrought iron is now largely used, with considerable economy in the cost of maintenance; the spring is either of steel or of india-rubber. In a few instances the more costly system of laminated springs has been adopted for drawbar and buffers, Figs. 11 and 18, placed sometimes just within the headstock, Fig. 8, and sometimes between the two cross-bearers, Fig. 11. The sole-bars are then made to project about 9 in. beyond the ends of the wagons, for the purpose of receiving the chains at the coal tips, as shown in Fig. 11.

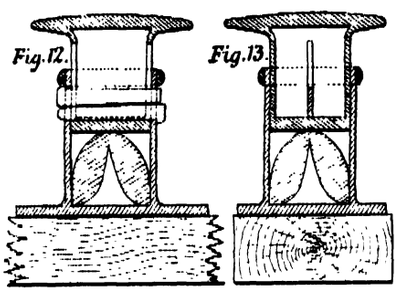
In the outside type of spring buffer it will be seen that the blow is not conveyed direct on to the sole-bar and thence to the adjoining wagon; for, as shown in Fig. 9, the headstock intervenes between the buffer and the sole-bar; this intercepting piece of timber is the wrong way of the grain, and is very rapidly pommelled to pieces by the concussions in buffing, aided by the reduced area of the sole-bar at the tenons. In order to obtain, at a comparatively small expense, a really direct transmission of the blow, the spring buffer shown in Fig. 10 has been introduced, in which it will be seen that the blow is received direct upon the end of the sole-bar, through the spring and base of the buffer; this form, therefore, has

* Paper read before the Institution of Mechanical Engineers at Nottingham. This paper was originally prepared for the summer meeting held in Cardiff, from which it was adjourned through want of time for reading it there.

TABLE No. II.—Principal Dimensions of Coal Wagons of Different Tonnages.

Principal Parts of Coal Wagons.	10-ton Wagon as now Made. Known as:		8-ton Wagon as now Made. Know as:		8-ton Wagon of Ten Years ago.	6-ton Wagon of Twenty Years ago.
	Taff Vale Type. 1.	Great Western Type. 2.	Taff Vale Type. 3.	Great Western Type. 4.	Taff Vale Type. 5.	Welsh Lines. 6.
Sole-bars, oak .. .. in.	12×5	12×5	12×5	12 ×5	11 ×4½	10×4
Headstocks, oak .. .. ,,	12×5	12×5	12×5	12 ×5	11 ×4	10×4
Middle bearers, oak .. .. .. ,,	12×5	12×5	12×5	12 ×5	11 ×4	10×4
Diagonals, oak .. .. ,,	11×3	11×3	11×3	9 ×4	7½×3	8×3
Longitudes, middle, oak .. .. ,,	11×3	11×3	9×3	6 ×4	8 ×2½	7×2½
,, end, oak .. .. .. ,,	11×3	11×3	9×3	4 ×3	8 ×2½	4×2½
Sides and ends, deal .. .. .. ,,	2½	2½ or 3	2½	2½ or 3	2½	2½
Floor, deal .. .. ,,	2½	2½	2½	2½	2½	2½
Body, inside length .. .. .. ft. in.	14 6	14 6	10 9	14 0	10 4	9 10
,, ,, width .. .. .. ,,	6 10	6 10	6 10	6 10	6 8	6 5
,, ,, depth .. .. .. ,,	3 6	3 8	3 5½	3 1	3 9	3 1½
,, internal capacity .. .. cub. ft.	347	363	254	295	258	197
,, capacity per ton .. .. ,,	34.70	36.30	31.75	36.87	32.25	32.83
Bearing springs, length .. .. .. ft. in.	3 3	3 3	3 3	3 3	3 0	3 0
,, ,, width .. .. .. in.	4	4	3½	3½	3	3
Wheel base .. .. ft. in.	8 3	8 3	6 5	8 3	5 3	5 3
Axles, length between centres of journals .. .. ft. in.	6 4	6 4	6 4	6 4	6 4	6 4
Axles, diameter through wheels .. in.	5	5	5	5	4½	4½
,, ,, in centre .. .. ,,	4½	4½	4½	4½	4	4
Journals, length and diameter .. ,,	8×3½	8×3½	7×3½	7×3½	6×3	6×3

some advantages. The pin or bolt used for fastening the head of the ordinary outside buffer has proved a great source of injury to the headstock; for the hole made to receive the pin is a source of weakness, and leads to early damage to the headstock. To remedy this, and to facilitate repairs, the author introduced a wrought-iron buffer with a gib and cotter fastening, its present form being shown in Figs. 12 and 13, annexed. This method of



astoning renders it unnecessary to cut away the headstock; and, besides enabling sufficient draw or initial compression to be given to the spring, facilitates the changing of a broken spring. To describe all the buffers and springs in use would be beyond the limits of this paper.

Axle Guards.—These are invariably of the W pattern, Fig. 16, page 500, made of 3½ in. × ⅜ in. iron for the legs, and 2½ in. × ⅜ in. for the wings; on the smaller wagons the legs are sometimes made of 3 in. × ⅜ in. iron. The bottoms of the guards on the same side of the wagon are frequently connected to each other by iron rods about 1¼ in. in diameter. The guards are secured to the sole-bars by seven ¾ in. round bolts, or in some recent instances by square bolts.

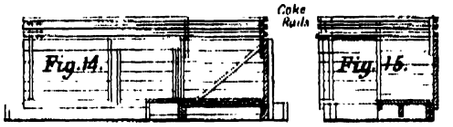
Brakes.—The invariable practice now is to have two brake blocks acting on the wheels on the same side of the wagon. Wood has been generally used, but of late years cast iron is becoming more in favour, as wood blocks wear away very rapidly, and require to be continually adjusted to the wheels, besides getting frequently burnt away by the friction. The leverage given is about twelve to one.

Bearing Brasses.—The brasses of coal wagons have a bearing of about 1⅞ in. of circumference. They usually wear short at the inner end for want of lubrication; and as a grease-hole is so near to that end, the author is of opinion that an explanation is to be found in the recent report of the Research Committee on Friction, where it is stated that the weight being greatest in the centre of a bearing, the oil will force itself out with a considerable pressure through a hole placed in the centre. When the wagon is loaded, the axle is always slightly bent, so that the greatest pressure comes just about the back hole, which would accordingly gather up the grease supplied by the front hole, in its passage to lubricate the full length of the journal. In further proof it may be stated that, when a wagon is lifted, the grease in the front hole of the brass is found to be the natural colour, while that in the back hole is not only dirty but quite hard. The lubrication is effected by means of grease, that known as "yellow grease" being commonly employed. Oil, though said to be a cheaper lubricant, is not likely to replace grease, on account of the cost of changing so many thousands of axle-boxes.

Bearing Springs.—The bearing springs, though usually the same width and about the same length for the same type of wagon, are varied very much by the different makers in regard to the number and thickness of the plates, ranging from four plates of ⅝ in. thickness, to sixteen plates of only ¼ in. thickness. They invariably have flat ends, and bear on shoes attached to the underside of the sole-bars. There are frequently bolts to hold the springs to the axle-boxes.

Wheels and Axles.—The tyres are usually of Bessemer steel, and are attached to the skeleton by rivets; Mansell's and other fastenings are also much used. The skeleton consists of eight double spokes 3 in. to 3½ in. wide, and ¾ in. thick; the boss is usually of cast iron, but sometimes of wrought iron. The axles are sufficiently described in the tabulated statement of dimensions already given.

Coke Wagons.—These are usually made by simply adding a few bars of timber, called "coke rails," to the top



of the 10-ton coal wagons, as shown in Figs. 14 and 15 annexed. They will then carry 8 or 8½ tons of coke.

Iron Ore and Rail Wagons.—The best form of iron ore and rail wagons, which invariably carry 10 tons, is shown in Figs. 16 and 17, page 500, representing one belonging to the Rhymney Railway Company. The end flaps are of iron, and are let fall upon the floor when it is desired to use the wagons for carrying long rails or bars. These wagons are fitted with spring buffers at each end, and with drawbar cradle and spring. As a rule private owners' ore wagons do not carry rails, and are constructed with underframes similar to those of the coal wagons, and with dead buffers at each end. In a few instances there are doors in the floors of these wagons, for enabling the ore to be rapidly and economically discharged.

Iron-Framed Wagons.—Another distinct type of wagon, not the property of any private owner, is the iron-framed wagon to carry 9 tons, which is now being constructed by the Great Western Railway Company for their own use, and which may be seen constantly working in South Wales. The plan of the underframe is shown in Fig. 16, page 500, together with the sections of sole-bar and headstock. There can be no doubt that iron or steel is the proper material for wagons which are subjected to continual rough work. There are many iron wagons now running that were made in 1844 and will yet last many years, notwithstanding that they have undergone conversion from the broad to the narrow gauge. A number of 10-ton coal wagons with iron frames, Figs. 19, 20, and 21, page 500, which the author believes to be the first coal wagons of the kind made for private owners in the South Wales district, have just been constructed by his firm for Locket's Merthyr Steam Coal Company. The body is of the ordinary kind, having side and end boards 2½ in. thick, with angle-iron capping, two side doors, and one end tip; the floor, Fig. 20, is of elm 1½ in. thick, resting on longitudinal deal bearers so arranged as to give a current of air between the top of the frame and the underside of the floor, in order to prevent decay. There are spring buffers at each end, as dead buffers would cause too much strain on the rivets of the iron frame. To prevent any jar or sudden shock, the buffers and drawbars are provided with special india-rubber springs, which require no metal stops. The general arrangement of the underframe is shown in Fig. 19, the following being the particulars of the iron used:

	in.	in.	in.
Two sole-bars and two headstocks, channel iron	9	by 3	by ⅜
Two cross bearers, channel iron	5	,, 2½	,, ⅜
One middle bearer, plate ...		8	,, 7/16
Two cover plates to headstocks, plate		8	,, 5/16
Four diagonals, angle iron ...	4	,, 3	,, ⅜

Size of Wagons.—A quarter of a century ago the wagons of the South Wales district, and indeed of all narrow gauge lines, were chiefly constructed to carry 6 to 7 tons; there were also some 4 and 5-ton wagons, some of which are still at work; then followed 8 tons; and now the 10-ton wagons are the most popular. The change was brought about partly by the extensive introduction of larger coal tips at the Cardiff and Penarth Docks, and partly because the larger wagons enabled the increased demand for coals to be complied with at but little extra cost for wagon hire. The following statement shows the percentage of different sized wagons constructed by the author's firm for this district during two decades, and during the last three years; no doubt the returns of other makers would show similar proportions:

	1861-70.	1871-80.	1881-83.
6, 6½, 7, and 8-ton wagons	77	35	8
10-ton wagons	23	65	92
	100	100	100

In the earlier part of the first decade the 6 and 6½-ton wagons preponderated; but, as already indicated, they gradually gave way to 7 and 8 tons, and these again to 10-ton wagons.

The author thinks it probable that the preference for larger wagons will continue to grow, and that it will not be long before the mineral freighters will ask for coal wagons to carry 12 tons. Indeed he has seen returns of the present 10-ton wagon having occasionally carried up to 11½ tons. The increase in the tare of the wagon would be comparatively small, as very few parts would require strengthening; whilst the larger the capacity of the wagon, the larger is the proportion of paying load to dead weight, as already shown in Table No. I.

THE PHYSICAL SOCIETY.

At the meeting of the Physical Society, held on November 22, the President, Professor Guthrie, in the chair, Mr. James Hewsher was elected a member of the Society. The following notes were read by Mr. R. T. Glazebrook, M.A., F.R.S.: "On the Permanence of some Standards of Electrical Resistance." The author has had occasion to compare with ten standard B.A. units a coil which had been tested by Lord Rayleigh in 1882, the coil then being two years old. He found that its resistance was 9.98335 B.A. units at 14.05 deg. Cent., while Lord Rayleigh found the value 9.98330 B.A. units. Thus either the coil and the standards have changed by exactly the same amount, which is improbable, for they are wires of different thickness, or they have all remained permanent. "On the Effect of Moisture in Modifying the Refraction of Plane Polarised Light by Glass." The author described some experiments he had been engaged in lately at the Cavendish Laboratory. Plane polarised light is made to fall on a plate or a wedge of glass at various angles, and the position of the plane of polarisation determined. It is found that this depends greatly on the hygrometric condition of the air in the neighbourhood of the glass. If moist air be blown on to perfectly clean glass the plane of polarisation of the emergent light is displaced from its normal position in one direction, while if dry air be blown it is displaced in the opposite direction. At an angle of incidence of 60 deg. the difference between the two positions is from 6 min. to 8 min. If, however, the glass be not perfectly clean, the effect of moisture is at first the same as that of dry air, though on stopping the draught an opposite effect is observed. The author assigns as the cause of this the heating of the surface, which, as Magnus discovered, is produced by a draught of moist air. He finds, on repeating Magnus's experiment, that the heating is not produced if the glass be clean, and he shows by an independent experiment that slight local heating does produce an effect on the plane of polarisation in the same direction as that due to the dry air.

Mr. Glazebrook also exhibited a spectrophotometer described by him in a paper read before the Cambridge Philosophical Society (Proc. Phil. Soc., vol. iv., part vi.), and made by the Cambridge Scientific Instrument Company from his design.

A note "On a Point in the Theory of Pendent Drops," by Mr. A. M. Worthington, was read by the secretary, Mr. Walter Baily. This was a note upon a paper recently communicated by the author to the Royal Society upon the measurement of the surface tension of a liquid from observations of the forms assumed by pendent drops. By making a measurement of a horizontal section of such a drop, and of the angle made by the tangent plane to the surface at the line where the section meets the surface with the horizontal, and knowing the density of the liquid, sufficient data are obtained to determine its surface tension. Professor Perry, remarking upon this paper, gave an account of some researches upon the subject in which, some years since, he had assisted Sir William Thomson. On the usually accepted theory of surface tension based upon the behaviour of liquids in capillary tubes, at every point of the surface of a liquid the equation

$$kp = \frac{1}{R} + \frac{1}{R^1}$$

must hold, where p is the pressure at that point or the difference of pressures on the two sides of the surface, R and R^1 the two principal radii of curvature, and k a constant. In the case of a drop whose surface is one of revolution about the vertical, the contour may be drawn from the equation; this was done, and theoretical drawings were made of a number of drops. These have since been compared by Sir W. Thomson with enlarged photographs of actual drops and the results are highly satisfactory. This law no longer holds in the case of a drop at its "critical point" or that point when it is about to fall, since here dynamical action comes in. Mr. Baily also read a paper by the same author "On a New Capillary Multiplier." This is an apparatus for the measurement of surface tension, and is a modification

of one used by M. Despretz. From one extremity of the arm of a balance is suspended a roll of platinum foil, consisting of a strip 50 centimetres long, and 5 or 6 centimetres broad, rolled up, the successive convolutions being prevented from touching by rolling up with the foil a number of small pieces of hard glass tubing about two millimetres diameter, which occupy the upper part of the helix, and preserve the form of the lower part. The coil is cleaned by igniting it in a Bunsen flame, and then suspending it with its lower end in the liquid to be examined. The increase in weight corrected for the part of the coil immersed is due to the fluid rising between the convolutions. From this the surface tension is readily calculated.

Mr. Hilger described a new solar eye-piece. In Professor Pickering's eye-piece there are two rectangular prisms of glass of slightly different refractive indices. The light of the sun undergoes partial reflection at the surface separating the two prisms, the ratio of the reflected to the incident light diminishing with the difference between the refractive indices. It is found, however, that such a prism under a high power always gives a double image due to the two glass surfaces, it being practically impossible even under enormous pressure to bring them into true contract. To obviate this, Mr. Hilger makes the second prism of Canada balsam, which gives the most satisfactory results, the image being pure and single.

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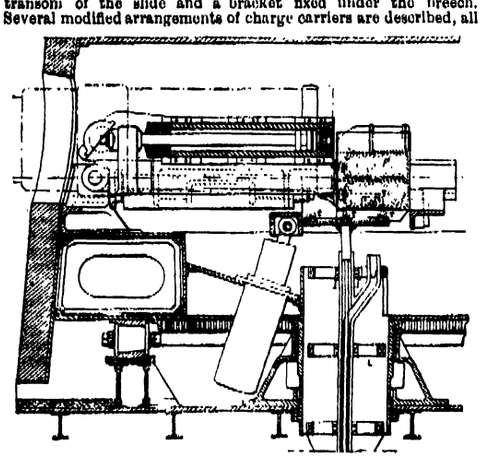
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ORDNANCE.

279. A. Sauvee, London. Working, Loading, and Checking the Recoil of Guns. [1*s.* 11 *Figs.*] January 2, 1884.—This relates to apparatus for loading guns in revolving turrets in any position of the platform on which is fixed the mounting of the gun, and for checking the recoil of the gun. Referring to the illustration, the charge is raised by a lift inside a tube L forming a central pivot attached to the platform on which rests the gun. The elevating apparatus consists of a hydraulic cylinder provided with two or more telescoping pistons, the smallest of which carries the table T provided with rollers *t* on which rests the charge carrier P containing the projectile, and two half charges of powder. The table is guided by slide blocks working in grooves in the guide bars I attached to the central tube L. The carrier P is guided by two side rollers p^2 working in grooves J in the guide bars I, which grooves branch off near the top of the tube, causing the charge carrier to travel backwards on the rollers *t*, and be brought into a position which will lead it behind the breech of the gun, when the rollers leaving the grooves; the continued ascent of the piston raises the charge carrier to the position shown between the rear transom of the slide and a bracket fixed under the breech. Several modified arrangements of charge carriers are described, all



having for object to bring it into position for loading. Any suitable apparatus may be provided for elevating or training the gun, for revolving the turret and ramming home the charge. The water for working the apparatus inside the revolving turret starts from a distributing box, the upper part of which is forced by means of the guide bars I to follow the revolving motion of the turret. The apparatus for running the gun in and out comprises a hydraulic cylinder sliding on a fixed piston, the rod of which is provided with two passages leading water to opposite sides of the piston. These passages are gradually closed by projections on the cylinder when at the limits of its stroke; they lead to a valve box where they are separated by a spring loaded valve. The passage leading to the near side of the piston also leads to the accumulator, and the other is provided with two stop valves, by which it can be connected to the accumulator or to waste. The action of the apparatus will readily be understood. In another arrangement the brake cylinders are also utilised for running the gun carriage in and out. A piston valve loaded by disc springs is arranged in the passages connecting the front and back ends of the brake cylinders. In this passage is arranged also the regulator valve, the position of which is regulated by means of a roller working in a slide groove cut in a bar attached to the gun carriage in such a manner that the pressure in the cylinders remains constant during the whole of the duration of the recoil. The valve is slightly raised during the first portion of the recoil, and then gradually recloses. Two other pipes leading to the ends of the cylinder can be connected to the accumulator or to waste by means of valves. (*Accepted October* 10, 1884).

666. H. S. Maxim, London. Machine Guns, &c. [10*d.* 18 *Figs.*] January 9, 1884.—The object is to utilise the force of the gases which issue from the muzzle of the gun at each discharge thereof to operate the breech mechanism of the gun or to store up energy to be subsequently used for extracting the empty cartridge case, cocking the hammer, bringing another cartridge into position for firing, and firing the same or preparing the arm for the next discharge. This is fully illustrated and described in our issue of November 7, 1884. (*Accepted October* 24, 1884).

11,863. J. B. and S. E. Howell, Sheffield. Blocks, Slabs, Plates, and Bars for Armour, Ordnance, &c. [2*d.*] August 15, 1884.—Two or more bars of iron or steel are twisted together and after heating are welded by forging, rolling, or pressing. (*Sealed November* 18, 1884).

PNEUMATIC CANNON.

4355. W. A. Bartlett, Washington, Col., U.S.A. Pneumatic Cannon. [6*d.* 9 *Figs.*] March 4, 1884.—This relates to cannon from which the projectile is driven by the force of an elastic gas generated or contained in some source of supply outside the chamber of the gun. The gun tube is of considerable length, is breechloading, and is surrounded by a flask or reservoir containing the compressed gas. A supply pipe leading from the flask to the gun tube near the breech is provided with a valve by which the passage of gas to the gun can be regulated. Referring to the illustration, the gun tube 1 is closed at the breech by the block 9, and passes from end to end through the flask 3 shown



constructed in sections connected together by means of flanges and packed joints. The gun tube is straightened by means of radial rods passing through the shell of the flask and through rings interposed between the sections. The radial rods bear on the gun tube, or are attached to a collar surrounding the said tube. As shown, a slide valve is employed for controlling the passage of the gas to the gun tube. The valve is opened by means of a pull rod, and is normally closed by a spring. A small pipe is connected with the gun tube near its muzzle, and leads to a small cylinder having a piston and rod bearing on a spring hook. When the projectile passes the muzzle, the piston disengages the hook, and the valve is closed. (*Accepted October* 8, 1884).

FIREARMS.

425. F. Beesley, London. Breakdown Hammerless Guns. [6*d.* 4 *Figs.*] January 2, 1884.—The lock mechanism is provided with a spring acting as a lifting or tumbler cocking lever when opening the gun, and as a spring for actuating the tumbler for discharging the gun when the gun is closed, and when the tumbler is released from the sear by the usual action of the trigger. These flat spring levers are pivotted at the front end of the action near the knuckle joint, and have their forward ends projecting beyond the knuckle joint, and lying under the barrels of the gun, and their rear ends extending into engagement with a slot in the lower forward part of one of the tumblers. A tumbling lever actuated by the under part of the barrels compresses the spring by the closing of the gun. (*Accepted October* 24, 1884).

9110. J. Victor, Du Quoin, Ill., U.S.A. Locks for Firearms. [6*d.* 9 *Figs.*] June 17, 1884.—The main spring is arranged and connected with the hammer, so that it effects the cocking of the same when the rear ends of the barrels are elevated, and also serves as the barrel check. The safety block for the hammer is connected with and operated by the trigger. An automatic trigger lock is connected with and operated by the lever, which locks the barrels in their normal position, so that when the lever is operated to admit of the dropping of the barrels, the trigger lock is released, and automatically engages the triggers. (*Accepted October* 24, 1884).

10,365. C. D. Abel, London. (*Archduke C. Salvator and G. H. Von Dormus, Vienna*). **Magazine Firearms.** [6*d.* 43 *Figs.*] July 19, 1884.—This has a vertically swinging breech block, an automatic cartridge conveyor, and a laterally attached or loosely hung magazine. The principal features are: The vertically swinging breech block adapted to automatically extract the exploded cartridge cases; the firing of the cartridges by means of a hammer, a mainspring, and a firing pin; the automatic introduction of the cartridges into the chamber of the arm; the operation of the parts by moving a guard lever backwards and forwards through a small angle; the arrangement of air suitable for the attachment of Mannlicher's magazine; the arrangement of magazine for the insertion of paper cartridge boxes; the arrangement of a lateral magazine having a fixed or removable cartridge box; the loading by means of a hopper, the arm being fixed in a special frame. The arrangement is such that when the guard lever is moved downward the hammer is cocked and a projection of the hammer disc is drawn away from under the breech block, whereby a bent blade spring connected with the breech block is freed so as to suddenly draw down the latter, the spring of the breech and withdrawal of the case being effected by the guard lever, which, when moved backward, forces the cartridge into position and closes the breech. (*Sealed November* 7, 1884).

PULLEYS.

504. J. H. Boddy, Leeds. Pulleys or Drums. [6*d.* 11 *Figs.*] January 3, 1884.—The rim of the wheel is of T section, the end of one spring spoke being connected to one side of the rim flange and the other end of the spoke to the reverse side of the boss flange. The spokes are fitted alternately in this manner. In another method springs are placed between an ordinary pulley rim and the rim of a concentric internal pulley, or the rim may be attached by spiral springs to arms projecting from a boss. (*Accepted October* 21, 1884).

617. W. G. Storey, York. Split Driving Pulleys. [2*d.*] January 4, 1884.—Pins on the boss of each half pulley fit into corresponding holes in the shaft. The boss and rim of one half pulley are made with lugs fitting into corresponding recesses made in the boss and rim of the other half, and secured by cross bolts with countersunk heads and nuts. (*Sealed October* 31, 1884).

1175. J. Bond, Longridge, Lanc. Lubricating the Bearings of Sheaves of Pulley Blocks, Loose Pulleys, &c. [4*d.* 3 *Figs.*] January 10, 1884.—The boss of the sheave pulley or wheel is formed with a series of triangularly-shaped cavities or recesses radiating from the axle which inclose a lubricant of a semi-liquid consistency, preferably the preparation known as "solidified oil." The apexes of the cavities are open to the axle, forming a series of narrow slots parallel to the axis. The sides of the cavities may be closed by a ring let into the boss. (*Accepted September* 23, 1884).

7092. O. R. Olsen, Indianapolis, Ind., U.S.A. Pulleys, [4*d.* 4 *Figs.*] May 1, 1884.—The rim is made of rolled metal and supported by means of a hub, spokes, and secondary rim cast in one piece. The secondary rim may be cast with lugs or projections on the side, one or more of the lugs or projections being placed at the inside of the joint of the rim and is rivetted to the rim. The hub and secondary rim may be in two parts. (*Sealed November* 14, 1884).

TUBING.

1869. J. T. Mason, Tunbridge Wells. Connection and Coupling of Pipes and Hose. [6*d.* 4 *Figs.*] January 22, 1884.—The one end has an undercut rim divided into eight parts, four being taken out, and on the other end is a sliding collar with a flat rim divided into eight parts, four being taken out so as to allow of insertion into the lower undercut rim. By turning the movable collar the junction is complete, and may be made permanent by a key spring. (*Accepted October* 7, 1884).

6065. J. B. Harris, Edinburgh. Hose Couplings. [6*d.* 4 *Figs.*] April 7, 1884.—That part of the coupling which enters the hose is formed with a ridge at about its middle, and the hose is tied at the rear and front of the ridge. The ridge may be extended to the rear so that the front half of the part shall be of less outside diameter than the rear part. (*Accepted September* 19, 1884).

3588. A. Ince, London. Union Joint for Lead Pipes without Solder. [6*d.* 7 *Figs.*] February 19, 1884.—The socket for receiving the end of the lead pipe is bored out at one end to the external diameter of the pipe and at the other end to a larger diameter, which is screw threaded. The end of the pipe after being passed through the smaller end of the socket is

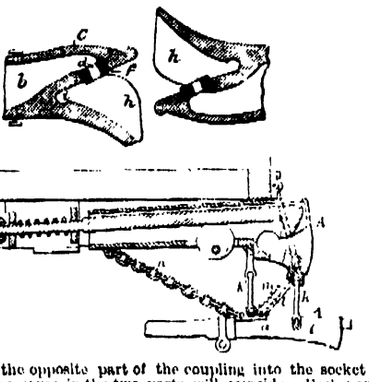


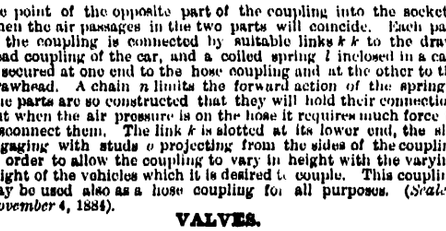
opened out and a screwed nipple having a conical end and bored out to the internal diameter of the pipe, is screwed into the larger end of the socket, forcing the lead pipe against the socket and making a perfect joint. The illustration shows the construction of a modified form of joint containing a thimble H. For jointing two pipes together two sockets and a double-end nipple are employed. (*Accepted September* 19, 1884).

6066. J. B. Harris, Edinburgh. India-Rubber Hose. [6*d.* 1 *Fig.*] April 7, 1884.—Brass wire cloth is coated with a preparation of india-rubber and cut into diagonal strips out of which the hose is made in the ordinary manner. (*Accepted September* 19, 1884).

9032. J. B. Harris, Edinburgh. India-Rubber Hose, &c. [4*d.* 2 *Figs.*] June 16, 1884.—The hose described in the former specification is surrounded with a coil of iron or other wire. The tube is finally enveloped with a strip of canvas. (*Accepted September* 30, 1884).

10,905. H. H. Lake, London. (*C. E. Mark, Flint, Mich., U.S.A.*) **Hose Couplings.** [6*d.* 4 *Figs.*] August 2, 1884.—The illustrations clearly show the construction of the coupling, which is in two similar parts. The cylindrical portion *a* of the coupling is attached to the hose, and has an air passage *b* which diminishes in size as it approaches the closed end of the device which terminates in a rounded hook formation *c*. The inclined diaphragm closing the end is provided with a small passage nearly at right angles to, and communicating with, the air passage, the outer face of the diaphragm being provided with an elastic packing *f* surrounding the small passage. The mouth of the coupling flares in two directions, sidewise from the inclined face of the diaphragm and in vertical cross section in order to guide





the point of the opposite part of the coupling into the socket when the air passages in the two parts will coincide. Each part of the coupling is connected by suitable links *k k* to the drawhead coupling of the car, and a coiled spring *l* inclosed in a case is secured at one end to the hose coupling and at the other to the drawhead. A chain *n* limits the forward action of the spring *l*. The parts are so constructed that they will hold their connection, but when the air pressure is on the hose it requires much force to disconnect them. The link *k* is slotted at its lower end, the slot engaging with studs *o* projecting from the sides of the coupling in order to allow the coupling to vary in height with the varying height of the vehicles which it is desired to couple. This coupling may be used also as a hose coupling for all purposes. (*Sealed November* 4, 1884).

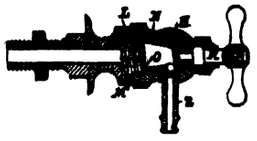
VALVES.

324. J. Hargreaves, Widnes, Lanc. Valves. [4*d.* 3 *Figs.*] January 2, 1884.—A metallic valve is combined with an india-rubber valve. A convenient construction consist of a flat circular metallic disc slightly smaller in diameter than the orifice to be closed, provided with a guide spindle and adapted to seat on arms or ribs so as to leave a small annular passage for fluid, and an india-rubber disc valve of larger diameter than the metallic disc valve, with the back of which it is held in contact by a binding plate. The india-rubber disc is adapted to close on a bevelled seating surrounding the metallic valve. (*Accepted October* 10, 1884).

689. B. Rhodes, London. Construction of Cocks or Valves. [4*d.* 3 *Figs.*] January 4, 1884.—The barrel of the valve is parallel and is fitted with a plug which can be raised and lowered by means of a screwed spindle. Within the barrel the plug is formed of an elastic material (such as described in Specification 1334 of 1879), which is compressed between a bearing in the lower part of the casing, and the inexpansible part of the plug, when the latter is forced down and perfectly fills up the passage way. (*Accepted October* 8, 1884).

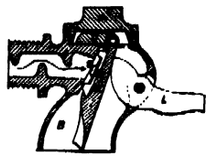
11,025. L. D. Craig, San Francisco, U.S.A. Valves or Cocks. [6*d.* 8 *Figs.*] August 7, 1884.—The outer case K of the valve has a screw thread at L working in a female screw M

on the hydrant or pipe connection. A valve plug rests upon a washer O resting on a spring which holds the plug firmly in its seat. The valve is operated by means of a key R having a square end



fitting in socket in the plug N, the port being brought into coincidence with or moved away from the discharge pipe Z. In a modification the plug N is fixed and the pipe Z is attached to a loose cone fitting over the plug; by turning the pipe Z the water is turned off or on. (*Sealed November* 11, 1884).

11,737. H. Trott, London. Ball Valves for High and Low-Pressure Water, &c. [4*d.* 2 *Figs.*] August 28, 1884.—Referring to the illustration, the valve is provided underneath with a full water outlet B. The inner valve C is bevel-shaped, so that whenever the ball lever L descends the flap valve E will follow and keep against the end of the lever. The valve E has hinged or side pin bearings D attached to the top of the valve



casing, and its lower end is prolonged and formed into a half-round shape to keep the water close. The valve E being jointed to the movable bearings D, it can readily be removed by unscrewing the top A, and is pressed by the lever L so as to bear equally all round its seating. The lever L is fixed to the casing as shown. Cross bridges F are cast in the inlet to the valve to resist part of the direct high-pressure water on the valve seating when open. (*Accepted October* 3, 1884).

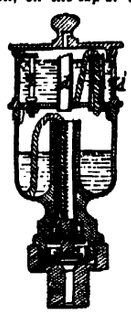
11,766. H. J. Pearson, Nottingham. Throttle Valves. [4*d.* 4 *Figs.*] August 29, 1884.—The cap or cover of the aperture and the frame which receives the valve disc are all cast in one in that class of valves in which the valve disc can be removed by a side aperture in the casing. (*Accepted September* 30, 1884).

LUBRICATORS.

678. J. Dewrance and G. H. Wall, London. Lubricators for Steam Engine Cylinders. [4*d.* 2 *Figs.*] January 4, 1884.—A valve seat is formed on the upper end of a central tube communicating with the steam cylinder. A valve having a long guide fitting loosely in the tube rests on the seat and is drilled centrally, and receives a spindle. When steam is admitted to the cylinder it raises the valve and passes into the oil vessel; when the pressure in the cylinder declines the inlet valve closes, and the pressure in the reservoir being greater than that in the cylinder, a small quantity of oil is forced past the spindle in the valve. (*Accepted October* 17, 1884).

2421. J. Baguely and W. Eastwood, Ashton-under-Lyne. Lubricators. [6*d.* 2 *Figs.*] January 31, 1884.—This consists of a closed vessel, having at its top a pipe furnished with a sight feed to convey the oil to the part to be lubricated, and at or near the bottom a pipe to introduce water under pressure beneath the oil whereby it is forced to the cylinder or other place to be lubricated. The supply pipe is provided with a stop-cock and regulating tap. (*Sealed November* 18, 1884).

12,101. H. P. J. Kessler, Oberlahnstein-am-Rhein. Lubricators. [4*d.* 4 *Figs.*] September 6, 1884.—This relates to lubricators with capillary wicks, the object being to maintain a constant level in the oil cup, and to provide for increasing or lessening the supply. A second oil cup with capillary wicks is arranged above the ordinary cup, and supplies it with oil. Referring to the illustration, on the top of the ordinary cup having



a capillary wick is fixed a second cup having a central tube *d* and several other tubes *d*1. One or more of these tubes may be provided with wicks for supplying the lower cup A with oil. A screw plug *g* has taper grooves in its screw, so that, according as it is screwed more or less down, there is a greater or lesser flow of oil from the upper to the lower cup. The grooves may be formed in the female screw. (*Accepted October* 10, 1884).

LOCK NUTS.

8176. W. Morley, London. Preventing Nuts and Bolts from Working Loose. [6*d.* 6 *Figs.*] May 26, 1884.—A washer having a projecting on its underside to prevent it from rotating is placed on the screwed end of the bolt, the washer and bolt being so formed that they cannot rotate independently. The nut is provided with a series of radial ratchet teeth on its underside in which takes a spring pawl arranged in a groove in the upper side of the washer. (*Accepted October* 17, 1884).

6505. T. K. Meller, Huddersfield. Lock Nuts and Bolts. [4*d.* 7 *Figs.*] April 18, 1884.—A pin is inserted longitudinally between the nut and the bolt in a groove cut partly in the one and partly in the other. The pin either passes through the end of the nut or through a special hole to the side of the nut, and the two ends are turned over or twisted together. *Accepted October* 17, 1884).

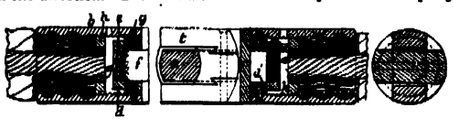
BELTS.

435. G. H. Hebblethwaite, Huddersfield. Fasteners of Driving Belts. [4*d.* 5 *Figs.*] January 2, 1884.—Two or more metal plates perforated for the reception of stitches or rivets and connected to each other by a knuckle joint or by links are employed. (*Accepted September* 26, 1884).

1955. J. B. Harris, Edinburgh. Machinery Belting. [6*d.* 2 *Figs.*] January 21, 1884.—Metallic nails or studs are inserted in the belts, bands, or straps so as to protect the whole of the inner surface from tricipal contact with the face of the driving pulley. (*Accepted September* 26, 1884).

ROPE COUPLING.

6186. M. Pataky, Berlin. (*A. Engelmann, Hanover*). Couplings for Rope Transmissions. [4*d.* 9 *Figs.*] April 8, 1884.—Referring to the illustration, the outer diameter of the shell *b* of the coupling is of the same size as the diameter of the hemp or wire rope, and the entire length of the coupling is as short as possible. The shell *b* is provided internally with a round coarse thread for the reception of the end of the rope and a sharp fine thread for the reception of discs *h* and *d*1 connected with the movable eye *c*. The disc *d*1 is movable on the shank *f* of the eye *c* and is screwed into the shell *b* and secured by screws *g*. A disc *d* screwed on the end of the shank *f* is provided with ratchet teeth fitting into similar teeth on the disc *d*1, which can thus only turn in one direction. The discs *d* *d*1 of the second part of the coupling



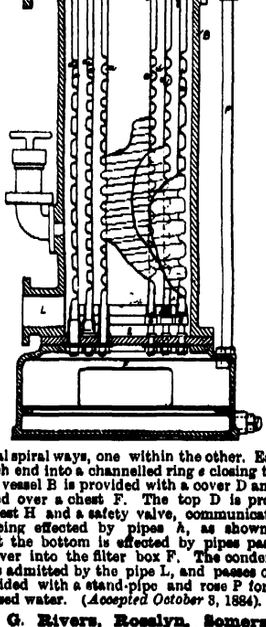
have no ratchets and are free to act as a swivel. If the rope has a wire core, the core is made red hot, a thread impressed upon it, and it is screwed into the box *a*, the hemp squeezing itself between *a* and *b*, the two being connected by the disc *h*. The space between the discs *h* and *d* and between the disc *d*1 and eye *c* are each equal to the depth of ratchet teeth, so that the eye can be turned in the one direction. If there is no wire core the box *a* and disc *h* are omitted. The eyes *c* are provided with removable swallow tail-shaped insertion pieces fastened by the screw *i*. The rope may be inserted in a smooth shell *b* and secured by a wedge to the inner side of which the wire is soldered. The length of the rope can be adjusted by turning the eye *c* by means of a hook key. (*Accepted September* 23, 1884).

INJECTORS.

679. J. Dewrance, London. High-Pressure Injector. [4*d.* 5 *Figs.*] January 4, 1884.—The casing around the steam cone, the mixing cone, and the overflow space, between the mixing cone and the delivery cone, are made in halves, one half being in the body of the injector and the other half in a removable cover secured to the body of the injector by bolts. (*Sealed November* 18, 1884).

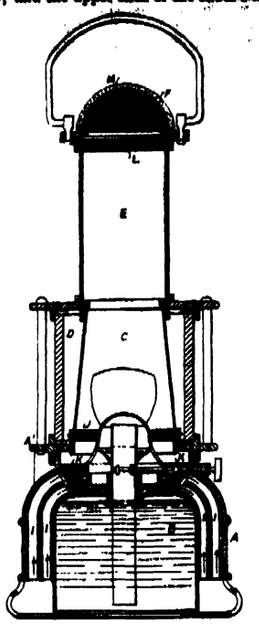
MISCELLANEOUS INVENTIONS.

4690. F. Hocking, Liverpool. Apparatus for Condensing and Cooling. [8*d.* 10 *Figs.*] March 11, 1884.—A spiral way, ways or passages are formed by or in tubes, and in which the steam and water pass a number of times round the tube. Referring to the illustration, the spiral passages *a* are formed by spirally indenting the surfaces of the tubes *b* by spiral grooves *d*, the grooves bearing against the internal tube *b*1, and forming a spiral passage as shown. The inner or outer or both tubes may be spirally indented, or a spiral bar or tube may be placed between two plain tubes. As shown the condenser is formed



of three conical spiral ways, one within the other. Each spiral way is fitted at each end into a channelled ring *c* closing the ends of the ways *a*. The vessel B is provided with a cover D and a bottom E, and is mounted over a chest F. The top D is provided with a steam inlet chest H and a safety valve, communication with the passages *a* being effected by pipes A, as shown. The communication at the bottom is effected by pipes passing through the bottom cover into the filter box F. The condensing or circulating water is admitted by the pipe L, and passes out at M. The box F is provided with a stand-pipe and rose P for inlet for air to the condensed water. (*Accepted October* 3, 1884).

4663. E. G. Rivers, Roselyn, Somerset. Safety Lamp. [6*d.* 1 *Fig.*] February 27, 1884.—A mica cone surrounds the flame of the lamp, and prevents breakage of the glass cylinder. Referring to the illustration, the oil reservoir B is surrounded by a jacket or casing A forming the base of the lamp, and is surmounted by a ring or annular piece A' which supports a tubular piece C of mica and a glass cylinder D. The upper end of the mica cone C is surrounded by a copper chimney E closed at its upper end by a hood F covered with asbestos cloth. Apertures at the base of the lamp communicate with vertical tubes I which conduct the air directly to the flame. The tubes I are of such length in proportion to their diameter that it is not possible for any flame to pass through them. The base of the cone C is closed by wire gauze J, and the upper ends of the tubes I are covered by



a ring K of wire gauze. The chimney outlet is protected by wire gauze L and M. The cotton wick is furnished with a woven asbestos fibre tip. (*Sealed October* 28, 1884).

11,679. J. J. Coleman, Glasgow. Mechanically Cooling Air. [4*d.* 4 *Figs.*] August 27, 1884.—The framework is in the form of a deep hollow rectangular casing at the top of one end of which are three bearings for a crankshaft formed with two cranks, which both lie in the same direction. At the other end of the top are two gas motor cylinders arranged as in the "Otto" twin motor. In the axial line of one cylinder, and between it and the corresponding crank is an air-compressing cylinder, an air-expansion cylinder being similarly placed with reference to the other cylinder. The same piston rod serves for each of the two axial pairs of cylinders, and is connected to the cranks. The air is drawn into the compression cylinder through a pipe connected to the side of the framing so that the air drawn in will be cooler than the general atmosphere, either in consequence of its being waste cold air, or in consequence of sprinkling the parts near with water. The compressed air after being partly cooled by water injected into the cylinder is led to a tower where it is cooled by water injected into the tower and falling down through a series of perforated plates therein. The air passes from the top of the tower to a casing within and near one end of the bed frame from which it passes through a number of horisontal drying pipes to a similar casing at the other end of the framing, from which it passes to the valve chest of the expansion cylinder. The sides of the framing are formed with openings through which waste air from the space cooled by the machine may pass. The horizontal drying pipes may be sprinkled with water. (*Accepted September* 30, 1884).

138. J. M'G. Croft, London. Wooden Pavement. [6*d.* 5 *Figs.*] January 1, 1884.—The lower portions of the wooden paving blocks are formed with grooves or channels, and the blocks are laid in rows transverse to the road, so that the groove or channel of one block aligns with those of the adjoining blocks. At the sides of the roads the blocks have channels or grooves arranged lengthwise of the road and connected with the transverse grooves or channels. The grooves serve to drain the roads. (*Accepted October* 24, 1884).

11,021. A. Hubner, Cologne-on-Rhine. Retaining Walls. [4*d.* 3 *Figs.*] August 7, 1884.—These are formed of a shell or framing, their front and lower surfaces being connected at intervals by metallic or other back stays and filled in behind with a backing of earth. (*Sealed November* 11, 1884).

11,539. A. Browne, London. (*J. G. Dreyfus, Paris*). Springs. [4*d.* 4 *Figs.*] August 22, 1884.—The spring is composed of a bar having a [J-shaped cross-section, and corrugated sides provided with corrugated outwardly projecting flanges. The sides and flanges taper towards the ends of the bar. (*Accepted October* 10, 1884).

8345. W. H. Chapman, Lewisham, Kent. Ventilating Mines, Sewers, Buildings, &c. [8*d.* 7 *Figs.*] May 28, 1884.—A series of ejector nozzles are arranged in a circle around the upper end of the shaft, and connected by a pipe with a pump, blower, or ventilating cowl. (*Sealed November* 11, 1884).

8110. T. Redman, Leeds. Mercurial Gas Governors. [6*d.* 4 *Figs.*] May 23, 1884.—The horizontal way forming the inlet to the governor and passing along the underside of the apparatus is extended to allow room for a boss to be cast on it, the upper outlet way being extended in a similar manner in the opposite direction. The inlet and outlet pipes are connected to these bosses, or to bosses on the lower and upper sides of the governor respectively. By this arrangement the governor can be arranged for horizontal or vertical pipes. (*Sealed November* 18, 1884).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

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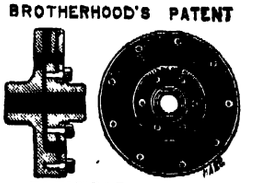
PETER BROTHERHOOD,

MECHANICAL ENGINEER,

BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.

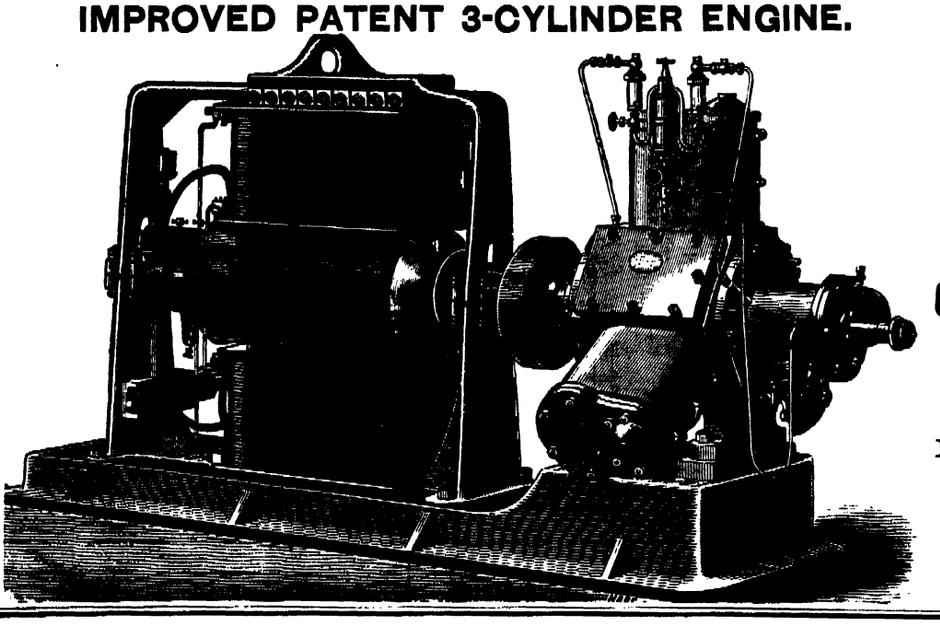
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1540 OF THESE BOILERS ARE NOW IN USE. They are the lightest and most economical in the market. We can show several 50 HP. Boilers occupying a floor space of only 6 ft. 6 in. square, which are evaporating 10.93 lbs. of water per lb. of coal, after eight years' hard work.

140,000 TUBES HAVE BEEN SUPPLIED FOR INSERTION IN EXISTING BOILERS. 5044

LEWIS OLRICK & CO., BOILER MAKERS to H.M. GOVERNMENT. Offices: 27, Leadenhall Street, London.



Down-draught arrangement.

REGISTERED TRADE MARK

PHOSPHOR BRONZE

THE BEST AND MOST DURABLE METAL FOR
BEARINGS AND BUSHES OF EVERY DESCRIPTION; HYDRAULIC PUMPS, PINIONS, VALVES, &c., &c.
Wire, Tubes, Sheets, Rods, Steam Fittings, Tools, &c. {2996 1475

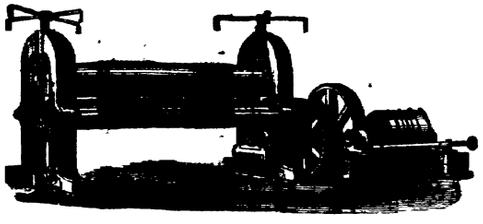
SOLE MANUFACTURERS UNDER SEVERAL PATENTS- 1475

The PHOSPHOR BRONZE COMPANY, Limited, Sumner & Emerson Streets, Southwark, London, S.E.

TANGYES LIMITED CORNWALL WORKS, BIRMINGHAM

LONDON: 35, Queen Victoria Street. NEWCASTLE: St. Nicholas Buildings. MANCHESTER: Deansgate. GLASGOW: Argyle and Hope Streets. (G.)

PLATE STRAIGHTENING AND BENDING ROLLS



The above are suitable for Rolling complete rings; the top roll being easily removable.

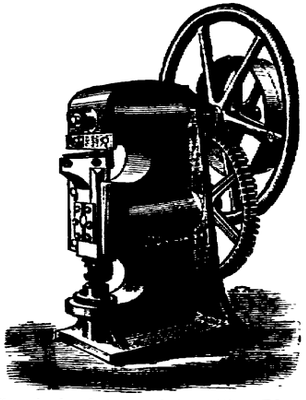
The rolls can be arranged for angle or T iron if required, at a slight extra cost.

The Price includes both Striking Gear and Foundation Bolts.

No.	To take Plates.	Thickness of Plates rolled cold.	Diameter of top Roll.	Diameter of bottom Rolls.	Approx. weight.	Price	If Arranged to bend L or T Iron, extra.
1	6 ft. wide	½ in.	10 in.	8 in.	105 cwt.	£145	£10 0 0
2	7 ,, ,,	½ ,,	10 ,,	8 ,,	115 ,,	155	10 0 0
3	7 ,, ,,	½ ,,	12 ,,	10 ,,	180 ,,	190	10 0 0
4	8 ,, ,,	½ ,,	12 ,,	10 ,,	195 ,,	205	15 0 0
5	9 ,, ,,	½ ,,	14 ,,	10½ ,,	210 ,,	220	20 0 0

180

PUNCHING AND SHEARING MACHINE

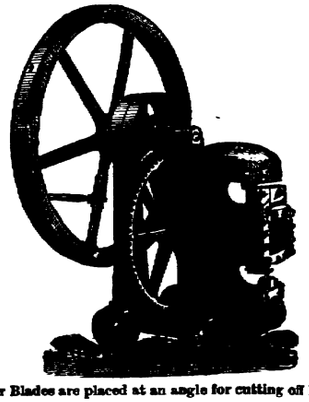


The Shear is placed at an angle for cutting off long bars.

No.	Will Punch Holes diam.	Through Iron Plates thick	Will Shear Iron Plates thick	Distance from edge of Plate		Approx. Weight	PRICE
				Shears	Punch		
A	1 in.	1 in.	1 in.	12 ins.	16 ins.	95 cwts.	£110
B	⅞ ,,	⅞ ,,	⅞ ,,	9 ,,	11 ,,	40 ,,	60
C	¾ ,,	¾ ,,	¾ ,,	7 ,,	8 ,,	19 ,,	38
D	⅝ ,,	⅝ ,,	⅝ ,,	6 ,,	6 ,,	11 ,,	25

One Round Punch and Die included in price. 181

PUNCHING AND SHEARING MACHINE



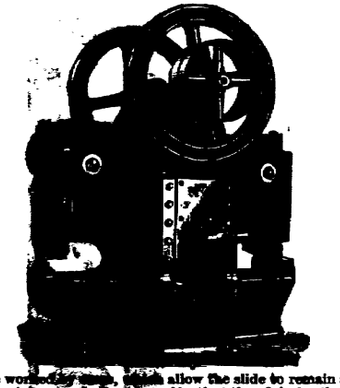
The Shear Blades are placed at an angle for cutting off long bars.

No.	Will punch holes diam.	Through Iron Plates thick.	Will shear Iron Plates thick	Distance from edge of Plate		Approx. weight cwts.	To work by Power only.	To work by Hand and Power.	If mounted on four wheels extra
				Shears	Punch				
1	⅝ ins.	⅝ ins.	⅝ ins.	8 ins.	8 ins.	15	£30	£33	£2
2	¾ ,,	¾ ,,	¾ ,,	10 ,,	8½ ,,	25	53	48	3
3	⅞ ,,	⅞ ,,	⅞ ,,	11 ,,	12 ,,	22	55	48	3
4	1 ,,	1 ,,	1 ,,	10 ,,	12 ,,	45	66	70	3
5	1 ,,	1 ,,	1 ,,	18 ,,	18 ,,	90	105	110	4

Punches and Dies to punch under any of the sizes named, extra.
Note.—No. 5 Machine is Double-geared. 182

IMPROVED LEVER

PUNCHING AND SHEARING MACHINE

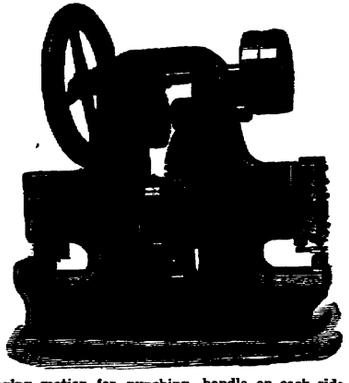


The Levers are worked by cams, which allow the slide to remain at the top during part the revolution, giving ample time for adjusting the plate for the next hole. This Machine can consequently be worked at a quicker speed than the ordinary Eccentric Machines. With Disengaging Motion for punching and for angle iron.

No.	Will punch Holes, diam.	Through Iron Plates, thick	Will shear Iron Plates, thick	Distance from edge of Plate	Will Shear Angle Iron	Price without Angle Iron Shears	If fitted with Angle Iron Shears, extra
1	¾ in.	¾ in.	¾ in.	14 in.	3×3×½	£100	£20
2	1 ,,	1 ,,	1 ,,	18 ,,	4×4×½	130	25
3	1 ,,	1 ,,	1 ,,	24 ,,	4×4×⅝	220	25
4	1¼ ,,	1¼ ,,	1¼ ,,	24 ,,	6×6×⅝	220	30
5	1¼ ,,	1¼ ,,	1¼ ,,	30 ,,	6×6×1	260	30

Punches and Dies to punch under any of the sizes named, extra. 184

PUNCHING AND SHEARING MACHINE



With disengaging motion for punching, handle on each side, and disengaging motion for angle iron.

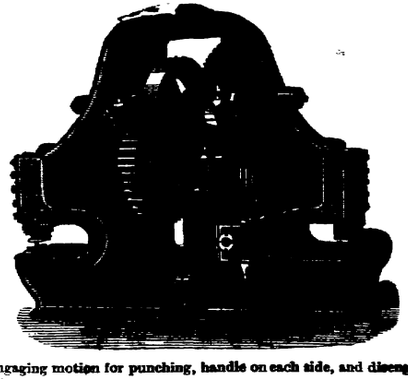
No.	Will punch holes diam.	Through iron plates thick	Will shear iron plates thick	Distance from edge of plate	Will shear angle iron	Approx weight without angle iron shears	Approx weight with angle iron shears	Price without angle iron shears	Price with angle iron shears	If with steam Engine extra
*0	¾ ins.	¾ ins.	¾ ins.	16 ins.	3×3×¼	3 tons	3½ tons	£90	£102	..
1	1 ,,	1 ,,	1 ,,	14 ,,	4×4×½	5 ,,	5½ ,,	132	144	£20
2	¾ ,,	¾ ,,	¾ ,,	18 ,,	4×4×⅝	5½ ,,	6 ,,	144	156	20
3	1¼ ,,	1¼ ,,	1¼ ,,	18 ,,	6×6×1	6½ ,,	7½ ,,	180	192	25
4	1 ,,	1 ,,	1 ,,	24 ,,	6×6×1	7½ ,,	7½ ,,	192	204	25

Punches and Dies to punch under any of the sizes named, extra. 183

*This Machine has single power Gearing.

POWERFUL

PUNCHING AND SHEARING MACHINE



With disengaging motion for punching, handle on each side, and disengaging motion for angle iron.

Will punch holes diam.	Through Iron Plates thick	Will shear Iron Plates thick	Distance from edge of Plate	Will shear angle Iron	Approx. weight with angle Irons and steam Cylinder	Price without angle Iron Shears	Price with angle Iron Shears	If with steam Engine, extra
1½ ins.	1½ ins.	1½ ins.	26 ins.	6×6×1	15 tons.	£330	£360	£30

Punches and Dies to punch under any of the sizes named, extra. 185

Copyright. Entered at Stationers' Hall.

DICK, KERR & CO., Engineers and Contractors, (Five Medals awarded, Calcutta International Exhibition, 1883-4.)



SOLE MANUFACTURERS OF

KERR'S PATENT

PORTABLE

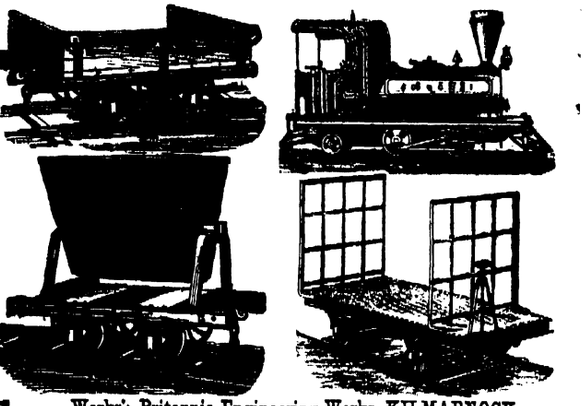
RAILWAY

SUITABLE FOR MINES AND PLANTATIONS

WAGONS & LOCOMOTIVES

FOR ALL CLASSES OF WORK.

Catalogues and Prices on application. 5024



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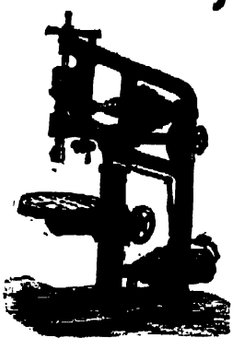
MAKERS OF ALL KINDS OF

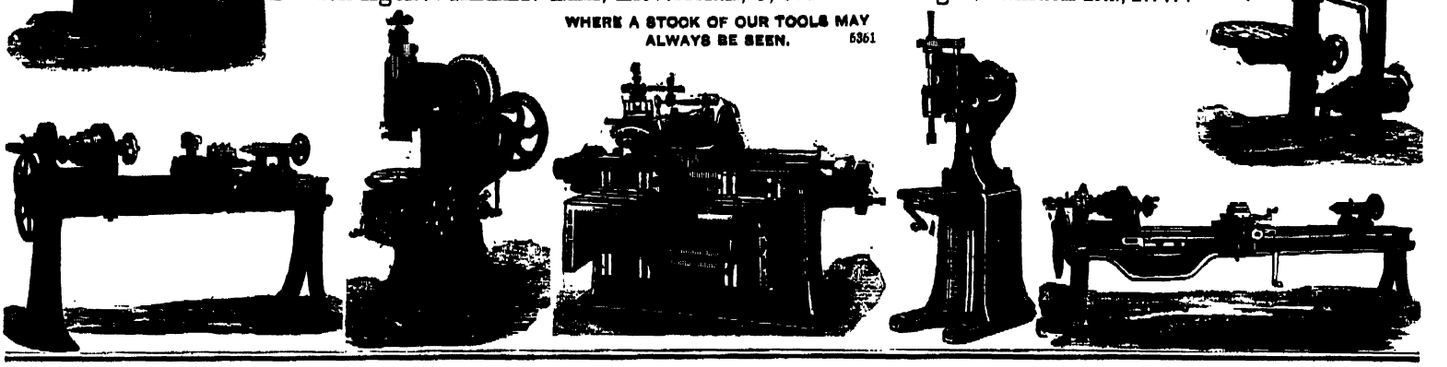
LATHES, PLANING, SHAPING, SLOTTING, DRILLING AND BORING MACHINES, &c., &c.

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London Agent: ALLEN LEE, Electrician, 3, Camden Cottages, Camden Rd., N.W.

WHERE A STOCK OF OUR TOOLS MAY ALWAYS BE SEEN. 5361





New Patent Barring Engine.

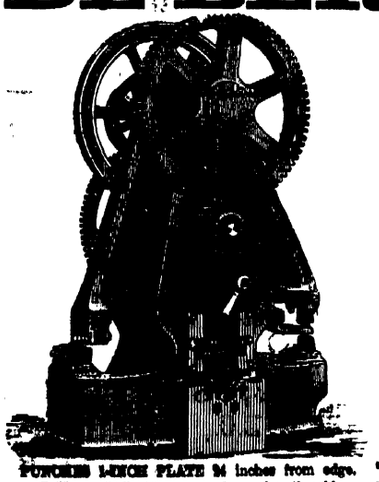
AUTOMATIC MOTION FOR MOVING INTO GEAR, AND FALLS OUT OF GEAR AUTOMATICALLY WHEN MAIN ENGINE STARTS.

The SIMPLEST, SAFEST and BEST, and also the CHEAPEST Automatic Safety Apparatus for Turning Main Engines.

Sole Makers: HICK, HARGREAVES & CO., ENGINEERS, MILLWRIGHTS, AND BOILER MAKERS.

SOHO IRONWORKS, BOLTON. 5199

DE BERGUE & COMPANY, LD.,



PUNCHING 1-INCH PLATE 24 inches from edge. CUTS ANGLE IRON 8×5×⅞, any length cold.

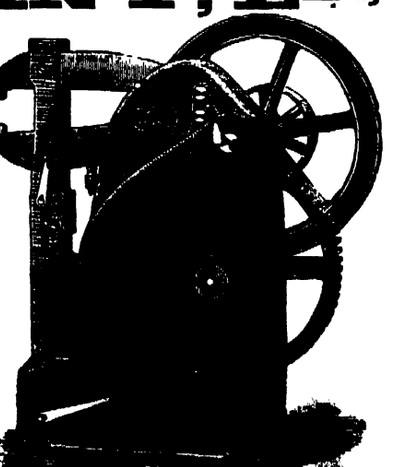
ENGINEERS, CONTRACTORS,

AND MAKERS OF

Punching and Shearing Machines,
Boiler and Girder Riveting Machines,
Flange Riveting Machines,
Angle and Tee Iron Straightening Machines,
Rail Straightening Machines,
Rivet-making Machines, Rivets,
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Plate Mill Shearing Machines,
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WROUGHT IRON BRIDGES, GIRDERS, AND ROOFING.

MANCHESTER.



PATENT FLANGE RIVETING MACHINE.

JOHN LYSAGHT, Limited,

TRADE MARK. TRADE MARK.

IRON ROOFS & BUILDINGS,

DESIGNS AND ESTIMATES UPON APPLICATION.

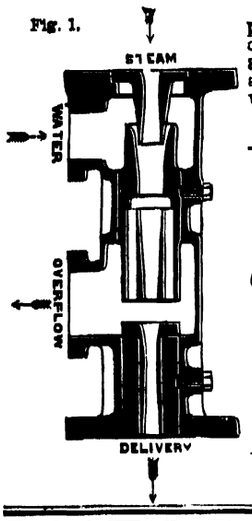
GALVANIZED CORRUGATED AND PLAIN SHEETS.
GALVANIZED STEEL SHEETS FOR WORKING UP.
GALVANIZED WIRE, WIRE NETTING, TANKS, &c.
WROUGHT AND CAST IRON GIRDERS, COLUMNS, &c.

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WOLVERHAMPTON: SWAN GARDEN MILLS.
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GRESHAM'S PATENT IMPROVED SELF-ACTING INJECTOR

For Supplying Stationary, Locomotive, Agricultural, or Marine Steam Boilers with Water.

Fig. 1.



The Self-acting Injector possesses the following **great advantages over all other** Injectors:—It is **perfectly** Automatic, and **cannot fail** to work. It will lift its water supply **15 ft.**; and can, when specially ordered, be made for **greater lifts.** It will work with **more ease** and **certainty** with **hot water** than **any** other Injector. If it ceases working from **any cause** (for instance, shortness of water, and consequent admission of air), it will **re-start Automatically** immediately the cause is removed. It will work **equally well** at **any pressure** from 10 lb. to 200 lb. It may be fixed in **any position** above or below the water supply.

The combining and receiving Cones of Fig. 2 can be taken out and cleaned without breaking any pipe joints.

The above and every other class of Injector, Ejector, and Elevator in stock and in progress; also Brass Fittings for Locomotive and other Boilers.

Upwards of **100,000** *of Gresham's Patent Injectors are now in use.*

GRESHAM & CRAVEN,

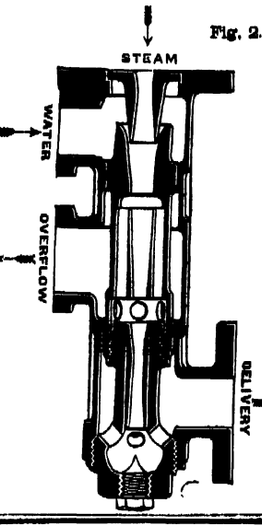
ENGINEERS, PATENTEES, & MANUFACTURERS,

Craven Ironworks, South Hall Street, Ordsal Lane, Manchester.

LONDON OFFICE:
A. L. SACRE, 60, QUEEN VICTORIA STREET, E.C.

AGENTS.—Glasgow: WILLIAM LESTER, 58, Renfield Street. Newcastle-on-Tyne: TANGYE BROS., St. Nicholas Buildings. Birmingham: TANGYES LIMITED, Soho. 5089

Fig. 2.



ROOT'S PATENT STEAM BOILER.

NEW MODEL

WITH

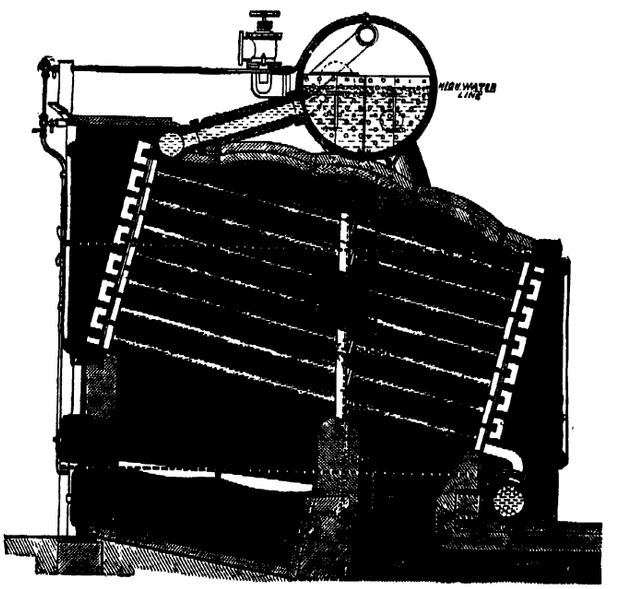
STOLLWERCK'S PATENT FEED-WATER PURIFIER.

High Pressure and Large Power with Safety Capacious Water and Steam Space.

—PERFECT CIRCULATION.—

GREAT EFFICIENCY AND ECONOMY.

Sulphates, Carbonates, and other Impurities Intercepted and Readily Removed from Purifier. Generative part of Boiler Continuing Free from Scale.



FOR PRICES AND PARTICULARS APPLY TO

THE PATENT STEAM BOILER CO.

—(ESTABLISHED 1869.)—

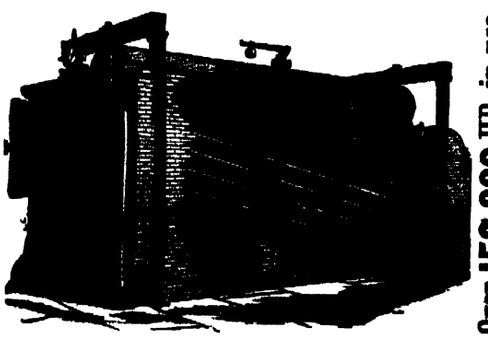
HEAD OFFICE AND WORKS: 28, HENEAGE STREET, BIRMINGHAM.

LONDON OFFICE: 11, QUEEN VICTORIA STREET, E.C.

CONRAD KNAP, REPRESENTATIVE. 5418

THE BABCOCK AND WILCOX CO.

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Over 150,000 HP. in use.

PATENT

WATER-TUBE STEAM BOILER.

Safe, Economical (as to space and fuel), and Durable; Having Perfect Water Circulation, and Spacious Steam-room; Easy of Transportation, and perfectly Accessible for Cleaning external and internally.

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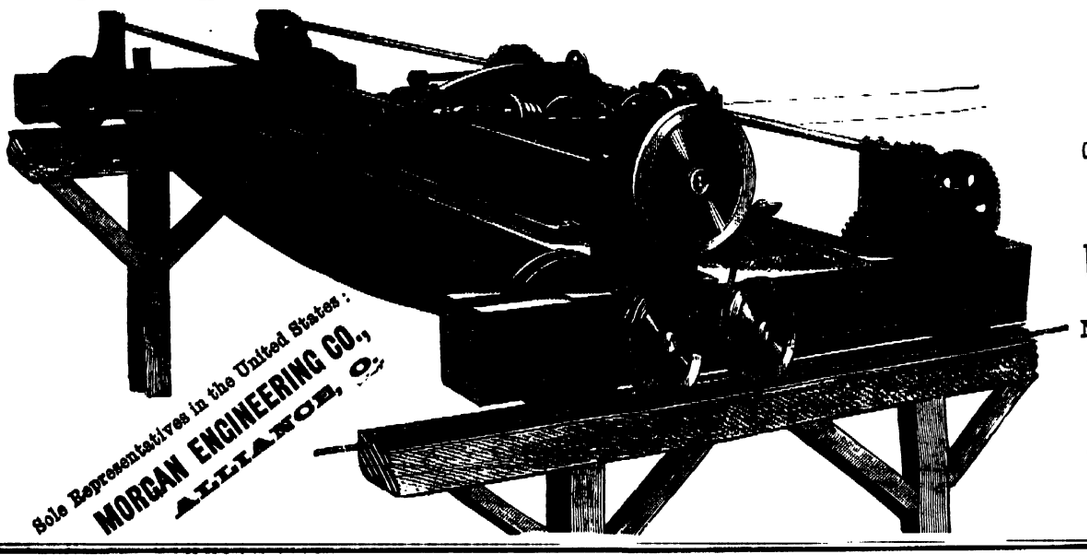
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And Lifting Machinery of all descriptions.

Boilers.
All types of Land and Marine, and in all sizes.



STEAM ENGINES
Of all types and powers for Mills, Mines, Water Works, &c.

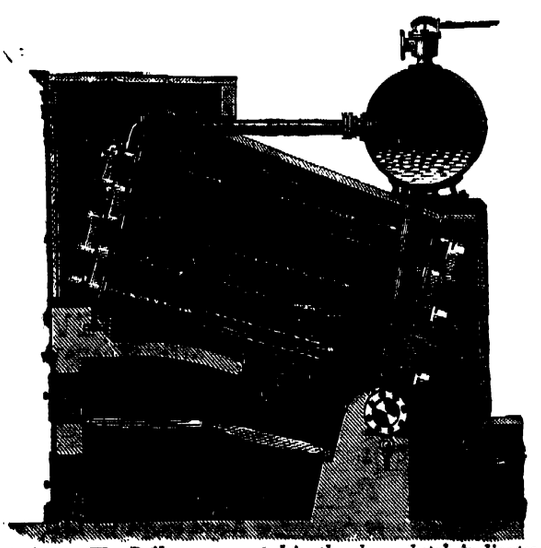
Winding Gear,
PUMPING MACHINERY,
Combined or separate.

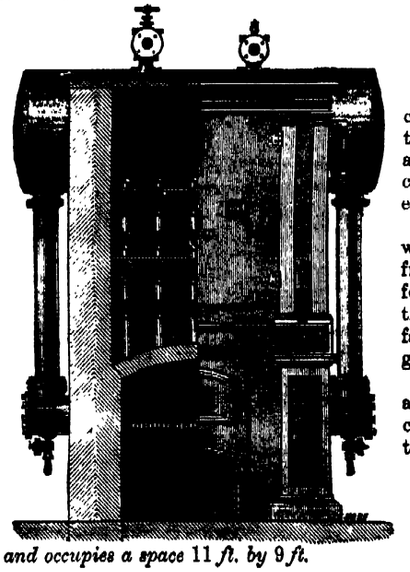
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Iron Roofs and Girder Work of all kinds. 4946

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ANNULAR WATER-TUBE SYSTEM.

FOR
FULL PARTICULARS,
Apply to
G.G.M. Hardingham
Engineer,
191, Fleet Street,
LONDON, E.C.





By this improved construction of Water-tube Boiler, considerable economy in first cost and in working is effected.

Although the waterways are exceptionally free from liability to fouling, the construction affords peculiar facilities for their regular inspection.

The system further allows of extreme compactness being attained.

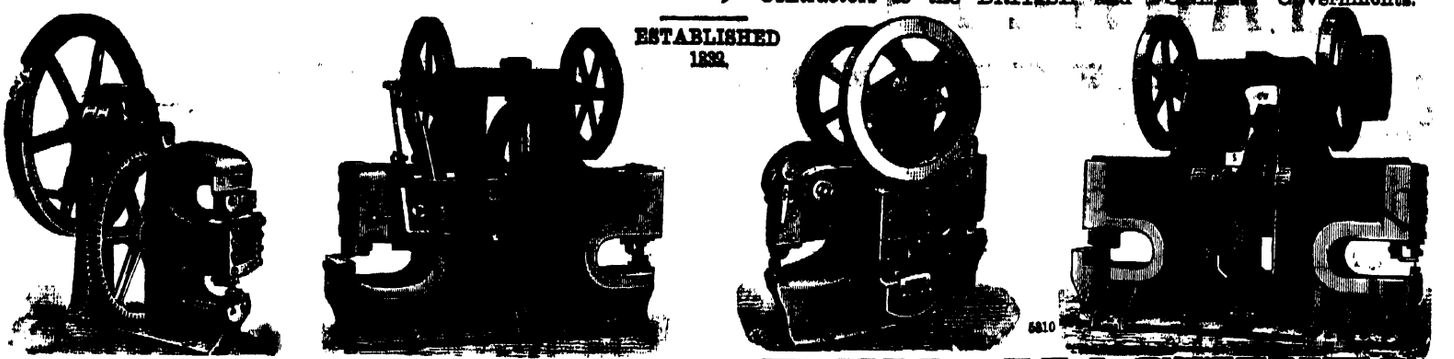
The Boiler represented in the above sketch indicates 110 *HP., and occupies a space* 11 *ft. by* 9 *ft.* 4967

FRANCIS BERRY & SONS, Ironfounders, Engineers, and Tool Makers,

SOWERBY BRIDGE, ENGLAND.

Contractors to the BRITISH and FOREIGN Governments.

ESTABLISHED 1832.

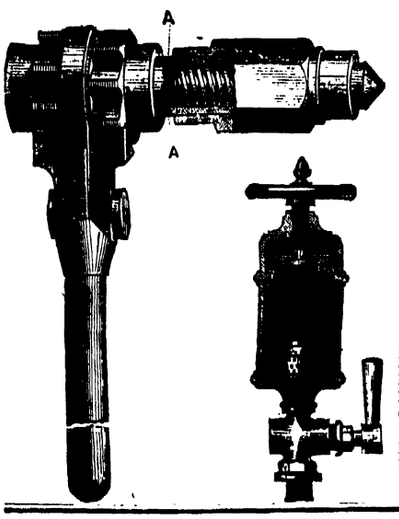


PUNCHING & SHEARING MACHINES.

NETTLEFOLDS LIMITED, BIRMINGHAM,

SOLE MANUFACTURERS OF

WESTON'S PATENT DIFFERENTIAL RATCHET BRACE.—STORER'S PATENT OPEN TOP SUET LUBRICATOR.



These BRACES, which have been several years before the public, and are MUCH APPRECIATED by them, NETTLEFOLDS have lately CONSIDERABLY IMPROVED by enclosing the SCREW in a SLEEVE (A) which always PROTECTS it from INJURY either from DIRT or BLOWS. This SLEEVE also acts as a GUIDE for the NUT, thus keeping it steady throughout the whole of its traverse, and consequently enabling the drilling to be effected with PERFECT ACCURACY.

The SUET LUBRICATOR has effected a saving of 70 per cent. in the cost of lubricating material used for Nettlefolds' Engines, and has now been fully tested in their works on 15 Cylinders working to 750 horse-power.

Messrs. HICKS, HARGREAVES & Co. write:—"We find the saving in *excess* of that stated in Messrs. Nettlefold & Chamberlain's Report—viz., 70 per cent., and the cylinders to which these Lubricators have been applied are in beautiful condition. We shall adopt them for all our engines."

By this Invention the steam is lubricated before passing to the valves, while the supply of grease is uniform and constant.

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GLASGOW ..	W. McGeoch & Co., Schaffer & Budenberg.	DERBY	Handyside & Co.
EDINBURGH..	Redpath, Brown & Co., Thos. Scott.	RUSSIA	Sumner, John M. & Co., Manchester.
BRISTOL	Weston, J. D., & Son.	AUSTRIA	Simon, Henry, Manchester. 788
		GERMANY	Schaffer & Budenberg, Manchester.

OF WHOM PRICED LISTS AND FULL PARTICULARS MAY BE OBTAINED.

BUCKLEY AND TAYLOR,

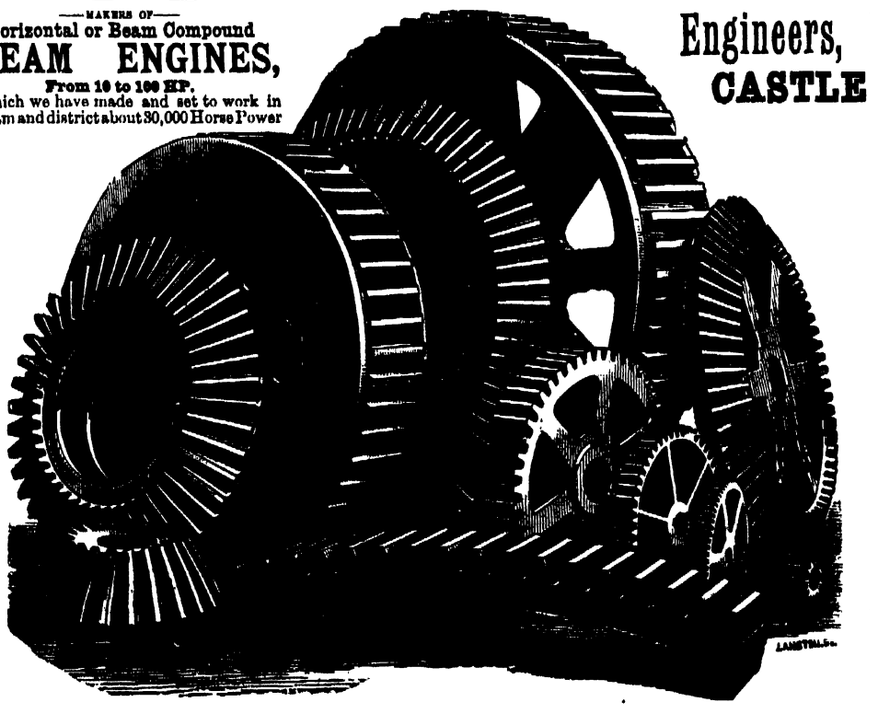
—MAKERS OF—

Horizontal or Beam Compound

STEAM ENGINES,

From 10 to 100 HP.

Of which we have made and set to work in Oldham and district about 30,000 Horse Power



Engineers, Millwrights, and Ironfounders,

CASTLE IRONWORKS, OLDHAM.

—MAKERS OF THE—

COMPOUND ENGINES

Driving the Textile Machinery at the Oldham Exhibition.

LANCASHIRE STEAM BOILERS,

Made with the best Machinery, with Holes Drilled or Punched, and Plates Planed.

PATENT ELASTIC SPRING

PINION AND BEVEL WHEELS,

Specially designed, and adapted for heavy work, varying loads, and sudden shocks.

PATENT BEVEL WHEELS,

WITH SEPARATE STEEL RIMS,

APPLIED IN CASES WHERE GREAT STRENGTH IS REQUIRED.

MAIN DRIVING DRUMS,

For Ropes or Belts up to 30 feet diameter.

All other classes of Wheels moulded by our Patent Machinery.

Agent for BUCKLEY & CO.'S (Sheffield) 4750

PATENT COMPENSATING PISTONS.

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MAKERS OF ALL KINDS OF RAILWAY PLANT,

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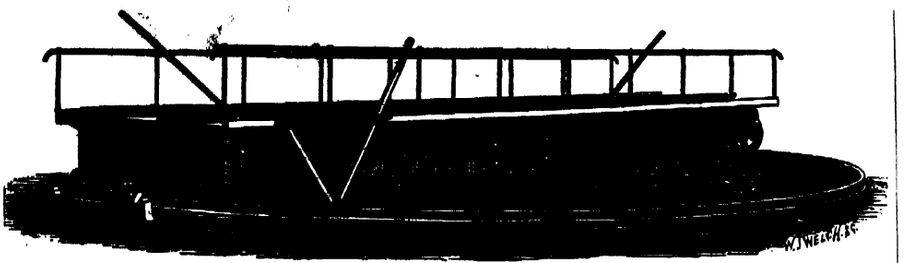
SWITCHES,

CROSSINGS,

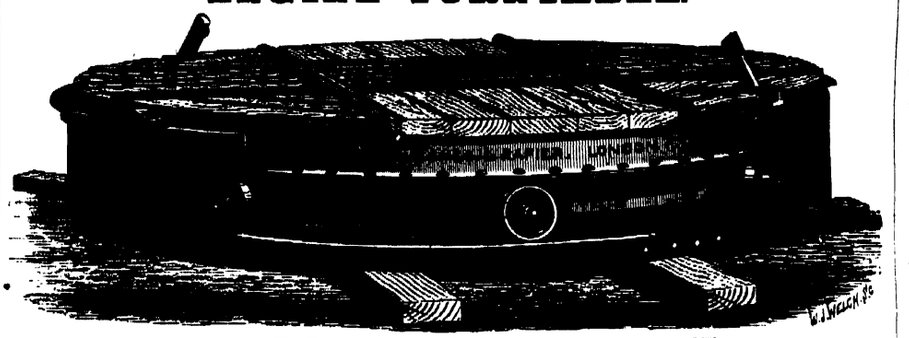
Engine Turntables,

CARRIAGE TURNTABLES,

TRAVERSERS.



ENGINE TURNTABLE.



CARRIAGE TURNTABLE.

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SIGNALS

HYDRANTS,

PUMPS,

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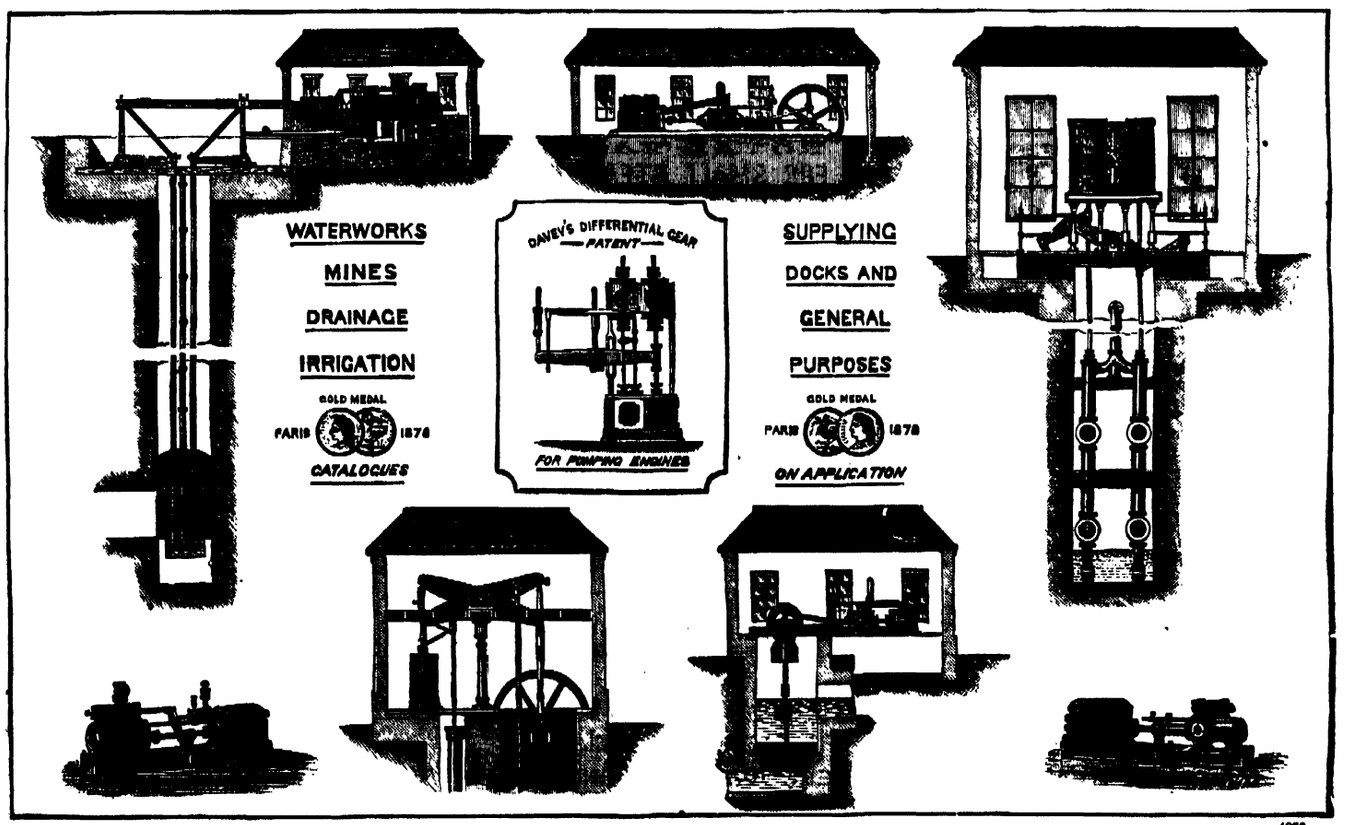
WATER CRANES

ALSO ALL KINDS OF

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Prices and Illustrations on application to RANSOMES & RAPIER, 5, Westminster Chambers, London. 5053

PUMPING MACHINERY.



4073

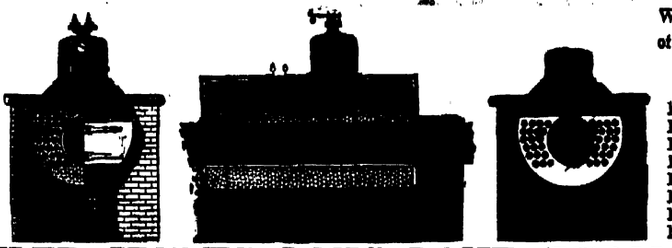
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F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

The most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
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5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breese, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the size and power of these Boilers, showing the small amount of space they occupy—

9ft.	long,	5ft. 0in.	diameter,	20-horse	power.
10ft.	,,	5ft. 6in.	,,	30	,,
12ft.	,,	6ft. 0in.	,,	40	,,
13ft.	,,	6ft. 6in.	,,	50	,,
14ft.	,,	7ft. 0in.	,,	60	,,
15ft.	,,	7ft. 6in.	,,	70	,,
16ft.	,,	8ft. 0in.	,,	80	,,
17ft.	,,	8ft. 0in.	,,	90	,,
18ft.	,,	8ft. 0in.	,,	100	,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140

BRASS & COPPER TUBES

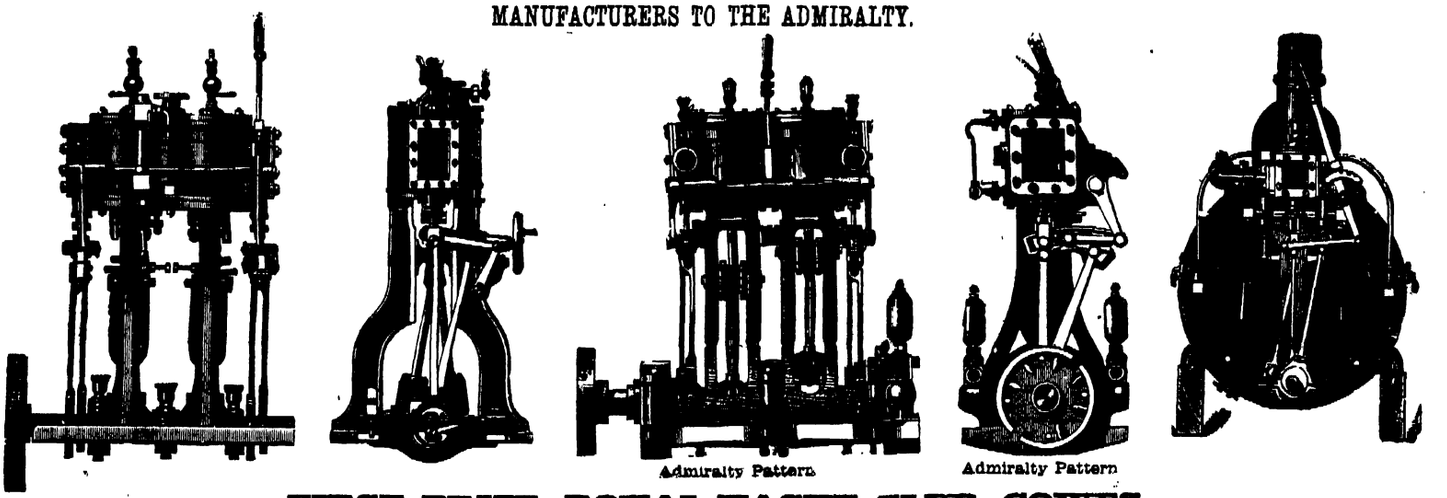
SEAMLESS & BRAZED, FOR BOILERS, SURFACE CONDENSERS &c 4957

BRASS & COPPER WIRE, SHEETS &c.

BIRMINGHAM BATTERY & METAL CO. BIRMINGHAM.

PLENTY & SON, EAGLE IRONWORKS, NEWBURY, BERKS.

MANUFACTURERS TO THE ADMIRALTY.



Admiralty Pattern. Admiralty Pattern

FIRST PRIZE, ROYAL YACHT CLUB, COWES.

PATENT ENGINES AND BOILERS FOR SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &c. 4227

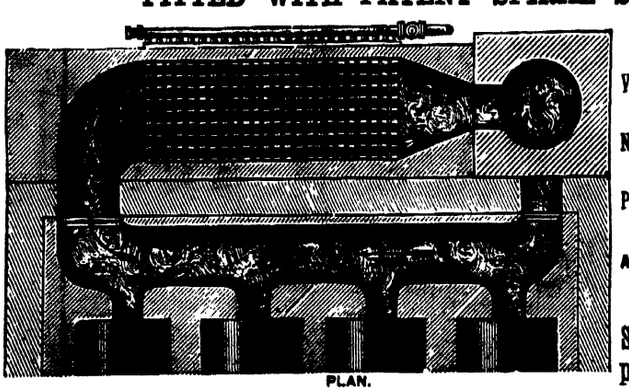
Simple, High-pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works.

Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(FOR UTILISING THE WASTE HEAT FROM STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION



PLAN.

SPECIAL ADVANTAGES.

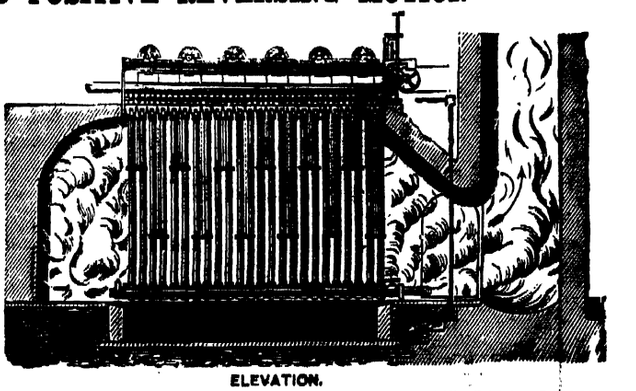
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New Patent Spiral Scrapers The most effectual removers of soot.

Patent Reversing Gear. Never sticks or gets out of order.

ALREADY IN OPERATION TO HUNDREDS OF STEAM BOILERS.

Saves from 20 to 25 per cent. of the fuel.



ELEVATION.

N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and abroad.

PRICES, TESTIMONIALS, AND FURTHER PARTICULARS ON APPLICATION TO 4430

ARTHUR LOWCOCK, (PATENTEE & SOLE MAKER) Oaleham Foundry, Shrewsbury, England.

ROOFS and BUILDINGS in IRON and STEEL.



From Photo. of Engine Shed 600 ft. by 180 ft., recently erected by MOREWOOD & CO.

MOREWOOD & CO.
WOODFORD IRONWORKS,
SOHO, BIRMINGHAM.
LONDON OFFICES—158, LEADENHALL STREET, E.C.

CORRUGATED AND GALVANISED SHEETS,
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Special Curved Corrugated Iron Roofs without Framing for moderate Spans.
WROUGHT IRON WATER TANKS, any size.
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Wrought-Iron Lattice and Plate Girders. Railway, Road and Foot Bridges.
DESIGNS AND ESTIMATES ON APPLICATION. 4909

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BRIGHTSIDE WORKS, SHEFFIELD,

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EVERY DESCRIPTION OF TOOL STEEL & STEEL CASTINGS,

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From 1 Cwt. to 50 Tons, for every kind of work,

Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.

BESSEMER STEEL WORKS PLANT,

FORGE AND ROLLING MILL MACHINERY,

Steam Engines for Mills, Ironworks, Collieries, &c.

SINGLE AND DOUBLE FLUED BOILERS. 5178

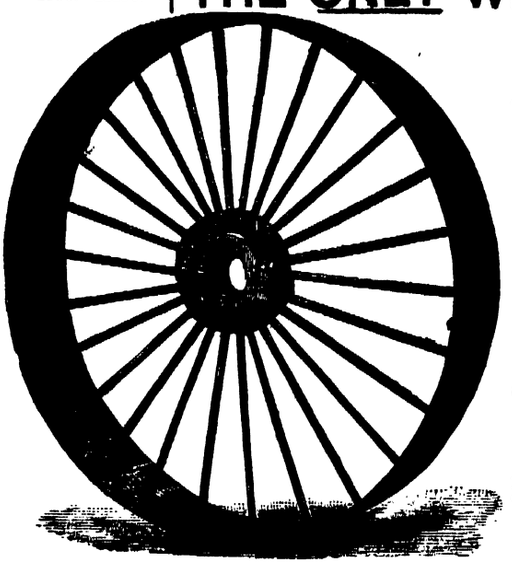
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Telegraphic Address, "LOGO." LEEDS.

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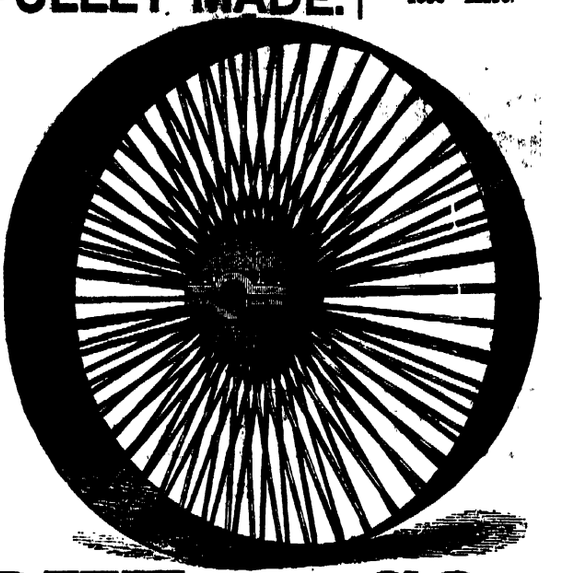
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USED SOLELY FOR

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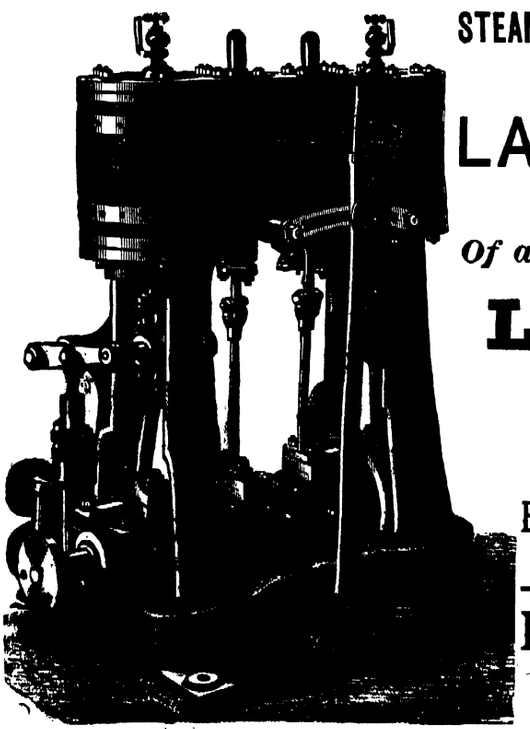
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STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,

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LAND AND MARINE ENGINES

Of all Sorts and Sizes up to 1,000 I. HP.

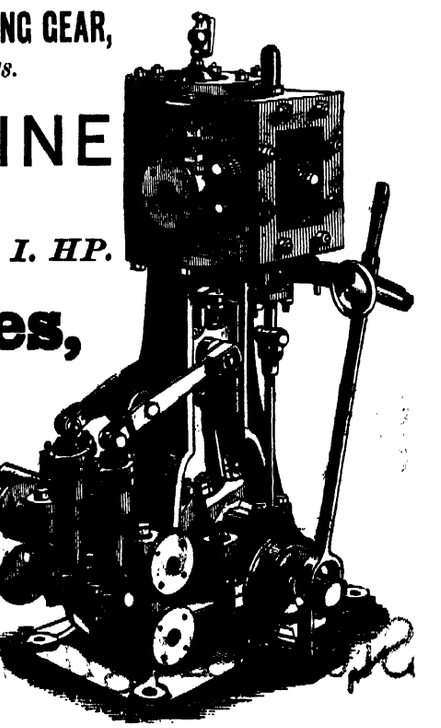
Launch Engines,

WITH

Patent Valve Motion.

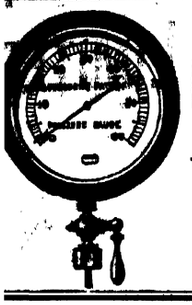
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In the above the reversing is accomplished with single eccentric for each cylinder, and the numerous complications and working joints of link motion are dispensed with, while all the properties of same are retained, and the steam and exhaust openings at ends of stroke are the same always, whether in full gear or not. 4926



Only Gold Medal for Gauges at the Paris Exhibition, 1878.

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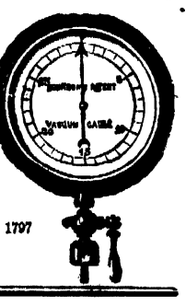
Telephone No. 6583.] SOLE AGENTS IN LONDON. [Telephone No. 6583.

M. BOURDON cautions Persons using Steam Gauges that a large number of very inferior instruments are sold, bearing his name, which are not of his manufacture, a great proportion of them also having a forged Trade Mark.

AGENTS:—J. CASARTELLI, 43, Market St., Manchester; CHADBURN & SONS, 71 & 73, Lord St., Liverpool. 1797

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CALCUTTA EXHIBITION, 1884, FIVE FIRST PRIZES.

Budapest Agricultural Meeting, 1882—Two Gold Medals and other Awards.
Vienna Agricultural Meeting, 1882—Special Diploma for excellency of work
Sydney Exhibition, 1880—Three First Prizes. 3001
Hanover Agricultural Meeting, 1881—Gold Medal and Diploma of Merit. [Prizes.
Paris Exhibition, 1878—Grand Prix, Gold Medal, and other

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

BELL'S Asbestos Works, Southwark. S.S. "Ruapehu," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.
Steam Pressure.....110 lbs. | Vacuum.....29 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 37 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,
D. HENDERSON, Chief Engineer, S.S. "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial over nine months, and comparing with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success in a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,
Mr. J. BELL. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts, Admiralty, Whitehall, 30th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos packing to sample submitted.

Elastic core.....square. | Elastic core.....round.

To Mr. JOHN BELL. JOHN COLLETT, Director of Navy Contracts.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber plaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at any list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is the great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 60 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

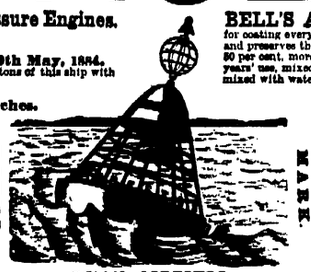
Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,
THOMAS WINTER, Colliery Engineer.



TRADE MARK.

— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depots and not through agents or factors.

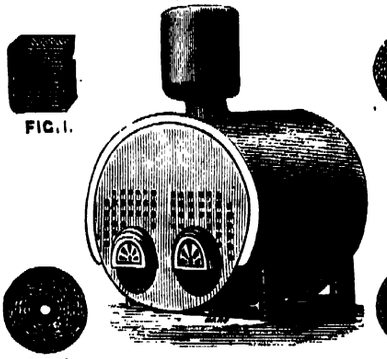


FIG. 1.

FIG. 4.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 80 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates.. .. .. .. 196 deg.
" " Covering.. .. .. .. 84 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 28th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly, "W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,
Quarries, Tavistock, 8th April, 1884.

Mr. JOHN BELL, Southwark, S.E.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,
W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ¼ in. to 3 in. wide, and any thickness from 1-16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at any price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.



FIG. 2

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and 1 millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts, Admiralty, Whitehall, S.W., 17th May, 1884.

SIR,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,
Mr. JOHN BELL. Director of Navy Contracts.



FIG. 3.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

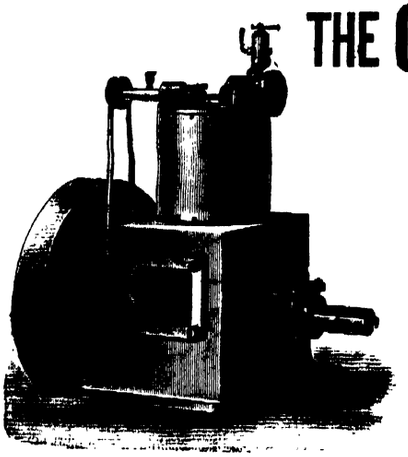
BELL'S "ASBESTOS LUBRICANT" REGD.

ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

OR THE DEPOTS— 4043

112a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER. 11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN



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HIGH SPEED ENGINES,

THE MOST EFFICIENT AND RELIABLE MADE.

Also LIGHT BALANCED PULLEYS, SHAFTING, &c.

Electric Lighting and Plating Installations, complete. 5189

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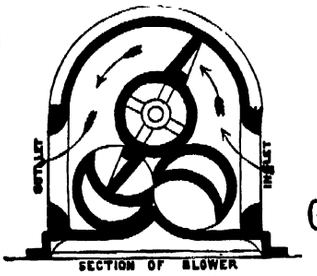
Baker's Patent Rotary Pressure Blower and Gas Exhauster.

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BAKER'S PATENT ROTARY PUMP.

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CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

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HALL'S PATENT STONE BREAKER.

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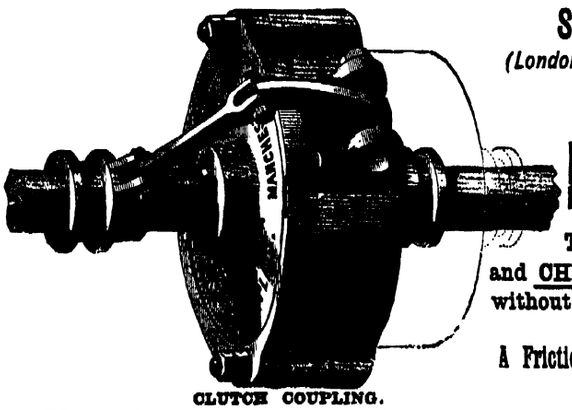
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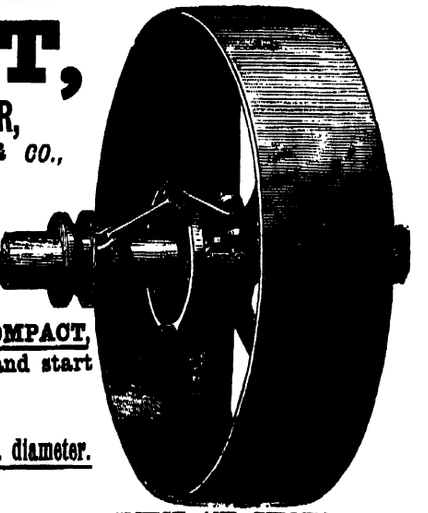
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A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.

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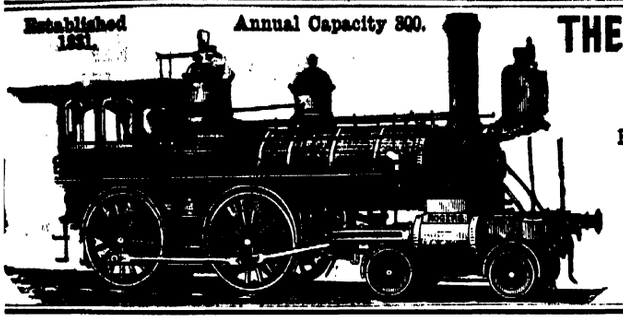
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IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

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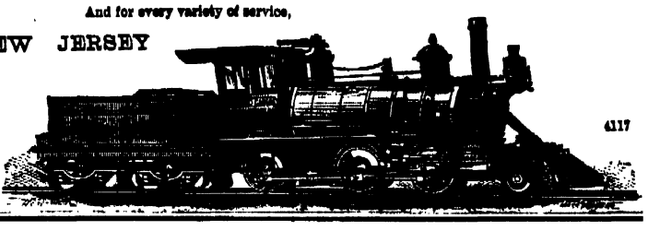
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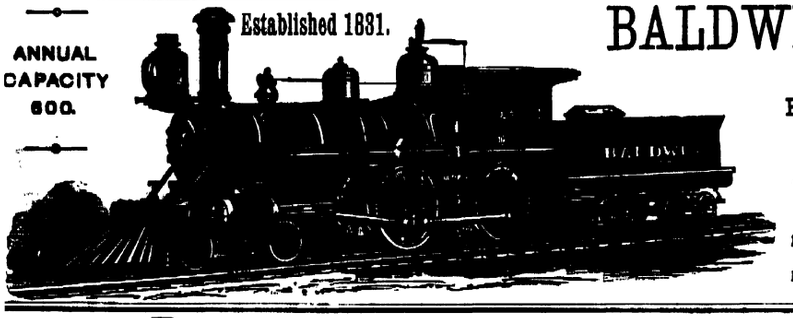
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UNITED STATES OF AMERICA.



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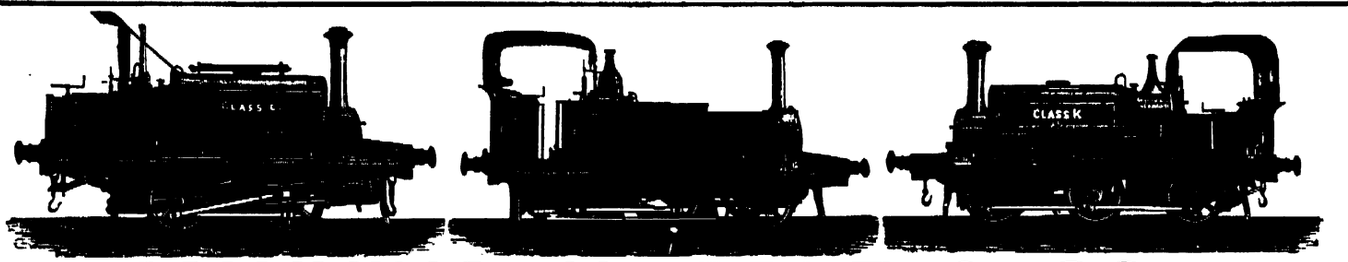
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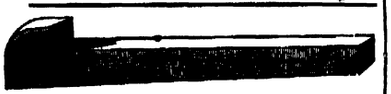
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Are the SIMPLEST and CHEAPEST for Boiler Feeding, Mining, and all other purposes. Every Pump tested in steam and water before leaving the Works. Best Material and Workmanship Guaranteed.
— THOUSANDS IN USE AT HOME AND ABROAD. —

	SINGLE ACTING.							DOUBLE ACTING.					
Size Nos.	1	2	3	4	5	10	15						
Diameter of Pump..	3	1½	1¾	1¾	2	2½	3						
Gallons per hour ..	60	97	119	184	320	466	727	900	1200	1466	1920	2620	19400
HP. of Boiler	4	6	8	12	21	35	55	69	90	110	180	195	730
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All Pumps fitted with gun-metal plungers and valves unless otherwise ordered. A large number always in stock. Catalogues with testimonials and full directions for fixing on application.
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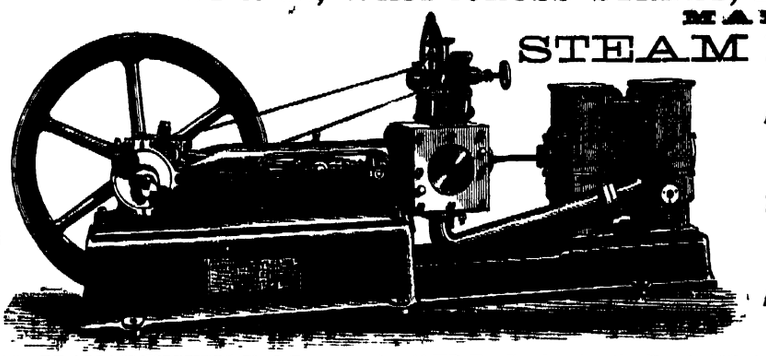
BOILERS
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WELL BORING TOOLS 5092

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MAKERS OF
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COMPOUND CONDENSING ENGINES, 30 to 300 H.P., with Rider's Patent Automatic Expansion,
Controlled only by the Governor.
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Ditto, Condensing.
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4930
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BRIGHT STEEL NUTS, STUDS, & MARINE ENGINE FORGINGS.

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MACHINERY constructed for Boats Built Abroad.

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Speciality in Small STEAM TUGS for towing Barges and Lighters. 5103

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—(ESTABLISHED 1821.)—

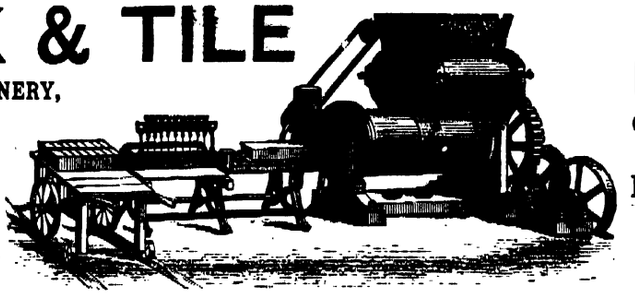
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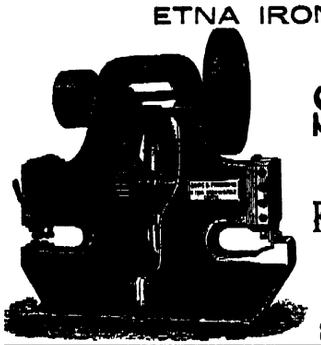
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FOR FORGES, SMITHIES, STAMPING, &c.

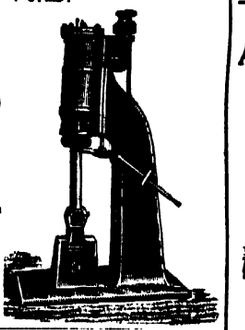
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THE CHIEF FEATURES OF THIS LUBRICANT ARE—

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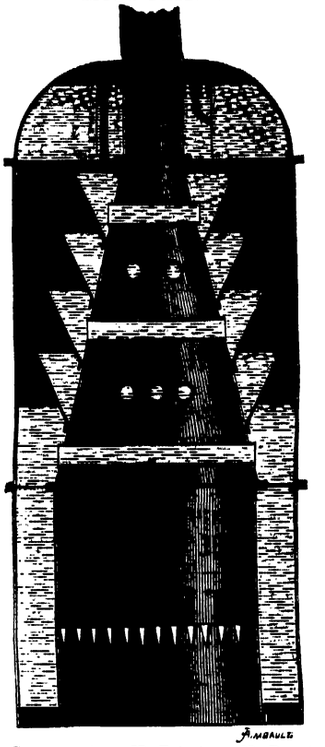
CAROLINE PARK, EDINBURGH.

LONDON: 46, WHITEFRIARS ST., FLEET ST., E.C.; CITY OFFICE: 188, PALMERSTON BUILDINGS, BISHOPSGATE ST., E.C.

BIRMINGHAM: 66, GEORGE STREET, PARADE. 5850

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(MOY'S PATENT).



No Incrustation—No Priming—No Burning of Fire Tube—Economy and Safety.

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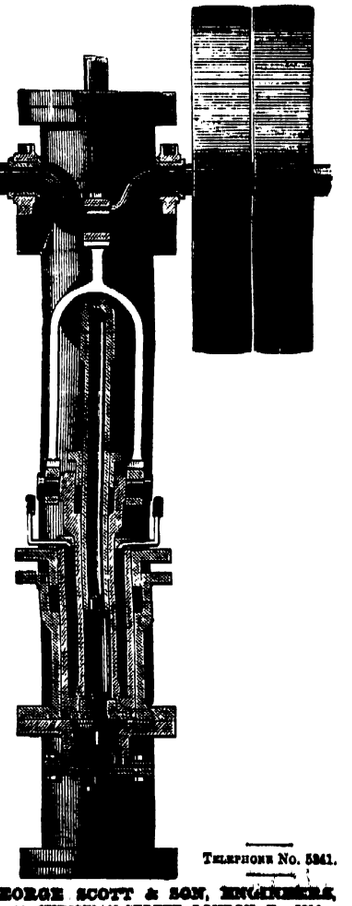
PATENT AGENT, 5455

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AIR COMPRESSOR

FOR ALL PURPOSES.



TELEPHONE No. 5941.

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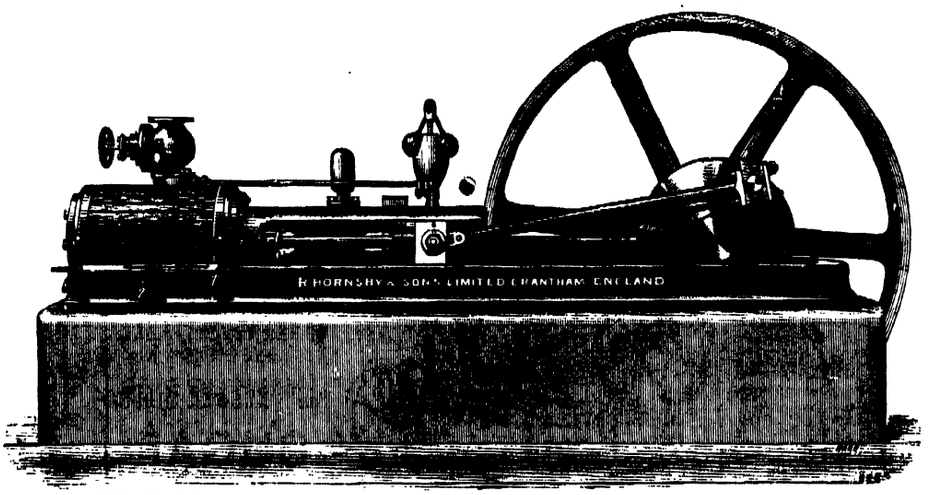
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With Inside or Outside Cylinders.

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With Inside or Outside Cylinders.

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WITH
CROSS-TUBE BOILERS.

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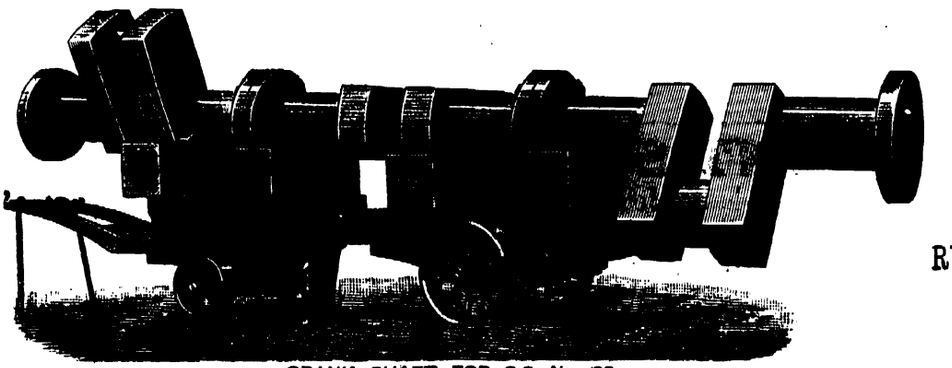
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MARINE AND OTHER CRANK SHAFTS

FORGINGS
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IN IRON & STEEL.

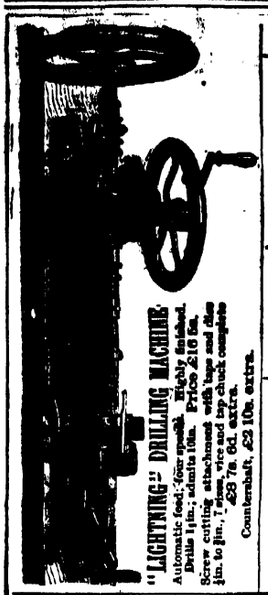


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Automatic feed; 36in. stroke. Highly finished.
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Price £20 per doz.
Knocks down completely for Shipment.

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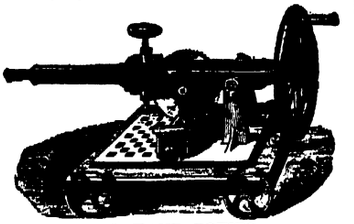
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LONDON, E.C.

Improved Patent Circular Cold Sawing Machines.

For cutting Iron or Steel Rails, Joists, Girders, T-iron, &c., as supplied to numerous Colonial & other Railways, Tramway Cos., &c. They give a clean and accurate cut (allowing equal expansion at joints), avoiding fractures and saving time. One man can cut an ordinary cast steel rail in 15 minutes; a 10in. Girder in 12 minutes; L-iron, 2½ by 2½ by ½ in 2½ minutes, &c. The hand and small steam power machines will cut cast steel rails up to 6in. high; round iron, &c., to 5in. diameter; Girders to 10in. high. Large steam power machine will cut the heaviest cast steel rail, round iron, &c., to 8in. diameter, Girders to 20in. high.



FOR HAND POWER.

With grooved table	£24	10	0
,, compound slide rest, extra	9	10	0
Drilling Machine, extra	6	15	0
Trolly with four wheels, extra	6	15	0

Weight complete, about 10 cwt.

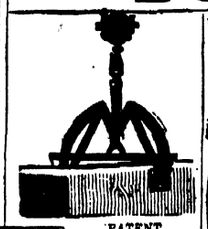
FOR STEAM POWER.

Small pattern, with grooved table	£41	10	0
,, compound slide rest, extra	18	0	0

Weight complete, about 8 cwt.

Large pattern, with grooved table	77	0	0
,, compound slide rest, extra	21	0	0
,, Drilling Machine, extra	8	10	0

Weight complete, about 24 cwt.



PATENT SELF-ADJUSTING STONEDOGS.

For 20in. stones up to 25 cwt., £4.
For 40in. stones up to 4 tons, £6,7s. 6d.
For 42in. stones up to 5 tons, £8 10s.
Made of Steel and adjust themselves.

"PANAMA" AUTOMATIC EXCAVATING CART.



Width of Box 42in., length 40in., depth 15in., of ¼in. steel plate.

54in. Wheels, 3in. tread. One man only necessary as the excavator fills, loads, and dumps at will of operator. Capacity 14 cubic feet. Price £20.

BOHLEEN'S PATENT EARTH BORERS.



For boring holes for telegraph and scaffold poles, fences, trees, tube wells, &c.

3in.	4in.	5in.	6in
10/-	11/-	14/6	15/-
7in.	8in.	9in.	10in.
16/6	17/6	19/-	20/6
12in.	15in.	18in.	
25/6	28/6	30/6 ea.	

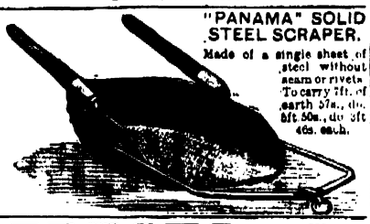
AUTOMATIC REVOLVING SCRAPER.



Dumps by raising handle, bowl revolves, empties, and rights itself.
30in. Steel bottom 74s. each.

"PANAMA" SOLID STEEL SCRAPER.

Made of a single sheet of steel without seam or rivets. To carry ¾ft. of earth 57s., do. 1ft. 50s., do. 1½ft 46s. each.



"EUREKA" AUTOMATIC TRUCKS. H741a

With these trucks one man can load, transport, and unload automatically from 800 to 1000 lbs. with astonishing ease and rapidity.



No. 4.—30in. or 33in. wheels. Capacity 4in. to 15in., for Iron Joists, Railroad Iron. £19 each.

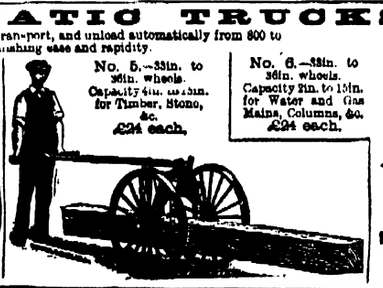


No. 2.—30in. wheels. Capacity 8in. to 9in., for Axles, Bar Iron, Shafting, &c. £19 each.

No. 1, with 30in. IRON wheels, for handling above articles in a hot state, £18 each.



No. 3.—33in. wheels. For handling Wheels and Axles combined, £20 each.



No. 5.—33in. to 36in. wheels. Capacity 4in. to 15in. for Timber, Stone, &c. £24 each.

No. 6.—33in. to 36in. wheels. Capacity 8in. to 15in. for Water and Gas Mains, Columns, &c. £24 each.



5447

For Price, &c., apply SMEDLEY BROTHERS,

PORTABLE ENGINES.
MORTAR MILLS.
"SPECIAL CLAY MILLS."

STEAM BOILERS

(CORNISH, LANCASHIRE, AND VERTICAL.)

TESTIMONIAL from Messrs. J. & R. BOWDEN, Marple, near Stockport, Jan. 7, 1878.

GENTLEMEN,—We have now had one of your Portable Engines and 7 feet pan Mortar Mills, in constant work for the last twenty months, and have great pleasure in stating that they have given us every satisfaction, and for construction, strength, and workmanship are the best we have seen.—Yours respectfully,

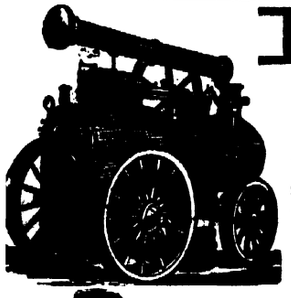
Messrs. SMEDLEY BROS. J. & R. BOWDEN (Builders)

EAGLE IRONWORKS, BELPER.

VERTICAL Combined Engines and Boilers.
HORIZONTAL ENGINES.

5109

ROBEY & CO.

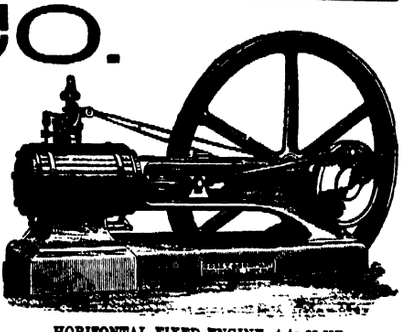


SUPERIOR PORTABLE ENGINES 2½ to 80 HP.

First PRIZE for PORTABLE ENGINES, Melbourne Exhibition, 1881.

PARIS, 1878, GOLD MEDAL.





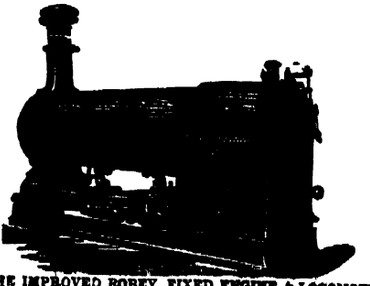
HORIZONTAL FIXED ENGINE, 4 to 60 HP.

☞ References can be given to upwards of 9,000 Engines now at work.



VERTICAL STATIONARY STEAM ENGINE AND BOILER Combined, of all Sizes, from 1½ to 16 HP.

The Patent "Robey" Mining Engine, 4 to 65 HP.

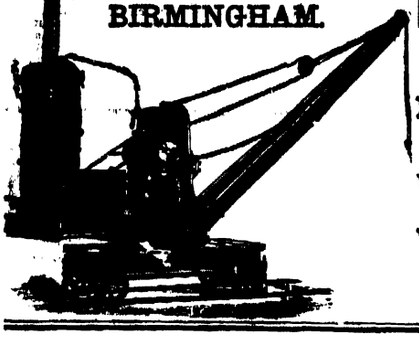


THE IMPROVED ROBEY FIXED ENGINE & LOCOMOTIVE BOILER Combined, 4 to 65 HP., and COMPOUND ROBEY SEMI-FIXED ENGINE. 4681

Prices and full Particulars of the Machinery here Illustrated on application to the Manufacturers:

ROBEY & CO., Globe Works, LINCOLN, ENGLAND.

BERKLEY STREET, BIRMINGHAM.



RICHARD C. GIBBINS & Co.

STEAM & HAND CRANES,
PORTABLE, WHARF, DERRICK,
FOUNDRY, OVERHEAD, TRAVELLING,
Warehouse Cranes and Pile Drivers,

1691

Warehouse Lifts and Hoists,
CRABS, JACKS, PULLEY BLOCKS, SCREW COUPLINGS, PLATELAYERS' TOOLS, &c.

14, QUEEN VICTORIA ST., LONDON, E.C.



THE CLAY CROSS COMPANY,

COAL, LIME, & IRON WORKS, CLAY CROSS, near CHESTERFIELD,

SUPPLY HOUSE, GAS, AND STEAM COAL,

AND ARE MAKERS OF

PIG IRON, GAS and WATER PIPES, and ALL CASTINGS

In connection with Gas and Waterworks, Collieries, Engines, Pumps, &c. 5136

London Offices and Exhibition Rooms: 53, QUEEN VICTORIA STREET, E.C. (opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents.

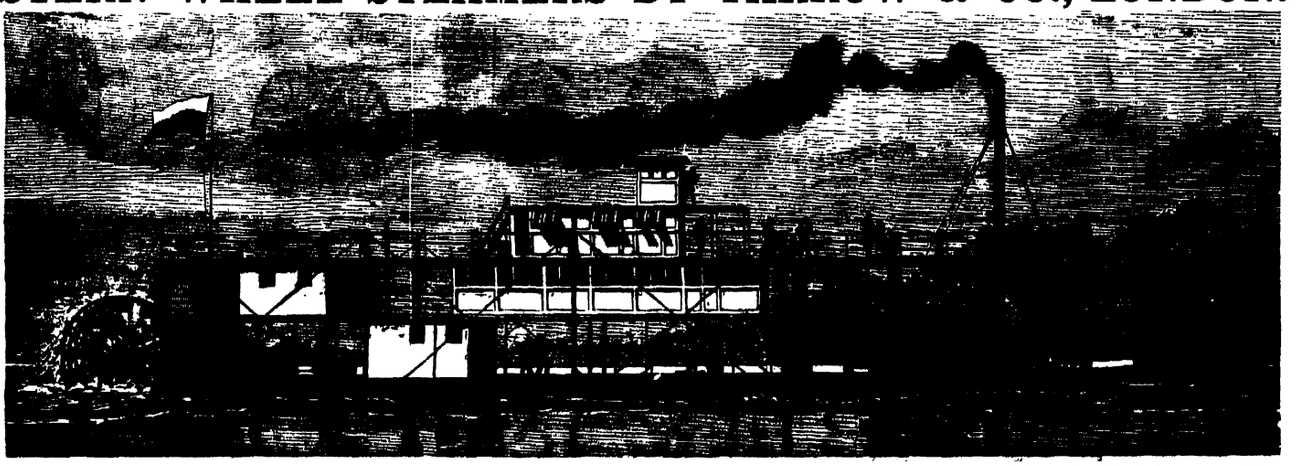
SHEPHERD, HILL & CO.

MACHINE TOOLS.

LEEDS, YORKSHIRE.
LONDON OFFICES—21, PARLIAMENT STREET.
(E. B. SAUNDERS, Agent). 4087

Manufacturers of all kinds of Slide Lathes, Planing, Shaping, Slotting, Boring, Drilling, Punching, Shearing, Bending, and Screwing Machines, suitable for every class of Engineers and Shipbuilders.

STERN WHEEL STEAMERS BY YARROW & CO., LONDON.



"INEZ CLARKE," 130 ft. by 28 ft., Speed 15 Miles an hour, Draft 15 inches. "STEPHENSON CLARKE," 100 ft. by 24 ft., Speed 13 Miles, Draft 13 inches. 5957

P. R. JACKSON & COMPANY,

STEEL AND IRONFOUNDERS
MILLWRIGHTS, ENGINEERS, &c.

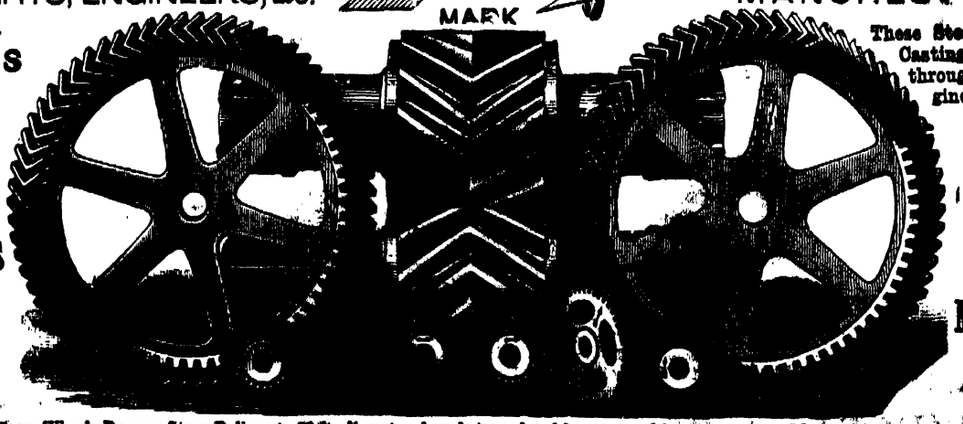
TRADE MARK

SALFORD ROLLING MILLS,
MANCHESTER.

MANUFACTURERS OF

JACKSON'S
Machine-Moulded
Spur, Bevel, AND Worm Wheel
CASTINGS.

PULLEYS
EITHER FOR
Straps or Ropes,
Spur or Bevel
Mortice Wheels
with Machine
cut Cogs.



These Steel or Iron Wheel Castings can be obtained through almost any Engineer, Millwright, or Machinery Merchant.

Care should be taken to specify

"P. R. Jackson & Co.'s MACHINE-MOULDED WHEELS."

And each Wheel should bear the above TRADE MARK

Fly Spur Wheels Rope or Strap Pulleys to 30 ft. diameter, bored, turned and key-grooved by Machinery, and [illegible]

MAKERS OF RAMSBOTTOM'S PISTONS & PISTON PACKING RINGS, in Iron, Steel, or Brass. [illegible]

EDWIN LEWIS & SONS,

WOLVERHAMPTON, STAFFORDSHIRE.

LAPWELDED IRON BOILER TUBES.

BUTTWELDED GAS, STEAM, and WATER TUBES.

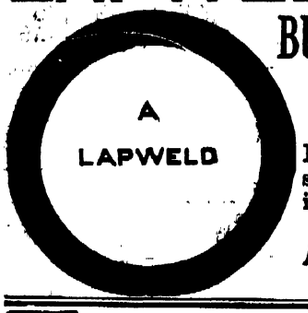
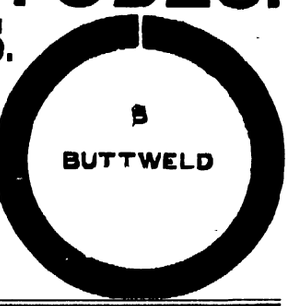


DIAGRAM SHOWING LAP AND BUTT WELDS.

These two Engravings, representing sections of Lapwelded Wrought Iron Tube (at A) and Buttwelded (at B) show conclusively the superior strength of Lapweld, which has nearly four times the surface in contact in the Weld over that given in Buttweld.

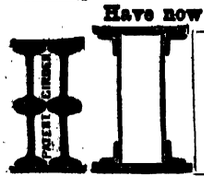


All Gas, Steam, or Water Tubes over Two-inch size are made Lapwelded by us. 4864



MEASURES BROS. & CO., SOUTHWARK STREET, LONDON,

Manufacturers of Patent Girders, Rolled Joists in Iron or Steel, Rivetted Girders, Flitch Plates, Bulb and Channel Iron, Contractors' Rails, Tee, Angle, and Scab Iron, Bonding Hoops, Bolts, Rivets, Washers, Chequered Flooring Plates, Patent Fire-proof Floors, Cast or Wrought Iron Columns, Stanchions, Tanks, and every description of Builders' Iron Work.



Have now in their TOWN STOCK 5,000 TONS, and can guarantee prompt delivery at lowest Market Prices.

ESTIMATES, SECTION SHEETS, AND BOOKS FREE ON APPLICATION.

ANGLES.

8 × 4	3½ × 3½
6 × 6	3 × 3
6 × 3½	2½ × 2½
6 × 3	2 × 2
4 × 3½	1½ × 1½
4 × 4	1 × 1

SECTION OF JOISTS.

8 × 8 = 161lbs.	4½ × 3 = 121lbs.	7 × 2½ = 141lbs.	9½ × 8½ = 241lbs.
8 × 1½ = 6 ,,	5 × 4½ = 23 ,,	7 × 3½ = 20 ,,	9½ × 4½ = 29 ,,
6 × 1½ = 7 ,,	6½ × 3 = 11 ,,	8 × 4 = 22 ,,	10 × 4½ = 32 ,,
4 × 3 = 12 ,,	6½ × 3½ = 16 ,,	8 × 5 = 29 ,,	10 × 5 = 36 ,,
4½ × 1½ = 8 ,,	6 × 6 = 29 ,,	8 × 6 = 34 ,,	10 × 6 = 56 ,,

12 × 5	= 42lbs.
12 × 6	= 56 ,,
14 × 6	= 60 ,,
16 × 6	= 62 ,,
17½ × 6½	= 82 ,,
19½ × 7½	= 100 ,,

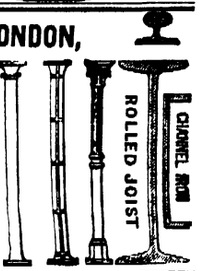
Joists—Lengths, from 6 to 36 ft. Plates—Width, 6" to 18". Length, 12 to 30 ft. Thickness, ¼" to ½". 5126

TEES.

5½ × 5½	
4 × 4½	
5 × 3	
3 × 3	
2½ × 2½	
2 × 2	
1½ × 1½	
1 × 1	

CHANNELS.

12 × 3	
9½ × 3½	
9½ × 3½	
8 × 3½	
6½ × 2½	
4½ × 2½	
2½ × 1½	
1½ × ¼	



GEORGE SALTER & Co.

WEST BROMWICH,

MANUFACTURERS OF

Spring Balances, Roasting Jacks,

BOURDON'S, SCHAEFFER'S, & SILVESTER'S

PRESSURE GAUGES,

COLLIERY SIGNAL BELLS, RASTRICK'S TUBE SCRAPERS,

CONICAL, SPIRAL, and all kinds of COILED SPRINGS made to order.

DYNAMOMETERS

For Testing Strength of Wire, Rope, Cement, Cloth, &c.

GOODS SUPPLIED THROUGH ALL MERCHANTS AND FACTORS



4760

SHAFTING

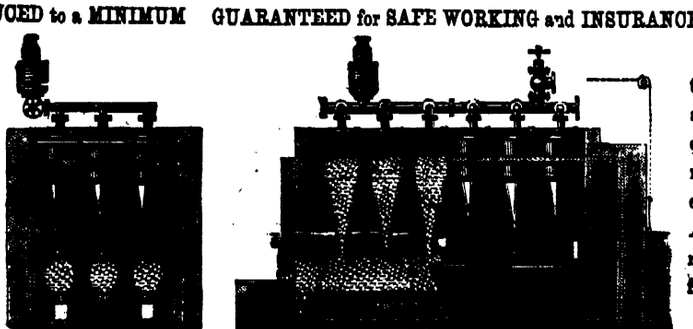
Turned true and bright to Whitworth's Gauges, any length, from 2 in. to 3 in. diameter, 12s. per cwt. at Nottingham. Also Couplings, Pulleys, Plummer Blocks, Hangers, Machine-made Spur, Bevel, and Mitre Wheels, Friction Gearing, &c.

H. HIND & SON, NOTTINGHAM, AND 62, BLACKFRIARS ROAD, LONDON, S.E. 4157

SHEPHERD'S IMPROVED PATENT INTERNALLY FIRED CONE SECTION BOILER.

RISK of EXPLOSIONS REDUCED to a MINIMUM GUARANTEED for SAFE WORKING and INSURANCE up to 150 lbs. PRESSURE.

BOILERS on this principle have been in constant work for some years, with great success in the economical production of steam without priming. There are no parts liable to collapse, or stays subject to corrosion. They can be exported cheaply



to all parts of the world. They are suitable for every description of work, and, consisting of a number of similar sections, are easy to erect, examine, and repair. Any portion can be removed and replaced quickly, and with great facility.

4820

For PLANS, ESTIMATES, and PARTICULARS of TRIALS, apply to the SOLE LICENSEES and MAKERS,

JAMES WATT & CO., (late Boulton & Watt), 90, Leadenhall St., London, E.C., and Soho Foundry, Birmingham.

Makers of Marine Engines, and of every kind of Land and Pumping Engines, Boilers, Hydraulic Machinery, Mining Plant, Air Compressors, Rock Drills, Milling and Sugar Mills, Mint Machinery, and of Coins for the British Government and Foreign Countries.

WATER PURIFICATION

JOHN HENDERSON PORTER, PATENTEE,

The PORTER-CLARK PROCESS

Awarded GOLD and SILVER MEDALS at the International Health Exhibition.

While largely employed in County Asylums, Hospitals, Schools, and Private Mansions, it is adopted upon a much larger scale in many Industries, upon Railways, and by Water Companies.

By this Process the Sulphates and Carbonates of Lime and Magnesia are removed and the water rendered fit for steam users. One Railway Company treats 1,000,000 gallons of feed water per day by this system. 5220

1 & 2, TUDOR STREET, LONDON, E.C., furnishes the necessary Plant.

15 PRIZE MEDALS.] **THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED,** [15 PRIZE MEDALS.

4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 3. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 3. GLASGOW, 1880, 2. LONDON, 1882, 1



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG. GLENBOIG STAR, and CUMBERNAULD. 5400

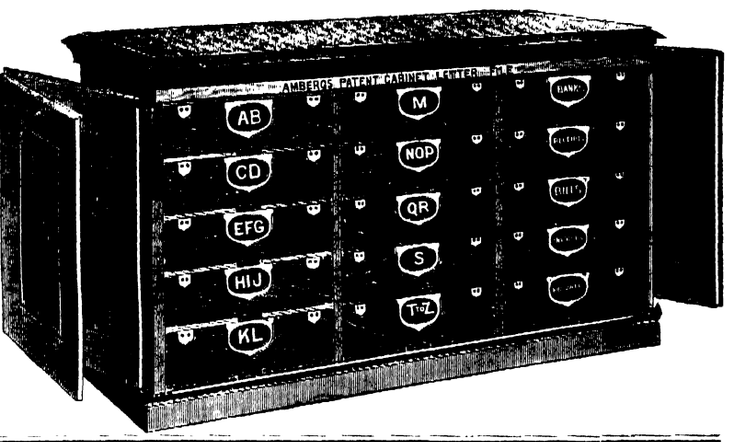
AMBERG'S PATENT SYSTEM OF LETTER FILING

THE BEST IN THE WORLD.

These CABINET LETTER FILES are made in many sizes, containing as few as six and as many as one hundred files each, at prices ranging from £4 upwards. They are elegantly and substantially made, the woodwork being of the best seasoned WALNUT, and the metal parts of BRASS and STEEL, NICKEL-PLATED. They are arranged for any class of correspondence, and can be adapted to ANY requirement. Each drawer or file divides the correspondence very minutely on the "Directory" plan. The system is extensively used by the Nobility, Members of both Houses of Parliament, Banks, Insurance Companies, the leading Firms and Companies, as well as many Private Gentlemen. Any correspondence, however large, may be so arranged that any one and all letters of whatever date, from any person, can be found instantly. The labor of folding, endorsing, numbering, pasting, binding, or indexing, is entirely dispensed with, and the saving of time, labor and expense over the ordinary methods is very great.

FIFTEEN-FILE CABINET, with Doors, as Illustrated.

375 INDEXED DIVISIONS WILL HOLD 9,000 LETTERS.



Illustrated Catalogue, with Testimonials, on application to

T. CAMERON, AMBERG & CO.,

SOLE MANUFACTURERS,

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71 & 73, Lake Street, Chicago; 69, Duane Street, New York. 5387

CHAPLINS' PATENT PORTABLE STEAM ENGINES & BOILERS

ALWAYS IN STOCK OR IN PROGRESS. PRIZE MEDAL, INTERNATIONAL EXHIBITION.



STATIONARY ENGINE. From 1 to 30-horse power. No Building required

HOISTING ENGINE 1 to 20-horse power. With or without Jib.

STEAM CRANE. 15 cwt. to 20 tons. For Wharf or Rail

CONTRACTORS' LOCOMOTIVE. 9 to 27-horse power. For Steep Inclines and Quick Curves.

SHIPS' ENGINE & DISTILLER For Winding, Cooking, and Distilling Sanctioned by H.M. Government.

WINDING & PUMPING ENGINE 6 to 30-horse power. 2468

—— Parties are Cautioned against Using or Purchasing Imitations or Infringements of these Patent Manufactures. ——

Patentees and Sole Manufacturers—**ALEXANDER CHAPLIN & CO.**, Cranstonhill Engine Works, GLASGOW.

LONDON HOUSE—63, QUEEN VICTORIA STREET, LONDON, E.C.

THOMAS TURTON & SONS,

MANUFACTURERS OF RAILWAY SPRINGS AND BUFFERS,

Files and Cast Steel of Superior Quality, Spring Steel, Shear Steel, &c. 4927

SHEAF WORKS, AND SPRING WORKS, SHEFFIELD.

LONDON OFFICES, 90, CANNON STREET, CITY. PARIS DEPOT, 12, RUE DES ARCHIVES. BOSTON, U.S., 40, KILBY STREET.

DANIEL ADAMSON & CO.,

[Established 1851.] ENGINEERS AND BOILER MAKERS, [Established 1851.]

DUKINFIELD, NEAR MANCHESTER.

SOLE MAKERS OF

THE WHEELOCK PATENT

Automatic Expansion Engine

Which has gained highest awards in competition with Corliss and other Automatic Expansion Engines

RIIKLEY PATENT INJECTOR

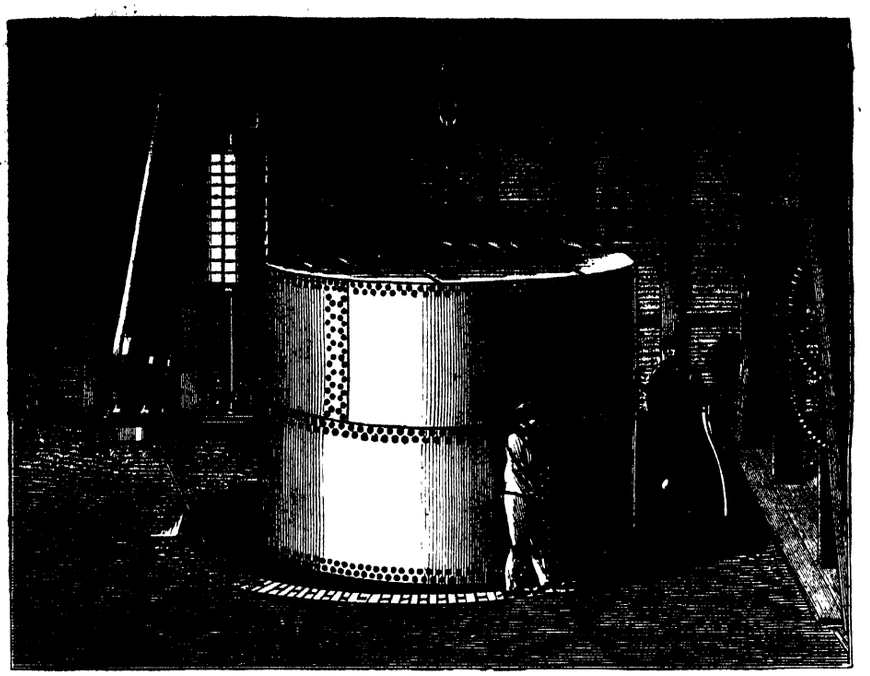


Steam Engines of all Classes.

BLOWING ENGINES
AIR COMPRESSORS,
BESSEMER PLANT,
TESTING MACHINES
PATENT HYDRAULIC
JACKS.

GENERAL HYDRAULI
ENGINEERS. 5470

HYDRAULIC RIVETTERS



OF THE MOST RECENT TYPES.

Punching, Shearing, Bending, Forging, Hoisting,

AND OTHER HIGH-PRESSURE

HYDRAULIC MACHINERY

Please Note Change of Address:

ANDERSON & CALLWEY

Hydraulic Labour-Saving Machine Makers,

CREMORNE WORKS, 4965

CHELSEA, LONDON, S.W.

Contractors to the British and Foreign Governments.

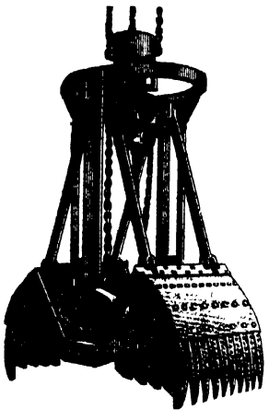


Fig. 533.—OPEN. HALF-TINE DREDGER.

STOTHERT & PITT, LIMD.

ENGINEERS, BATH,

SOLE MANUFACTURERS OF WILD'S PATENT

SINGLE-CHAIN DREDGERS

FOR USE WITH ORDINARY STEAM CRANES.

Makers of all kinds of

STEAM AND HAND CRANES, HARBOUR-MAKING PLANT,

CONCRETE MIXERS, PILE DRIVERS, ETC.

LONDON OFFICE: 30, WALBROOK, E.C. 4620

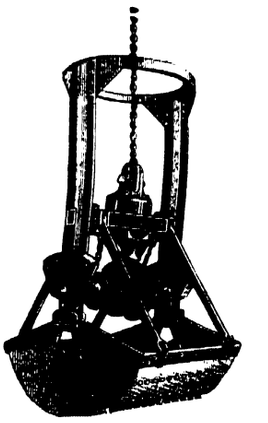


Fig. 533. CLOSED.

FOR MINING, **LEATHER**

GEO. ANGUS & Co.

ENGINEERING, **INDIA-RUBBER**

NEWCASTLE-ON-TYNE

18, BILLITER STREET, LONDON.

AND GENERAL MECHANICAL PURPOSES **GUTTA-PERCHA**

5101

LIVERPOOL.

And BUTE DOCKS, CARDIFF.



This Machine can be made with either Single, Double, or without Angle Iron Cutter.

BEAM-BENDING ANGLE IRON CUTTING AND HORIZONTAL PUNCHING MACHINE.

Shipbuilders' and Boilermakers' Tools.

SMITH BROTHERS & CO.,

KINGSTON ENGINE WORKS, GLASGOW,

MAKERS OF ALL KINDS OF

Punching and Shearing Machines, Plate-Bending Rollers, Beam-Bending and Horizontal Punching Machines (with either Double, Single, or without Angle Iron Cutter Combined), Plate-Edge Planing Machines, Keel Plate or Garboard Strake Bending Machines, Plate-Straightening Machines, Countersink Drills, Single-Drill Verticals, &c., &c.

PRICE AND PARTICULARS ON APPLICATION. 5321

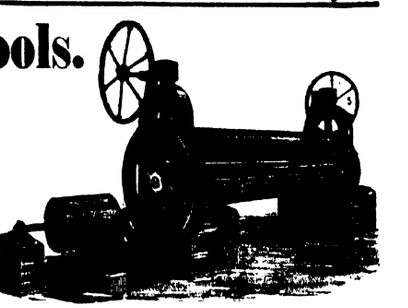
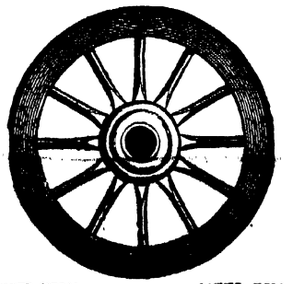


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SILVER MEDAL SILVER MEDAL

WHEELS.

Made by Machinery, all sizes, for Carriages, Carts, Vans, Wagons, Cabs, Omnibuses, &c.

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Large Stock always on hand. Tyreing Repairs, and Special Orders executed at the shortest notice.

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SMITH, PARFREY & HITCHINGS

PIMLICO WHEEL WORKS, 5113

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—MAKER OF—

OIL MILL MACHINERY

On the old system, or the ANGLO-AMERICAN.

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AND ALL KINDS OF MILLWRIGHT AND ENGINEERS' WORK. 5278

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GAUGE GLASSES

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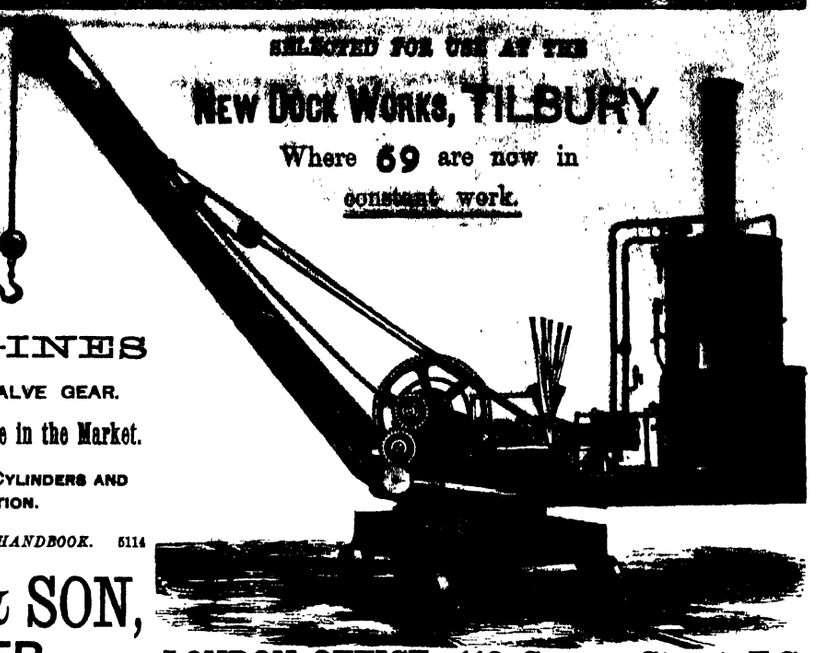
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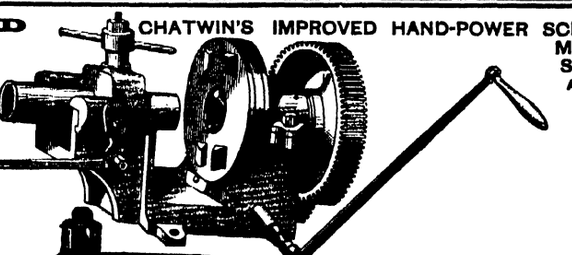
A

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AND

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CHATWIN'S IMPROVED HAND-POWER SCREWING MACHINE, SCREWING AT ONCE OVER.



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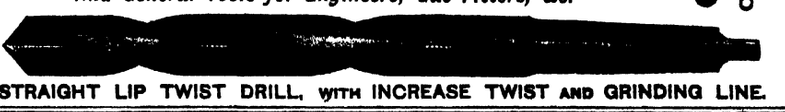
PATENT HAND-POWER SCREWING MACHINES, TWIST DRILLS,

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STRAIGHT LIP TWIST DRILL, WITH INCREASE TWIST AND GRINDING LINE.

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GREEN'S PATENT

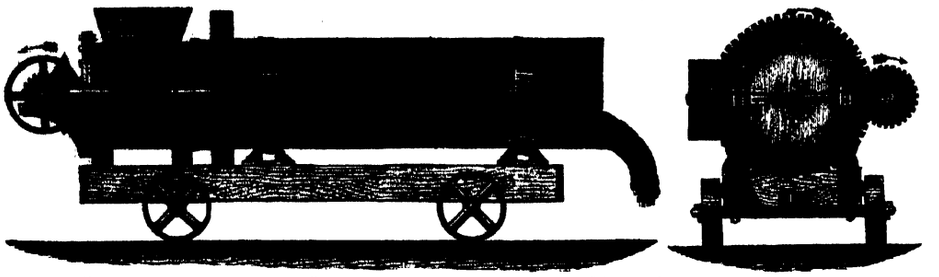
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"Patent Concrete Mixer," capable of mixing 80 to 100 cubic yards per day of 9 hours.

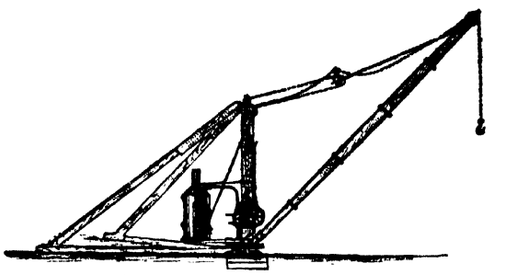
PRICE £90, AS SHEWN.

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SCOTCH DERRICK CRANES,

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STOCK SIZES to Lift 1½, 5, or 7 Tons, 50 ft. Jibs. 5008

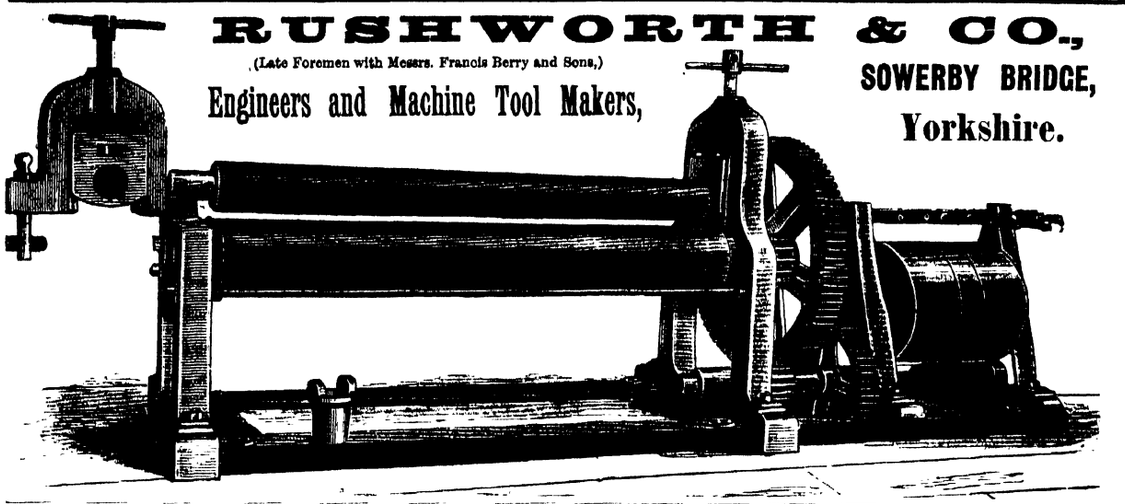
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PLATE BENDING ROLLS,

Special Angle & T Iron Bending Machines,

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PLATE EDGE PLANING MACHINES 5163

For Boiler Makers and Ship Builders.

Highest Prize was awarded at the Tynemouth Exhibition

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The Simplest and best Direct-Acting Dredg' YET MADE.

FIVE DREDGERS on this principle already constructed, and are working in the most satisfactory manner, working expenses being reduced fully FIFTY PER CENT. BELOW that of Bucket and Ladder Dredgers.

5347

These Dredgers can be made to work to any depth not exceeding 35 ft., and to dredge in any material from 100 to 1,000 tons per hour.

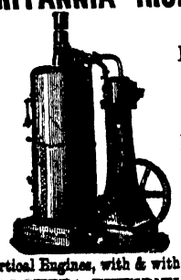
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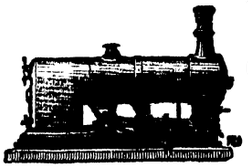


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MORE THAN 12,350 ENGINES MADE AND SUPPLIED.
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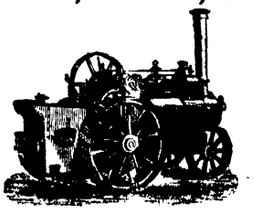
Portable and Semi-Portable Engines for all kinds of Fuel.

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High-Pressure and Compound Engines, with and without Boilers.

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Vertical Engines, with & without Boilers.

ENGINES SPECIALLY EQUIPPED FOR DRIVING ELECTRIC LIGHT MACHINERY.

CALCUTTA EXHIBITION, 1884.—Five Gold and Three Silver Medals.
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ELECTRICAL EXHIBITION, Crystal Palace, 1882.—Gold Medal.
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PARIS EXHIBITION, 1878.—Two Gold Medals and other Prizes.

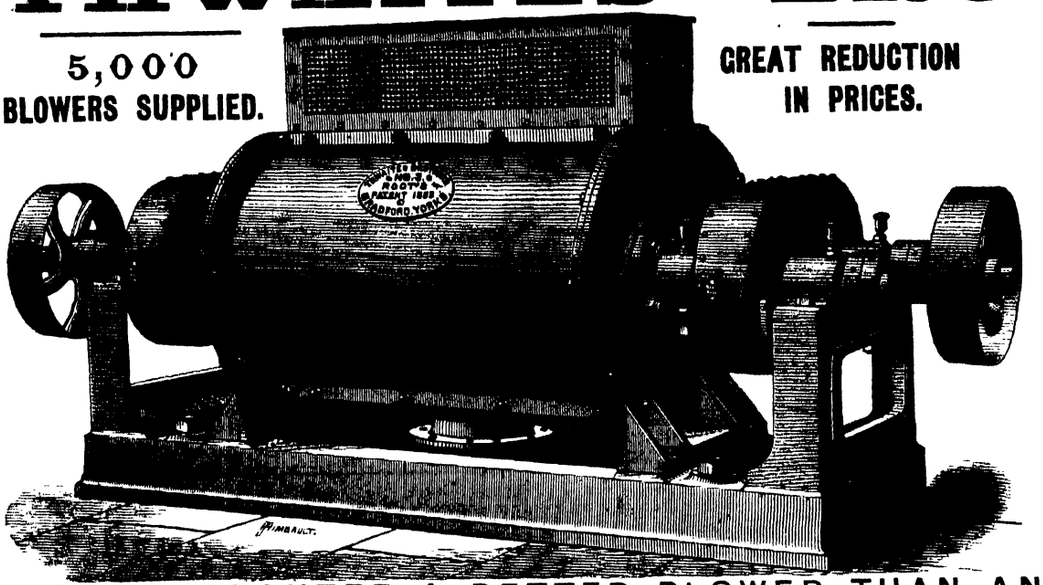
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3939

THWAITES BROTHERS,

5,000 BLOWERS SUPPLIED.

GREAT REDUCTION IN PRICES.



VULCAN IRON WORKS,
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ORIGINAL SOLE MAKERS OF
ROOT'S PATENT IMPROVED
BLOWERS and EXHAUSTERS
New 1884 Pattern, either for Cold or Hot Air or Gas.

ADVANTAGES CLAIMED.

The internal revolving parts are in one piece.—The journal bushes enable adjustment without skilled labour.—All the working parts are fitted to run as close as possible without contact; it is therefore air-tight, without internal friction of parts.—Having fewer parts, and those perfectly balanced, it runs with a steady motion and with less power.—Being entirely of metal, it does not shrink or swell, and can be used for hot air or gases.—It can be used for blowing and exhausting at the same time, and the blast can be reversed.—All parts interchangeable and in duplicate.

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THE ORIGINAL RUSSIAN LUBRICATING OIL. GOLD MEDAL, PARIS, 1878.

Never Gums. Never Freezes. Pure Hydrocarbon. Free from Acid. Prevents Corrosion. Body Superior to Olive, Lard, or Rape Oil.

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GAS WORKS.
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PAPER WORKS.
SHIPBUILDERS.
CONTRACTORS.
SPINNERS.
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&c., &c.

IMPORTANT TO USERS OF BELTING.

GANDY v. REDDAWAY AND OTHERS.

Advertisements have been issued and largely circulated in this country and abroad by Mr. Maurice Gandy, in which he gives prominence to our name without mentioning the whole of the facts in connection with the above action. It is therefore necessary for us to inform the Users of Belting that the ACTION of

GANDY v. REDDAWAY & CO. and Others was dismissed as regards us, WITH COSTS TO BE PAID BY GANDY to

F. REDDAWAY & CO., the Patentees and Sole Makers of REDDAWAY'S BELTING.

We claim to manufacture the BEST and STRONGEST Cotton Belting in the Market, by Machinery of special construction and of our own invention.

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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.

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With a two-page Engraving of the ENGINES AND BOILERS OF THE S.S. "COUNTY OF SALOP."

Portland Cement,

manufactured by

Francis and Co.,

5333

The celebrated Nine Elms Brand, established 1810.
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WORKS: NEW BILTON AND NEWBOLD. 4967

Locomotive Tank Engines designed and constructed by MANNING, WARDLE, AND COMPANY, Boyne Engine Works, Leeds. 2487
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Locomotive Tank Engines, TRAMWAY ENGINES AND CARS.
Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough. 5906
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R. E. Crompton and Co., ELECTRIC LIGHT ENGINEERS,
MANSION HOUSE BUILDINGS, E.C. 5426
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Mr. J. H. Rimbault, Engraver to "Engineering," "Iron," "The Steamship," &c., 30, Maiden Lane, Covent Garden, W.C. Private orders promptly executed. 506

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Any other Engine.
Crossley's Patent Self-Starter, Safest, Best, and Simplest made, may now be applied. 5383
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Steam Launches can be Shipped most conveniently from the Mersey to all parts of the world. A large number of various sizes always in progress at COCHRAN & CO.'S, Birkenhead. See page 4. 4749

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ENGINEERS. 4457

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Miller, Tupp, & Rouse, Steam LAUNCH BUILDERS, HAMMERSMITH, LONDON.
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Worthington Pumping ENGINE COMPANY, 5445
114, QUEEN VICTORIA STREET, LONDON, E.C.
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NEWCASTLE-ON-TYNE.
SPRINGS, BUFFERS, STEEL CASTINGS, FORGINGS, TOOL STEEL, FILES SPRING STEEL, &c. SIEMENS STEEL BLOOMS AND BARS. 3703
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SHEFFIELD.
See Advertisement, page 37. 3627

Stannah's Pendulum Pumps. For Prices see alternate weeks. 3238

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George Russell & Co., ENGINEERS and BOILERMAKERS,
ALPHA STEAM CRANE and ENGINE WORKS,
MOTHERWELL, near GLASGOW.
SILVER MEDAL, PARIS, 1867. 4021

Atkinson's Gas Engines, SELF-STARTING, COMPOUNDED, SIMPLE, AND ECONOMICAL.
BRITISH GAS ENGINE AND ENGINEERING CO.,
11, QUEEN VICTORIA STREET, LONDON.
See Advertisement last week, page 23. 5341

SIEMENS STEEL PLATES, ANGLES, RIVETS, BARS, FORGINGS, CASTINGS, &c.
The Landore Siemens-Steel CO., LIMITED,
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Removed from 76, Cheapside, E.C. 5095
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A First-Class Lubricant.

"Engelbert's Lubricator."

SEE ADVERTISEMENT LAST WEEK,
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IRON AND BRASS FOUNDERS, BOW, LONDON, E.
DREDGING MACHINERY.
HYDRAULIC MACHINERY.
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HUNTER'S PATENT FLOATING CRANE FOR DOCKS, &c.
STEAM LAUNCH MACHINERY. 4955

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Wolverhampton. 4963

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MANCHESTER—5, MARKET STREET.
NEWCASTLE—1, ST. NICHOLAS BUILDINGS. 5189

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Price Lists on application. 5001

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Steam Hammers (with or without guides). Hand-worked or Self-acting TOOLS for SHIPBUILDERS & BOILER MAKERS.
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Thomas Kell and Son, Litho- graphers, &c., execute every description of Lithography, Chromo-lithography, Engraving, and Printing, Engineering, Architectural, and Pictorial Drawing in best manner. Paper Drawing, photo-lithography, &c.—40, King St., Covent Garden, W.C. 5462

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International HEALTH EXHIBITION.
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Bread-Making Machinery
In Bakery Section. 5365
86, UPPER GROUND STREET, BLACKFRIARS, LONDON, S.E.

London Mutual Boiler In- SURANCE COMPANY, LIMITED. Established in 1874 for the INSURANCE and PERIODICAL INSPECTION of all kinds of Land and Marine Boilers throughout the United Kingdom.—For particulars apply to the Secretary 17, Queen Victoria Street, London, E.C. 5366
The Assured are secured against loss from claims established under the Employers' Liability Act, 1880.

Hathorn, Davey & Co., LEEDS.
PUMPING MACHINERY
For Mines, Water Supply, Irrigation, Graving Docks, Drainage of Fens and General Pumping Purposes.
ALSO
HYDRAULIC MACHINERY OF ALL KINDS.
The "DOMESTIC" MOTOR.
CATALOGUES ON APPLICATION. 5356

HIGHEST AWARD, PARIS, 1878.
Goldsworthy's Emery, Emery Cloth, Glass Paper.
MANCHESTER. 5455

East Ferry Road Engineering WORKS CO., LIMITED, Hydraulic Engineers, Millwall, London, E. Parker's Patent Portable Hydraulic Cranes, Lifts, and Hoists. Duckham's Patent Suspended Weighing Machines. 5124
See Illustrated Advertisement last week, page 14.

Dredgers and Excavators.— HIGHEST PRIZE AT TYNEMOUTH
FOR
HYDRAULIC DREDGERS.

Bruce and Batho, 9, VICTORIA CHAMBERS, 5349
WESTMINSTER, S.W.
See Illustrated Advertisement last week, page 49.

L. Sterne & Co., Limited. ENGINEERS,
Sole Makers of
Clerk's Patent Self-Starting Gas Engine.
HIGHEST AWARD,
BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881.
GOLD MEDAL,
CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

Strong's Patent Feed-water Heaters and Purifiers,
WITH
STERNE AND WAINWRIGHT'S PATENTED IMPROVEMENTS.

Emery Wheels, Emery Machines, Spiral Springs.
The Crown Iron Works, GLASGOW.
The Crown Iron Works (Hollinwood), MANCHESTER.
10, Victoria Chambers, WESTMINSTER.
City Office and Show Rooms, 40, CANNON STREET, E.C.
10, Rue Laffitte, PARIS. 2588

Royal Indian Engineering College, Cooper's Hill, Staines. The course of study is arranged to fit an engineer for employment in Europe, India, or the Colonies. Sixty Students will be admitted in September, 1885. For competition the Secretary of State will offer FIFTEEN APPOINTMENTS in the Indian Public Works Department, and TWO in the Indian Telegraph Department. For particulars apply to the SECRETARY at the College. 5432

TENDERS.

INDIA OFFICE,
29th November, 1884.

INDIAN STATE RAILWAYS.

BY ORDER OF THE SECRETARY OF STATE FOR INDIA IN COUNCIL.

The Director General of Stores for India is prepared to receive

Tenders from such Persons as may be willing to SUPPLY—PORTLAND CEMENT.

The Conditions of Contracts may be obtained on application to the Director General of Stores, India Office, Westminster, S.W., and Tenders are to be left at his Office, at any time before Two o'clock p.m., on Tuesday, the 9th December, 1884, after which no Tender will be received.

A. ABERCROMBIE JOPP, J 309
Director General of Stores.

INDIA OFFICE,
4th December, 1884.

BY ORDER OF THE SECRETARY OF STATE FOR INDIA IN COUNCIL.

INDIAN STATE RAILWAYS.

The Director General of Stores for India is prepared to receive

Tenders from such Persons as may be willing to SUPPLY—IRONWORK FOR BRIDGES. GALVANISED IRONWORK FOR ROOFING.

The Conditions of Contract may be obtained on application to the Director General of Stores, India Office, Westminster, S.W., and Tenders are to be left at his Office at any time before Two o'clock p.m. on Tuesday, the 23rd December, 1884, after which no Tender will be received.

A. ABERCROMBIE JOPP, J 335
Director General of Stores.

CHATHAM PIER.

The Local Board of Health for Chatham are prepared to receive

Tenders for the Construction

of the proposed IRON PIER on the site of the existing Sun Pier, on the Medway at Chatham, and the maintenance thereof for twelve months after the completion of the work.

Plans and Drawings may be seen, and Specifications and Quantities may be obtained, on payment of One Guinea, at the Office of Messrs. LAW & CHATTERTON, Civil Engineers, 46, Queen Anne's Gate, Westminster, on and after Wednesday, the 10th instant.

Sealed Tenders, endorsed "Tenders for Chatham Pier," must be addressed to the Clerk, Local Board Offices, Chatham, on or before Wednesday, the 24th instant.

The lowest or any Tender will not necessarily be accepted.

GEORGE WINCH,
Clerk to the Local Board.

Chatham,
3rd December, 1884. J 330

LONDON AND SOUTH-WESTERN RAILWAY COMPANY.

TO CONTRACTORS AND BUILDERS.

The Directors invite

Tenders for such Works as

they may think fit to order within the several Districts of the Railway, including Repairs to the Company's Stations, Buildings, Bridges, House Property, &c. The Contracts to extend from the date of acceptance of the Tender to the 31st of December, 1886, inclusive.

Full particulars can be obtained at the Offices of the Company's Engineer at Waterloo, Bishopstoke, and Exeter Stations respectively, where, on and after Monday, the 8th of December, 1884, printed copies of the Form of Tender, Contract, Specification, and Schedule of Prices, will be supplied on payment of the sum of Two Guineas for each set.

Tenders to be delivered to me on the form supplied, not later than Ten o'clock a.m. on Tuesday, the 16th of December, 1884.

The Directors do not bind themselves to accept the lowest or any Tender.

By order,
FRED. J. MACAULAY,
Waterloo Bridge Station, Secretary.
London, 27th November, 1884. J 298

DARLASTON URBAN SANITARY AUTHORITY.

SEWERAGE WORKS.—CONTRACT No. 3.

TO CONTRACTORS AND OTHERS.

The Local Board of Darlaston acting as the Urban Sanitary Authority, invite

Tenders for the Construction

of TEN MILES or thereabouts of 18 in., 15 in., 12 in., 10 in., and 9 in. EARTHENWARE and CAST IRON PIPE SEWERS, together with all necessary Manholes, Flushing Chambers, and Ventilating Shafts, also the CONSTRUCTION of Engine and Boiler House, Cottage, Tanks, Filter Beds, Drains, Carriers, Roads, Ejector Chambers, and other works as shown.

The Plans, Specification, and Detail Drawings can be inspected at the Offices of the Engineer, Mr. EDWARD PRITCHARD, 2, Storey's Gate, Westminster, or 37, Waterloo Street, Birmingham, from whom Bills of Quantities, Forms of Tender, and other particulars can be obtained on payment of One Guinea.

Sealed Tenders, properly endorsed, to be delivered to the undersigned, on or before the 18th day of December, 1884.

The Local Board do not bind themselves to accept the lowest or any Tender sent in.

By order,
JOSEPH CORBETT, Clerk to the Local Board.
Darlaston, 24th November, 1884. J 264

EMPIRE OF BRAZIL.

Tenders for Lighting by Gas

the City of Rio de Janeiro, will be received at the Brazilian Legation, and at the Consulate General in London, on or before the 28th of February, 1885.—For particulars and Specifications, apply to the BRAZILIAN CONSULATES GENERAL in London and Liverpool. J 319

NEWLYN PIER.

TO CONTRACTORS.

The Newlyn Pier and Harbour Commissioners are prepared to receive

Tenders for the Construction

of a CONCRETE PIER at NEWLYN, in the County of Cornwall.

The Contract, Drawings, and Specifications may be seen and Bills of Quantities obtained at the Office of the Engineer, Mr. J. C. INGLIS, 13, Buckland Terrace, Plymouth.

Tenders endorsed "Newlyn Harbour Contract," are to be sent to the Harbour Office, Newlyn, Penzance, not later than 13th December, 1884.

The Commissioners do not bind themselves to accept the lowest or any Tender.

(Signed),
R. TOMAN, Secretary.
Dated 15th November, 1884. J 243

BOMBAY, BARODA, AND CENTRAL INDIA RAILWAY COMPANY.

The Directors are prepared to receive, up to Noon on Thursday, the 11th inst.,

Tenders for the Supply of the following STORES, viz.:—

CLASS A.
STEEL RAILS.
TIMBER SLEEPERS.
CAST IRON SLEEPERS and FITTINGS.

CLASS B.
STEEL CROSSINGS.

CLASS C.
SHOVELS and BEATERS.
DIVING STORES.

CLASS D.
BRUSHES.
PORTLAND CEMENT.

Tenders must be made on Forms, copies of which, with Specifications, can be obtained on application at the Company's Offices, 45, Finsbury Circus, E.C., on payment, for Class A, 21s. each; Class B, 10s. 6d. each; Class C, 5s. each; and Class D, 2s. 6d. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender. By order,
J. PITT KENNEDY,
Offices: 45, Finsbury Circus, Officiating Secretary.
London, E.C., 2nd December, 1884. J 318

GREAT SOUTHERN AND WESTERN RAILWAY COMPANY, IRELAND.

TULLOW EXTENSION.—TO RAILWAY CONTRACTORS.

The Directors of the Great Southern and Western Railway Company are prepared to receive

Tenders for the Construction

of the EXTENSION LINE from Baltinglass, in the county of Wicklow, to Tullow, in the county of Carlow, a length of about 10 miles 4 furlongs and 8 chains, the whole of which is to be constructed for a single line.

The Plans, Sections, Drawings and Specifications may be seen at the Offices of Mr. BENJAMIN F. FLEMYNG, C.E., No. 35, Dawson Street, Dublin, on and after Monday 24th instant.

A Copy of the Land Plan, Longitudinal Section, and Specification, will be supplied on payment of Five Guineas, with a Schedule of the Engineers' quantities, which quantities are not guaranteed, but given for the purpose of enabling contractors, who purchase plans, &c., to check their own quantities by.

Tenders, accompanied by estimates enclosed in sealed envelopes marked "Tender for Extension Works," and addressed to the undersigned, must be delivered at the Company's Office, not later than Ten a.m., on Friday, the 19th December next.

The Directors do not bind themselves to accept the lowest or any Tender, nor will any Tender be received except accompanied by an estimate, both on Forms to be supplied on application to Mr. Benjamin F. Flemyng's Office.

FRANCIS B. ORMSBY, Secretary.
Kingsbridge Terminus, Dublin,
15th November, 1884. J 222

APPOINTMENTS OPEN.

Civil Service Commission.—FORTHCOMING EXAMINATION.—ARCHITECTURAL DRAUGHTSMAN in the Department of the Director of Engineering and Architectural Works in the Admiralty at the Head Office (26—32), 24th December.

The date specified is the latest at which applications can be received. They must be made on Forms to be obtained, with particulars, from the SECRETARY, Civil Service Commission, London, S.W. J 234

Blast Furnace Manager.

WANTED, for an Iron Works in the West Cumberland District, a thoroughly experienced MAN accustomed to the manufacture of Bessemer pig iron, and spiegeleisen on the most modern system of working. Applicant to state salary expected, and give reference as to qualifications.—Address, J 303, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. J 303

The West Cumberland Iron and Steel Co., Limited, Workington, are REQUIRING a CHIEF ENGINEER, fully conversant with the engineering of the Bessemer and Siemens processes, and with rail and plate rolling.—Apply to the GENERAL MANAGER, stating salary required, previous experience, and giving references. J 296

Wanted, a Works Manager, to Superintend the Manufacture of Traction, Portable, Stationary, and Marine Engines, &c. Preference will be given to one accustomed to Marine and Locomotive work.—Apply, with testimonials, and stating salary required, to CHARLES BURRELL and SONS, Limited, Engineers, Thetford. J 321

TO CIVIL ENGINEERS.

THE HIGHWAYS COMMITTEE FOR THE WESTERN DIVISION OF THE COUNTY OF SUSSEX are desirous of receiving

Applications for the Appointment to the office of West Sussex COUNTY SURVEYOR. Candidates must be Members of the Institution of Civil Engineers. The duties will be:—

1. To survey, personally, every county bridge (in number, at present, 45), including the roads over the same, and so much of the approaches thereto as are liable to be repaired by the Rapes in which the bridges are respectively situate, once a year between Christmas and Lady Day, and to attend the Easter Quarter Session for the said Western Division, and make a written report to such session as to the condition of every county bridge, and to state in such report the date when every such bridge was surveyed;

2. To survey, personally, and make a special report upon any county bridge, if called upon to do so by the Bridge Committee within whose jurisdiction such bridge is situate;

3. To survey, personally, any culvert or bridge, not being a county bridge, if called upon to do so by the Justices of the Petty Sessional Division within whose jurisdiction such culvert or bridge is situate, and report to such justices on the state of such culvert or bridge;

4. To survey, personally, any police station or other county building, if called upon to do so by the Justices of the Petty Sessional Division in which such station or other building is situate, and report upon the state thereof either to the Justices or the Constabulary Committee, as he shall be directed.

The County Surveyor will receive, annually, a retaining fee of Fifty Guineas, which shall cover the annual surveys and reports mentioned under Duty No. 1, and also any surveys and reports mentioned under Duties Nos. 2, 3, and 4; but for every special attendance required by the Justices, or the Bridge Committee, whether at any bridge or at Petty Sessions, he shall be paid One Guinea-and-a-half, to cover his expenses. He will also be paid a commission of five per cent. on all contracts entered into by the county over £20, which are subjected by the county to his control or supervision, such per centage to include and cover the preparation of plans and specifications and superintendance of the work, and anything connected therewith which would be usually included in the five per cent. paid as remuneration for his services to an architect or surveyor.

Candidates are requested to send in their applications, accompanied by testimonials of recent date, indorsed "Application for appointment of West Sussex County Surveyor," on or before Thursday, the 11th day of December, 1884, to J 265

Horsham, THOMAS BEDFORD,
22nd November, 1884. Horsham,
Clerk to the Committee.

Wanted, a Young Man as Assistant Engineer and Mechanical Draughtsman in London Office. Railway work chiefly. Must trace and copy rapidly and neatly, and be qualified to draw out Plans and Specifications of Machinery.—Reply, stating age, experience, and salary required, to T. X. D., care of Messrs. STREET & Co., 30, Cornhill, E.C. J 301

Draughtsman, Trained in large GENERAL ENGINEERING and BRIDGE WORKS, GLASGOW, three years' ENGINEERING COURSE GLASGOW UNIVERSITY, THIRTEEN YEARS' EXPERIENCE, including BRIDGES, ROOFS, Structural Ironwork generally, RAILWAY WORKS, QUANTITIES, SPECIFICATIONS and ESTIMATES, DESIRES a SITUATION.—Address, J 332, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. J 332

Wanted, Two First-Class Loco. DRAUGHTSMEN.—Apply, R. & W. HAWTHORN, Newcastle-on-Tyne. J 300

Draughtsman Wanted; accustomed to Marine Boilers of best class.—State age, experience, and wages expected, to CENTRAL MARINE ENGINEERING CO., West Hartlepool. J 320

Young Engineer Wanted, who has served his time, and is desirous of learning Electric Light Engineering; must have scientific knowledge, and be a good draughtsman.—Apply, by letter, to J. H. HOLMES & CO., Newcastle-on-Tyne. J 328

Wanted Immediately, a Good FITTER; acquainted with the fixing and working of saw mill machinery, to go to South America on a two years' engagement. Terms, £3 per week, board and lodging found.—Apply, with testimonials, to A. RANSOME & CO., Saw Mill Engineers, King's Road, Chelsea, London. J 323

Agents Wanted, to push First-class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool. 5233

Lists of Berths Vacant or WANTED. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5378

SITUATIONS WANTED.

A Civil Engineer, M.Inst.C.E. with 25 years' practical experience in the Construction and Maintenance of Railways and Public Works, is prepared to inspect and report on above, OR would accept position with a COMPANY or PRIVATE FIRM whose active business habits and professional knowledge would be of service; is specially conversant with American railways; has held high and confidential positions. First-class testimonials and references in England and America.—Address, C. E., Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. J 312

A Contractor's Engineer, having seven years' experience, SEEKS ENGAGEMENT, either at home or abroad; accustomed to carrying out works, the management of men, surveying, levelling, quantities and drawing.—Address, E. H., Offices of ENGINEERING. J 320

Pattern Maker.—Situation WANTED, by young man (24), first-rate general hand, steady and industrious; excellent references.—Address, J. EDGAR, 27, Lower Hester Street, Northampton. J 324

PARTNERSHIPS.

Wheatley Kirk, Price, and Goulty. (Established 1850.) MECHANICAL VALUERS, AUCTIONEERS, AND ARBITRATORS

Albert Chambers, Albert Square, Manchester; and 52, Queen Victoria Street, London, E.C.

Engineering Firms of Good REPUTE, open to admit partners or desirous of selling outright, are requested to communicate with the undersigned, who have numbers of clients open for such.—WHEATLEY KIRK, PRICE, and GOULTY, 52, Queen Victoria Street, London, E.C. 4926

Partnerships.—Gentlemen (practical engineers) desirous of entering established Engineering concerns, are invited to communicate with the undersigned, who have numerous bona fide establishments open to admit such. References are given and required.—WHEATLEY KIRK, PRICE, and GOULTY, 52, Queen Victoria Street, London, E.C.

To Civil Engineers in practice.—The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright.

WHEATLEY KIRK, PRICE and GOULTY, 52, Queen Victoria Street, London, E.C. 5371

Partnership with Speciality and 75 per cent. profit.—The Proprietor of valuable speciality in engineers' hand tools (patented in England and on Continent) is OPEN to JOIN FIRM having good connection, who could manufacture same. The article is on the market, and realising 75 per cent. besides manufacturers profits. No one need apply who has not modern tools or prepared to invest £1000 in pushing article.—Address, G. S., Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. J 310

To Engineers and Contractors.—An Engineer, thoroughly experienced in the Erection of Iron Bridges, Piers, &c., possessing capital, SEEKS EMPLOYMENT in the above with a view to Partnership.—Address, A. Z., Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. J 327

To Model Makers.—An Engineer with small capital would like to JOIN an established mechanical or architectural model maker in PARTNERSHIP.—Address, M. A., Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. J 338

WANTED, &c.

Wanted Immediately, Planing MACHINE, to take in 4 ft. high by 4 ft. by about 14 ft. long; two Tool Boxes; extra strong for cutting steel.—Address, stating lowest prices, to HADFIELD'S STEEL FOUNDRY CO., Sheffield. J 297

Wanted, a Good Overhead TRAVELLING CRANE, for Hand-power; span about 52 ft. from centre to centre of longitudinal rails; light, strong, easily handled, to lift at least 20 tons; hook to fall 30 ft. from beams.—Give full particular and tracings to Messrs. JOHN and HENRY GWYNNE, 80, Cannon Street, London, E.C. J 313

Wanted, a quantity of Steel RAILS, 80 and 50 lbs. per yard, also a 3 HP. HORIZONTAL ENGINE, in exchange for a pair of Horizontal Engines in excellent condition, cylinders 16 in. and 22 in., 36 in. stroke, fly spur wheel, 12 ft. diameter, weighing about 8 tons. Can be seen at work.—Address, GEORGE CRADOCK & CO., Rope Works, Wakefield. J 333

Wanted, Engineering Works. Open to Rent or Purchase. State full particulars of plant, locality, &c.—Address, J 331, Offices of ENGINEERING, 35 & 36, Bedford St., Strand. J 331

"Engineering," Wanted, Two or Three Copies of JANUARY 11th, 1884. One Shilling given.—Address, WYLDE, Offices of ENGINEERING, 35 & 36, Bedford St., Strand, W.C. J 311

Lists of Machinery Wanted or on SALE. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5262

FOR SALE.

For Sale, Stone Breaker, size 12 in. by 6 in. Weight 2 tons; with Hall's Patent Elastic Steel Connecting Rods.—Apply, C. E. HALL, Standard Iron Works, Washford Road, Sheffield. 5346

For Sale, Half HP. Hot Air ENGINE; second-hand.—Address, 46, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. J 307

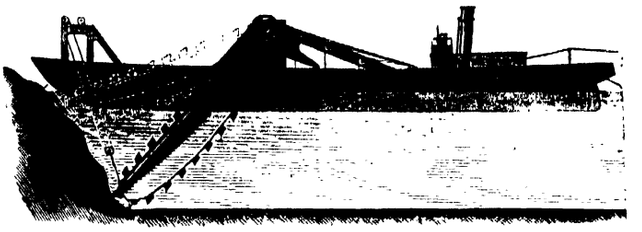
For Sale, by Private Treaty, VALUABLE RIVERSIDE ENGINE WORKS, on the TYNE, with stone quay, frontage of about 300 ft., where vessels can lie alongside for fitting, repairs, &c. The works are in perfect order, and are fitted up with the most modern plant and machinery.—For particulars apply to WILKINSON & MARSHALL, Solicitors, 32, Grainger Street West, Newcastle-upon-Tyne. J 306

For Sale, Two New Locomotive BOGIE TANK ENGINES, gauge 3 ft. 6 in., cylinders 14 in. diameter, 20 in. stroke, four wheels coupled, 3 ft. 9 in. diameter, and four wheeled Bogie under cylinders, copper fire box, brass tubes, wrought-iron wheels, steel tyres and axles, side tanks, 900 gallons; awning, hand and steam brake; spark arresting chimney; made to a first-class specification for a Colonial Line and now not required.—For further particulars apply, THE HUNSLET ENGINE CO., Leeds, or R. ELLIOTT COOPER, Esq., C.E., 3, The Sanctuary, Westminster. J 305

Whitworth Lathe, 6 ft. Screw cutting, with numerous chucks, &c., fitted for both treadle and steam power; £60.—BRITANNIA COMPANY, makers of Lathes (160 varieties), Colchester.—Catalogue of Lathes, also of parts, finished or rough, six stamps. J 309

DREDGING SPECIALITIES.

DREDGERS to raise up to 1,000 Tons per hour, from any depth, and adapted for cutting in front, in centre, or at sides.



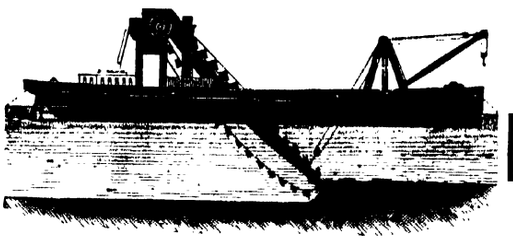
DREDGERS for River Bar, Dock, Canal or Harbour Work.

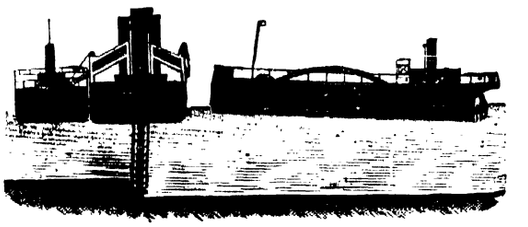
LAND EXCAVATORS, for Dock, Canal, or Railway Cutting, to cut and raise up to 200 Tons per hour.





HOPPER DREDGERS, with all the most modern improvements, to raise up to 1,000 Tons per hour, and carry their own spoil.





PARTICULARS ON APPLICATION TO

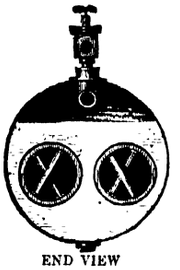
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PAISLEY, N.B. 6102

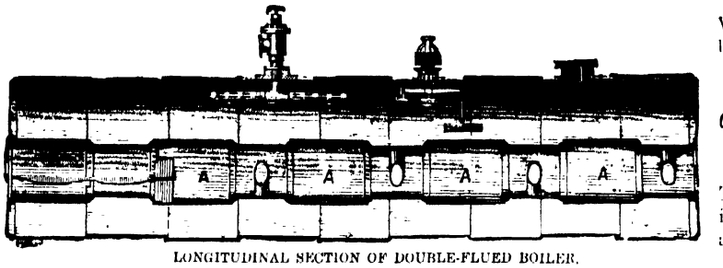
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PATENT FLANGED FLUED BOILER.

THOUSANDS OF THESE BOILERS are now at work, large numbers having been working at very high pressures night and day for upwards of ten years, and with a success both in **Safety, Economy and Freedom from Repairs.**



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LONGITUDINAL SECTION OF DOUBLE-FLUED BOILER.

Which has not been equalled by any other Flued Boiler in the Market.

CIRCULARS FREE BY POST, GIVING FULL DETAILS.

The strength of this Flue and its provision for contraction and expansion are unrivalled.

HAWKSLEY, WILD & CO., Patentees and Manufacturers,

BRIGHTSIDE BOILER AND ENGINE WORKS, SHEFFIELD. 5367

JAMES FARMER & SONS,

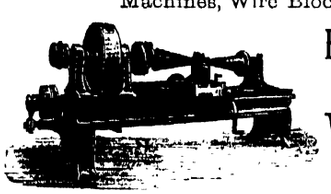
ADELPHI STREET IRONWORKS, SALFORD, MANCHESTER,

MAKERS OF

STEAM ENGINES, BLEACHING, FINISHING, DYEING & CALICO PRINTING MACHINERY,

WIRE MACHINERY

Consisting of Continuous and other Rolling Mills, Wire Pointing Machines, Wire Looms, Wire Testing Machines, Wire Blocks, &c.



COPPER TUBE ROUGHING LATHE.

BRASS & COPPER TUBE MILLS.

Wrought Iron TUBE MACHINERY.



PATENT DRYING AND PULVERISING MACHINE.

COMPLETE PLANT FOR

LINOLEUM MACHINERY

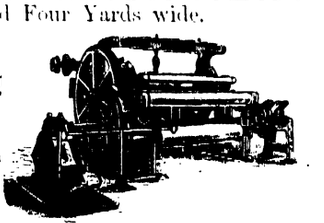
Two and Four Yards wide.

"PATENT"

Drying & Pulverising MACHINE

For Excrementitious Matter & other Materials and Compounds.

MACHINERY IN GENERAL



POWER WIRE LOOM. 4859

FOR BRICK, TILE, & PIPE MACHINES,

JOHN WHITEHEAD & CO.,

ALBERT WORKS, PRESTON, LANCASHIRE,

HAVE BEEN AWARDED

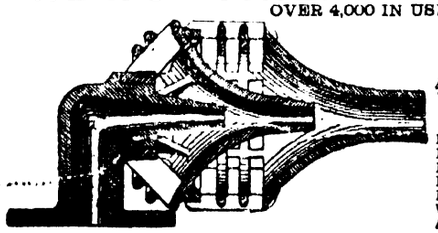
FOURTEEN PRIZES by the Royal Agricultural Society of England,

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Also Awarded the PRIZE MEDALS of the INTERNATIONAL EXHIBITIONS of LONDON, 1851, 1862, and 1874; PARIS, 1855, 1856, 1867, and 1878.

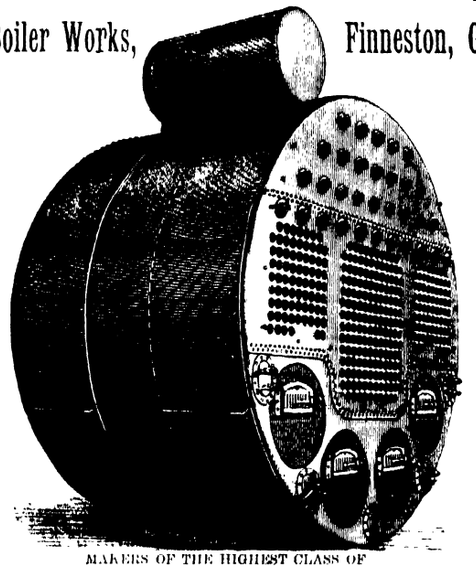
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HIGH PRESSURE MARINE BOILERS.
Best and Cheapest Means of Preventing Unequal Expansion.
"WEIR'S" PATENT HYDROKINETER.
OVER 4,000 IN USE.



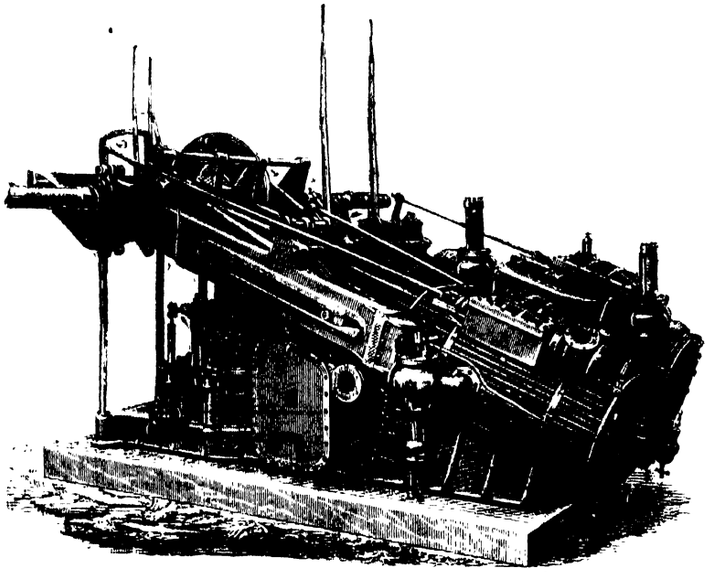
G. & J. WEIR,
49, JAMAICA STREET,
GLASGOW.
MENZIES & BLAUBURN, KING STREET, NEWCASTLE-ON-TYNE. WM. REID & CO., 5, NEW LONDON STREET, LONDON, E.C. A. & R. BROWN, WATERLOO ROAD, LIVERPOOL. R. HUGHES & CO., FULTON STREET, DITTO. W. S. VON ESSEN, ENGINEER, HAMBURG. AGENT FOR SCANDINAVIA & GERMANY 5231

H. WALLACE & CO.,
Lancefield Boiler Works, Finneston, GLASGOW.



MAKERS OF THE HIGHEST CLASS OF 5394
MARINE, LAND, LOCOMOTIVE, AND LAUNCH BOILERS.

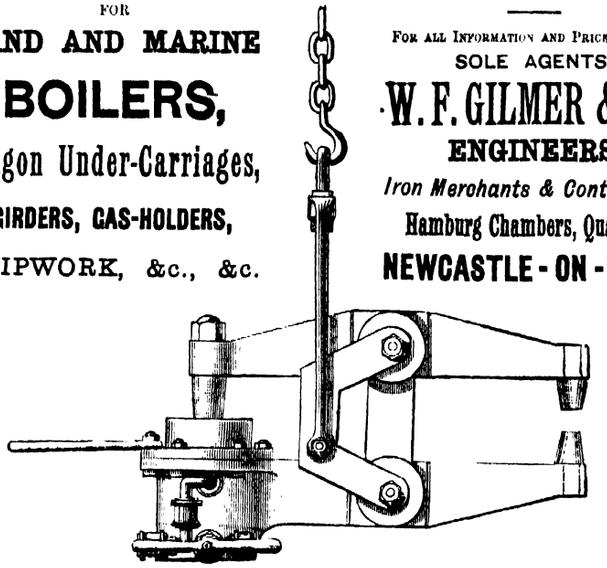
RANKIN & BLACKMORE,
ENGINEERS, GREENOCK,
MAKERS OF RANKIN'S PATENT
2-CYLINDER DISCONNECTING COMPOUND ENGINES
AND
4-Cylinder Disconnecting Triple-Expansion Engines,
FOR PADDLE AND TWIN-SCREW STEAMERS.



The principal advantages claimed for these Engines, as compared with the ordinary 4-cylinder Compound and 6 or 8 cylinder Triple-Expansion Engines, are –
SIMPLICITY OF CONSTRUCTION, ECONOMY OF FUEL, ACCESSIBILITY OF WORKING PARTS, SUPERIOR EFFICIENCY, AND LESS TEAR AND WEAR.
FULL PARTICULARS AND PRICES ON APPLICATION.

For Illustration of 4-cylinder Twin-Screw Engines, see ENGINEERING of this day fortnight. 5229

ARROL'S PATENT PORTABLE
HYDRAULIC RIVETTING MACHINES
FOR
LAND AND MARINE
BOILERS,
Wagon Under-Carriages,
GIRDERS, GAS-HOLDERS,
SHIPWORK, &c., &c.



FOR ALL INFORMATION AND PRICES APPLY TO
SOLE AGENTS,
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ENGINEERS,
Iron Merchants & Contractors,
Hamburg Chambers, Quayside,
NEWCASTLE-ON-TYNE.
4964
LARGE NUMBER IN USE AT HOME AND ABROAD.

Effects a Saving on Application.

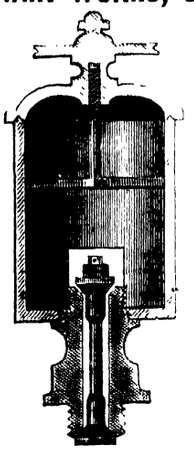


Testimonials of 50% over Oil.
WASHINGTON BUILDINGS, 4288
23, BRUNSWICK STREET, LIVERPOOL.

WHITEHOUSE & CO.'S
PATENT
Self-Acting Adjustable Lubricator,
TIPTON HALL CHAIN WORKS, STAFFORDSHIRE.

A Clear Saving of 50 per cent. in Oil, Tallow, or Grease.

Cannot get out of order.



Perfectly Clean in working.

One Month's free trial allowed.

SIZES.
2 in., 2½ in., 3 in., 3½ in., 4 in.

Prices on Application.

Self-acting, with two valves which are set to requisite feed by means of lock-nut, to permit only necessary lubricant to flow. It ceases working with the engine, and remains closed until the engine commences working again, thus effecting every possible saving.

Agents { LONDON: J. C. S. OGG, 13, Crutched Friars, E.C.
MANCHESTER: C. J. BROWN, 7, Exchange Arcade.
LIVERPOOL: HOLT & ADDLINGTON, 24, Fenwick Street. } 6212

J. VEITCH WILSON & CO.Y.

MANUFACTURERS OF

Lubricating Oils

FOR

Steam Cylinders & every description of Machinery

5380

GLASGOW. MANCHESTER. DUNDEE.

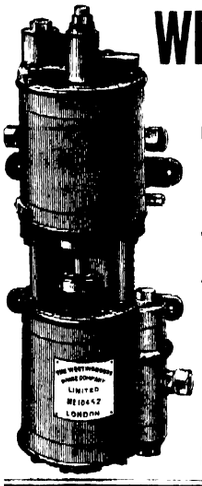
DRON & LAWSON, Cranstonhill Tool Works, GLASGOW.

PRICE LISTS ON APPLICATION.



PRICE LISTS ON APPLICATION.

MAKERS OF ALL KINDS OF MACHINE TOOLS FOR ENGINEERS, SHIPBUILDERS, &c.
Specialities: Screwing Machines, Taps, and Hand Screwing Apparatus.
Sole Makers in this Country during the currency of the Patent of DUDGEON'S TUBE EXPANDERS 4460



WESTINGHOUSE PATENT AIR PUMPS

Upwards of 12,000 in use in all parts of the World.

CHEAP! SIMPLE! DURABLE! EFFECTIVE!

Occupy very little room, and work equally well for
AIR, VACUUM, OR WATER.

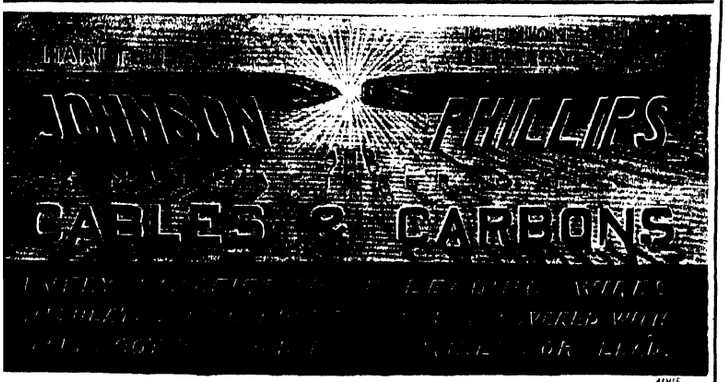
Two sizes for Air and Vacuum are kept in Stock, but either can be adapted so as, with a given pressure of steam, to compress air to any required density.

ALL PARTS ARE WORKED TO STANDARD GAUGES

WATER PUMPS, working on the same system, are made to order.

Prices on application to

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LIMITED, 5409
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4905

BILLINGTON & NEWTON,

SOLE MANUFACTURERS

OF

CROWN

TRADE MARK

PHOSPHOR-TIN,

PHOSPHOR BRONZE,

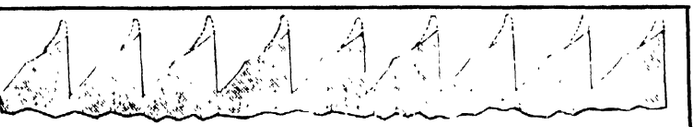
PATENT FERRO MANGANESE BRONZE,

BABBITT'S & KINGSTON'S PATENT ANTIFRICTION METALS,

PLASTIC METAL AND WHITE BRONZE.

LONGPORT, STAFFORDSHIRE. 5159

Agents.—London: HAUGHTON & CO., 110, Cannon Street, E.C.
North of Europe: A. SINGTON & CO., St. Peter's Square, Manchester.
Scotland: P. & W. MACLELLAN, Trongate, Glasgow.



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NEPTUNE FORGE, CHAIN, ANCHOR, ENGINE AND BOILER WORKS.

JOSEPH WRIGHT & Co.

TIPTON, STAFFORDSHIRE

SOLE MAKERS OF

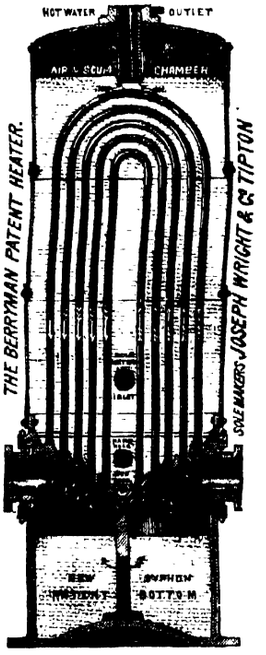
BERRYMAN'S IMPROVED PATENT UNIVERSAL EXPANDING TUBULAR

FEED-WATER HEATER



THE WELL KNOWN
BERRYMAN HEATER
AND
INTERHEATER,
ARE NOW FITTED WITH OUR NEW
PATENT
SYPHON BOTTOM
AND OTHER IMPROVEMENTS,
SAVING
FROM 15% TO 50% OF
COALS,
BOILER POWER,
WATER & LABOUR.
OVER 1000 SOLD

SUITABLE
FOR HIGH OR LOW
PRESSURE
AND COMPOUND
ENGINES.



SOLE MAKERS OF THE A1. SPECIAL BEST BEST J.W. & Co. (REGISTERED BRAND)

CRANE CHAIN.



5077

CHAIN CABLES

THEY HAVE NEVER BEEN SURPASSED FOR STRENGTH, UNIFORMITY OR DURABILITY, AND ARE MADE BY SPECIAL WORKMEN FROM IRON OF SPECIAL QUALITY, PREPARED EXPRESSLY FOR THIS COMPANY ONLY.

THE STEEL COMPY. OF SCOTLAND,

LIMITED.

(SIEMENS PROCESS).

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MANUFACTURERS OF

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I. & W. BEARDMORE,

PARKHEAD IRON and STEEL FORGE and ROLLING MILLS, GLASGOW,

CONTRACTORS TO THE ADMIRALTY AND FOREIGN AND COLONIAL GOVERNMENTS.

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STEEL PLATES, SHEETS AND BARS

(Siemen's Process) and

IRON SHEETS, PLATES AND BARS

FOR SHIPS, BOILERS, BRIDGES, &c.

	Ship	Boiler	Special	Extra Fine
BRANDS	P S Steel	P SS Steel	P SB Steel	P SB Steel ♚

FOR COMBUSTION CHAMBERS.

Boiler End & Furnace Plates, Flanged & Welded. Special Steel for Anti-Collapse Rings & Welded Tubes.

IRON AND STEEL FORGINGS OF ANY DIMENSIONS FOR MARINE ENGINES AND OTHER PURPOSES.

IRON AND STEEL CRANK SHAFTS OF SPECIAL MANUFACTURE.

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Newcastle-on-Tyne . . . . . Wm. KELSEY | Antwerp . . . . . Capt. RYAN
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ESTABLISHED 1862.

STANNERS CLOSE'S STEEL CO.,

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MANUFACTURERS OF EVERY DESCRIPTION OF

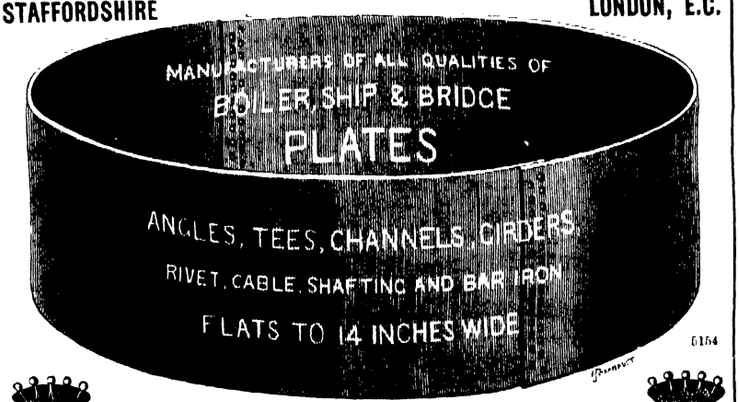
CAST STEEL FORGINGS AND CASTINGS,

Piston Rods, Slide Rods, Motion Bars, Crank Shafts, Propeller Shafts, Axles, Wire Billets, Spades and Shovels, &c., &c. 5288

Gold Medals, Melbourne, 1881; Paris, 1878. First-Class Medals Paris, 1855; London, 1862.

SHELTON BAR IRON COMPANY

STOKE-ON-TRENT, STAFFORDSHIRE AND 122, CANNON STREET, LONDON, E.C.



5154

SHELTON BRANDS. GRANVILLE

W. BOAZ'S PATENT BOILER TUBE CLEANER



THIS SCRAPER is acknowledged by all the leading Engineers to be the most durable and effective Scraper that has ever been brought before their notice

In ordering please state inside diameter of tubes

PRICE LIST

Upto 2in.	2¼in	2½in	2¾in	3in	3¼in	3½in	4in diam
3/-	3/6	4/-	4/6	5/-	5/6	6/-	6/6 7/- each

WORKS:—29, WEST INDIA DOCK ROAD, LIMEHOUSE, LONDON, E. 5258

THIS alloy is an improved brass, hard, durable, and strong as mild steel, possessing a beautiful golden colour; when melted it produces sound castings of fine grain; it can be forged hot and cold, and takes a very high polish.

DELTA METAL IS BEING LARGELY USED FOR ALL KINDS OF MACHINERY

DELTA METAL.

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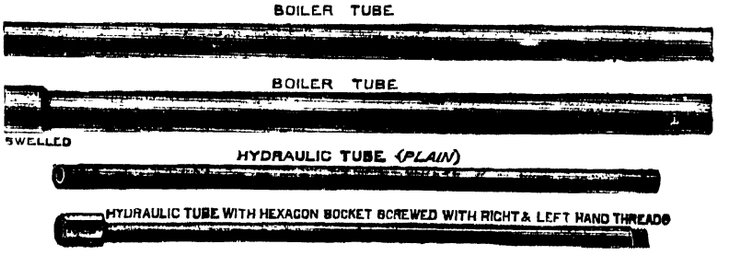
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THE WELDLESS STEEL TUBE COMPY.,

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PATENT WELDLESS STEEL TUBES

For Boilers, Hydraulic Presses, Ferrules, Boring Rods, Bushes, Shafting, Couplings, Spindles, Collars, and other uses.

TRADE WELDLESS MARK 5427

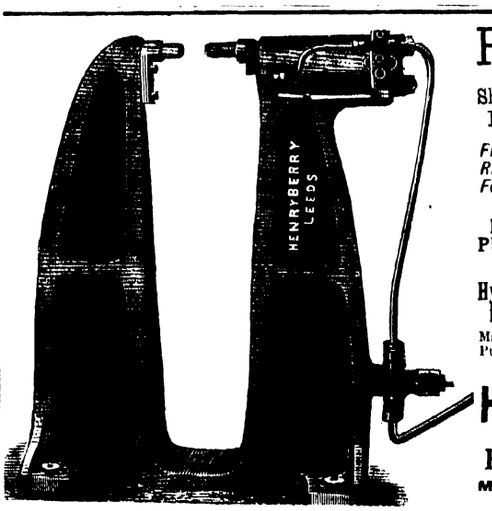
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TUBE WORKS,

TUBES

WOLVERHAMPTON. STAFFORDSHIRE

5166



RIVETTERS

FOR

Ship, Locomotive, Carriage Builders, and Boilermakers,

VIZ.:

Fixed and Portable Hydraulic Riveting, Flanging, Bending, Forging, and Punching and Shearing Machines,

HYDRAULIC PRESSURE PUMPS & ACCUMULATORS

HYDRAULIC CRANES,

Hydraulic Pressure Valves, Packing Leathers and Moulds, &c.

Machines made to work direct from Pumps, without an Accumulator, if required.

HENRY BERRY,

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HUNSLET, LEEDS.

MESSRS. LANGE & GEBHARD

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LINOLEUM FLOOR CLOTH MACHINERY.

PRINCIPAL FACTORIES } STAINES, ADDLESTONE.
SUPPLIED WITH PLANT } Cie. Fr. du Linoleum, Paris, Bremen, &c.

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PRIZE MEDALS.

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London - - - 1862
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Paris (Class 53) 1867
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Trieste - - - 1871
Moscow (Gold) - 1872
Moscow (Silver) 1872
London (Annl.) 1873
Brussels (Silver) 1876
Brussels (Brnz.) 1876
Sydney - - - 1879
Melbourne (1 Gold, 2 Silv.) 1881



AGRICULTURAL SHOWS.
Manchester and Liverpool - - 1857
Royal - - - - 1869
Royal - - - - 1870
Manchester and Liverpool (2) - 1871
Ayrshire - - 1876
Highland Society (2) - - 1876
Royal Cornwall 1877
Royal Manchester, Liverpool, and N. Lan - 1878
Ditto ditto 1880

Manchester (Gold) Soc'y Prom. Scientific Industry - 1878
Yorkshire Fine Art and Industrial Exhibition, - - 1879
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For all Commercial, Manufacturing, Railway, and Mining Uses. Adapted to the Standards of all Nations.

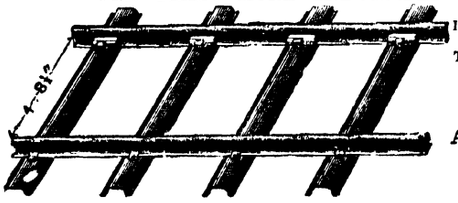
Works: ALBION FOUNDRY, LIVERPOOL.

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Fennell Street, MANCHESTER.
Siddals Road, DERBY
Albion Works, McAlpine Street, GLASGOW. 844

WOOD'S PATENT

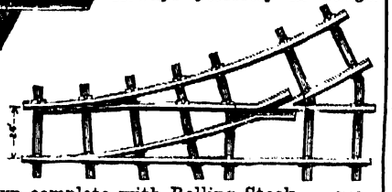
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TEN TIMES MORE ENDURABLE THAN TIMBER.



In use upon many Railways in England and the Colonies.
The first and only Cross Sleeper in use upon English Railways with Flat bottomed Rails.
Ample Bearing on Ballast.
Can be shifted without damage
Always perfectly in Gauge.

THE MOST SIMPLE AND PERFECT FASTENING.



Narrow Gauge Railway, from 16 in. to 36 in., in use in the Cleveland and many other Mines.

Agricultural, Portable and Light Passenger Railways put down complete with Rolling Stock. 3855

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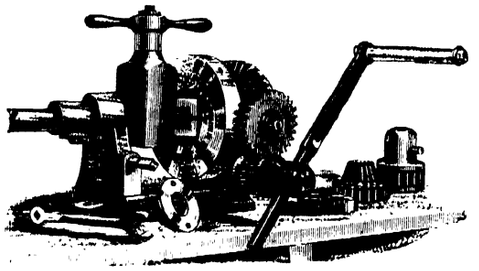
CHARLES WINN & CO.,

GENERAL METAL WORKERS AND ENGINEERS,

Head Offices & Works,] BIRMINGHAM. [GRANVILLE STREET.

IMPROVED PORTABLE SCREWING MACHINE

—o—
DETAILED PRICE LISTS ON APPLICATION.
—o—



—o—
DETAILED PRICE LISTS ON APPLICATION.
—o—

AMONG OTHERS WILL BE FOUND THE FOLLOWING ADVANTAGES:

Instantaneous release of pipe when screwed by a simple operation, thus dispensing with the slow return motion which has hitherto been a vexatious delay.
A powerful self-centreing pipe holder, which will grip 2-in. tube as firmly as ¼-in., without distorting its shape or splitting it.
Simplicity of the screwing arrangement, whereby the most inexperienced can screw any size of tube, and to any length of threads.
An arrangement, by which the dies are instantaneously readjusted and are made self-centreing, so that *accuracy* and uniformity of size is assured.

The Best Material and Workmanship is used throughout. 4216

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Contractors to Her Majesty's War Department.

HOT WATER BOILERS,

PIPES AND CONNECTIONS.

IRON PIPES,

&c., FOR Gas & Water Works.

THE THAMES BANK IRON COMPANY, UPPER GROUND STREET, LONDON, S.E.

HOT WATER AND Hot Air Apparatus

— ERECTED COMPLETE. — 4294

THE LARGEST AND MOST COMPLETE STOCK IN THE TRADE.

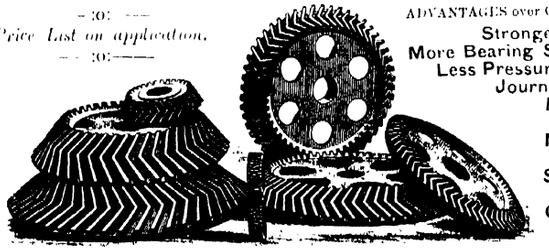
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DOUBLE HELICAL TOOTH WHEELS.

Bevel or Spur Gear from 3 in. to 20 ft. diameter.

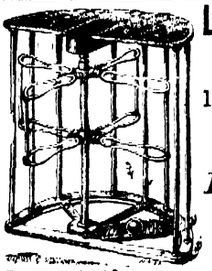
MADE BY SPECIAL MACHINERY.

Price List on application.



ADVANTAGES over ORDINARY GEARING,
Stronger Tooth.
More Bearing Surface on Tooth.
Less Pressure on Collar of Journals.
Free from Jerks and Backlash.
More Teeth in Gear.
Smoother Working.
Greater durability
5324

WILLIAM WHITTAKER & CO., Engineers, &c., OLDHAM.



LE GRAND & SUTCLIFF,

ARTESIAN WELL ENGINEERS,
100, BUNHILL ROW, LONDON.

"Abyssinian" Tube Wells.

REGISTERING TURNSTILES.

THE TUBULAR PILE, 5074
For Bridge and Pier Building, &c., &c.

THE

"LANCASTER"

THE Speciality of the "Lancaster" Steam Trap consists in the LOOSE DISC VALVE at the orifice of the discharge pipe in connection with a QUICK THREAD SCREW motion, worked by the float. This Valve is FRICTIONLESS in action, and being loose CANNOT STICK in its seat. It is very prompt in its movements for opening and closing the discharge pipe, and the working parts are VERY SIMPLE and EASILY EXAMINED. It also acts as a Safety Valve, as any excessive pressure exerted against the face of the loose disc valve would by virtue of the QUICKNESS OF THE SCREW THREAD, force it open. Three of these Steam Traps were employed for draining the steam pipes with which I heated Messrs. A. BAACKE & Co.'s Fossil Meal Composition at the recent Engineering and Metal Trades Exhibition at the Agricultural Hall, London. They acted with REGULARITY and EFFICIENCY, one of the traps being specially put to a severe test in draining the DIRTY WATER collected by the Steam Filtering apparatus attached to the steam Supply Pipes. Three other Traps of the same construction were connected with STEERING GEAR in different parts of the Hall, and they as well as the Steam Traps at Messrs. Baacke's Stand, were in action UNINTERRUPTEDLY during the whole time of the Exhibition, and gave ENTIRE SATISFACTION (Signed)

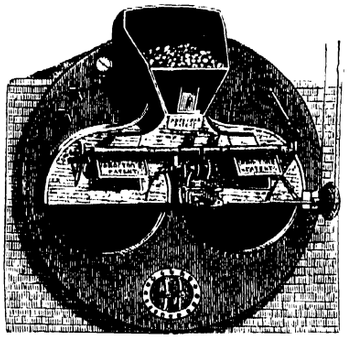
D. K. CLARKE, M.I.C.E.

LANCASTER AND TONGE, 4335
Engineers and Brassfounders. PENDLETON, near MANCHESTER, Patentees and Sole Makers

Received PRIZE MEDAL at the Smoke Abatement Exhibition, South Kensington, London.

PROCTOR'S

Patent Mechanical Stoker



BUFFER SPRINGS & BUFFERS ENTIRELY DISPENSED WITH.

WORKS NOISELESSLY.

Will apply the Stoker for Two Months upon approval.

Over 1000 Boilers or 2000 Furnaces have been supplied with these Stokers.
Over 200 Machines now working on the Continent.

The Simplest, Cheapest, and most Efficient in the Market.
Will guarantee to produce more Steam with less Coal than can be done by hand firing.
No drilling of the Boiler to fix it; the bolts that hold the ordinary front are used to fix the Stoker.

J. PROCTOR, PATENTEE & MAKER,
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he PATENT ANHYDROUS LEATHER Co., Portsmouth.

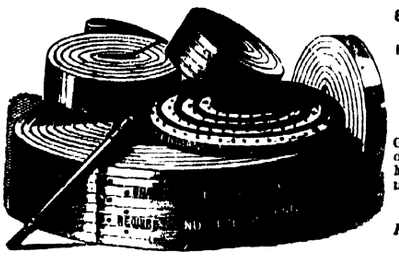
Contractors to H.M. Government.

SOLE PATENTEES AND MANUFACTURERS OF

HYDROUS LEATHER AND OTTON BELTING.

ATHER HOSE, rfectly Waterproof.

ain Driving Belts nout Cross Joints, any th, and to transmit required HP.



Short Out Strap Butts and Strapping for Home and Export.

WATERPROOF PUMP BUTTS, &C.

N.B.—All Waterproof Goods are stamped with our Registered Trade Mark, without which none are genuine.

ESTABLISHED 1860.

Prices and Testimonials Free. 5078

ELECTRIC EXHIBITION.—This Belting was at work at the Royal Aquarium, transmitting up to 130 HP.

CHARLES FRANCIS, SON & Co.

CEMENT MANUFACTURERS,

WEST MEDINA MILLS, NEWPORT, ISLE OF WIGHT.

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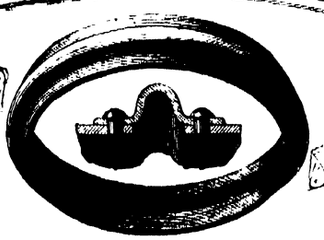


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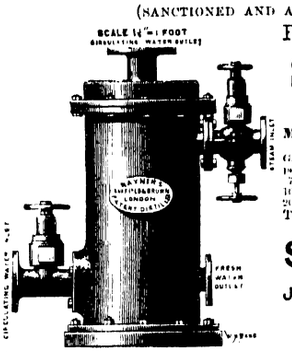
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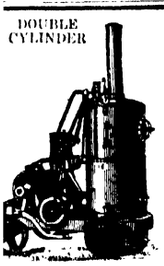
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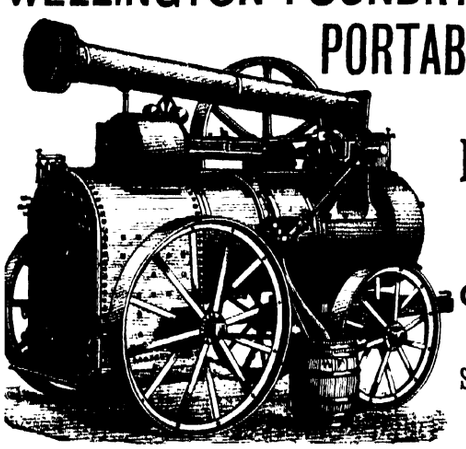
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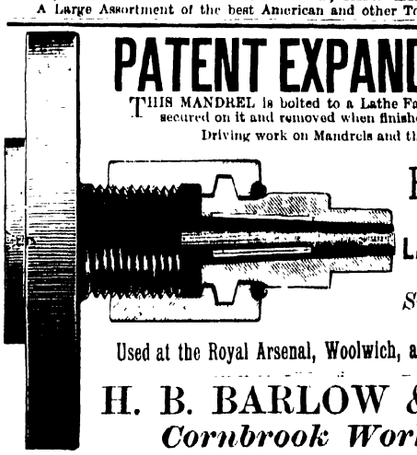
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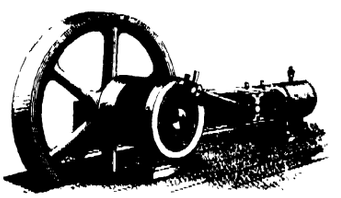
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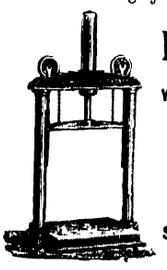
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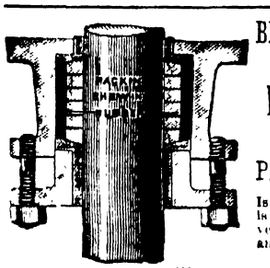
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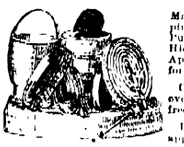
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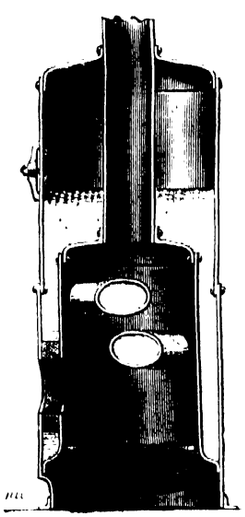
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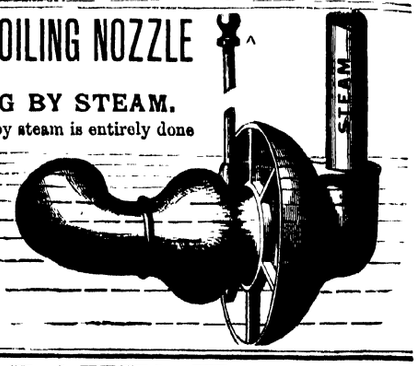
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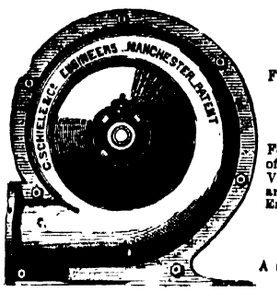
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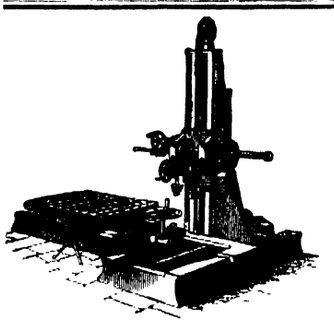
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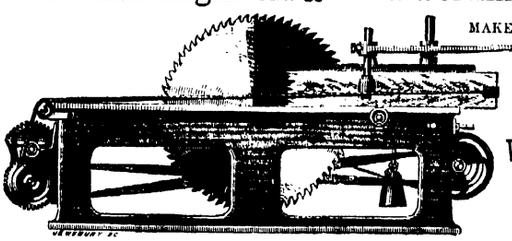
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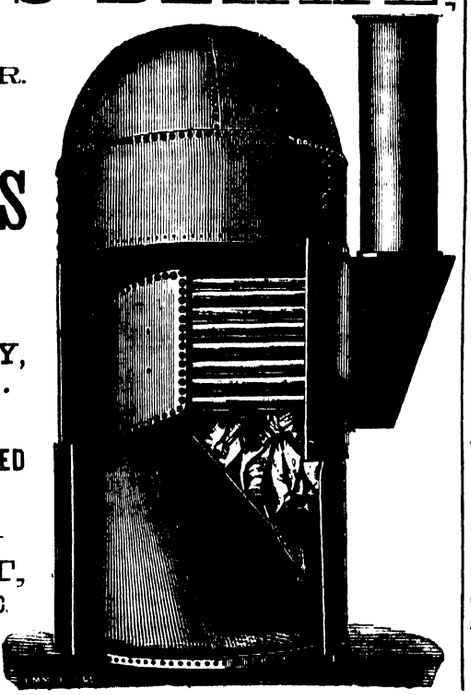
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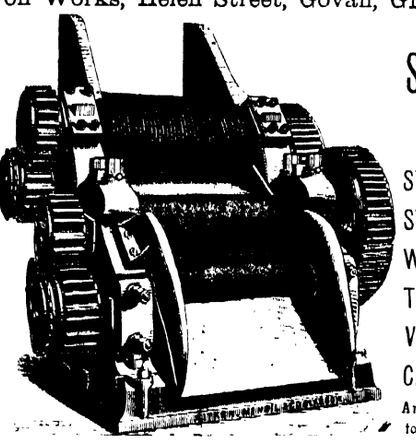
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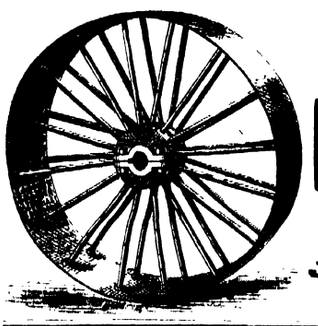
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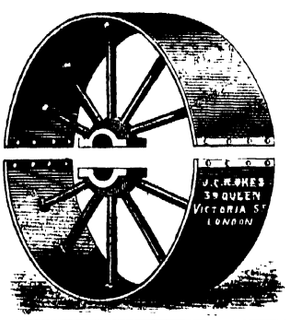
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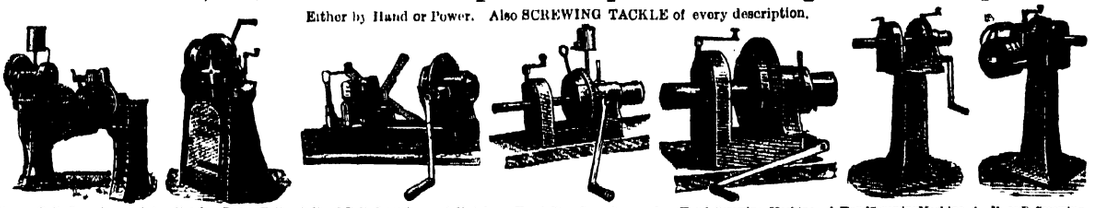
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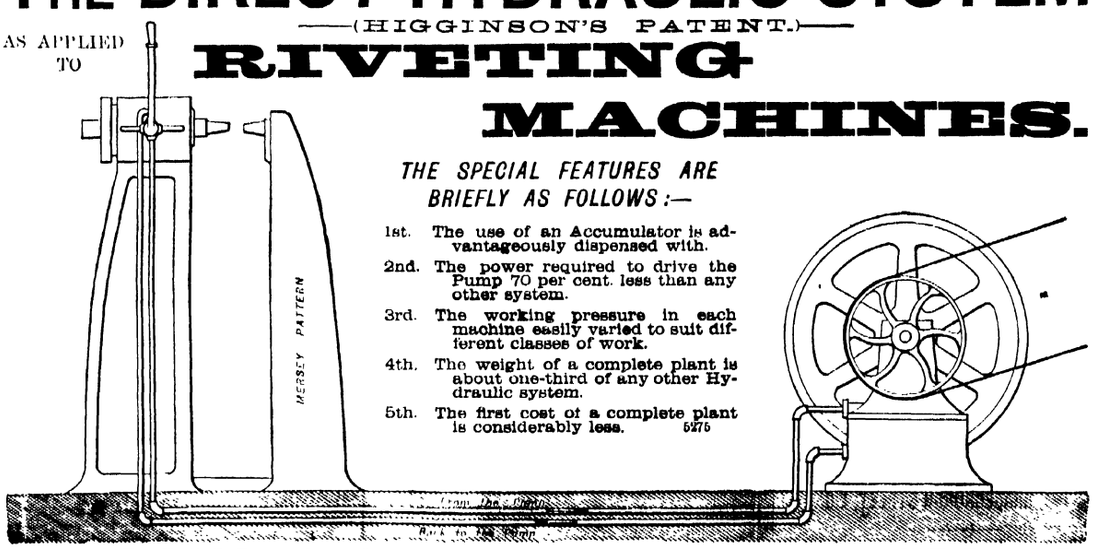
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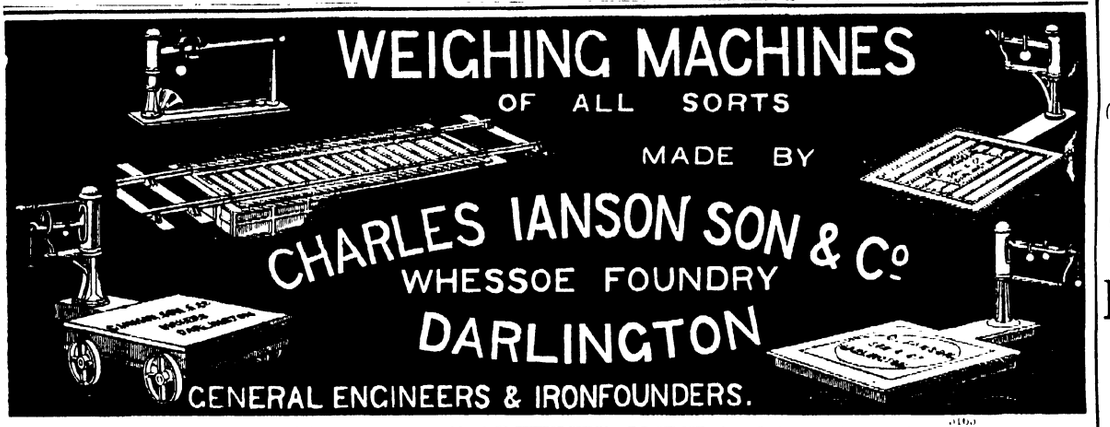
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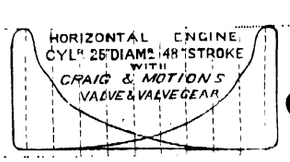
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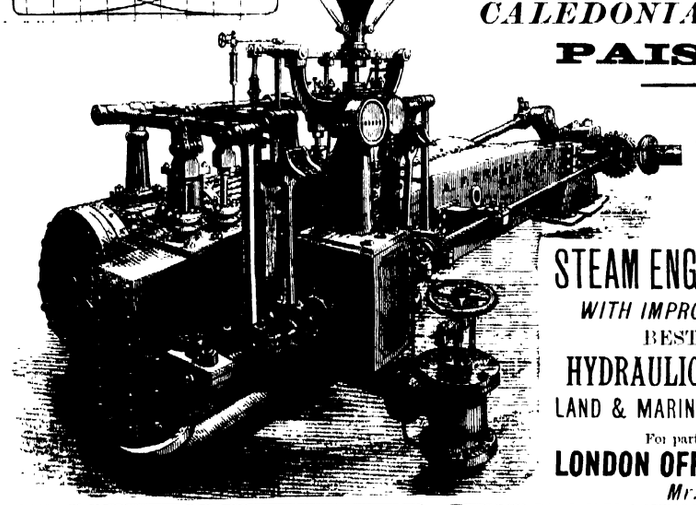
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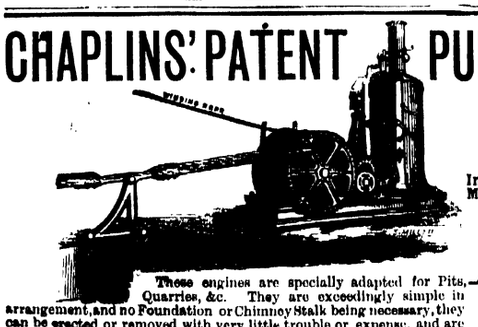


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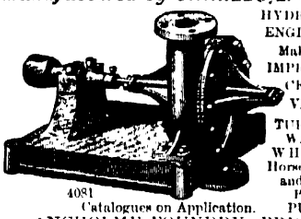
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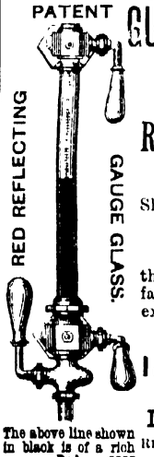
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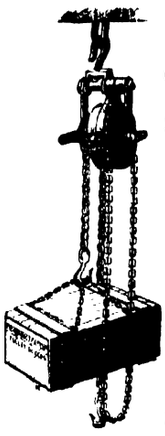
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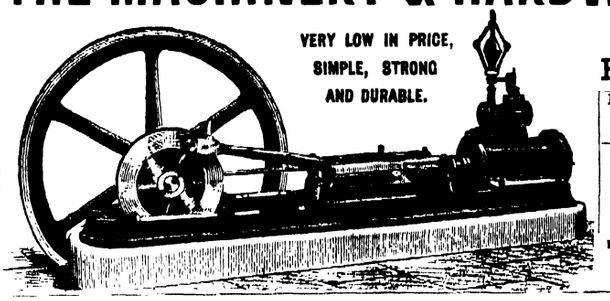


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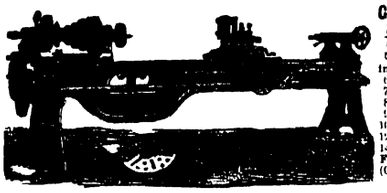
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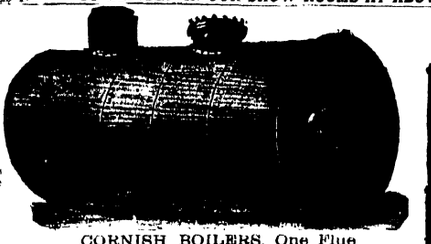
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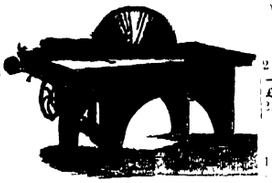
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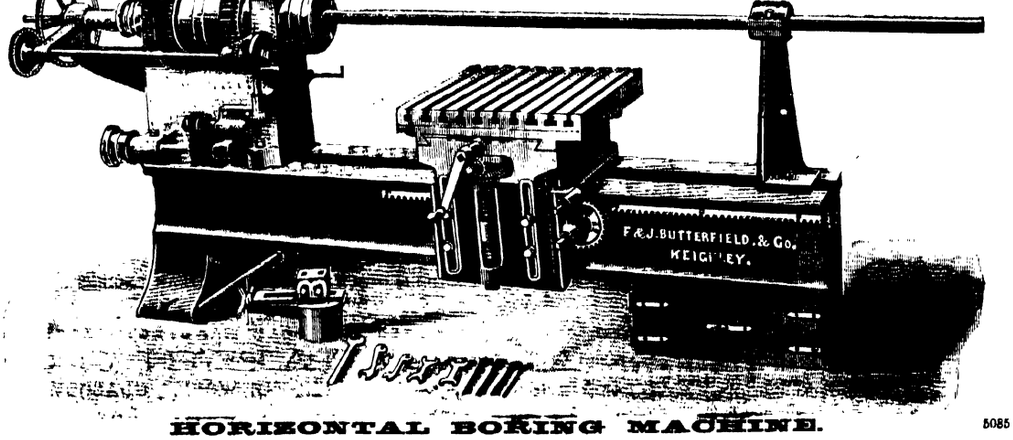
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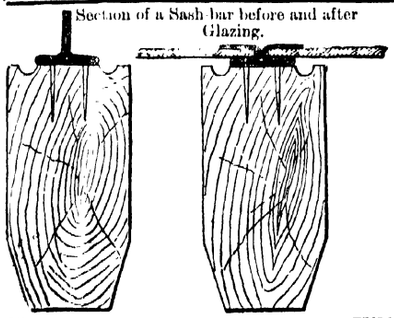
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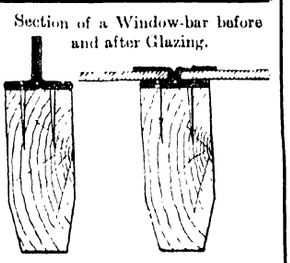
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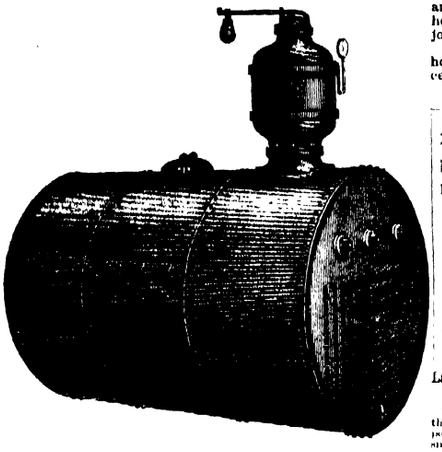
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80	5 0	7 0	2 3	2 3	189	78	£134
80	5 6	7 6	2 9	2 6	225	90	£154
80	6 0	7 6	2 9	2 3	265	97	£174
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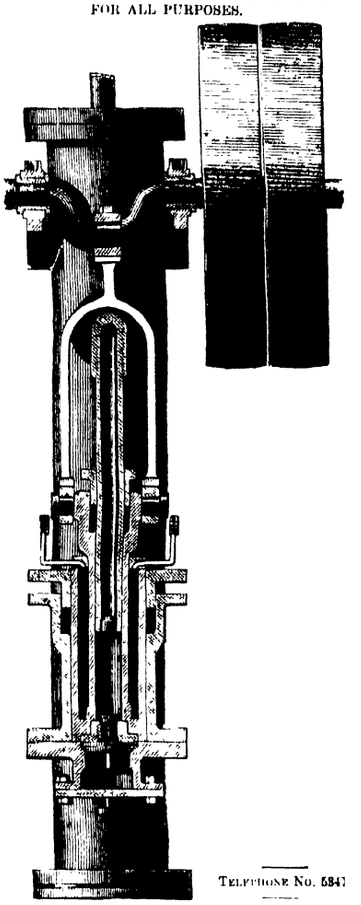
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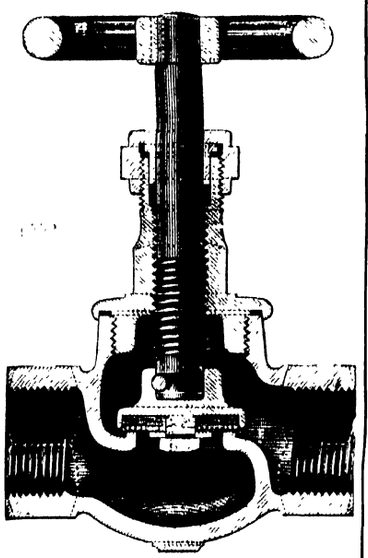
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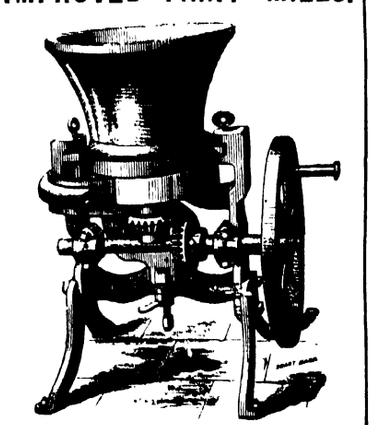
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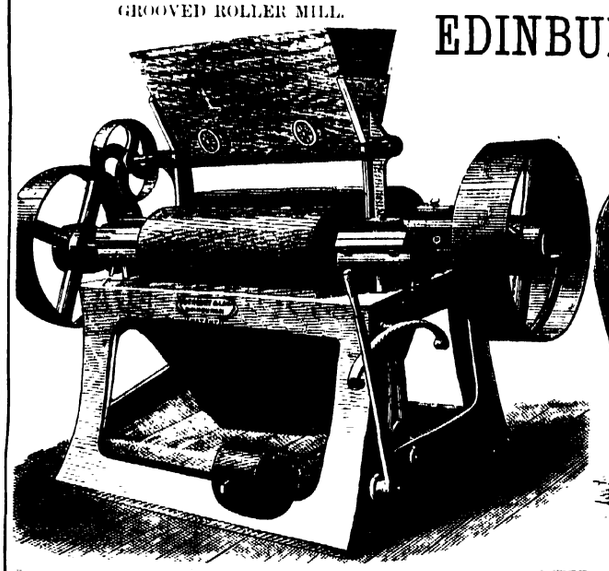
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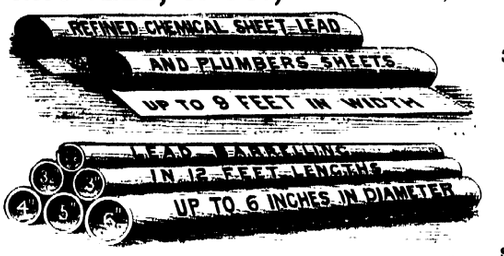


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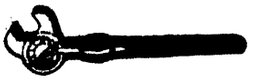
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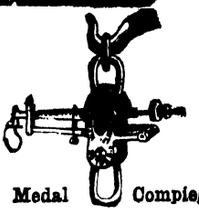


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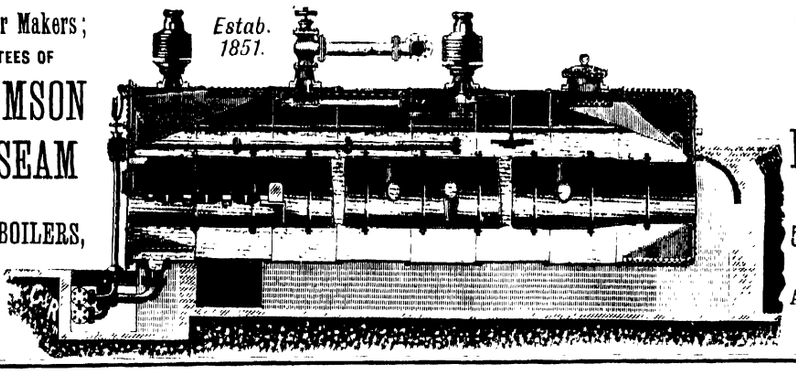
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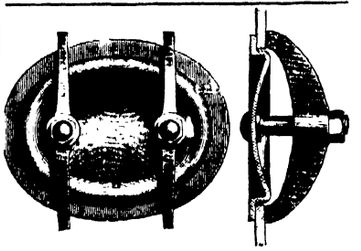
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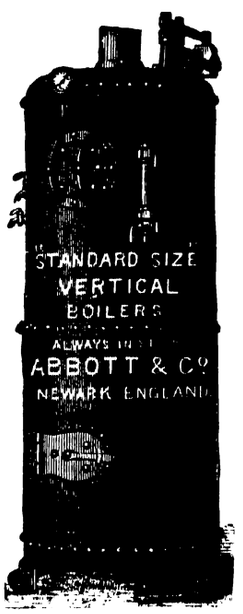
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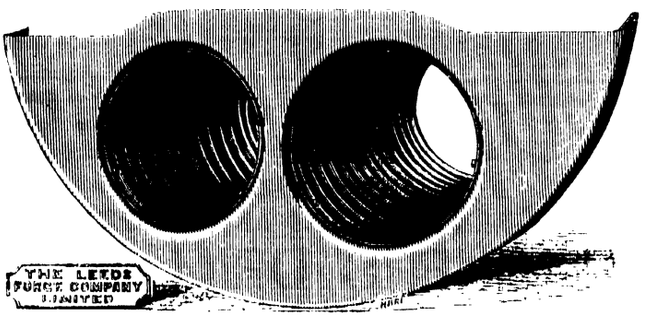
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THE STEAMBOAT EQUIPMENT OF WAR VESSELS.

So much attention has been paid within the last few years to the development of the torpedo boat, that the no less important advances made in smaller steam craft carried by vessels of war have been comparatively unnoticed, outside those circles directly interested in the subject. It will be understood that we use the expression torpedo boat in its generally accepted sense of a small high-speed vessel designed exclusively for purposes of torpedo warfare. It must not be forgotten, however, that the service pinnaces and cutters, to which we are about to refer, are also intended to be fitted with either spar or fish torpedoes.

The first steamboats supplied for the Royal Navy to be carried by larger vessels, appear to have been twin-screw boats 42 ft. in length. These were built in the Royal Dockyards and fitted with machinery by the leading engineering firms of the day. It is needless to say they were very different craft to the present type of steam pinnaces, almost the only advantage they possessed being great strength. This was obtained, however, at the expense of lightness and rather by lavish use of material, than by a scientific disposition of the parts and careful selection of substances most highly suited for the purposes they had to perform.

In any account of the history of naval steamboat equipment the name of Mr. John Samuel White, of East Cowes, naturally occurs first, and coupled with it should be that of Messrs. Belliss and Co., of Birmingham, who have made all the machinery for Mr. White's boats from the first. In the present instance we propose dealing almost entirely with vessels built at the East Cowes establishment. The introduction of the modern type of steam service cutters and pinnaces, may be said to have originated about the year 1864, when Mr. J. Samuel White made a series of experiments at East Cowes, with a view to applying steam power to the life-boats then being built under his father's patent. The good results obtained by a small steam life cutter 24 ft. in length, built for the yacht of the late Marquis of Hastings, attracted the attention of the Admiralty authorities, and an order was given to Mr. White to build a 27 ft. life cutter which was to be attached to H.M.S. Sylvia, then being equipped for a surveying expedition under the command of the late Captain Brooker. We have been unable to procure a copy of the official trial of this vessel, but a similar one, tried shortly after on the measured half-mile in Portsmouth harbour, attained a speed of 6.978 knots. This, we believe, was considerably faster than the larger 42 ft. navy launches were then capable of running. The boiler pressure was 66 lb., the revolutions 277.33 per minute, and the indicated horse-power 13.38. A four-bladed screw 2 ft. 1 in. in diameter, 3 ft. 5 in. pitch, and 4¼ in. in length, was used. The draught of water was 2 ft. 4 in. forward, and 2 ft. 6 in. aft.

Some experiments were made by the officers of Portsmouth Dockyard with a view of ascertaining the "life-boat" qualities of this cutter It was found that if filled by a sea she would still float with machinery, coal, and crew in place. It was also found impossible to capsize her by the ordinary means. Her excellent seagoing features were shortly afterwards proved in a very practical manner during actual service. Whilst crossing a bar on the east coast of Africa she was filled by a heavy sea, but did not turn over. The boats of an American man-of-war which were crossing the bar at the same time were, however, capsized, the crews being thrown out, and saved by the English boat.

There is no need for us now to enlarge on the advantages of the life-boat system. At sea its value has been proved over and over again in collisions in fogs, through boats falling from the sides of ships, on account of gear failing, in cases of boats getting amongst heavy breaking seas, and in numberless other instances. In spite of this the life-boat principle, either from carelessness or a foolish economy, is too seldom carried out, and numberless small steamers—chiefly pleasure boats—go to sea, when half a dozen good sized breakers would send them to the bottom.

After his success with the Sylvia's boat Mr. White offered to construct for the Navy a 36 ft. single-screw life pinnace with a total weight of machinery not exceeding 40 cwt., which was less than half the weight of existing machinery in the 42 ft. navy launches. This boat was to be guaranteed to steam at the then exceptionally high speed of eight knots an hour, and also to be equal in towing power to the 42 ft. service launches. The offer was accepted, and the series of trials which followed the delivery of this boat proved that she could more than fulfil her guarantee The following particulars of performance (Table A) are extracted from the report of her official speed trial, which was run on the measured mile in Stoke's Bay on October 26, 1867.

TABLE A.—*Trial of H.M. Steam Vessel Steam Pinnace No. 2.*

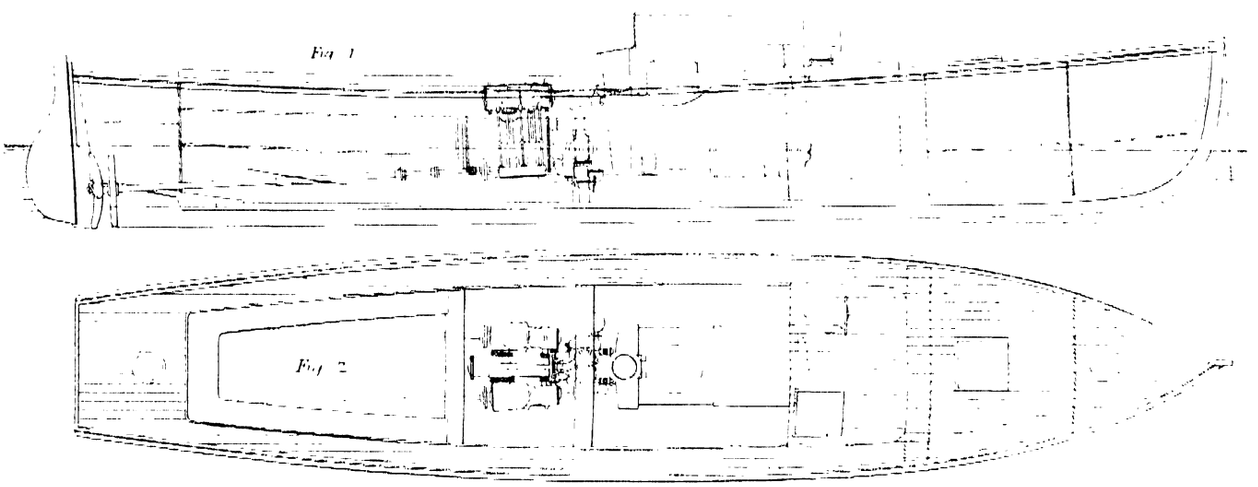
Nominal horse-power	6
Makers name (engines)	Messrs. Belliss and Co
Draught water { Forward	2 ft. — in
{ Aft	2 ft. 11 in
Load on safety valve	50 lb
Steam pressure in boilers	74 116 lb
Mean revolutions	289.33 per minute
Mean pressure in cylinder	58 166 lb.
Indicated horse power	31.29
Speed of vessel	8.52 knots
Time under way at full speed without stopping	2 hr. 5 min
Wind { Force	2
{ Direction	S.S.W
Sea	Smooth
Quantity coal on board	1 cwt
Engines	
Description	Simple non condensing on cast iron standards exhausting through quieting tank into funnel.
Number and size of cylinders	Two; 6¾ in. diameter by 6 in stroke.
Boiler	
Description	Circular launch type with wet bottom furnace
Grate surface	2.5 sq. ft
Tube heating surface	143 sq ft
Propeller	
Description	Common four-bladed.
Diameter	2 ft. 9 in
Pitch	3 „ 11 „
Length	0 „ 6 „
Immersion upper edge	0 „ 1 „

When filled with water and with machinery on board, this boat sustained afloat thirty men, whose united efforts in rushing from side to side on the thwarts failed to capsize her, there being still a considerable surplus of buoyancy even when in this condition. We believe it was the success attained with this boat that induced the Admiralty to determine generally that all future cutters and pinnaces for Her Majesty's Navy should be of the same type, and since then we are informed that over 300 have been supplied.

In the year 1878 it was considered desirable to increase the speed of the larger boats in the Royal Navy, and with a view to attain this end Mr. J. S. White and Messrs. Belliss and Co. determined to fit the boats with compound engines, and to use a closed stokehold with forced draught. The adoption of the combined system resulted in a great saving in fuel and a large increase of power in terms of the total weight of machinery required, and this in turn naturally gave a considerably higher speed. The following details of the trials of two pinnaces fitted with machinery of this type, are taken from the official reports. Table B refers to a twin screw boat, of which we give two illustrations on the present page, and Table C to a single screw vidette boat.

TABLE B. *Measured Mile Trial of H. M. 48 ft. Steam Pinnace No. 109. Twin Screw. Full Power.*

Date		February 14, 1880
Where tried (measured mile)		Stoke's Bay
		ft. in
Draught water { Forward		2 10
{ Aft	„	3 3
Average boiler pressure		118.5 lb. to sq. in
Mean pressure of air in stokehold		2.77 in. of water
Mean pressure in receiver { Starboard		8 lb
{ Port		5 „
Average vacuum in condensers		2.91 in
Weather barometer	„	29.81 „
Mean number of revolutions { Starboard		346.18
{ Port		339.17
		lb.
Mean pressure in cylinders { Starboard { High pressure		59.683
{ Low	„	19.150
{ Port { High-pressure		62.216
{ Low	„	16.635
Mean Indicated Horse Power developed by Engines		
High pressure cylinders (69.66) Low „ „ (21.36)		Total 191.23
Speed of vessel		13.304 knots
Wind { Force		2
{ Direction		Ahead and astern.
State of Sea		Smooth
Quantity of coal on board		7 cwt.
Description of coal		Nixon's navigation
Engines		
Makers name		Belliss and Co. (boat by John Samuel White)
Description		Inverted compound.
Number of cylinders		4
Diameter of cylinders, high pressure		7½ in.
„ „ low „		11¾ „
Length of stroke	„	8 „
Description of circulating pump		Reciprocating, worked off engine shaft.
Size		4½ in. diameter
Description of air pump		Single-acting, worked off engine shaft
Size		4½ in diameter.
Size of blowing fan		20 in.
How driven	„	Direct by single cylinder engine 2½ in diameter by 1½ in. stroke placed under deck in stokehold.
Description of condenser		Water in tubes, copper body, brass tubes tinned
Area cooling surface		211 sq. ft.



TWIN SCREW PINNACE, CONSTRUCTED BY MR. J. S. WHITE, EAST COWES.

Boiler:	
Description	Cylindrical wet bottom ordinary launch type of steel, with Low-moor firebox and dome.
Number of furnaces	1
Length of firegrate	2 ft. 3 in.
Breadth	2 „ 6 „
Number of tubes	158
Description of tubes	Brass, 1¾ in. diameter.
Heating surface of tubes	200 sq. ft.
Propellers:	
Twin or single screw	Twin.
Number of blades on each	4

	Starboard. ft. in.	Port. ft. in.
Diameter	3 2½	3 2½
Mean pitch	4 6½	4 6½
Greatest length	0 5½	0 5⅝
Immersion upper edge	0 5½	0 5½

Area of rudder 6.25 sq. ft.
One steering wheel with wire rope on parallel barrel.

Circles.

—	Both Engines Full Power. To Starboard.	To Port
Angle of rudder	40 deg.	40 deg.
Full circle made in	1 min. 21 sec.	2 min. 6 sec.
Number of revolutions per circle	(Starboard engine, 342 (Port „ 288	Starboard engine, 416 Port „ 416
Diameter of circle	180.5 yards.	174.5 yards.

Full circle made in 1 min. 8 sec. with one engine ahead and one astern, helm amidships.

TABLE C.—*Measured Mile Trial of H.M. 48 ft. Steam Pinnace No.* 144. *Full Power.*

Date	August 4, 1880.
Where tried	Measured mile, Stoke's Bay.
Draught of water { Forward	2 ft. 7 in.
Draught of water { Aft	3 ft. 10½ in.
Average boiler pressure	121.5 lb. to square inch.
Mean pressure of air in stokehold	1.87 in. of water.
Average vacuum in condenser	22.66 in.
Weather barometer	29.98 „
Mean revolutions per minute	387.65 „
Mean pressure in cylinders, high-pressure	77.12 lb.
Mean pressure in cylinders, low-pressure	20.00 „
Indicated horse-power developed	86.92 „
Mean indicated horse-power developed, high-pressure cylinder	50.06 „
Mean indicated horse-power developed, low-pressure cylinder	36.86 „
Speed of vessel	12.148 knots.
Wind { Force	2
Wind { Direction	Bow and quarter.
State of sea	Smooth.
Quantity of coal on board	6 cwt.
Description „ „	Nixon's navigation.
Engines:	
Makers' name	Belliss and Co. (boat by John Samuel White)
Description	Inverted compound.
Number of cylinders	Two.
Diameter of cylinders, high-pressure	7¼ in.
„ „ „ low „	11½ „
Length of stroke	8 „
Description of circulating pump	Reciprocating double-acting, worked off engine shaft.
Size	4¼ in. diameter.
Description of air pump	Double acting, worked off engine shaft.
Size	4¼ in. diameter.
Size of blowing fan	20 „
How driven	Direct by single cylinder engine, 2¼ in. diameter by 1¼ in. stroke.
Description of condenser	Water in tubes, copper body, brass tubes tinned.
Area of cooling surface	180¼ sq. ft.
Boilers:	
Description	Locomotive type with wet bottom to furnace, of steel, with Low-moor firebox and dome
Number of furnaces	One.
Length of firegrate	2 ft. 9 in.
Breadth „	2 „ 6 „
Number of tubes	185
Description of tubes	Brass, 1¼ in. diameter.
Heating surface in tubes	200 sq. ft.
Propellers:	
Twin or single screw	Single.
Number of blades	Four.
Diameter	3 ft. 4¾ in.
Mean pitch	3.6
Greatest length	5¼ in.
Immersion of upper edge	2½ „
Area of rudder	0.5 sq. feet.

Circles. Full Power.

—	To Starboard.	To Port.
Angle of rudder	40 deg.	40 deg.
Full circle made in	1 ft. 21 in.	1 ft. 19 in.
Revolutions per circle	508	456
Diameter of circle	170 yards.	153 yards

(*To be continued.*)

THE AUSTRALIAN COLONIES AS A FIELD FOR ENGINEERS.

We published an article on this subject some time ago (*vide* ENGINEERING, January 25 and February 6, 1884), in which we pointed out the disorganisation which had overtaken the Public Works Departments of not a few of these colonies, by the play of the political and other influences to which they are subjected, and drew attention to the special difficulties and annoyances to which, consequently, members of the profession in the public service of these colonies are exposed in the discharge of their arduous and responsible duties.

The general tenor of our remarks was illustrated by reference to what had recently been experienced, and was being experienced in the railway departments of Victoria and New South Wales. As regards the former colony, we stated that the disorganisation long prevailing there, and which had brought the working of the railway department almost to a dead-lock, had at length, happily, roused public indignation, and led to an attempt being made to place the department beyond the reach of political parties by the appointment of an independent board of management, to the chairmanship of which an experienced railway manager from this country had been appointed. How far the object sought is being attained, time alone will demonstrate.

With respect to New South Wales, we showed, by reference to extracts from the public press of that colony, that the internal jars and discords in its Railway Department were then, unfortunately, in full play. That, in fact, they were such that, for example, no sooner was an important railway extension completed by the engineer-in-chief, and handed over to those in charge of the railways in operation, than the practice was commenced of worrying up complaints against the newly completed works, and, forthwith, they were subject to being altered or pulled to pieces, without any reference to, or consultation with, the engineer-in-chief—a condition of things which resulted in the appointment of a Board of Inquiry, which is still, we believe, dragging on its weary way with the lethargy characteristic of these colonial "boards," without, so far as is yet known, any tangible result.

Now we learn by the South Australian newspapers that the condition of things in the railway department of that colony is equally unsatisfactory, and that it is, in like manner, passing through, or has just passed through, the turmoil of a Board of Inquiry. The circumstances which appear to have led to this *exposé* of the internal working of the South Australian Railway Department are, as we learn from the local press, briefly as follows: An accident occurred some time ago at the opening of a railway extension. The occurrence was proved, on investigation, to have been solely due to the accidental breakdown of the locomotive engine employed on the occasion. It was, however, of a type of which the locomotive engineer had, it appears, reported unfavourably. It was accordingly charged against him, or at all events broadly insinuated, that, as a consequence of his supposed prejudice against the engine in question, he had wilfully contributed to bring about the accident, and the occasion was taken advantage of to make an attack upon him involving his personal honour and veracity. The usual "Board of Inquiry," peculiar to colonial institutions in such cases, was appointed to investigate the charges. Those who happen to have knowledge of how these matters are conducted in the colonies will at once realise the amount of worry and annoyance, not to speak of the waste of valuable time, thereby entailed. We quote the following from one of the South Australian newspapers in reference to the subject:

"We must confess that when the Nairne railway-opening fiasco was perpetrated we were of opinion that there was very strong evidence to justify the assumption that the head of the locomotive department was vindictively prejudiced against the type of engine employed, and that he had wilfully contributed to the unpleasant contretemps. We can therefore claim that, starting out with such a prejudice, we should be liable to attach too little rather than too much weight to the evidence that might be forthcoming in the locomotive engineer's favour. Justice, however, compels us to say that the evidence that has been forthcoming has been such as to prove that he has, beyond a shadow of a doubt, been the most profitable officer that the Public Works Department has possessed. The evidence of the engineer-in-chief exonerates him from the culpability which we were disposed to suspect him of in connection with the Nairne breakdown.

"It appears to us, in fact, that the locomotive engineer has been made the victim of a persecution against which we enter our strongest protest. We were foremost in demanding a searching investigation, but we shall certainly object to any unfairness being displayed or tolerated. Hence, feeling that injustice has been done the locomotive engineer, and our own suspicions against him having been proved to be wrong, we hasten to make him some amends by placing before the public a little of the other side of the question which has not yet attracted sufficient attention."

Then, after giving statistics to prove the economy with which the locomotive engineer's department has been conducted, in comparison with other departments of the railway, the article from which we quote proceeds thus:

"It is very clear, therefore, that the locomotive engineer's management has been much more economical than that exercised in other departments, and there is strong ground for supposition that the locomotive engineer has incurred ill-will simply from his desire and determination to practice all possible economy.

"We might have felt disposed to defer these remarks had it not been that the locomotive engineer appears to us to have been made very much the scapegoat of the faults of others, and has had undeserved censure bestowed upon him. Our own opinion is that it is to be regretted that the 'friction' which has now been made public, did not arise a little earlier in our history, if, as it appears to be in this case, it was the fruit of an officer effecting for the country a saving of some hundreds of thousands of pounds."

The same paper, in a subsequent issue, adds:

"In our opinion a gross attempt has been made to drive out of the public service an officer who has roused the ill-will of his compeers by paying a more strict attention to the economical management of his department, and the convenience and safety of the public, than his brother officers have thought it worth their while to do. Be that as it may, the public have had quite enough of the unseemly squabbling which has been going on, and quite sufficient has been made upon this head. The attempt to defame the officer at the head of the locomotive department has ingloriously failed, and has recoiled upon the heads of his persecutors. We confess to a feeling of some gratification upon one score that this has been the result. Had the locomotive engineer been 'engineered' out of office, or by systematic badgering compelled to resign, we should have had another instance of the Hickson affair. Like that unfortunate officer, he would have been made the scapegoat of all the blunders and bungling of others."

What stronger evidence, we may ask, could be adduced in proof of what we have previously said regarding the unsatisfactory position of official life in the Australian colonies? That an official of high standing in the service should be exposed to the ordeal of defending himself against virulent attacks upon his honour and reputation based on such flimsy grounds, and dictated seemingly by such personal animus as is indicated in this case, is a forcible example of the "colonial experience" to which professional men in the service of these governments are subjected, apparently as a consequence of the honest discharge of their duty. This case, however, appears to be only another instance in point of the misrepresentation and persecution to which others in similar positions frequently find themselves exposed, and under which some have at times been driven to resign rather than continue longer to be subjected thereto.

In the interests of the profession at large, to whom the welfare of its individual members must at all times be a matter of interest and importance, we have once more drawn attention to the subject, and shall do so again whenever occasion shall present itself.

LITERATURE.

Primers of Electricity. By PROFESSOR E. J. HOUSTON, New York.

When the members of the Franklin Institute projected the late Philadelphia Electrical Exhibition they determined that it should not only be a meeting ground for manufacturers and scientists, but that it should also serve as a means of rapid education for the people, upon whose entrance fees the success of the undertaking depended. Accordingly great pains were taken to announce by means of placards and labels the names and the purposes of

the different apparatus shown, and to prepare the spectators to appreciate what they saw, Professor E. J. Houston undertook to write a series of primers of electricity, dealing with the essential principles of the production and utilisation of this mysterious agent. He produced twelve small tracts, each of four pages quarto, printed in clear type with wide margins, and within these confined limits he compressed an enormous amount of exact scientific information. The series forms a complete answer to those who deny the possibility of popularising science without vulgarising it, for in no case is accuracy sacrificed, or a difficult point left uncleared. Of course it is only the main principles that are touched upon; the author has kept constantly before his mind the class of people for whom he was writing, and has never allowed himself to wander out of the track which he had laid out. He starts with the assumption that his reader has no previous knowledge of electricity whatever, and he aims at teaching him just so much, that when he sees a dynamo machine, a lamp, a battery, or a telephone, he may form a clear mental picture of the nature of the uses it serves, and of the processes that are taking place within it. The subject is divided into (1) arc lights; (2) incandescent lights; (3) dynamo-electric machines; (4) voltaic batteries; (5) electric currents; (6) effects of an electric current; (7) magnetism; (8) electro-magnetism; (9) electricity produced by friction; (10) the telephone; (11) the microphone; and (12) the storage battery. Thus the whole ground of an electric exhibition, excepting telegraphy, is fairly covered, and a non-technical visitor can, during a half-hour's rest, acquire sufficient information to convert his attitude of mind from one of aimless wonder to that of intelligent interest.

BOOKS RECEIVED.

Englische Tunnelbauten bei Untergrundbahnen, sowie unter Flüssen und Meeresarmen. Ein Reisebericht von DR. PHILIPP FORCHHEIMER. Mit 19 Holtzschnitten und 14 Lithographirten Tafeln. Aachen: J. A. Mayer.

A Treatise on the Stability of Ships. By SIR EDWARD J. REED, K.C.B., F.R.S., M.P. With numerous Diagrams and Tables. London: Charles Griffin and Co.

The Boiler Maker's Ready Reckoner. By JOHN COURTNEY. Revised and Edited by D. KINNEAR CLARK, C.E. Second Edition, Revised, with Additions. London: Crosby Lockwood and Co.

The Law Relating to Gas and Water. By W. H. MICHAEL, Q.C., and J. SHIRESS WILL, Q.C. London: Butterworths. [Price 30s.]

The Dynamo: how Made and Used. A Book for Amateurs. By S. R. BOTTONE. London: Swan, Sonnenschein, and Co.

International Electric and Gas Exhibition at the Crystal Palace, 1882-83. Report of the Gas Section. By the Committee appointed by the Gas Institute. Two Vols. London: Published for the Committee by the Secretary, 22, Great George-street, Westminster.

MESSRS. BULLIVANT AND CO.'S WIRE ROPE WORKS.

WIRE rope making, of which there are records extending back for the last sixty years, has made great progress within the last few years, and is still increasing rapidly. This advance has been rendered possible chiefly by the introduction of the flexible type, which has naturally extended the field in which wire rope can be applied. At first only iron wire, made from either charcoal or B B iron, was used, but within the last ten to fifteen years, a change has been made in the material, and steel has superseded iron, in much the same manner that the iron wire rope superseded hemp and chain for ship work. In collieries, too, it is seldom that iron ropes are used now, steel being all but universal, at any rate in the most important works. A more surprising change is that which has taken place in the running rigging of ships, for at the present time flexible steel wire rope is very largely used for this purpose in all positions, excepting always cases in which ropes have to be handled; the terrible injury that might be inflicted by a broken strand, preventing its use for that purpose.

These facts have been more especially brought home to us by a visit we have recently paid to the new factory which Messrs. Bullivant and Co. have lately erected on the river side at Millwall, near the entrance to the South-West India Docks; their trade having increased to such an extent as to have outgrown the original premises.

These works cover a space of 2½ acres, and have a frontage of 310 ft. on the Thames. They are not quite completed, but the part already at work is capable of producing 300 to 400 tons of rope per month; whilst the factory when complete will have a capacity of about 600 tons a month.

TABLE I.—*Patent Flexible Steel Wire Hawsers and Cables Compared with Hemp and Chain.*

Patent Flexible Steel Wire Hawsers and Cables.				Chain Cable.				Tarred Hemp Rope.		
Size, Circumference.	Weight per Fathom.	Guaranteed Breaking Strain.	Diameter of Barrel or Sheave round which it may be worked.*	Size.	Weight per Fathom.	Proof Strain.	Breaking Strain.	Size.	Weight per Fathom.	Breaking Strain.
in.	lb.	tons.	in.	in.	lb.	tons	tons.	in.	lb.	tons
12	116	220	72							
11	97	270	66							
10	80	220	60							
9	66	180	54							
8	53	150	48	2 5/16	280	96¼	134¾	25	146	125
7	41	116	42	2 1/16	231	76¾	107 7/16	23	123	106
6	33	88	36	1⅞	166	55½	77⅛	19	84	72
5	23½	64	30	1¾	112	37½	55¼	15	56	50
4½	15	39	27	1⅝	68	22⅝	34½	13	39	34
4	12	33	24	1	54	18	27	12	33	29
3½	9	26	21	15/16	48	15 5/16	23 7/16	11	28	24½
3	7	18	18	13/16	30	10⅛	15½	9	19	16¾
2½	4½	12	15	..	..	..	..	7½	13	11¼
2½	2½	9	13½	11/16	21	7	9½	6½	11½	10
2	2½	7	12	..	..	..	..	5½	9	8
1¾	2	5½	10½	⅝	17	5½	7½	5	6½	6
1½	1⅞	4	9	..	..	..	..	4	4	4
1¼	1	2½	7½	½	14	4½	6	3½	3½	2⅞
1	¾	1½	6	..	..	..	..	2½	2	1½

* Where the rope only passes over a sheave, the diameter of the sheave may be one-sixth less than where the rope takes an entire turn round.

TABLE II.

Steel Wire Rope for Standing Rigging.					Iron Wire Rope for Standing Rigging.		
Size.	Number of Wires in a Strand.	Number of Strands in a Rope.	Weight per Fathom.	Breaking Strain.	Weight per Fathom.	Breaking Strain.	Size.
in.			lb.	tons.	lb.	tons.	in.
8 circum.	19	6	62	100	51¼	44 3/10	8
7 ,,	19	6	46	123	42⅛	36 1/10	7
6 ,,	19	6	34	90	31½	27 1/10	6
5 ,,	19	6	23	64	21⅛	18 1/10	5
4½ ,,	19	6	19	51	17⅞	15 3/10	4½
4 ,,	7	6	15½	40	13⅞	11 9/10	4
3½ ,,	7	6	11⅓	32	10⅛	9 7/10	3½
3 ,,	7	6	8	24	8⅛	7 1/10	3
2½ ,,	7	6	6	16	5⅞	4⅘	2½
2½ ,,	7	6	5	13	4½	4	2½
2 ,,	7	6	4	10	3⅝	3	2
1½ ,,	7	6	3	8	3	2 2/10	1½
1¼ ,,	7	6	2	6	2½	1¾	1¼

The wire for making the rope is taken to that part of the premises which adjoins the water side, where it goes through a preliminary testing. It is then made into coils, and is cleaned, either in strong potash liquor or in acid. The galvanising shop is here, and contains four baths of special design arranged purposely for treating wire. It should be mentioned that unusual care is required in galvanising steel wire, such as that used in rope making, as it may easily become crystallised in the process if not properly treated. The general arrangement is simple, the wire being unwound from bobbins by a machine and drawn, first through a bath of acid in the case of steel wire, and then through the galvanising bath. On emerging from the latter it passes through a bed of sand or asbestos, and is then wound on reels. Messrs. Bullivant have introduced modifications in many details of the process, which, however, mainly apply to their own particular business, and into which it is unnecessary to enter. The firm galvanise wire only for their own use, the plant being especially suitable for that purpose alone.

The wire is then tested again, when it is ready to be taken to the large building, which forms the main part of the premises, in order that it may be twisted into strands. Before describing the latter process, however, it may be as well to give a few particulars of the composition of various kinds of rope.

What is known as a "laid rope" comprises a heart, consisting either of a strand of wires or a hemp rope. This forms the axis of the whole rope, and round it are laid—or twisted—six strands; each of these strands being composed of a core, either of hemp or metal, round which, in turn, are laid six wires. A "formed rope," on the other hand, is composed of six strands laid round a heart as before, but each strand contains a greater number of wires. Thus the six wires will be laid round the core as before, and outside this in turn another layer, consisting of twelve wires, will be placed, making nineteen in all with the core. We shall give further details on this point later on. Besides these two terms the only other distinctive title recognised in the trade, is that of "cable laid rope," which is composed, as in ordinary hemp rope, of six laid ropes closed together. The latter form is often adopted for large sizes, but Messrs. Bullivant are of opinion that it is the worst form in which wire can be put together.

To go back to the machines, we find these grouped in the large building. They are of various sizes and descriptions, representing the different stages of improvement through which the process has passed, as experience has suggested fresh combinations. The oldest style of machine is of a vertical type, and appears to be simply a modification of a well-known apparatus used in ordinary rope making. The bobbins containing the wires are placed horizontally on "forks," which in turn are let into a plate at the base.

The wires to form the strand, or the strands to form the rope, for the process is the same in each case, are unwound from the bobbins as the action proceeds and are carried overhead, where the closing is effected by suitable mechanism. The turn is thrown out of the wire, or rather the turn is prevented, by a train of spur gearing which rotates the bobbins. The apparatus is effective and makes excellent rope, but it cannot be run at a very high speed. The next improvement was the adoption of a horizontal machine in which the bobbins are suspended on spindles arranged in a horizontal line within a revolving frame. The bobbins are balanced to prevent them revolving and so putting a turn in the wire, and the strands are closed by means of the revolving frame. These machines will run from 200 to 300 revolutions per minute, and are very effective. In another machine the whole of the bobbins are mounted round the periphery of a wheel or frame of large diameter, their axes being horizontal as before. A considerable saving in the length of the machine is thus effected and other advantages are gained. In this apparatus the bobbins are caused to revolve on their spindles by means of an ingenious arrangement of eccentric gearing connected by short links. After the wires leave the bobbins they converge towards a cone shaped "nozzle," which has six grooves cut in it, and which is bored through its axis for the passage of the core. The grooves guide the strands or wires, as the case may be, in the necessary direction for forming the rope, and after emerging from the grooves, the strands pass through a stationary nut or die known as the "lay plate," which exactly fits the rope. This completes the closing. The distance between the nut and the end of the nozzle determines, to a certain extent, the length of the twist or the pitch of the strands, technically known as the lay of the rope. The longer the lay the less violence is done to the texture of the metal when a heavy strain is put on the rope, but naturally there is a limit to the looseness with which the strands may be closed.

Messrs. Bullivant have very few of the old machines left, and these are now kept more as a stand-by in cases of pressure of work. The principal machine in the shop is of the latest type, and will throw off a rope of 30 tons in one length. It is capable of making ope up to 21 in. in circumference, which would have a breaking strain of 1200 tons on the single part. This is in excess of any actual requirement up to the present time, but considering the increase in the size which has taken place during the last few years it is thought that such a rope may some day be called for. Messrs. Bullivant are about to make a 14 in. steel rope which will have a breaking strain of 500 tons. Ten years ago the largest steel rope that had been made was 7 in. in circumference. The smallest rope now in general demand is ¾ in. in circumference, but smaller sizes are made for special purposes. There is also in the principal shop a large machine used for cabling or closing very long ropes. It is 150 ft. long, and is driven by spur gearing worked from a shaft below the floor. It will turn out three miles of 4 in. rope a day, and is principally employed in making telegraph cables and other long ropes.

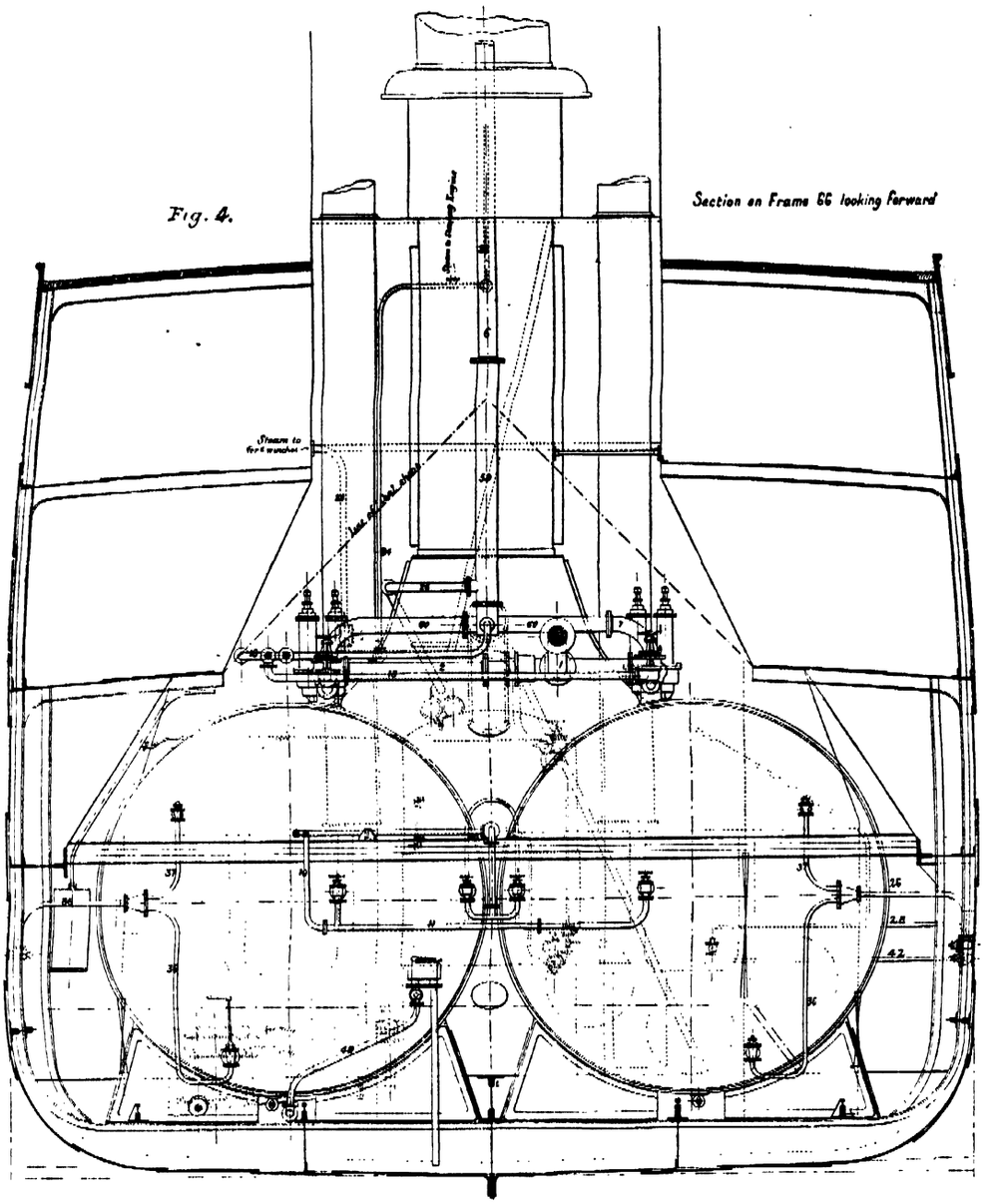
The machines are run by a fine pair of horizontal engines by Messrs. Robey, of Lincoln, steam being supplied by a couple of Lancashire boilers by

ENGINES AND BOILERS OF THE S.S. "COUNTY OF SALOP."

CONSTRUCTED BY THE BARROW SHIPBUILDING COMPANY, LIMITED, BARROW-IN-FURNESS.

(*For Notice, see opposite Page.*)

Fig. 4. *Section on Frame 66 looking forward*



Messrs. Abbott, of Newark. Besides these there are other engines and boilers in various parts of the works.

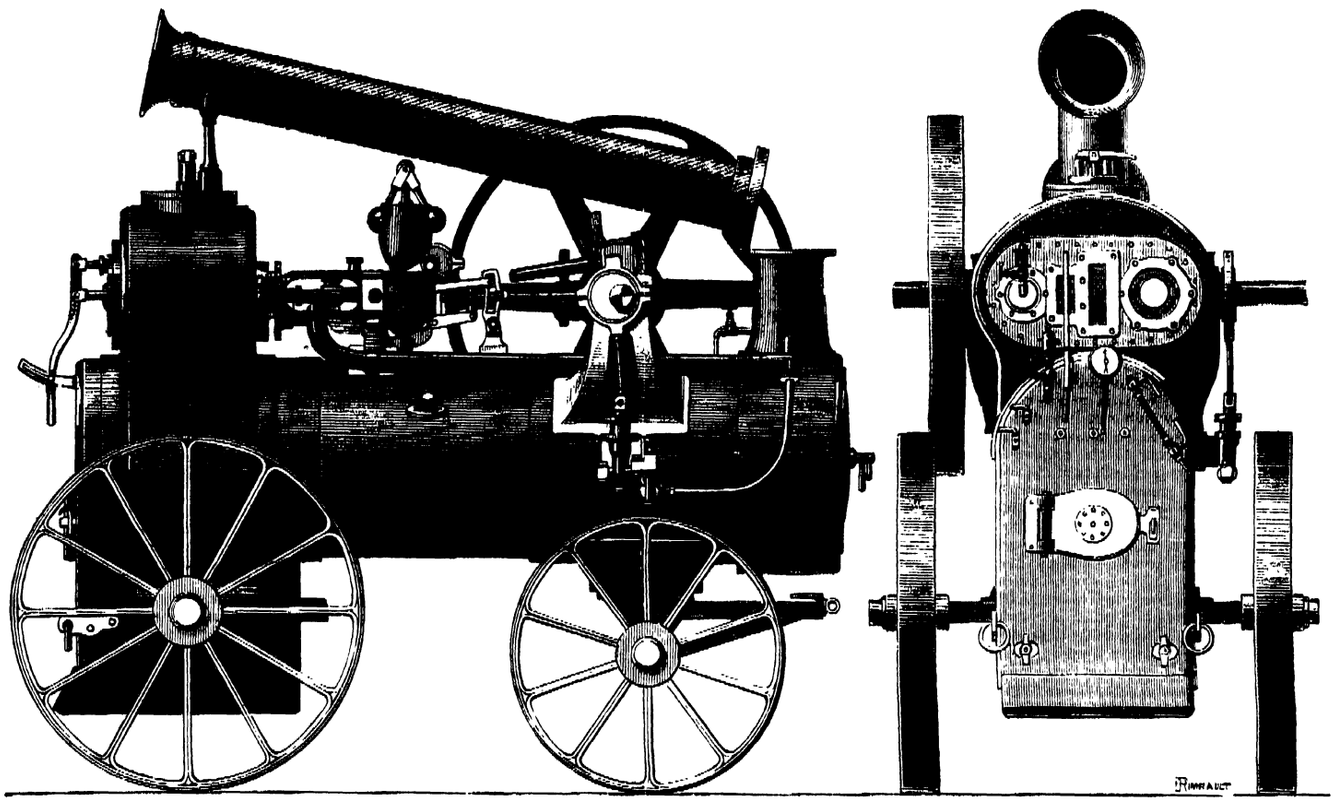
The flexibility of the rope lies principally in the multiplication of the number of wires of which it is made, and the way they are laid. This number may range between 36 and 400. It is a comparatively easy thing to make a rope with few parts, but the difficulties rise in proportion as the numbers are increased. Great skill is then required so as to arrange the wires in such a way that each will bear its due proportion of strain. The wires are specially made for the purpose, and are either of iron or steel. It is seldom that a stouter gauge than No. 9 B.W.G is used, the additional size and strength of the rope being made up, as stated above, by multiplication of parts. Thus, a 4½ in. flexible rope has strands with hemp centres, surrounded by wires of 13 B.W.G., whilst a 6 in. rope has a hemp centre surrounded by twelve wires, which are in turn surrounded by eighteen wires, all of 13 gauge. In a 14 in. steel rope, the heart would be of hemp, and the centre of each strand would be an iron wire. The latter would be surrounded by six steel wires; these would be coated with twelve wires, and these again with eighteen wires, which in turn would be covered by a layer of twenty-four wires, all of 11 B.W.G. Six strands thus made would be closed together to form a rope. It will be understood we are referring now to Messrs. Bullivant's practice, as many makers proceed on other lines, and we may remark that there is a very great difference between the mode of manufacture and quality of different wire ropes made.

The cores are either of hemp or iron, the former material giving a much more flexible rope. The iron used for centres is selected for its softness and ductility. The hemp is formed into a rope of special make, hardness being a desirable feature, and is treated by a process, for which an apparatus has been erected, and which consists principally in boiling the rope in linseed or other oil, care having to be taken that there shall be no acid in the latter, otherwise an internal source of decay will be set up, especially with steel wire, which crystallises in the presence of acid. The ropes when complete are tested, there being a 100-ton machine for this purpose; when the tensile strength is above this limit each strand is tested separately.

The old objection to wire rope was on the score of its rigidity, but recent improvements have removed this drawback, although there are many mariners and engineers who still hold the old prejudice. In Table I., which has been prepared from data supplied by Messrs. Bullivant, the diameter of a sheave or barrel round which flexible rope of various sizes may work, is given, will be seen to be within the limits of ordinary practical work. The experiments made at Devonport Dockyard also tend to show the superior handiness of the flexible steel rope. In these trials an 8 in. Bullivant steel hawser was tried against a 25 in. hemp rope, when the report as to handiness in working was entirely in favour of the steel hawser. In actual service the armourclad Caledonia, 6832 tons, was towed from Liverpool to Plymouth by a 4 in. steel wire hawser weighing 12 cwt. On this occasion a 13½ in. hemp hawser weighing 45 cwt., and the 1½ stream chain weighing 130 cwt., broke in the endeavour to do the same work. Another memorable towing feat with Messrs. Bullivant's rope was that in which the P. and O. steamer Khedive, 3724 tons, towed the Deccan, 3400 tons, of the same company, from Gibraltar to Southampton in eight days, encountering in the channel a strong easterly gale. For this purpose two 4½ in. steel hawsers were used. In towing out of the harbour it was necessary to make the hawsers fast round the bits, and when out at

EIGHT HORSE-POWER COMPOUND PORTABLE ENGINE.

CONSTRUCTED BY MESSRS. R. HORNSBY AND SONS, LIMITED, ENGINEERS, GRANTHAM.



sea they were slacked away to their full length, when they showed no signs of having been bitted. Another instance of the use of wire rope may be given. Messrs. Day, Summers, and Co., of Northam, have on their patent slip a 9 in. flexible rope which is wound on a barrel 4 ft. 6 in. in diameter. This same firm has recently supplied to the Russian Government 100-ton sheer legs in which a 6 in. rope works round a 36 in. diameter barrel.

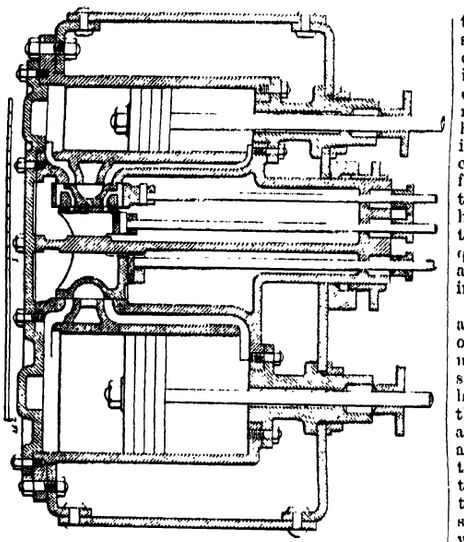
It should be remembered, however, that in comparing wire with ordinary rope or chain, that the tensile strength, and not the circumference, should be taken as a standard comparison. Probably a more extended use for wire rope will be found in working tramways, such as that now running at Highgate.

The most striking instance of the flexibility of wire rope was exhibited in the case of lifting the Eurydice, when a turn was taken of a 7 in. rope round a 2½ in. pin. This of course was only done in a case of emergency, and naturally injured the rope, which however stood to the work. Nippers such as we recently referred to are the right things to use in such cases.* The injury that occurs to a rope if too sharp a nip or bend be put in it, is that the strands or wires get misplaced or "spew" out. This of course throws all the strain on to fewer parts when the rope is used again, and so reduces its breaking strain. A 5¾ in. Bullivant flexible steel wire cable, held by an automatic nipper, was tested before the Admiralty and Lloyd's officials to 81¼ tons, the nipper being applied and released by one man. The rope ultimately broke at a strain of 86.3 tons, the guaranteed breaking strain being 80 tons.

In conclusion, we give in Table II., on page 515, particulars of wire rope used for standing rigging, which have been compiled from Messrs. Bullivant and Co.'s list.

THE S.S. "COUNTY OF SALOP."

WE give this week on page 524 general views of the s.s. County of Salop, while on the opposite page and on our two-page engraving we publish further views showing the arrangement of her engines and boilers. The s.s. County of Salop was



built by the Barrow Shipbuilding Company, Limited, to the order of Messrs. Abrahams and Co., of Liverpool, and under the superintendence of Mr. F. J. Pilcher, their consulting engineer. We shall in an early issue give further illustrations of the engines and boilers of this vessel, and we shall then describe them fully.

COMPOUND PORTABLE ENGINE.

WE illustrate above a new pattern of compound portable engine constructed by Messrs. Richard Hornsby and Sons, Limited, of Grantham, and which will be exhibited by them at the Smithfield Show at the Agricultural Hall next week. This engine may be regarded as a development of the type of portables with which Messrs. Hornsby and Sons' name has been so long identified, namely, that in which the cylinders are inclosed in a steam dome which forms the upper part of the firebox casing. Thus in the engine now illustrated it will be seen from the annexed section that the two cylinders, steam chests, and connecting steam passage between the high and low-pressure cylinders are all cast in one and are entirely immersed in the raised firebox or steam dome of the boiler; most efficient steam-jacketting is thereby obtained, the connecting passage from the high-pressure cylinder exhaust, to the low-pressure steam chest (the latter acting as the intermediate receiver), as well as the cylinders, being entirely surrounded with steam at the full boiler pressure. Waste-water cylinder cocks are thus dispensed with, as the cylinders being always as hot as the steam, no condensation can take place, and the steam supply being practically in such a dome quite dry, no water ever gets into them. The dome and boiler is entirely cased with wood and sheet iron.

The cylinders have been designed so that the pistons and slides are as easily got at from behind as in an engine of the ordinary type. The piston rods pass through necks, which latter are held very simply by a nut outside the boiler steam dome front, thus staying the boiler at the same time. The three slide spindles and the exhaust pipe are all contained in a trunk, which also projects through the boiler dome front, a gland and packing being arranged round it to make a steam-tight joint, so that by simply taking off the two nuts that hold the cylinder necks, and the nuts that hold the back flange, the cylinders can readily be removed, should occasion require. The engine is also fitted with automatic expansion gear, arranged with Messrs. Hornsby's patent eccentric controlling gear.

The engine is mounted on a wrought-iron fore carriage and road wheels. The outside firebox top proper is still retained, the dome being rivetted on the top of it, so that the necessary strength and stiffness is obtained to take the working strains of the engine. This dome is also of such a shape as to require but little staying circumferentially. The boiler is of steel, and is stayed for a working pressure of 140 lb. to the square inch.

The particular engine shown by our engravings will be exhibited at the Smithfield Show next week, and it is rated by the makers at 8 horse-power, its chief dimensions being as follows:

Engine:	ft.	in.
Diameter of high-pressure cylinder ...	0	5
,, low ,, ,, ...	0	9
Stroke	1	0
Revolutions per minute . 160		
Diameter of flywheel .. .	4	6
Width ,, .	0	6½

* See page 32 *ante*.

Boiler:	sq. ft.
Grate area	4.33
Firebox heating surface	30
Tube " "	95
Total " "	125

METALLURGICAL NOTES.

Magnetic Ore Dressing.

According to a paper read by Herr O. Heberle, at a meeting of German engineers of the Central Rhenisch district, a large amount of ore is treated by magnetic dressing and separating at the Friedrichsegen Mine. The ore in question is a mixture of zinc blende and spathic iron ore, the two minerals being so nearly of the same specific gravity that their separation by usual methods cannot be carried out, so that for the past three years recourse has been had to the magnetic process. The material to be treated comes partly as hand-picked lumps, and partly as a product of hydraulic dressing of the ores from the mine. The hand-picked portion is in pieces from 40 mm. to 120 mm. diameter, while that from the hydraulic dressing is in bits of 6 mm. diameter and less. The treatment of this material comes under three heads: 1, the calcination of the ore; 2, the electro-magnetic separation; and 3, the further hydraulic treatment of a portion of the material so separated. The calcination of the ore is intended to convert the carbonate of iron of the spathic ore into the magnetic oxide, which can be acted upon by the magnets. The lump ore is calcined in tall kilns mixed with small coke. Owing to the sulphur contained in the ore, the fuel required is very little, only about 50 kilos. of coke per 8 tons ore, which is the daily charge for one kiln worked by two men. This calcination costs only about 80 pfennige per ton ore. The calcined ore is crushed by stone-breakers and rolls to a size of 5 mm. diameter. The small ore is calcined in long horizontal furnaces. This is much dearer and costs 2½ marks per ton ore. All the calcined ore, after cooling, passes to the magnetic apparatus through a classifying sieve, which separates out all above the diameter of 4 mm., delivering it back for further crushing, while all of less size than 4 mm. passes down shoots to the magnets. The magnetic plant consists of 16 separate groups of magnets, each four forming one apparatus, in two pairs one above the other. The upper pair receive the ore as it comes from the classifying sieve and separate it, though not completely, into blende and iron ore. The products of this separation are passed on, each by itself, to one of the lower pair of magnets. The final result of this is blende with quartz, iron ore, and a middle product of both kinds. This middle product is returned to the apparatus for further treatment. The whole of the magnetic apparatus is connected with a powerful exhaust, as very much dust is formed during the treatment of the ore. The arrangement of the magnet is as follows: Each separator has four magnets attached to the fixed axis of a revolving brass drum, so that the drum revolves round the outside of the magnets, which remain always in the same position, close to one side of the drum. The ore is fed automatically down an inclined plane, so as to come in contact with the outside of the drum at the point where the magnets are fixed on the inside. The magnetic oxide of iron becomes at once attracted by the magnets and sticks to the drum, which, revolving in a contrary direction to the downward ore feed, carries the oxide upwards, till it gets beyond the attraction of the magnets, and is thrown down on the other side; while the blende, not being attracted, falls at once to the ground under the feed point. A Gramme dynamo of one horse-power supplies enough current for a group of four such drums. The special advantage claimed for this arrangement is that the magnets are protected from all wear and tear, and from dust, heat, &c.; also that there is no necessity for interruption of current, nor for any arrangement for scraping the attracted ore from the magnets, as with other apparatus in use in which the magnets are not surrounded by a drum. With two such groups of four separators, 24 tons of calcined ore can be treated in 12 hours, giving 7 to 8 tons blende and 16 to 18 tons iron ore. The iron ore is not further treated, but the separated blende is subjected to hydraulic dressing, by which it is concentrated, and also some lead ore is taken out of it.

Improvement in Revolving Calcining Furnaces.

Furnaces in the form of revolving cylinders are widely known and considerably used in this country, notably in the case of "black ash" furnaces in alkali works; also as revolving puddling furnaces, and the Siemens revolving "direct process" furnaces for producing iron. As calciners, revolving cylinders have not found much use, the branches of metallurgy to which they are particularly adapted not being much practised here; though in the form of the Oxland and Hocking furnace they have been recommended and employed for the calcination of arsenical pyrites for the production of arsenious acid. In America revolving cylinders are largely used in the working of silver ores, being found very effective for calcining or roasting the ore with salt, for the purpose of chloridising the silver preparatory to its extraction by various processes in use. There are three well-known forms of furnace in operation, the Howell, the White, and the Brückner. The two former are "continuous action" furnaces, the ore being fed in at one end and passing out at the other, the cylinder being set at an inclination for this purpose. They are long furnaces, and comparatively narrow. The Brückner furnace is shorter and wider, and is not continuous in its action, each charge being kept in the furnace as long as desired, and then emptied out completely. The furnace is set without any inclination of the cylinder. It is much in favour as a chloridiser, and has the advantage of being more suitable than the other forms of cylinder for use in oxidising-roasting of sulphides when required. Revolving calcining cylinders have not so far had any great success, or obtained any favour, in the treatment of lead ores as a preliminary to cupola smelting. Smith's furnace, which has been used in America, was a long cylinder, set at an inclination, with the ore feed at one end, the other end being connected directly to the hearth of a reverberatory furnace, in which the ore was agglommerated after coming from the cylinder, the calcination in the cylinder being carried on by the waste heat passing off from the reverberatory furnace. A furnace of this description would not be suitable for treating many lead ores, which would get pasty and semi-fused at the hotter part of the cylinder, and cause much trouble and imperfect work. But the cylinder furnace has recently been taken up and adapted to lead smelting in a very ingenious manner by Mr. T. C. Huntington, manager of the large works of Messrs. G. Henfrey and Co., near Spezia, in Italy. These works are almost the largest of their kind in Europe, and are most excellently equipped in all respects for working lead-silver ores. The method of smelting is mainly that of calcination and agglomeration, followed by reduction in blast furnaces. Mr. Huntington, though finding advantages in the use of the revolving cylinder, found it better to have cylinder and agglomerating furnace quite separate. It was also found that with the cylinder fired at one end, as usual, satisfactory results were not obtained, as with many ores the temperature necessary to carry on active oxidation at the flue end, was sufficient to clot and sinter the ore at the fire end, preventing further efficient calcination and clogging the cylinder. After some experiments, the arrangement finally adopted by Mr. Huntington is as follows: The cylinders, some 15 ft. long by a little under 5 ft. wide, revolving in the ordinary manner on rollers, are placed horizontally, and are fired by producer gas. At each end is an inlet for gas and for hot air, it being so arranged by means of reversing valves that the direction of the flame may be changed as desired, as in the ordinary regenerative furnaces. The charge of ore is fed into the cylinder from a hopper placed over it, and its calcination is watched through openings left for the purpose in the ends. When it is found that the ore is so hot at the fire end of the cylinder that sintering might commence, the gas and air are reversed, and so the greatest heat removed to the cooler end, till that in turn becomes hot enough to require reversing to take place. In this manner it has been found possible to carry on the oxidation of lead ore rich in silica, and particularly liable to clotting, without any difficulty, and to a degree of perfection not obtained in any of the ordinary forms of calcining furnaces. When a charge is finished it is discharged through doors in the sides of the cylinder, as is done in the Brückner furnace, into a hopper wagon placed below, the wagon being then raised by hydraulic lift to the top of the agglomerating furnace. This latter works continuously at a sufficiently high temperature to at once liquefy the ore which comes to it thoroughly oxidised from the cylinders. Sulphate of lead, formed during calcination, is decomposed by the well-known action of the silica, the final product obtained being a slag almost completely free from sulphur, and in excellent condition for the following treatment in the blast furnace. The cylinders and agglomerating furnaces are placed close together, the waste heat from the latter being utilised in heating the air for the cylinders, by means of a "recuperator," built in a chamber at the flue end of the furnace, the air on its way to the cylinders passing through pipes or channels in brickwork, which are heated from outside by the furnace-gases passing away to the main flue, as in the recuperator of the Ponsard furnace. This supply of hot air to the cylinders very much diminishes the quantity of gas required for heating them, and materially assists calcination.

THE STATE OF THE NAVY.

The imperative necessity that exists for taking some immediate steps to increase our Navy, has received yet further confirmation from the fact of the recent meeting at the Royal United Service Institution.

It appears that the Council of that Institution, which partakes to some extent of a semi-official character, realising the extreme danger of our present naval situation, determined to obtain what may be termed a service opinion, as to "What are the most urgent measures that should be taken for increasing Her Majesty's Navy?" and with this object in view they appealed to Sir E. J. Reed to prepare a paper on that text, the outcome of which was the lecture delivered before a large and highly representative meeting in the theatre of that Institution on the 26th ult., and we now propose to briefly consider the paper and the discussion which followed.

Sir E. Reed divided his subject into five parts:

1. Armoured line-of-battle ships.
2. Unarmoured auxiliaries of line-of-battle ships.
3. Armoured cruisers.
4. Unarmoured.
5. Torpedo vessels.

In the first place the lecturer referred to the necessity for immediately completing all the new ships now in hand, and argued at some length the financial loss occasioned to the country by the delay hitherto permitted in completing the building of our armoured ships, a delay caused in some measure by the rapid development and constant changes that are being effected in everything relating to the equipment of these vessels, such as in constructive details, armour, machinery, guns, torpedo fittings, &c., and partly by reason of the parsimonious manner in which the ship-building votes are estimated and dealt out from year to year, but we cannot admit that either of these causes should be allowed to interfere with the prompt completion of the ships ordered.

Sir E. Reed laid down as a fact that three years is abundant time for the construction of the largest ironclad that is ever built, an assertion which he very rightly declared, no private shipbuilder in the country would controvert.

Taking the cost of an ironclad, including machinery, as built in the Royal Dockyard at 600,000*l.*, he then proceeded to show if completed in three years the actual cost, computing the interest at 5 per cent., would be 630,500*l.*, while the same vessel taking six years to build, the time generally occupied in the Royal Dockyards, the cost would be 688,465*l.*, thus in addition to possessing a complete vessel in three instead of six years, there would be gained a saving in expense of nearly 58,000*l.*

The lecturer then proceeded to consider the question of armoured battle-ships, and in doing so he briefly referred to the policy, erroneous in his opinion, now prevailing at the Admiralty of limiting the armoured belt of our present battle-ships to only about one-third of the entire length of their hull, but he refrained from entering into a discussion on this point, because when the Inflexible question arose nearly all the naval officers holding official and highly responsible positions at the Admiralty expressed their entire confidence in such ships; but Sir E. Reed proceeded to take exception to the method of classification adopted by Sir T. Brassey in comparing English and French ironclads, as he treated the whole displacement of the former as armoured tonnage, which Sir E. Reed argued was a false premise, as the actual armoured tonnage of the English ships was but one-half of their total displacement, whilst the French ships, being wholly armoured, their displacement and armoured tonnage are one and the same quantity,

With this method of classification, and taking ships having 15 in. of armour and upwards, the lecturer compiled a table in which he showed fourteen French ships having an aggregate armoured tonnage of 126,288 tons as against eleven English ships with an aggregate armoured tonnage of 51,570 tons, or less than half the armoured tonnage of the French ships.

Without wishing to criticise this or any other form of classification, we must remark that the only correct and useful comparison to be instituted between ironclads is that of their fighting efficiency, in which must be considered their respective gun-power, speed, handiness, coal endurance, protection afforded to vital parts, stability under all circumstances, and date of completion.

In ships with 12 in. of armour and less, Sir E. J. Reed acknowledged that England is superior to France in the proportion of three to one.

The lecturer then summed up his remarks on armoured battle-ships by saying that it is necessary to at once construct five such vessels, having a full length armoured belt (or an equivalent and therefore increased number of ships having only a limited armour belt) to place us on an equal or slightly superior position to France in this respect.

The lecturer then advanced a few observations on his plan of ship torpedo defence, as shown by a sectional drawing, which he asserts is to be obtained by placing an armoured deck, or inner bottom (say, 4 in. thick near the armoured belt, and tapering down to 2½ in. or 3 in. towards the keel) above the outer bottom, but at some distance therefrom, and below the boilers, engines, &c., the space between these bottoms being greatly subdivided both transversely and longitudinally. The naval torpedo will, he says, be stopped, and compelled to explode outside of the outer bottom, and the débris of that bottom will be dashed against the inner armoured bottom, which will be of course far more difficult of penetration by this débris than the ordinary ⅞ in. steel plating, which at present is all that

separates the engines, &c., from the outer bottom. This form of construction possesses also other incidental advantages by preventing a shell from getting into the ship below the belt (by glancing off it), and by localising the injurious effects of ramming.

This system of ship torpedo defence would possibly be effective in so far as the Whitehead attack is concerned, as that torpedo carries only a small charge and delivers its blow some 10 ft. beneath the water line, but whether it would be efficacious against a torpedo having a charge of 200 lb. of dynamite, and which would strike its blow somewhere about the point where the inner armoured bottom connects itself to the armour-belt by a horizontal piece is yet to be proved; but still, if not adequate for torpedo defence, **Sir E. Reed's system of armoured inner bottom affords great additional structural strength.**

The next point treated of was that of torpedo boat-catchers or destroyers, or, as the lecturer termed them, unarmoured auxiliaries of the battle-ships, one of which he considered should be attached to each of the first-class ironclads, for the purpose of frustrating a torpedo boat attack by capturing or destroying them.

This species of vessel would have to be very fast, to have their machinery well protected against machine shell-gun fire, and to be equipped with a light shell gun and torpedo.

Though in connection with these torpedo boat catchers Sir E. Reed dwelt almost entirely on the question whether or no they should be provided with a gun equipment (which appears to us a *sine qud non* for all men-of-war), yet we think that every feature connected with this novel kind of craft requires very careful consideration, and is at least as important as the single one submitted to the meeting; in fact it hardly seems settled what is the actual sphere of work of these scouts.

Sir E. Reed then entered on the consideration of his third point, or armoured cruisers, and to avoid the possibility of the debate degenerating into the competitive advocacy of rival types of ships, he refrained from alluding to more than an epitome of his views on this point, which are "that where the engines, boilers, and magazines of ships are protected by curved decks, those decks to be effectual against the fire of even the lightest naval guns, must be from 2½ in. to 3 in. thick; and that where the water-line is not protected by armour, it will be liable to be so rent and torn by shot and shell that it will usually be impossible to stop leakage."

The lecturer declared five to be the least possible number of these armoured cruisers, that is, one for each of our foreign stations, and they should, he remarked, be fairly armoured, powerfully armed, endowed with a speed of from 19 to 20 knots, supplied with an abundant coal supply, and have a displacement of some 8000 tons.

In the course of his remarks on armoured cruisers Sir E. Reed severely criticised the theory of coal protection, which he sums up by saying, "Let us get whatever defence there is to be derived from coal while it lasts, but do not let us play upon the sailor, the cruel farce of telling him to look for part of his permanent defence to that which is put on board expressly for him to use;" these remarks we entirely agree with.

The lecturer next dwelt on the question of unarmoured cruisers, referring especially to the necessity of providing them with a thick deck over boilers, engines, &c., and also with a sufficient reserve of buoyancy under such attacks as may be reasonably looked for not from unarmoured, but fairly armed ships. While in regard to the speed at present attained by this class of ship he expressed great dissatisfaction with the small progress so far effected in increasing their rate of steaming, on the grounds that in the Inconstant class, built some eighteen years since, a speed of 16½ knots was obtained, a result which has been improved upon only to the extent of half a knot in the new ships of this class, while we are entitled to look for far greater progress in this period, considering the use of steel, increased power of engines, &c. At the same time, Sir E. Reed does not consider that the Admiralty are to blame, as private firms, in making an exceptional effort and sacrificing something that would not be possible in our naval service, have only succeeded in giving to this class of ship a speed of 18 knots. At least eight or ten of these unarmoured ships are (according to the lecturer) urgently wanted.

The question of torpedo boats was then taken in hand by Sir E. Reed, and here he considered that two kinds are necessary, viz., sea-going and ship torpedo boats; we think, however, it is highly improbable that any further increase will be made in the so-called ship or second-class torpedo boats, owing to their inferior sea-going qualities and small coal supply, but these craft will be replaced by a special class of boat, termed a guard machine gun-boat, superior in these two particulars to the second-class boats now in our service.

The lecturer computed that at least fifty of the larger or sea-going class of torpedo boats are needed, and this number we consider to be far under the mark of what is actually necessary, looking to the fact of our extensive coast line, and that the Germans are providing each of their principal naval ports with some fifty of these boats.

Sir E. Reed lastly sketched out a programme of urgent necessity, and roughly computed the cost of fulfilling it. This programme consists of the completion of all the ships now in hand as soon as possible, and the building at once of the following in addition to those vessels:

Five armoured battle ships, five extremely fast armoured cruisers, eight extremely fast unarmoured cruisers, fifteen extremely fast auxiliaries to battle ships or torpedo boat catchers, and fifty torpedo boats of the first class. The total cost he calculated would be 6,355,000*l.*, expended in the following manner: (1885-6) 3,355,000*l.*; (1886-7) 1,900,000*l.*, and leaving 1,100,000*l.* to complete.

This paper of Sir E. J. Reed's must undoubtedly be admitted to be a masterly conception, and should prove a strong power in the hands of those who remain unsatisfied with the meagre and half-hearted proposals of the Government as explained by Lord Northbrook and Sir T. Brassey on Tuesday night.

The value of Sir E. J. Reed's proposals lay in the fact that in the discussion which followed his lecture, a unanimous opinion was expressed not that these were sufficient, but that they were far from being adequate to fulfil the pressing needs of the Navy, and it must be borne in mind that this opinion is entirely a service one, and therefore is the declaration of those who believe that our Navy is in a most dangerous condition, and not of those who can realise any possible benefits, except patriotically, by an increase of our Navy.

Before proceeding to consider the remarks of the various speakers at this meeting, it may be interesting to compare the proposals of the Government and of Sir E. J. Reed, which latter has received the support of the Navy generally.

Government.

3	armoured battle ships (in dockyards).	
1	" "	contract.
5	" cruisers	"
2	torpedo rams (Polyphemus class)	"
10	auxiliaries unarmoured (scout class)	"
30	seagoing torpedo boats	"

Cost, 3,100,000*l.*; time, 5 years.

Sir E. J. Reed.

4	armoured battle ships (in dockyards).	
1	" "	contract.
5	" cruisers	"
6	unarmoured "	"
15	auxiliaries unarmoured	"
50	seagoing torpedo boats	"

Cost, 6,355,000*l.*; time, 2 to 3 years.

The lecture was followed by an animated and important discussion in which many eminent naval officers and experts took part, and Sir Spencer Robinson in the course of his remarks pointed out the fact that the immense diversity of the opinion of naval officers was one great cause of the fact that the state of things (inefficiency of the Navy) had not been remedied, and he implored them not to split over trifles, but combine together to urge on the authorities the necessity for change and improvement with a combined voice. These remarks we would strongly commend to the notice of naval officers generally.

Admiral Sir J. Hay, M.P., said that the most urgent measure was to obtain some money. After dealing generally with the lecture he stated that on the principle of not putting all one's eggs into one basket, he would rather have two Riachuelos than one Duperré, and believed that five of the former would certainly defeat two of the latter class. In reference to the gun question, he stated that we required some 3800 guns, including a reserve, while we only possess 387 actually ready.

Captain Noel, R.N., thought that at least one million should be permanently added to our naval estimates, and that for the last twenty-four years he considered that the Navy had been starved. He disagreed with the lecturer's method of classification, believing the Inflexible to be a very excellent vessel; he did not consider it right to take away half her tonnage in comparing her with the Duperré.

Mr. White, late of the Constructor's Department at the Admiralty, and now chief constructor to Sir W. Armstrong and Co., opened the adjourned discussion on Thursday afternoon, when he defended the Collingwood class, with their partial armour, for which design he held himself equally responsible with Mr. Barnaby, the present chief constructor. He also looked on Sir E. Reed's classification as at least peculiar, maintaining that armoured tonnage and fighting efficiency are not interchangeable terms. He denied that Sir W. Armstrong advocated the abandonment of armour in English ships, and concluded by stating that in his opinion the Esmeralda, with whose design he had nothing to do with, represented the best cruiser that had ever been built of 3000 tons displacement.

The Right Hon. W. H. Smith, M.P., concluded a temperate and well-considered speech with the remark that "we ought to combine together in order to endeavour to inform our fellow-countrymen of the condition in which Her Majesty's Navy is, and of the real necessity which exists for the important addition to it which Sir Edward desires."

Mr. E. Norwood, M.P., briefly touched on the report of the Committee on Construction and Repair of Her Majesty's Ships, of which he was a member, and stated that "they had abundance of evidence from the Constructive Department of the Admiralty, which gave upon the whole the admission that the quality of the work turned out by private firms was quite equal to that turned out at dockyards."

Captain Colomb, R.N., asked for a yearly expenditure of 5000*l.* for experiments to remedy in some measure the diversities of opinion existing among naval officers in regard to constructive details, armour, guns, torpedoes, &c. He believed that naval officials as a rule were in favour of the "Collingwood" method of armouring, and he believed that an overwhelming majority in the Navy considered that the "Dreadnought" was the best type of battle-ship.

Admiral J. C. Wilson said he preferred the Thunderer class, but would not attempt to go into the technical questions; he confessed, however, that he liked to put his foot on a ship which he knew had an armoured belt around the water line.

Amongst others who joined in the discussion were Lord H. Lennox, M.P., Sir Charles Nugent, Mr. Arnold Forster, and Admiral W. Gore-Jones.

The chairman, Sir E. Fanshawe, in addressing the meeting, referred to our obsolete ironclads, and said all these ought to be knocked out of the lists of ships fit to defend the honour of the country in action, and they ought to be replaced with ironclads of the most powerful description, though many of these obsolete ironclads would do good service as local defence ships of our own coast.

Sir E. J. Reed then replied to the various speeches, and pointed out that his scheme of spending 6,355,000*l.* in the next three years referred only to new ships, and that the important part of his programme which referred to the rapid completion of the vessels now under construction would really bring up the total to about 8,000,000*l.*

As to the question of the difference between the Collingwood and Duperré system of armoured belt, he said, it seemed to him a fundamental principle that a ship called an armoured ship, and reckoned as an armoured ship, should have armour enough to keep her upright under a fire falling upon her unarmoured parts.

This important meeting then terminated with a cordial vote of thanks to the lecturer.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, November 21, 1884.

SOUTHERN *iron is arriving from Alabama, and selling* at 16.25 dols. for forge and 17 dols. to 18 dols. for foundry. Western bituminous iron is coming in and underselling the anthracite iron of Eastern Pennsylvania. The downward tendency in prices is still very marked, and trade is greatly disturbed. Rumour prevails as to probable large transactions in steel rails. Reductions are being made in mills and at furnaces, and in nearly all branches of labour. The outlook is discouraging, but the American market is subject to sudden fluctuations. Bessemer pig is saleable at 18.50 dols. at tide water; steel slabs at 36.50 dols. A purchase of 6000 tons of spiegeleisen was made to-day from German makers. Old rails are saleable at 17.50 dols here. Scrap is dull. Business generally has not begun to pick up. Political agitations are over. Philadelphia exhibitors to the number of 200 or over are shipping exhibits to New Orleans. The main building covers 30 acres. The display of southern mineral, timber, and agricultural resources will be immense. Rates by rails to New Orleans from Philadelphia, 31 dols. An improvement in business is probable about mid January. The glass trade is suffering. Timber is quiet. The textile manufacturers are still further restricting production, and the carpet weavers of the city have resolved upon striking. The latest railroad returns exhibit declining earnings. The Trunk line war of rates continues, but the Pennsylvania Company retains its regular rates.

ITALY AND SICILY.—Signor Gabelli has published in a recent official report his ideas on the uniting Sicily with the Italian Peninsula by means of a tunnel. The first thing to be considered, according to Signor Gabelli, is the conformation of the sea bottom at the straits, and he states that it is beyond all doubt that in a south-easterly and north-westerly course, starting from Pizzo, on the coast of Calabria, and ending at Sant' Agata, on that of Sicily, there exists a submarine chain of mountains separating the basin of the Mediterranean from that of the Adriatic. The sides of these mountains are very steep, and the course of the contemplated tunnel is clearly established from these hydrographical conditions. It only remains to be seen whether the nature of the soil is sufficiently solid and compact for the purposes required.

HYDRAULIC DREDGER (BRUCE AND BATHO'S SYSTEM) FOR BURMAH.



The above engraving represents a dredger, on Messrs. Bruce and Batho's system, lately constructed for use in British Burmah. It is designed to work to a depth of 15 ft., and is of the following general dimensions: Length, 120 ft.; breadth, 32 ft.; depth, 7 ft.; and mean draught, 3 ft. The vessel is propelled by twin screws worked by independent pairs of high-pressure engines, supplied by steam from an ordinary marine multitubular boiler 9 ft. in diameter by 9 ft. 6 in. long. In an early issue we shall give detailed drawings with full particulars of this dredger, and for the present shall merely add a short general description of its equipment and mode of action. The whole of the operations involved in working the excavator are performed by hydraulic power, which is furnished by a pair of direct-acting differential pumping engines with steam cylinders 15 in. in diameter, and pumps 4¼ in. in diameter, the stroke of both being 18 in. All the rams are controlled by slide valves placed amidships, so that one man can regulate the whole of the motions without leaving his station. The excavator is mounted on the end of a beam pivotted on A frames fixed to the deck. This beam is raised into the position in which it is shown in the engravings by a hydraulic ram about half way between the centre and the excavator, and it is caused to descend partly by the weight of the excavator, and partly by a smaller hydraulic ram near the other end. The excavator itself is worked by two rams coupled together by side rods, so that they move in unison. The lower and larger ram is connected by rods to the three segmental scoops, and serves to draw them together when they are receiving a load of soil, shingle, or rock, a pressure of 30 tons being available and amply sufficient for that purpose. The smaller ram opens the excavator when it is raised. The two hydraulic cylinders with the hemispherical shell and the casting to which its component parts are attached, are hinged to the beam by a universal joint, through the trunnions of which the pressure water enters. The shoot for discharging the spoil is connected to the beam and follows the excavators ready to receive its load as it falls. The speed of working is about forty lifts an hour, and, as the excavator has a capacity of 160 cubic feet, the work done amounts to 300 tons per hour.

Up to the present 7 dredgers have been constructed on Messrs. Bruce and Batho's system, and four have been supplied to the Government of India, and are giving the most satisfactory results both as regards working expenses and economy in the cost of maintenance and repairs. As may be seen from the official reports to the Government of India, the cost of dredging with one of these machines is now only 1d. per cubic yard, while after some years of work the dredger was described as "perfect in every way." The fact that all the working parts are either on board, out of water, or above the material acted upon by the excavator, accounts for the great differences in wear and tear as compared with the bucket and ladder type of dredger.

PUMPING ENGINE AT THE EASTBOURNE WATER WORKS.

(*Concluded from page* 474.)

We shall now proceed to describe the pumps, &c., under the floor of the engine house.

The pump rods, as already stated, are connected at their lower ends to the crosshead of the pump plunger. This is a substantial forging of Bessemer steel 11 in. deep at the central portion; the inside of this crosshead is bored larger than the diameter of the plunger, and a bush, in halves, the use of which will presently appear, is inserted and serves to transmit the necessary downward pressure to the plunger. To the crosshead are also fitted two steel pins, 3½ in. in diameter, which by means of a pair of links connect the crosshead (Fig. 2) with a lever which is in this instance employed to balance the working parts of the engine and pump by means of a weight suspended from its outer end, and to work the auxiliary pumps. This method of balancing the parts keeps the pressure upon the engine bearings uniform on both strokes. Although desirable in large engines such as the present, exerting say 100 indicated horse-power, this plan of balancing is not necessary with smaller engines of 100 indicated horse-power. Nos. 2 and 3 engines are balanced only by their flywheels.

The condenser is supported by the pump girders. It is 3 ft. 6 in. in diameter, and 4 ft. 6 in. high; the air pump is single-acting, 17 in. in diameter, and 24 in. stroke. It is carried by and placed inside the condenser; the centre of the air-pump is not however concentric with that of the condenser, but is nearer the centre of the engine; by this means a longer stroke is obtained than would have been otherwise possible. A non-return valve is fitted to the discharge branch of the hot-well. The injection water is drawn from, and the discharge water returned to, a cooling pond at a short distance from the works.

The feed and air-charging pumps are carried on the top of the condenser. The former is 3½ in. in diameter, the latter 3 in. in diameter. Both are single-acting with a stroke of 13 in. The bucket of the air-charging pump is packed with leather, the valves are 1 in. in diameter, and means are provided for opening the suction valve when the pump is not required to supply air.

The main pump (Figs. 39 to 46) is of the bucket and plunger type. The working barrel is 20 in. in diameter, the plunger is 15 in. in diameter, and the depth of the suction rose from the well girders is 55 ft. The pump is carried from the well girders by means of strong brackets cast on the top pipe. A second set of girders (Fig. 3), of much lighter section, are fixed in the well at the level of the suction box, this being fitted with wheels, which can, with the suction pipes below, be run to one side to admit of the bucket being lowered for examination or repacking, &c., and the suction valve itself can be examined or taken out if necessary. This very convenient arrangement cannot at present be used, as the pumping power available is not sufficiently great to lower the water far enough in the well. The valves have therefore to be drawn from the well floor. This is, however, a very simple operation, as it is only necessary to remove the nut at the top of the plunger, and move the engine slightly round, when the bush in halves previously alluded to, will come out; the plunger and rods are then free to pass through the pump crosshead, which, with the other gear, is not interfered with.

The rising main is 21 in. bore, 1⅞ in. thick, with flanges 2¾ in. thick. The suction pipes are 22½ in. bore. A wrought-iron rose 24 in. by 40 in. by 24 in. is fitted to the end of the suction pipe.

The pump rods through the rising main are of Bessemer steel with scarfed joints, held together with cast steel boxes. The bucket (Fig. 46) and suction valve are of the same design, with the exception of the suction valve having a conical projection which fits the bored seat in the suction box. The valves themselves are of the double-beat description, specially designed to give a maximum waterway with a small lift; the lift does not exceed 1¼ in. They are of solid gun-metal; the beats and the spindles in which the valves slide, are also lined with gun-metal. The suction valve is loaded with lead. The bucket packing consists of manganese bronze rings about ⅜ in. wide and ⅛ in. thick. These have been found to wear exceedingly well. In order that the suction valve may be readily drawn, it is provided with a coarse screw thread on the top which is easily found by a rod with a bell-mouth that is lowered from the top of the pump.

The pump is connected to the air vessel by a pipe 14 in. bore. The air vessel itself is 3 ft. 6 in. internal diameter by 12 ft. total height. The volume of air at working level is about 75 cubic feet, or about twenty-two times the discharge from the pump per single stroke. A stop back valve, working in a brass seat, is fitted on the inlet from the pump. Two 5 in. safety valves, capable of discharging the whole water thrown by the pump with a very slight increase in head, are fitted between the pump and air vessel, and also an easing cock 3 in. bore, to relieve the pump of pressure when starting.

Fuel and Heat Tests.—This machinery was officially tried on February 18 and 19 by Mr. G. A. Wallis, Messrs. Moreland and Son being represented by their manager, Mr. David Bonar. No. 1 engine was used for low-service work, and Nos. 2 and 3 engines for high-service work. It was not considered desirable to run Nos. 2 and 3 engines at full speed on account of danger from excessive pressure in the main, and they were therefore run at the speed given in the Table, 20.78 and 20.89 revolutions respectively. No. 1 engine was supplied with steam from No. 3 boiler, and Nos. 2 and 3 engines from Nos. 1 and 2 boilers. These also furnished steam to the donkey engine, so that the actual duty of Nos. 2 and 3 engines is slightly in excess of that given. Special care was taken that at the commencement and finish of the test the grates should be equally charged with coal, and as they are

only 4 ft. long, it was possible to judge with accuracy. On economical grounds possibly it would have been better to steam Nos. 2 and 3 engines from a single boiler; all the boilers were, however, used in the test to prevent any chance of loss from leaky valves, &c.

The engines were in their usual working order, no overhaul or adjustments having been made since they were put to work. Observations of the counter water-pressure gauge, well gauge, and steam and vacuum gauges were made every hour, and frequent indicator diagrams were taken. The coal was most carefully weighed and checked.

The mean observations and the results of this trial are given below in a tabular form. The general results are, however, that No. 1 engine used 1.53 lb. of coal per indicated horse-power, and 1.78 lb. per pump horse-power, that Nos. 2 and 3 engines used 1.80 lb. per indicated horse-power, and 2.097 lb. per pump horse-power. Expressed in the form usual with pumping engines, the duty performed by No. 1 engine in millions of foot-pounds of water raised per 112 lb. of coal was 124.6 millions, the mean duty of Nos. 2 and 3 engines being 105.8 millions. We are not aware that the results given by the large engine, have ever been excelled.

Specimens of indicator diagrams (Figs. 47 to 54) taken from all three engines during the trial are given. In each case also the high and low-pressure diagrams are shown combined, being reduced to the same scale of pressure, the ratios of the length of the diagrams being in direct proportion to the areas swept through by the pistons.

The low-pressure indicator diagram, in the case of No. 2 and 3 engines (Figs. 49 and 50), almost exactly coincides with the theoretical expansion curve passing through the terminal pressure at the point of exhaust of the high-pressure diagram. The steam in both of these engines is reheated to a certain extent by the high-pressure steam jacket, but of course at the cost of some additional steam condensed in the jacket. The steam in No. 1 engine is not so heated.

Unlike the ordinary Woolf or tandem engine, in which the expansion is continued to nearly the end of the low-pressure piston's stroke, these engines are all arranged for an early cut-off in the low-pressure cylinder. By so doing the range of temperature in the first cylinder is materially reduced, and the loss of energy from useless expansion at the commencement of the high-pressure exhaust so common in most engines of this type, is almost entirely prevented. No. 1 is for all practical purposes a receiver engine, and the diagrams sufficiently indicate that a receiver of large capacity is not necessary or even desirable.

TABLE I.—*General Dimensions.*

—	No. 1 Engine.	No. 2 and 3 Engines.
High-pressure cylinder .. diameter	20 in.	each 18 in.
Low " .. "	38½ "	" 32 "
Pump working barrel .. "	20 "	" 17⅝ "
Pump plunger .. "	15 "	" 13 "
Discharge per revolution	45 gals.	" 25 gals.
Boilers, diameter	7 ft.	
" length	25 "	
" furnaces (two in each) diameter	33 in.	
Firegrate area per boiler	22 sq. ft.	
Total heating surface per boiler	807 "	

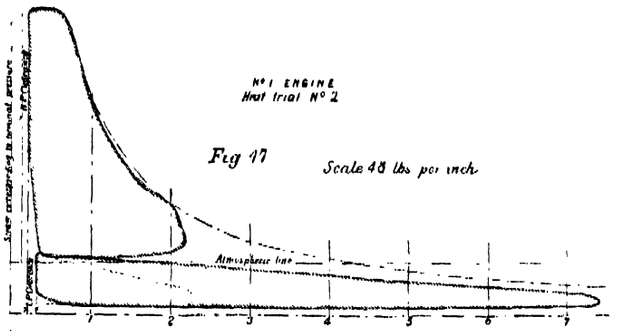
15.46 lb. per indicated horse-power, including that used in the steam jackets.

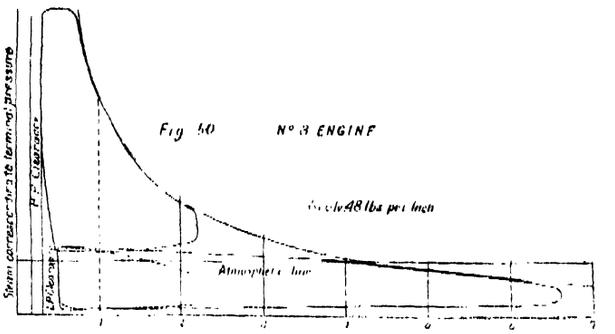
Neither the head, nor the speed, in this trial was the same as in the twelve hours' trial; the indicator diagrams taken in the latter case show, however, a slightly smaller consumption of steam than those taken in the former case. In any case the engine was quite as economical during the twelve hours' test as during the fuel test.

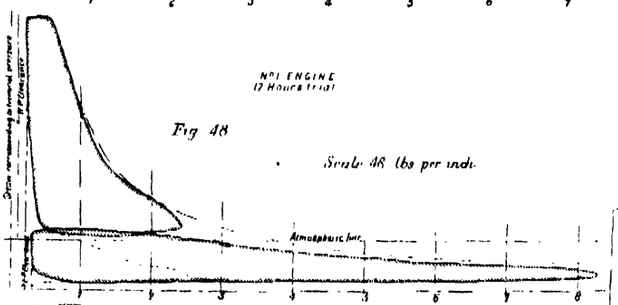
TABLE III.—*Results of a Test made on February* 18, 1884, *to ascertain the Amount of Heat Rejected by No.* 1 *Engine.*

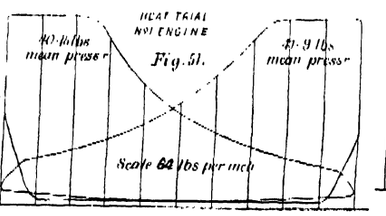
OBSERVATIONS.

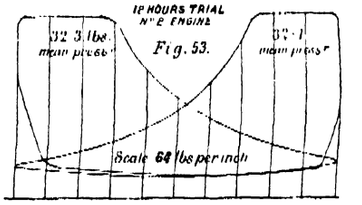
Duration of test	64½ min.
Revolutions in that time	1592
" per minute	24.69
Head of water pressure gauge ..	278.083 ft.
Well gauge..	5.656 "
Total head from water level in well..	308.24 "

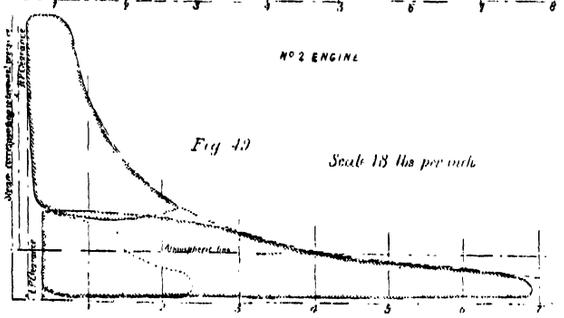


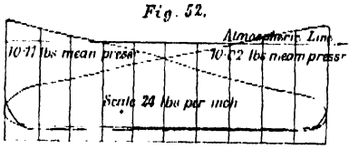












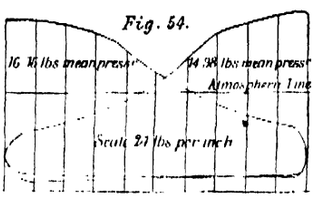


TABLE II.—RESULTS OF TWELVE HOURS' TRIAL.

	No. 1 Engine.	No. 2 Engine.	No. 3 Engine.
Total revolutions in twelve hours	16,875	14,358	15,040
Average " per minute ..	23.44	20.78	20.89
Total amount of water raised in gallons	759,456	374,040	376,020
Average total lift in feet	243.04	335.4	341.48
" steam pressure above atmosphere	69.15	74.02	74.92
" vacuum, inches of mercury	28.58	28.65	28.75
Horse-power of water raised	77.97	52.8	54.00
Indicated horse-power	90.70	124 collective	
Ratio percentage of pump to indicated horse-power ..	86	86.1	
Coal consumed in twelve hours, including ash, in pounds ..	1666 lb.	1888 lb.	
Ash "	46 "	60 "	
Coal " per hour, including ash	138.83 lb.	224 "	
" per square foot of firegrate per hour ..	6.31 "	5.1 lb.	
Coal per horse-power of water raised, including ash ..	1.78 "	2.09 "	
" indicated " " " "	1.53 "	1.80 "	
Duty per 112 lb. of coal in millions of foot-pounds in water raised ..	124.6	105.8	
Average temperature of injection	..	48 deg.	
" " discharge	..	73 "	
" " feed water	..	156 "	

As a confirmation of the results of the direct fuel trial, the heat rejected by No. 1 engine has been frequently measured. The results agree almost exactly; it is therefore only necessary to select one trial made upon the same day as the first trial.

From Table III. it will be observed that the heat rejected per pump horse-power was 281.3 pound-degrees, and allowing a good margin for radiation this is equivalent to but 18 lb. of steam per pump horse-power, or

Steam gauge	76.458 lb.
Vacuum gauge	28.583 in.
Temperature of injection water ..	47.5 deg.
" discharge water..	72.25 "
Rise in temperature ..	24.75 "

The discharge water was delivered into one of the softened water tanks 12 ft. 10½ in. long, 12 ft. 10 in. wide or 23,754 square inches area; the amount delivered during the trial increased the depth of water in the tank by

7 ft. 4½ in., or at the rate of 1.376 in. per minute. The temperature of the discharge water was taken in a stand-pipe near the air pump, where the water was well mixed, and of very nearly equal temperature at any depth; the maximum reading was taken in all cases. The feed water was drawn from the hot-well, the condensed water from the steam jackets circulated back to boilers.

Results.

Water discharged per minute $\frac{23,754 \times 1.376}{27.7} = 1180$ lb.

HP. of water raised $\frac{450 \times 308.24 \times 24.69}{33,000} = 103.81$ HP.

Pound degrees of heat rejected per horse-power of water raised ... $\frac{1180 \times 24.75}{103.81} = 281.3$

Heat supplied by steam per pump horse-power per minute ...

Heat rejected	281.3
Heat used per pump horse-power	42.76
Radiation, loss, &c., estimated	17.64
Total ...	341.7

Ditto per hour = 341.7 × 60 = 20,502
Total heat of steam at 76 lb. pressure 1211
Deduct temperature of hot-well ... 72

1139 heat units.

Steam used per pump horse-power per hour $\frac{20,502}{1,139} = 18$ lb.

ADMIRALTY SHIPBUILDING CONTRACTS.

To the Editor of Engineering.

Sir,—Mr. Barnaby, in giving evidence before Lord Ravensworth's Committee, says in quite a playful way, "We get the ships and the builder has to accept the loss, which he often has to do." "A Government contract for building ships of war, I believe, almost always results in loss."

Now is it not the case that the system that causes almost every contract to result in a loss to the shipbuilder, is squandering the resources of the country as well? I am certain it is so, and the fact that the few ships and torpedo boats proposed to be built last night are to cost over three millions show that is is the case.

Neither Mr. Barnaby nor the public are much interested in the shipbuilders' losses, but if the systems of official direction, and interference with work, become so much costlier year by year that they completely baffle shipbuilders, and cause a loss on every contract, in spite of the experience gained with the one that went before, does not the country suffer also?

The question is, will the country tolerate the present expensive system of carrying on contract work in the future?

Yours, &c.,
Navis.

STERN-WHEEL STEAMER ON THE NILE.

To the Editor of Engineering.

Sir,—We have received a telegram from the engineer in charge of the "Yarrow boat No. 2" from Assouan, in conformity with the annexed paragraph; which we think you will consider of sufficient interest for insertion.

"Advice has been received that the Yarrow stern-wheel steamer, which was put together at Alexandria, reached Assouan last Sunday and passed the cataract easily. The passage from Cairo to Assouan, including stoppages, was the quickest on record, towing 30 tons in two lighters."

We remain, yours faithfully,
Yarrow and Co.

Isle of Dogs, Poplar, London, E., December 2, 1884.

SECONDARY BATTERIES.

To the Editor of Engineering.

Sir,—I have perused with much attention Mr. J. S. Sellon's letter in your issue of the 28th ult., and, if not too much trespassing on your valuable space, would venture a few remarks which, coming from an impartial pen, may not prove out of place impartial, since I have no interest in the patents of either side.

Mr. Sellon claims "roughening by *any* chemical process" his plates for a specific purpose, and Messrs. Parker and Elwell claim "roughening plates by means of *nitro-sulphuric acid*," having a similar object in view. Now it is well known that Messrs. Parker and Elwell have achieved great results with their battery, and in the electrical world it is very highly thought of, indeed considering its lightness and durability (its strength increasing with use) many regard it as being superior to the Faure-Sellon. I would therefore ask, does Mr. Sellon pretend to claim widely the use of "roughening plates" in all manners for this purpose? If he does and can, then the sooner our patent laws are altered the better. I, however, doubt his being able to do so, since no patent is valid unless described in such a way that any competent person, skilled in the particular matter to which it relates, can work by or manufacture with it according to the description given. It is therefore dubious whether a patent such as Mr. Sellon's would hold in a court of law.

Since Plante's battery first appeared, no new and successful "active material" has been brought into use in so-called secondary batteries, and we all know that lead peroxide and spongy lead are the substances at present mainly depended on. One of, if not the greatest difficulty, is to make these chemically or electrolytically permanently adherent to the electrode, and the question is "Has Mr. Sellon, prior to Messrs. Parker and Elwell manufactured a battery equal to theirs?" If not, his claim to priority can hardly be maintained on the simple basis of vague wording.

By way of exemplification, let us suppose that I am the inventor of some new reagent for dissolving and thereby roughening surfaces of lead; query, Would Mr. Sellon's attempted generalisation prevent me from patenting and profiting by my valuable invention?

Messrs. Parker and Elwell have found out that by acting on sheet or perforated lead or any lead surface with a mixture of nitric and sulphuric acids (one of which is a solvent, the other a precipitant of that metal), it may be roughened and its surface increased and fitted for the formation or reception, as the case may be, of the active material of secondary batteries. And I leave it to others to decide if this is not as great an invention as those on which many of Mr. Sellon's numerous patents are founded.

As a further proof of my impartiality I would add that I am not personally acquainted with any of the above parties, nor have I transacted business with them.

I am, Sir, your obedient servant,
Electrolyte.

London, December 1, 1884.

CORLISS VALVES.

To the Editor of Engineering.

Sir,—In reply to Mr. Inglis's remarks in Engineering of the 7th ult. about my "patent" traversing Corliss valve, I have no doubt that Messrs. Hick, Hargreaves, and Co. will eventually use this arrangement, or some similar one they will invent, or will buy some other party's invention. They will have to do this to satisfy the demands of the public. Good and practical engineers have asserted that the traversing Corliss valve, as named above, is what was wanted to improve the ordinary Corliss valve. I have no doubt if Mr. Inglis will reflect a little he will remember instances where Corliss valve boxes have to be bored out, and new valves fitted, on account of the irregular wear and tear and leakage. Engines have been made with bushes put into Corliss valve boxes to be taken out when the faces were worn and replaced with new ones.

However Mr. Inglis and myself write or talk, the public will decide for themselves whether the traversing Corliss valve will be used or not, and I have no fear of the result.

Respecting Mr. Inglis's remarks about us making and using Corliss's valve gear, my firm did not use the trip motion or valve gear for *Corliss valves*, but we wished to apply it to working stamper valves of beam engines. Mr. Inglis had never applied this gear to stamper valves, and when he saw an engine to which we had applied it, he was some time before he could understand how it worked. This same trip motion had been applied to beam engines in Dundee, where I saw it working before I applied to Mr. Hargreaves for a license. Further information about the license I can give to you, but have already trespassed too much on your valuable space. Reference is made by Mr. Inglis to a description of traversing valve gear in your issue of the 22nd of August last; of course the valves in that engine are made to traverse, and are an infringement of my patent.

Yours truly,
John Musgrave.

Globe Iron Works, Bolton, Lancashire.
November 29, 1884.

THE MAXIM GUN.

To the Editor of Engineering.

Sir,—In your issue of November 28, 1884, you gave a short extract in your Patent Record of a new gun patent (No. 606, January 3, 1884), issued to me, and follow it up with the remark; "This is fully illustrated and described in our issue of November 7."

I beg to inform you that this is not the patent which was illustrated in your issue of November 7, but quite a different gun. The gun which you did illustrate operated by the recoil of the barrel, while the patent referred to was for a gun operated by the force of the gases escaping from the muzzle of the gun, not by the recoil. Will you please make the correction and oblige,

Yours very truly,
Hiram S. Maxim.

57d, Hatton Garden, London, December 2, 1884.

ASPHALTE FLOORS.

To the Editor of Engineering.

Sir,—I have an asphalte flooring in my fitting shop, which I find impossible to keep clean.

The tools used in this shop are: Three lathes, one shaping, one slotting, one drilling, and one milling machine.

The metals worked are steel and iron, and as we are using oil as a lubricant for the cutting tools, the flooring has become caked with a thick sticky paste of oil and dust. I have it scraped daily, but with very poor effect. I have tried washing with unsatisfactory result, as the tools in the place prevent this to be effectually done.

I should feel obliged if you could assist me by the insertion of this letter, as some of your numerous readers may be able to recommend a plan by which asphalte flooring can be kept free from grease.

I am Sir, yours faithfully,
Hugo Schmidt.

85, Mount-street, W., November 29, 1884.

TRIAL TRIPS AND LAUNCHES.

The Polycene, which was launched November 6, had her official trial trip on November 30; the speed attained was 8¾ knots, with a consumption of 147 lb. of coal per hour. Her dimensions are 62 ft. by 17½ ft. by 6¾ ft., and she is fitted with compound surface condensing engines of 68 indicated horse-power. The vessel was built to the order of Count A. W. Knüth, by the Helsingors Jernskibs-og Maskinbyggeri.

On Saturday, the 22nd of November, Messrs. Hall, Russell, and Co., Aberdeen, launched, to the order of Mr. John Fleming, Aberdeen, a beautifully-modelled screw steamer named the Glen-Eagles, a vessel of about 207 tons gross, and measuring 130 ft. by 23 ft. by 11 ft. Her engines will be of 72 horse-power. Her principal design is for deep-sea trawling, and for fish and special cargo-carrying; but she is adapted for towing, lighterage, and salvage in time of need.

The same day the screw steamer Chalhuin, recently built and engined by Messrs. David J. Dunlop and Co., Port-Glasgow, went down the Firth of Clyde on her official trial trip, and attained the rate of 10½ knots loaded. She is owned by Messrs. Lloyd, Lowe, and Co., London.

On the following day a screw steamer named the Earl of Leitrim had her official trip on the Clyde. She was built at Paisley by Messrs. J. M'Arthur and Co., and engined by Messrs. Muir and Houston, Glasgow, for the Earl of Leitrim, by whom she is intended primarily for establishing a direct means of communication between the tenantry at Milford and Mulroy Bay in the north of Ireland and Glasgow and the West of Scotland. On the measured mile the vessel attained a speed of 10½ knots per hour.

On Friday, November 28, the s.s. Vane Tempest, the sixth steamer built by Messrs. Edward Withy and Co., Middleton Shipyard, West Hartlepool, for the Marquis of Londonderry, went on her trial trip. The late marquis conceived the idea of supplying the suburbs of London with coal direct from his own collieries in Durham, without transhipment in lighters, and entered into a contract with Messrs. Edward Withy and Co. to build this special steamer, capable of passing under the Thames bridges, and discharging her cargo alongside Nine Elms Wharf. She is of peculiar design, the masts, funnel, davits, &c., being made to lower down level with the deck. The principal dimensions of the vessel are: Length over all, 190 ft.; beam extreme, 30 ft.; depth of hold, 13 ft. 6 in. The anchors are all of the patent stockless type, hauling direct up into the hawse pipes, and thus dispensing with the usual anchor crane. It is highly necessary, on account of the crowded traffic on the Thames, that the vessel should be able to drop the anchors quickly to prevent collisions. Engines of 90 nominal horse-power were fitted by Messrs. T. Richardson and Sons, Hartlepool, and on her trial trip with a full cargo of 900 tons, she proved to be a good sea boat, and her average speed was 9 knots in a heavy beam sea. The builders have marked the amount of surplus buoyancy and the length of the righting lever on the vessel's side, in connection with the Plimsoll mark.

On Saturday, the 29th ult., the Italia, under the command of Commodore Carnevalo, went for her first trial trip in the Bay of Naples to test her engines before leaving for Spezzia. She left her moorings at 10.30 a.m., and, after pausing a moment at the entrance of the harbour to be photographed, proceeded to Castellamare, coasted round the bay as far as Sorrento, and returned to Naples at 5 p.m. Steam was supplied to two of her engines only by the aft set of twelve boilers. By order no attempt was made to attain speed, and the engines were run steadily throughout the day at about fifty-six revolutions per minute, with an average working pressure in her boilers of 43 lb. to 44 lb. per square inch. The machinery gave complete satisfaction, and the Italia proceeded to Spezzia early on Sunday morning, where she will receive her four 100-ton guns, and the remainder of her equipment will be completed. The Italia is fitted with Mr. J. McFarlane Gray's steering machinery, made by Messrs. Forrester, of Liverpool. Her four engines, of 4500 horse-power each, to which steam is supplied by twenty-six boilers, are the work of Messrs. John Penn and Sons, of Greenwich.

On December 1 there was launched from the yard of her builders, Messrs. Raylton, Dixon, and Co., an iron steamship named the Redistribution, of the following dimensions: Length over all, 203 ft.; breadth, 30 ft.; depth moulded, 15 ft. 10½ in.; with a carrying capacity of 1120 tons on 14 ft. 10 in. draught. The engines, of 95 horse-power, are by Messrs. Blair and Co., of Stockton.

On Tuesday, December 2, Messrs. Murdoch and Murray, Port-Glasgow, launched the Vale Royal, an iron barque of about 350 tons net register. She has been built to the order of Mr. Henry Smith, London, and measures 138 ft. by 36 ft. by 13 ft. She was built under the superintendence of Mr. M'Ewan, marine surveyor, Greenock.

NOTES FROM THE SOUTH-WEST.

Rhymney Railway.—The Rhymney Railway Company will apply next session for power to construct a new line joining their Bute Dock Branch Railway to the company's low-level line, to widen the arch of a bridge carrying Crwys-road over the Cardiff and Caerphilly Railway, and to require the Pontypridd, Caerphilly, and Newport Railway Company to construct proper sidings in connection with their junction with the Taff Vale Railway at Pontypridd.

Bristol Industrial Exhibition.—The Bristol Industrial and Fine Arts Exhibition closed its doors upon the public on Saturday, after having attracted 210,000 visitors from all parts of Bristol, Somerset, Gloucestershire, Wiltshire, and the neighbouring districts. Thanks

to the energy of the promoters of the Exhibition, and to the support of the public, the guarantors have not been called upon to pay a farthing; but, on the contrary, about 2000*l.* will be handed over to the Bristol University College.

New Dry Dock at Swansea.—A new dry dock is to be constructed near Dickson's Wharf, Swansea, by Messrs. Young, Christies, and Co. The contract has been let to Mr. Walker, the contractor for the Barry Dock.

Shot Firing in Mines.—On Thursday, some workmen's representatives attended at Ynishir Steam Coal Colliery by the consent of the proprietors, with a view of satisfying workmen generally as to shot firing. This colliery is to be adopted by the representatives of the Home Office to ascertain whether existing rules relating to shot firing in mines are sufficiently stringent. After descending the colliery the examiners proceeded to a spot inspected by Mr. T. Wales, Her Majesty's inspector, and Mr. Randall, deputy inspector. The result was, as far as could be gleaned on the spot, that the examiners, on behalf of the colliers, came to a different conclusion to that arrived at by the Government inspectors, as regards shot firing in this particular part of the colliery, the examiners considering that it could be done there with safety. It appears that the distance from the spot where shot firing had taken place here, to the locality where a small blower of gas was issuing from a crack in the roof, was about 250 yards. The blower was so slight that the examiners could not find it without holding the Davy lamp close to the crack. The gas, it is stated, would not ignite in the lamp, unless it was held close to the place from which the gas was issuing. A careful examination of the whole district was made, and with the exception of the before-mentioned small blower, the examiners did not find any trace of gas, not even in the return airway, where the whole body of air was returning towards the up-cast shaft.

Newport.—Business in steam coal has continued in much the same state; the clearances have, however, not been so heavy. The arrivals of iron ore have again fallen off considerably, but the market has continued dull. In the manufactured iron and kindred trades, there is no improvement; still the tone is not worse. Last week's shipments of iron are limited, consisting of only 850 tons of rails and fishplates to Singapore, and 55 tons of iron to Oporto. Last week's coal clearances amounted to 31,972. From Bilbao there arrived 1950 tons of iron ore.

The Bute Docks.—In connection with the proposed transfer of these docks to the Taff Vale Railway Company, it is stated that the Bute Trustees, as landowners, are to receive royalties similar to those payable by the railway company to Lord Windsor, in connection with the Penarth Dock; and that the Marquis of Bute is to receive, in respect of the capital expended upon the dock undertaking, 75,000*l.* four per cent. preference stock, and 862,500*l.* ordinary stock of the amalgamated company, which is to pay the expense of constructing the new Roath Dock.

Cardiff and Monmouthshire Valley Railway.—A company proposed to be incorporated desires to obtain powers necessary for constructing and conducting new railways, which will affect Roath, Llanedern, Michaelston fedw, Machen, St. Mellon's, Basseleg, Graig, Risca, Mynyddislwyn, and Henllys. The company also intend to ask for authority to enter into arrangements for running powers and agreements with the Brecon and Merthyr Tydvil Junction Railway Company, the Great Western Railway Company, the London and North-Western Railway Company, the Midland Railway Company, the Taff Vale Railway Company, the Rhymney Railway Company, &c.

Alexandra (Newport and South Wales) Docks.—This company will seek next session for powers to construct certain lines of railway from the Alexandra Dock to Newport Dock, to purchase lands in the parish of St. Woolas, on the east side of the Great Western (South Wales) Railway, to make junctions and connection between the intended railways and the several railways and sidings leading to the wharves on the Usk, also between the sidings on the north-east corner of the company's property, and the railway of the Tredegar Wharf Company, nearly opposite Brithdir Railway; and also to obtain running powers over the lines of the Great Western Railway Company, the Brecon and Merthyr Tydvil Junction Railway Company, and the Pontypridd, Caerphilly, and Newport Railway Company.

Nantyglo and Blaina Iron Works Company (Limited).—The annual meeting of this company was held at Manchester on Thursday. The meeting was conducted in private, but it has transpired that the report presented by the directors was adopted after some discussion, and that hopeful views were expressed as to the state of the company's property at Nantyglo. The company has ceased the manufacture of iron and has leased the right of working its coal to sundry individuals. Out of the revenue derived from this source a dividend of 2½ per cent. was paid upon the preference shares for 1883-84.

Cardiff.—The steam coal trade has not shown any material change. The royal mail contracts have been distributed among three or four local merchants. Small steam coal has gone off well, and prices have been rather firmer. The patent fuel market is in a satisfactory state. The demand for iron has continued inactive. Last week's clearances comprised 137,341 tons of coal, 8295 tons of patent fuel, 280 tons of iron, and 350 tons of coke. From Bilbao there arrived 9250 tons of iron ore, and 1107 tons came to hand from other sources.

Torpedo Boats for the Cape.—The screw steamer Borghese, of Glasgow, Captain D. Smith, which docked in the Bute East Basin, Cardiff, on Sunday, will proceed to London for part of her general cargo, and thence to Portsmouth to load two torpedo boats for service at the Cape.

Blaenavon.—The Blaenavon Steel Works and Mills, which were idle while some important repairs were being carried out, are now in full activity again.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the market was steady, but there was no more animation in it than there has been for the last six months. No. 3 g.m.b., f.o.b., Tees was again offered at 36s. 3d. per ton for prompt delivery. There is no new feature in trade, but the indications all point to more months of bad trade, and shorter time for the workmen of the North of England. Shipments of iron from Middlesbrough are fairly good for the season of the year, but they are far short of what they ought to be.

The Make and Disposal of Pig Iron.—To-day the Cleveland Ironmasters' Association issued from their offices at Middlesbrough the monthly returns showing the make and disposal of pig iron in the North of England. Of the total number of blast furnaces in the district, 156, there have been 99 in operation. The total make of pig-iron has reached 198,679 tons, which is a decrease of 2408 tons. The stocks now stand at 301,553 tons, an increase of 13,572 tons on November. The shipments were only 74,654 tons, a decrease of 11,682 tons. These returns are certainly far from satisfactory, even allowing that we are close upon the end of the year.

The Manufactured Iron Trade.—This industry continues in a depressed state. Most of the mills are running short time, and are likely to be only irregularly employed for some time to come. Ship plates are quoted 5*l.* and angles 4*l.* 12s. 6d. per ton less 2½ per cent. at works. Last week we stated that the arbitrator, Dr. Watson, of Newcastle, was likely to leave wages in the North of England manufactured iron trade as they are, and this is exactly what he has done. To-day he issued his award, and while deciding that wages shall remain unchanged till the end of January, points out, as forcibly as he can, the desirability of employers and operatives agreeing upon a scale which shall regulate wages better than an arbitration can. The men will no doubt endeavour to formulate the basis of a scale which the employers can accept.

Shipbuilding and Engineering.—A few more orders have recently been secured for steamers on the north-east coast, but considering the enormous productive power of the Tyne, Wear, and Tees, they are scarcely worth alluding to. Yesterday Messrs. R. Dixon and Co., of the Cleveland Dockyard, Middlesbrough, launched a steamer which they have built for sale. Few firms are, however, in the position to adopt such a course in times of depression. Messrs. Dixon are very slack, but they have obtained an order for a steel steamer the plates for which will be supplied by Messrs. Bolckow, Vaughan, and Co., of Middlesbrough, who have now their new Siemens-Martin furnaces in operation. There is nothing new in engineering. In the steel trade there is no additional activity, but it is reported that the prospects are brightening. There is a belief in some quarters that, as wages and materials have come down to the lowest level, trade will gradually revive. It is certainly a favourable time to build ships, and some capitalists seem to recognise that fact.

The Salt Trade.—The several companies in Middlesbrough are still energetically sinking for salt, but none of them have yet achieved the success of Bell Brothers, of Port Clarence, who are now doing a large business in chemicals, to manufacture which they use the salt which they were the first in this part of the country to raise.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

The Hull and Barnsley Railway.—For the benefit of working men alone, if not for that of capitalists, operations for the completion of the Hull and Barnsley Railway were resumed this week. Many hundreds of unemployed workmen in Hull and district will be enabled to now gain a livelihood, and the capital requisite for the completion of the work has been obtained at par.

Bad Trade in South Yorkshire.—Notwithstanding the advent of cold weather the coal trade is only very stagnant and the exports of coal from the neighbouring ports of Hull, Grimsby, and Goole, show a reduction on the previous week. Instead of miners' wages going up, the contrary is the case.

Scarborough.—The Harbour Commissioners report that the recent extension of the fish shed seems to have supplied the accommodation required. The receipts for the quarter ended October 31 amounted to 888*l.*, against 1019*l.* for the corresponding quarter of last year.

Hull and the East Indian Railways.—The Hull Town Council has resolved "that a request be made on behalf of the council to the council for India, and also to the various Indian railways, to make Hull one of their ports for the shipment of their material, and to place it in the same position in this respect as Liverpool and London."

The Barrow Colliery Dispute.—The men who are out on strike at this colliery, and who principally reside in the Barnsley district, have passed the following resolution: "That this meeting is determined not to return to work unless we can secure an honourable settlement, whereby every man shall be allowed to resume work as there is work for him, and that we are willing to meet Mr. Kellett at any time to bring about such settlement, and that we request all miners who are working at other collieries to remain at such collieries until the men fighting the battle have arranged a fair and honourable settlement.

Impoverished Trade.—In no branch of the Sheffield trades is there any improvement to note. The silver branches are all dull, and there is not likely to be any renewal of orders until the home markets are more settled. This awakening of trade does not appear likely yet. In the iron and steel branches the workmen are but poorly employed.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The pig-iron warrant market was somewhat unsteady last Thursday, and closed with the prices 1d. per ton under those of the previous day. There were transactions in the forenoon at 43s. 3d., 43s. 2d., and again at 43s. 3d. cash, also at 43s. 4d. and 43s. 4½d. one month; the close being sellers at 43s. 3d. cash, and 43s. 5d. one month, and buyers offering ½d. per ton lower. Up to 43s. 4d. cash was paid in the afternoon, and 43s. 5d. one month, but the close was buyers at 43s. 2d. cash, and 43s. 4d. one month, with sellers asking ½d. per ton more. Friday's market was quiet, and it was evident that the excitement was dying down. Prices gradually declined, and the close showed a fall of 3½d. per ton, making a decline of 9d. on the week. Business was reported in the morning at 43s. 2d. down to 43s. cash, and buyers at the close were offering 43s. cash, and 43s. 2d. one month, with sellers at 1d. more per ton. There were transactions in the afternoon at 43s. down to 42s. 10½d. cash, also at 43s. 2d. down to 43s. 0½d. one month, with sellers at the close at 42s. 11d. cash, and 41s. 1d. one month, and buyers offering ½d. lower per ton. Monday's market was also quiet, and prices closed ½d. per ton under those of Friday. Transactions took place in the forenoon at 42s. 9½d., 42s. 11½d., and 42s. 10d. cash, and the close was sellers at 42s. 10d. and 43s. cash and one month respectively, with buyers ½d. less per ton. In the afternoon there were transactions at 42s. 10d., 42s. 11½d., and 42s. 11d. cash, the market closing at 42s. 10½d. cash and 43s. one month nominal. The warrant market was a shade firmer on Tuesday, but the close was not so strong, and the final quotations showed very little change from those of the previous day. On forenoon 'Change business was done at 42s. 11½d., 43s., and again at 42s. 11½d. cash, the close being sellers at 42s. 11½. cash and 43s. 1½d. one month, and buyers ½d. per ton less. Iron changed hands in the afternoon at 43s. down to 42s. 10½d. cash, and buyers at the close were offering 42s. 10½d. cash and 43s. one month, with sellers asking ½d. per ton more. Somewhat better prices were obtained to-day up to 43s. 0½d. cash and 43s. 2d. one month being paid during the forenoon, but at the close in the afternoon there were sellers at 43s. cash and 43s. 1½d. one month, with buyers at ½d. per ton lower. The excitement of the market has now very greatly died down, but very little business is doing, owing, in great measure to the uncertainty which exists as to the future movements of those persons who were responsible for the recent violent fluctuations in prices. The prospects of the iron trade do not in any way improve, and in fact if there has been any change the present position of the trade is rather worse than better. Outside investors and speculators cannot be induced to purchase, and even the dealers are perplexed as to the mode in which they should operate. Warrants still remain in such a position that a sharp movement either way may be effected, without any regard to the course of trade. The demand from abroad has been very dull during the past week or ten days, and the quotations for special brands are, in consequence, a shade lower. Shipping iron is steady, but there is very little business doing, and though the prices are quotably unchanged, concessions are made in order to lead to business. There are now only 93 blast furnaces in actual operation, two that were blowing at Kinneil Iron Works having been stopped. At this time last year there were 100 furnaces in blast. With the stoppage just mentioned, the make of pig iron will have been reduced to the extent of about 400 tons per week. Last week's shipments of pig iron from all Scottish ports amounted to 6540 tons, as against 6935 tons in the preceding week, and 9268 tons in the corresponding week of last year. To the United States there were shipped 816 tons; to South America, 308 tons; to Australia, &c., 180 tons; to France, 250 tons; to Italy, 220 tons; to Germany, 567 tons; to Belgium, 410 tons; and lesser quantities to other countries. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood yesterday afternoon at 579,669 tons, as compared with 579,863 tons yesterday week, showing a decrease of 194 tons for the week.

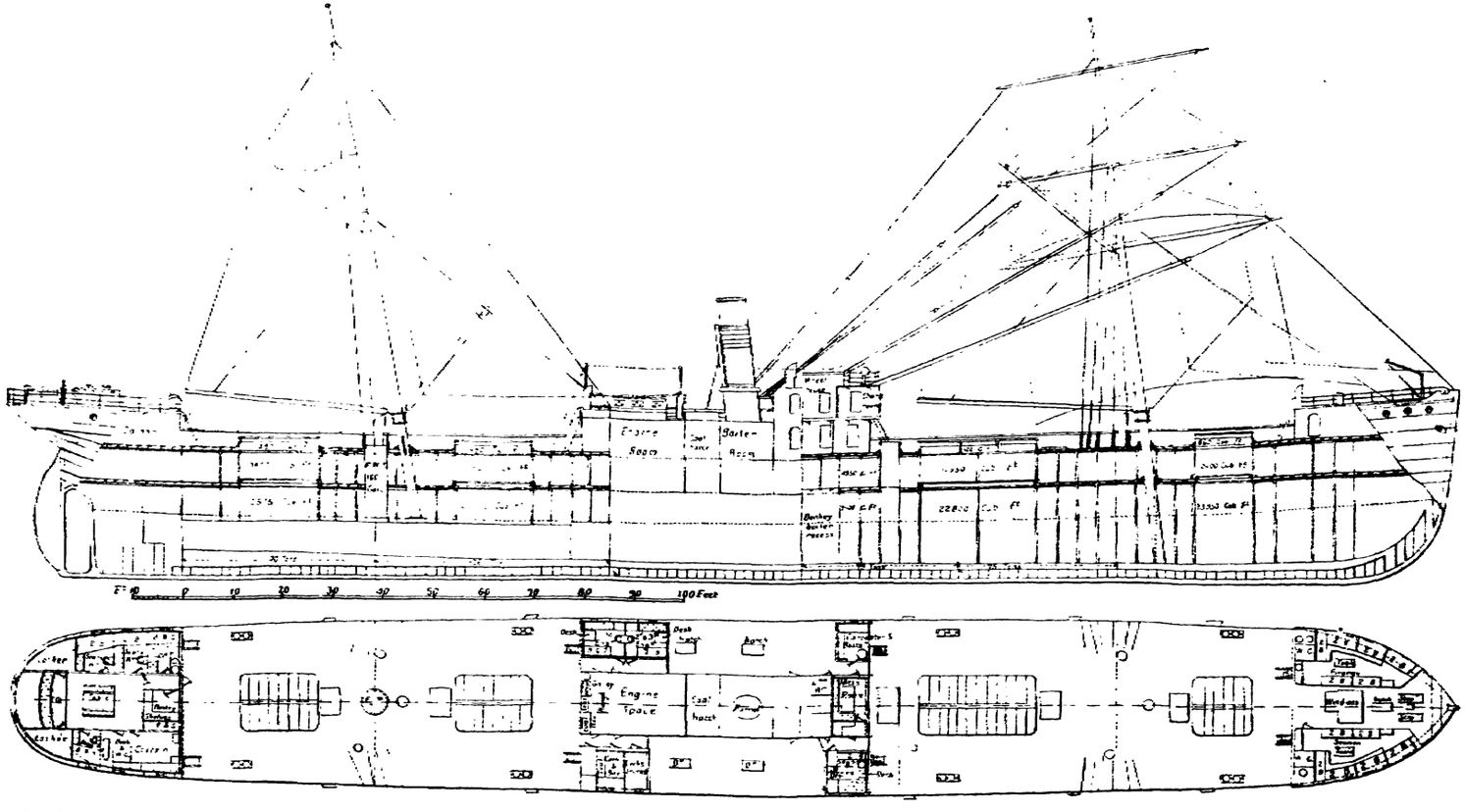
Official Inspection of the Forth Bridge.—On Thursday of last week, Major General Hutchinson and Major Marindin, of the Board of Trade, accompanied by Mr. Baker, one of the engineers, and Mr. Arrol, one of the contractors of the Forth Bridge, made an official examination of the structure. They inspected minutely the piers and caissons, and descended the shaft of No. 1 caisson to the air chamber where the work of excavation is being rapidly pushed forward. It is understood that the inspectors expressed satisfaction with the progress being made.

Institution of Engineers and Shipbuilders in Scotland.—An ordinary meeting of this Institution was held last week, Professor James Thomson, F.R.S., President, in the chair. An interesting and well illustrated paper entitled "On Manipulating the Material, and Building and Drilling the Great Tubes required in the Forth Bridge," was read by Mr. Andrew S. Biggart, one of the resident engineers on the bridge works. Much interest was taken by the members present in the descriptions given by Mr. Biggart regarding the special machi-

THE S.S. "COUNTY OF SALOP."

CONSTRUCTED BY THE BARROW SHIPBUILDING COMPANY, LIMITED, BARROW-IN-FURNESS.

(*For Notice, see Page* 517.)



nery which had been designed by Mr. Arrol, one of the contractors, for doing the work referred to. The discussion was opened in a few remarks by Mr. F. W. Dick, of the Blochairn Steel Works, and continued over till next meeting. A paper was subsequently read by Professor Henry Dyer, C.E., M.A., late Principal of the Imperial Japanese Engineering College at Tokio, on "Energy and Entropy and their Applications in the Theories of Air and Steam." The discussion on it was also postponed till next meeting of the Institution.

Society of Chemical Industry.—At the monthly meeting of the Glasgow and West of Scotland branch of this Society, held last night, an interesting paper was read by Mr. W. J. A. Donald, on "Chromed-Tanned Leather." The process and the specimens exhibited excited a lively interest among the members.

Clyde Shipbuilding Trade.—The output of new shipping from the Clyde shipbuilding yards during the month of November, was 13 vessels, of an aggregate of 13,667 tons, being the smallest monthly output since 1880, if we except the month of January, 1881 and that of 1884, when the progress of work was much interfered with by the annual holidays. In the corresponding month of last year the ouput was upwards of 30,000 tons more. The total output for the past eleven months was 272,254 tons, or fully 100,000 tons short of that of the same period of 1883. The largest steamers were the Rimutaka, 4500 tons, built by Messrs. Elder and Co., and the Glamorganshire, 2800 tons, built by the London and Glagow Engineering and Shipbuilding Company. The largest sailing vessel launched during the month was the Middlesex, 1730 tons, built by Messrs. Barclay, Curle, and Co.

Mr. William Pearce and the Shipyard Ironworkers.—During the past few days a considerable amount of excitement has existed in the shipbuilding circles of Govan and Glasgow on account of a wages hitch that has occurred between Mr. William Pearce, of Messrs. John Elder and Co., and a number of the unemployed shipyard ironworkers. On being approached to ask what he was willing to do in order to provide employment for those workmen who have recently been thrown idle for want of work, he undertook to lay down, at his own risk, a steamer of 5000 tons, on condition that the men would consent to engage for a twelvemonth at such a reduction of wages as would bring them to the level paid in the year 1879. The matter was talked over fully and freely, and the two official representatives of the men cheerfully consented on behalf of the latter that they would accept the proposed terms, certain suggested modifications being agreed to by Mr. Pearce, who, on the faith of the bargain entered into, proceeded to order the necessary materials. Subsequently the workmen at one of their meetings declined to abide by the proposed terms, their opinion being that the terms were then applicable to a 4000-ton vessel. At once Mr. Pearce countermanded the orders given out, and for the last two or three days a considerable amount of official and unofficial negotiation has been going on, in the hope that the men would see it to be their duty and to their advantage to fall in with Mr. Pearce's proposal. At present the matter seems to be in a fair way of being amicably settled, although in the absence of Mr. Pearce in London it is just possible that a day or two may elapse before the breach created last week has been healed up.

QUEENSLAND RAILWAYS.—On the first section of the Logan Railway, platelaying and ballasting have advanced to 7¼ miles from the junction with the South Brisbane branch, and the bridges on the section are going on satisfactorily. On the second section, the heaviest work is the Logan bridge, for which the guide staging for sinking the cylinders is all erected. Great progress has been made with the bridges and flood openings on this section. About 6000 sleepers are ready, and a large quantity of ballast has been procured from the local quarries. Tenders will shortly be called for the second section of the Brisbane Valley branch line; and Parliamentary plans for the extension of the Highfields branch from Caberlah to Crow's Nest township have been adopted. Tenders for the line from Stenthorpe to the southern border of the colony, which will ultimately connect Queensland with the railway system of New South Wales, are to be invited in the course of a few weeks. The construction of the second section of the Killarney branch is progressing. On the western extension of the main line the Maranoa Bridge is nearly finished. The superstructure is now complete, and the bridge will be tested in the course of a week or so. As soon as this has been done, platelaying will commence from the bridge, and it is expected to proceed without interruption for forty miles. A contract for the Kilkivan Railway has been let to Messrs. M'Dermott, Owen, and Co., who have signed their plans, and are now making preparations to begin work. Very good progress is being made with the section of the Central Railway between Pine Hill and Jericho. A bridge over the Belyando, which is about two miles west of Pine Hill, is so far finished that a ballast engine is running over it. The line is laid twenty-five miles from Pine Hill.

ENGINES A
...OR'S OF THE S.S
...OW SHIPBUILDING COMPANY, LI

(For Notice, see Page 517.)

Fig. 1.

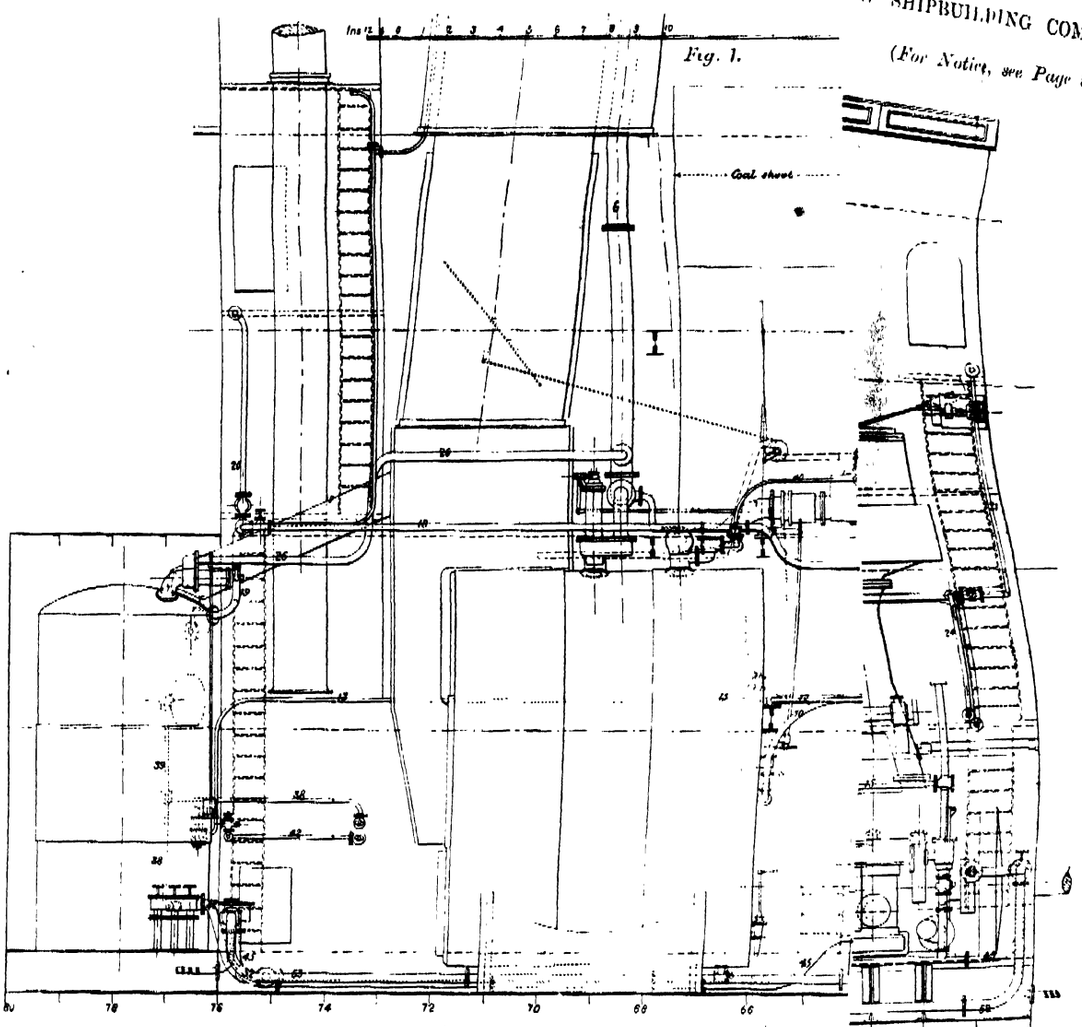
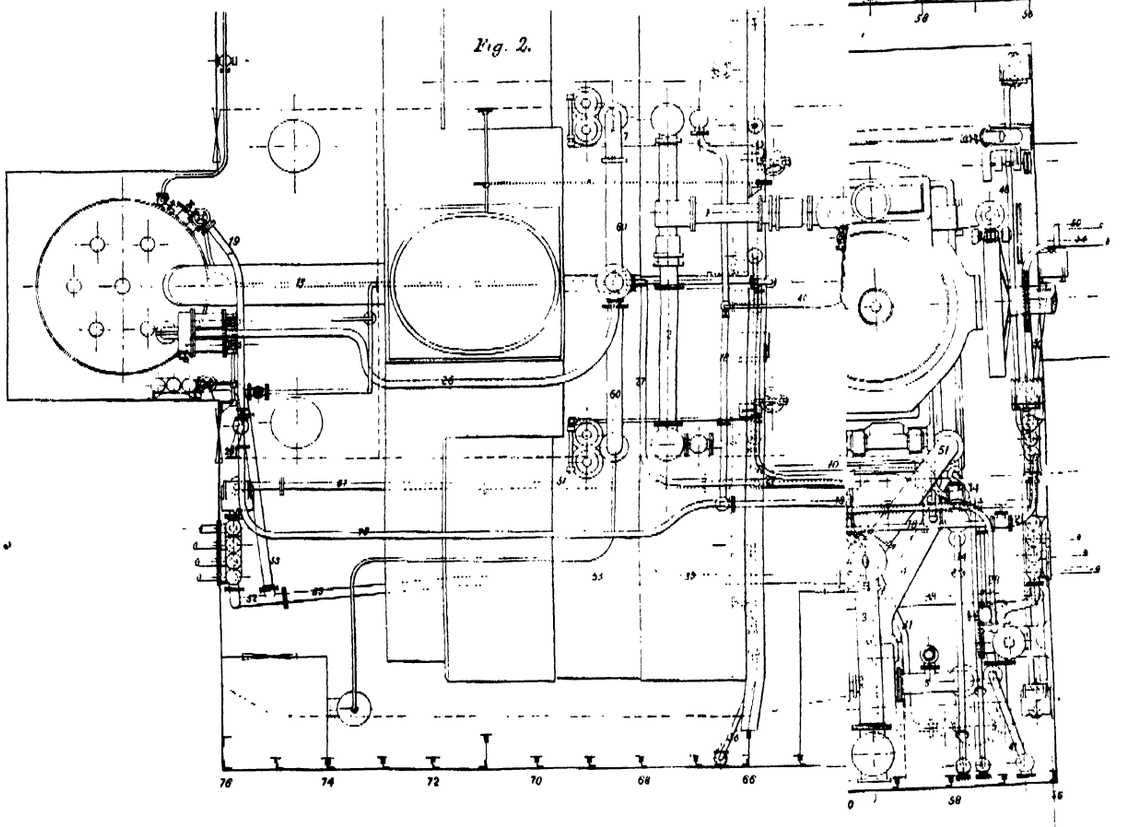


Fig. 2.



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The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Students' meeting, Friday, December 5th, at 7.30 p.m. Paper to be read and discussed: "Trigonometrical Surveying," by Harley H. Dalrymple Hay, Stud. Inst. C.E. Mr. Henry Law, M. Inst. C.E., in the chair. Ordinary meeting, Tuesday, December 9th, at 8 p.m. Papers to be discussed: "The Working of Tramways by Steam," by the Hon. R. C. Parsons, B.A., B.C.E., M. Inst. C.E. "The Sydney Tramways," by W. Shellshear, Assoc. M. Inst. C.E.

THE SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—Thursday, December 11th, 1884, at the Institution of Civil Engineers, 25, Great George-street, S.W. Annual general meeting for the election of Council and officers for 1885. Paper "On Electricity in America, 1885," by W. H. Preece, F.R.S., Past-President.

THE SURVEYORS' INSTITUTION.—Monday, December 8th, the discussion on Mr. Shaw's paper will be resumed, and a paper will be read by Mr. E. Smyth (Professional Associate), entitled "The Arithmetic of Compensation for Agricultural Drainage." The chair to be taken at 8 o'clock.

THE PARKES MUSEUM OF HYGIENE, 74A, Margaret-street, Regent-street, W.—Precautions against Cholera. Monday, December 8th, at 4.30 p.m.: "National Precautions; Regulation of Travelling; Ships; Importation of Clothes, Rags, &c.; Usefulness of Quarantine," by Mr. Ernest Hart, Chairman National Health Society. Wednesday, December 10th, at 4.30 p.m.: "Local Precautions; Duty of Sanitary Authorities in Town and Country, and of the Householder," by Mr. Shirley Murphy, Medical Officer of Health for St. Pancras. Friday, December 12, at 4.30 p.m.: "Personal Precautions to be taken by each Individual: Panic; Food and Drink; Clothing," by Dr. Norman Chevers, C.I.E., President of the Health Department, Social Science Association, and of the Epidemiological Society.

PHYSICAL SOCIETY.—Saturday, December 13th, at 3 p.m.: "On the Effect on an Electrical Current on the Thinning of a Liquid Film," by Professor A. W. Reinold, F.R.S., and Professor A. W. Rücker, F.R.S.; "On a Theory of the Molecular Architecture of Solids, Illustrated by a Wire Vibrating Torsionally," by Mr. Hubert Tomlinson.

ENGINEERING.

FRIDAY, DECEMBER 5, 1884.

NAVAL EXPENDITURE.

MISERABLY insufficient is the only term that can in justice be applied to the programme set forth by the Admiralty, in answer to the popular demand which has been made for a more efficient Navy. There can be no possible doubt after all that has been said and written during the last few months that the present naval resources of the nation would be quite inadequate to bear the strain put upon them in the event of a very possible hostile combination. It is so trite a thing to say that the safety of this country depends on its naval supremacy that we should be almost ashamed to repeat it, did not the circumstances of the hour bring it so forcibly home to us. Surely those responsible for our naval administration must have forgotten this fact when they were persuaded to support in Parliament the ill-advised proposals that were set forth on Tuesday last. It has been the fashion lately to say a good deal about the questions of national defence being kept outside the bounds of politics, but in the present case, when the subject is one of more than usually vital importance, it has been deliberately sacrificed to party considerations. For ourselves, we have no politics in these columns, and probably the Conservatives, had they been in power, would have acted with no more boldness or wisdom than the present administration. One thing, however, is apparent. A Liberal or Radical government is always in a stronger position, when a necessity arises for additional expenditure, than one of the opposite party. It would be difficult, under existing conditions, for a Conservative opposition to attack a Liberal policy of increased expenditure on the Navy, and were such a thing done it would be credited, and rightly so, to party manœuvre. Economy has always been the Liberal strong card, and if, therefore, a Liberal Government should propose additional expenditure on the Navy it might safely rely on its reputation for supporting the necessity of such expenditure. But it is absurd in the present instance to speak of any excuse being necessary when asking for more money for the Navy.

Men of various positions—those most capable of judging of these matters have spoken, detailed statements have been put forward, undeniable facts have been cited, all pointing to one conclusion—that we are living in a fool's paradise if we think that the Navy is capable of meeting any demand that is likely to be made upon it in the event of a great war. We do not see how it is possible to get away from this conclusion, and indeed no serious effort has been made by the official apologists to reply in detail to any of the contentions advanced, not only by irresponsible critics, but by those whose status and authority preclude the supposition that their strictures are not deserving of consideration. It is true Lord Northbrook made a passing allusion to the paper lately read by Sir Edward Reed, and challenged in general terms the correctness of his comparison of the respective strengths of English and French first-class ships. He gave on the authority of the whole Board of Admiralty certain figures intended to show that we are eleven first-class ships and four quasi-obsolete ships ahead of our neighbours. Total quantities alone were given, and no particulars of how they were arrived at were vouchsafed; under these circumstances the figures may be looked upon as [illegible] worthless, and might just as well have been doubled or trebled for all the conviction they carry. On the other hand, Sir Edward Reed, in the [illegible] which we deal with on another page, gives ship and ship and detail for detail. Whether or no he was fully justified in all the conclusions he arrived at, the country will be more ready to place reliance in his straightforward statement than any loose and unsupported expressions of opinion from Whitehall.

It would only tire our readers were we to follow Lord Northbrook through the various points of his long statement. He made the most of the small sop he had to throw to the popular demand, and brought forward all the stock excuses which have been used by official apologists time out of mind. He had an easy task in discussing the relative strengths of ships to obscure the issue, and indeed it is difficult enough to arrive at any definite conclusion, however single-minded one may be in the attempt. For instance, Sir Thomas Brassey takes 9 in. armour as a standard of comparison, Sir Edward Reed has a small opinion of anything under 14 in. Some critics attach a first importance to the gun, others consider speed a primary consideration, and others again place handiness and power of ramming in the front rank. The fact is, until some recognised basis of comparison is settled, specialists may go on arguing for ever and neither the public nor themselves be a bit nearer a definite conclusion. We want a system of judging ships by points much the same, to compare great things with small, as that followed in deciding on the merits of competitors at dog-shows. The vessels should be divided into classes and certain definite values given for different features. Thus so many points would be awarded for thickness of armour, penetrative power, and weight of guns, speed, handiness, coal endurance, &c. Possibly the Admiralty authorities have such a system, which, for certain good reasons, they keep to themselves.

The net result of the recent agitation is that we are to have, in addition to what had already been proposed, four ironclads, two torpedo rams, five belted cruisers, two "Scouts," and thirty torpedo boats. These are to cost 3,100,000*l.* In addition to this 1,600,000*l.* will be spent on naval ordnance, and 825,000*l.* on coaling stations. These sums are, if we understand rightly, although there appears to be some obscurity on this point, to be extended over a period of five years, and 800,000*l.* is the addition to be made for new vessels to next year's estimates, but in any case nothing is to be done for four months or so.

Turning to another place we find still less cause for satisfaction. From Lord Northbrook we did not expect much; as he says "he is a man inclined to economy," no doubt the one great virtue which placed him in the position he holds, and we knew all that could be wrung from him would be conceded grudgingly. From Sir Thomas Brassey, however, a little more sympathy might have been expected. The popular owner of the Sunbeam is nothing if he his not enthusiastic, and one can imagine the generous zeal with which the present Secretary to the Admiralty would have espoused the popular cause had not fate trammelled him with the responsibilities of office. Perhaps no more remarkable exhibition of the power of official ambition could be displayed than that of the late chief of the Royal Naval Artillery Volunteers, using all the arts of a special pleader to mistify and obscure the true state of the facts. It is a *rôle* that by no means suits his style of oratory, and his slighting allusion to the "imperfect acquaintance" of his critics with the subject, came but awkwardly from his lips. With regard to this part of the subject, it would be well for both the First Lord and Sir Thomas Brassey to remember that it is too late now to speak contemptuously of outside criticism. The financial element which has such undue influence in all these questions has had its hand forced on the present occasion entirely by outside pressure. We should be sorry to think it was an evidence of Parliamentary decadence, but certainly what Parliament has failed to do, has been accomplished mainly through the instrumentality of an evening journal. We remember the able manner in which members in the House of Commons have lately endeavoured to arrest attention in this matter. In the early part of the year Lord Henry Lennox could hardly secure an audience of four members to listen to instances of naval deficiencies quite as cogent, and details fully as important, as any that have since been brought forward. The arguments of Sir Edward Reed also failed to carry anything like the same weight when delivered from his place in the House of Commons as they did the other night at the Royal United Service Institution, after attention had been aroused by the series of articles in the *Pall Mall Gazette*.

We do not now intend criticising the details of the expenditure proposed. A return is promised from which fuller information may be derived, and we shall deal with the subject more fully at another time. In truth, however, there is so little to talk about, that beyond a general and

inclusive expression of disappointment, we have not much further to say. We may have been somewhat startled by the proposal to build two torpedo rams, after the experience with the Polyphemus, but we let that pass for the moment. Perhaps the Admiralty has been more successful in concealing some later triumphs of that vessel than they were in hiding her early failures.

There is, however, a small modicum of comfort in the proposals put forward. The great bulk of the money asked for, is to be spent in contract-built vessels. After the inquiry which Lord Ravensworth presided over in the early summer, the report of which we recently commented upon, the result could hardly have been otherwise. The emphatic testimony which the Director of Naval Construction and other witnesses, bore to the lower cost of contract-built ships, and their equality in regard to workmanship and materials to those constructed in the Royal Dockyards, rendered it imperative that steps should be taken in this direction. It is to be hoped, too, that an indication of a long-desired reform may be perceived in Sir Thomas Brassey's statement that "with regard to contractors no obstruction will be imposed on their exertions."

During the sitting of the Committee to which reference has been made, it was shown very clearly that ships built by private firms under contract with the Admiralty, were far more costly and took far longer to finish than any other class of vessels either for mercantile purposes or for foreign navies. It is a well-known fact, and one that was testified to by witnesses of all classes before the Commission, that comparatively seldom is money made out of an Admiralty building contract; and yet contractors are paid a higher price for the results obtained when they build a ship for the English Government, than for almost any other description of work. As we have already said, there is only one reason to assign for this, and that is the system by which the details of the work are settled. The Admiralty prepare drawings, which are made as vague as possible, and the specification is drawn in such a way that nearly everything is left to be settled by the resident overseer who represents the Admiralty interest. This official, like all of his class, has a haunting fear of responsibility, and no detail is settled until it has been duly authorised by some higher authority. Those who know the rate at which papers and drawings filter through Admiralty or dockyard departments, will easily appreciate the time it often takes to arrive at any definite conclusions. The grievances of the "overseer" system are, however, well known, and have been frequently referred to in these columns; we should not have referred to them here had we not fancied that Sir Thomas Brassey's remarks, read by the light of the evidence referred to, gives promise of one of the most wished-for reforms in the execution of Navy contracts. Such a reform, however, will require the benevolent co-operation of the Constructive Department at the Admiralty, for at present Mr. Barnaby and his assistants are of opinion that they cannot prepare beforehand full drawings of the ships they require. We think they are altogether too modest and that such a feat is quite within their powers.

PRIVATE BILL LEGISLATION.

Once more the time has arrived when projectors have, by the deposit of plans, to make public the nature of the schemes proposed to be introduced by them during the Parliamentary session of 1885, and again it is our intention to place before our readers a short description of the more important of these, in order that their scope and intention may be rendered rather more intelligible to those affected than is possible by the mere recapitulation of the exceedingly terse announcements contained in the Parliamentary notices which the standing orders of both Houses require to be made. The number of projects for which plans have been deposited at the Private Bill Office, is 199, of which 74 are for railways, 21 for tramways, 59 miscellaneous, including subways, and 45 for works, for which provisional orders will be sought.

The metropolis, always a happy hunting-ground for the projectors of railways and other kindred means of conveyance, is favoured with several schemes directed to the improvement of the communications within its boundaries; the most important of these, three in number, have for their common object the formation of a direct north and south line, and are doubtless the immediate outcome of the opinion so strongly expressed during the progress of the unsuccessful Parks Railway Bill of last session, that such a communication was both necessary and desirable, and that its route should be more or less in the direction of St. Martin's-lane and Tottenham Court-road, having junctions with or other means of access to, with the London and North-Western, Great Northern, and Midland Railway systems at one end and the South-Eastern and Charing Cross at the other.

Powers are sought to incorporate a company to construct such a line, called the Charing Cross and Euston Railway, about 2½ miles in length. It commences at the west side of Belvedere-road, Lambeth, by a junction with the South-Eastern Railway, and runs parallel to that line on what will be a widening on the north side of Charing Cross Bridge; it is then continued to the Strand, occupying the site of Villiers-street—for which a new street will be substituted—thence it is carried past St. Martin's Church, taking a small portion of the churchyard, to the upper end of St. Martin's-place; from this last point to High-street, Bloomsbury, the route of the new street now being formed by the Metropolitan Board of Works is followed. The line is now carried up Tottenham Court-road as far as the Whitefield Congregational Chapel; here it turns to the west, passing close to and on the west side of the Board School in Whitfield-street, and sweeps round on tolerably sharp curves to the intersection of Euston and Tottenham Court roads; it is then carried nearly parallel with the former to near Gower-street Station of the Metropolitan Railway, where it again turns northward, and passing on the west side of Cardington-street, and under the carriage-shops north of Euston Station, terminates by a junction with the London and North-Western Railway at its crossing under the Hampstead-road. A spur about a furlong in length, commencing at York-terrace and terminating by a junction with the main line near Adelaide-street, provides for the construction of a convenient exchange station with the Charing Cross Station, and a subway across the Strand near Villiers-street is also doubtless intended to facilitate interchange of traffic here. Land is also taken at Oxford-street, Gower-street, and near Euston Station, apparently for station purposes, the two last being convenient for exchange with the Metropolitan and London and North-Western systems.

The line is nearly level across the Thames; it then falls on a gradient of 1 in 70 to pass under the Strand. Under the new street the maximum gradient is 1 in 70, and the depth of the rails below the surface varies from 20 ft. to 29 ft. Beneath Tottenham Court-road the depth varies from 24 ft. to 27 ft., precluding tunnelling for the greater part of the distance. The line is carried under the Metropolitan Railway by gradients of 1 in 70, there being a difference in the level of the rails of 20 ft. To avoid as much as possible the acquisition of property, and in most cases the consequent heavy trade compensations, which, as a rule, are prohibitive to the construction of railways in business localities, advantage has, it will be observed, been taken of the proposed construction of the streets by the Metropolitan Board of Works. That public body, no doubt, unless favourable arrangements have been made, will oppose as they did last session in the case of the London Central Electric Railway, when they sought to obtain a considerable payment for the desired occupation of the subsoil of these thoroughfares.

The new street in substitution of Villiers-street consists of the widening of Buckingham-street and its continuation across the Metropolitan District Railway Station at Charing Cross to the Embankment roadway. This is by no means a project of startling novelty, for in 1846 Mr. Giles was the engineer of a line called the Charing Cross Junction Railway, which was very similar in character to the present scheme; it was about two miles long, 2508 yards of it being driven tunnel, and commenced by a junction with the London and North-Western Railway at a point about 200 yards north of the junction of this year's line; it was carried along the west side of the Hampstead and Tottenham Court-roads as far as Oxford-street, thence in a direct line to the west end of Salisbury-street, Strand. A branch connected the line with a then proposed bridge over the Thames on the site of Charing Cross Bridge, and new lines projected the same session, made connections with the southern railway systems. A large central terminus, occupying the site bounded by Salisbury and Craven-streets, the Strand, and the river, for the accommodation of both goods and passengers, formed part of the undertaking. In 1864, a scheme, also similar to the present, but laid out almost entirely under existing or projected thoroughfares, was sanctioned, but as restrictions were placed upon making any openings for construction in the various thoroughfares, it was found impracticable to carry it out. Another attempt, however, was made in 1871, when a scheme, afterwards called the London Central Railway, was authorised. This was rather more comprehensive than the preceding, as it commenced by a junction with the Midland Railway at a point north of St. Pancras Station, thence ran parallel with the Euston-road to Tottenham Court-road, junctions being made with the London and North-Western Railway, and with the Metropolitan Railway, with exchange stations. The line was then carried clear of Tottenham Court-road on its west side to Oxford-street, whence it passed under a new street to have been formed by the company to St. Martin's-place; it then proceeded through property to a junction with the South-Eastern Railway on the north side of Charing Cross Bridge at a point clear of the platforms of the station there. Though backed up by favourable agreements with the companies affected, the appeal to the public for funds met with no success, and the subject has remained in abeyance until the present session, when time only will show whether such a widely acknowledged want will be at last satisfied.

The Central London Subway, to construct which a company is to be incorporated, is evidently, as are many others afterwards to be referred to, a result of the success of the City and Southwark scheme of last session, for which powers were granted, to construct between the Elephant and Castle and King William-street, City, a subway consisting of two lines of brick or iron tubes 10 ft. in diameter, along which a frequent succession of vehicles resembling tram-cars were to be drawn by cable traction on the Hallidie system. The present scheme is the construction of two lines of similar tubes between King's Cross and Charing Cross. Commencing at Liverpool-street, they pass along the south side of the Euston-road, but inside property, to Gower-street Station. Thence they turn to the south and are carried down Gower-street and Bloomsbury. Thence they take the course of the new street already described as far as St. Martin's-place, from which point to their termination opposite Craig's-court existing streets are followed. A short spur near Mabledon-place permits of a depôt being formed clear of the subway. The total length is about two miles. The maximum depth below the surface is about 40 ft. The gauge is to be 3 ft. 6 in., and during the construction of the works, temporary openings may be made in the streets. Powers are also to be taken and land, &c., is scheduled to enable the Metropolitan Railway to make connecting passages and other means of communication between their stations at Gower-street and King's Cross and the proposed subway. In order to lessen the cost of the acquisition of property, it is proposed to limit the liability of the company to the purchase of easements only under properties affected by the subway. Power to underpin buildings likely to be injured by the works are also to be included, as well as to limit the enforced purchase to parts only of property when such alone are required. The working of the subways is to be on the above-mentioned cable traction system, or by some other means, other than steam locomotives, which may be sanctioned by the intended Act or by the Board of Trade.

The remaining rival scheme is also independently promoted and is called the King's Cross, Charing Cross, and Waterloo Subway. It commences within the property of the London and South-Western Railway Company, on the north-west side of Waterloo Station, at a point about a chain south-east of York Road, opposite Vine-street; it traverses that street and College-street, then crosses the Thames to Northumberland Avenue, along which it is taken to Charing Cross; thence it is carried under St. Martin's-lane, Long Acre, Little Queen-street, Theobald's-road, and Gray's Inn-road, and terminates at the north-west corner of Liverpool-street, near King's Cross Station. The works consist of two tunnels, each about 2¾ miles in length, and 10 ft. in diameter, in some places laid alongside, in others one is above the other. The greatest depth is at the Thames crossing, where the tubes are 72 ft. below high water; elsewhere the depth is about 60 ft.

below the surface of the ground. The maximum gradient is 1 in 17, and the gauge is to be 4 ft. 8½ in. Land, apparently for station purposes, is taken at the commencement and the termination of the line, and at Hemming's-row, Drury Lane, Little Queen-street, and at the corner of Gray's Inn-road and Theobald's Road. Powers are also to be taken to enable the Great Northern, Midland, Metropolitan, and South-Western Railway Companies, to enter into agreement for the construction, maintenance, and working of the subway, the latter of which is to be, as described in the preceding case, by cable, traction or other means excluding steam locomotives.

The improvement of the communication between the City and West-end is also proposed to be attained by the construction of subways similar to those last executed from Hyde Park to the Royal Exchange by an independent company; the scheme is called the Marble Arch, Regent Circus, and City Subway. Commencing opposite the Marble Arch it traverses Oxford-street for its whole length, Holborn (avoiding the Viaduct by making a detour along Charterhouse-street and Snow-hill), Newgate-street, the Poultry, and terminates in Cornhill opposite the centre of the Royal Exchange. The length is about 3¼ miles; the subway is formed of two tunnels 10 ft. in diameter, laid as described in the preceding scheme; the greatest depths are 70 ft., 67 ft., and 62 ft., the maximum gradient is 1 in 20. Land, apparently for station purposes, is included at Regent Circus, Tottenham Court-road, Southampton-row, Great Turnstile, Farringdon-street, St. Paul's Churchyard, and at the commencement and termination.

The gauge is to be 4 ft. 8½ in., and the working is to be as mentioned in the description of the London Central Subway, and similar clauses, with the exception of that relating to easement and that relating to property, are to be inserted in the Bill.

Another independent company is to be formed for the purpose of constructing the Islington (Angel) and City Subway, which commences opposite that tavern in the City-road, is carried along the latter for its whole length, and thence along Finsbury Pavement and Moorgate-srteet, and terminates at Lothbury. The length is about 1¾ miles, and it is formed by two tunnels 10 ft. in diameter, laid as before described; the maximum depth is 48 ft. below the surface. Stations will probably be placed at Macclesfield-street, Nelson-street, Old-street, and Ropemaker-street, and at the "Angel" and the Bank. The gauge is to be 4 ft. 8½ in., the working is to be as mentioned in the description of the London Central Subway, and clauses similar to those in the last described scheme are to be inserted in the Bill.

The only subway or railway scheme relating to the south side of the metropolis proper is that called the Clapham and City Subway, which is proposed to be an independent extension of the authorised City and Southwark Subway before alluded to, along the Kennington and Clapham-roads to Clapham Common, a distance of 2¾ miles. The tunnels, two in number and 10 ft. in diameter, are to be laid as described in the three last-mentioned schemes, the greatest depth being 56 ft. The gauge and method of working are also the same as in those schemes. Powers are to be taken to enable the City and Southwark Subway Company to construct or work the proposed subways. Stations will be placed at Clapham Common, South Lambeth-road, South Island-place, Kennington-road, and Lower Kennington-lane.

It will be seen that in the case of cable traction subways, as in that of atmospheric, pneumatic, and electric railways, as soon as it has been demonstrated by the passing of an Act that such means of traffic are feasible, the following session is sure to abound with further examples of the same system when the peculiar advantages of the particular system will be put well in front. In the cable system with tunnels constructed in the manner proposed, being briefly as follows: Property on the line of route will be secured against structural injury, which too often has resulted from the construction of the ordinary tunnels suited for locomotives, which are large in comparison with those intended, which necessitates considerable disturbance of the subsoil during the progress of the works; small subsequent damage and inconvenience from vibration on account of the lightness of the vehicles made use of, and lastly, the safety and economy which are assumed to be secured by the method of working, which on the other hand will efficiently provide for a large amount of passenger traffic. But it must be borne in mind that in the case of the parent scheme nothing has yet been done towards providing this.

The Charing Cross and Waterloo Electric Railway is proposed to be extended a distance of about 100 yards to near Spring Gardens, and a small piece of property is to be acquired.

An independent company is proposed to be incorporated to construct the Metropolitan, Notting Hill, and Shepherd's Bush Extension Railway, which commences by a junction with the Metropolitan Railway at a point about 140 yards north of Uxbridge-road, passing along that road in a westerly direction to Shepherd's Bush. It then turns slightly to the south and forms a junction with the Kensington and Richmond line of the London and South-Western Railway, where it is crossed by Shepherd's Bush-road. The line is about one and a quarter miles in length. That part under the Uxbridge-road is formed in covered way, the remainder in open cutting, the latter being on a gradient of 1 in 67. It is difficult to understand the precise object of this line, for though it might improve the connection between the South-Western and Metropolitan system if worked with a through service of trains, yet it seems hardly probable that it would be found advisable to admit such extra trains upon the Inner Circle, which, since its completion, has not been worked with anything like satisfactory regularity, and such a proceeding would hardly tend to an improvement in that direction. If worked as an independent company, with proposed running powers to Queen's-road Station, the confusion would be worse, as it is absurd to think of working into a station with but two lines of rail and no sidings, and through which it is proposed to run with its regular traffic, ten trains each way per hour.

THE WEATHER OF NOVEMBER, 1884.

DURING the first part of November the weather in the British Isles was very mild with moderate downfall, very favourable conditions for tillage and seeding operations. The latter part was sharp and bitter by contrast, though on the whole temperature has been seasonable. From the 1st to the 9th the prevalent winds were from between S. and W.; the 10th to the 16th, between S.E. and N.E.; and the 17th to the 29th, between N. and N.W. Barometric pressure above 30 in. continued from the 10th to the 20th. With this high pressure the weather was dry though hazy and cloudy, with very little sunshine in England. At extreme positions to which the Isle of Man is central, the mean atmospheric pressure and temperature were as follows:

Positions.	Mean Pressure.	Difference from Normal.	Mean Temperature.	Difference from Normal.
	in.	in.	deg.	deg.
North ..	29.97	above 0.20	43	above 1
South ..	30.18	,, .24	47	nil.
West ..	30.09	,, .21	45	,,
East ..	30.12	,, .25	43	below 1
Central ..	30.12	,, .24	46	above 2

From these results it is seen that pressure was nearly a quarter of an inch above the normal value, and this excess was uniformly distributed, hence it might be inferred that the resultant of the winds would be normal. The daily general directions of the winds give a resultant from W. on 9½ days, and the normal resultant is W. by N., a very close agreement. The temperature results accord with the winds in being of normal value. As regards the downfall the following results show that there was a deficiency in the south and east districts, a trifling excess in the north and west districts; and on the whole rainfall has been less than the normal, which result seems related to the high pressure.

Places.	Rainy Days.	Amount.	Difference from Normal.
		in.	in.
Sumburgh	25	4.44	above 0.26
Scilly	21	2.34	below 1.45
Valencia	20	5.52	above 0.38
Yarmouth	17	1.78	below 1.53

Rainfalls exceeding 1 in. in twenty-four hours were measured at Valencia on the 1st, 1.36 in.; Roche's Point on the 7th, 1.25 in.; Stornoway 1.5 in., and Ardrossan 1.0 in. on the 9th; and Stornoway 1.33 in. on the 27th. A thunderstorm occurred at Shields on the 20th. Atmospheric pressure ranged between 30.6 in. on the 14th and 29.0 in. on the 5th. A depression centre, in latitude 50 deg. N., longitude 11 deg. W., 6th, 6 P.M., advanced north-north-eastward to Malin Head by the 7th, 8 A.M., and quickly progressing and developing, reached the west of the Shetlands by 6 P.M., and was on the Arctic Circle near Norway on the 8th A.M. No very severe tempest affected these islands. The highest temperature, 61 deg., was recorded at London on the 7th; the lowest, 15 deg., at Wick on the 30th. Great differences of temperature frequently existed between the stations at the same instant; thus, on the 13th, Scilly reported 53 deg., Parsonstown only 30 deg.; on the 15th, Roche's Point 50 deg., Leith 30 deg.; on the 16th, Scilly 48 deg., Nairn 25 deg.; on the 22nd, Scilly 45 deg., Parsonstown 23 deg.; on the 25th, Scilly 45 deg., Cambridge 24 deg.; on the 26th, Scilly 49 deg., Oxford 29 deg.; and on the 30th, Valencia 47 deg., Aberdeen 16 deg. An estimate of clear days, yields ten for Ireland, six for south and east England; and of overcast days fifteen for east England, seven for the central district; for other districts the numbers are intermediate. The duration of bright sunshine may be compared with these estimates. Reckoned in percentage of its possible duration, these islands on the whole had 20 per cent. of sunshine during the five weeks ending December the 1st; the Channel Isles had 34, south Ireland 25, north Scotland 23, west Scotland 21, north Ireland 20, east Scotland, east and north-west England 19, south England 17, south-west and north-east England 16, and central England 15.

THE "ILLUSTRATED JOURNAL OF PATENTED INVENTIONS."

WE have before us the first issue of the *Illustrated Journal of Patented Inventions*, containing descriptions of inventions for which patents have been granted. The drawings for illustrating these descriptions or abridgments are furnished by the patentees, the descriptions themselves being supplied by the Examiners' Branch of the Patent Office. The descriptions, although in some few cases not quite what they might be, are far more comprehensive than many of those hitherto published by this office in classes, or than those that appear in the Official Gazette of the United States Patent Office, but the printing, and especially the illustrations, are not to be compared with those in that Gazette. The illustrations are, in some few cases, insufficient, and are certainly not well chosen, and we hope the day is not far distant when the Board of Trade will deem it advisable for the Patent Office to undertake to select the drawings required, and that these drawings will be reproduced by a method which will, at any rate, render them distinct, which is far from being the case in the present issue, especially in regard to the more complicated subjects.

Passing now to the object of these abridgments, we presume that they are intended to facilitate cursory investigations as to what has been proposed to be done, and also to give increased facilities to country inventors for making such investigations. The officials responsible for this production must be entirely ignorant of the method of procedure in such cases, for we find that the only index that the issue contains, is a numerical one consisting of three columns of numbers, the first being arranged in order and indicating the numbers of the patents, the second indicating the numbers of the journals in which their abridgments will be found, and the third the pages of those numbers. Thus, in making a complete subject matter search by the aid of these abridgments, it is necessary first to take the numbers of all specifications under the required heading from the ordinary indexes, then to strike off from the list all those that have not been sealed, and, by the numerical index in the illustrated journal, to obtain the pages and numbers of the journal where the remainder will be found; and, finally, after having referred to the abridgment, to refer to those complete specifications which have not been sealed, and are therefore not included in the abridgments, these latter specifications having to be separated from the "provisional only" contained in the numbers first struck off. Such a search cannot be made with any degree of certainty except at the Patent Office Library, at 25, Southampton-buildings, unless, perhaps, the searcher concludes that all those specifications not found in the abridgment were not sealed, and of the remainder, those not found in the boxes or bound volumes containing the specifications at the special place where he is searching are "provisionals only," and therefore not published. So far as we are aware, there are

THE THOMSON-HOUSTON DYNAMO.

(*For Description, see opposite Page.*)

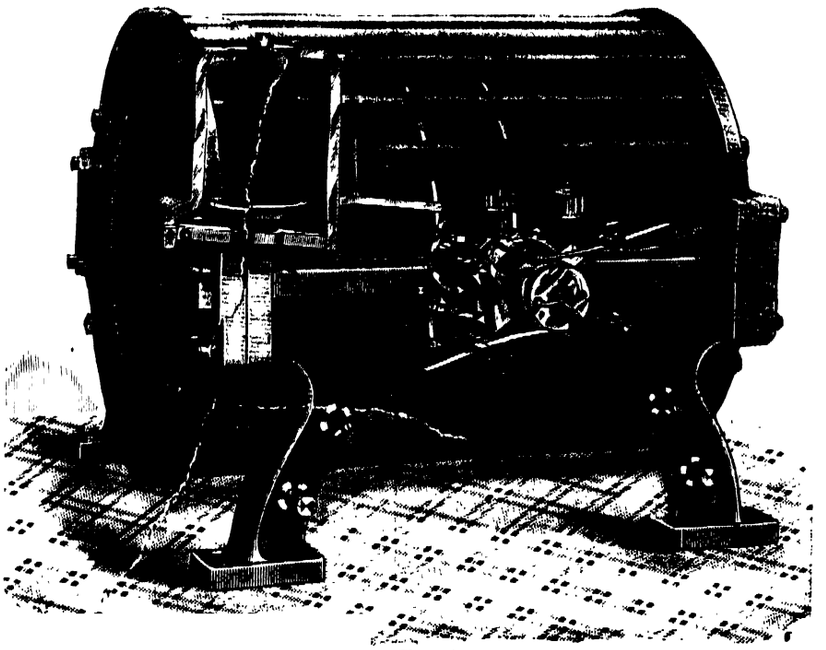


Fig. 1.

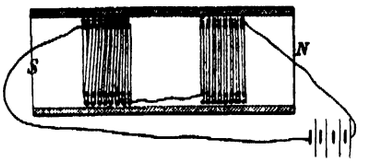


Fig. 2.

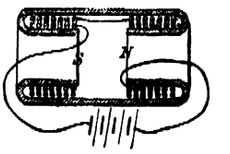


Fig. 3.

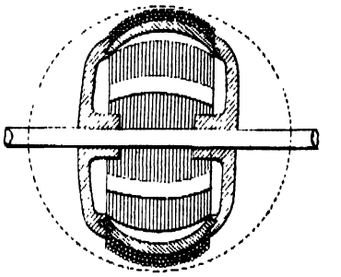


Fig. 5.

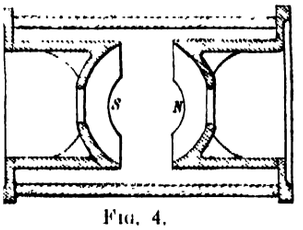


Fig. 4.

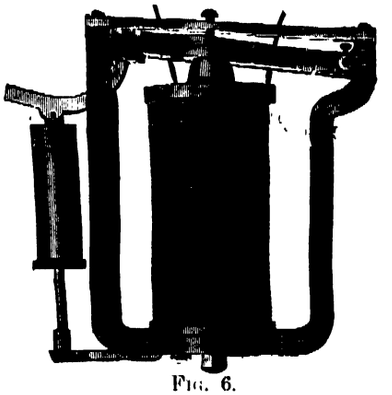


Fig. 6.

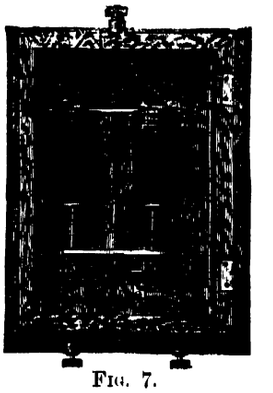


Fig. 7.

no means of separating these three classes of specifications except by the aid of a single manuscript book kept by the librarian at Southampton buildings.

In view of this, it would be interesting to know how many specifications are missed during the year from the boxes in which they are placed, say, at the South Kensington Patent Museum Library or the Manchester Free Reference Library; or how many are missing from the boxes at any one time, including those which have been taken from the boxes, and removed to some other part of the library for perusal (the boxes being replaced in position), and also those that are out of place. We can only hope that the future numbers of the Journal will contain complete alphabetical and subject-matter indexes of their contents. We also think that it would have been advisable to have delayed the publication, say, another month, when the abridgments could have been printed in numerical order (except in a very few cases), that all complete specifications should be included in the abridgments, and that, to make the Journal complete in itself, the numbers, and perhaps the titles and names of the inventors, of the remaining specifications should be given with the statement after them of "provisional only." With the improvements we have suggested, the Journal would also be of far more value to those persons who desire either to make a search at their own homes or who desire merely to themselves posted with any particular class of current inventions. As issued at present it is practically useless for these purposes.

The price of the Journal is one shilling, about two and a half times as much as the American Gazette, which contains a larger number of abridgments and complete indexes, together with other valuable information relating to American patents.

After a careful and impartial perusal of the Journal we must confess to having experienced a deep sense of disappointment with the production in its entirety, for bearing in mind the fact that our Patent Office officials have now had seventeen years' experience in abridging and over thirty years in indexing specifications, we certainly expected a far more complete and satisfactory production.

LIGHTING TRAINS BY ELECTRICITY.

Two typical methods of lighting trains by electricity are before the public. In the first, which we described in detail last week, a dynamo, situated in the van, is driven by belts from the axle, and feeds a secondary battery from which the current is taken to the lamps. An automatic regulator breaks the connection between the generator and the accumulator, as soon as the electromotive force of the former falls below that of the latter, and thus prevents the discharge of the battery through the coils of the armature. In the second method the dynamo is driven continuously by an independent engine. This was first tried, we believe, upon the Metropolitan District Railway by Mr. Massey, of Twyford, who placed an engine, boiler, and dynamo in a van, and fed the lamps directly from this source.* About the same time, Mr. F. W. Webb, of Crewe, fitted up a train running between Manchester and Liverpool, with a Brotherhood three-cylinder engine and a Siemens dynamo coupled directly together and fixed upon the back of the tender, and this train has run continuously ever since. Another modification of the same system is now in active operation on the Great Eastern Railway, and can be seen upon certain of the trains on the Chingford line every evening. In this arrangement a Heenan and Froude spherical engine,† coupled directly to a dynamo, is mounted longitudinally upon the barrel of the locomotive boiler. The two are inclosed in a box measuring about 3 ft. by 2 ft. by 1 ft., and on a tank locomotive, where the natural outline of the boiler is destroyed by the tanks, this is scarcely to be noticed. The engine is supplied by steam from the locomotive boiler, the regulator being placed inside the cab, so that it is under perfect command of the driver. By means of a Cardew voltmeter,* permanently connected to the poles of the dynamo, the speed of the engine can be adjusted to give the proper degree of brilliancy to the lamps. The dynamo, which was made by Messrs. Crompton and Co., is designed to run at 1000 revolutions per minute, and at this speed it gives a current of 42 ampères with an electromotive force of 48 volts. The trains consist of fifteen carriages, and are lighted by sixty Woodhouse and Rawson lamps of the type so largely used at the recent Health Exhibition, and to which a gold medal has been awarded, there being one in each of the first and second-class compartments, and two in each third-class carriage of five compartments. The illumination is amply sufficient in all parts, the substitution of an incandescence 16-candle lamp for the former gas burner showing such a marked difference that it is impossible to enter a carriage without noticing it. The former globes and pipes have not been interfered with, the jointed gas tube being merely turned on to the top of the carriage. The conductors are laid under a wood beading, and at each compartment, insulated wires are led to two spring contacts under the hinged weather cover. The lamp and its holder are fixed to a substantial block fitted with terminals corresponding to the above-mentioned spring contacts, so that the whole can be removed and replaced with as much facility as an oil lamp, and in much the same way. The connection between the

* See ENGINEERING, vol. xxxvii., page 207.

† *Ibid.*, page 201.

* See ENGINEERING, page 236 *ante*.

THE THOMSON-HOUSTON ELECTRO-MOTOR.

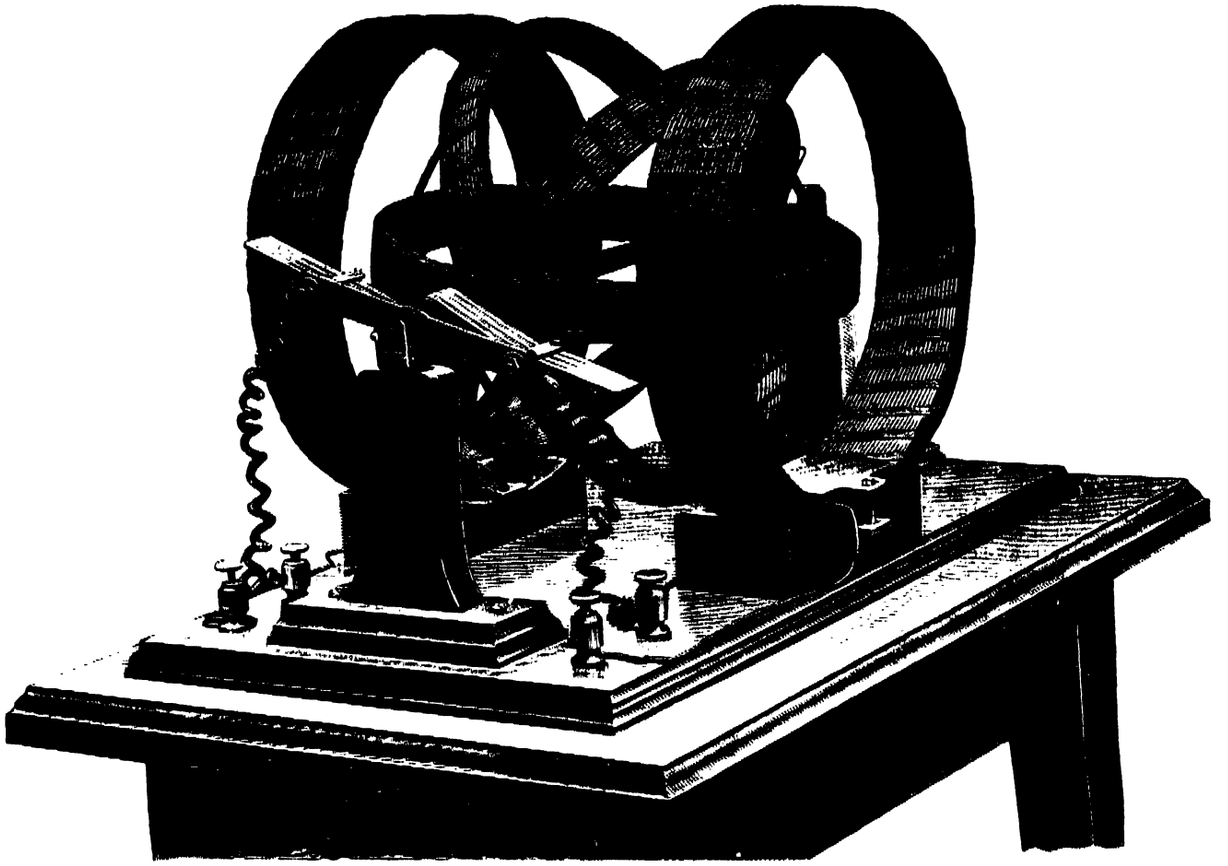


Fig. 8.

engine and train, and between the various carriages, has been very carefully worked out. At the end of each carriage there are a pair of male terminals, and the space between the adjacent carriages is bridged by a pair of flexible conductors laid together, and furnished at each end with a double spring socket, which fits the terminals and obtains a strong frictional grip on them. All the parts are very strongly constructed, so that they can be found in the dark, and will suffer no injury from the roughest of usage.

The electrically lighted train has now been running five weeks, and the wiring of other trains is being actively proceeded with. Mr. T. W. Worsdell, the locomotive superintendent, under whose control the experiments are being made, has fitted dynamos to five locomotives, so that in a short time it may be expected that the system will be in operation on such an extended scale that it will be possible to obtain a reliable account of its cost. Messrs. Heenan and Froude, of Manchester, are the contractors, and the work is being carried out by their electrician, Mr. R. Woodley, of 4, Agnes-street, Burdett-road, E.

There are now two thoroughly efficient methods of electric train lighting at work in the metropolis, and it is possible, therefore, for the railway companies to institute a reliable comparison. Each possesses advantages and defects of its own. The Brighton system is encumbered with from 22 cwt. to 30 cwt. of secondary batteries, and with the loss which arises from the double conversion of the energy. On the other hand the light is always available whether the engine is backed on to the train or not, and the power is derived from an economical motor. On the Great Eastern trains the total weight is exceedingly small, only 4 cwt. or 5 cwt., and the current is applied directly to the lamps without any loss. The disadvantages are that when the locomotive leaves the train all the lights go out, and that the spherical engine may be expected to make a greater demand for steam, for a given power, than a locomotive. The relative merits of the two systems would seem to depend greatly upon the circumstances in which they are tried. On a small scale the balance of advantage lies with the dynamo in the van, since the train is self-contained, and when the usual engine is in the shed, the light is equally well maintained by any other, and no alteration of the ordinary method of working the traffic is required. On a large scale these advantages disappear, since if all the engines working on a given section were fitted with dynamos, the trains would be equally well served by any of them, and arrangements might be made to always maintain the lights by attaching a fresh engine for the return journey before the first was uncoupled.

THE PHILADELPHIA ELECTRICAL EXHIBITION.—No. IX.

By C. J. H. Woodbury, Boston.

The Thomson-Houston System.

This exhibit contained electrical lighting apparatus which can lay claim to much that is original, both in the application of electrical principles, as well as mechanical construction. Dynamos with regulators which preserve a constant current, irrespective of the number of lamps in circuit; are lights burning steadily, without any glycerine dash-pot among the feeding mechanism; a divided current, operating two series of small arc lamps; incandescence lamps on arc circuits, and regulated by a distributor without help of clockwork. These all tended to render the exhibit attractive to those interested in the latest applications of electrical science for illumination.

It has become a conventional matter to term inventors of electric lighting systems "professor," regardless of their title to such designation, but the co-inventors of this system, E. J. Houston and Elihu Thomson, held the chairs of Professors of Physics and Chemistry respectively at Philadelphia, and were prominent in scientific circles, before the invention of the system bearing their name.

For a number of years, the conduct and active work in the development of this system of electric lighting has devolved upon Professor Thomson, while his former associate, Professor Houston, still retains his professorial chair.

The first publication of any tests of electric lighting dynamos in America was made in 1877, by a committee of the Franklin Institute, of which Professors Thomson and Houston were members.

The dynamo machine differs as widely in its general appearance (see Fig. 1) from any of the conventional forms of dynamos, as it does in its electrical arrangement. A spherical armature is nearly enclosed by two pole-pieces, and these in turn are surrounded by iron bars, completing the magnetic circuit, giving a cylindrical outline to the whole machine. For the design of the magnet, conceive a tube (Fig. 2), magnetised by coils inserted in each end. Then fold the ends of the tube (Fig. 3) until they are within the ends of the coil, and it would still be a magnet, but with the poles near each other. The lines of electrical effect would also produce magnetism in the portion of the tube outside of the coils, as well as at the poles on the ends of the tube within the coils, giving, as will be seen by reference to the sketch, a higher magnetic saturation than would be obtained from the influence of coils acting only in one direction, without any iron to prevent external effusion of lines of magnetic polarisation. As a matter of actual construction, the details of these magnets are somewhat modified, the hemispherical concave terminals to the pole-pieces (Fig. 4) being shaped to conform to the outline of the armature, and the outside frame of wrought-iron rods, while completing the magnetic circuit, also serves as a portion of the frame essential to the stability of the machine. This construction renders the dynamo very compact, and the iron rods also serve to protect the machine from receiving injury.

The armature core is built upon a hollow iron shell in the form of an oblate spheroid, the ends of which being environed by the field coils, are magnetised thereby, and form an addition to the pole pieces of the field magnets. The polar portions of the armature are made of two concavo-convex pieces of iron strongly ribbed, and, provided with bosses, Fig. 5, permit secure attachment to the armature shaft. These end pieces of the armature are not completely hemispherical, and the space between them is bridged with iron bars, insulated at their points of support; then soft iron wire, insulated with japan, is wound around these bars, completing the surface of the core. The armature winding consists of three coils of wire lying in planes of sixty degrees from each other, and to secure mechanical and electrical equality, is wound in the following order: First half of first coil; first half of second coil; whole of third coil; last half of second coil; last half of first coil. By this winding the highest dif-

ferences of potential are found on the outside wires, and the coils follow each other in electrical sequence.

Three of the terminals of these coils are secured to their respective segments on the commutator, while the other three terminals at the other end of the armature, are fastened to each other by a good electrical contact, making the armature of three branches, rather than three electrically distinct coils.

The commutator consists of a copper ring divided into three segments and mounted in such a manner that the air has free access to the inner sides of the commutator. The current is taken from the commutators by two pair of brushes mounted on yokes, whose variable position modifies the tension of the uniform current produced by the dynamo. Leaving for a moment the consideration of the part which the armature plays in this operation, we will refer to the method used for automatically working the brushes in accordance with the demands of the lighting circuit. The yokes carrying the brushes are swung by a system of levers whose first member is also the armature of an electro-magnet, the coils of which are in a variable shunt from the main circuit. The pole-piece of the electro-magnet terminates in the form (approximately) of a paraboloid, which enters a hole in the armature a little larger in diameter than that of the pole-piece at its largest part. This arrangement in combination with such length of the magnets as will bring the centre of magnetic intensity at a certain place near the end of the pole-piece, renders the component of the attraction magnet a uniform force within the limits of the motion allowed the armature.

The electro-magnet of the automatic regulator, Fig. 6, would not be sufficiently sensitive for slight changes in the current if its coils were in the main circuit, therefore a pair of solenoids, whose coils are in the main circuit, are used to shunt a variable amount of current through the regulator magnet. This controller magnet, Fig. 7, is placed in some convenient position near the dynamo, generally against the wall of the building. In earlier forms of this dynamo, the strength of current allowable by the regulator was fixed by the position of a sliding weight on the arm of the regulator, but at the present time it is more permanently adjusted by a spring between the coils of the controller magnet, which partially sustains the weight of the armature, and renders the action of the magnet more sensitive to fluctuations in the current. Having described the general construction of the dynamo, reference will again be made to the operation of the automatic regulator.

The engraving, Fig. 8, of a Thomson-Houston electro-motor, in skeleton form, illustrates the windings of the dynamo, and shows how the connection of the coils at the end of the armature farthest from the brushes, renders it more properly one of three branches extending from a common centre, than what would be properly understood by a three coil armature.

It is related that the arrangement of the Brotherhood engine furnished the first inception for the idea which caused the invention of this method of winding an armature. The inventors were seeking to produce an electro-motor without any dead points, and obtained very good results by the use of a revolving armature with coils wound on three radial arms 120 deg. from each other. From that beginning, the step seems short to wind the three coils radially on a common wire core.

As the three branches of the coils of the armature traverse the field of force of the magnets, the electrical impulses are transmitted to the commutator; for a portion of the revolution two of the helices are acting in multiple arc. Although at one end, the wires of these helices are in contact, their separation at the ends leading to the commutator and the brushes prevents the completion of a conductor which would short-circuit the armature.

When the resistance in the external circuit is diminished, the increased current thrown through the regulator magnet, draws each pair of brushes nearer together, and forms thereby a conductor by which a helix on the armature is put into circuit with a helix which has not as yet produced a current of equal tension, and the union of these currents of different potential, produces a resultant current. The steadying effect of large coils is probably the principal cause why no undesirable results follow this action. It is certain, however, that the apparatus operates satisfactorily, the dynamo supplying a constant current, whether the lamps on the circuit be the maximum within the capacity of the dynamo, or only one; it also serves to correct the variable results due to fluctuations in speed of the dynamo.

The writer has made some experiments with a 25-light Thomson-Houston dynamo, to test the efficiency of the regulating device under extreme conditions of service. The engine was a slide valve with throttle governor, built during the last generation, and abused thereafter. Its speed fluctuated with the load, and would be considered too irregular for any kind of work requiring a uniform rate. The lights were hung close to each other, and twenty-four of them rapidly switched out by three persons, leaving one lighted lamp in the circuit. Then one of the conductors was withdrawn and replaced at the binding post, rapidly changing the resistance of the circuit from one lamp to infinity. These variations in the circuit were reversed and the number of lamps changed in various methods, without in any manner changing the operation of the lamps kept in circuit.

The economy of such a dynamo is naturally greatest when the maximum number of lamps is in circuit, as the friction of journals and resistance of the air at the armature are constant factors, and the loss of energy in the armature is less than that due to the union of different currents in the armature, because such action moves the neutral point of the armature backwards. The curve, Fig. 9, shows a

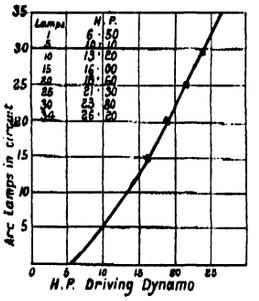


Fig. 9.

plotting of results obtained by placing a dynamo of thirty-light capacity, in the swinging dynamometer of Professor Brackett, and noting the power with different numbers of lights in circuit.

It is hardly necessary to state that a similar curve would ensue from observations upon the economy of any prime mover working at various capacities. The proper point of cut-off in steam engines has an analogous factor in a dynamo.

The novel method of preventing sparking on these dynamos is worthy of especial mention. A small rotary blower is attached to the armature shaft and ejects a sharp puff of air on the commutator as the opening between the segments leaves the brushes. This breaks up the train of fine matter which forms the conductors permitting such sparks. An attendant poured a stream of oil upon the commutator of a dynamo, with thirty-five arc lights in circuit, without any more serious result than the loss of the spilled portion of the oil.

(To be continued.)

NOTES.

New Photographic Films.

Herr H. W. Vogel, a German chemist, has discovered that silver tetrabromofluoresceïn is remarkably sensitive to greenish-yellow rays. He also finds that if a cadmium bromide collodion plate containing eosin is immersed in a silver solution, its sensitiveness to blue rays is much diminished, and the action of the yellow rays greatly increased. The addition of eosin to collodion silver bromide containing a small quantity of silver iodide, produces a film which is sensitive to yellow and blue rays. Wet gelatine plates containing eosin are also found by Herr Vogel to be much more sensitive to yellow rays than dry plates.

Marion's Photographic Printer.

Messrs. Marion and Co., the photographic dealers, of Soho-square, have introduced a new photographic paper which produces very fine effects with an exposure of a few seconds. The developing can, moreover, be done by gaslight, which is a convenience in dark winter weather. The emulsion on the paper is a trade secret at present, as the process has not been patented, but the developer is a weak solution of ferrous oxalate. The tints of the picture are highly artistic, and range from a warm reddish brown to purple and black. The new paper requires considerable practice to manipulate properly, but it is likely to be very serviceable in winter when the light is poor.

Trunk Line Telephony in Belgium.

The Belgian Government has connected Antwerp and Brussels by telephone for the transmission of trunk line messages. The system employed is that of Van Ryaselberghe, and admits of the simultaneous transmission of telegrams and telephonic messages over the same wire. The existing telegraph lines have therefore been fitted with telephones, no new trunk telephone line being required. The example is perhaps worthy of imitation in this country. The public tariff for telephonic communication is 1 franc for the first five minutes' use of the line, and 1.50 francs for over five minutes' talk. At night the rate is doubled. The Government hope to establish similar communication between Brussels and Liége, Verviers, Mons, Gand, Charleroi, and Louvain.

Legal Ohm Standards.

M. I. René Benoit, who was commissioned by the Minister of Posts and Telegraphs, France, to construct several mercury standard ohms, has now completed the work, which was carried out at the Bureau International des Poids et Mesures, Paris. The tubes employed are of the thickness of ordinary thermometer tubes and 1.20 metres long. The bore is one square millimetre in sectional area, and as regular as could be obtained. A scale in millimetre divisions was engraved on the tube over a length of 1.05 metres. The tubes were carefully callibrated and inserted in reservoirs of mercury. Being long and somewhat unmanageable, M. Benoit has constructed copies in tubes which curve several times on themselves. These standards have been constructed with such care that the average error in their resistance is exceedingly small. M. Benoit in fact considers that their mean error is about $\frac{1}{100000}$ of the ohm.

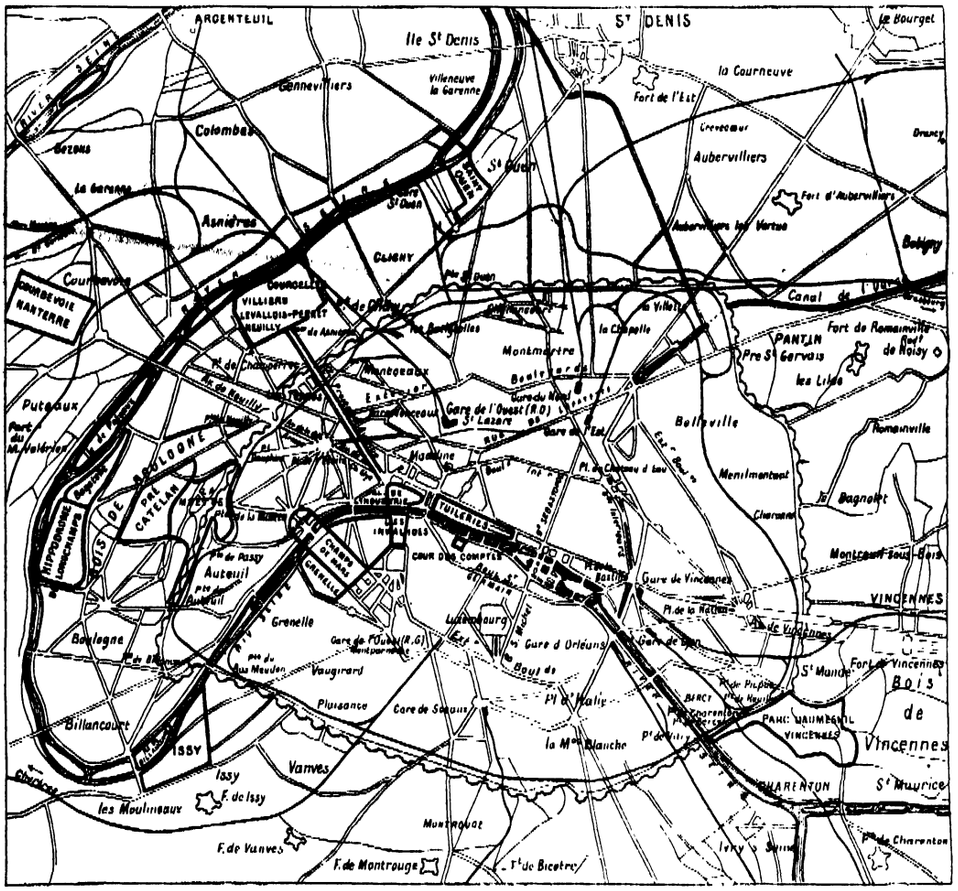
The Vacuum Brake.

We have to record another narrow escape of an express train, owing to the failure of the vacuum brake on the Midland Railway. The train in question was the 3 P.M. express from London to Bradford on the 29th ultimo. When approaching Nottingham, the driver as usual applied the brake, but it entirely failed to act, and the train ran a quarter of a mile past the station at which it was intended to stop, being ultimately brought to a stand by the steam brakes on the engine and tender. The explanation given to the alarmed passengers that the brake had failed without warning, is certainly not reassuring, and it does not require a very vivid imagination to picture the effects of a similar failure when running up to buffer stops or on meeting a sudden obstruction on the line. This incident again points strongly to the inference that the vacuum brake is not fit to run alone, and is another illustration of the way in which it has been nursed and kept going by the aid of the steam brakes on the engine and tender. Though subject to be affected by cold, and though their use prevents the brake being "capable of being applied to every vehicle in a train," as required by the Board of Trade, the steam brakes have undoubtedly been the means of mitigating the effects of the inefficiency and uncertainty of the vacuum system.

Electric Lighting at Turin.

MM. Gaulard and Gibbs have established between the Exhibition at Turin, the station at Lanzo, and several intermediate stations, an electric lighting circuit, the total length of which is 80 kilometres (about 50 miles), and the conductor is formed of chromated bronze 3.7 millimetres in diameter, and uncovered. This wire carries an alternating current produced by a Siemens dynamo of 30 horse-power, so that the current can be utilised simultaneously in various modes of lighting, either at the Exhibition, the terminal station at Lanzo, or at intermediate stations, by means of Gaulard and Gibbs' secondary generators. On September 25 last, the system began to operate, in a regular fashion, the following arrangement of lamps. 1. At the Exhibition, nine Bernstein lamps, one Soleil lamp, one Siemens lamp, nine Swan lamps, and five other Bernstein lamps. 2. At the Turin-Lanzo station, distant 10 kilometres, thirty-four Edison lamps of 16 candle-power, forty-eight of 8 candle-power, and one Siemens arc lamp. On September 29, according to M. Tresca in his report to the French Academy of Sciences, the trial was more conclusive still, the system being completed to Lanzo, a dis-

PROPOSED SITES FOR THE PARIS EXHIBITION, 1889.



tance of 40 kilometres, where twenty-four Swan lamps of 100 volts each were regularly fed. These lamps demand a considerable range of capability on the part of the Gaulard and Gibbs system, and M. Tresca's commission has reported its entire success.

NOTES FROM PARIS.

By H. VIVAREZ.

SOCIETY OF ELECTRICIANS.

THE International Society of Electricians has resumed its monthly séances. The Society is arranging, for the month of January, 1885, an exhibition that is intended to illustrate the most recent development of electrical science. This exhibition will be held at the Observatoire, and admission will be free of charge; a number of conferences will be arranged there during the time it remains open. Applications for space, together with notices of the subjects to be exhibited, should be sent to the President of the Société Nationale des Electriciens, 3, Rue Seguier, Paris. Such application must be forwarded prior to the 25th of December next.

THE INTERNATIONAL EXHIBITION OF 1889.

At the present moment the great International Exhibition to be held in Paris in 1889, is a subject attracting considerable attention; in the opinion of its organisers the undertaking will prove a fitting homage to the memory of the French Revolution, and at the same time a practical demonstration of the progress that a century will have seen develop, in the moral and material history of humanity. All, or nearly all, European nations have played their part in the great work of freedom inaugurated by this revolution, and their participation in celebrating its centenary will, therefore, have a special value and significance. To some extent it may be regarded as a promise of international union, and an official protest against the condition of armed peace which has now for so many years contributed to weaken and cripple nationalities. Dreamers and philanthropists may hope that an exhibition promoted with such an object, may prove to be a step towards the universal and lasting peace so earnestly desired by many. But practical people know that one of the greatest attractions of future international exhibitions will be found in the collections of objects devoted to war and destruction. However this may be, one of the chief features of the 1889 Exhibition, will be its retrospective character, and this will prove alike its great attraction and its *raison*

The organisers of the Exhibition have recently appointed a commission to examine, in the first place, the financial part of the undertaking, and to report on the most suitable site to be adopted. This class of industrial and artistic demonstration is rarely successful so far as actual profits on outlay are concerned. The Fisheries Exhibition of last year and the Health Exhibition at South Kensington this year, were notable exceptions. But the advantages usually resulting are of a special order, in which the accountant's formula of debit and credit does not enter. The Paris Exhibition of 1878 was a striking proof of this. The definitive financial statement of this enterprise was submitted to the Chamber of Deputies only a few days ago, with the melancholy result that the receipts fell short of the expenditure by 31,000,000 francs. The necessity of removing the buildings in which it had been held, in order to restore the Champ de Mars to its original uses, helped certainly to swell this deficit. It is evidently illogical to build and to destroy in order to rebuild and destroy again. But logic does not govern the world. Many persons urge that the new Temple of Industry shall be placed on the extensive area where the first Federation was accomplished, and where, since that time, peaceful demonstrations and military displays have succeeded one another almost continuously. Probably the experience of the past will be of little purpose, and we shall again see disappear there in a few years, buildings which will be erected at an expense of millions of francs. Certainly the site has much to recommend it—proximity to the centre of Paris, easy means of communication by the streets and by the Seine, to say nothing of the advantage invaluable in the eyes of the Municipal Council, that it lies within the limits of the Octroi. On the other hand, such buildings must perforce be temporary, whilst one great object of the Exhibition is to be permanent, and to serve as a monument reared to labour, and to serve as a link between the present and the past. All the propositions for an Exhibition in the city are open to the same objection; and not the least fault would be that for some years the Parisian population, so ill-provided with breathing space and gardens, would be deprived of one such area which it could ill afford. Paris is stifling within its girdle of fortification, and under its lofty tenement houses. For this reason at least it would be preferable to find a more distant site, for example at Courbevoie, where an admirable location exists, or in the Bois de Boulogne, which would readily lend its admirable framework of foliage to the most ambitious effects of architecture. One of the auxiliary advantages of such a selection would be to hasten the completion of a metro[illegible] railway in Paris, which would become an absolute necessity, to deal with the great increase in traffic. Not being absolutely indispensable, if the Exhibition is held on the Champs de Mars, or at the Tuileries, it is probable, that if either of these sites be selected, the work of the Metropolitan Railway will advance with the severe slowness that characterises most works executed under State influence. If, on the contrary, the railway were an indispensable factor in the success of the Centenary Exhibition, it would without doubt be finished within five years. These few remarks will serve as a commentary to the plan which we annex, and which is reproduced from the *Le Temps*.

A number of preliminary projects have been already [illegible]posed, a brief notice of which will add interest to [illegible]is plan, and should be placed on record. Three [illegible]hemes are suggested for occupying the site of the Tuileries. 1. That of M. Mourceau, which would include the Place du Carrousel, the Tuileries Gardens, and part of the Place de la Concorde, and utilise as an annexe the Palais de l'Industrie. 2. The project of MM. Oline and Bernard, utilising the Gardens of the Tuileries, the Palais l'Industrie, a part of the Quai d'Orsay, and of the Champs Elysées, the Esplanade of the Invalides, and the whole width of the Seine, covered over for the length of this esplanade. 3. The scheme of M. Carbon, which takes in the Tuileries Gardens, the Place de la Concorde and the Invalides. Three projects are offered for converting the Champ de Mars. 1. M. Fouquiau, which includes the Palais de l'Industrie, the Trocadero, the Champ de Mars, the Esplanade of the Invalides, and the Quai d'Orsay. 2. M. Pasquier, who on behalf of a land company would offer for a permanent National Palace the area situated between the Champ de Mars, the Quai de Grenelle, the Boulevard de Grenelle, and the Avenue la Motte-Piquet. 3. M. S. Ferraud, who proposes to cover over the Seine from the Place de la Concorde to the Trocadero, and to include the Palais de l'Industrie, the Esplanade des Invalides, the Trocadero, and the Champs de Mars. The Bois de Boulogne, which offers exceptional advantages for the purpose, is proposed by five projectors. 1. By M. A. d'Aulnay, who takes a site by the fortifications between bastions 55 and 59, and having an area of about 600 acres. 2. By M. Dutrou who wishes to place the Exhibition between the racecourse and the lake. 3. By M. Jolibois, who would take 360 acres at Longchamps. 4. By M. Berger, for the fields at Bagatelle and the Ile de Puteaux on the Seine. 5. By M. Colibert, a scheme similar to the preceding one, less the Ile de Puteaux. Two projects are for Issy, one by MM. Naud and Co., and the second by M. de Saint-René; the site of these is indicated on the plan. The Municipal Council of Saint Cloud suggest the land facing the river between Saint Cloud and Suresnes, opposite the Bois de Boulogne. For Courbevoie there are two proposals: 1. By M. Devic; and 2. By MM. Maillart, Norbert, and Torbel. Both these refer to the great plateau of Courbevoie beyond the avenue of the Champs Elysées, and of the Grande-Armée. The buildings, it is suggested, would be permanent and be converted into a Paris Crystal Palace. MM. Drevet and Blondin, who propose Neuilly and Levallois-Perret, would appear to seek a permanent development of the French metropolis in the direction of the large and almost unoccupied lands in this district, and would wish that the Exhibition should be made a permanent monument. At Asnières, Gennevilliers, Ile St. Denis and Saint-Ouen, MM. Bernard and Joly propose to acquire about 250 acres in this favourite suburb, and, finally, M. Flamant advocates utilising the Parc Daumesnil, the Bois de Vincennes, and a part of the adjoining country. The foregoing indications are sufficient to show that the great Centenary Exhibition of 1889 is to be carried out on a scale of magnificence which will throw in the shade all its predecessors.

THE DARLING.—The locking of the Darling, so as to make the stream navigable all the year round, has been talked of for many years past, but it is only recently that the scheme has been put definitely before the South Australian public. The River Darling Navigation Company, which has been initiated at Wilcannia, is represented by Mr. T. W. Chambers, and that gentleman has made several statements to influential meetings of merchants and others in Adelaide. The advantages of the scheme are undoubted, although the cost, 310,000*l.*, seems heavy.

STEEL RAILS IN THE UNITED STATES.—The productive capacity of the steel rail mills of the United States is about 1,600,000 tons per annum. About 600,000 tons went into new lines last year, and the amount used as renewals, new second track, and siding, is estimated as 650,000 tons, or 5.42 per cent. of the total amount of rails in track. This rate is equivalent to a renewal of the lines once in 18.4 years. At the end of 1883, a little more than half the track of the United States was iron. The consumption of rails for maintenance ran down from 10.30 per cent. in 1872, when steel rails were first used, to 5.92 per cent. in 1877; then rose again to 11.16 per cent. in 1881, and receded again to 5.42 per cent. in 1883. The production of steel rails increased from 83,391 tons in 1872 to 1,304,393 tons in [illegible]

LUBRICATING OILS.

*Measurements of Friction of Lubricating Oils.**

By C. J. H. Woodbury, Boston, Mass.

At the meeting of this society held in November, 1880, the writer presented a paper under this same title, giving the comparative results of some measurements of friction upon a variety of lubricating oils, submitted to a somewhat narrow range of conditions. On this occasion it is proposed to treat the subject from a different, but perhaps equally practical, point of view, and limit the subject to the examination of a single lubricant under a wide range of investigation.

In the course of some work on this subject for the Factory Mutual Insurance Companies, it became a matter of importance to know the coefficient of friction of a lubricant at a series of temperatures and pressures. These measurements were made upon another machine designed by the writer, similar in principle, but differing from the one used in the previous experiments in its general construction. The earlier machine was made for the specific purpose of testing spindle oils, and fulfilled conditions of high speeds and light pressures in a satisfactory manner, but was unsuited for work with heavy pressures upon the standard bearing where the friction was measured. A standard brand of mineral oil, free from admixture of any animal oil, was selected for these experiments, because previous experience had shown that it was more uniform than any other lubricating oil, and duplicate samples could be obtained when desired. A test of this oil showed:

Flash	342 deg. Fahr.
Fire	410 ,,
Evaporation by exposure to 140 deg. Fahr. for twelve hours	.02
Specific gravity	.888

The operation of the machine is based on the principle of measuring the friction between two annular discs, and the whole designed for the purpose of observing this with precision.

The machine, shown in perspective in Fig. 1 and in elevations in Figs. 2 and 3, consists of a cast-iron frame in the form of an arch, with a brace at the rear, and further stiffened with transverse webs arranged to present the utmost rigidity against the stresses liable to be applied to the machine.

The lower disc is secured upon the top of an upright shaft, its top being an annulus, ground to a true plane surface. Upon this rests the upper disc which is in the form of a hollow ring based upon a flat plate, and is made of very hard composition, cast in one piece. The bottom of this disc is scraped to a true plane surface, so that the contact between these two discs is uniform.

A partition divides the interior of the hollow ring forming the upper disc, so that water can be introduced through the connecting tubes to control the temperature of the discs, and in some instances it is desired to use the water as a medium to retain the heat of friction. The sides and top of the upper disc are surrounded by a case made of hard rubber, and the space filled with sider-down.

In experimenting, ice water is generally used to reduce the temperature of the discs to nearly the freezing point of water, and then the friction is noted at each degree of the rise in temperature due to the heat of friction.

A tube of thin copper, closed at the bottom, reaches through to the bottom of the disc, and a thermometer with its bulb placed within this tube indicates the temperature of the frictional surface. A tube leading through the upper disc conducts the lubricant under trial to the recess in the middle of the lower disc. The upper end of this tube, being of glass, indicates the supply and rate of feeding of the oil. As the friction of a journal depends quite largely upon the method of lubrication, uniformity in the manner of supply is of the utmost importance.

Over the upper disc, a yoke with four arms rests upon four columns which extend through the upper disc to the middle of the frictional surfaces; these columns being cast as a portion of the disc. In the centre of this yoke is a hole with hemispherical bottom. The lower end of the upper spindle is round, and fitting into this hole makes a ball and socket joint. This construction transmits the stress due to the weight applied upon the spindle to four points in the middle line of the frictional surfaces, and the strains due to excessive loads will not distort the discs so as to interfere with the uniformity of the thickness of the film of oil between the surfaces; while the ball and socket joint allows the surfaces to meet without any cramp or binding due to imperfection or wear which would prevent the surfaces from revolving in a true plane.

The axes of the upper and lower spindle do not coincide, but are on parallel lines about one-eighth of an inch from each other. This prevents the surfaces from wearing in rings, because the same points are not continuously brought in contact with each other.

A slight countersink in the top of the upper spindle receives the centre point in the middle of a beam which sustains the weighted platform beneath the table. The weight pressing the discs together is thus exerted along the axis of the upper spindle.

It has been found that it is essential to obtain the pressure by the direct application of weight, for any plan of using weighted levers or springs upon a disc requires the use of an additional point of support whose friction introduces an error which cannot be measured.

The upper disc with its load must be free to turn slightly in the easiest possible manner with slight changes in the friction. The use of knife edges to support the upper spindle was out of the question, because it must be sustained in all directions.

Instead of holding it in ordinary journals, the friction of motion was substituted for the friction of repose, by placing two pulleys whose arbors were long sleeves, at the two points of support, and running the spindle through the middle of these pulleys. The torsional effect due to the friction of the pulleys against the spindle was nullified by revolving them in reverse directions, so that the friction of motion due to one thousand revolutions per minute was substituted for the greater friction of repose. The friction of the two pulleys is so nearly in equilibrium that the spindle could be sustained on a smooth surface, without the friction of one pulley exceeding the other enough to turn the upper spindle; that is, the frictional couples at the supports neutralised each other.

At the left of the machine, a counter records the number of revolutions made during any given time. A lever at the top controls a small friction clutch in order to stop or start the counter at any time during an experiment.

Under certain conditions, the friction varies so rapidly that the dynamometer measuring it must be instantaneous and automatic in its action.

The dynamometer shown on the right hand of the machine consists of a mechaniam of segments and pinions for multiplying the deflection of a steel bar, and indicating the stress necessary to produce such deflection, by the position of the hand on the dial. An arm, which ends in the arc of a circle, projects from the lower surface of the upper disc, and is connected to the dynamometer with a flexible brass tape. When the machine is in operation, the lower disc is revolved, and tends to carry the upper disc around with it, by a force equal to the friction due to the lubricant between the discs.

The frictional resistance is obtained from the dynamometer by the principle of couples of equal moments. The reading on the dynamometer indicates the force of a couple whose arm is the length of the lever projecting from the upper disc, and this couple is opposed by a couple of equal moment, of which the dimensions of the frictional surface form the data for computing the arm, and the frictional resistance of the lubricant is the unknown quantity.

When the friction is too great for the dynamometer a pair of compound levers reduces the stress upon the steel bar in the dynamometer to one-fifth that of the whole pull of the frictional component, so that the capacity of the dynamometer is five times the amount marked upon the dial. The resistances at higher pressures are so much less than was anticipated that it has not been necessary thus far to use these reducing levers.

The coefficient of friction is deduced from the data of observation in the following manner:

Let

P = Weight on disc, pounds.
R = Outer radius of frictional contact, feet.
r = Inner ,, ,, ,,
ρ = Radius of any infinitesimal ring or band of the frictional surface, feet.
N = Number of revolutions per minute.
W = Reading on dynamometer, pounds.
l = Length of arm on upper disc, feet.
ϕ = Coefficient of friction.

Suppose that the annular surfaces of the disc be divided into an infinite number of elementary areas by equidistant circles and radial lines, then will

$$\text{Width of band} = d\rho \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$\text{Angle between two successive radial lines} = d\theta \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\text{Length of arc between two radii} = \rho\, d\theta \quad . \quad . \quad . \quad . \quad . \quad (3)$$

$$\text{Elementary area} = \rho\, d\rho\, d\theta \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$\text{Area of annulus} = \pi (R^2 - r^2) \quad . \quad . \quad . \quad . \quad (5)$$

$$\text{Pressure per unit of area} = \frac{P}{\pi (R^2 - r^2)} \quad . \quad . \quad . \quad . \quad (6)$$

$$\text{Pressure on elementary area} = \frac{P\, \rho\, d\rho\, d\theta}{\pi (R^2 - r^2)} \quad . \quad . \quad . \quad . \quad (7)$$

$$\text{Friction on elementary area} = \frac{\phi P\, \rho\, d\rho\, d\theta}{\pi (R^2 - r^2)} \quad . \quad . \quad . \quad . \quad (8)$$

$$\text{Moment of friction on elementary area} = \frac{\phi P\, \rho^2\, d\rho\, d\theta}{\pi (R^2 - r^2)} \quad . \quad . \quad . \quad (9)$$

$$\text{Moment of friction on entire disc} = \frac{\phi P}{\pi (R^2 - r^2)} \int_r^R \int_0^{2\pi} \rho^2\, d\rho\, d\theta \quad (10)$$

$$\text{Integrating} = \frac{2\pi\, \phi P}{\pi (R^2 - r^2)} \left\{ \frac{\rho^3}{3} \right\}_r^R \quad . \quad (11)$$

$$\text{Substituting the limits} = \frac{2\, \phi P (R^3 - r^3)}{3 (R^2 - r^2)} \quad . \quad . \quad (12)$$

$$\text{Work of friction per minute} = \frac{4\, \phi\, \pi\, P N (R^3 - r^3)}{3 (R^2 - r^2)} \quad . \quad (13)$$

$$\text{Resistance of the dynamometer} = 2\pi\, l\, W N \quad . \quad . \quad . \quad (14)$$

The friction equals the resistance, hence

$$\frac{4\, \phi\, \pi\, P N (R^3 - r^3)}{2 (R^2 - r^2)} = 2\pi\, l\, W N \quad . \quad . \quad . \quad (15)$$

$$\phi = \frac{3\, W\, l\, (R^2 - r^2)}{(2\pi (R^3 - r^3)} \quad . \quad . \quad . \quad (16)$$

This is not in a form convenient for continual use, and is susceptible of much simplification, if the proper dimensions are used for the various parts in connection with the frictional surfaces, and the dynamometer arm. It is also important for the sake of simplicity that the length of the line of mean area of the disc be 1 ft., so that the number of revolutions per minute is equivalent to the frictional velocity in feet per minute. For convenience, it was desirable that the area of the discs be 10 square inches.

If c = radius of circle whose circumference is 12 in., then

$$2\pi c = 12 \quad . \quad . \quad . \quad . \quad (17)$$

$$c = \frac{12}{2\pi} = 1.909 \text{ in.} \quad . \quad . \quad . \quad (18)$$

Area within this circumference,

$$\pi c^2 = 11.46 \text{ square inches} \quad . \quad . \quad (19)$$

If this circumference divide the annulus of 10 square inches area into two equal parts, then the outer rim of the annulus will circumscribe an area of 11.46 + 5 = 16.46 square inches. The radii corresponding to these circles are

$$R = \sqrt{\frac{A}{\pi}} = 2.289 \text{ in.} = .1907 \text{ ft.} \quad . \quad (20)$$

$$r = \sqrt{\frac{a}{\pi}} = 1.434 \text{ in.} = .1195 \text{ ft.} \quad . \quad (21)$$

$$R^2 - r^2 = .0221 \text{ ft.}\ ;\ R^2 - r^2 = .00523 \text{ ft.} \quad . \quad (22)$$

Substituting these values in equation (16)

$$\phi = \frac{6.286\, W\, l}{P} \quad . \quad . \quad . \quad (23)$$

This equation can be made still more simple if the length of the arm l is of such length that

$$\phi = \frac{2\, W}{P} \quad . \quad . \quad . \quad . \quad (24)$$

Substituting this value of ϕ in equation (23), we have

$$l = .3156 \text{ ft.} = .3787 \text{ in.}$$

Generally the weight on the discs is referred to in pounds to the square inch, then

$$\phi = \frac{W}{5\, p} \quad . \quad . \quad . \quad . \quad (25)$$

If the reducing levers which have been referred to are used, the reading on the dynamometer is one-fifth of the pull on the arm, and when the machine is used with this attachment

$$\phi = \frac{W}{p} \quad . \quad . \quad . \quad . \quad (26)$$

The blank used in taking notes of the observations made upon the work with the machine is shown in Table III.

After the temperature of the discs has been reduced by a current of ice water, the circulation of the water is stopped, the machine started, and the reading of the dynamometer noted at each degree of temperature.

As the machine is generally used without the compound levers, the column of coefficient of friction is obtained by dividing the dynamometer reading by five times the pressure in pounds per square inch.

Table I. contains the record of the dynamometer readings, and shows the resistance of friction of a paraffin oil tested in the machine, at a series of pressures of 1 lb. to 40 lb. per square inch, and temperatures from 40 deg. to 100 deg. Fahr. Readings were noted at each degree, but a tabulation of the friction at every fifth degree answers all required purposes.

The results are clearer expressed by the diagram, which shows in a graphical manner the relations of these measurements to each other within the limits of the data (Fig. 4).

As the temperature rises, the increasing fluidity of the oil diminishes the friction within the limits of free lubrication.

It is also seen that the resistance does not increase proportionately with the pressure, nor at a uniform rate. The lubricant, while separating the surfaces of a journal, and protecting them from injury, also introduces the resistance of its own cohesion; and at small pressures the film of oil is thicker and the resistance due to viscosity of the oil exceeds that at high pressures, when a smaller amount of oil lies between the surfaces.

A film of the lubricant adheres to each of the frictional surfaces, and that portion which lies between these two films is pulled in one direction upon one side, and in the other direction upon the other side, and as a resultant, the movement of this centre layer is a rolling motion, whose rate of progression varies with the difference between the adhesion of oil between the two frictional surfaces.

Nearly five years ago I stated,* as a result of some early work on this subject, that "friction exists at the surface of the two discs between the film of oil acting as a washer and the particles of oil partially imbedded within the pores of the metal," and the result of all subsequent investigation has tended to confirm this view of the subject.

Table II. shows the coefficient of friction as computed from the first table of resistances by the formula previously given.

$$\phi = \frac{W}{5\, p}$$

ϕ = coefficient of friction.
W = resistance of friction as shown by dynamometer, in pounds.
p = pressure upon frictional surfaces in pounds per square inch.

It does not seem feasible to deduce a formula which will meet the limitations of this table; and if such an equation were given, it could serve no practical use either in practice or theory, because it would be bound to these specific results, and unsuited for application elsewhere; but from these results one can observe certain generalities capable of wide application.

It will be observed that, in a general way, the co-

* Paper read before the American Association of Mechanical Engineers.

* Transactions New England Cotton Manufacturers' Association, Fifteenth Annual Meeting, p. 61.

THE MEASUREMENT OF FRICTION OF LUBRICATING OILS.

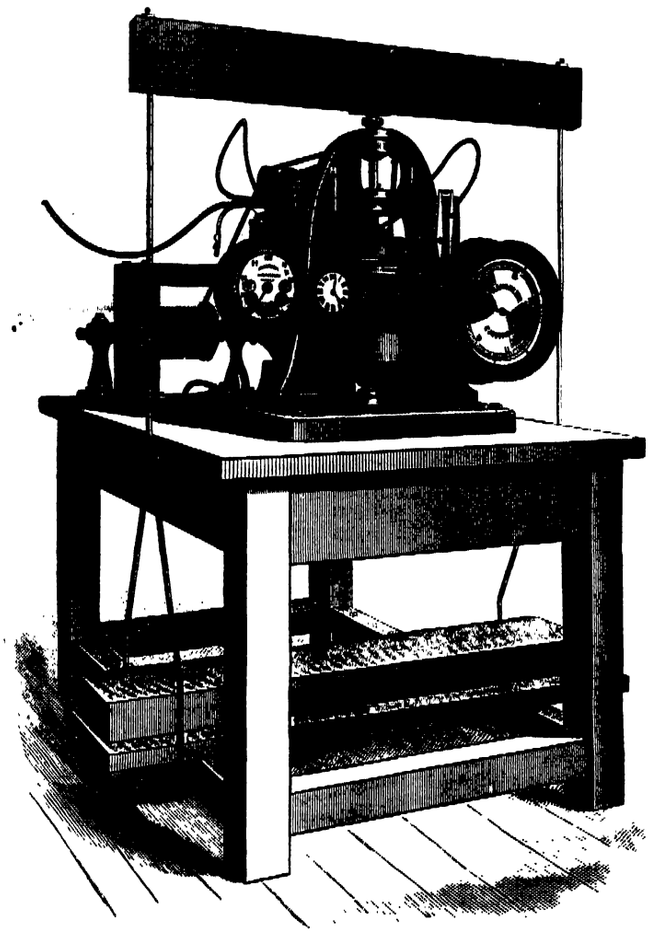
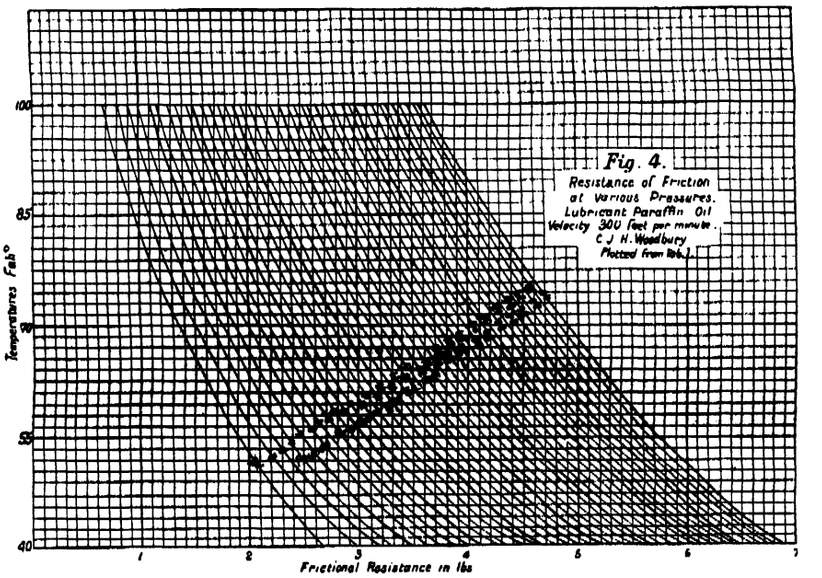
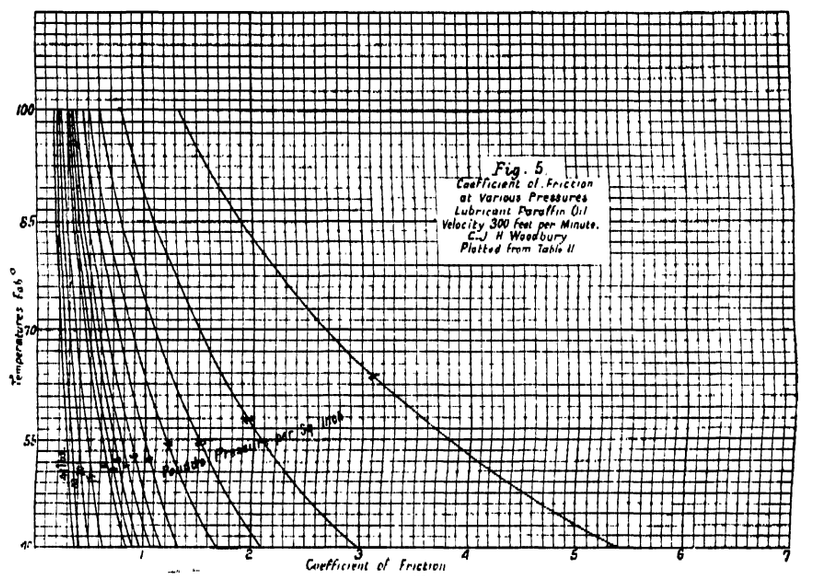


FIG. 1.





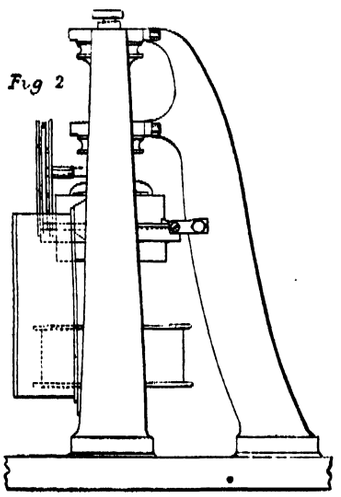


Fig. 2

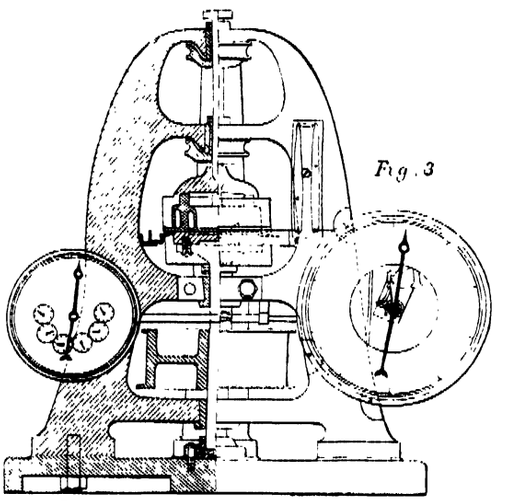
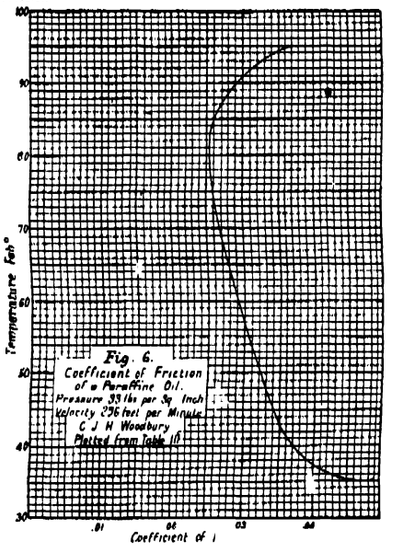


Fig. 3



efficient of friction diminishes inversely with the pressure, and directly with the fluidity of the oil, as indicated by the temperature; and that the rate of these differences diminishes with the increase of pressure. The reason for this is that the resistance due to the viscosity of oil is greater at low than at high temperature, and that with heavier pressures the film of oil is actually thinner, besides being relatively smaller in proportion to the pressure.

On this account, the frictional difference between lubricants is much less at high than at low pressure during continuous lubrication, although the differences in regard to endurance are more widely marked at high pressure.

It is almost universally asserted to be a general principle that the coefficient of friction is independent of the pressure, regardless alike of the actual facts in the matter, and of the limitations of Morin's Experiments,* which form the common source of authority on the subject.

The coefficient of friction between any two solids is accepted to be a constant ratio; but when a lubricating medium is interposed, then the frictional relation between these three substances becomes variable, according to the effect of temperature, pressure, and velocity upon the lubricant, and the problem bears certain analogies to those of hydrodynamics relative to the efflux of a fluid through a narrow orifice. When the pressures are great, these variables form such a small ratio to the whole frictional resistance that they escape observation unless the measurements of friction are taken in an accurate manner.

If the lubricant is not used, the variables disappear altogether, and then the coefficient of friction becomes

* Nouvelles Expériences sur le Frottement, Faites à Metzen, 1831. Par Arthur Morin, Capitaine d'Artillerie. 128 pp., 4to. Plates.
Second Mémoire. 1832. 103 pp., 4to. Plates.
Troisième Mémoire. 1833. 142 pp., 4to. Plates.

TABLE I.—Resistance of Friction of a Paraffin Oil at a Velocity of 300 ft. per Minute.

Pressure in Pounds per Square Inch.	Temperatures.												
	deg. 40	deg. 45	deg. 50	deg. 55	deg. 60	deg. 65	deg. 70	deg. 75	deg. 80	deg. 85	deg. 90	deg. 95	deg. 100
	Resistance of Friction.												
1	2.60	2.30	2.13	1.91	1.70	1.51	1.34	1.19	1.06	.95	.85	.75	.69
2	2.99	2.61	2 32	2.08	1 86	1.66	1.50	1.34	1.21	1.09	.99	.89	.80
3	3.16	2.78	2.49	2.23	2.00	1.80	1.62	1.47	1.32	1.20	1.10	.99	.90
4	3.34	2 93	2.62	2.35	2.12	1.92	1.74	1.59	1.45	1.33	1.21	1.10	.99
5	3.50	3.08	2.76	2.49	2.25	2.04	1.85	1.69	1.55	1.43	1.30	1.19	1.09
6	3.65	3 20	2.88	2.61	2.36	2.15	1.96	1.79	1.65	1.51	1.39	1.28	1.17
7	3.79	3.32	3.00	2.71	2.47	2.25	2.06	1.89	1.74	1.61	1.48	1.36	1.26
8	3.91	3.43	3.10	2.82	2.57	2.34	2.16	1.99	1.83	1.69	1.56	1.45	1.34
9	4.05	3.56	3.22	2.93	2.67	2.45	2.25	2.07	1.92	1.78	1.65	1.53	1.42
10	4.18	3.66	3.33	3.03	2.77	2.54	2.34	2.17	2.01	1.86	1.74	1.62	1.51
11	4.30	3.79	3.43	3.14	2.88	2.65	2.45	2.26	2.11	1.96	1.83	1.70	1.59
12	4.41	3.89	3.55	3.25	2.99	2.75	2.54	2.36	2.19	2.04	1.91	1.78	1.66
13	4.52	4.00	3.65	3.35	3.08	2.84	2.63	2.44	2.27	2.13	1.99	1.85	1.73
14	4.64	4.10	3.75	3 44	3.16	2.93	2.72	2.53	2.36	2.22	2.07	1.94	1.81
15	4.75	4.21	3.85	3.55	3.26	3.02	2.80	2.61	2.44	2.29	2.15	2.01	1.88
16	4.85	4.32	3.95	3.64	3.36	3.12	2.90	2.70	2.53	2.36	2.23	2.09	1.95
17	4.95	4.42	4.00	3.75	3.46	3.21	3.00	2.79	2.62	2.46	2.31	2.17	2.04
18	5.08	4.54	4.16	3.84	3.56	3.30	3.08	2.89	2.71	2.54	2.40	2.25	2.12
19	5.18	4.63	4.26	3.93	3.65	3.40	3.18	2.98	2.80	2.64	2.49	2.33	2.21
20	5.28	4.73	4.35	4.03	3.75	3.49	3.27	3.07	2.89	2.73	2.57	2.41	2.27
21	5.36	4.84	4.46	4.13	3.83	3.59	3.36	3.16	2.98	2.82	2.65	2.49	2.35
22	5.46	4.94	4.56	4.23	3.94	3.68	3.45	3.25	3.07	2.90	2.73	2.57	2.42
23	5.55	5.05	4.65	4.32	4.03	3.76	3.54	3.33	3.15	2.97	2.81	2.64	2.49
24	5.65	5.13	4.74	4.41	4.10	3.84	3.62	3.42	3.23	3.05	2.89	2.72	2.56
25	5.75	5.22	4.83	4.50	4.19	3.93	3.70	3.49	3.31	3.13	2.95	2.79	2.63
26	5.83	5.31	4.92	4.58	4.26	4.01	3.78	3.57	3.38	3.21	3.03	2.86	2.71
27	5.93	5.41	5.01	4.67	4.35	4.09	3.86	3.65	3.46	3.29	3.11	2 94	2.78
28	6.03	5.50	5.10	4.75	4.45	4.18	3.95	3.73	3.54	3.36	3.18	3.02	2.85
29	6.10	5.59	5.19	4.84	4.54	4.26	4.02	3.81	3.62	3.44	3.26	3.09	2.92
30	6.19	5.67	5.28	4.92	4.61	4.33	4.10	3.88	3.69	3.51	3.34	3.15	2.99
31	6.26	5.75	5.35	5.01	4.69	4.41	4.16	3.95	3.76	3.58	3.40	3.23	3.05
32	6.35	5.83	5.43	5.09	4.77	4.49	4.24	4.04	3.84	3.65	3.46	3.29	3.12
33	6.43	5.91	5.52	5.16	4.85	4.57	4.33	4.11	3.91	3.72	3.54	3.35	3.18
34	6.50	6.00	5.60	5.25	4.93	4.65	4.41	4.19	3.99	3.80	3.61	3.43	3.24
35	6.58	6 06	5.69	5.32	5.01	4.73	4.48	4.26	4.05	3.86	3.68	3.50	3.32
36	6.65	6.15	5.75	5.40	5.09	4.81	4.57	4.34	4.13	3.93	3.75	3.56	3.38
37	6.73	6.22	5.83	5.49	5.17	4.88	4.64	4.41	4 21	4.01	3.82	3.63	3.45
38	6.80	6.31	5.92	5.57	5.25	4.97	4.72	4.49	4.29	4.09	3.89	3.70	3.52
39	6.88	6.39	6.00	5.65	5.34	5.04	4.79	4.56	4.35	4.15	3.95	3.76	3.57
40	6.97	6.46	6.06	5.73	5.41	5.12	4.86	4.63	4.42	4.21	4.02	3.82	3.62

TABLE II.—Coefficient of Friction of a Paraffin Oil at a Velocity of 300 ft. per Minute.

Pressure in Pounds per Square Inch.	Temperatures.												
	deg. 40	deg. 45	deg. 50	deg. 55	deg. 60	deg. 65	deg. 70	deg. 75	deg. 80	deg. 85	deg. 90	deg. 95	deg. 100
	Coefficients.												
1	.5880	.4760	.4260	.3820	.3400	.3020	.2680	.2380	.2120	.1900	.1700	.1500	.1380
2	.2990	.2610	.2320	.2080	.1860	.1660	.1500	.1340	.1210	.1090	.0990	.0890	.0800
3	.2107	.1853	.1660	.1487	.1333	.1200	.1080	.0980	.0880	.0800	.0733	.0675	.0600
4	.1670	.1466	.1310	.1175	.1060	.0960	.0870	.0795	.0725	.0665	.0605	.0550	.0495
5	.1400	.1232	.1104	.0996	.0900	.0816	.0740	.0676	.0620	.0592	.0520	.0476	.0436
6	.1217	.1067	.0960	.0870	.0787	.0717	.0653	.0597	.0550	.0503	.0463	.0427	.0390
7	.1080	.0940	.0847	.0774	.0706	.0643	.0588	.0540	.0497	.0460	.0423	.0390	.0360
8	.0978	.0858	.0775	.0705	.0642	.0585	.0540	.0498	.0458	.0423	.0390	.0359	.0335
9	.0900	.0791	.0715	.0651	.0593	.0544	.0500	.0460	.0427	.0395	.0367	.0340	.0316
10	.0836	.0732	.0660	.0606	.0554	.0508	.0468	.0434	.0402	.0372	.0348	.0324	.0302
11	.0782	.0687	.0624	.0571	.0524	.0482	.0445	.0411	.0384	.0356	.0330	.0311	.0289
12	.0735	.0648	.0592	.0542	.0498	.0458	.0423	.0390	.0365	.0340	.0315	.0297	.0277
13	.0695	.0615	.0561	.0515	.0474	.0437	.0405	.0375	.0349	.0328	.0306	.0285	.0266
14	.0663	.0586	.0533	.0491	.0451	.0419	.0389	.0361	.0337	.0317	.0296	.0283	.0259
15	.0633	.0561	.0513	.0475	.0435	.0403	.0375	.0349	.0325	.0305	.0280	.0268	.0257
16	.0608	.0540	.0494	.0455	.0420	.0390	.0363	.0338	.0316	.0295	.0278	.0261	.0244
17	.0582	.0520	.0477	.0441	.0407	.0378	.0353	.0328	.0308	.0289	.0272	.0255	.0240
18	.0564	.0504	.0462	.0426	.0396	.0364	.0342	.0321	.0301	.0282	.0264	.0250	.0235
19	.0545	.0487	.0448	.0414	.0384	.0358	.0335	.0314	.0295	.0278	.0262	.0245	.0233
20	.0528	.0473	.0435	.0403	.0375	.0349	.0327	.0307	.0289	.0273	.0257	.0241	.0227
21	.0510	.0460	.0424	.0394	.0364	.0342	.0320	.0302	.0284	.0268	.0252	.0238	.0224
22	.0496	.0450	.0414	.0384	.0358	.0334	.0314	.0296	.0280	.0264	.0248	.0234	.0220
23	.0483	.0439	.0404	.0374	.0350	.0327	.0308	.0290	.0274	.0258	.0244	.0230	.0216
24	.0471	.0436	.0396	.0868	.0342	.0320	.0302	.0285	.0269	.0254	.0241	.0226	.0213
25	.0460	.0418	.0386	.0360	.0336	.0314	.0296	.0279	.0265	.0250	.0236	.0223	.0210
26	.0448	.0408	.0378	.0352	.0328	.0308	.0290	.0274	.0260	.0246	.0233	.0221	.0208
27	.0439	.0400	.0370	.0346	.0322	.0302	.0286	.0270	.0256	.0243	.0230	.0218	.0206
28	.0430	.0392	.0364	.0340	.0318	.0298	.0282	.0266	.0252	.0240	.0228	.0216	.0204
29	.0421	.0386	.0358	.0334	.0313	.0294	.0277	.0263	.0250	.0237	.0225	.0213	.0201
30	.0413	.0378	.0352	.0328	.0307	.0289	.0273	.0259	.0246	.0234	.0222	.0210	.0199
31	.0404	.0371	.0347	.0323	.0304	.0284	.0268	.0255	.0243	.0231	.0219	.0208	.0197
32	.0397	.0364	.0339	.0318	.0298	.0281	.0265	.0252	.0240	.0228	.0216	.0205	.0195
33	.0390	.0358	.0335	.0313	.0294	.0277	.0262	.0249	.0237	.0226	.0214	.0203	.0193
34	.0382	.0353	.0330	.0309	.0290	.0274	.0260	.0246	.0234	.0224	.0213	.0202	.0191
35	.0376	.0347	.0326	.0304	.0286	.0270	.0256	.0243	.0231	.0220	.0210	.0200	.0190
36	.0370	.0342	.0320	.0300	.0283	.0267	.0254	.0244	.0230	.0219	.0208	.0198	.0188
37	.0364	.0336	.0315	.0297	.0279	.0264	.0251	.0239	.0228	.0217	.0206	.0196	.0186
38	.0358	.0332	.0312	.0293	.0276	.0262	.0248	.0235	.0226	.0215	.0205	.0195	.0185
39	.0353	.0328	.0308	.0290	.0274	.0258	.0246	.0234	.0223	.0213	.0203	.0193	.0183
40	.0340	.0323	.0303	.0289	.0271	.0256	.0243	.0232	.0221	.0211	.0201	.0191	.0181

reduced to a constant ratio. This latter class of friction is rarely considered, except for the friction of repose, in matters pertaining to the stability of structures; while the problems of mediate friction enter into the operation of the moving parts of every machine.

This is not the place to enter into a criticism of the work of Morin, but it should be observed that his investigations were devoted to measurements of a sled upon tracts in the interests of the Ordnance Corps; and although he made some experiments upon friction of oiled bearings, they were not subjected to the frictional conditions of lubricated journals under conditions analogous to those in machines.

In a letter* written March 15, 1879, Gen. A. Morin said [Translation], "The results furnished by my experiments as to the relations between pressure, surface, and speed, on the one hand, and sliding friction on the other, have always been regarded by myself, not as mathematical laws, but as close approximations to the truth within the limits of the data of the experiments themselves."

Considerations of safety have fixed the minimum limit of the flashing point of a lubricating oil at 300 deg. Fahr., with a proportion of volatile matter not exceeding five per cent. thrown off by exposure to 140 deg. Fahr. for twelve consecutive hours. With the saving clause of proper limits of pressure, a fluid oil offers less frictional resistance than a viscous one.

Although the data in Table II. show that the coefficient of friction diminishes with the increase of fluidity, it does not warrant any extreme position in respect to the use of thin oils, except for light pressures, because, under all circumstances, the film of oil must be thick enough to keep the surfaces of a journal from actual metallic contact. In the severe work of heavy pressure a viscous oil must be used in order to retain its place upon the bearing surfaces in sufficient thickness to protect the inequalities upon the journal from colliding. In some places, it has been found that the use of an extremely thin oil resulted in a diminution of the friction of the machines at the expense of more rapid wear of the journals. Such results are not apt to occur upon journals of light pressure, such as spindles, where a thin oil is used with good judgment.

Table III.—*Boston Manufacturers' Mutual Fire Insurance Company, March* 12, 1883.

Frictional Tests of No. 58 Unknown Mineral Oil.

Temp. Disc.	Ending	95	Duration of experiment .. ..
" "	Beginning ..	35	Counter .. { Ending .. 910,382
Temp. Room	Ending	60	{ Beginning 904,102
	Beginning ..	62	Total revolutions 6220
Time	Ending	10.31	Rev. per minute {
	Beginning ..	10.10	Feet " " " 296

Pressure on Frictional Surfaces 33 lb. per Square Inch.

Temperature.	Dynamometer.	Coefficient of Friction.	Temperature.	Dynamometer.	Coefficient of Friction.	Temperature.	Dynamometer.	Coefficient of Friction.
35	8.00	.0485	64	4.80		93	3.45	
36	7.00		65	4.75	.0288	94	5.80	
37	6.65		66	4.70		95	6 10	.0370
38	6.45		67	4.66				
39	6.30		68	4.60				
40	6.12	.0371	69	4.57				
41	6.02		70	4.54	.0275			
42	5 90		71	4.50				
43	5.82		72	4.45				
44	5.75		73	4.42				
45	5.68	.0344	74	4.39				
46	5.61		75	4.37	.0265			
47	5.55		76	4.35				
48	5.49		77	4.33				
49	5.42		78	4.31				
50	5.36	.0325	79	4.29				
51	5.32		80	4.27	.0260			
52	5.28		81	4.27				
53	5.22		82	4.25				
54	5.17		83	4.25				
55	5.12	.0310	84	4.28				
56	5.09		85	4.31	.0261			
57	5.06		86	4.41				
58	5.03		87	4.51				
59	4.99		88	4.62				
60	4.95	.0300	89	4.75				
61	4.91		90	4.90	.0297			
62	4.88		91	5.05				
63	4.84		92	5.22				

Table III. shows the record of a test of a very limpid mineral oil which reached, in the frictional machine, its limit of lubrication at 82 deg. Fahrenheit under a pressure of 33 lb. to the square inch; beyond that point, the oil became so fluid that the pressure reduced the thickness of the sheet of oil, until portions of the surfaces met in actual contact.

At lower temperatures the greater resistance shows a large coefficient of friction on account of the viscosity of the oil, while the rise in friction at higher temperatures, as shown in the upper part of the curve, indicates a resistance produced by the collision of portions of the discs, and the diagram illustrates a graphical representation of the beginning of a hot bearing.

These results have been submitted in the hope of presenting facts which will add somewhat to the means for a fuller treatment of the problem of lubrication. The several economies pertaining to lubrication operate at the expense of each other. An economy of oil may represent an extravagance in motive power; a liberal allowance of limpid oil may save motive power at the expense of the repair account, and above all the final result must show the greatest amount of lubrication for a dollar. Lubricants are wasted, not worn out by attrition, and it is of more importance to know how to use oil, than what oil to use. The problem of lubrication seeks to know what combination of oil casks, coal pile, and wear and tear will represent the fewest dollars; and in its broad sense it cannot be solved on any experimental basis, nor settled by a final dictum from any one source, but it will reach its solution through the practical experience of intelligent observation, aided by the resources of technical science.

Steel Rails in Germany.—Krupp, of Essen, has just taken a contract for 1400 tons of steel rails at Erfurt. The contract price was 6*l.* 18s. per ton.

Antwerp International Exhibition, 1885.—The Lords of the Committee of Council on Education have received information through Her Majesty's Principal Secretary of State for Foreign Affairs, that Her Majesty's Consul at Antwerp has been appointed British Commissioner for the International Exhibition, which is to be held at Antwerp next year, and that Mr. P. L. Simmonds has been appointed by the Executive Council of the Exhibition at Antwerp their agent-general for Great Britain and Ireland. The Exhibition in question is a national undertaking under the immediate patronage of His Majesty the King of the Belgians, and of the Belgian Government. The President of the Exhibition is H.R.H. the Count of Flanders and the Vice-President the Minister of Agriculture, Industry, and Commerce. The office of the agent-general is at 35, Queen Victoria-street, and communications from intending exhibitors should be addressed to him there.

* Transactions Institution Mechanical Engineers of Great Britain. 1883. p. 666.

"ENGINEERING" ILLUSTRATED PATENT RECORD.

COMPILED BY W. LLOYD WISE.

SELECTED ABSTRACTS OF RECENT SPECIFICATIONS PUBLISHED UNDER THE ACT OF 1883.

The number of views given in the Specification Drawings is stated in each case after the price; where none are mentioned, the Specification is not illustrated.

Where Inventions are communicated from abroad, the Names, &c., of the Communicators are given in italics.

Copies of Specifications may be obtained at 88, Cursitor-street, Chancery-Lane, E.C., either personally, or by letter, enclosing amount of price and postage, addressed to H. READER LACK, Esq.

The date of the advertisement of the acceptance of a complete specification is, in each case, given after the abstract, unless the Patent has been sealed, when the date of sealing is given.

Any person may at any time within two months from the date of the advertisement of the acceptance of a complete specification, give notice at the Patent Office of opposition to the grant of a Patent on any of the grounds mentioned in the Act.

DYNAMO-ELECTRIC MACHINES.

572. C. F. Cooper, Kingston-on-Thames. Armatures of Dynamo Machines. [6*d.* 6 *Figs.*] January [illegible] 1884.—The armature core consists of a soft iron cylinder built up from a series of rings or sections of rings and supported and connected with the axis at its ends only by non-magnetic metallic frames, to which the rings are secured by bolts passing longitudinally of the armature. (*Accepted October* 17, 1884).

SECONDARY ELECTRIC GENERATOR.

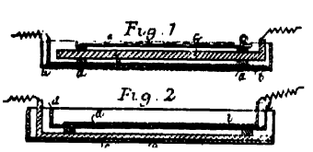
1157. J. Swinburne, London. Induction Coil. [2*d.*] January 10, 1884.—The usual iron core is dispensed with, the coil being made of, say, ten fine insulated conductors wound round one thick insulated conductor. An alternating current of high tension is led through the fine conductors in series and the thick conductor is connected to the translating devices. For direct currents a commutator driven by an electromotor in the circuit is employed for alternating the current which is effected at each length of wire so as to avoid sparking. The induced current is regulated by causing any variation to alter the speed of the motor. (*Accepted November* 7, 1884).

ELECTRO-MAGNETS.

13. W. Lemer, London. Electro-Magnets. [2*d.*] January 1, 1884.—The armatures of the electro-magnets are themselves permanent, or electro-magnets, and are alternately attracted and repelled according to the change of polarity in the electro-magnets caused by reversing alternately the direction of the electric current by means of a commutator, so that it will be impossible for the armatures to remain attracted when like poles are opposite to each other. (*Accepted October* 14, 1884).

PRIMARY ELECTRIC BATTERIES.

230. J. Enright, London. Galvanic Batteries, &c. [6*d.* 4 *Figs.*] January 2, 1884.—The electrolytic fluids are continuously removed at the rate at which they deteriorate, fresh and active fluids being supplied at the same rate. The zinc plate of the battery is embedded in mercury, and is perforated and corrugated and has its larger surface horizontal. Fig. 1 is a vertical section of a single-fluid battery cell with a flat plate *b* of zinc resting on the bottom of the cell *a*, and almost covered with mercury. The carbon plate *c* is separated from the zinc plate *b* by paraffined wood *d*. The elements are lifted out by means of bars *e*. The cells are arranged in a number of tiers one above another, and with several cells in each tier connected by short pipes. The end cell of each tier is somewhat wider than the others to receive a ball float governing an admission valve. Above the batteries is arranged a cistern containing a solid mixture of bichromate of potash and sulphuric acid, the cistern being supplied with water from a main by an ordinary ball-cock. The solution is drawn from



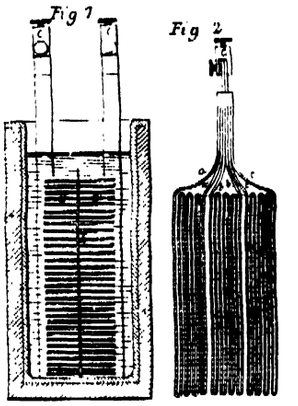
the bottom of the cistern into the upper tier of battery cells by a ball-cock. The outlet from the bottom tier is governed by a valv controlled by the armature of an electro-magnet, which, when the current is passing, is attracted and the valve opened. The main current is passed through a second electro-magnet in the circuit, which repels its polarised armature. As the current decreases, this armature returns towards its coil and completes a mercury contact, making the circuit to the first-named magnet. In another arrangement, a coil of high resistance in the circuit is caused by the heat developed by the passage of the current to expand air, and so give motion to a mercury column and open the circuit of the magnet. Fig. 2 shows a section of a two-fluid battery in which the carbon plate *c* rests on the bottom of the trough *a*. A porous trough *d* is separated from the carbon plate by strips of wood, and contains sufficient mercury to nearly cover the zinc plate *b*. The electrolytes are bichromate of potash or nitric acid, or a mixture of the two, and dilute sulphuric acid or sulphate of zinc or soda. (*Accepted October* 31, 1884).

718. W. P. Thompson, London. (*E. E. Senet, Paris.*) **Voltaic Batteries.** [4*d.*] January 5, 1884.—The batteries comprise an outer jar containing the acidulated water, and also a hollow cylinder of zinc within which is a porous pot containing a liquid exciter consisting of equal parts of a saturated solution of sulphate of iron and potash ("iron alum") and sulphuric acid, and four per cent of nitric acid. Crystals of soda or hydrochloric acid may also be added if desired. (*Sealed October* 17, 1884).

12,374. C. Baudet, Paris. Galvanic Batteries. [6*d.* 11 *Figs.*] September 18, 1884.—The electrodes are composed of plates of zinc and charcoal or platinum, or one side of a plate of zinc may be coated with platinum. These plates are superposed, and are separated by an india-rubber frame forming a tight joint inclosing a chamber between the plates containing the exciting liquid, each plate being pierced with one or more holes. The electrolyte is circulated upwards or downwards, the bottom or top being connected to a supply reservoir and the top or bottom to a waste reservoir. If two separate plates are employed for the electrodes, they are connected by a resin or cement mixed with metal filings or powdered charcoal. When required to clean the cells they are washed with a current of water. (*Accepted October* 14, 1884).

SECONDARY ELECTRIC BATTERY.

1709. E. P. Alexander, London. (*J. L. Moisy, Paris*). **Accumulators or Secondary Batteries.** [6*d.* 2 *Figs.*] January 18, 1881.—The electrodes of the battery are composed of band, strips, or ribbons of lead cut into the form of combs and doubled or folded transversely on themselves any desired number of times. Two electrodes placed with the points of the teeth



facing each other and separated by a perforated sheet of gutta-percha constitute an element. The illustrations show one element of a battery, the electrodes B B being placed with the points of the teeth facing, and each electrode being formed of three bands of lead *a b c* folded, and with their ends brought to a single terminal C; *x* is the perforated sheet of gutta-percha. (*Accepted September* 30, 1884).

ELECTRIC CONDUCTORS.

557. A. Millar, Crosshill, Renfrew, N.B. Insulated Wire for Coils of Electrical Apparatus. [2*d.*] January 3, 1884.—The ordinary round wires are replaced by insulated flat wires, which may be made from sheet metal or preferably from round wire flattened between rollers. The wires may be covered by any of the methods used in covering round wire by braiding or lapping threads or narrow ribbons of fibrous insulating material, or by the method of japanning described in Specification 4592 of 1881. (*Accepted October* 31, 1884).

[illegible]s. [4*d.* 7 *Figs.*] January 5, 1884.—The conductors are supported in pipes formed with one or more channels, one for each conductor. The conductors may be bare and supported by non-conductors at short distances apart. (*Accepted October* 31, 1884).

1158. H. G. Baker, London. Covering the Core of Submarine Telegraph Cables. [4*d.* 1 *Fig.*] January 10, 1884.—The cable is covered with a plaited covering of tarred hemp yarn which protects the core and prevents any possibility of it becoming twisted or kinked and breaking. This plating may be covered by one or more similar coverings. (*Sealed May* 13, 1884).

1453. A. T. Archer, Southampton. Protecting the Public from Broken and Falling Telegraph or Telephone Wires. [6*d.* 3 *Figs.*] January 15, 1884.—Ferrules of gutta-percha or other insulating material are fixed tightly or the conductors, and are connected together by straps, ties, or cords, so as to cause them to support each other in the event of one or more wires breaking. (*Sealed April* 22, 1884).

2754. T. J. Mortin, Woking, Surrey. Facilitating Communication and Electric Lighting in Railway Trains. [6*d.* 7 *Figs.*] January 3, 1884.—A longitudinal bar is suspended along both sides of the carriage by means of clamps carried by the axles. These bars are connected by means of cross-bars, to which, along the centre line of the carriages, is suspended one or more insulated conductors. At each end of the carriage the conductors pass through tubes carried by the crossbar, the ends of the conductors being forced to project beyond the ends of the tubes by springs, and having attached to them buttons, which are pressed against corresponding buttons of the adjoining carriage. (*Sealed October* 28, 1884).

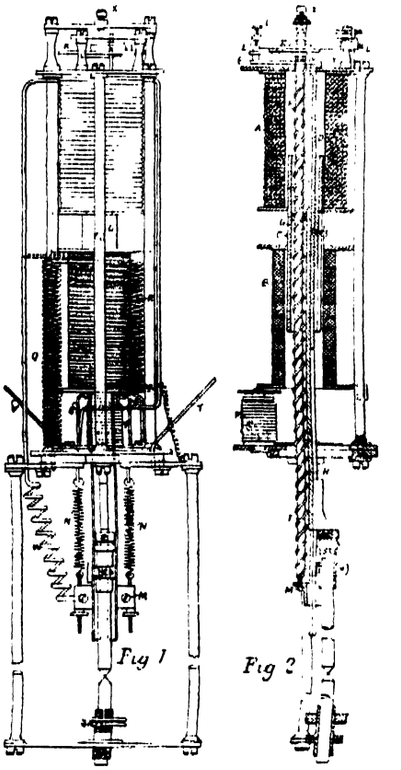
3159. W. R. Lake, London. (*W. W. Averell, Bath, N.Y., U.S.A.*) **Insulating and Protecting Electric Wires or Conductors.** [6*d.* 5 *Figs.*] February 12, 1884.—The conductors are insulated in concrete consisting of silicious material, asphaltum and petroleum residuum. A ditch is first dug, a foundation of hydraulic concrete laid in the bottom, and a layer of the insulating concrete is tamped and rammed whilst hot. The conductors are laid on the base so prepared and a second layer of concrete placed on them, and is rammed and tamped, and other conductors are placed upon the layer, and are insulated in like manner. (*Sealed May* 16, 1884).

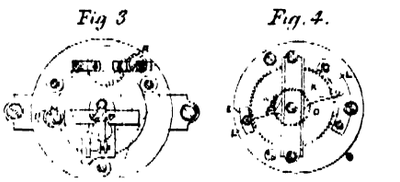
4346. W. R. Lake, London. (*T. S. Leigh, Philadelphia, U.S.A.*) **Insulating Materials or Compounds for Electrical Conductors.** [2*d.*] March 4, 1884.—One pound of common brown soap and one and a quarter pound of alum are each dissolved in two gallons of hot water and mixed together, the flocculent mass formed being dried and dissolved in benzine, turpentine, or gasoline. One pound of soap is employed to one gallon of the solvent and one gallon of boiled linseed oil and half a gallon of copal varnish added. White oxide of zinc or white lead may be employed to thicken the mixture. (*Sealed June* 10, 1884).

ELECTRIC ARC LAMPS.

898. J. Brockie, London. Arc Lamps. [6*d.* 3 *Figs.*] January 7, 1884.—A star wheel which revolves as the carbons approach one another is controlled by a regulating magnet wound in reverse directions in a shunt circuit across the arc, the detent engaging with the star wheel making electrical contact with the wheel where the winding begins in the reverse direction, so that one coil is short-circuited during the contact of any arm of the star wheel. When the detent is cleared of the wheel, the coil being in circuit tends to reverse the magnetism and so allow the armature to fall and stop the star wheel. A resistance coil may be arranged to be cut-out of the star wheel instead of the reverse coil, and may be arranged to cut off the lamp should the arc become abnormally long. In a modification an anchor escapement is employed, so that the star wheel can only escape one tooth at a time. In this arrangement the detent normally in contact with the star wheel is insulated, and the other detent is connected so as to cut the magnet coils out of circuit, leaving the resistance coil in circuit. In the first two cases, the main magnet may be arranged to be cut out instead of the reversing or resistance coils. A relay may be used to put in or close the circuit of any of the above arrangements, in which case the star wheel may be replaced by a simple disc having an insulated brake piece to which the connection is made. A sinuous band of platinum may be placed on the disc to distribute any sparking which may occur between the brake piece and disc. The wheel frame of the lamp is of iron, so that the magnet may attract the frame directly for separating the carbons. (*Accepted November* 7, 1884).

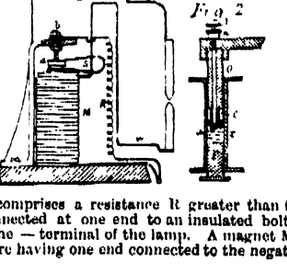
3901. F. Thornton and O. Romanse, London. Electric Arc Lamps. [6*d.* 6 *Figs.*] February 25, 1884.—The weight of the carbon and its holder tends, by means of a nut, to turn a quick-threaded screw having an escapement wheel on its axis and mounted in a movable frame, so that when raised the arc is struck. Referring to the illustrations, a hollow cylindrical core C is acted on in opposite directions by the main and shunt solenoids A and B, and carries a bar D. The bar D has projecting from its upper end an arm E forming a bearing for the upper end of a quick-threaded screw F, on which works a nut G fixed to a bar H sliding in dovetail guides in the bar D, and carrying the upper carbon-holder. The screw F is provided at its upper end with an escape wheel K controlled by the escapement lever L, which can be arrested by means of a stop L' on it and a stop E' on the bar E. The bottom end of the screw is carried by a crosshead M fixed across the lower end of the bar D, and suspended springs N N, which allow of the adjustment of the lamp. The wheel K is fixed to the screw by means of a pawl gearing with the teeth of a ratchet wheel on the screw, so that the screw can be rotated to raise the carbon-holder for insertion of a fresh carbon The automatic cut-out arrangement consists of a solenoid





whose core is pressed upwards by springs, and makes contact between two metallic strips S, which completes the lamp circuit through the resistance coils Q R. The travel of the bar D is limited by stops X Y. When the current is turned on to the lamp, the carbons being in contact, the greater part passes from the terminal T to the lower carbon, and by the top carbon and flexible conductor W to the coils A and P and to the terminal V. The current flowing through the coil P draws down its core, which breaks the connection between the contacts S, and so the cut-out circuit from the terminal T through the coils Q and R, and by contacts S to the terminal V. The current passing through the coil A attracts the core C upwards and separates the carbons. When the core drops it allows the escapement lever to vibrate and the screw to revolve, feeding the carbons together, when the core will again be raised. In a self-focussing lamp a cord connected to the upper carbon holder passes up over a pulley, thence down over a second pulley, and upwards to a fixed arm. The second pulley is fixed to a sliding bar carrying the bottom carbon-holder. (*Accepted October* 14, 1884),

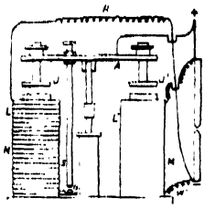
3443. C. Lever, Bowdon, Cheshire. Electric Arc Lamps. [6*d.* 5 *Figs.*] May 30, 1884.—This relates to arc lamps such as described in Specification 2092 of 1882. The cut-out



arrangement comprises a resistance R greater than that of the normal arc connected at one end to an insulated bolt *b*, and the other end to the — terminal of the lamp. A magnet M is wound with coarse wire having one end connected to the negative carbon,

and the other to the —terminal. A spring S carrying the armature *a* is secured to the core of the electro-magnet, and makes contact when not attracted with the bolt *b*. The current passes from the + terminal, through the magnet core, spring S, bolt *b*, and resistance R to the — terminal. A shunt magnet draws the carbons together against the resistance of a spring, and the current passes from the + terminal through the carbons, wire W, and shunt magnet M to the — terminal, causing the magnet to attract the armature *a*, and thus cut-out the circuit to be broken. The dash-pot made in the interior of the shunt solenoid, or constructed outside it, is shown in Fig. 2. The core O works as a plunger in the brass cylinder *c* forming the bobbin on which the coils are wound, and is formed at its lower end with an annular recess *e*, and a slot leading from the recess covered by a small flap or valve *d*, ——— position of which is regulated by the screw T, and regulates the area of the slot. The space between the end of the core, and an adjustable iron plug P serving to regulate the attraction of the solenoid, is filled with glycerine. The glycerine passes, when the coil O is lowered, through the slot into the space *e*. (*Sealed October* 28, 1884).

11,561. C. Lever, Bowdon, Cheshire. Electric Arc ——— [4*d*. 1 *Fig*.] May 30, 1884.—This relates to automatic out-outs for arc lamps regulated on the shunt principle as described in Specification 2092 of 1882. *Referring* to the illustration, the connections and construction of the apparatus are clearly shown. The action is as follows: On the current being turned on to the lamp it flows from the + terminal through the fine wire on the limb L¹ of the double magnet M, causing it to attract its armature A, and to bring the carbons into contact as described in the above-



mentioned specification. The main circuit is thus completed before the screws J J touch the poles of the electro-magnet. Should the arc become unduly lengthened, the screws J will touch the poles and the screw S will come in contact with the end of the coarse wire G. The whole of the current will then pass from the + terminal through the armature A, screw S, thick wire on the limb L of magnet M and resistance R to the — terminal. The resistance R is equal to the normal resistance of the arc. Should the carbons again come in contact, the resistance will be short-circuited, and the lamp will again come into action. (*Sealed November* 4, 1884).

ELECTRIC INCANDESCENCE LAMPS.

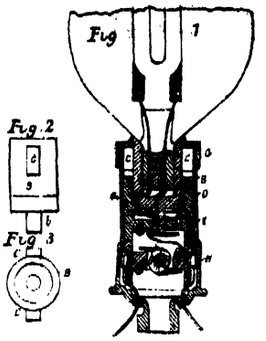
10. W. E. Debenham, London. Electric Lamps Emitting Light in a Vacuum. [2*d*.] January 1, 1884.—The globe is made of a glass which only melts at a very high temperature, and is exhausted whilst raised to as great a heat as the glass will bear without deformation; the glass at the place of insertion of the conducting wires being additionally heated to obtain closer union of the glass and metal. (*Accepted October* 17 1884).

234. J. H. Gardiner, London. Manufacture of Incandescence Lamps. [6*d*. 16 *Figs*.] January 1, 1884.—The thread to form the filament is wound whilst in a moist and flexible state upon a cylindrical block, made in two parts, to a spiral form, with two straight ends projecting in opposite directions, and is kept tightly distended by springs until it sets in the spiral form. The filament is carbonised in the usual way, and is if desired plated by igniting it in the presence of hydro-carbon vapour to adjust its resistance, its ends being held in clips supported upon a glass rod. The ends of the filament are passed into and cemented in sockets at the ends of the conductors, whose other ends are simply looped. The conductors are coated spirally with glass being clamped centrally in a screwed mandrel, which can be revolved and moved longitudinally, a spring piece bearing on the thread regulating the longitudinal movement. The platinum is heated by two blow-pipes, one on either side, and a thread of glass wound spirally upon it, so as to cover it evenly. The conductors are then clamped upon a holder at the required distance apart, and the filament inserted by being sprung into position under slight compression. The globe is blown from a small tube of glass, part of which is left projecting from opposite sides of the bulb, and a third tube is sealed into the globe at the side for exhaustion. The first two tubes are cut off, and the filament and conductors are inserted by being passed through one hole and turned round and round, until its further extremity passes through the other hole when the glass-covered conductors are sealed in the holes. The filament may be plated to greater length than required, the ends being cut off so as to insure good conductivity in the parts which enter the sockets. (*Accepted October* 7, 1884).

411. E. Barlow, Dalston, Middlesex. Holder for Electric Lamps. [2*d*.] January 2, 1884.—The holder is constructed in two sections. The lower section consists of a tube screwed at its lower end for attachment to a suitable bracket or support, and screwed or fitted at its upper end to receive the lower end of the upper section or a union ring. The leads pass through two holes in a disc of insulating material placed loosely in the upper portion of the tube. The upper section consists of a short tube fitted at its lower end so as to be fitted to or connected with the lower section, or to take the union ring, and contains a plug carrying hooks for taking into the loops of the lamp. These hooks terminate in stems, passing through the plug to its lower end, where they form contact plates, and make contact with the ends of the leads. The upper section may carry a spring crutch or support for holding the lamp with a suitable degree of tension against the hooks. (*Accepted October* 31, 1884).

806. T. Coad, London. Electric Safety Lamps. [6*d*. 4 *Figs*.] January 5, 1884.—The globe is surrounded by an outer casing containing water impregnated with carbonic acid gas under pressure for operating a flexible disc to which a contact piece is connected in such a manner that normally the circuit to the lamp is closed, but if the casing be broken, the pressure on the flexible disc will be removed and the circuit to the lamp broken. In order to prevent danger from sparking at the contact surfaces when the contact is made and broken, these surfaces are covered with india-rubber, which prevents any dangerous gas coming in contact with the sparks produced. The lamp and battery are combined in one case, the conductors from the battery to the lamp being entirely closed. A flanged disc and a flanged ring bearing respectively on the lower and upper sides of a flanged dome on the outer casing, and clamped together by bolts, prevent escape of the gas from the casing. (*Accepted November* 7, 1884).

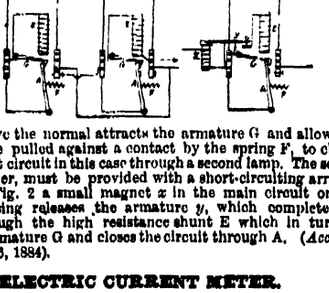
6877. H. Watt, London. (*E. Weston, Newark, N.J., U.S.A.*) **Incandescent Electric Lamps.** (6*d*. 16 *Figs*.) April 26, 1884.—The socket or holder of the lamp is provided with spring contacts so arranged as to correspond with and bear against the lamp terminals when the lamp is in place. Locking devices are employed to hold the lamp in place in its socket Referring to the illustrations, the neck of the globe is secured in an insulating cylindrical cup B having a coaxial projection *b* on its lower end. The terminals of the lamp are led out to a metal rim *a* on the cup B and to a plate secured to the end of the projection *b*. Ears or lugs C are formed on or secured to the base B. The holder consists of a shell D of sheet metal lined with insulating material, to which are secured spring contacts E making contact with the terminals on the cup B. The projection *a* passes easily outwards through the bottom of the insulated lining of the shell D, the terminals E being on opposite sides of the bottom. The ——— D has at its upper end an internal flange notched so as to ——— the passage of the lugs C, the lamp being locked by means of a cap



G having notches so that it can be passed to the position shown and secured to the shell D by screws, care being taken that notches in D and G when secured together do not correspond. A support H containing a device for making and breaking the circuit to the lamp may be secured to the shell D. If the cap G is dispensed with the lamp is prevented from turning by means of recesses in the flange of D into which the lugs C pass. The base B may have vertical and horizontal grooves, and the holder be provided with lugs which are passed up the vertical grooves and are then turned to enter the horizontal grooves so as to hold the lamp in position. Or spring catches on the shell D may enter a horizontal groove in the cup B. (*Sealed July* 25, 1884).

12,127. W. P. Thompson, London. (*O. A. Mowe, New York, U.S.A.*) **Incandescent Electric Lamps.** [6*d*. 17 *Figs*.] September 8, 1884.—The globe is constructed of a single piece of glass blown into a mould and with a smooth surface opposite the neck. The neck of the globe is narrowed and cut off, and the filament inserted within the globe, the conductors being suspended across the edge of the neck. The gas is then heated about the conductors, which by their own weight sink into the glass which closes above them. The portion of the neck cut off is then welded to the neck by means of a blow-pipe and a platinum stopper inserted, and the tube is drawn down to a smaller diameter to prevent the stopper from falling out. The air is then exhausted, and the glass is sealed around the stopper. Slight depressions are formed in the neck so as to afford points for the grasp of the holder. The filament is in the form of two incomplete circles having preferably slightly different diameters, and connected with each other by a curved continuation of the filament. The circles of different diameters serve, it is stated, to break up the vibrations caused by jarring into vibrations of smaller amplitude. The clamps formed at the ends of the conductors, each consist of an enlargement flattened into a disc doubled preferably in the axis of the wire, so that two lips are formed which receive the filament between them. The lips of the two clamps of a lamp are turned in towards each other, so as to make use of the resilience of the carbon loop in case of defective clamping. The ends of the filaments before being inserted between the lips are coated with metal by electrolysis, and the clamps crushed around and soldered to them. A bridge piece of glass unites the two conductors. The filaments are first shaped and carbonised, and subsequently subjected to heat in a bath of powdered carbon or hydro-carbon. The carbonising mould has grooves formed in its outer surface for the limbs of the filament and a tubular inclosing case. The holder consists of an outer shell surrounding the neck of the lamp having at one extremity two insulated contact plates connected with the lamp conductors. The contact plates form respectively a central plate and a ring surrounding the plate and bear against similar contact surfaces connected with the leads. (*Accepted October* 10, 1884).

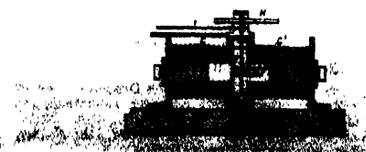
11,617. C. D. Abel, London. (*Siemens and Halske, Berlin*). **Apparatus for Short-Circuiting Incandescence Lamps arranged in Series.** [6*d*. 8 *Figs*.] August 25, 1884.—Each lamp is provided with a bye-pass or shunt circuit of high resistance through which a small portion of the current is always passing, and which on a slight increase of current effects the closing of a second shunt circuit of low resistance. Fig 1 shows a diagram of one arrangement. The shunt circuit constitutes a high resistance solenoid E which on any increase of



current above the normal attracts the armature G and allows the lever A to be pulled against a contact by the spring F, to close a second shunt circuit in this case through a second lamp. The second lamp, however, must be provided with a short-circuiting arrangement. In Fig. 2 a small magnet *x* in the main circuit on the current ceasing releases the armature *y*, which completes the circuit through the high resistance shunt E which in turn attracts the armature G and closes the circuit through A. (*Accepted September* 26, 1884).

ELECTRIC CURRENT METER.

10,366. R. E. Dunston, London. Electric Meters. [4*d*. 3 *Figs*.] July 19, 1884.—A soft iron armature fixed on a vertical spindle pivotted between two coils is deflected against the resistance of a spiral spring. An index finger on the spindles moves over a graduated scale and indicates the current passing at any instant. The coils may be arranged to measure the quantity or the electromotive force of the current. Referring to the illustration, the coils C are wound on a tubular casing D of rectangular section. Within each coil is a soft iron core, the end of which is so curved that its distance from the central spindle gradually increases from side to side. The spindle F has



fixed to it the armature G, one end of a volute spring H, and a light index I moving over a graduated scale. (*Accepted October* 3, 1884).

ING APPARATUS.

61. W. E. Langdon, Derby. Electric Block Signalling Instruments. [6*d*. 4 *Figs*.] January 1, 1884.—The signalling handle or commutator of block instruments is locked in the position line clear or line blocked, by means of a locking bolt, which can be pushed inwards or outwards by means of a thumb-piece. (*Accepted October* 7, 1884).

1369. T. R. Brailsford, London. Electric Signalling Apparatus. [6*d*. 3 *Figs*.] January 12, 1884.—An insulated conductor leads from each place to the signalling a——— and in each place there is the usual contact apparatus by which such conductor can be connected to one pole of a battery. The conductors at the signalling apparatus each terminate in a spring contact pressing upon a metal plate, surrounding a cylinder, and in the form of a right-angled triangle, so that the contact springs leave it successively. The circuit passes from the metal plate to an electro-magnet, an electric bell, and to the other pole of the battery. The cylinder tends to revolve by means of a weight, but is prevented by a ratchet operated by an electro-magnet. When the circuit from any place is completed, the ratchet is attracted and the cylinder revolves until the circuit is broken by the particular contact spring leaving the plate, and thus breaking the circuit. The drum is arranged to expose to view the required indication. (*Accepted October* 31, 1884).

11,715. W. R. Lake, London. (*The Equitable Electric Company, New York, U.S.A.*) **Electrical Signalling and Apparatus therefor, chiefly Designed for Use in Connection with Telephonic Systems.** [6*d*. 5 *Figs*.] August 27, 1884.—The object is to notify to a person calling up a distant station whether any one is there present to receive his message or to put him in communication with another station or subscriber, or when the station will be attended or ready to receive messages if the attendant be absent. There is arranged in close proximity to the call apparatus or bell an automatic responding instrument operated by means of a spring or other motor, and locked by the armature or the call apparatus when it is inoperative. The automatic responding instrument is constructed to pass to line currents induced from the action of an independent battery in certain predetermined impulses upon the call apparatus being actuated. (*Accepted September* 30, 1884).

TELEGRAPHIC APPARATUS.

4660. W. P. Thompson, London. (*H. Van Hoevenbergh, Elizabeth, N.J., U.S.A.*) **Printing Telegraphs.** [6*d*. 2 *Figs*.] February 28, 1884.—A double electro-magnet controls the movement of an escapement device, and two other electro-magnets are adapted respectively to actuate a press lever and to determine the position of a printing platen consisting of two single platens united at an angle with each other, and situated respectively in the planes of the two type wheels. According as the platen lever is attracted or not, the one or the other platen face will be presented to its corresponding type wheel, and if the press lever is then actuated, it will cause an impression to be taken from that type wheel. (*Sealed June* 6, 1884).

TELEPHONIC APPARATUS.

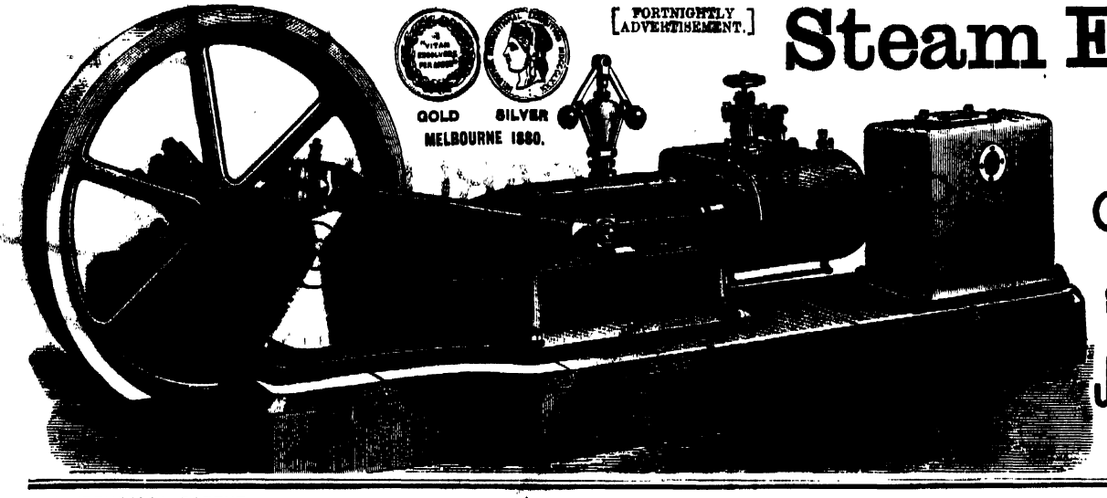
6996. A. M. Clark, London. (*D. G. Barnard, Winslow, N.J., U.S.A.*) **Telephonic Receivers.** [4*d*. 4 *Figs*.] April 29, 1884.—The object is to provide a double telephone receiver which may be readily applied to both ears simultaneously, and in which the diaphragm cells adapt themselves automatically to the ears and thus exclude extraneous sounds. The diaphragm cells are supported in a holder composed of two arms hinged together and pivotted to the cells and drawn towards each other by a bowspring attached to the free ends of the arms, and forming an electrical connection between the terminals of the two receiver bobbins. (*Sealed September* 9, 1884).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of Engineering, 35 and 36, Bedford-street, Strand.

Zinc in Modern Buildings.—The free use of zinc is a new feature in modern buildings and is well exemplified in the now nearly completed Hôtel Métropole at Northumberland Avenue. F. Braby and Co. (Limited), Euston-road, are carrying out an extensive contract in that metal, the exterior decoration of the two top stories of the immense pile of buildings, as well as the louvre or manzard roofs, being entirely in that material. The effect is very good; and the mode, in comparison, not expensive.

Death of Mr. I. Newton.—The death is announced of Mr. I. Newton, chief engineer of the Croton Water Department, New York. He committed suicide by cutting his throat. He had been suffering greatly from ill-health, aggravated by close attention to business, and his mental balance at last gave way. Mr. Newton in early life became associated with Ericsson, and aided him in the construction of the ironclad Monitor. He accompanied the Monitor to Hampton Roads as an officer, and he superintended the engine during the memorable fight with the Merrimac. He was also second assistant-inspector of vessels for the United States Government. During the war he had charge of the bureau of ironclads, and when he resigned from the Navy, Congress gave him a vote of thanks. In March, 1881, he was appointed chief engineer of the Croton Aqueduct in the Department of Public Works. He was a member of the American Society of Civil Engineers, the American Society of Mechanical Engineers, and other organisations.



[FORTNIGHTLY ADVERTISEMENT.]

GOLD SILVER MELBOURNE 1880.

Steam Engines

Fitted with

Expansion Valves

VARIED BY

GOVERNOR.

ALSO

STEAM HAMMERS.

JOHN COCHRANE,

Engineer,

BARRHEAD, N.B. 5319

BROTHERHOOD'S PATENT



FLEXIBLE COUPLING

PETER BROTHERHOOD,

MECHANICAL ENGINEER,

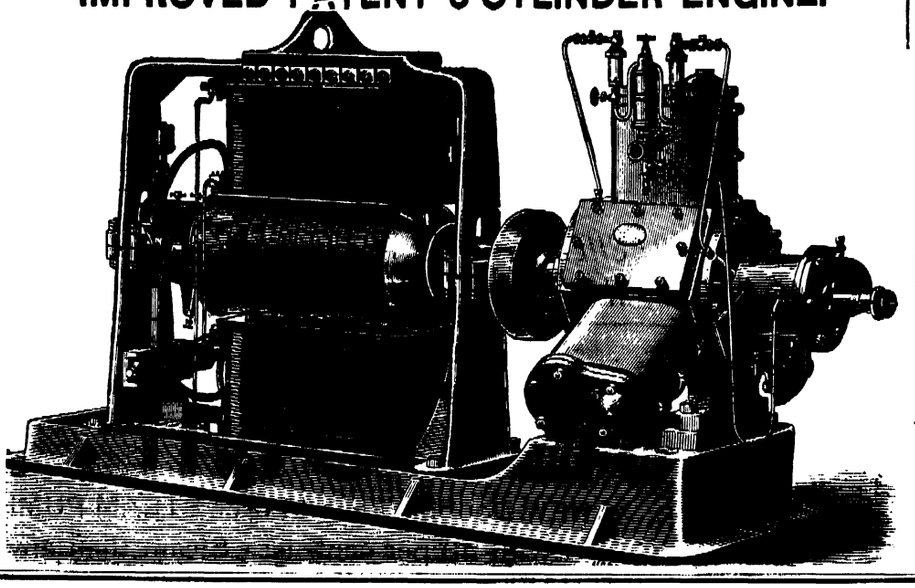
BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.

IMPROVED PATENT 3-CYLINDER ENGINE.

BROTHERHOOD'S PATENT



FLEXIBLE COUPLING



THE MOST

ECONOMICAL

AND

EFFECTIVE

FOR

SHIP LIGHTING

As in General Use in the British, French, Italian, Danish, &c., &c., Navies.

FOR DRIVING

FANS,

CENTRIFUGAL

PUMPS,

AND OTHER

HIGH-SPEED

MACHINERY.

5804

W. H. ALLEN & CO.,

MAKERS OF THE Improved

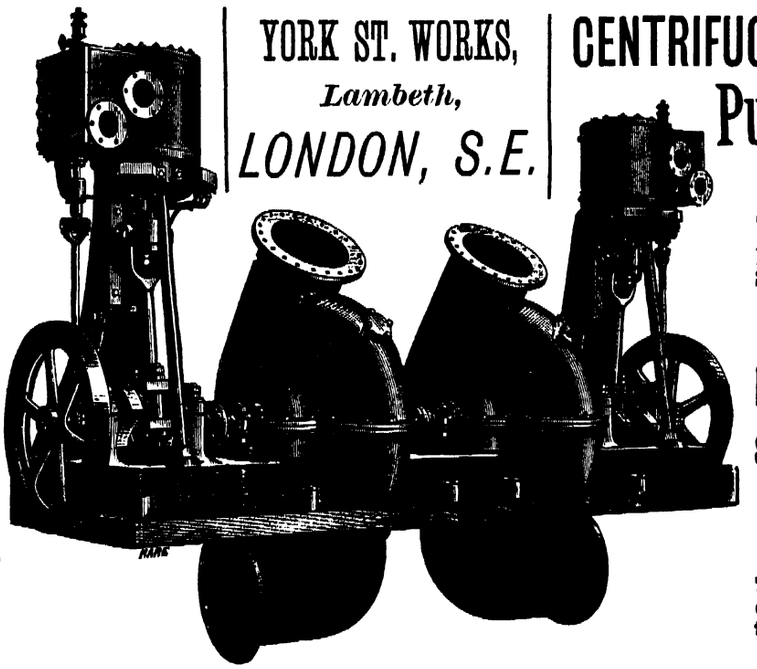
600

Of these Pumps and Pumping Engines have been fitted on the Swiftest and Largest Steamers afloat, sailing in all parts of the World.

YORK ST. WORKS,

Lambeth,

LONDON, S.E.



CENTRIFUGAL CIRCULATING Pumping Engines

This engraving represents a pair supplied to the magnificent S.S. "Umbria," the latest addition to the Cunard Line.

—:o:—

Every important Line has some of these Engines in their Steamers. {5380 5411

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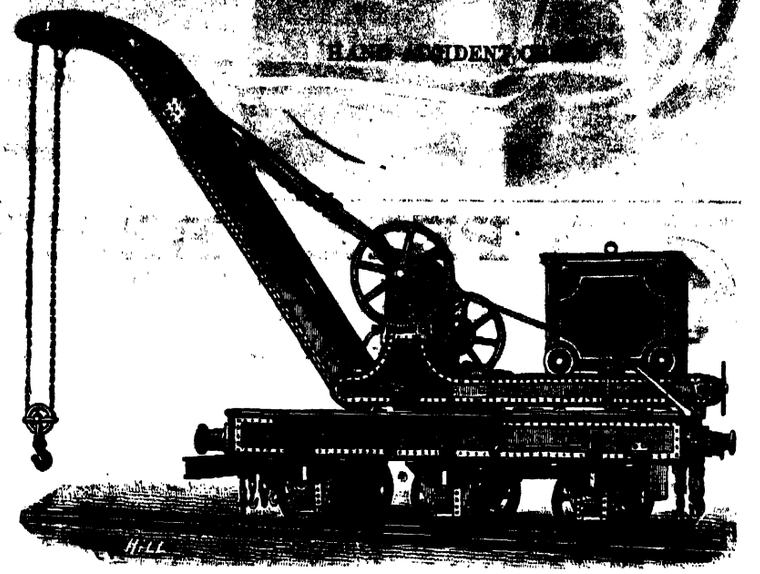
These Pumping Engines are cheaper, occupy less space, and are superior to any other form of Pumps for large or small steamers.

COWANS, SHELDON & CO., LTD.,

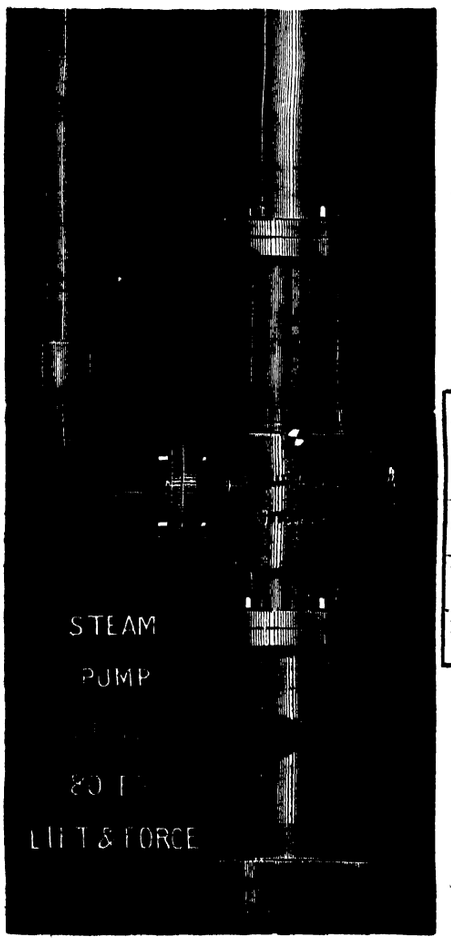
ENGINEERS AND IRONFOUNDERS,

ST. NICHOLAS WORKS, CARLISLE.





TURNTABLES, CRANES, MASTING SHEERS, AND TRAVERSERS OF EVERY DESCRIPTION BY STEAM, HAND, OR HYDRAULIC POWER. 5007



HALL'S PATENT

JETOMETER

NEW Double Lift and Force STEAM PUMP up to 80 ft.

WORKS with 40 per cent. less Steam than any other Jet Pump.
INVALUABLE for all Water Raising purposes.
NO moving parts, Oil, Grease, or Attention.
THOROUGHLY reliable under all conditions.
EXTREMELY simple; High-Class Materials; and Low in Price.

SEND FOR PARTICULARS.

No. and Class	6 A	8 A	10 A	12 A	14 A	16 A	16 B	18 B	20 B	25 B	30 B	35 B	40 B	45 B	B 50
PRICE COMPLETE	£2 10	£3	£3 10	£4 10	£7 10	£9 10	£12	£15	£20	£25	£30	£35	£40	£45	£50
Gals. per hour	300	500	700	1,000	2,000	3,000	3,000	4,000	6,000	8,000	10,000	15,000	20,000	25,000	30,000
Diam. of Steam Jet	3/16 in.	1/4 in.	5/16 in.	3/8 in.	1/2 in.	9/16 in.	9/16 in.	5/8 in.	11/16 in.	13/16 in.	7/8 in.	15/16 in.	1 in.	1 3/16 in.	1 1/4 in.
Delivery and Suction Pipes	1/2 in.	3/4 in.	1 in.	1 1/4 in.	1 1/2 in.	2 in.	2 in.	2 1/2 in.	3 in.	3 1/2 in.	4 in.	4 1/2 in.	5 in.	5 1/2 in.	6 in.

Patentees and Sole Makers:

FAIRBURN & HALL,

CHIEF OFFICE } 63, ROYAL EXCHANGE, MANCHESTER. 4765

FIRST-CLASS AGENTS WANTED in ALL PARTS of the WORLD.

CHARLES CHURCHILL & CO.,

AMERICAN MACHINERY AND TOOL IMPORTERS,

21, CROSS STREET, FINSBURY, LONDON, E.C.

ESTABLISHED IN 1862.



C. C. & Co. have just removed to much larger premises with ample show rooms and warehouse, and will carry a greatly increased stock of all the best American tools.

SOLE AGENTS FOR

THE ONLY GENUINE AMERICAN MORSE TWIST DRILL,

WITH CENTRE GRINDER, LIPPING STOCKS AND DIES, REAMERS AND MILLING CUTTERS,

Stephens' Patent Vices, Horton Chucks, Cushman Chucks, Westcott Chucks, Sweetland Chucks, Stanley Rule & Level Co.'s Planes, &c., &c., Gould's Manufacturing Co.'s Pumps, and a great variety of New American Tools.

New Catalogue for 1884 just issued, 216 pages Quarto, sent on receipt of One Shilling in Stamps.

(THE LARGEST CATALOGUE OF AMERICAN TOOLS EVER PUBLISHED IN GREAT BRITAIN.) 5364



Anglo-American Oil Press for 16 12 lb. Cakes.

ROSE, DOWNS & THOMPSON,

Established 1777.

OLD FOUNDRY, HULL.

Makers of the ANGLO-AMERICAN

OIL-MILL MACHINERY,

For crushing Linseed, Cotton Seed, Rape, Palm Kernels, Copra, &c., with a saving of 20 to 30 per cent. in labour and power, and 2 to 4 per cent. in Oil. (See *Engineer*, May 6, 1881, and Nov. 23, 1883.)

PRESSES FOR ALL KINDS of OIL SEEDS.

Elevators and Creepers for Grain Warehouses, Accumulators and Hydraulic Dock Machinery, Stationary Engines, Boilers, Trawling Engines, and Capstans for Fishing Boats.

SOLE MAKERS OF

HODGE'S & THOMPSON'S PATENT

KINGSTON EXCAVATOR.

Grabs and Buckets for Mud, Sand, Shingle, Silt, Clay, Rock, Débris, Boulders, Coke, Ore, &c., supplied on Pontoons for Harbour and Dock Dredging.

NO HEAVY BALANCE WEIGHTS.

NO SPECIAL CHAINS.

PERFECT AND RAPID WORK.



Kingston Dredger with Mud Bucket. 5127

London Office (Dredging Machinery): 36, KING WILLIAM STREET, E.C.

MANLOVE, ALLIOTT, FRYER & CO.,

ENGINEERS, BOILER MAKERS, IRON AND BRASS FOUNDERS, COPPERSMITHS, &c.

Works—NOTTINGHAM & ROUEN. London Offices—50, QUEEN VICTORIA STREET, E.C.

SOLE MAKERS OF

HALPIN'S Patent COMPOUND STEAM ENGINE,

(Patented by DRUITT HALPIN, C.E., 9, Victoria Chambers, Westminster, from whom information may be obtained.)

This Engine has given the most economical results yet recorded.

HIGH PRESSURE AND CONDENSING ENGINES of ordinary construction,

STEAM BOILERS—Lancashire, Cornish, Galloway, Multitubular, Compound, Vertical, &c.

Centrifugal Machines or Hydro Extractors of all Constructions for Sugar, Cloth, Wool, Chemicals, &c.

NUSSEY AND LEACHMAN'S PATENT CONTINUOUS CLOTH PRESSING MACHINE.

SUGAR MACHINERY. LAUNDRY MACHINERY.

MACHINERY AND APPARATUS FOR TREATMENT OF TOWNS REFUSE.

WATER WHEELS, SHAFTING, GEARING, AND ALL KINDS OF ENGINEERING AND MILLWRIGHT WORK.

THE EXHAUST INJECTOR for feeding Steam Boilers; ensures Economy of Fuel, Economy of Water, increased Steaming Power of Boiler

SEE FUTURE ADVERTISEMENTS. 5076

GRANGE IRON COMPANY, LIMITED,

Foundry, Engineering, and Boiler Works, DURHAM.

COLLIERY HEAPSTEADS, SCREENS AND PULLEYS.

—: PUMPING MACHINERY :—

Air-Compressing, Winding, Hauling & Steam Engines of all kinds.

THE GRANGE PATENT AUTOMATIC EXPANSION GEAR FOR WINDING ENGINES.

STEAM CRANES. GAS PLANT.

VENTILATING FANS.

Endless Chain Plant. —:— *Boring Tools.*

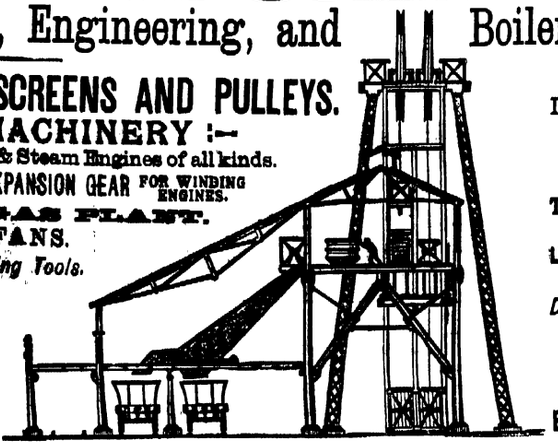
CHEMICAL WORKS PLANT.

TANK LOCOMOTIVES

FOR COLLIERIES AND IRONWORKS.

—:o:—

HYDRAULIC PUMPS AND SLIPWAYS.



—(SOLE MAKERS OF)—

LISHMAN AND YOUNG'S PATENT AIR

LOCOMOTIVE ENGINES

FOR UNDERGROUND HAULAGE.

THE HASWELL MECHANICAL COAL-GETTER

(HALL AND LOW'S PATENT).

LEONARD WATSON'S PATENT COMBINED DIRECT STEAM AND HAND STEERING GEAR.

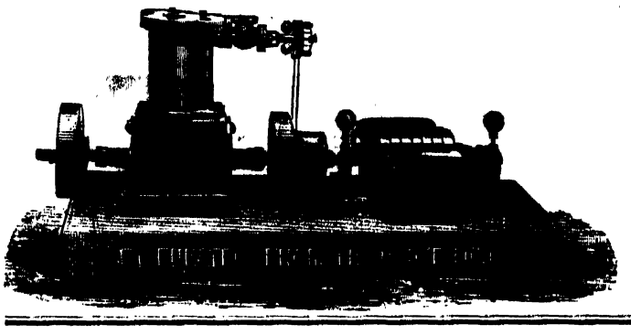
Differential Pumping Engines, with Lawrence and Ogle's Patent Gear.

IMPROVED COMPOUND CRUSHING ROLLS

FOR DRY OR WET COAL. 4908

Edwards' Coal-Washing Machines

CHANDLER'S PATENT HIGH-SPEED ENGINE



SINGLE OR DOUBLE. SILENT & STEADY.

SPECIAL TOOLS having been made for these ENGINES they are MODERATE in PRICE.

1200 REVOLUTIONS per Minute. Perfect System of Lubrication. No Indicators, no attention. Half-pint of Oil is sufficient for Two Days' Supply. Forged Steel Crank and Phosphor Bronze Working Parts throughout. MADE IN FOUR SIZES.

F. D. BUMSTED, Cannock Chase Foundry and Engine Works, REDNESFORD, STAFFS. 5228

MANUFACTURER OF PAPER BAG MAKING MACHINERY.

BRABY'S PATENT GLAZING.

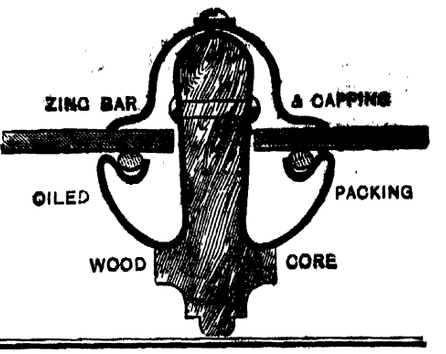
Glass set free, allowing Expansion and Contraction, and precluding Breakage.

ABSOLUTELY WATERTIGHT. PAINTING AND PUTTY SUPERSEDED.

OVER ONE MILLION FEET FIXED.

DRAWINGS AND PRICES ON APPLICATION.

MODELS AND SECTIONS ON VIEW. 5902



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BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing:—

New Zealand Shipping Co., Limited.

Bell's Asbestos Works, Southwark, S.S. "Rimapehu," Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your round Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results:—

14,000 miles continuous steaming without renewal.

Steam Pressure.....110 lbs. | Vacuum.....28 inches.

My experience does not show an equal result from any other packing.

The voyage from New Zealand to Plymouth was accomplished in 27 days 22 hours, being the fastest run from New Zealand on record.

Yours obediently,
D. HENDERSON, Chief Engineer, S.S. "Rimapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial fever nine months, and comparing it with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success when a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,
Mr. J. Bell. G. H. CLARKE, Sup. Engineer.

Department of the Director of Navy Contracts, Admiralty, Whitehall, 20th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos Packing to samples submitted.

Plastic core.....square. | Plastic core.....round.

To Mr. John Bell. *JOHN COLLETT, Director of Navy Contracts.*

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Round Block Packing with solid and hollow rubber core, and *Fig.* 3 without core, but with rubber inlaid.

As these packings are extensively imitated, and as it is a common practice among dealers and agents to supply the cheaper manufactures at my list prices, users are requested to see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal; ⅛ in., 20 per cent.; ¼ in., 150 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates, lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To Bell's Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the Packing we had formerly; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,
THOMAS WINTER, Colliery Engineer.



— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depôts and not through agents or factors.



FIG 1. FIG.2 FIG.4. FIG.3.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION,

for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; covers 50 per cent. more surface than any other coating, and is absolutely indestructible. It can be stripped off after many years' use, mixed up with 20 per cent. of fresh, and applied again. The composition is supplied dry, and is only to be mixed with water to the consistency required for use.

A Horizontal Boiler, 17 ft. 6 in. long, 15 HP., gave the following results:—

Temperature on Plates.. .. .. .. 192 deg.
" Covering.. .. .. 94 deg.

One ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering:—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 29th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly, "W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited.

Gunnislake, Tavistock, 9th April, 1884.

Mr. John Bell, Southwark, S.E.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gradients, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ⅛ in. to 3 in. wide, and any thickness from 1-16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to obtain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and 1 millimetre to 20 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above:—

Department of the Director of Navy Contracts, Admiralty, Whitehall, S.W., 17th May, 1884.

Sir,—I have to inform you that your tender for Asbestos Millboard has been accepted. JOHN COLLETT,

Mr. John Bell. Director of Navy Contracts.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanized Asbestos Cloth, thus producing an excellent joint where expansion and contraction under other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REGD.

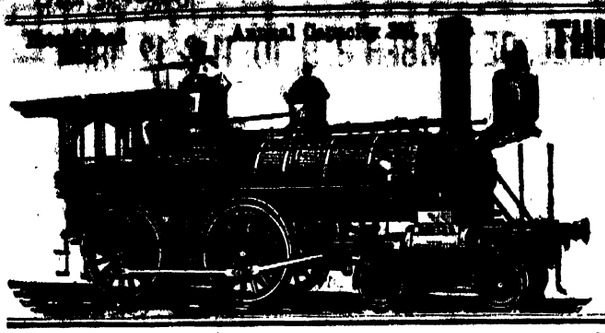
ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E.

4942

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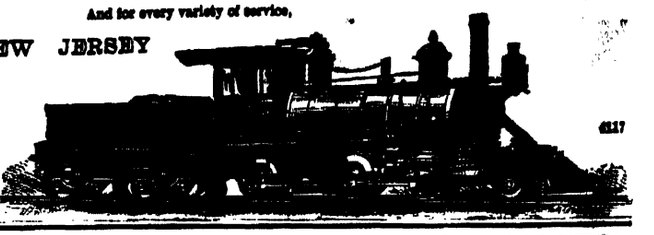
THE ROGERS LOCOMOTIVE AND MACHINE WORKS.

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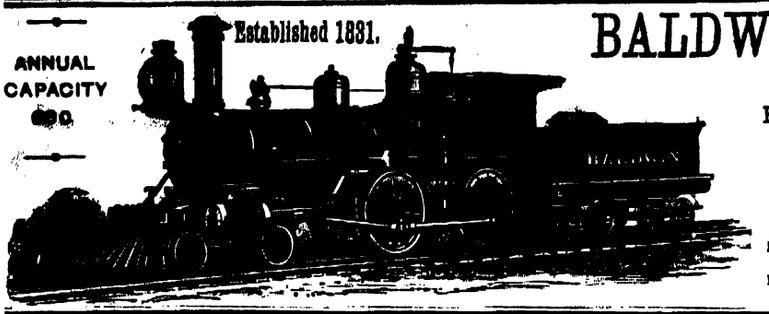
And for every variety of service,

PATERSON, NEW JERSEY

UNITED STATES OF AMERICA.



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Established 1831.

ANNUAL CAPACITY 600

BALDWIN LOCOMOTIVE WORKS,

PHILADELPHIA, U.S.A.

BURNHAM, PARRY, WILLIAMS, & Co., *Proprietors.*

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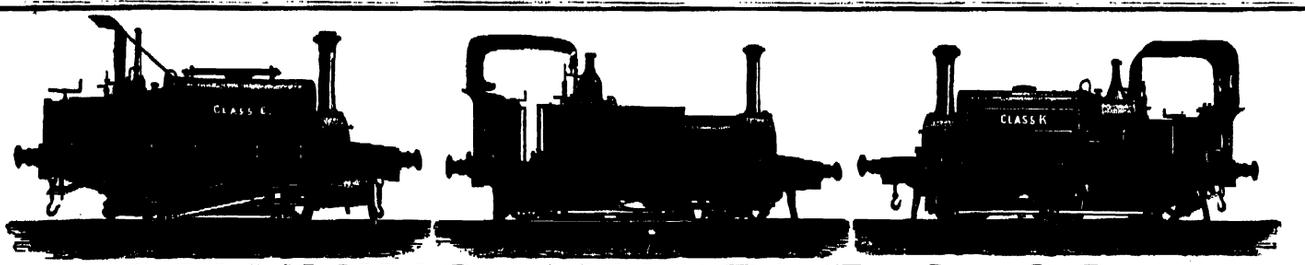
Adapted to every variety of service, and built accurately to standard gauges and templates. Like parts of different engines of same class perfectly interchangeable.

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Have designed and constructed one hundred various types of Tank and other Locomotive Engines for upwards of thirty different widths of gauge, adapted where necessary for passing round sharp curves and ascending steep gradients, suitable for any climate, and for burning coal or wood, &c.: also for special duties required by Railway Companies, Contractors, Collieries, Iron Works, and Mines, Brick Works, Quarries, Gas Works Ship Yards, Docks, Sugar Plantations, &c., &c. They are built accurately to standard gauges and templates in order that like parts of various classes of Engine will fit different Engines of the same type, and so that duplicates can be supplied on the shortest notice. The materials are the best of their respective kinds, and the workmanship cannot be excelled.

MANNING, WARDLE & Co., having designs and models of such a great variety of Engines, are enabled to execute orders for Locomotive Engines adapted to most requirements in a very short time.

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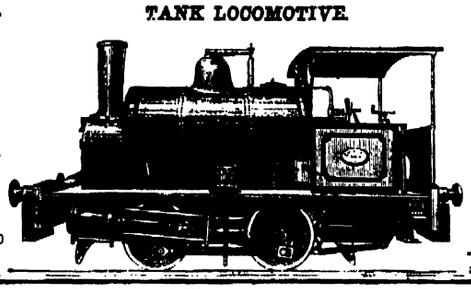
VARIOUS CLASSES IN PROGRESS.

TRAMWAY LOCOMOTIVES.

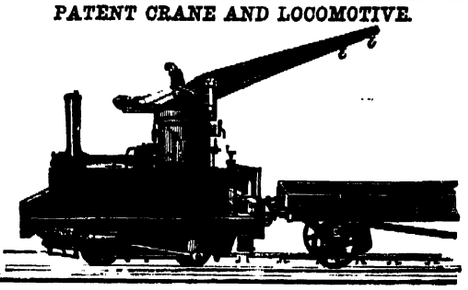
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11 Awards:—Gold and Silver Medals, London, Paris, Vienna, Toronto, Sydney, Melbourne, Bradford, &c.

A really First-class Quality supplied. Main Driving Belts made up to 6 ft. wide to transmit 1000 Ind. HP. Single Belts kept in stock.

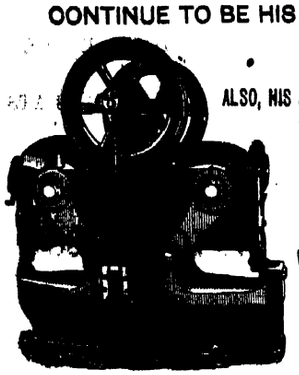
ESTABLISHED 1797. THOMAS FLEMING, SON & CO., HALIFAX, ENGLAND. ESTABLISHED 1797. 5318

JOHN CAMERON'S SPECIALITIES

ESTABLISHED 1852.

OONTINUE TO BE HIS

STEAM PUMPS



For all Purposes, and of which he continues to manufacture by far a larger number than any of his imitators. 10,000 SOLD.

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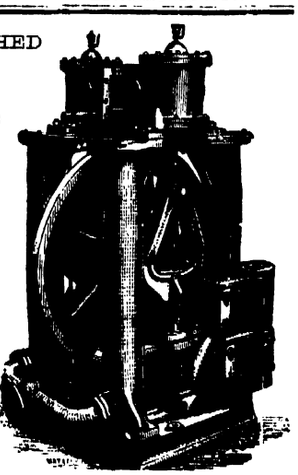
Punching and Shearing Machines

As used in all the principal Shipbuilding Yards (public and private) throughout the World.

ALWAYS READY OR IN PROGRESS TO ALL SIZES.

OLDFIELD ROAD IRON WORKS, SALFORD,

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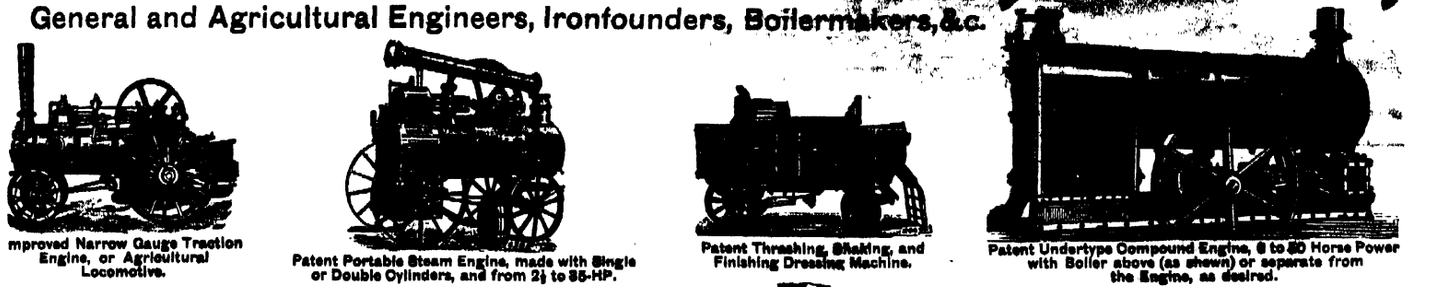
STAND No. 4, SMITHFIELD SHOW, AGRICULTURAL HALL, DECEMBER 8, 9, 10, 11 & 12, 1884.



Vertical Engine, Type No. 1, with Vertical Cross Tube Boiler, 2½ to 12 HP. Vertical Engine, Type No. 2, with Vertical Multitubular Boiler, 1 to 8 Horse Power. Traction Engine with Finishing Threshing Machine and Straw Elevator on the Road. Semi-Portable Steam Engine mounted with Vertical Double Cylinders, 10 to 20 Horse Power. [illegible]

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General and Agricultural Engineers, Ironfounders, Boilermakers, &c.

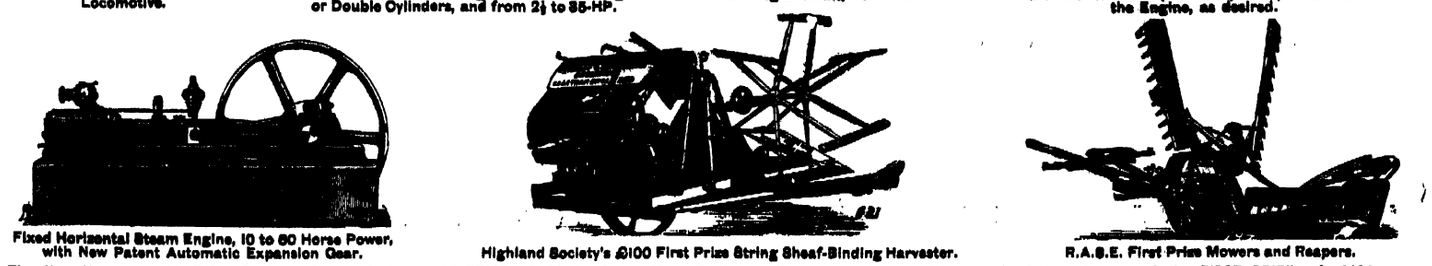


Improved Narrow Gauge Traction Engine, or Agricultural Locomotive.

Patent Portable Steam Engine, made with Single or Double Cylinders, and from 2½ to 35-HP.

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Fixed Horizontal Steam Engine, 10 to 60 Horse Power, with New Patent Automatic Expansion Gear.

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The New Hornsby 1884 Twine Binder, winner of the FIRST PRIZE of £100 of the R.A.S.E. at Shrewsbury (August 6th to the 13th, 1884), and the FIRST PRIZE of £100 of the Highland and Agricultural Society of Scotland (being the two largest prizes ever offered), besides other high-class Awards.

For Particulars of the most modern improved and successful Agricultural Machinery, including the R.A.S.E. First Prize Mowers, Reapers, Binders, Ploughs, Dressing Machines, Corn Screens, Turnip Cutters, Root Pulpers, &c., SEE ILLUSTRATED CATALOGUES in English, French, German, Spanish, Russian, &c., sent GRATIS and POST FREE on application.

PLOUGH SHARES OF CAST IRON, CHILLED, WROUGHT IRON, MALLEABLE IRON AND STEEL, OF PATTERNS TO SUIT EVERY VARIETY OF WORK, AND MADE TO LOCAL PATTERNS IF DESIRED.

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Cape Town Agricultural Show—FIVE FIRST PRIZES.
National Agricultural Society of Victoria—TWO FIRST PRIZES.
Bar Sur Aube, France—FIRST PRIZE (GOLD MEDAL), for Collection of Hornsby's Mowers.
Neufchatel Brey, France—FIRST PRIZE (GOLD MEDAL).
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London Office: 84, LOMBARD STREET.—(Telephone No. 1294). South African Depot: EDINBURGH BUILDINGS, DOCK ROAD, CAPE TOWN.

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TWO FIRST CLASS GOLD MEDALS, CALCUTTA EXHIBITION, 1884.

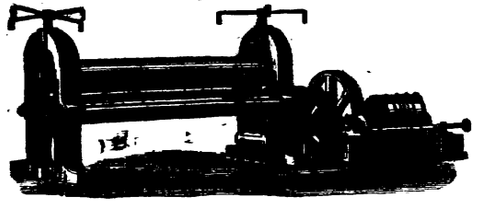
CONTRACTORS BY APPOINTMENT TO HER MAJESTY'S WAR DEPARTMENT.

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TANGYES LIMITED CORNWALL WORKS, BIRMINGHAM

LONDON: 35, Queen Victoria Street. NEWCASTLE: St. Nicholas Buildings. MANCHESTER: Deansgate. GLASGOW: Argyle and Hope Streets. (G.)

PLATE STRAIGHTENING AND BENDING ROLLS



The above are suitable for Rolling complete rings; the top roll being easily removable.

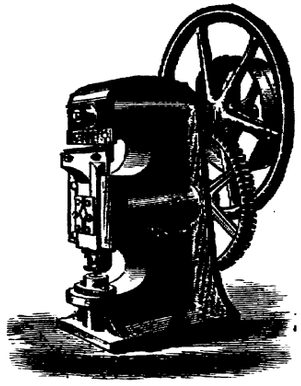
The rolls can be arranged for angle or T iron if required, at a slight extra cost.

The Price includes both Striking Gear and Foundation Bolts.

No.	To take Plates.	Thickness of Plates rolled cold.	Diameter of top Roll.	Diameter of bottom Rolls.	Approx. weight.	Price	If Arranged to bend L or T Iron, extra.
1	6 ft. wide	½ in.	10 in.	8 in.	105 cwt.	£145	£10 0 0
2	7 ,, ,,	½ ,,	10 ,,	8 ,,	115 ,,	155	10 0 0
3	7 ,, ,,	½ ,,	12 ,,	10 ,,	180 ,,	190	10 0 0
4	8 ,, ,,	½ ,,	13 ,,	10 ,,	195 ,,	205	15 0 0
5	9 ,, ,,	½ ,,	14 ,,	10½ ,,	210 ,,	220	20 0 0

180

PUNCHING AND SHEARING MACHINE

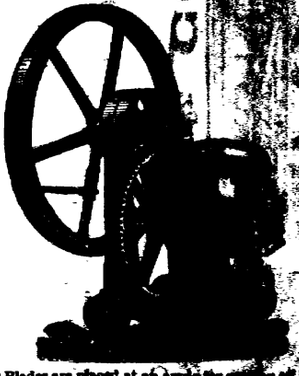


The Shear is placed at an angle for cutting off long bars.

No.	Will Punch Holes diam.	Through Iron Plates thick	Will Shear Iron Plates thick	Distance from edge of Plate: Shears	Distance from edge of Plate: Punch	Approx. Weight	PRICE
A	1 in.	1 in.	1 in.	13 ins.	16 ins.	95 cwts.	£110
B	¾ ,,	¾ ,,	¾ ,,	9 ,,	11 ,,	40 ,,	60
C	½ ,,	½ ,,	½ ,,	7 ,,	8 ,,	19 ,,	38
D	½ ,,	½ ,,	½ ,,	6 ,,	6 ,,	11 ,,	25

One Round Punch and Die included in price. 181

PUNCHING AND SHEARING MACHINE



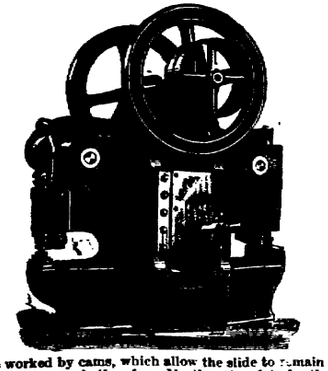
The Shear Blades are placed at an angle for cutting off long bars.

No.	Will punch holes diam.	Through Iron Plates thick.	Will shear Iron Plates thick	Distance from edge of Plate: Shears	Distance from edge of Plate: Punch	Approx. weight cwts.	Can work by Power only.	Can work by Hand and Power.	If mounted on four wheels extra
1	¾ ins.	¾ ins.	¾ ins.	8 ins.	8 ins.	15	£30	£33	£2
2	,,	,,	,,	10 ,,	11 ,,	25	33	46	3
3	,,	,,	,,	11 ,,	12½ ,,	32	35	48	3
4	,,	,,	,,	10 ,,	12½ ,,	45	60	70	3
5	1 ,,	1 ,,	1 ,,	18 ,,	15 ,,	80	105	110	4

Punches and Dies to punch under any of the sizes named, extra.
Note.—No. 5 Machine is Double-geared. 182

IMPROVED LEVER

PUNCHING AND SHEARING MACHINE

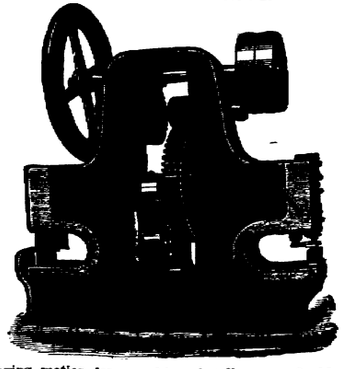


The Levers are worked by cams, which allow the slide to remain at the top during half the revolution, giving ample time for adjusting the plate for the next hole. This Machine can consequently be worked at a quicker speed than the ordinary Eccentric Machines. With Disengaging Motion for punching and for angle iron.

No.	Will punch Holes, diam.	Through Iron Plates, thick	Will shear Iron Plates, thick	Distance from edge of Plate	Will Shear Angle Iron	Price without Angle Iron Shears	If fitted with Angle Iron Shears, extra
1	¾ in.	¾ in.	¾ in.	14 in.	3×3×½	£100	£20
2	1 ,,	1 ,,	1 ,,	18 ,,	4×4×⅝	180	25
3	1 ,,	1 ,,	1 ,,	24 ,,	4×4×⅝	220	25
4	1¼ ,,	1¼ ,,	1¼ ,,	24 ,,	6×6×¾	280	30
5	1¼ ,,	1¼ ,,	1¼ ,,	30 ,,	6×6×1	360	30

Punches and Dies to punch under any of the sizes named, extra. 184

PUNCHING AND SHEARING MACHINE



With disengaging motion for punching, handle on each side, and disengaging motion for angle iron.

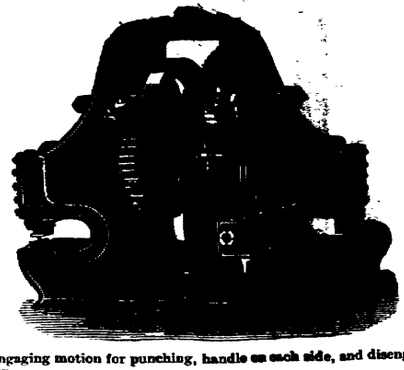
No.	Will punch holes diam.	Through iron plates thick	Will shear iron plates thick	Distance from edge of plate	Will shear angle iron	Approx weight without angle iron shears	Approx weight with angle iron shears	Price without angle iron shears	Price with angle iron shears	If with steam Engine extra
*0	¾ ins	¾ ins.	¾ ins.	16 ins.	3×3×½	3 tons	3¼ tons	£90	£102	...
1	1 ,,	1 ,,	1 ,,	14 ,,	4×4×½	5 ,,	5½ ,,	132	144	£20
2	¾ ,,	¾ ,,	¾ ,,	18 ,,	4×4×⅝	5½ ,,	6 ,,	144	156	20
3	1¼ ,,	1¼ ,,	1¼ ,,	18 ,,	6×6×1	6¾ ,,	7¼ ,,	180	192	25
4	1 ,,	1 ,,	1 ,,	24 ,,	6×6×1	7¼ ,,	7¾ ,,	192	204	25

Punches and Dies to punch under any of the sizes named, extra. 183

*This Machine has single power Gearing.

POWERFUL

PUNCHING AND SHEARING MACHINE



With disengaging motion for punching, handle on each side, and disengaging motion for angle iron.

Will punch holes diam.	Through Iron Plates thick	Will shear Iron Plates thick	Distance from edge of Plate	Will shear angle Iron	Approx. weight with angle iron shears and steam cylinder	Price without angle Iron Shears	Price with angle Iron Shears	If with steam Engine, extra
1¼ ins.	1¼ ins.	1¼ ins.	26 ins.	6×6×1	15 tons.	£280	£360	£30

Punches and Dies to punch under any of the sizes named, extra. 185

4500

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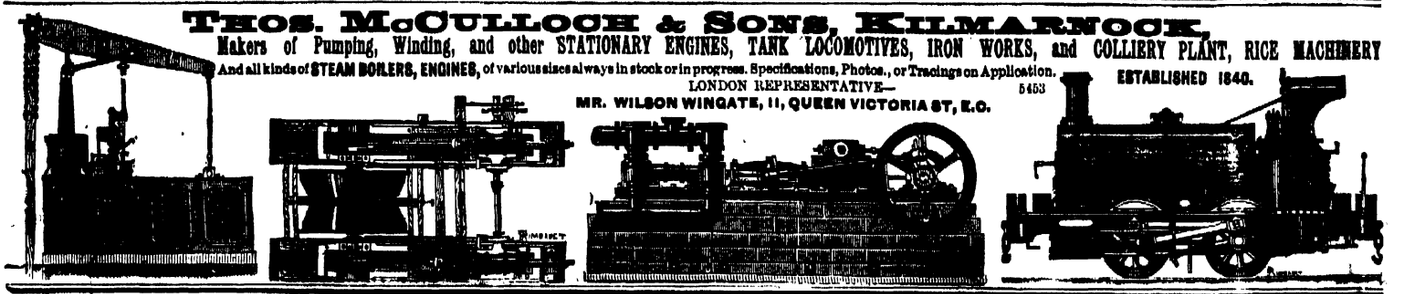
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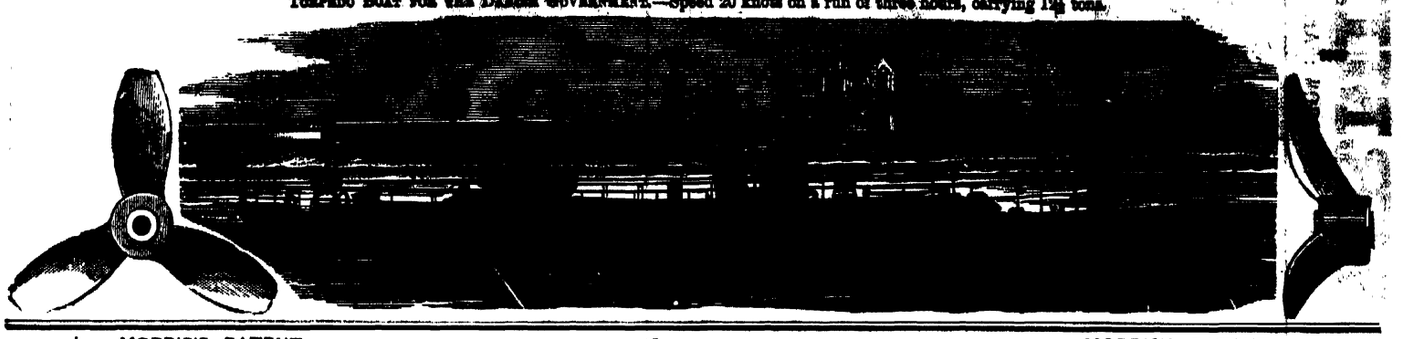
STEAM YACHT AND LAUNCH BUILDERS,

CHURCH WHARF, CHISWICK, LONDON, W.

YACHTS AND LAUNCHES FOR SEA OR RIVER SERVICE, from 25 to 100 feet in length, and Speeds from 10 to 25 Miles per Hour

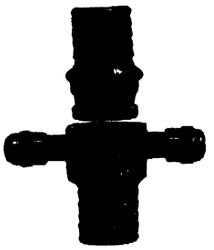
Thornycroft's Patent Screw Propellers made for all sizes of Vessels. Efficiency superior to any hitherto brought out.

TORPEDO BOAT FOR THE DANISH GOVERNMENT.—Speed 20 knots on a run of three hours, carrying 12½ tons.



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SIMPLEST AND QUICKEST IN THE WORLD.

Used by all the leading Fire Brigades in Europe

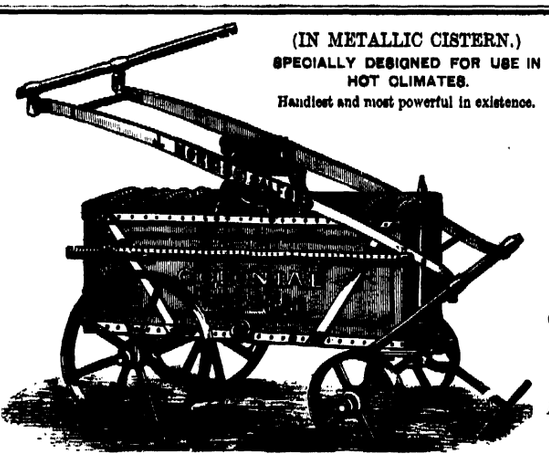
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(IN METALLIC CISTERN.)

SPECIALLY DESIGNED FOR USE IN HOT CLIMATES.

Handiest and most powerful in existence.



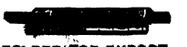
MORRIS'S PATENT

DIAGONAL DOUBLE WOVEN

SPRING MATTRESS.



TO FIX ON ANY KIND OF BEDSTEAD.



FOLDED FOR EXPORT.

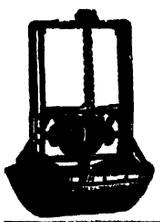
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NEVER GETS OUT OF ORDER.
NEVER NEEDS REPAIR. 5339
NEVER LOSES ITS SHAPE.

HOSE PIPES of Copper-Rivetted Leather, India Rubber, Canvas and Rubber-Lined Canvas.

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PRIESTMAN BROTHERS,

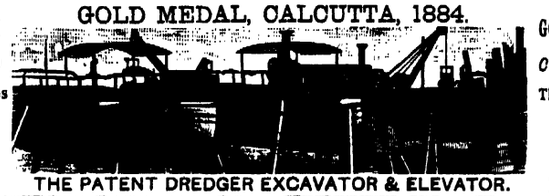


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DIPLOMA of HONOUR, AMSTERDAM
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" French Government
" Italian Government
" Cape Government
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" Chilian Government

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GOLD MEDAL, CALCUTTA, 1884.



THE PATENT DREDGER EXCAVATOR & ELEVATOR.

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GOLD MEDAL FISHERIES, LONDON,
Sydney, New Zealand, Tynemouth.

CONTRACTORS FOR DREDGERS TO
The Indian Board
The Mersey Dock & Harbour Board
" South Australian Government
" New Zealand Government
" Spanish Government
" Victorian Government
" New South Wales Government
" Dutch Government
" Queensland Government 5361

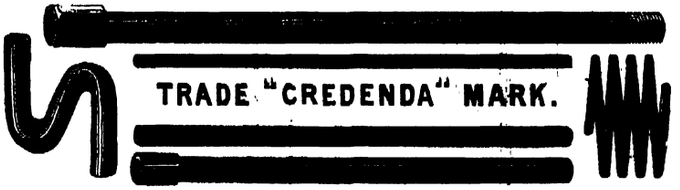


—:- PATENT -:—

COLD-DRAWN SEAMLESS

THE CREDENDA
COLD-DRAWN SEAMLESS
STEEL TUBE COMPANY,
BIRMINGHAM.

FOR BOILERS AND STAYS,
HYDRAULIC PRESSES,
AIR RESERVOIRS.



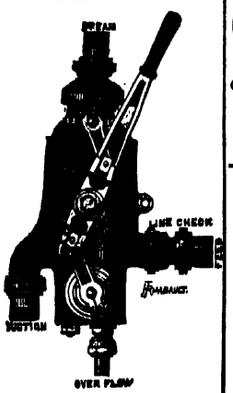
STEEL TUBES.

BIRMINGHAM WORKS & OFFICES:
LEDSAM STREET,
MONUMENT LANE STATION.

LONDON OFFICE:
4, WATER LANE,
GT. TOWER STREET, E.C.

BORING RODS, COUPLINGS,
BUSHES, SPINDLES, COLLARS,
BICYCLES & OTHER USES.

CLASS A.



LOCO. PATTERN, SINGLE LEVER.

THE HANCOCK

INSPIRATOR

ONLY GOLD MEDAL Paris, 1878.

FIRST AWARD, Sydney, 1879.

60,000 IN USE.

THE DONKEY PUMP AND INJECTOR COMBINED FOR FEEDING ALL CLASSES OF STEAM BOILERS ECONOMICALLY AND RELIABLY.

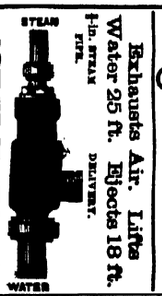
No Adjustment.

Draws Water at 140°.

All Sizes lift water 25 ft.

Delivers to Boiler up to 212°.

ESTIMATES FOR FITTING COMPLETE with Guarantee to start in good working order, and all information on application to—



Feeds through Heaters.

Can be used as a Pump only.

No Valves or Wearing Parts.

Can be examined instantly.

THE HANCOCK INSPIRATOR CO., 108, Upper Thames St., London, E.C.

CLASS O.



Cheap Class of Machine.

STATIONARY PATTERN. 5115

Henry Bessemer and Co., Limited,

Manufacturers of Cast Steel,

SHEFFIELD.

FORGINGS

In Steel of any size.—Quotations given either for uses or finished complete.

STEEL CASTINGS

Applicable in all cases where extra strength and durability are essential. This Steel is guaranteed to contain not more than 0.30 per cent. carbon, and to bear a tensile strain of 34 tons to the square inch.

TYRES AND AXLES.



SOFT CAST STEEL

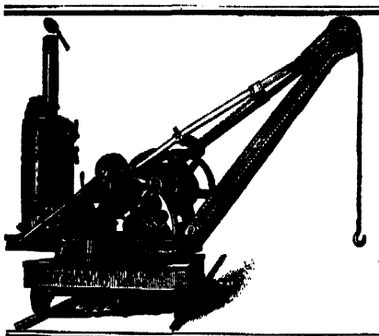
In bars and rods, for general use in Engineering Works.

BLOOMS, BILLETS, & SLABS

Of any size or temper, or of special soft quality, for use in lieu of best Charcoal Iron, &c.

SPRING STEEL,

Of superior quality. 5137



EXORS. OF WM. BALMFORTH,

RODLEY, NEAR LEEDS.

MANUFACTURERS OF

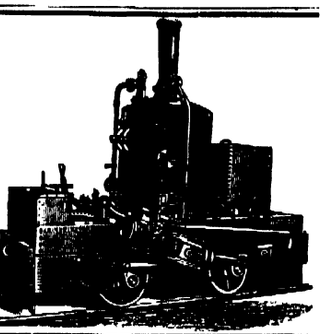
LOCO. STEAM CRANES, CONTRACTORS' LOCOS.,

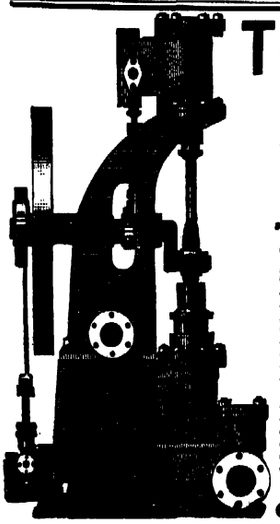
TRAVELLERS, HOISTS,

AND ALL KINDS OF LIFTING MACHINERY.

Boilers fitted with Fox's Patent Corrugated Steel Fire Boxes.

4697





THE COALBROOKDALE CO., LTD.

MAKERS OF

DIRECT-ACTING

AND OTHER

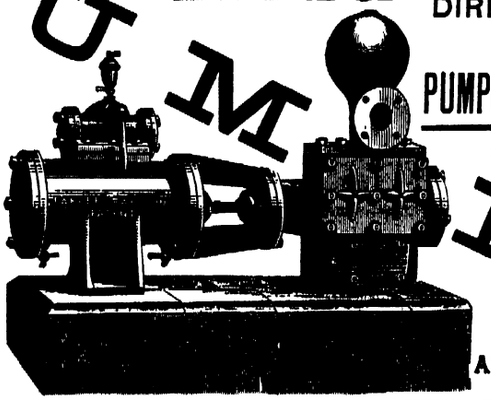
PUMPING MACHINERY

SIMPLE & COMPOUND

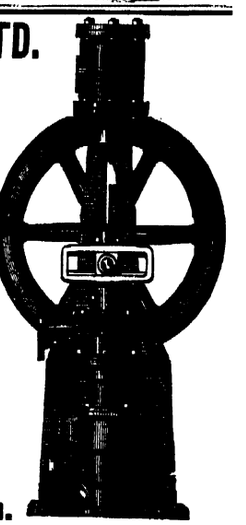
FOR

WATERWORKS.
COLLIERIES.
BREWERIES.
QUARRIES.
CHEMICAL WORKS.
SEWAGE WORKS.
POTTERIES.
STEAM SHIPS.
IRRIGATIONS.
DRAINAGE.

BOILER FEEDERS.
FIRE ENGINES.
HYDRAULIC PUMPS



FOR ALL PURPOSES.



COALBROOKDALE, R.S.O., SHROPSHIRE. 5139

S. OWENS & CO.,

HYDRAULIC AND GENERAL ENGINEERS, WHITEFRIARS STREET, LONDON,

MANUFACTURERS OF

PUMPING MACHINERY OF EVERY DESCRIPTION.

SOLE LICENSEES AND MANUFACTURERS FOR GREAT BRITAIN OF

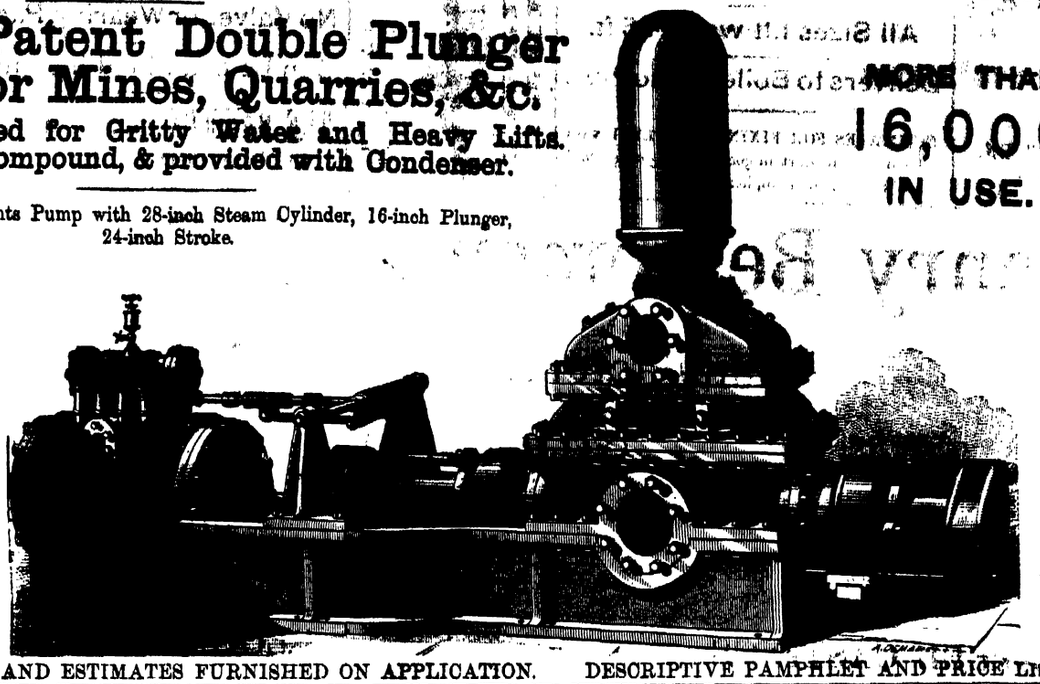
BLAKE'S PATENT DIRECT-ACTING STEAM PUMP.

Blake's Patent Double Plunger Pump, for Mines, Quarries, &c.

Specially adapted for Gritty Water and Heavy Lifts. Also made Compound, & provided with Condenser.

Illustration represents Pump with 28-inch Steam Cylinder, 16-inch Plunger, 24-inch Stroke.

MORE THAN 16,000 IN USE.



5093

SPECIAL DESIGNS AND ESTIMATES FURNISHED ON APPLICATION. DESCRIPTIVE PAMPHLET AND PRICE LIST FREE

Mr. William Knowles' Patent Automatic Supplementary Governor,

FOR SECURING AND MAINTAINING AUTOMATICALLY ALMOST PERFECT ACCURACY OF SPEED IN STEAM ENGINES UNDER VARYING LOADS AND STEAM PRESSURES.

HICK, HARGREAVES & CO., Sole Makers and Licensers,

SOHO IRONWORKS, BOLTON.

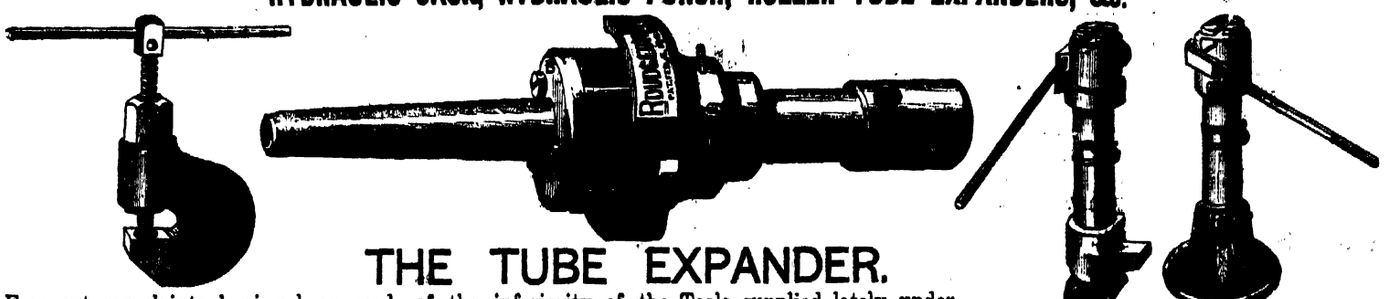
5199

RICHARD DUDGEON,

114, FENCHURCH STREET, LONDON, E.C., & 24, COLUMBIA STREET, NEW YORK,

INVENTOR, PATENTEE, AND SOLE MAKER OF HIS

HYDRAULIC JACK, HYDRAULIC PUNCH, ROLLER TUBE EXPANDERS, &c.



THE TUBE EXPANDER.

Frequent complaints having been made of the inferiority of the Tools supplied lately under cover of LISTS and ADVERTISEMENTS headed "DUDGEON'S ROLLER TUBE EXPANDERS," R. DUDGEON begs to make known that, having now retired to America, he cannot guarantee any Expanders unless made by himself at his New York Factory, all of which and those only are stamped as under:—

R. DUDGEON, N.Y., Patd. Feb. 5th, 1867, on the Guide-ring of each Tool, WITHOUT WHICH NONE ARE GENUINE.

These can always be obtained at R. Dudgeon's English Depôt, 114, Fenchurch Street. If more convenient to get them through Merchants care should be taken to specify "*Dudgeon's own make*" on the *Order*, but as R. Dudgeon observes with regret that *imitations* bearing his *stamp counterfeited* are being sold as his, he would respectfully recommend both Merchants and Users requiring Expanders of his make to apply direct. In urging this he merely wishes to secure the identity of what *is* made by himself, by which he is content to stand or fall.

R. Dudgeon takes this opportunity of returning thanks for past favors, either by orders or recommendation, and it being his intention strictly to maintain the Quality and Workmanship so essential for such a Tool as the Expander, begs to solicit a continuance of the same

2240

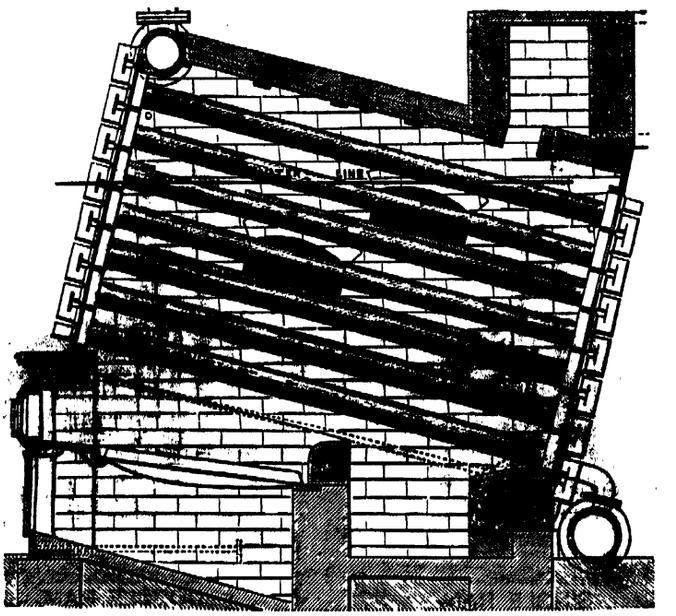
CATALOGUES AND PRICE LISTS ON APPLICATION TO R. DUDGEON, 114, FENCHURCH STREET, LONDON, E.C.

ROOT'S PATENT STEAM BOILER

SPECIALLY SUITABLE FOR VERY HIGH PRESSURE & EXPORT.

Sizes up to 100 HP. Nominal, and when required in small light pieces for Mule Transport or special positions.

Easily Erected by Unskilled Labour.



ALL OVER THE WORLD.

MANY EMINENT FIRMS.

FOR PRICES AND PARTICULARS APPLY TO

THE PATENT STEAM BOILER CO.

(ESTABLISHED 1862)

HEAD OFFICE AND WORKS: 28, HENEAGE ST., BIRMINGHAM.

LONDON OFFICE: 11, QUEEN VICTORIA ST., E.C. 5418

CONRAD KNAP, REPRESENTATIVE.

15 PRIZE MEDALS.] **THE GLENBOIG UNION FIRE CLAY COMPANY, LIMITED,** [15 PRIZE MEDALS.

4, WEST REGENT STREET, GLASGOW.

SANTIAGO, 1875, 1. PARIS, 1878, 2. SYDNEY, 1879, 2. AMSTERDAM, 1883, 1. MELBOURNE, 1880, 2. GLASGOW, 1880, 2. LONDON, 1882, 1



ALL DESCRIPTIONS OF FIRE CLAY GOODS BRANDS, GLENBOIG, GLENBOIG STAR, and CUMBERNAULD. 1400

100 TO 200 PER CENT. MORE POWER THAN OTHER ENGINES FROM SAME QUANTITY OF GAS.

OTTO

CROSSLEY BROS., LIMITED, MANCHESTER.

Crossley's Patent TWIN-ENGINES. Impulse every revolution. The steadiest running Gas Engine yet made.

THE "OTTO." GOLD MEDAL at Crystal Palace, & HIGHEST AWARD at Paris Electrical Exhibitions.



New Patent SELF-STARTER. Best, Safest, and Simplest made, may now be applied.

CROSSLEY'S NEW VERTICAL ENGINE, Requiring little floor space.

½ TO 100 HP. IND. MANY IMPROVEMENTS. OVER 15,000 IN USE.

LONDON: 24, POULTRY, E.C.

GAS ENGINE

GLASGOW: 58, UNION STREET

5382

CHEAP GAS FOR MOTIVE POWER

The motive power at the Works of Messrs. CROSSLEY BROTHERS, Limited, consists of Otto Engines driven by DOWSON CHEAP GAS, with average fuel consumption of 1·3 lb. per ind. H. P. per hour.

THE DOWSON ECONOMIC GAS COMPANY, Ltd., 3, Gt. Queen St., Westminster, S.W. 6383



FIRE-BOX AND BOILER STAY TAPS, SQUARE-THREAD TAPS, AND ALL KINDS OF SPECIAL TAPS.

SCREWING MACHINES, STOCKS, TAPS and DIES, TUBE CUTTERS, WRENCHES, &c. Catalogues on application. 5397

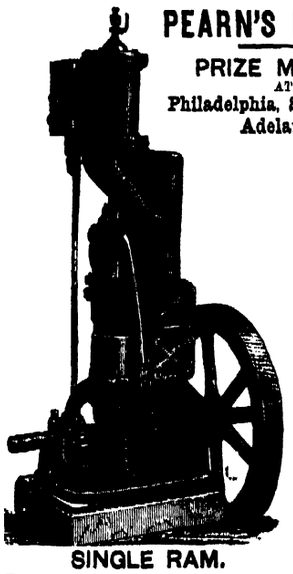
JOHN COWLEY & SON, Clarendon Street, HYDE, near MANCHESTER.



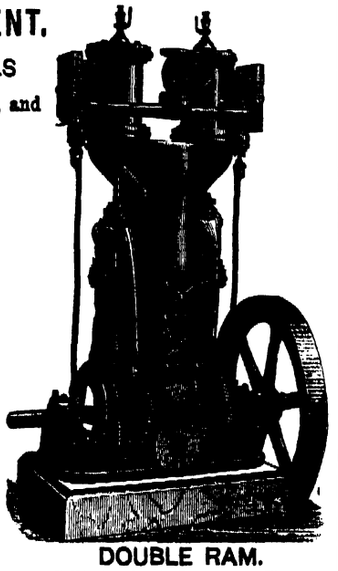
THE MANCHESTER PUMPING ENGINE.

PEARN'S PATENT.

PRIZE MEDALS
AT
Philadelphia, Sydney, and Adelaide.



SINGLE RAM.



DOUBLE RAM.

Fast superseding all others in Iron and Steel Works, Collieries, Mills, Breweries, Chemical Works, and for fire and general purposes. References can be given all over the world.

GOLDSCHMIDT, HANLO & CO.'S
PATENT
"PORTLAND" ROTARY PUMP

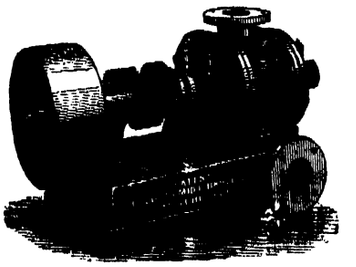
CAN BE DRIVEN BY HAND, BELT, OR STEAM ENGINE ATTACHED.

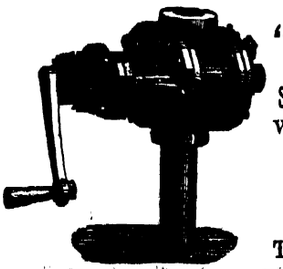
No Valves. Positive Action.

Will draw 25 ft. on suction, and force to a considerable height.

Can be run fast or slow, NOT depending on Centrifugal Force.

Direct passage of Fluid from Suction to Delivery Pipe.





THE
"PORTLAND PUMP"
IS THE
SIMPLEST & MOST EFFECTIVE in the MARKET.

Will Pump all kinds of Fluids (Hot or Cold), Dyes, Acids, Tars, Oils, &c.

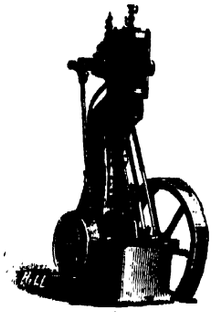
Can be completely emptied in a second.

FOR PRICES AND PARTICULARS APPLY TO
THE SOLE LICENSEES AND MAKERS

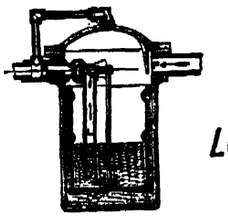
FRANK PEARN & CO., West Gorton, MANCHESTER.

Sole Agents for London and District: Messrs. A. HAACKE & CO., 21, Lime Street, London, E.C. 4074

WILLIAM HANSON,



VERTICAL STEAM ENGINE.



STEAM TRAP.

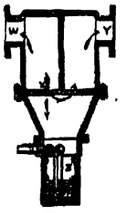
QUEBEC WORKS,
BRADFORD.

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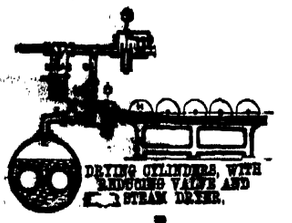
LONDON OFFICE: 87, WALBROOK.

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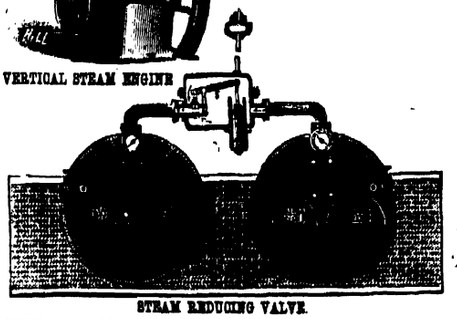
CATALOGUES ON APPLICATION.



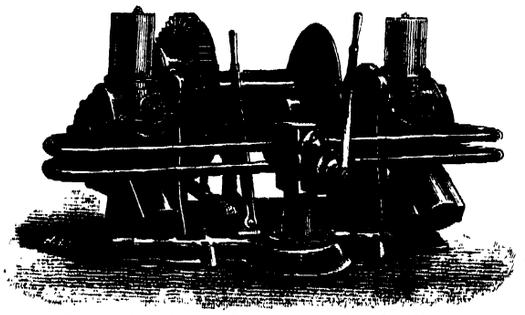
STEAM DRYER.



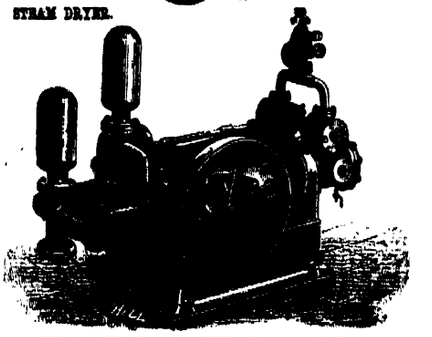
DRYING CYLINDERS, WITH REDUCING VALVE AND STEAM DRYER.



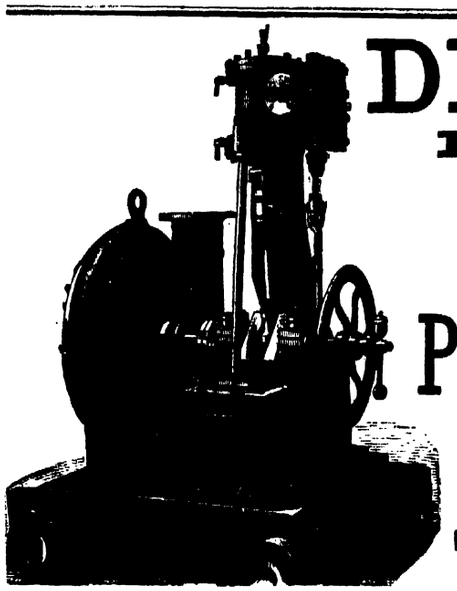
STEAM REDUCING VALVE.



STEAM WINCH, FOR HOISTING PURPOSES ON LAND OR SEA.



STEAM PUMP, MADE TO SUIT ANY KIND OF WORK. 4070

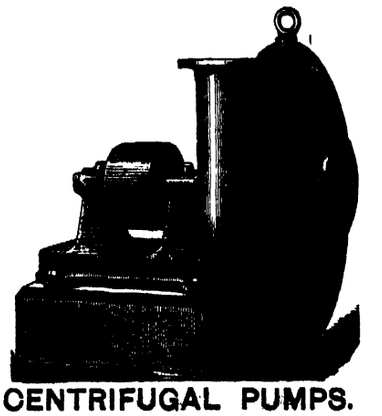


DRYSDALE & CO.
LONDON ROAD, GLASGOW.

DIRECT-ACTING
Vertical Centrifugal
PUMPING ENGINES
FOR
Circulating or Ballasting Purposes.

—:o:—

RECEIVED AWARD AT THE NORTH-EAST COAST EXHIBITION TYNEMOUTH, 1882. 4081



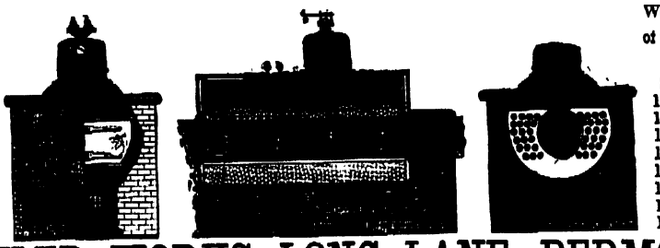
CENTRIFUGAL PUMPS.

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS.

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breese, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the sizes and power of these Boilers, showing the small amount of space they occupy—

9ft.	long,	5ft. 0in.	diameter,	20-horse	power.
10ft.	,,	5ft. 6in.	,,	30	,,
12ft.	,,	6ft. 0in.	,,	40	,,
13ft.	,,	6ft. 6in.	,,	50	,,
14ft.	,,	7ft. 0in.	,,	60	,,
15ft.	,,	7ft. 6in.	,,	70	,,
16ft.	,,	8ft. 0in.	,,	80	,,
17ft.	,,	8ft. 0in.	,,	90	,,
18ft.	,,	8ft. 0in.	,,	100	,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 5140



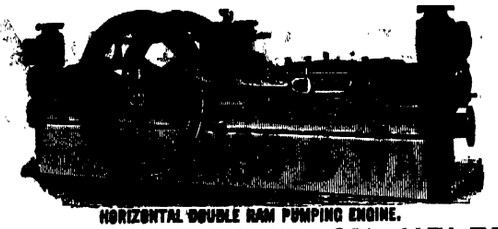
DOUBLE RAM PILLAR PUMPING ENGINE.

W. NEILL & SON,

ENGINEERS, IRON & BRASS FOUNDERS, BOILER MAKERS, &c.

MANUFACTURERS OF

PUMPING ENGINES, BLOWING ENGINES, STEAM ENGINES, AIR COMPRESSORS, and VACUUM PUMPS.



HORIZONTAL DOUBLE RAM PUMPING ENGINE.



BLOWING ENGINE AND AIR COMPRESSOR. 4258

BOLD IRON WORKS, ST. HELEN'S JUNCTION, LANCASHIRE.

JESSOP'S CRANES

For Particulars see last Week's "ENGINEERING," or WRITE FOR HANDBOOK.

J. JESSOP & SON, LEICESTER. 5113

Or 113, CANNON STREET, LONDON.

JAMES GOODWIN & Co.,

Ironfounders, Bridge Builders, Engineers, & Boiler Makers,

MOTHERWELL NEAR GLASGOW.

MAKERS OF *Cast Iron Chairs, Cast Iron Sleepers,* COLUMNS, TANKS, *Ingot Moulds, and General Castings.*



VIADUCT AT HIGH BLANTYRE, CALEDONIAN RAILWAY. LENGTH, 790 FEET. ERECTED 1882.

SOLE MAKERS OF HOPE'S PATENT Stone Breakers.

Foundries also at Ardrossan, Ayrshire, AND Johnstone, Renfrewshire.

5274

MAKERS OF IRON ROOFING AND GENERAL STRUCTURAL WORK.

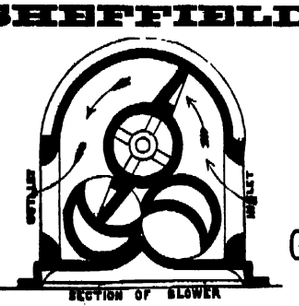
THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

Baker's Patent Rotary Pressure Blower and Gas Exhauster.

BAKER'S PATENT ROTARY PUMP.

CRUCIBLE STEEL CASTINGS.



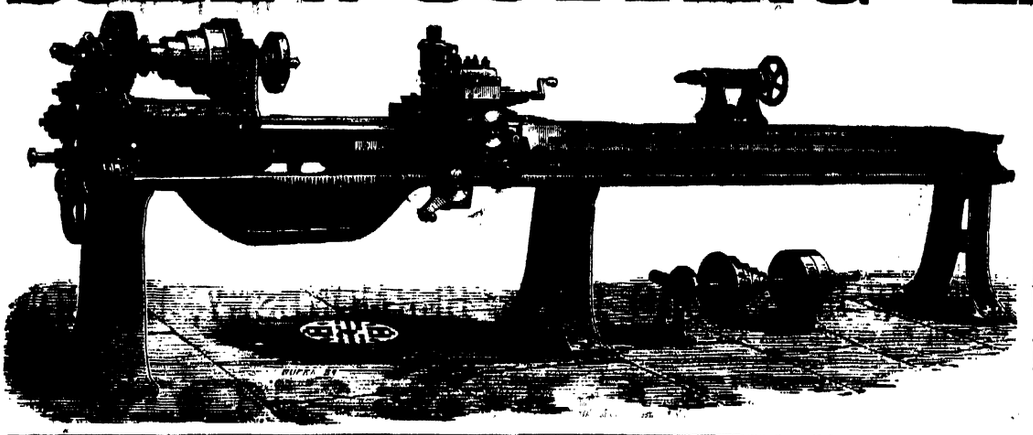
SECTION OF BLOWER

HALL'S PATENT STONE BREAKER.

General Machinery of Every Description.

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4668

SCREW-CUTTING LATHES,



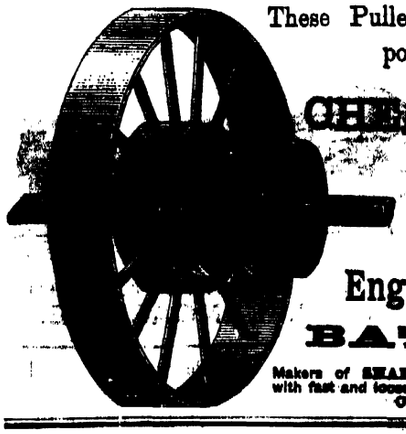
6 in. to 24 in. Centres.

PRICED CATALOGUES ON APPLICATION.

LOUDON BROTHERS,

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These Pulleys are **TURNED IN A LATHE,** and not polished on a Grindstone like those generally sold.

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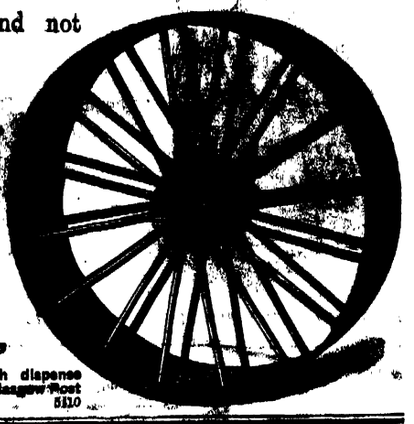
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Engineers, Ironfounders & Millwrights,

BATLEY, YORKSHIRE,

Makers of **SHAFTING** and **FRICTION PULLEYS** for Electric Lighting Machinery, which dispense with fast and loose Pulleys: one Pulley answers for both. In use at L.&N.W. Railway, Mine Sheet; Glasgow Post Office; King's Cross Station; and all principal Factories home and abroad. 5110

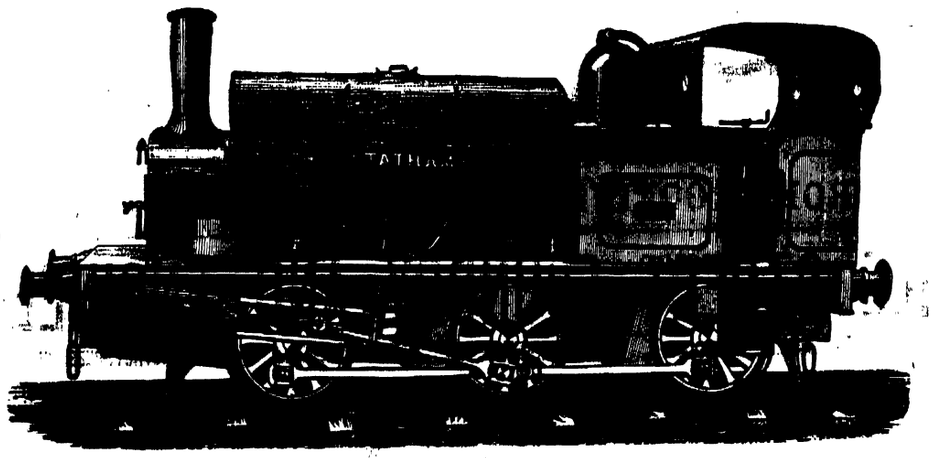


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PRICES and SPECIFICATIONS on Application.



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LOCOMOTIVE TANK ENGINES

OF ALL SIZES AND TO SUIT ANY GAUGE OF RAILWAY,

For Main Line or Branch Railways, Contractors, Ironworks, Collieries, &c.

CRANES! CRANES!

SEE HALF-PAGE ADVERTISEMENT NOV. 14th, Page 55.

RAILWAY PLANT!!

SEE HALF-PAGE ADVERTISEMENT NOV. 28th, Page 55.

RANSOMES & RAPIER, 5, Westminster Chambers, LONDON, S.W., and Waterside Ironworks, IPSWICH. 8052

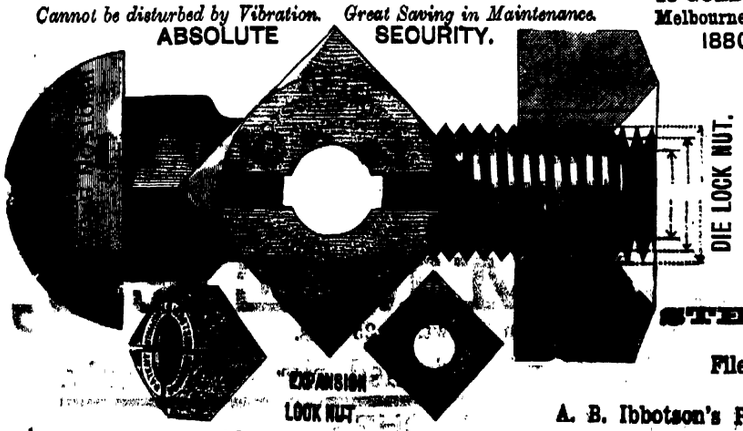
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AND COMPANY, LIMITED,

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SHEFFIELD.

Manufacturers of

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STEEL FORGINGS, AXLES, &c., RAILWAY SPRINGS OF ALL KINDS.

Files (Hand Cut only), Saws, Edge Tools, and Patent Automatic Central Coupling Buffers.

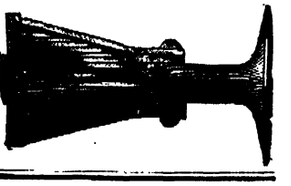
A. B. Ibbotson's Patent Steel Die and Expansion Lock Nuts, and Steel Bolts, Railway Fastenings, &c., &c.



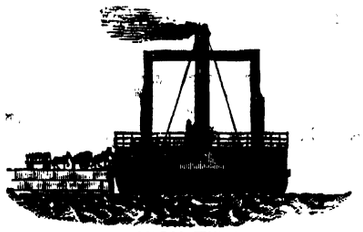
GEORGE TURTON'S PATENT WROUGHT IRON BUFFERS,

AND PATENT COMPOUND CAST STEEL SPRINGS. {4120 3618

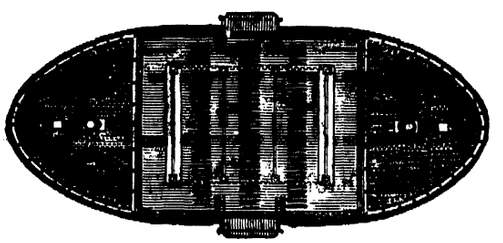
LONDON OFFICE: 4, WESTMINSTER CHAMBERS, VICTORIA STREET, S.W.



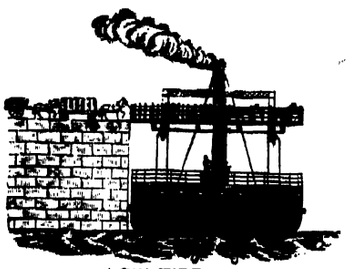
PATENT ELEVATING STEAMER,



HIGH TIE.

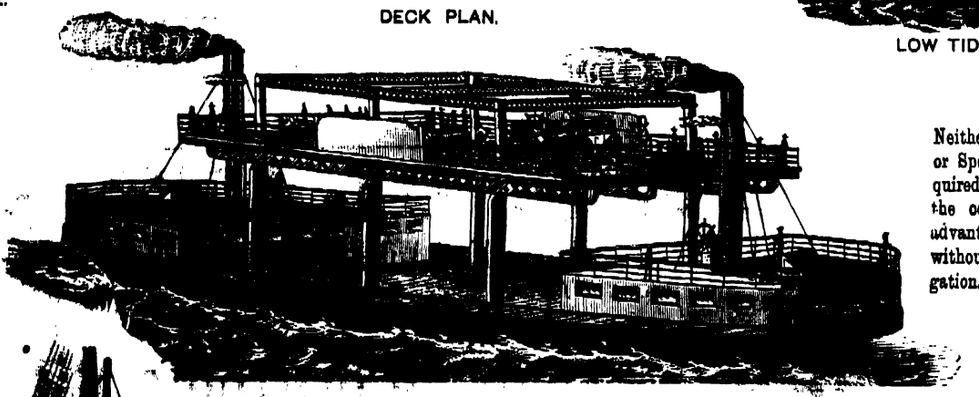


DECK PLAN.

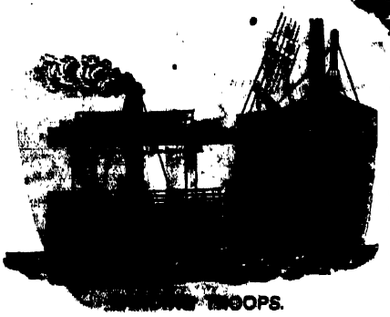


LOW TIDE.

For Ferry Traffic, to Land and Embark Passengers, Carriages, Wagons, and Cattle on same level as Pier or Quay, irrespective of the rise and fall of tide. Also for Landing and Embarking Troops, Horses, and Artillery.



Neither Slips or Pontoons, or Special Berths are required. At a fraction of the cost it has all the advantages of a Bridge, without obstructing Navigation.



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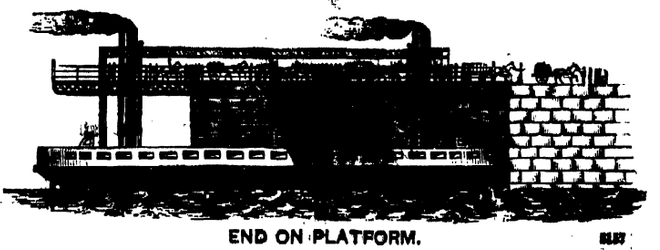
W. SIMONS & CO.,

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SCOTLAND,

CONSTRUCTORS.



END ON PLATFORM.

ESTABLISHED 1839.

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ESTABLISHED 1839.

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Manufacturers of the only Patent Safety Starting, Turning, or Barring Engine.

Makers of STEAM ENGINES up to 3,000 HP.

With Patent Automatic Cut-off Motion. Adaptable to Stamper Valves, Slide Valves, and Corliss Valves, which can also be applied to existing Engines.

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On Condie's principle, with Patent Valve Motions, from 3½ cwt. to 25 tons.

Wrought-Iron and Steel STEAM BOILERS with drilled rivet holes only.

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(LATE B. GOODFELLOW. ESTABLISHED 1838.)

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All Descriptions of Millwright Work.

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IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

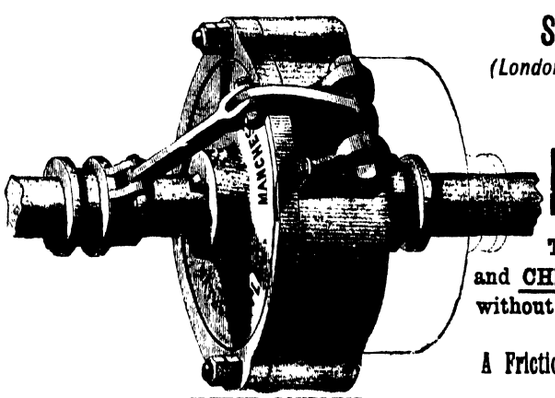
CYLINDERS, &c., BORED AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINERY.

FLY-WHEELS, ROPE AND BELT PULLEYS, &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 5066

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CLUTCH COUPLING.

LIBERAL TERMS TO THE TRADE.

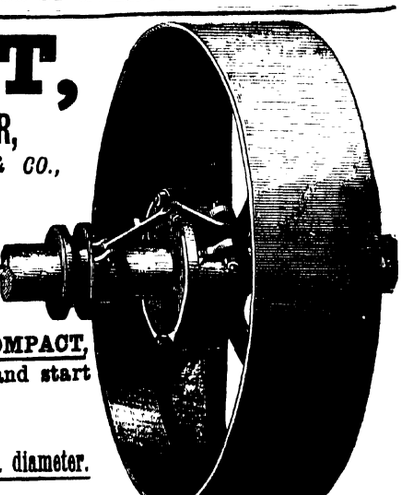
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These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.

PRICES ON APPLICATION.



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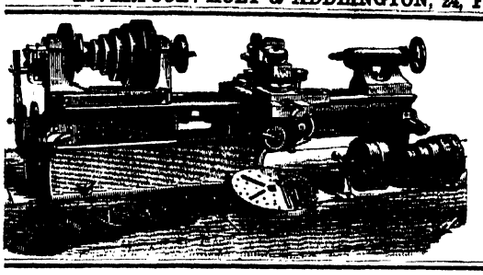


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Improved Self-Acting, Sliding, and Screw Cutting Lathes,
For Foot or Power. 5240

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The Royal Agricultural Society of England have awarded every FIRST PRIZE to CLAYTON AND SHUTTLEWORTH for PORTABLE and other STEAM ENGINES since 1863, and PRIZES at every MEETING at which they have competed since 1849.

Steam Engines, Portable and Fixed. (Over 21,500 Sold)
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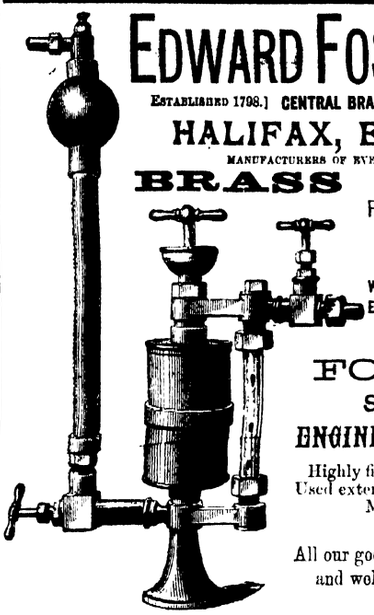


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PATENT VERTICAL
Multitubular Boiler,
— WITH QUADRANT FLUE TUBES. —
ADVANTAGES:
Compactness, Durability, Economical, Accessible, Cheap in First Cost, Suitable for all uses, and adapted for Export.

VARIOUS SIZED BOILERS
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For Steam, Gas, and Water.

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FOR SPECIALITIES OF STEAM WHEEL VALVES, STEAM COCKS, ETC. ASK FOR ILLUSTRATIONS.

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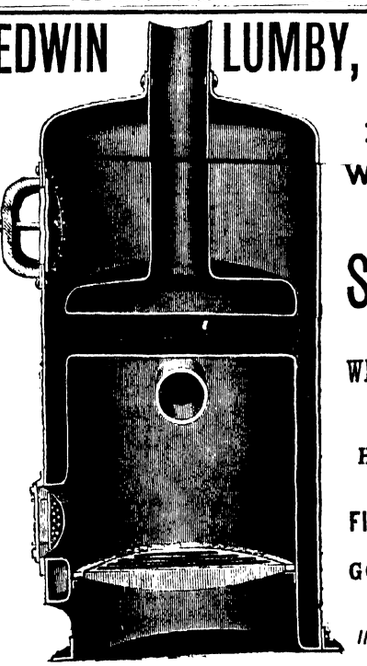




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ENGINE LUBRICATOR,
Highly finished in Brass or Iron, Used extensively on both Land and Marine Engines.

All our goods are of High Quality and well adapted for Export.

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WEST GROVE WORKS,
HALIFAX,
Manufacturers of
WROUGHT [illegible]
AND
RIVETED
STEAM BOILERS
(Cross Tubes & Multitubular).
ALSO
WROUGHT WELDED AND RIVETED
BOILERS
FOR
Hot Water Heating Apparatus.
HOT WATER VALVES.
FIRE & BURGLAR PROOF SAFES.

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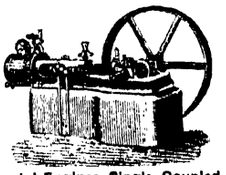
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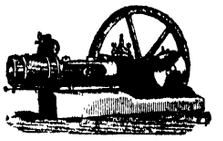
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Portable and Semi-Portable Engines for all kinds of Fuel.

MORE THAN 12,350 ENGINES MADE AND SUPPLIED.





Horizontal Engines, Single, Coupled, and Compound, with Cornish, Lancashire, Locomotive, Multitubular, or Vertical Boilers.

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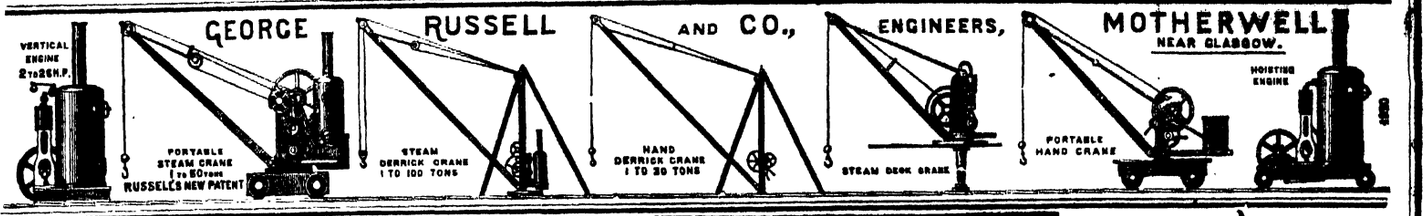
ENGINES SPECIALLY EQUIPPED FOR DRIVING ELECTRIC LIGHT MACHINERY.

CALCUTTA EXHIBITION, 1884.—Five Gold and Three Silver Medals.
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PARIS EXHIBITION, 1878.—Two Gold Medals and other Prizes.

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GEORGE RUSSELL AND CO., ENGINEERS, MOTHERWELL

NEAR GLASGOW.



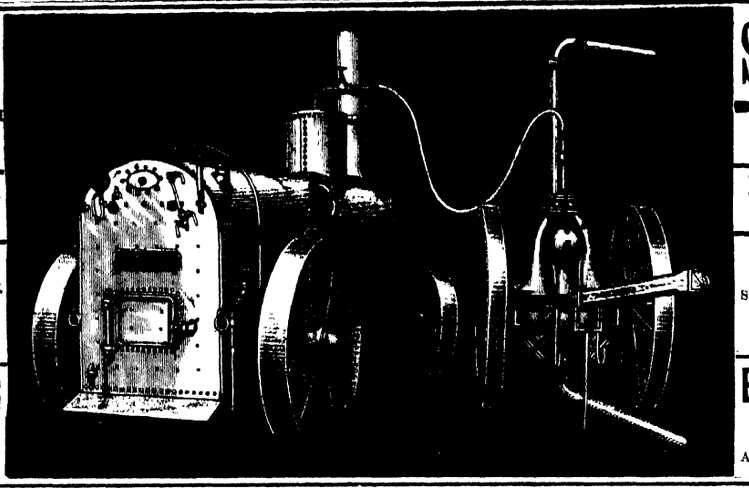
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Will Pump almost anything.

No Moving Parts except the simple Valves.

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Such as Well-Sinking, Foundations, Sea Walls, &c.
USE ON BOARD STEAM SHIPS
Over 250 Vessels now fitted, &c., &c.

THE PULSOMETER
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PULSOMETERS ON HIRE.



STEAM PUMP.

Will Work Suspended on a Chain.

No Oiling, Packing or skilled attention.

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Such as Raising Water for Stock, Irrigation, &c.
MANUFACTURERS' USE
For General Pumping, &c.

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A LARGE STOCK KEPT OF PULSOMETERS, BOILERS, PIPES, &c. 4889

PATENT ROLLED

SHAFTING

IN IRON AND STEEL

By Royal Letters Patent.

BUTLER'S PATENT FRICTIONAL COUPLINGS.

and



The Kirkstall Forge Co., Leeds,
SOLE MAKERS. 4901



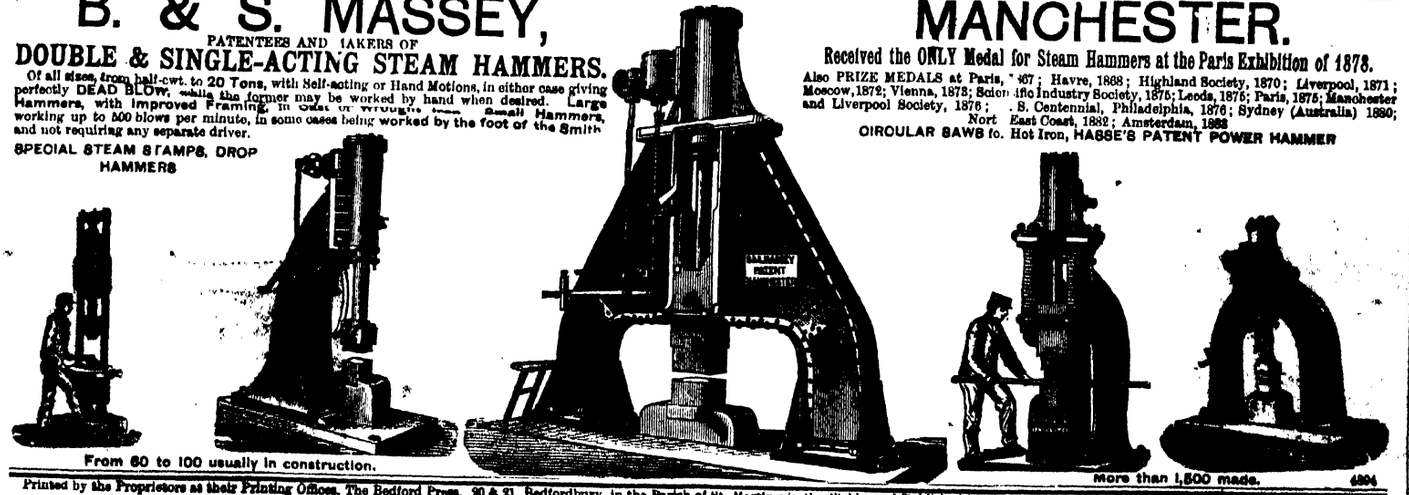
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B. & S. MASSEY, MANCHESTER.

PATENTEES AND MAKERS OF
DOUBLE & SINGLE-ACTING STEAM HAMMERS.

Of all sizes, from half-cwt. to 20 Tons, with Self-acting or Hand Motions, in either case giving perfectly DEAD BLOW, while the former may be worked by hand when desired. Large Hammers, with Improved Framing, in Cast or Wrought Iron. Small Hammers, working up to 500 blows per minute, in some cases being worked by the foot of the Smith, and not requiring any separate driver.

SPECIAL STEAM STAMPS, DROP HAMMERS



From 60 to 100 usually in construction.

Received the ONLY Medal for Steam Hammers at the Paris Exhibition of 1878.

Also PRIZE MEDALS at Paris, '67; Havre, 1868; Highland Society, 1870; Liverpool, 1871; Moscow, 1872; Vienna, 1873; Scientific Industry Society, 1875; Leeds, 1875; Paris, 1875; Manchester and Liverpool Society, 1876; U.S. Centennial, Philadelphia, 1876; Sydney (Australia) 1880; North East Coast, 1882; Amsterdam, 1883

CIRCULAR SAWS &c. Hot Iron, HASSE'S PATENT POWER HAMMER

More than 1,500 made. 4894

Printed by the Proprietors at their Printing Offices, The Bedford Press, 20 & 21, Bedfordbury, in the Parish of St. Martin-in-the-Fields, and Published by CHARLES GILBERT, at the Offices of ENGINEERING, 35 & 36, Bedford Street, in the Parish of St. Paul, Covent Garden, both in the County of Middlesex.—Friday, December 5th, 1884.

ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND JAMES DREDGE.

OFFICES FOR ADVERTISEMENTS AND PUBLICATION, 35 & 36, BEDFORD STREET, STRAND, LONDON, W.C.

VOL. XXXVIII.—No. 989.] *LONDON: FRIDAY, DECEMBER 12, 1884.* [PRICE...6*d*. BY POST..6½*d*.

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With a Two-page Engraving of BRIDGE OVER THE RIVER INDUS, AT ATTOCK; PUNJAUB NORTHERN STATE RAILWAY.

Portland Cement,

manufactured by

Francis and Co.,

5338

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Rugby Portland Cement

COMPANY.

MANUFACTURERS OF

Portland Cement

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RUGBY, WARWICKSHIRE.

WORKS: NEW BILTON AND NEWBOLD. 4867

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AND

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Stannah's Pendulum Pumps.

For Prices see alternate weeks. 3238

Over 15,000 "Otto" Engines

AT WORK,

Using 25 to 75 % less Gas per Brake HP. than Any other Engine.

Crossley's Patent Self-Starter,

Safest, Best, and Simplest made, may now be applied. 5383

Crossley's Patent Twin-Engine

Impulse every Revolution. Very Steady in Running

HIGHEST AWARD AT PARIS ELECTRICAL EXHIBITION.

Crossley Bros., Ld., Manchester.

Steam Launches. — Messrs.

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Screw Steamers having speeds up to twenty-six miles an hour. Paddle Steamers having draughts down to 6 inches of water. Machinery constructed for boats built abroad. 5384

Steam Launches can be

Shipped most conveniently from the Mersey to all parts of the world. A large number of various sizes always in progress at COCHRAN & CO.'S, Birkenhead. See page 4. 4749

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Have FOR SALE, New STEEL STEAM YACHT, 60 ft. by 10 ft. 4 in., New WOOD STEAM LAUNCH 40 ft. by 7 ft. 6 in., and Second-hand ditto, 22 ft. by 5 ft. 6 in. 3551

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SHIP AND LAUNCH BUILDERS ENGINEERS. 4457

G. F. G. Des Vignes, Chertsey,

Surrey, Builder of First-class High-speed Steel Yachts, Launches, & Torpedo Boats. Estab. 1869. 3784

Patent Spring Safety Valves.

THOMAS ADAMS,

WORKS OF THE "ANT AND BEE,"

WEST GORTON, MANCHESTER.

SEE LARGE ILLUSTRATED ADVERTISEMENT, NOV. 21, PAGE 48. 4872

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SHEFFIELD. GOLD Medals, Paris and Melbourne, '78 & '80. For Engineers, Railways, Tramways, Mines, Hydraulic Work, Dredgers, &c., &c. Specially sound, dense, and of unequalled strength, toughness and durability. Our Unhammered Steel Castings, as recently tested by H.M. Govt., stand 40 to 65 tons per sq. inch (varying according to the hardness and purpose required) and up to 20 per cent. elongation. Can be thoroughly relied upon for regularity and uniformity of temper. See Advertisement page 24 4593

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Ready for Delivery.

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ENGINES, for marine and general purposes. Stock sizes from 6 to 150 I. HP. Special patterns for Electric Lighting.—WILLANS & ROBINSON, Thames Ditton, Surrey. 5283

R. E. Crompton and Co.,

ELECTRIC LIGHT ENGINEERS,

MANSION HOUSE BUILDINGS, E.C. 5426

See Advertisement last week, page 12.

Worthington Pumping

ENGINE COMPANY, 5445

114, QUEEN VICTORIA STREET, LONDON, E.C.

See Illustrated Advertisement, page 46.

Hunter and English,

ENGINEERS AND MILLWRIGHTS,

IRON AND BRASS FOUNDERS, BOW, LONDON, E.

DREDGING MACHINERY.

HYDRAULIC MACHINERY.

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Pumping Machinery

Of all Kinds.

5054

39, QUEEN VICTORIA STREET, LONDON, E.C.

Field's Patent Boilers and

TUBES,

LEWIS OLRICK & CO., London. 5046

See Illustrated Advertisement, page 26

George Russell & Co.,

ENGINEERS and BOILERMAKERS,

ALPHA STEAM CRANE and ENGINE WORKS, MOTHERWELL, near GLASGOW.

SILVER MEDAL, PARIS, 1867. 4921

Steam Hammers.—

Massey's Patent Hammers

RECEIVED THE *ONLY* PRIZE MEDAL PARIS 1878.

More than 1500 made.

Drop Hammers Hasse's Patent Power Hammer.

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For Mines, Water Supply, Irrigation, Graving Docks, Drainage of Fens and General Pumping Purposes.

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HYDRAULIC MACHINERY OF ALL KINDS.

The "DOMESTIC" MOTOR.

CATALOGUES ON APPLICATION. 5356

Locomotive Tank Engines

designed and constructed by

MANNING, WARDLE, AND COMPANY,

Boyne Engine Works, Leeds.

See their Illustrated Advertisement, page 39. 3487

Locomotive Tank Engines,

TRAMWAY ENGINES AND CARS.

Built by THE FALCON ENGINE and CAR WORKS, Limited, Loughborough. 5206

See Illustrated Advertisement, Nov. 28, page 9.

The Patent Corliss Engine

And PATENT CORLISS GEAR ENGINE, with special Improvements by DOUGLAS and GRANT, Dunnikier Foundry, Kirkcaldy, N.B. These engines are made Horizontal or Beam, Condensing, Non-Condensing, and Compound. Also makers of Rice Mills, and Paper Mills, and General Engineers. Machinery shipped or trucked direct from the premises. 3590

John Cochrane, Engineer,

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Advertises his STEAM ENGINES, STEAM HAMMERS, STEAM PUMPS, &c., in this Paper every Fortnight. Catalogues, &c., on application. 5320

Steel Hydraulic Cylinders.—

HENRY BESSEMER & CO., Limited,

SHEFFIELD.

See Advertisement last week, page 37. 3657

Tweddell's

Hydraulic Rivetting Machines

14, DELAHAY STREET, WESTMINSTER, LONDON, S.W. 4897

See Illustrated Advertisement last week, page 53.

L. Sterne & Co., Limited.

ENGINEERS,

Sole Makers of

Clerk's Patent

Self-Starting

Gas Engine.

HIGHEST AWARD,

BRITISH SECTION ELECTRICAL EXHIBITION, PARIS, 1881.

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CRYSTAL PALACE ELECTRICAL EXHIBITION, LONDON, 1882.

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Emery Wheels.

Emery Machines,

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The Crown Iron Works (Hollinwood), MANCHESTER.

10, Victoria Chambers, WESTMINSTER.

City Office and Show Rooms, 40, CANNON STREET, E.C.

10, Rue Laffitte, PARIS. 2588

Royal Indian Engineering College, Cooper's Hill, Staines. The course of study is arranged to fit an engineer for employment in Europe, India, or the Colonies. Sixty Students will be admitted in September, 1885. For competition the Secretary of State will offer FIFTEEN APPOINTMENTS in the Indian Public Works Department, and TWO in the Indian Telegraph Department. For particulars apply to the SECRETARY at the College. 5422

TENDERS.

INDIA OFFICE,
12th December, 1884.

BY ORDER OF THE SECRETARY OF STATE FOR INDIA IN COUNCIL.

INDIAN STATE RAILWAYS.

The Director General of Stores for India is prepared to receive

Tenders from such Persons as may be willing to SUPPLY—

1. STEEL RAILS, 41½ lbs. per yard.
2. BRASS BOILER TUBES.

The Conditions of the Contracts may be obtained on application to the Director General of Stores, India Office, Westminster, S.W., and Tenders are to be left at his Office at any time before Two o'clock p.m. on Tuesday, the 23rd December, 1884, after which no Tender will be received.

A. ABERCROMBIE JOPP, J 375
Director General of Stores.

HIS HIGHNESS THE NIZAM'S GUARANTEED STATE RAILWAYS COMPANY, LIMITED.

His Highness The Nizam's Guaranteed State Railway Company, Limited, is prepared to receive

Tenders for the Supply and DELIVERY OF:—
BESSEMER STEEL VIGNOLES RAILS,
BESSEMER STEEL FISH PLATES, and
WROUGHT IRON FISH BOLTS, NUTS, and WASHERS.

Tenders are to be delivered in sealed envelopes, addressed to the undersigned, marked "Tender for Bessemer Steel Rails," or as the case may be, not later than Two o'clock p.m. on Monday, the 22nd day of December next.

The Form of Tender, copy of Specification and Conditions of Contract may be obtained at the Offices of the Company on payment of 2s. 6d. in each case.

The Directors do not bind themselves to accept the lowest or any Tender.

By order of the Board,
G. H. M. BATTEN, Secretary.
7, Great Winchester Street, E.C.,
11th December, 1884. J 377

BOROUGH OF BRIGHTON.

TO CONTRACTORS AND OTHERS.

Notice is Hereby Given that the Town Council will receive

Tenders from such Persons as may be willing to enter into a Contract for the SUPPLY of such quantity of PORTLAND CEMENT as may be required for a period of twelve months, to be delivered at either of the Brighton Railway Stations as ordered, in quantities of about six tons at one time.

Forms of Tender and Specification may be obtained at the Office of the Borough Surveyor, Mr. PHILIP C. LOCKWOOD, C.E., at the Town Hall, Brighton. Sealed Tenders addressed to the Works Committee, and endorsed "Tender for Portland Cement" must be left at my Office, at the Town Hall, before Four o'clock in the afternoon, on Tuesday, the 23rd day of December, 1884.

Power is reserved to reject the lowest or any Tender.

Town Hall, Brighton, FRANCIS J. TILLSTONE,
4th December, 1884. Town Clerk. J 344

LANCASHIRE AND YORKSHIRE RAILWAY.

The Directors are prepared to receive

Tenders for the Construction of—

A RAILWAY from Pendleton to Hindley, length 13 miles 9 chains.
A CONNECTING LINE at Agecroft, length 38 chains; and
A CONNECTING LINE at Westhoughton, length 1 mile 30 chains.

Plans and Specifications may be seen, and quantities, with Forms of Tender obtained, on application at the Engineer's Office, Hunt's Bank, Manchester, on and after Monday, the 15th instant.

Tenders to be in the hands of the undersigned, not later than Ten o'clock on the morning of Monday, the 12th January proximo.

The Directors do not bind themselves to accept the lowest or any Tender.

J. H. STAFFORD,
Hunt's Bank, Manchester, Secretary.
5th December, 1884. J 345

GREENOCK HARBOUR TRUST.

JAMES WATT DOCK AND OTHER WORKS.

The Trustees are prepared to receive

Tenders for the Construction of:—

(First.) TWO WAREHOUSES, each 90 ft. long by 107 ft. wide. To be built of brick with iron columns;
(Second.) TWO SHEDS of a total length of 500 ft. by 107 ft. in width. To be built of brick with iron roofs; and
(Third.) A COVERED WAY 680 ft. long by 27 ft. wide. To be built of iron and concrete.

Drawings may be seen, and Copies of Conditions, Specification, and Form of Tender, obtained at the Engineer's Office, on deposit of Postal Order for £1, which will be returned to all those whose Tenders are lodged and properly filled in.

Sealed Tenders marked "Tender for Warehouses, Sheds, and Covered Way," must be lodged with the undersigned, on or before Monday, the 5th January, 1885.

None other than the Printed Forms of Tender will be received by the Trustees.

The Trustees do not bind themselves to accept the lowest or any Tender.

Any further information may be obtained from WALTER ROBERT KINIPPLE, Engineer to the Trustees, 17, West Blackhall Street, Greenock.

Greenock, THOS. WILSON, J 368
10th December, 1884. Clerk to the Trustees.

TO CONTRACTORS AND OTHERS.

The EDMONTON LOCAL BOARD OF HEALTH invite **Tenders for 1,000 ft., or thereabouts**, of 15 in. CAST-IRON PIPES, including necessary Bends, Junctions, and Stop Valves.

Particulars may be obtained of Mr. G. EMMS EACHUS, 2, Great Queen Street, Westminster, the Engineer to the Board.

Tenders endorsed "Tender for Iron Pipes," to be delivered at my Office, on or before Ten a.m., on Tuesday, the 23rd December instant.

The Board do not bind themselves to accept the lowest or any Tender. By order, J 369
Church Street, WM. FRANCIS PAYNE,
Lower Edmonton. Clerk to the Board.

BOROUGH OF BEDFORD.

CORPORATION WATER WORKS.

NOTICE TO BUILDERS, BRICKLAYERS, EXCAVATORS, BRICKMAKERS, AND OTHERS.

The Urban Sanitary Authority of the Borough of Bedford are prepared to receive

Tenders for the Execution of certain Works in connection with the construction of a NEW SERVICE RESERVOIR, FILTER BEDS, and STORAGE TANK.

Plans to be seen, and Specifications and all particulars can be obtained by application to Mr. J. LUND, Borough Surveyor, Corn Exchange, Bedford, after the 24th inst.

Tenders to be sent in for the whole or any portion of the work not later than the 6th January, 1885.

The Authority do not bind themselves to accept the lowest or any Tender.

T. S. PORTER,
Clerk to the Urban Sanitary Authority.
12th December, 1884. J 378

APPOINTMENTS OPEN.

Blast Furnace Manager. WANTED, for an Iron Works in the West Cumberland District, a thoroughly experienced MAN accustomed to the manufacture of Bessemer pig iron, and spiegeleisen on the most modern system of working. Applicant to state salary expected, and give reference as to qualifications.—Address, J 303, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. J 303

Wanted, a Head Foreman over Fitters, Turners, &c., in a manufactory where steam cranes, winches, and other ships' deck machinery is made.—Apply, stating age, experience, and salary expected, enclosing only copies of any recent testimonials, to J 367, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. J 367

Wanted, a Mechanic to go to South America to take charge of Engine, Boiler, and Saw-Mill Machinery; also wanted, a FOREMAN of Saw-Mills, to go to the same place.—Apply, by letter only, to A. B., Messrs. S. WORSHAM and Co., Saw Mill Engineers, Oakley Works, King's Road, Chelsea, S.W. J 352

Agents Wanted, to Sell Fine DURABLE COMPOUND MACHINERY OILS, amongst mills, mines, and other steam power users. Liberal commission.—Address, J. B. TYLOR, 24, Finch Street, Whitechapel, London. J 354

Agents Wanted, to push First-class MACHINERY OILS commanding a large and successful sale. Liberal commission.—Address BOX 201, Post Office, Liverpool. 5233

Lists of Berths Vacant or WANTED. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5378

SITUATIONS WANTED.

Draughtsman, Trained in large GENERAL ENGINEERING and BRIDGE WORKS, GLASGOW, three years' ENGINEERING COURSE GLASGOW UNIVERSITY, THIRTEEN YEARS' EXPERIENCE, including BRIDGES, ROOFS, Structural Ironwork generally, RAILWAY WORKS, QUANTITIES, SPECIFICATIONS and ESTIMATES, DESIRES a SITUATION.—Address, J 332, Offices of ENGINEERING, 35 & 36, Bedford Street, Strand, London, W.C. J 365

An Engineer, recently returned from Brazil, wants SITUATION at home or abroad, to fix or look after any kind of machinery; thoroughly practical; holds first-class Board of Trade Certificate for competency.—Address, J. S. A., 3, Nassington Road, Hampstead Heath, London. J 342

Wanted, Situation as Assistant Draughtsman or Engineer, 7½ years' experience in Workshops and Drawing Office, good references.—Address, J 348, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. J 348

Young Gentleman, who has had experience in Shops and Drawing Office of Mechanical Engineer, DESIRES ENGAGEMENT early in January as Assistant Draughtsman.—Address, J 357, Offices of ENGINEERING. J 357

Civil Engineer, well versed in Parliamentary and Permanent Railway work, good and quick Draughtsman, and had experience in large office, OFFERS his SERVICES after Christmas.—Address, Z., Offices of ENGINEERING. J 374

Contractor's Engineer (Scotch) REQUIRES APPOINTMENT; has had thirteen years' experience in Railway and Harbour Works; good references.—Address, J 353, Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. J 353

Required, to Place a Gentleman (aged 18) in an Engineer's Drawing Office, after Christmas, for three hours every morning of the week, where he could learn thorough mechanical and general engineering drawing. A moderate premium would be paid.—Address, R., Offices of ENGINEERING, 35 and 36, Bedford Street, Strand, London, W.C. J 349

Staffordshire Terra Metallic PAVINGS.—An Importer of Portland Cement, Sanitary Pipes, &c., at Rotterdam, Holland, WISHES to REPRESENT an English House in the above article. Please state immediately lowest quotation, c.i.f., Rotterdam for cash.—Address, W. S. H., care of Messrs. NYGH & VAN DUNBAR, Rotterdam. J 350

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To Civil, Mechanical, Marine AND ELECTRICAL ENGINEERS. There are now on the Register the names of gentlemen duly qualified to fill various situations as Engineers, Managers, Draughtsmen, &c.

Particulars and Terms may be had on application to Mr. JAMES MACDONALD, M.I.M.E., 32, Queen Anne's Gate, Westminster, S.W. 5440

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Engineering Firms of Good REPUTE, open to admit partners or desirous of selling outright, are requested to communicate with the undersigned, who have numbers of clients open for such.—WHEATLEY KIRK, PRICE, and GOULTY, 52, Queen Victoria Street, London, E.C., and Albert Square, Manchester. 4926

Partnerships. — Gentlemen (practical engineers) desirous of entering established Engineering concerns, are invited to communicate with the undersigned, who have numerous bona fide establishments open to admit such. References are given and required.—WHEATLEY KIRK, PRICE, and GOULTY, 52, Queen Victoria Street, London, E.C., and Albert Square, Manchester.

To Civil Engineers in practice. —The undersigned INVITE CONFIDENTIAL COMMUNICATIONS from Firms, or Gentlemen of standing and repute, who are open to admit qualified Partners, or to sell outright.

WHEATLEY KIRK, PRICE and GOULTY, 52, Queen Victoria Street, London, E.C. 5371

To Steel Makers.—The InVENTOR of a Process and Machine for the continuous production of small Bars and Wire direct from the molten steel, without the previous casting into ingots, and reducing these to smaller sections, is desirous of combining with a Firm of good standing for the development of his invention.—Address, B. M. 567, Messrs. DEACONS, Leadenhall Street, E.C. J 372

WANTED, &c.

Wanted, a Light Draught STEAMER of the following dimensions:—Length, 120 ft., over all; beam, 20 ft.; draught not to exceed 4 ft. 6 in., with 40 tons of coal on board; preferred to be built of wood, copper fastened. To have compound engines and twin screw; speed from 8 to 10 knots per hour.—Apply, with particulars, to Messrs. G. D. PETERS & CO., Moorgate Works, Moorfields, E.C. J 372

Wanted, a First-class HoriZONTAL ENGINE, condensing preferred, about 18 HP. Nominal; new, or good second-hand in thorough repair.—GEO. RILEY, 56, South Lambeth Road, London, S.W. J 359

Wanted, Root's Blower, No. 3, in good working condition; state lowest price.—Apply to HENRY BROOK, Colne Street Iron Foundry, Huddersfield. J 341

Wanted, Second-hand, Treble- Geared Self-acting Screw-cutting BREAK LATHE, 18 in. centres, not less than 20 feet bed, face plate with paws.—LOUDON BROTHERS, 150, Upper Thames Street, London, E.C. J 356

Wanted, Specialities to Make, by Firm of Machine Tool Makers, having exceptional and first-class facilities for good work at reasonable prices.—H.W., Offices of ENGINEERING. J 347

Wanted, to Treat with a Firm of Mechanical Engineers for the MANUFACTURE, either on Royalty or by Assignment, of a Newly Patented STEAM PUMP of simple and economical construction.—Particulars on application to STEAM PUMP, care of Mr. JOSEPH BERNAYS, M.I.C.E., 96, Newgate Street, London. J 355

Lists of Machinery Wanted or on SALE. See "ENGINEERING REVIEW," weekly 1d.—E. & F. N. SPON, 16, Charing Cross, London; or of all News Agents. 5262

FOR SALE.

For Sale, The Universal Pulveriser. Will grind all kinds of Refractory Materials, Ores, Stones, &c. Weight 4 tons. New.—Apply, C. E. HALL, Standard Iron Works, Washford Road, Sheffield. 5246

For Sale, Largest Stock in England, Engineers' Machine Tools, Steam Hammers, Steam Engines, Wood-working Machinery, all sizes, best materials and workmanship, low prices; send for stock list.—SCOTT BROTHERS, Halifax.

For Sale, Steel Launch, Twin SCREW (in progress and nearly finished), 55 ft. long by 13 ft. beam, 6 ft. 6 in. deep, draught 3 ft. 6 in. engines 10 in. and 15 in. by 14 in. stroke. No wood work fitted; can be shipped in three sections; designed for high speed and light draught.—For Specification and price, apply to LOUDON BROTHERS, 111, Bethwell Street, Glasgow, and 150, Upper Thames Street, London. J 343

For Sale, New Horizontal ENGINE, 16 in. by 30 in. cylinders, complete; with governor, flywheel, and feed pump. Price to clear out, £100.—Address, J. MOORE & CO., 32, Victoria Street, Manchester. J 368

For Sale, Planing Machine, 14 ft. long by 6 ft. square, with three tool-slides; Lathe, 18 in. centres, 20 ft. gap bed, screw-cutting and surfacing; double-ended Punching and Shearing Machine, for 3 in. plates, 15 in. gaps; Steam Hammer, 1½ cwt., £45; 5 cwt., £75 (Nasmyth pattern), by J. Brown & Son, complete with anvil blocks, self-acting hammer, &c.—Address, JOHN HETHERINGTON & CO., 28, Victoria Street, Manchester. J 364

For Sale, by Private Treaty, VALUABLE RIVERSIDE ENGINE WORKS, on the TYNE, with stone quay, frontage of about 300 ft., where vessels can lie alongside for fitting, repairs, &c. The works are in perfect order, and are fitted up with the most modern plant and machinery.—For particulars apply to WILKINSON & MARSHALL, Solicitors 32, Grainger Street West, Newcastle-upon-Tyne. J 306

For Sale, Two New Locomotive BOGIE TANK ENGINES, gauge 3 ft. 6 in., cylinders 14 in. diameter, 20 in. stroke, four wheels coupled, 3 ft. 9 in. diameter, and four wheeled Bogie under cylinders, copper fire box, brass tubes, wrought-iron wheels, steel tyres and axles, side tanks, 800 gallons; awning, hand and steam brake; spark arresting chimney; made to a first-class specification for a Colonial Line and now not required.—For further particulars apply, THE HUNSLET ENGINE CO., Leeds, or R. ELLIOTT COOPER, Esq., C.E., 8, The Sanctuary, Westminster. J 285

For Sale, Two Compound BEAM ENGINES, by Hall of Dartford, and now working in Messrs. Wm. Joynsons & Son's Mill, St. Mary Cray. Can be seen at work by getting an order from MASSON, SCOTT & BERTRAM, Engineers, York Place, Battersea. Particulars as follows:—

One 36 HP. COMPOUND STEAM ENGINE, diameter high-pressure piston, 15½ in., stroke, 3 ft. 4 in.; diameter low-pressure piston, 28½ in., stroke, 5 ft.; condensing water pumps, 9 in., iron; double-acting mill water pump, 9½ in., BRASS; diameter of fly-wheel, 20 ft.; also spare pistons.

One 24 HP. COMPOUND STEAM ENGINE, diameter high-pressure piston, 11½ in., stroke, 3 ft. 3 in.; diameter low-pressure piston, 21½ in., stroke, 4 ft. 6 in.; condensing water pump, 6 in., iron; double-acting mill water pump, 7 in., BRASS; diameter of fly-wheel, 18 ft.; also spare pistons. Will be sold cheap. J 325

For Immediate Sale, at low prices for cash.
SECOND-HAND.

AIR COMPRESSOR, on air receiver, 2 steam cylinders, 6 in. diam. each, air cylinder, 9½ in. diam.
LANCASHIRE BOILER, 18 ft. 3 in. by 7 ft. diameter.
Twenty HORIZONTAL and VERTICAL ENGINES, cylinders from 3 to 20 in. dia.; second-hand and new.
10 in. TANK LOCOMOTIVE, by Fletcher, Jennings, and Co., 4 wheels coupled.
HORIZONTAL ENGINE, 8½ in. by 18 in., with reversing gear and winding drum, 3 ft. 10 in. by 3 ft. 10 in.
10-ton SELF-CONTAINED WEIGHING MACHINE.
20-ton ditto ditto.
ECLIPSE ROCK DRILL, on tripod and weights, and about 60 lbs. Steel Tools.
A New 9 HP. CHAPLINS' LOCOMOTIVE.
For prices and full particulars apply to "PHILLIPS MONTHLY MACHINERY REGISTER," Newport, Mon. 4904

Modern Engineering Works to be LET or SOLD, situate in Midland County on canal bank, and within collecting area of two important railway stations; about 4½ acres of land (which can be increased if desired); excellent buildings, with steam power, suitable for any engineering manufacturing purposes.—Apply to WHEATLEY, KIRK, PRICE & GOULTY, Albert Square, Manchester, or 52, Queen Victoria Street, London, E.C. J 367

A Tweddell Hydraulic RiVETTER for Sale Cheap, 6 ft. gap, complete and never been used.—Address, P. B., Offices of ENGINEERING, 35 and 36, Bedford Street, W.C. J 92

Engines, Boilers, Steam and Electric Launches (Wood or Steel) supplied quickly; prices moderate.—HENRY TIPPING & CO., Greenwich, London, Steam Ship Contractors, &c. G 896

Sextant, by Elliot Brothers, London, TO BE SOLD; fitted with neutral tint glasses, Stella telescope; in perfect order and adjustment.—Apply, CAPTAIN KNOCKER, 20, Wellington Road, Nantwich, Cheshire. J 358

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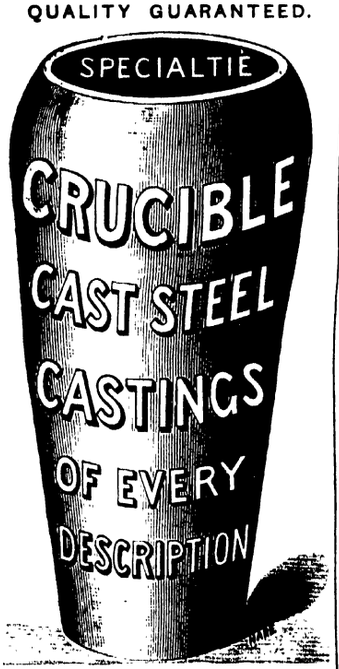
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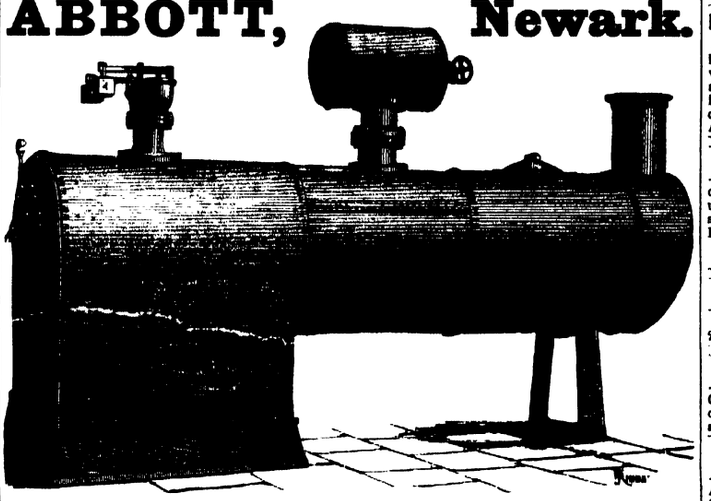
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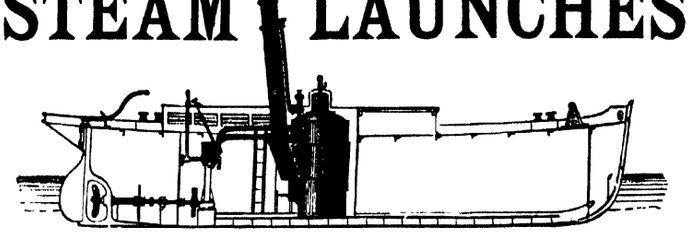
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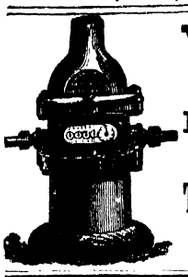
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PETHER'S PATENT DIAPER BRICKS, manufactured only by the Burham Brick, Lime and Cement Company.
A great variety of designs are prepared for diapered surfaces, string courses, circular columns, window heads, &c., to be seen at their London Depôt. 5338



WATER METERS.

H. FROST'S PATENT.

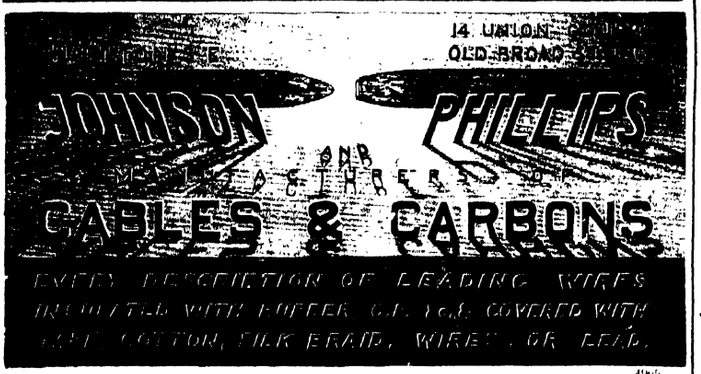
POSITIVE! RELIABLE! DURABLE!

Many Thousands in use both at Home and Abroad.

THE MANCHESTER WATER METER CO., Ltd.

TIPPING STREET, ARDWICK, MANCHESTER.

ESTABLISHED 1860 4433

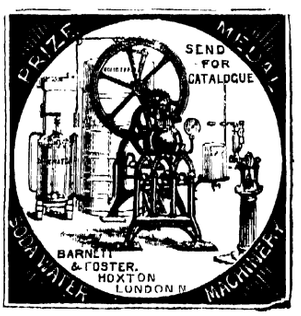


4065

Soda Water Machinery,

For the Manufacture of all kinds of Aerated Drinks in the highest state of perfection,

— BY —



BARNETT & FOSTER,

"NIAGARA WORKS,"

25½, EAGLE WHARF ROAD,

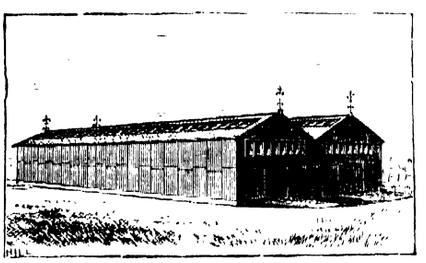
LONDON, N.

A COMPLETE SODA WATER MACHINE, including Bottling Apparatus, is supplied for **£40** per set for producing 100 doz Lemonade, Ginger Ale, &c., per day.

No technical knowledge is required, as all information is given to purchasers of Machines. 4010

ILLUSTRATED CATALOGUE FORWARDED FREE

IRON ROOFS & FIRE-PROOF BUILDINGS.



TANKS & CISTERNS.

Galvanizing Baths.

DAVIES BROS & Co CONTRACTORS FOR IRON ROOFS BUILDINGS BRIDGES &c CROWN IRON WORKS WOLVERHAMPTON

Galvanized and Painted Corrugated Sheets.

IRON ROOFS, IRON BUILDINGS,

ENGINE SHEDS, STORES.

Constructional Iron Work and Smiths' Work of every description. 5027

DAVIES BROS. & CO., Crown Ironworks, Wolverhampton.

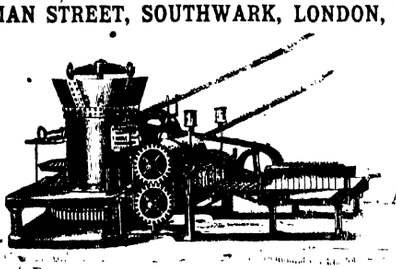
MURRAY'S PATENT BRICKMAKING MACHINERY.

Sole Manufacturers, THOMAS MIDDLETON & Co., Engineers,

LOMAN STREET, SOUTHWARK, LONDON, S.E.

Patent Steam Driven Cutting Tables.

Patent Lubricating Solid Die, for all sorts of Clay.



Patent Plunger Brick Press, for Bricks or Tiles.

Patent Brick Shaping Apparatus, for all kinds of Fancy Bricks.

IMPROVED ROLLER BRICK MACHINE, 12,000 to 40,000 Bricks per day, for Clamp and Kiln Burnt Bricks. 3164

Sole Manufacturers of all kinds of Clay Crushing Rolls, Mixing Mills, Steam Engines & Hydraulic Machinery.

S. OWENS & Co.,

WHITEFRIARS ST., LONDON, E.C.

HYDRAULIC ENGINEERS,

SOLE MANUFACTURERS OF

Blake's Patent Steam Pumps.

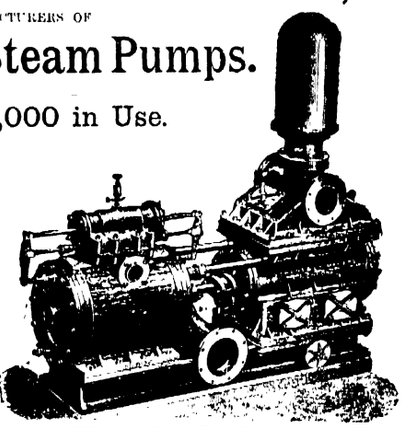
More than 16,000 in Use.

FOR PUMPING

TAR WATER,

OR

Ammoniacal Liquor.



6004

Price Lists and full Particulars furnished on application.

BILLINGTON & NEWTON,

SOLE MANUFACTURERS

OF



CROWN PHOSPHOR-TIN,

PHOSPHOR BRONZE,

PATENT FERRO MANGANESE BRONZE,

BABBITT'S & KINGSTON'S PATENT ANTIFRICTION METALS,

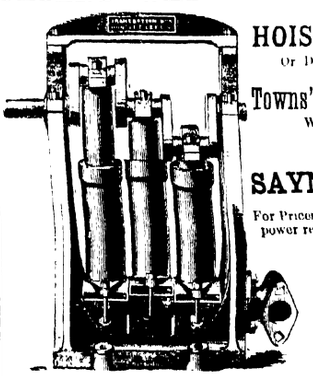
PLASTIC METAL AND WHITE BRONZE.

LONGPORT, STAFFORDSHIRE. 6150

Agents — London: HAUGHTON & CO., 110, Cannon Street, E.C.
North of Europe: A. SINGTON & CO., St. Peter's Square, Manchester.
Scotland: P. & W. MACLELLAN, Trongate, Glasgow.

JOHN RAMSBOTTOM'S

PATENT WATER ENGINES & STEAM PUMPS



Are for **HOISTING USES,** Or Driving all kinds of Machines by **Towns' Water Pressure** Where sufficient.

This Pump is **UNSURPASSED** Either for SIMPLICITY, PRICE, Or for General Efficiency.

ADDRESS— 4986

SAYNOR ROAD, LEEDS.

For Prices, should give the Water Pressure, and the power required.

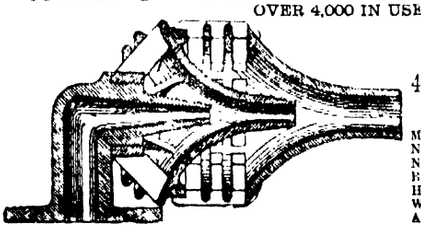


HIGH PRESSURE MARINE BOILERS.

Best and Cheapest Means of Preventing Unequal Expansion.

"WEIR'S" PATENT HYDROKINETER.

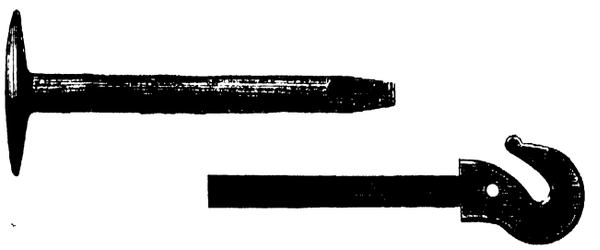
OVER 4,000 IN USE.



G. & J. WEIR,

49, JAMAICA STREET, GLASGOW.

MENZIES & BLAGBURN, KING STREET, NEWCASTLE-ON-TYNE. WM. REID & CO., 5, NEW LONDON STREET, LONDON, E.C. A. & R. BROWN, WATERLOO ROAD, LIVERPOOL. R. HUGHES & CO., FULTON STREET, DITTO. W. S. VON ESSEN, ENGINEER, HAMBURG, AGENT FOR SCANDINAVIA & GERMANY 5281



Apply—THE KIRKSTALL FORGE CO., near Leeds. 4036

"STANDARD" STEAM BOILING NOZZLE

FOR

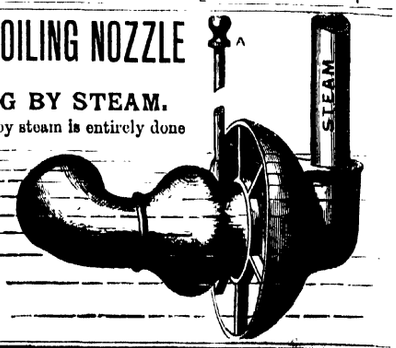
HEATING OR BOILING BY STEAM.

The objectionable noise when boiling by steam is entirely done away with, and the liquor Heated or Boiled QUICKLY, ECONOMICALLY, and SILENTLY.

½ ¾ 1 1½ 2 3 4 in. pipe

50/- 60/- 65/- 100/- 130/- 175/- 260/-

NUMEROUS TESTIMONIALS. 4991



PICKING, HOPKINS & CO.

BOW, LONDON, E.

—: MAKER OF :—

SUGAR, RICE AND FLOUR MILLS, STEAM ENGINES, Boilers, LINOLEUM MACHINERY.

SUGAR MACHINERY

JAMES LANDALE,

Engineer, KIRKCALDY, N.B. 4945

East Ferry Road Engineering Works Co., Limited,

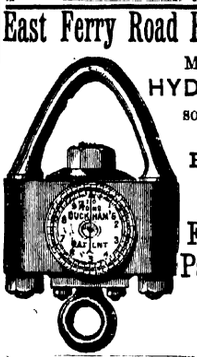
MILLWALL, LONDON, E.

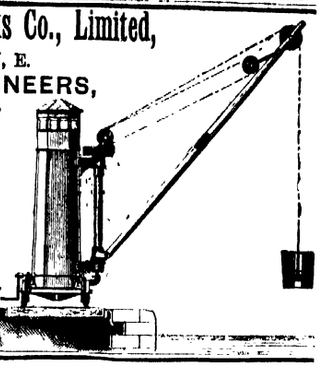
HYDRAULIC ENGINEERS,

SOLE MANUFACTURERS OF

Parkes's Patent Portable Hydraulic Cranes, Lifts, and Hoists.

F. E. Duckham's Patent Suspended Weighing Machines. 5123





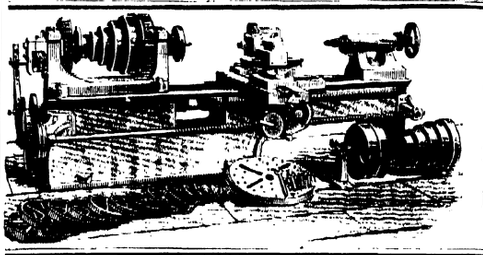
THE BOWLING HOOP OF EVERY DESCRIPTION IN IRON OR STEEL

STEEL CASTINGS

THE BOWLING IRON Co LTD BRADFORD YORKS

ORIGINAL PATENTEES AND SOLE MAKERS

4567



SPECIALITY IN LATHES

SMITH & WILSHAW, HALIFAX, ENGLAND

Makers of all kinds of

Improved Self-Acting, Sliding, and Screw Cutting Lathes,

For Foot or Power. 5210

Ships' Engine and Steering Telegraphs.

Over 3000 Vessels have been fitted with **CHADBURN & SON'S** Patent Telegraphs, including all the noted Steamers in the World, also 200 Vessels for English and Foreign Navies.

EXHIBITION AWARDS { LONDON, PARIS, N.E. COAST, AMSTERDAM, FISHERIES.



CHADBURN & SON'S NEW PATENT 'DUPLEX GONG 1883.

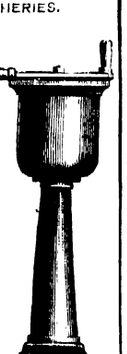
ENGINE AND STEERING REPLY TELEGRAPHS.

ORDERS INDICATED BY SOUND & SIGHT.

A DEEP GONG from Astern to Ahead.



A SHRILL GONG from Ahead to Astern.



TELEGRAPH WORKS WATERLOO ROAD,

GLASGOW-69, ANDERSTON QUAY. **LIVERPOOL.** LONDON-96, FENCHURCH ST. 5040

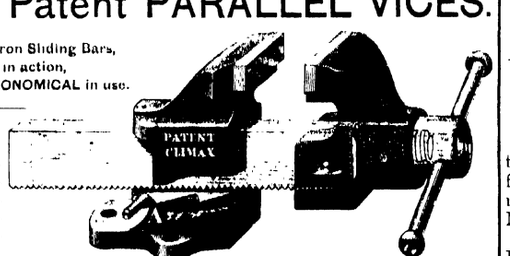
"CLIMAX" Patent PARALLEL VICES.

Steel Jaws and Wrought Iron Sliding Bars,
INSTANTANEOUS in action,
SIMPLE in construction, ECONOMICAL in use.

—:o:—

Width of Jaw	Opens	Size of Bar	Price
3 in.	6 in.	1¼ by 1 in.	37s.
4 in.	8 in.	2 by 1½ in.	40s.
5 in.	10 in.	2½ by 1½ in.	50s.
6 in.	12 in.	3 by 1½ in.	70s.
7 in.	14 in.	3½ by 1¼ in.	100s.

—:o:—



Easily and quickly adjusted without using the screw, saving time; secure grip obtained by screw and lever, the best combination for the purpose, screw is never exposed and only used for tightening the grip; opens double the width of the jaws; few and simple in its parts, not liable to get out of order, there being no cams, toggles, hooks and clutches, strong and durable, working parts wrought iron and steel.

PATENTEES AND MANUFACTURERS: 5352

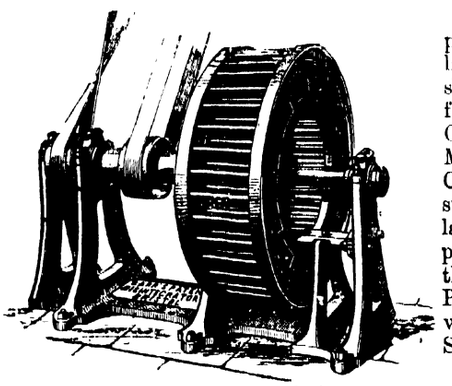
CRAMPTON BROS., 25, West Bar Green, SHEFFIELD.

"CARR'S DISINTEGRATOR,"

Registered Trade Mark, No. 6380.

AWARDED BRONZE MEDAL, PARIS UNIVERSAL EXHIBITION, 1878.

CARR'S PATENT DISINTEGRATOR.



This Machine effectually pulverizes by the combined influences of percussion and of centrifugal force, Iron, Zinc, and other Ores; Asphalte, Artificial Manures, Phosphates, Fire Clay, and many other substances. It is also largely in use for the pulverization of Coal for the manufacture of Coke, Patent Fuel, &c.; and is very effective for mixing Sugar.

These Machines are capable of reducing to a fine granular powder from 50 to 200 tons per day (according to size) of any unfibrous material. Machines made to order from 18 inches diameter, to suit special requirements of purchasers; those small machines being specially adapted to the requirements of Chemical Manufacturers for Mixing and other purposes.

No Agents. All Machines will in future bear the Registered Trade Mark ("Carr's Disintegrator") in three places—viz.: on Bedplate, and on outside Face of each Cage.

A Descriptive Pamphlet will be sent free on application to the Managing Trustee of the Estate of the late Patentee, 2523

PHILIP TRIGGS, Albion Chambers, BRISTOL.

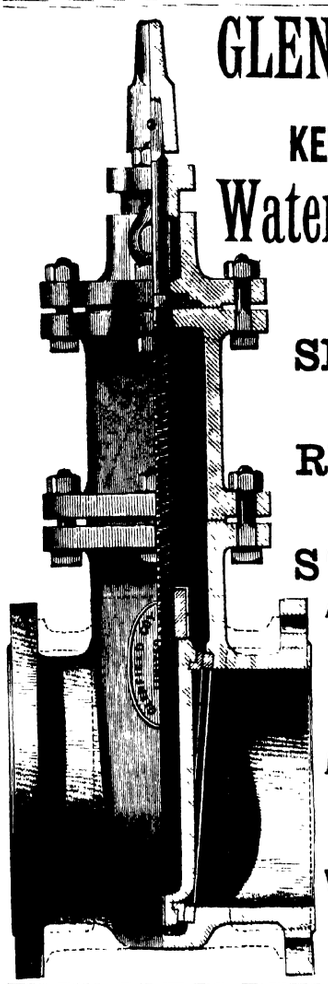
GLENFIELD CO., Ltd.

— AND —

KENNEDY'S PATENT

Water Meter Co., Ltd.

KILMARNOCK, N.B.



SLUICE VALVES,
AIR VALVES,
RELIEF VALVES,
HYDRANTS,
STAND POSTS,

And all Classes of Water Fittings.

PENSTOCKS, FLUSHERS, AND SEWERAGE FITTINGS.

ACCUMULATORS, PUMPS & HYDRAULIC MACHINERY.

KENNEDY'S PATENT
WATER METERS
50,000 IN USE. 5461
NINE PRIZE MEDALS.

GEO. BOOTH & CO.,

HALIFAX, ENGLAND.

MAKERS OF

LATHES

PLANING, SLOTTING, SHAPING, BORING, DRILLING, AND SCREWING MACHINES.

SPECIALITY:

Punching & Shearing,

PLATE BENDING,

PLATE PLANING,

ANGLE-IRON BENDING,

And all Classes of Shipbuilders' and Boilermakers' Tools.

ALSO SELF-ACTING STEAM HAMMERS.

Contractors to the British and Foreign Governments. 4748



SLAG WOOL *Loose* *and* SILICATE CLOTH *Felted.*

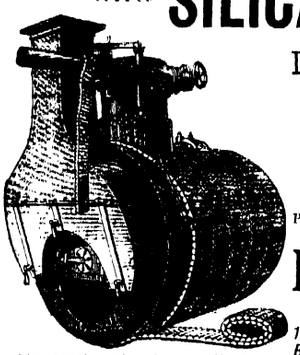


Illustration Showing Application of Silicate Cloth.

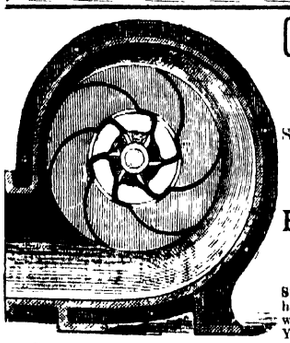
Incombustible.
Best Non-conductor Extant.
Easily Applied.
Removable.
Re-applicable.

PRICES, ESTIMATES, AND FULL INSTRUCTIONS FREE ON APPLICATION TO

D. ANDERSON & SON, Ltd.,

PATENT FELT MANUFACTURERS, 5223

10, London Street, Fenchurch Street, LONDON; 118, Broomielaw, GLASGOW; and Lagan Felt Works, BELFAST.



CAPELL Double-Power FAN

(PATENT),

THE MOST POWERFUL YET MADE.

See *Engineer*, February 16th, 1883, and Tests of Mr. D. K. CLARKE, C.E., *Engineer*, March 28th, 1884.

LICENSEES FOR THE NORTH:

R. LLOYD & CO., 136, Steelhouse Lane, BIRMINGHAM.

ACORN AND MIDLAND WORKS, Darlaston, 3rd June.—"DEAR SIRS,—In reply to yours of the 29th, the CAPELL 20 in. FAN we had of you is working satisfactorily, and is doing quite as much work as the 30 in. it replaced, and *taking less power* to drive it.—Yours truly, J. SIMPSON & SONS."

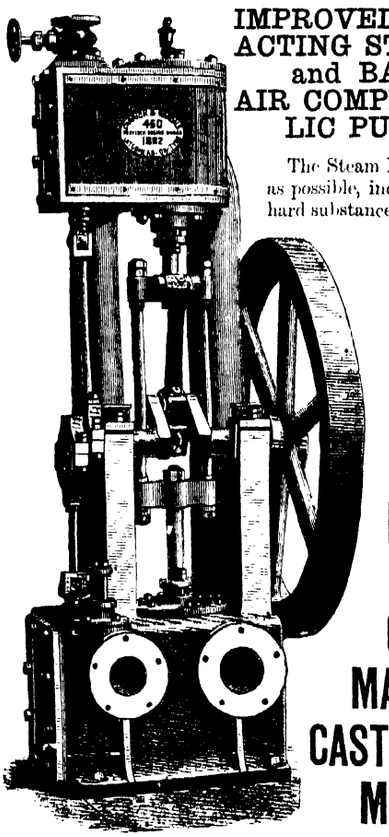
From S. NORTHWOOD & SON, Viaduct Foundry, Birmingham.—"We have much pleasure in testifying to the excellent manner in which the CAPELL FAN works which you supplied to us some time ago. Although a larger Fan than we had previously in use, it takes *considerably less power* to drive, while at the same time we get a better and more uniform blast, and Fan we do not drive up to speed." 5379

Agents for London and District:

Messrs. HOPKINSON & PRINCE, 15, Walbrook, London, E.C.

CARRICK & WARDALE,

Redheugh Engine Works, GATESHEAD.



IMPROVED SINGLE & DOUBLE ACTING STEAM FEED, BILGE and BALLAST PUMPS, AIR COMPRESSORS, HYDRAULIC PUMPS & PRESSES.

The Steam Pumps as illustrated are, as nearly as possible, incapable of being choked, save with hard substances; and in working it has been found that shavings, waste, corn, small coals, &c., pass easily through, which renders them eminently suitable for ballast pumps for ships.

They are largely used in Chemical Works, Breweries, &c., where ordinary lifting valve pumps are readily choked; and by Railway Companies for supplying water at watering stations.

MAKERS OF EVERY DESCRIPTION OF CHEMICAL WORKS MACHINERY AND CASTINGS, HYDRAULIC MACHINERY, &c. 5134

THE STEEL COMPY. OF SCOTLAND,

LIMITED.

(SIEMENS PROCESS).

150, HOPE STREET, GLASGOW.

MANUFACTURERS OF

Steel Rails, Plates, Angles, Beams, Bars, Hoops, Forgings, Steel Castings, Blooms, &c. 1091

I. & W. BEARDMORE,

PARKHEAD IRON and STEEL FORGE and ROLLING MILLS, GLASGOW,
CONTRACTORS TO THE ADMIRALTY AND FOREIGN AND COLONIAL GOVERNMENTS.

MANUFACTURERS OF

STEEL PLATES, SHEETS AND BARS

(Siemen's Process) and

IRON SHEETS, PLATES AND BARS

FOR SHIPS, BOILERS, BRIDGES, &c.

	Ship	Boiler	Special	Extra Fine
BRANDS	P S	P SS	P SB	P SB
	Steel	Steel	Steel	Steel

FOR COMBUSTION CHAMBERS.

Boiler End & Furnace Plates, Flanged & Welded. Special Steel for Anti-Collapse Rings & Welded Tubes.

IRON AND STEEL FORGINGS OF ANY DIMENSIONS FOR MARINE ENGINES AND OTHER PURPOSES.

IRON AND STEEL CRANK SHAFTS OF SPECIAL MANUFACTURE.

AGENTS:—Liverpool, TAYLOR & SON, 39, Wapping

London, 11, Queen Victoria St., E.C. ... W. J. MARTIN | Hamburg, Hopfensack No. 11 .. Wilh. RUMP 5332
Newcastle-on-Tyne ... ... Wm. KELSEY | Antwerp ... ... Capt. RYAN
Belfast, 67, Donegall Street ... ... H. H. BUTLER | Rotterdam, Willemskade No. 9 .. Post van der BURG & Co.

FORSYTH, MILLER, AND CO.,

BROAD STREET, MILE END, GLASGOW.

IMPROVED

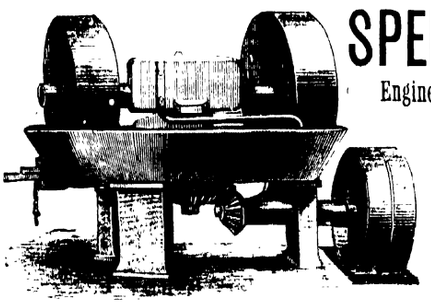
Malleable Iron (or Steel) Castings.

Hydraulic Cylinders,

Spur Wheels and Pinions for Rolling Mills, and other Heavy Castings up to 6 Tons.

London Office: Crown Wharf, 5, Upper Thames St., E.C.—GEORGE HATCH, Agent.
To which Small Patterns may be sent.

Agents for Sweden and Norway: LANDER & LARSSON, New Edmund Street, Birmingham.
Agent for France: T. GRIGNE, LATE T. TATIN, 12, Rue de Malte, Paris. 4911



SPENCER & CO.,

Engineers, Millwrights, & Founders,

MELKSHAM, WILTS.

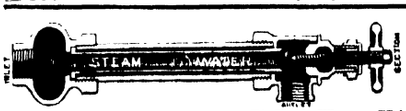
GRINDING MILLS

FOR

LOAM, COAL, OR BLACKING.

3½ ft. pan, 5 cwt. Rollers £17
4½ ft. „ 10 cwt. „ £27

— LARGER SIZES FOR MORTAR, LIME, ORE, &c., ON APPLICATION. — 5102



STEAM TRAPS

OVER 13,000 SOLD. VAUGHAN'S PATENT WATER
SILVER MEDAL AWARDED. EJECTOR OR STEAM TRAP.
POSITIVELY THE ONLY RELIABLE APPARATUS EVER MADE.

Satisfaction Guaranteed.
Simple. Cheap.
Saves broken joints, broken cylinders, broken pipes.
Absolutely reliable.
Unvarying.

CAN BE APPLIED TO

Steam Engine Piping. Steam Hammer Pipes and Cylinders.
„ „ Cylinders. Heating Pipes.
„ „ „ Jackets. Heating apparatuses of all kinds.
„ „ Valve Casings. &c., &c., &c. 4856

VAUGHAN & SON, ROYAL IRONWORKS, WEST GORTON,

CONTRACTORS TO H.M. GOVERNMENT, **MANCHESTER.**

London Agent: JAS. KEITH, 57, Holborn Viaduct. Belfast: Messrs. PATTERSON & SONS.

ENGINEERING & METAL TRADES' EXHIBITION, LONDON, JULY 1883.

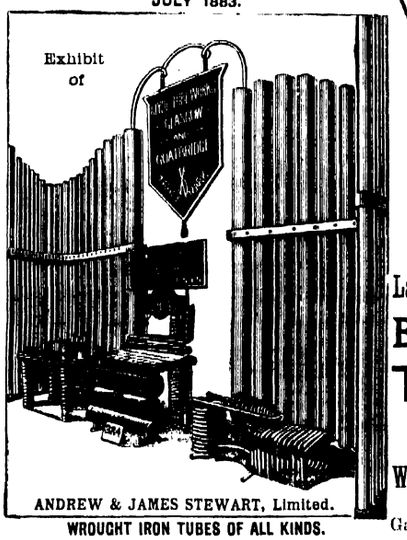


Exhibit of

ANDREW & JAMES STEWART, Limited.
WROUGHT IRON TUBES OF ALL KINDS.

ANDREW & JAMES STEWART, LTD.

Clyde Tube Works,
GLASGOW
AND
COATBRIDGE.

Address
41, OSWALD ST.,
GLASGOW.

Lap-Welded
BOILER TUBES
OF IRON & STEEL

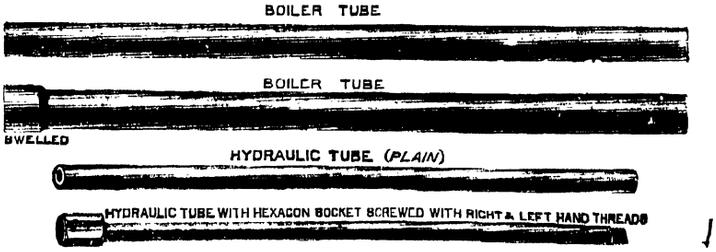
WROUGHT IRON TUBES
FOR 5105
Gas, Steam, Water, &c., &c.

THE WELDLESS STEEL TUBE COMPY.,

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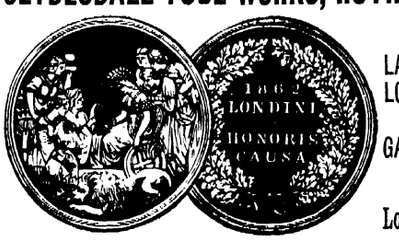
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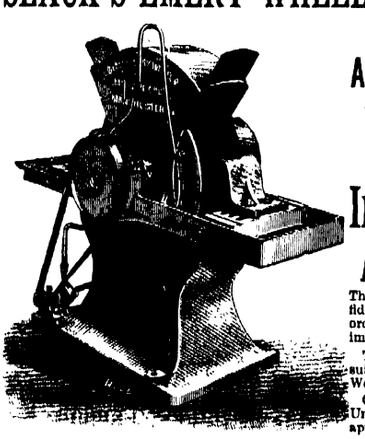
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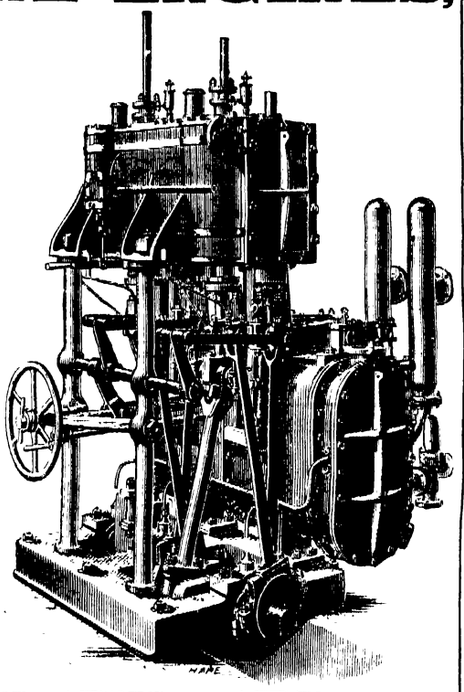
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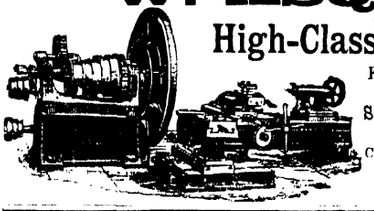
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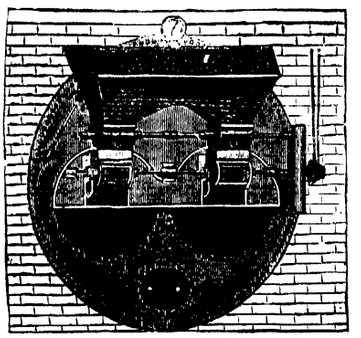




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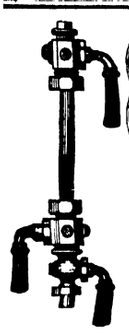
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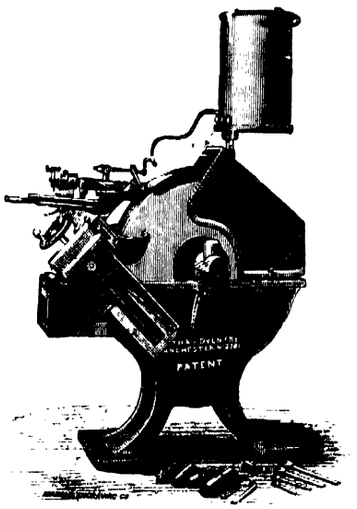
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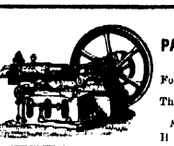


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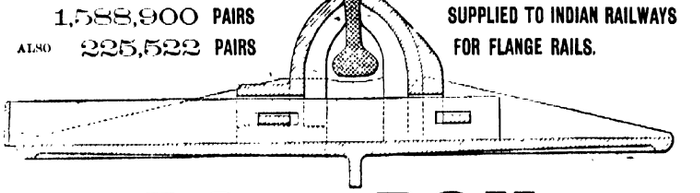
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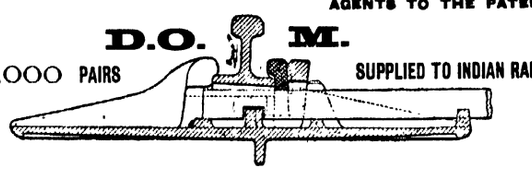
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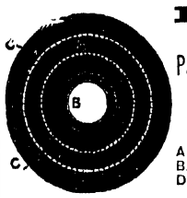
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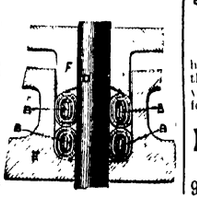


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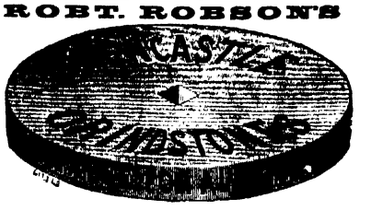
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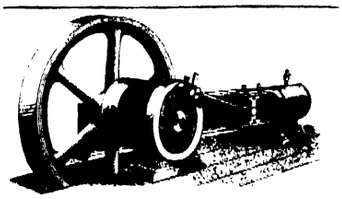
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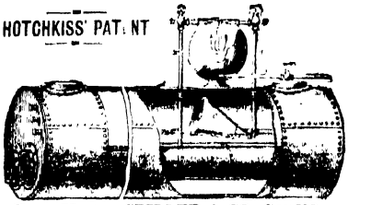
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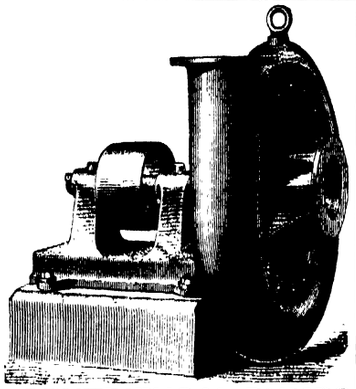
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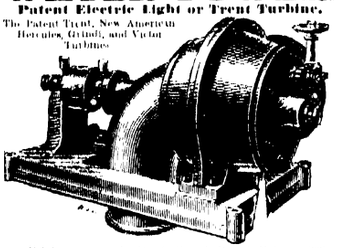
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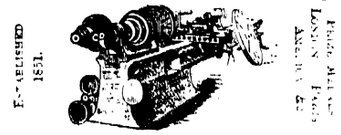
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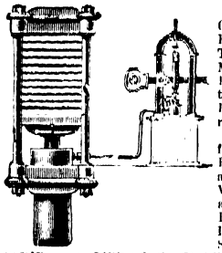


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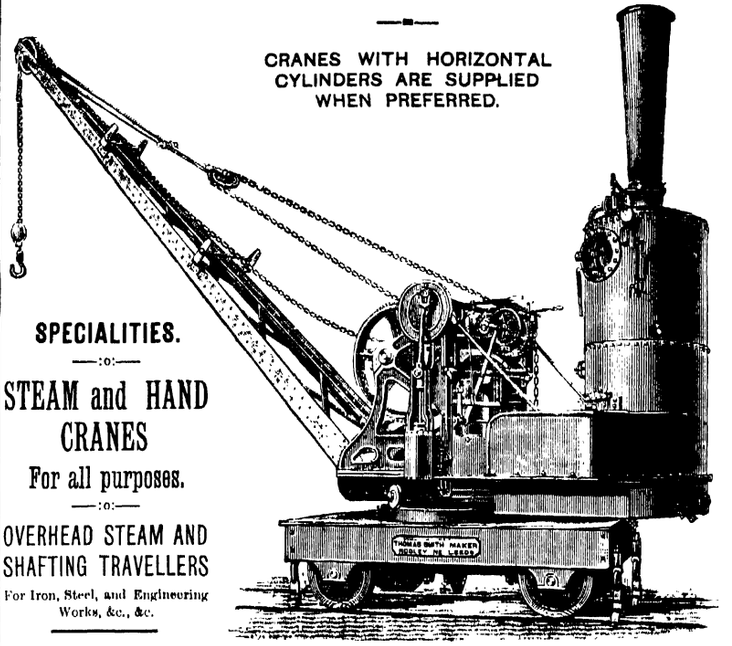
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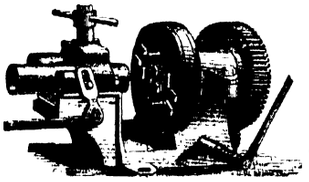


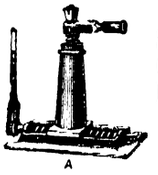
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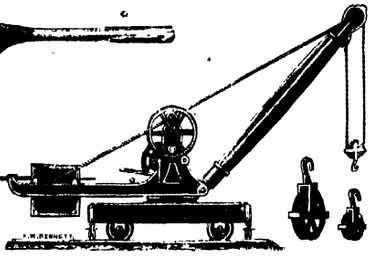








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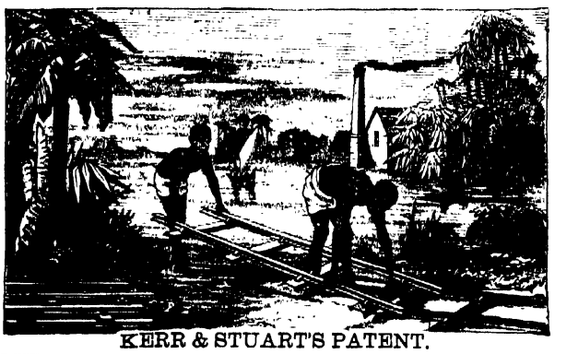
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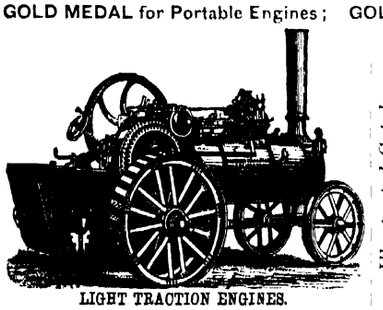
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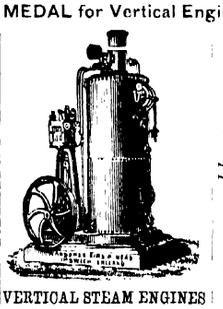
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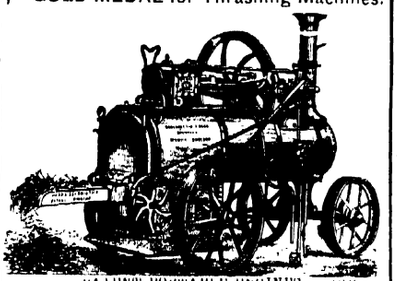
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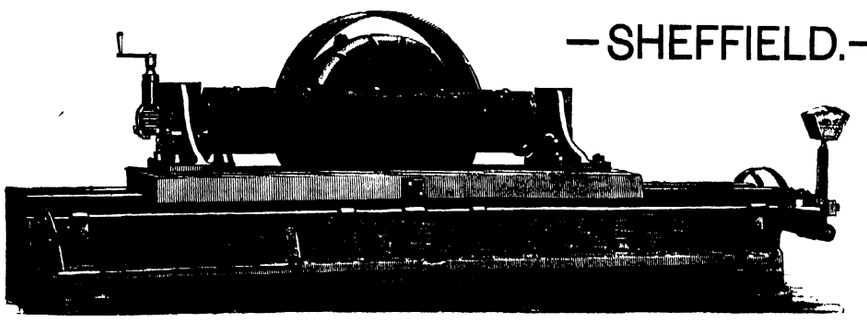


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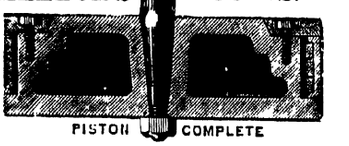


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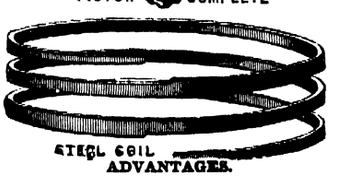
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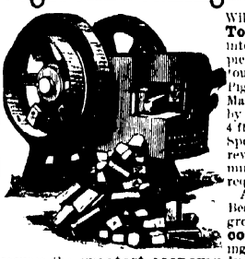
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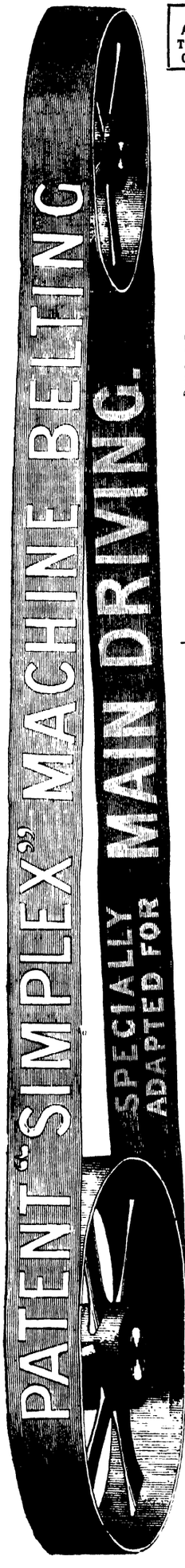
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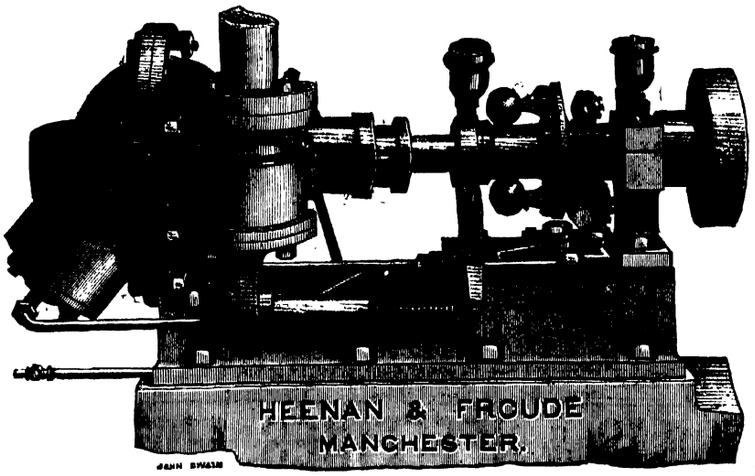
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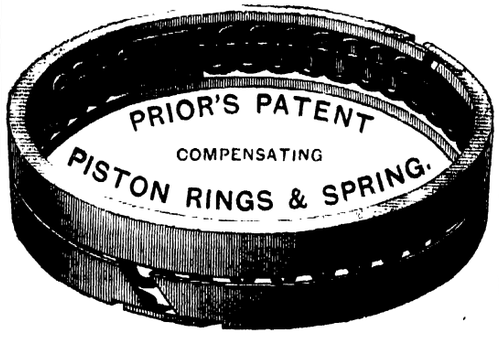
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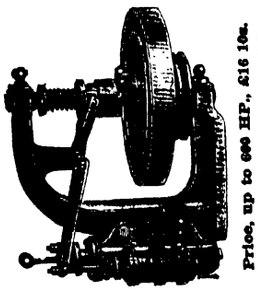
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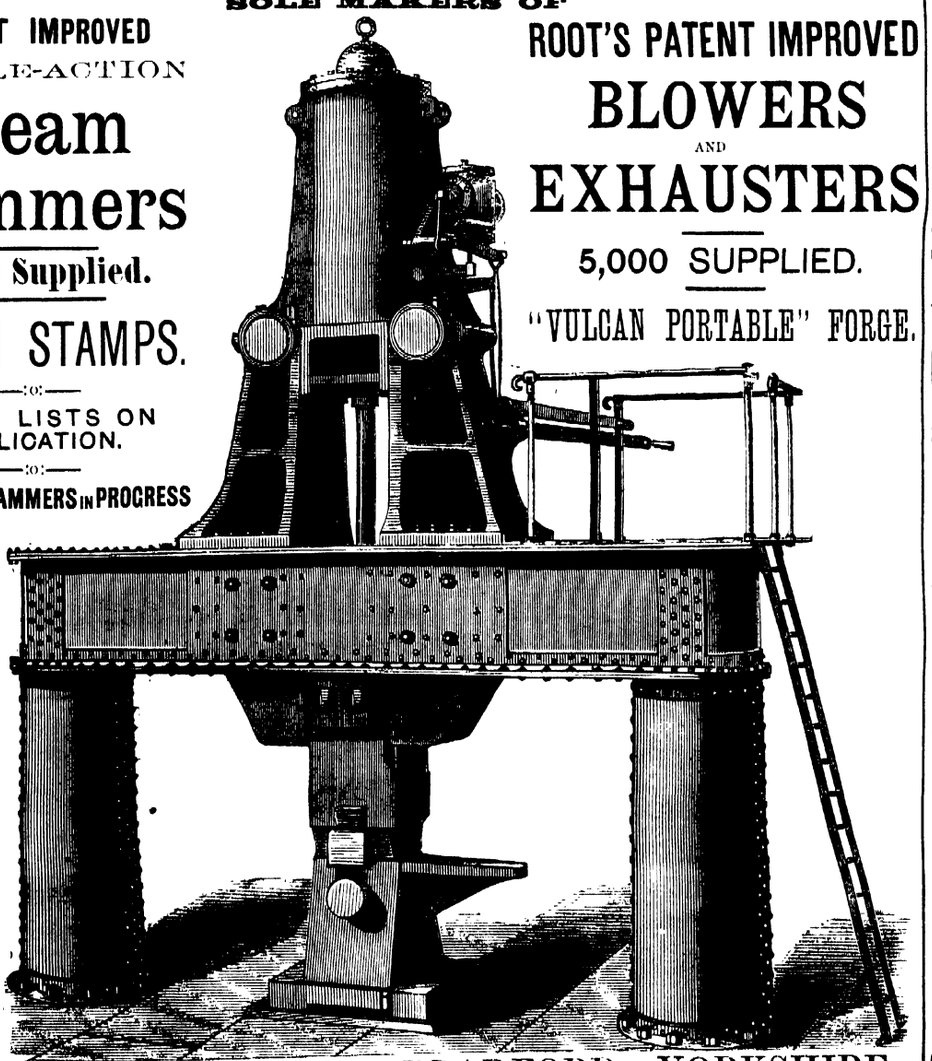
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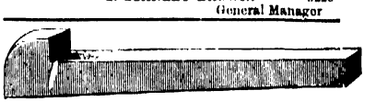
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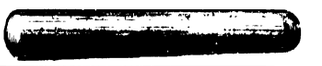
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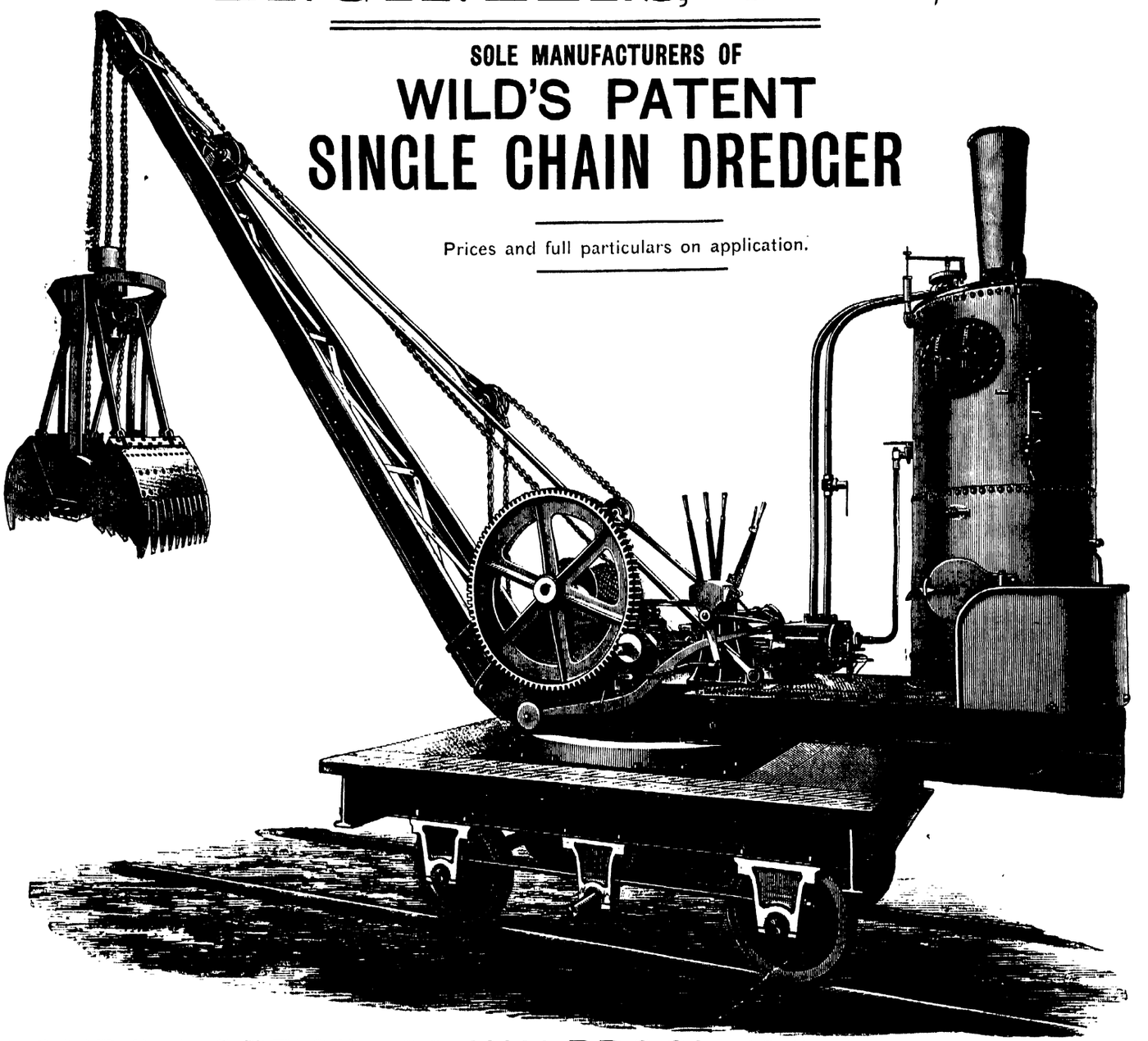
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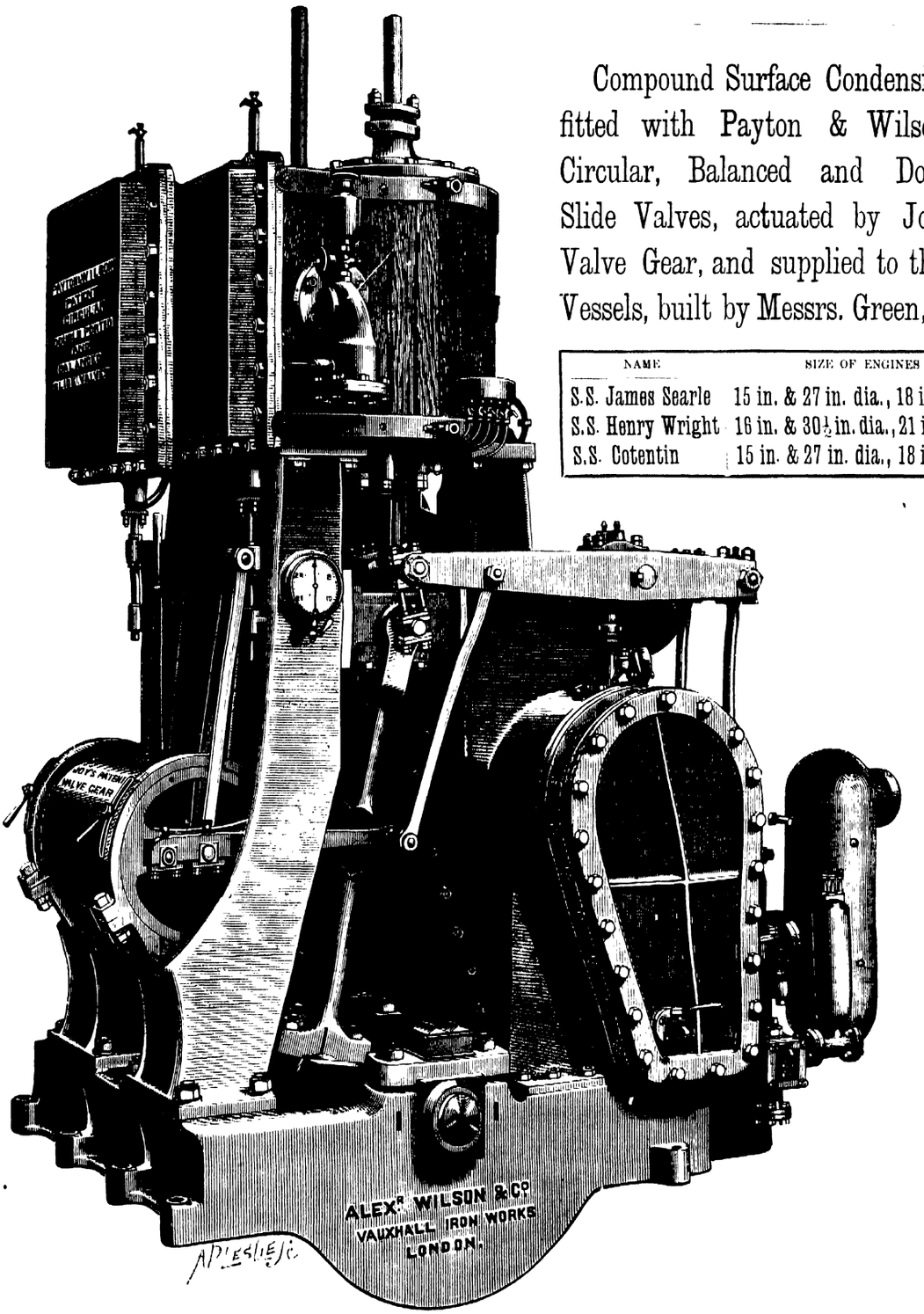
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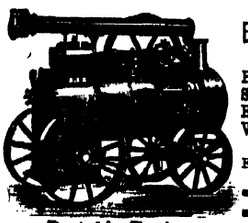
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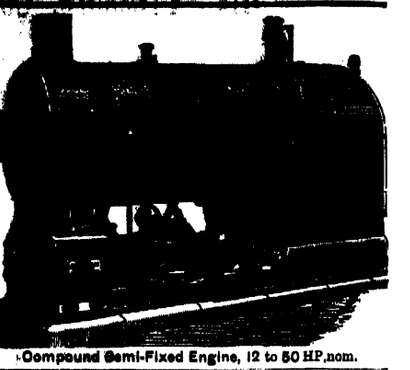
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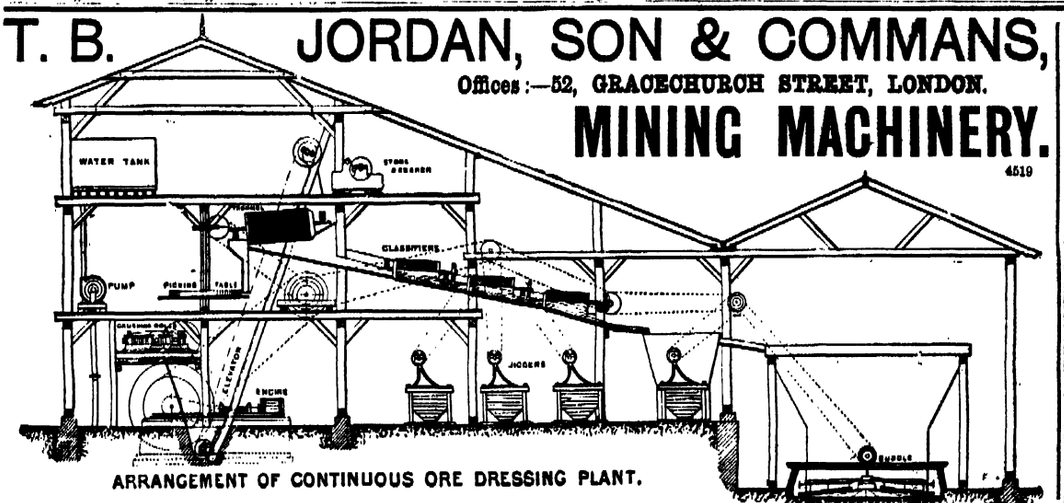


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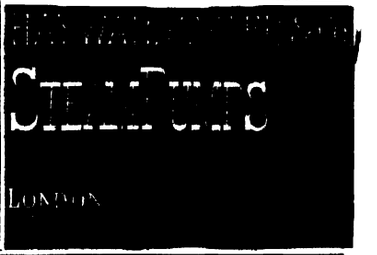


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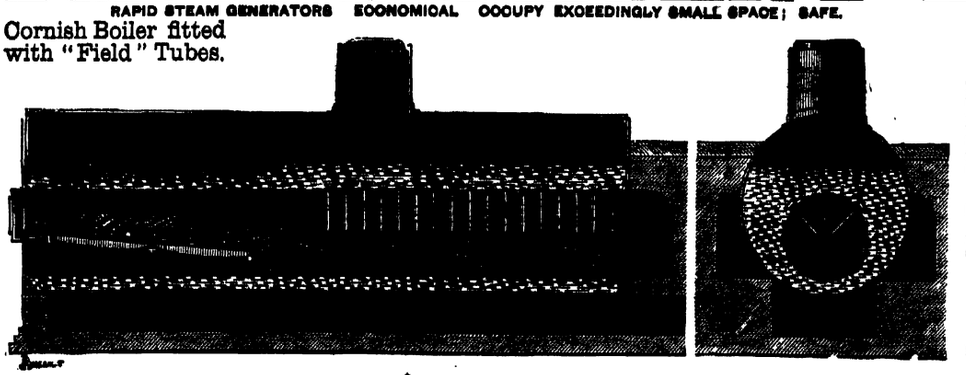
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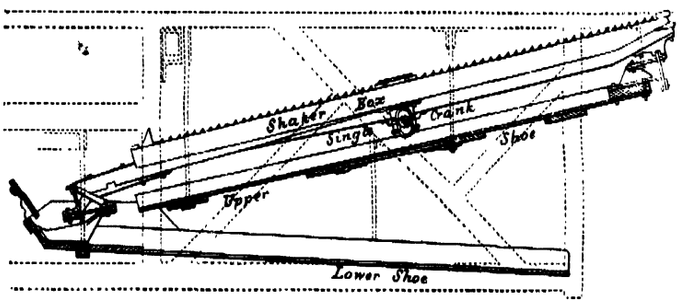
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THE SMITHFIELD CLUB SHOW.

THE remarks which we have made for the last few years when dealing with the Smithfield Club Show as to the decreasing interest of that Show from an engineer's point of view, apply fully to the exhibition which has been held during the present week at the Agricultural Hall. It is not that the exhibits have deteriorated in quality or diminished in numbers—for the collection of engines and machines is as large and certainly fully as good as in any former years—but simply that the exhibits represent, with but very few exceptions, types of construction with which every frequenter of agricultural exhibitions is thoroughly familiar. This being so our notice of the Show will necessarily be a brief one.

Compound engines are well represented, they being shown by Messrs. Marshall, Sons, and Co., Messrs. John Fowler and Co., Messrs. Richard Hornsby and Sons, Limited, Messrs. Ruston, Proctor and Co., and Messrs. Garrett and Sons. Messrs. John Fowler and Co.'s stand, in fact, looks as if the firm had practically given up pushing the construction of non-compound engines, the whole of the engines they exhibit—with the exception of a small fixed horizontal engine—being of the compound class, the types represented being a steam ploughing engine, traction engines for general purposes and heavy haulage, and an "underneath" semi-fixed engine. Messrs. Hornsby and Sons' exhibits include the new type of compound portable which we illustrated last week (*vide* page 517 *ante*) and also one of their "underneath" compounds, which we described on a former occasion, while Messrs. Ruston, Proctor, and Co.'s and Messrs. Garrett and Sons' compounds are also of their regular patterns. We notice, however, that in the compound shown by the last-named firm, which is of their semi-portable "B" type, the brackets which serve to bolt the firebox to the wrought-iron ash-pan, serve also as sockets for the gudgeons or axles of the travelling wheels when the engine is made portable. This is a neat detail. The engine is also fitted with the Pickering governor, which we understand Messrs. Garrett are adapting for all their compounds.



NALDER AND NALDER'S SINGLE CRANK THRASHING MACHINE.

The compounds shown by Messrs. Marshall, Sons, and Co., of Gainsborough, comprise one of their 8-horse "underneath" semi-fixed engines of the type which we have already described, and a 16-horse compound portable engine of a new pattern. In this engine, of which we give an engraving on page 539, the two cylinders with the slide valve chest, intermediate receiver, and stop valve chamber, are combined in one casting, on the top cover of which the double spring safety valves are arranged. Circular bored crosshead guides are used in the place of the ordinary slide bars, one end of each of these guides forming the front cylinder cover and piston rod stuffing-boxes, while the opposite end is bolted to a wrought-iron bridge plate extending across the engine; this plate also carries the governors and the automatic expansion gear, which is applied to the high-pressure cylinder. The engine is fitted with a multitubular feed-water heater as shown in the illustration, this heater consisting of a number of small brass tubes through which the feed water is made to pass in the opposite direction to the exhaust steam, which traverses the outside of these tubes. One end of the heater is bolted firmly to the smokebox to which the pump is fixed, the opposite end being free to move endwise to allow for any variation occasioned by expansion and contraction. The crankshaft carriages are bolted to exceptionally strong wrought-iron hornplates well rivetted to the boiler barrel, the plummer-blocks sliding in dovetail grooves at the top of the hornplates, and being tied direct to the cylinders by strong rods, which take all the thrust and pull due to the working of the engine. The cylinders are 7½ in. and 12½ in. in diameter, both 14 in. stroke. The flywheel is 5 ft. 6 in. in diameter by 10 in. wide on the face, and the boiler is made for a working pressure of 160 lb. We notice that on this boiler Messrs. Marshall have abandoned gauge cocks, and have provided duplicate glass water gauges instead—a far preferable arrangement. The engine is speeded for 155 revolutions per minute, and is mounted upon wrought-iron travelling wheels and a steel plate forecarriage.

As regards traction engines and portables, there there is but little to be said. Messrs. Aveling and Porter, of Rochester, are, we are glad to say, getting excellent results with their spring wheels, descriptions of which have already appeared in ENGINEERING (*vide* vol. xxxvi., page 52, and vol. xxxvii., page 181), and an engine fitted with these wheels is exhibited by them at the Smithfield Show. We notice, however, that since we last illustrated this arrangement Messrs. Aveling and Porter have simplified the construction by making the outer tyre of cast instead of wrought iron. The wheel as now made is shown by our engravings on page 538, from which it will be seen that the outer tyre is a single casting having a channel on its inner side to contain and guide the blocks cast on the ends of the spokes of the inner wheel. These blocks are cast on to double spokes, each double spoke being formed by bending a bar so that the bend is inclosed in the cast block. This is an improvement on the two separate spokes employed in former wheels, and insures a better combination of the spokes and blocks. These spoke blocks being placed in the channel of the outer tyre with the spokes in their proper positions around the centre of the wheel, the centre boss is then cast on to the inner ends of the spokes in the usual manner. It will be noticed that from the manner in which the springs are arranged each pair of springs tends to force together the outer ends of the two arms against which they abut. To relieve the spokes from any bending strain due to this action, a cast-iron strut (not shown in our engravings) is introduced between the two spokes and bolted to the blocks at their outer ends. The boss and spokes, &c., having been connected as described, the springs and connections have only then to be placed in position to finish the wheel. By the adoption of the simple mode of construction just described Messrs. Aveling and Porter have been able to reduce the cost of these spring wheels so much that their use now involves but a very small addition to the cost of the engine. Besides an engine with these spring wheels, Messrs. Aveling and Porter also show examples of their well-known steam ploughing and ordinary traction engine.

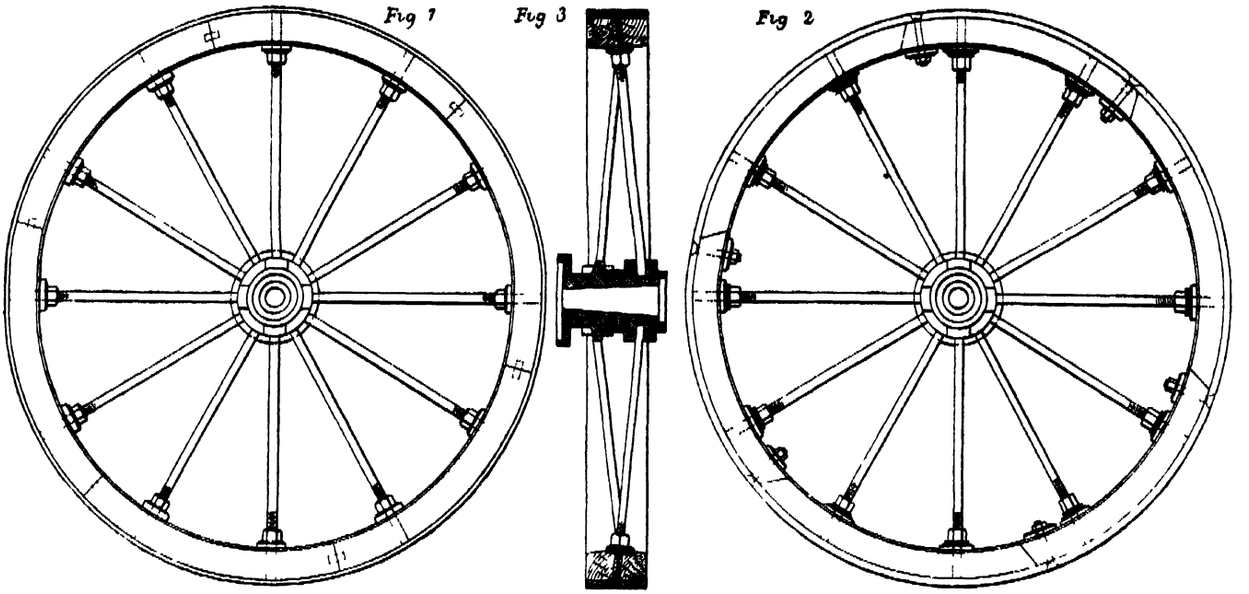
Messrs. Garrett and Sons, of Leiston, show for the first time a new pattern of travelling wheel, this being exhibited on one of their "No. 8" portables, and illustrated by us on page 538. Referring to our engravings it will be seen that this wheel is composed of a cast-iron boss, into which wrought-iron spokes are fused; these spokes are screwed and furnished with nuts and plates at the outer ends, which there pass into wooden segments or felloes forming an elastic lining to a wrought-iron tyre. These segments can either be framed together with radial joints as usual with wood wheels, and as shown in Fig. 1, or they may be bevelled together as shown in Fig. 2, under which latter arrangement each alternate segment acts as a wedge between its neighbours. In either case the tyre is heated and contracted round the rim in the way common to wooden wheels, the result being that the wooden segments are pressed tightly upon the collars and nuts around the spokes, which may nevertheless be adjusted further as may be found necessary from time to time. In the arrangement shown in Fig. 2, which is that to which Messrs. Garrett and Sons give the preference, there are also provided countersunk headed bolts passing through the tyre and wooden lining at each joint between the segments, which bolts afford a means of adjustment by the nuts and collars operating upon the inside of the wooden lining. In either case (Fig. 1 or 2), however, Messrs. Garrett contend it will be found possible to tighten up the wooden lining quite sufficiently to compensate for any shrinkage of the wood or extension of the wrought-iron tyre by the "drawing" action in travelling over rough hard pavements, so that it will never be requisite to shorten and re-heat the tyre. Messrs. Garrett and Sons inform us that they have had three years' experience with a set of wheels made on the plan shown by Fig. 1 of our engravings, and that they have given very satisfactory results, the wooden rim affording an elasticity which is wanting in some forms of iron wheels. The engine on which these wheels are exhibited is also fitted with an improved arrangement of spark arrester, which we hope to illustrate in a future number.

Of the other engines exhibited by Messrs. Clayton and Shuttleworth, Messrs. Marshalls, Sons, and Co., Messrs. Ransomes, Sims, and Jefferies, Limited, Messrs. Robey and Co., Messrs. Ruston, Proctor, and Co., Messrs. E. R. and F. Turner, Messrs. Charles Burrell and Sons, Mr. Edward Humphries, Messrs. Davey, Paxman, and Co., Messrs. Tasker and Sons, Messrs. Barrows and Stewart, Messrs. Foster and Co., Limited, Messrs. Brown and May, Messrs. Gibbons and Robinson, the Reading Iron Company, Limited, Mr. E. S. Hindley, Messrs. W. N. Nicholson and Son, and several other firms, we can only say that they well represent the types of construction adopted by their respective makers, and which are too well known to require description or even comment here. Messrs. Riches and Watts show one of their small vertical tandem compound condensing engines which we described when brought out at the York Show last year. A new firm we notice—namely, Messrs. J. T. Marshall and Co., Limited, of Nottingham—make their appearance for the first time, and are represented by a 3-horse portable of a good but scarcely novel design. We notice also that Mr. James Coultas, of Grantham, shows an 8-horse portable engine, in the design of which, *as in the engine exhibited by him last year*, he has taken especial care to avoid bolt holes through the boiler under the lagging. This engine is also fitted with Mr. J. P. Coultas's neat chimney raising gear which we have noticed on former occasions.

But a few lines would suffice to catalogue the scanty list of implements collected at the Agricultural Hall which present any freshness in design, or important modification in their working parts, and it is impossible—on recalling the characteristics of the Smithfield Show for the past few years—to avoid the conclusion, that as each successive occasion presents itself, the interest to the visitor grows steadily less, and may before long disappear altogether. Probably the dulness which unfortunately exists in the agricultural implement trade may have had much to do in giving to the present Show a depressing effect which does not usually attend it.

Two firms, Messrs. Nalder and Nalder, of Wantage, and Messrs. Ruston, Procter, and Co., of Lincoln, exhibit thrashing machines that will repay examination, the former possessing a modification in detail, while the latter may almost be classified as a new implement. Ingenuity devoted to methods of working the shakers, has resulted in a variety of designs followed by different makers, who have, however, universally abandoned the primitive form of flat vibrating bars, and adopted the box type of shaker to which the required motion is given in many ways, and by different modes of suspension, the source of movement being in all cases the main shaft of the machine, which is driven by a strap from the engine. Messrs. Nalder and Nalder have for many years occupied a front rank among the improvers of thrashing machines, and their work is marked rather by gradual progress than by striking innovations or radical inventions. In the machines which they exhibit this year there is a considerable improvement and simplification in the mode of working the shaker boxes, and of this an

EXHIBITS AT THE SMITHFIELD CLUB SHOW.



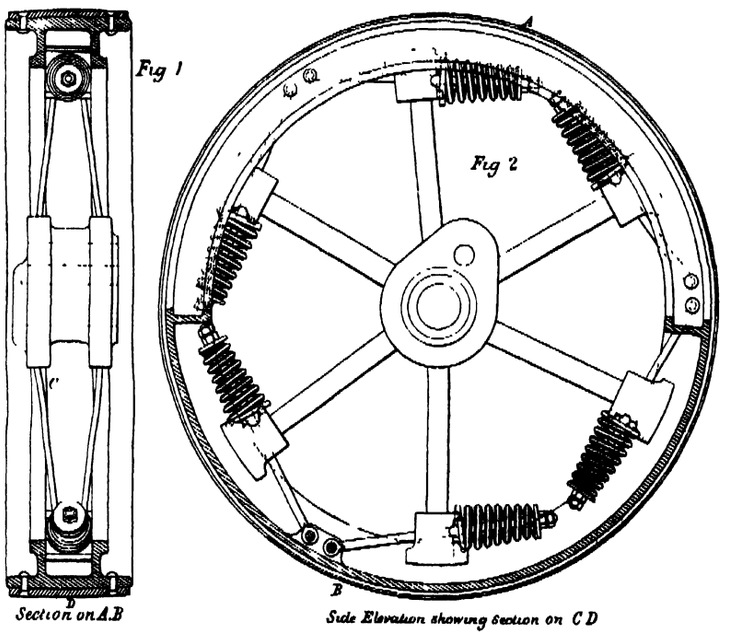
COMBINED IRON AND WOOD WHEELS, CONSTRUCTED BY MESSRS. R. GARRETT AND SONS, LEISTON.

illustration is given on the preceding page. From this it will be seen that the shaker boxes are attached to the upper and lower shoes at opposite ends, and that one crank only, which is placed in a central position, gives the requisite movements to all the parts. The momentum of the shoes is compensated by specially stronger spring hangers not shown in the illustration.

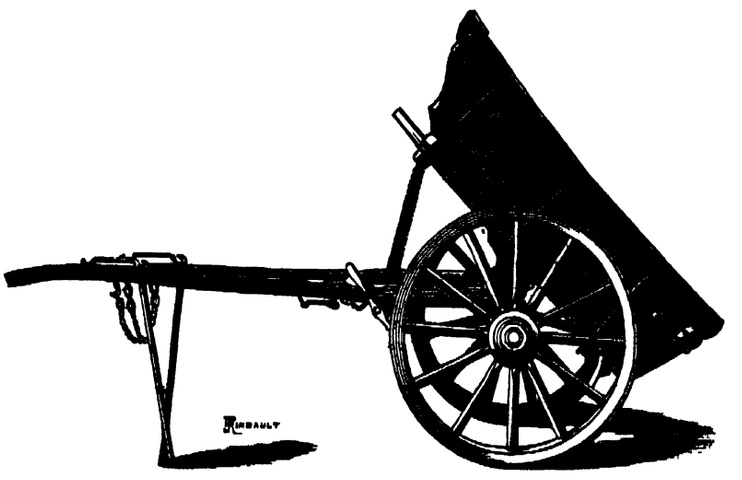
The arrangement of the thrashing machine exhibited by Messrs. Ruston, Proctor, and Co., of Lincoln, aims at a reduction in the number of parts, and a consequent simplification of mechanism, without any sacrifice of efficiency. The special features of their machine are illustrated by an engraving on page 542. Cranks for working the shaker boxes and shoes are done away with, and in their place two pairs of eccentrics, one on each side of the machine, are substituted. These eccentrics are mounted on the main motion shaft carrying the pulley by which the machine is driven. The eccentric straps are provided with horns as shown, which take the ends of shafts running across the machine and drive the shoes direct. The shaker boxes are attached by brackets to the crossbars, two boxes being worked by each pair of eccentrics. From the eccentrics at the upper end, rods pass down outside the framing of the machine to the lower end and give motion to another pair of crossbars which carry the shaker boxes in a similar way. The shoes are suspended by spring hangers in the usual manner. By this arrangement an ample throw is given to the shaker boxes, and the movement, which differs from that obtained with the ordinary crank motion, appears to be very efficient in shaking out the straw fed into the machine. In adapting the arrangement we have described, some modifications in the bracing of the framework is rendered necessary, although existing machines can be altered with but little trouble and expense. Before dismissing the thrashing machines, we may mention that Messrs. Ransomes, Sims, and Jefferies are extending the use of their spherical bearings which they introduced some years ago. They have also added a dust separator and discharging hopper to the chaff-bagging spout of their thrashing machine.

Messrs. Clayton and Shuttleworth, of Lincoln, show among other implements, two of their ordinary type of power chaff-cutting machines, to which a new delivery attachment has been added. Besides the ordinary blast elevator which is used for raising the chaff and delivering it into the sacks, a high level delivery appliance is added. This consists of a casing similar to that of the ordinary delivery, but instead of the trunk, a rising discharge column built up in lengths like a stove pipe is substituted. By this arrangement the chaff can be delivered to a height of 30 ft. and for a distance of 60 ft.

The ensilage interest is represented by various



SPRING WHEEL FOR TRACTION ENGINES, BY MESSRS. AVELING AND PORTER, ROCHESTER.

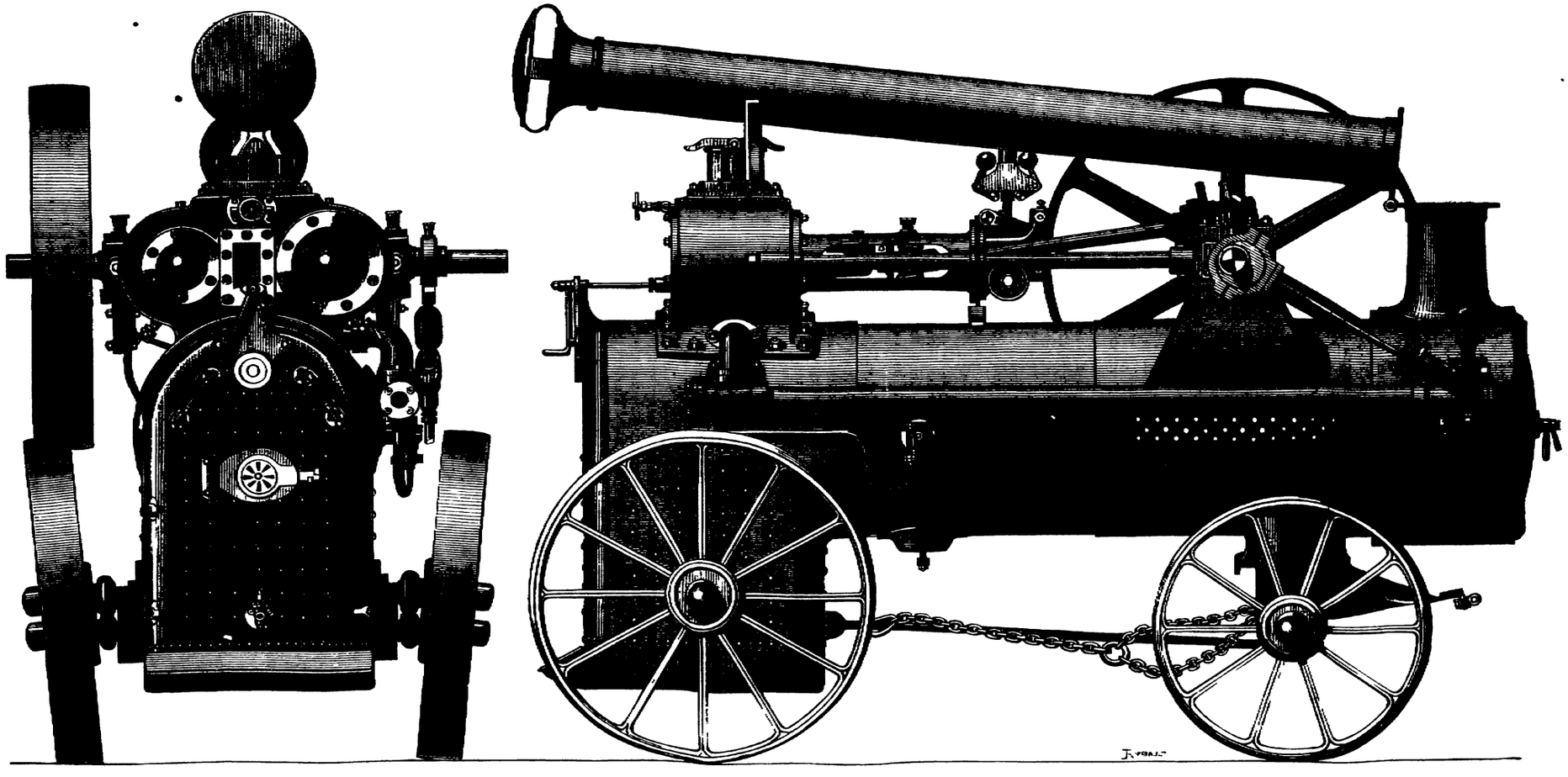


MARGETSON AND HEK'S TIPPING CART, CONSTRUCTED BY THE BRISTOL WAGON COMPANY.

16-HP. COMPOUND PORTABLE ENGINE AT THE SMITHFIELD CLUB SHOW

CONSTRUCTED BY MESSRS. MARSHALL, SONS, AND CO., ENGINEERS, GAINSBOROUGH.

(*For Description, see Page* 537.)



more or less strong-scented specimens of preserved forage at the stands of the various seedsmen, which form a standing feature of the Smithfield Show by some models exhibited by Messrs. F. W. Reynolds and Co., London, of their systems of silos, already described in ENGINEERING,* and by Messrs. Carson and Toone, whose ensilage cutter we also referred to in our notice of the Royal Society's Show at Shrewsbury. This latter firm have improved the ensilage and chaff-cutter they exhibited at Shrewsbury by substituting for the canvas apron of the elevator, a chain carrying laths or paddles which convey the material up the incline with more certainty than the previous arrangement.

Amongst the exhibits of wheeled vehicles we may mention that of the Bristol Wagon Works Company. Amongst other objects shown is Messrs. Margetson and Hek s screw tip cart, of which this company are the sole makers. It is tipped by means of a vertical screw in front, which is so arranged that it adjusts itself to the arc in which the cart body moves as it is being tipped. The screw adjusts itself to the curve by its end being made to pass through a boss forged on a horizontal spindle working in bearings, and a nut is fitted to the underside of the cart through which the screw travels; this nut works in brackets with oval holes. The screw is worked by a pair of mitre wheels, one attached to the end of the screw and the other to a horizontal spindle working in bearings, the spindle terminating by the handle with which the cart body is tipped. This same principle is also applicable to four-wheel wagons, and in these the body is made to tip upon brackets which go round the back axle inside the wheels and carry the hind springs; these brackets are attached to the wagon axle and the springs to the frame of the body, and the same arrangement also applies to wagons without springs. The screw tip carts can also be fitted with a brake working on both wheels, and so arranged that no weight is thrown on the horse's back.

Messrs. W. N. Nicholson and Son, of Newark, show a novelty in grain mills, which, from the specimen of the work it turned out, should be a useful machine to the farmer. The mill consists of the usual taper fluted roller working within a fluted concave, the point in which it differs from other mills being that the concave is not stationary, but rotates in the same direction as the roller, at a much slower speed. This result is obtained without any complication of the machine. The two parts are mounted on the same shaft; the concave is provided with an internally toothed wheel, and the roller shaft with a pinion, and between the two wheels there is an intermediate wheel which connects them. The result of this arrangement is that a shearing action is obtained on the grain, similar to

* See page 58 *ante*.

that in roller milling, and at the same time the concave is worn equally all round, instead of principally in one place, as is usual. The product passes over a gauze sieve and is divided into flour, middlings, bran, and tailings. They also show a large and a small bone mill, the latter being a new pattern designed for the use of farmers who grind bones for their own use. The breaking rollers are formed of steel-toothed discs threaded on a shaft and separated by distance washers. A ring on the side of each disc enters a groove in the adjoining washer at each side, and thus if the disc should split it is held in place and prevented passing through the rolls.

In addition to a fine collection of their usual implements, Messrs. Ransomes, Sims, and Jefferies, Limited, Ipswich, show a new "steel chill" plough in which the breast or mould board is chilled to the hardness of steel on the acting side, and is left soft at the back, so that while it resists the continual grinding of the soil it is not liable to be broken. This plough will turn a furrow 10 in. to 12 in. deep, and 10 in. to 12 in. wide, thoroughly breaking up the slice that is raised, as if it had been rough harrowed. The Anglo-American rake exhibits some modifications. The wooden seat standard has been replaced by a spring steel bar, and an additional delivery lever has been added, so that the rakes can be lifted either by the man who is riding, or by one walking behind.

The Albion Iron Works Company, of Rugeley, show a fine collection of their grist mills. They also exhibit a horse gear, suitable for driving the mills and the machinery, which exhibits a small but important improvement. The connection between the pole cap and the vertical spindle is made by a pawl and ratchet wheel, the result being that should the horse stop suddenly the momentum of the machinery does not drive the pole against his haunches, and there is no sudden strain put upon the connection.

Messrs. Riches and Watts show a considerable number of their grist mills, to which they have now added a sifter or meal separator, which divides the products into three qualities as it leaves the mill. This sifter is independent of the machine, and consists of an inclined trough clothed with woven wire.

The Aylesbury Dairy Company, of St. Petersburg-place, Bayswater, show two of the Danish cream separators which they have done so much to popularise in this country. One of them is shown with and one without Professor Fjord's regulator, which consists of a long taper tube in which there works a rod. By varying the depth to which the rod descends in the tube the flow of milk into the centrifugal separator can be regulated with the greatest exactness.

Messrs. Pfeil and Co., of St. John-street, E.C., make a large show of light engineers' tools. They are now making a 5 in. centre lathe, specially for electrical engineers, which is a handy tool. It is single geared, and the slide rest is carried by a saddle fixed to the front of the bed, so that it can be pushed out of the way when the hand rest is in use, and need not be actually removed. They also show screw-cutting or gap lathes, drilling machines, &c.

Messrs. G. Lewis and Co., Kettering, have a large show of sack and can lifting apparatus, the principal novelty being an elevator for raising and emptying railway milk cans. It resembles a magnified sack truck with a platform for the can to stand upon, and a winch to raise it. The chains from the winch are connected to a lever on the platform, to balance their tensions, and when they are wound up, the platform with the can rises to the top of the guides, when the can is gently tipped over, and its contents discharged in a tank or other receptacle. For lowering, the wheels of the winch can be thrown out of gear, and the descent regulated by a brake. The sack elevators are provided with an arm to keep the mouth of the sack open, and a weighing apparatus.

Messrs. T. Bradford and Co. show a large selection of their churns, but do not appear to have brought out any novelties of late.

Mr. T. Corbett, Shrewsbury, exhibits a collection of winnowers, chaff-cutters, and other food preparing machines, which have been so successful at previous shows, both at home and abroad.

Messrs. Carson and Toone, of Warminster, show a vertical water-wheel, resembling a feathering paddle-wheel set on end. The floats, which are curved, lie close to the wheel on the back or advancing side, and extend as soon as they reach the opposite side. Each float is pivotted on a spindle, which is rotated by a tappet as the float enters the stream, and thus the extension of the float is made to occur at the right moment.

Messrs. Holmes and Sons, of Norwich, show a specimen of their well-known thrashing machine, which, however, differs but little from their former types. The beater plates are now fixed on channel iron instead of wood supports, and some other small structural alterations have been made.

Messrs. J. and F. Howard, Bedford, show a sheaf binder, in which various improvements have been made in the binding mechanism. To insure that small sheaves shall not be turned out, the tripping is now done by one of the packers instead of by the compressing lever. The string is gripped between two wheels, one of which is grooved, the other running in the groove. The grooved wheel is notched at intervals around its periphery, and the string, laid in one of these notches, is carried forward by the rotation until it is held firmly between the two wheels. These wheels are driven by a wormwheel, and a screw on a shaft which is actuated by bevel segments on the cam wheel. This arrangement gives a very tight grip, which is not liable to fail.

THE ATTOCK BRIDGE.

(*Continued from page* 494).

Piers.—Each pier consists of eight wrought-iron columns connected by horizontal and diagonal cross bracing; four of these columns are nearly vertical, while two up stream and two down stream are raking and act as struts to prevent overturning, as well as carrying a share of the load. Figs. 4 and 5 show the elevations of a pier, and Figs. 6, 7, 8, 9, and 10 are details, see pages 492 and 493 *ante*. Each column is square in cross-section, and is built of four L irons 5½ in. by 5½ in. by ⅝ in., and two plates 2 ft. 6 in. wide by ½ in. thick, two sides being solid plate, and two sides formed of short plates with spaces between which acted as manholes during rivetting, and will be so used as often as painting is required.

The horizontal braces are at vertical intervals of 23 ft., and the main plates and angle irons were in suitable lengths to bring the joints in the columns at similar intervals. The strutting columns join into the main columns in the upper tier just under the head of the pier. The method adopted in erecting was as follows: A 50 ft. derrick was placed near the centre of the pier, and inclined towards the particular column being operated on; the 23 ft. lengths having been previously rivetted up were hoisted into place, and the cover plates temporarily fixed with bolts. The outside horizontal braces were then hoisted and bolted in place, followed by the interior horizontal braces, and lastly by the vertical diagonal bracing. This completed one tier, which was then completely rivetted. The derrick was now raised on to a platform laid on the uppermost tier of bracing, and the next lengths were lifted, the process being repeated until the pier was finished. The first shoe was set on the 6th of February, 1882, and the piers were all to full height by the end of May of the same year, although a sudden temporary rise of the river in March at one time threatened serious delay.

The expediency of providing a material more elastic than masonry for the piers was fully confirmed during the construction of this work. On the 31st of March, 1883, there was a sharper earthquake shock than usual. It was found that the first span girders moved forwards and backwards on the pier head over 1 in. Unfortunately there were no means of measuring the movement on the higher piers, but from the accounts given by the workmen the movement must have been much greater. The expansion rollers of course allowed of this movement without causing any strain, but had not the expansion arrangement been quite clean and in good working order, considerable strain on the pier must have resulted.

Staging.—While the piers were in progress materials were being collected and prepared for the staging for erecting the girders. After several consultations and the preparation of drawings and models, it was finally decided to erect the two main spans on timber staging, and drawings were prepared and timber cut up for the work during the flood season of 1882. For the smaller spans no difficulty was anticipated or experienced, the bed of the river in these spans being dry for the greater part of the year, and a quantity of material, which had originally been procured for other works, was on hand. This material consisted in the first place of a number of wrought-iron cylinders 3 ft. in diameter and in 9 ft. lengths with angle-iron flanges designed for constructing temporary bridge piers during the Afghan campaign; and, second, of a quantity of standards made of angle iron with cross struts and bracing designed by Mr. G. L. Molesworth for staying for girders in localities where timber is scarce and consequently expensive. The amount of material of each of these kinds was limited, therefore both had to be used. Figs. 30 to 34 of our two-page plate show No. 5 span, in which both kinds were combined. The cylinders were used to construct standards equally spaced, and in this case the standards were at a distance of 41 ft. 7½ in. centre to centre, which divided the smaller spans into six equal spaces, timber trusses being used to bridge over the intervals. Each standard was composed of two columns built up of the cylinders with angle-iron bracing and a wooden cap sill.

The stagings for Nos. 1 and 2 spans were commenced in April, 1882, masonry or concrete plinths being in each case built on the rock for the standards. These stagings were ready early in June, and the girders were in position by the end of July. During their erection one heavy flood occurred, and some heavy pieces of timber were washed against the groups of standards against No. 2 pier, but no damage resulted, wooden fenders having been erected in front of this group in anticipation of floods. The work on these two spans was purposely done slowly in order to keep a small gang of rivetters constantly employed during the flood season, who would thus thoroughly understand the work and the erection of the description of girder used by the time the larger spans had to be put together. The staging for No. 5 span was similar to that in No. 2 span, and the materials for it were taken across the river early in October, and its erection commenced.

For the two principal spans Nos. 3 and 4, a different system had to be adopted. In these spans no intermediate supports could be erected as they carry the main channel of the river, and the velocity of the water at its lowest, exceeds five miles an hour in the third span, sweeping the rocky surface clean. The frequency also with which rafts of timber from the upper reaches pass, often without men to guide them, also large boats with produce, add to the dangers a staging with intermediate supports would have had to encounter. Moreover it was desirable that any staging should be practically clear of cold seasons minor floods, and should allow of a rise in the river of at least 30 ft. without causing any material obstruction to the waterway.

Figs. 35 to 44 (the latter on page 543) show the staging for No. 3 span as erected, while the perspective view on page 546 shows it in course of construction. It consisted of a series of long struts springing from a point near the base of each pier and spreading out in a fan to support a horizontal beam of double whole timbers on which the platform was laid for erecting the girders. The corresponding struts in the up and down stream fans (which were 19 ft. apart centre to centre, the same distance as the girders) were connected by horizontal braces, each brace being a pair of half timbers bolted together with the struts between them, and with diagonal struts in the rectangle between each pair of horizontal bracings. At equal vertical distances of 12 ft. ledgers of half timbers in pairs connected all the main struts of each fan with each other and with the main column of the pier with which they were in line, being clamped to the columns by heavy wrought-iron straps. The outer main struts were built up of whole timbers clamped together, commencing at the bottom with three, one of which eventually branched into a secondary strut. Similarly the vertical next the pier commenced with two whole timbers, and divided afterwards into two struts. At the level of each tier of ledgers above the fourth, counting from the bottom, sets of 1-in. chain horizontal diagonal bracings were put in. These chains were drawn tight by ordinary wagon screw couplings, four hundred of which were got out from England specially for the work.

The two outermost struts from opposite sides were connected at top by a beam of the same section being dropped in before the sill pieces were laid. This beam was 63 ft. long and of sal wood (the rest of the staging being deodar), and was trussed by three vertical struts 10 ft. deep with rods of 2 in. round iron forming a queen truss of 63 ft. span. When in place this trussed beam, together with the long struts which it connected, formed a gigantic strut and straining beam truss under the sill pieces.

During erection and until the straining beams were in place each fan was tied back to the main column of the pier with which it was in line by the ledgers, which for the time had to bear a considerable amount of tension.

The timber, readily procurable on the Indus, does not exceed an average of 22 ft. in length, and the number of joints in the work was therefore very great. The stagings were built out from the piers piece by piece, beginning with the vertical struts next the piers, which were soon carried up to their full height. To facilitate the hoisting of the timbers into place two pairs of Manilla 9 in. hawsers were stretched across each span, from the top of the 250 ft. completed girders at the shore ends and over a pyramid of sleepers placed on the top of the centre pier. From these hawsers tackles were suspended at convenient points as the work progressed. When the building out of the fan portions was completed, rails were laid on the sills, and two large temporary cranes made for the purpose were moved out to the extremities. The 63 ft. trusses were then built on boats, were brought under the cranes, and were raised into place, the cast-iron angle sockets at the ends of the straining beams being dropped over the ends of the long struts, which were sprung back slightly to allow of this being done. When these were in place the sill piece was completed over the top and the platform laid on, a line of rails to the metre gauge being put upon it to bring out the girder material. These stagings proved very satisfactory; levels were taken daily at several points during the time the girders were being built to test the stagings for settlement, and, notwithstanding the great number of joints, the maximum deflection of the platforms under the full weight of over 600 tons (in addition to the weight of the staging itself), was only 1⅛ in. The stagings were by far the most difficult, as well as tedious, part of the work of the construction of the bridges. They were commenced on October 9, 1882, and the second one was not completed until the beginning of February, 1883. Much of this time, however, was lost by bad weather, for during high winds, which are very prevalent at Attock in the winter, it was unsafe to allow men to work in such high and exposed situations, when their hands and feet quickly become numbed by cold, and their power of doing effective work is reduced to a minimum. As much as a week at a time was, on occasions, lost from this cause.

(*To be continued.*)

METALLURGICAL NOTES.

Early History of Bessemer Work in America.

Two long papers were read on this subject at the New York meeting of the Society of Mechanical Engineers. One, by Mr. W. F. Durfee, gave an account of the work done at Wyandotte, Michigan, where the first Bessemer steel was produced in America in September, 1864. The paper is very amusing, and graphically describes the many difficulties that had to be overcome, as well as the great amount of opposition and enmity from nearly every person of influence in Wyandotte, which did not by any means stop short at merely "moral" opposition, but used physical as well. As usual in such cases, the opposition took at first the form of derision and contempt, a great local authority expressing the general feeling when he said "If that d——d Yankee expected to blow cold air through melted iron and not have it chill up, he *must* be a d——d fool." However, success was reached, and the knowing ones were as much confounded in Michigan as they were in England. This other paper was by Mr. R. W. Hunt, and dealt with the history of the original steel plant at Troy, where steel was produced by Bessemer process a few months later than at Wyandotte, viz., in February, 1865. The paper is very interesting, and details the difficulties encountered and the manner in which they were overcome by the late A. L. Holley. The record of the experiments and work done, quoted in this paper, consists partly of entries made by Holley himself. During the discussion that followed, an amusing anecdote was told as to the style of criticism and opposition encountered, and the style of person from whom it came, in the early days of the Bessemer process. A Mr. Himrod, a leading blast furnace man of Ohio, was of opinion that the outlay for a Bessemer plant in course of erection was vastly in excess of what was required for such a simple process. Pressed for his reasons for this opinion, he stated that it was really only a question of agitating the molten metal, and that this could be done by very much simpler means. He had gone into the matter, and had made experiments. Urged to give details, he at last said that he had borrowed a ladle from an adjoining works, had run pig-iron into it, and then had fastened a potato on the end of a rod and stuck it into the bath. The result, as he triumphantly stated, had been that "it had made a h—ll of a balloo!"

Clapp and Griffith's Stationary Bessemer Converter.

At the meeting of the American Society of Mechanical Engineers, Mr. R. W. Hunt made a very interesting statement concerning the use of the above converter at the works of Oliver Brothers and Phillips, of Pittsburg. The metal made in it is remarkably low in carbon, and possesses the important quality of welding very well, boiler tubes of very good quality having been made from it. In order to test the question to what extent the employment of a cinder-tap made it possible to use inferior pig, Mr. Hunt blew a mixture of 50 per cent. of a pig iron containing 0.9 per cent. of phosphorus, and 50 per cent. of average western Bessemer pig. The steel made contained 0.54 per cent. of phosphorus, 0.0065 per cent. silicon, 0.08 per cent. sulphur, and 0.12 per cent. carbon. It worked well and bent cold double. Cast into a 7 in. ingot, rolled into a billet, and then into a half-inch rod, a test showed a tensile strength of 74,000 lb., an elastic limit of 62,000 lb., an elongation of 25.25 per cent., and a reduction of area of 48 per cent. One test was made from a sprue from the bottom of an ingot, rolled to a half-inch rod, and yielded a tensile strength of 78,000 lb., and an elongation of 28 per cent., results justly regarded as astonishing. These results confirm the good accounts published in Europe in regard to the use of small converters for special work. It is, of course, well known that fixed converters have been used for decades in Sweden, to make a high quality of metal. But they had the drawback that blowing had to be continued till the metal was ready for tapping. The Clapp and Griffith converter is so arranged that the tuyeres can be practically closed by plugs at the end of the blow. The building in America of a number of four and five-ton converters during the past few years for the manufacture of steel for special purposes, is sufficient evidence of the drift of opinion among metallurgists. At one time the claim was made, on behalf of the open-hearth process, that it was impossible to produce in converters, in successive blows, a uniform metal as to contents of carbon, silicon, and manganese. The evidence of the past year, not only as regards the work of small converters, but also as to large ones, has disposed of this objection. The introduction of the Clapp and Griffith converter marks a further step in the same direction. The plant is so cheap and its capacity so small, that it places the Bessemer process within the reach of smaller works, and in this country it will find a wide field for a variety of purposes for which the puddling furnace has so far held hardly disputed sway.

Works at Mechernich, Germany.

One of the most interesting, as well as most extensive, mining and smelting establishments in Europe, is situated at Mechernich, in the Eifel district, a journey of an hour and three quarters from Cologne by rail. Here are the works of the Mechernich Lead Company, whose yearly produce of refined lead is over 25,000 tons, being very much more than is produced by any other single works. But it is not the large amount of metal turned out which gives interest to these works; it is the very low-grade material from which the lead is obtained, and the great bulk of rock which has to be handled in order to reach the above produce. This rock is a soft sandstone, in which is disseminated galena in fine grains and crystals. There are a few nodules of ore of larger size, and besides the galena, there occur also small quantities of carbonate and molybdate of lead; but these are quite insignificant by comparison, practically the whole of the metal occurring as galena finely sprinkled through the light yellowish sandstone. The great amount of this sandstone that has to be worked may be judged from the fact that the usual average assay of the rock, as it goes to the dressing works, does not exceed 3 per cent. of lead. Latterly, owing to the very low price of lead, it is understood that some of the lowest grade parts of the workings are being left, so that the average of the stone raised may assay a little higher, but with anything like a normal lead price 2½ to 3 per cent. stone is worked. The property of the company extends for some two miles or so along a low ridge, which forms the outcrop of the lead-bearing sandstone, which dips towards the north. The working is carried on partly by quarrying and partly by mining, there being two main points of operations, some distance apart, with a quarry and a mine at each point, the rock being got by open workings as far as the dip will allow, and then followed by mining. The quarries are on an enormous scale, working on many terraces with lines of tramway at several different levels. The blasting is carried on by means of electric shot-firing from a central station, and recently electric lighting has been successfully introduced for night working. A layer of red sandstone several yards in thickness has to be removed before coming to the lead-bearing yellow sandstone, and huge waste heaps are being pushed out into the surrounding country from the several dumping points to where this red sandstone is taken. The yellow sandstone, as quarried, is hauled away to the mouth of the neighbouring mine, right over which are erected the dressing works, in a building many stories high, each story smaller in area than the one below it, till the final one is just large enough for the ascending trucks of ore to be emptied out above the stone breakers, through which it is at once passed. The ore from the quarry, and that from the mine, are raised to this top story, and then pass down through a series of crushers, classifying cylinders, revolving sorting tables, &c., being deprived during the passage of a large amount of pebbles of all sizes, which contain no lead, and of pieces of worthless sandstone. The whole is finally reduced to powder and subjected to hydraulic dressing and concentration. The mechanical arrangements are very perfect, the great mass of material passing down through the several stories, and from one stage of the process to another, with a minimum of manual labour. The final result of this dressing of the ore is, that a portion of it is concentrated to 60 per cent. of lead, and goes direct to the smelting works; while another portion reaches only about 20 per cent of lead, and is taken away to another central dressing works, at which, together with a similar product from the other quarry and mine, it is further treated, and eventually also concentrated to 60 per cent lead and sent to the smelting works. The ore as delivered to the smelting works is very pure indeed, and the working of it is very simple. It is calcined and agglomerated in large "double-decked" furnaces, and is then smelted down in blast furnaces, with limestone and iron ore as fluxes, yielding a very soft lead containing a little over 7 oz. of silver per ton. The lead is desilverised by the zinc process. The company employ over 4000 workmen, and have in use twenty-five full-sized locomotives on twelve miles of railways. They have erected large stores for supplying necessaries to the men; also flour mills, bakehouses, and a large brewery, everything being sold at cost price to employés of the works. In spite of the "bad times," which have fallen, perhaps, more severely on the lead trade than on any other metallurgical industry, this company continues to pay a large dividend on its capital. There are some other works in the district operating on the same class of material, but they are comparatively small and unimportant. Water is scarce and has to be economised. At the large dressing works above described, elaborate arrangements are made for using it over and over again. The final residue of sand from the crushed sandstone is pumped out with the water from the last stage of the dressing process into settling tanks outside the buildings. The water, after clearing, is used again, and the sand hauled on to large waste heaps. Enormous quantities of this sand are accumulating, and together with the heaps of red sandstone from the quarries, give the country a very desolate appearance. And in windy weather a general state of grittiness sets in which renders a stay at Mechernich anything but pleasant.

STEAM TRAMWAYS.

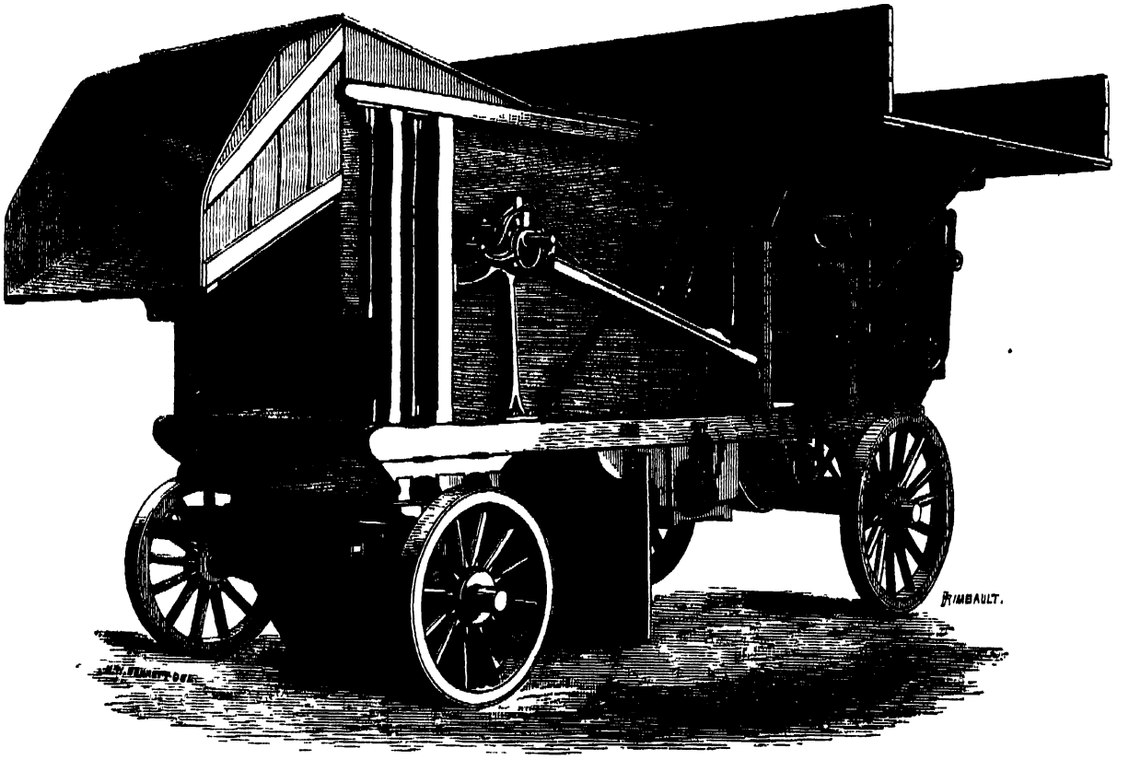
At the fourth meeting of the session of the Institution of Civil Engineers, on the 2nd of December, Sir J. W. Bazalgette, C.B., President, in the chair, the first paper read was on "The Working of Tramways by Steam," by the Hon. Richard Clere Parsons, B.A., B.C.E., Dublin, M. Inst. C.E.

The author commenced by stating that very little success had attended the various efforts made from time to time to work passenger traffic with engines on ordinary macadamised roads. He then proceeded to discuss the reasons why these efforts were not successful, and showed that the special privileges accorded to tramway companies by Act of Parliament, had enabled steam to be used with advantage for the conveyance of passenger traffic along the streets of towns. The Board of Trade regulations were explained, and the manner in which they had of late been modified so as not to impose unreasonable hindrances to the use of steam, and at the same time to protect the public from danger. The author next described in detail the construction of the type of tramway engines which he considered to be most suitable to the requirements of street traffic. The cylinders were placed as high as possible, to be raised out of the mud, and were readily accessible from the front, to permit of the cylinder cover and pistons being easily removed. The connecting rods worked directly on to the cranks on the trailing axle, and the four wheels were coupled as in ordinary locomotives. He stated that many such engines had been constructed by Messrs. Kitson and Co., of Leeds, and were working satisfactorily in this country and abroad. Various methods for rendering the exhaust steam invisible were referred to, and it was shown that surface condensation was more satisfactory and more economical than superheating. Atmospheric condensers were described as of great value where water was expensive, and it was stated that considerable economy could be effected by their use. The construction of the brakes fitted to tramway engines was of considerable importance, as the safety of the public to a great extent depended upon their being both quick and powerful in action. Sand-boxes should also be provided so as to sand the rails both in front and rear of the engine, and they should

FINISHING THRASHING MACHINE AT THE SMITHFIELD CLUB SHOW.

CONSTRUCTED BY MESSRS. RUSTON, PROCTOR, AND CO., ENGINEERS, LINCOLN.

(*For Description, see Page* 537.)



not so liable to become choked. On some tramways, especially abroad, the tramway engine and car had been combined, and amongst the best of this type was that designed by Mr. W. R. Rowan. The passenger car was supported upon two four-wheeled bogies. The engine acted as the leading bogie, which supported one-half of the carriage when empty; and when loaded a large portion of the weight of the passengers was available to increase the adhesion of the engine wheels on the rails. The engine could be detached from the car in five minutes, and a fresh engine substituted in about the same time. The character of the permanent way, where steam was to be used, might be considered as only second in importance to that of the construction of the engine. At first it was too light, and difficulties were experienced in fitting the joints of the rails. It was contended that the line should be substantially laid, so as to avoid as much as possible frequent repairs, which were of a costly nature. In some localities this was especially necessary, as the wear and tear of the ordinary cart traffic, which generally made use of the tramway lines, were very heavy. Having explained in detail the construction both of a tramway engine and of a tramway, with a view to economy in working, the author proceeded to discuss what were the necessary expenses on an average line. As the result of experience where a frequent service was maintained, the cost of working the engines, including wages, fuel, oil, and repairs, was 2.28d. per mile run. The question of depreciation, both of the rolling stock and of the permanent way, was next discussed, and it was held that, both for the engines and the cars, an annual allowance for depreciation at the rate of 10 per cent. would be sufficient, provided the ordinary repairs were paid for out of revenue. The depreciation on the line was taken at the rate of 3 per cent. per annum, which was laid aside to form a sinking fund, interest upon which was allowed to accumulate at the rate of 5 per cent., and in this way the cost of the line would be paid off in about twenty years. As the result of these computations, the total working expenses of a line, including all items of expenditure, which were given in detail, amounted to 0.33d. per mile run. As a practical rule, every surplus penny per mile run above the working expenses would give 2.2 per cent. dividend to the shareholders. The author concluded by advocating the use of large cars and moderate fares as the best means of securing the largest receipts, and consequently of insuring good dividends to the shareholders.

The second paper was on "The Sydney Steam Tramways," by Mr. Walter Shellshear, Assoc. M. Inst. C.E.

In this communication the author observed that the system of steam tramways in operation in the city of Sydney, was perhaps the most advanced in the world. When it was decided to hold an International Exhibition in Sydney in 1879, a Bill was passed through Parliament empowering the Government to construct a tramway from the railway terminus at Redfern to within a few yards of the Exhibition gates. It was resolved to adopt steam as the motive power, and four Baldwin 12-ton tramway motors were ordered from Philadelphia, U.S., and eight bogie double-decked cars, seated for 90 passengers. The permanent way was constructed on the longitudinal principle. This line was 1 mile 45 chains in length, and its cost, including rolling stock, was 22,269*l*. The convenience of the system was so highly appreciated by the public, that in a few months the construction of fifteen lines had been authorised by the Local Legislature. The author then traced the growth of the system, and stated that, at the end of 1882, a length of 22 miles was open, and that the capital expended, including rolling stock, machinery, and workshops, amounted to 412,561*l*. The number of passengers in that year reached 15,269,900, equal to 986,400 per mile, and the earnings amounted to 81422. per mile. The lines were laid to a gauge of 4 ft. 8½ in. Difficulty was at first experienced with the permanent way from the rails being of insufficient strength to support the weight of the motors. The rails were of inferior quality, having been re-rolled from old railway metals. The tramways were now laid on a cross-sleeper road, with steel rails of the Vignoles type. The sleepers were rectangular, laid on a 4 in. bed of Portland cement concrete. The roadway was formed of tarred bluestone. Where the street traffic was light the tarred bluestone roadway answered fairly well; but with heavy street traffic much difficulty was experienced in keeping the roadway up to the rail level. The author then described the rolling stock. Besides the Baldwin motors from Philadelphia, two engines had been supplied by Messrs. Kitson and Co., of Leeds, and one engine by Messrs. Merryweather and Sons, of London. The Baldwin motors were saddle-tank locomotives, inclosed by cabs concealing the boilers and most of the machinery. No attempt had been made at condensing, but the engines were fitted with a chamber into which the exhaust steam passed, muffling the noise. Four different sizes of these engines were at work. The cylinders were horizontal, and, the working parts being well balanced, they travelled with remarkable smoothness. These motors had much to recommend them; but the wear and tear on the dusty and sandy roads were by no means a small item of maintenance. Fifty-seven motors were in use in October, 1883. The Kitson motors were originally fitted with a system of condensing tubes, but these had been removed, as the steaming power of the boiler was thereby much reduced. The cylinders of the Kitson engines were inclined at a considerable angle, and, the gearing being somewhat heavy, they did not run so smoothly as the Baldwin motors. The Government were having some experimental steam cars constructed in Philadelphia, in which an ordinary tramcar and motor were combined. All the cars were built on the American bogie principle. They were mostly double-decked, with a roof over the upper deck; the lower deck was divided into compartments with ten seats in each compartment. The rolling stock was fitted with vacuum brakes, as well as with powerful hand brakes. Of the stock of eighty-one cars and five bogie trucks at the end of 1882, all but eight cars had been manufactured by local firms. Extensive workshops had been erected, including a tramcar shed and a motor running shed, each 300 ft. long. Some idea of the magnitude of the service might be afforded from the fact that, along one street in Sydney, 973 trams passed daily, and on public holidays this number was considerably exceeded. The author contended that, for steam tramways, the greatest attention was necessary in the design of the permanent way, that a substantial rail, thoroughly well supported, was essential to economy, and that it was advisable to have the streets well paved, in order to reduce the amount of grit on the road, and thus diminish the wear and tear of the locomotives. The satisfactory results achieved on the Sydney tramways seemed to show that horse traction must yield to mechanical power. In an appendix the author gave a tabular statement of the gross earnings, the working expenditure, and the net earnings of all the lines in operation during the years 1880 to 1882 inclusive.

METROPOLITAN SEWAGE DISCHARGE.

THE second and final report of the Royal Commission on Metropolitan Sewage Discharge was issued on Tuesday last. We shall in an early issue deal with the report, but meanwhile we subjoin the summary which the Commissioners give at the end of their report, of their conclusions and recommendations:

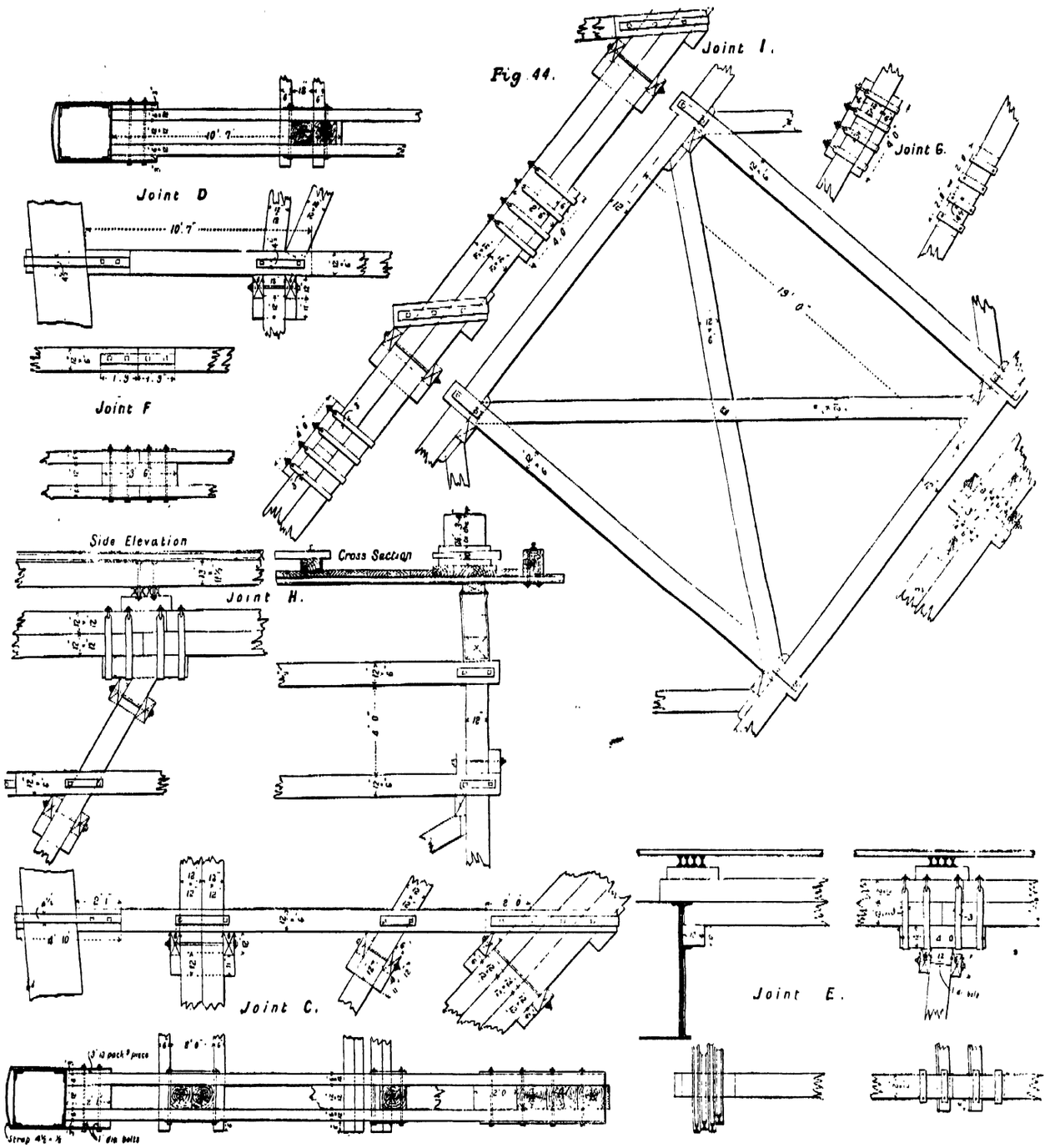
Our opinion of the evils described in our first report, as resulting from the present system under which sewage is discharged into the Thames by the Metropolitan Board of Works, is much strengthened, and we believe these evils imperatively demand a prompt remedy. We are of opinion that it is neither necessary nor justifiable to discharge the sewage of the metropolis in its crude state into any part of the Thames. We are of opinion that some process of deposition or precipitation should be used to separate the solid from the liquid portions of the sewage. Such process may be conveniently and speedily applied at the two present main outfalls. The solid matter deposited as sludge, can be applied to the raising of low-lying lands, or burnt, or dug into land, or carried away to sea. The entire processes of precipitation and dealing with the sludge can be, and must be, effected without substantial nuisance to the neighbourhoods where they are carried on. The liquid portion of the sewage, remaining after the precipitation of the solids, may, as a preliminary and temporary measure, be suffered to escape into the river. Its discharge should be rigorously limited to the period between high water and half ebb of each tide, and the top of the discharging orifice should be not less than 6 ft. below low water of the lowest equinoctial spring tides. By this means much of the existing evil will be abated. But we believe that the liquid, so separated, would not be sufficiently free from noxious matters to allow of its being discharged at the present outfalls as a permanent measure. It would require further purification, and this, according to the present state of knowledge, can only be done effectually by its application to land. In the case of the metropolis, the best method of applying the liquid to land, with a view to its purification, would be by intermittent filtration. We have

BRIDGE OVER THE RIVER INDUS, AT ATTOCK.

MR. F. L. O'CALLAGHAN, ENGINEER.

(*For Description, see Page* 540.)

Fig. 44.



reason to believe that sufficient land, of a quality suitable for this purpose, exists within a convenient distance of the northern outfall. The liquid portion of the sewage would be pumped up to this land from the separating works, and, after filtration, would be conducted to the river. We do not know whether suitable land in sufficient quantity can be found in convenient positions near the southern outfall. If not, the liquid must be conveyed across to the north side by a conduit under the river. If suitable land, in sufficient quantity, and at reasonable cost, cannot be procured near the present outfalls, we recommend that the sewer liquid, after separation from the solids, be carried down to a lower point of the river, at least as low as Hole Haven, where it may be discharged. In this case it will also be advisable that the liquid from the southern sewage should be taken across the river, and the whole conveyed down the northern side. It may be found that the separating process can be effected more conveniently at the new than at the present outfalls; this will depend on various considerations of cost and otherwise. If the outfalls are removed further down the river, the main conduit or conduits may, if thought desirable, be made of sufficient capacity to include a general extension of the drainage to the whole of the districts round London, as recommended by Sir Joseph Bazalgette and Mr. Baldwin Latham. In new drainage works, the sewage should be, as far as possible, separated from the rainfall.

TREVITHICK'S ENGINE.

To the Editor of Engineering.

Sir,—Judging from the protracted and voluminous correspondence which has appeared in the columns of your contemporary *The Engineer*, there is a large body of readers deeply interested in the early history of the steam engine, as applied to locomotion. Your excellent little article and illustrations of one of Trevithick's high-pressure engines rescued from decay by the enterprising locomotive superintendent of the London and North-Western Railway, comes at an opportune time, if only to divert our minds from the contradictory and positive assertions of opposite "facts," so manifest in the correspondence alluded to. I should be loth to initiate a controversy, probably as difficult to clear up as the history of the real "Rocket," yet it is not beyond the bounds of probability that there may be some interest awakened by an inquiry into the true position of locomotive science in Trevithick's time, or about the period you name in your article, i.e., 1804, for there are many points or questions of interest common to both; for instance, one might ask, "What is there marvellous in Hackworth putting a return flu into the boiler of the Royal George in 1827-9, if Trevithick had done the same thing in 1804-6?" It would also be interesting to learn Mr. Webb's authority for so reconstructing the relics "he found on a scrap heap" into a stationary engine; are they not more likely to have belonged to a locomotive?

I know I have seen somewhere a drawing said to have emanated from Trevithick, which showed a somewhat similar arrangement applied to a locomotive, and I believe one of his patent specifications describes such an engine and four-way cock, &c., as applied to a carriage for running on the roads. In fact, when I heard some time ago that the respected locomotive superintendent of the London and North-Western Railway had made a find of some Trevithick relics, I fully anticipated the restoration

of an ancient locomotive at the Crewe Works; your article and the illustrations in your issue of the 21st ult. have dispelled that illusion.

It is not that I seek to disparage Mr. Webb's efforts; on the contrary, they stand in honourable contrast to a public department whose very plea for existence is that it should perform such duties as thus rescuing from decay the evidences of mechanical invention or genius of bygone days. Some years ago I saw lying just outside of the Patent Office Museum at South Kensington, some very similar relics to those which fell into Mr. Webb's hands; there were, I remember, the cast-iron shell of the boiler with the cylinder in it, the four-way cock, crosshead, guide-bars, stays, and front plate of boiler, "with return flue," amongst them. Making a mental note of it at the time, and visiting the spot many months after, I found the guide-bars and stays conspicuous by their absence; those parts for which a "place" had been found, were stuck together somehow and placed in a corner with a label on, directing visitors to certain letters patent. Upon reference to these, I found that those parts which are described in the specification had been put out of the way of examination; and those portions of the exhibit, neither described nor shown in the letters patent, were put prominently forward to the front, and the whole thing gave evidence of utter incapacity and inappreciativeness somewhere.

My object is not to injure any one, but simply to give utterance to a very generally felt pain at the neglect or indifference of those appointed to perform these public services, a neglect which is brought out in such a striking manner, when from time to time (as in this case) we find independent and enterprising gentlemen setting such an excellent example.

It may be we shall be told there are no funds for the purpose, and that there is less need for it to be done at the public expense if private gentlemen do it at their own cost, and a thousand other characteristic and effete excuses will be offered; but surely in this case sufficient brains and money could have been found to direct the construction of the few "missing links," in what I believe if it had been energetically investigated would have turned out to have been a high-pressure steam locomotive or carriage constructed long before the name of "Rocket" was thought of, and it might have been placed in a position to be seen by thousands who can never hope to see Mr. Webb's at Crewe. However, we have to thank him for the rescue and you for the picture of it, and I for one shall be glad to learn through your columns the information incidentally asked for in a former part of this letter, as to where the drawings or authority exist under which Mr. Webb has reconstructed the old engine as a stationary one.

Yours truly,
OBSERVER.

AWARDS FOR VENTILATORS AT THE HEALTH EXHIBITION.

To the Editor of Engineering.

SIR,—We observe in several contemporaries that our statements with respect to the non-invitation of certain exhibitors of ventilators to the testing, and the farcical nature of the tests, are *fully corroborated by other exhibitors* who were also *not invited* to the tests. On the face of this, how can it be asserted, as it is, that all were invited?

The more light that is thrown on this matter shows but all the more conclusively that there has been mismanagement somewhere, and it is only right, seeing that this is a public matter, that the public should know who is responsible for it, and also that measures should be promptly taken to secure the rectification of the error which has been committed, otherwise a lasting reproach will not only rest upon the conduct of Jury 10 and their testing engineer, but upon the Health Exhibition itself.

As showing the opinion of the press on the matter, we beg to give an extract from a lengthy "leader" which appears in a contemporary. "In view of the remarks of Messrs. Boyle and Son, published in our present issue, it would appear that some strange mismanagement has overtaken the jury which decided the 'ventilation' awards at the Health Exhibition. If as Messrs. Boyle say, their well-known ventilators were not included in the list of apparatus tested, and if their positon, as competing exhibitors, has thus been practically ignored, we certainly feel entitled, in the interests of 'fair play and no favour' to *ask* for an explanation of these anomalies.

"We approve of the demand of Messrs. Boyle, not only on account of the alleged grievance of that firm alone, but of all other firms who have competed in the section alluded to, whether they have received awards or not. No firm of inventors can have the slightest satisfaction in receiving any award, the fairness and impartiality of which can be called in question. We are certain, therefore, that we only re-echo public sentiment and professional opinion, when we ask that such a matter as that to which attention is being directed should be fully investigated. If exhibitions and their juries do not obtain the confidence of the public, the mainstay of these institutions is at once sapped and destroyed."

A correspondent who signs himself "An Architect," says, "It is to be regretted that gentlemen more practically scientific were not appointed to adjudicate on ventilators at the Health Exhibition." And he asks, referring to the tests, "Could any greater farce in the name of science, be enacted?" All that we can say in reply to this query is, "time will show."

Yours, &c.,
ROBERT BOYLE AND SON.

64, Holborn Viaduct, December 1, 1884.

ROYAL INDIAN ENGINEERING COLLEGE.

To the Editor of Engineering.

SIR,—It would be impossible to state more concisely the case against the Cooper Hill College than is done by Professor Shaw in your paper of the 21st instant, but it may encourage those who hesitate to accept his conclusions, to point out through such an impartial organ as ENGINEERING *how fully* British India has been supplied with civil servants ever since the abolition of Haileybury College, which the Honourable East India Company established in place of their seminary at the Castle, Hertford, purposely to train their "writers," as the young fortunates were then styled. That good and often almost perfect civil and military officials were turned out at John Company's pet scholastic institutions of Haileybury and Addiscombe, no one who knows the history of our administration since 1805 up to the political extinction of the great company, will gainsay, but there was an evil engendered in both, viz., a clannishness or family touch, which in too many cases prevented impartial estimates of public wants being formed by men who rarely even consulted native or non-official opinion, or gauged popular feeling by the independent press; I need not go further back than point to the lamentable mistakes made shortly before the so-called mutiny or great rebellion.

I do not say that the Indian official is less of an anti-progressist now than he then was, but he will and must become so with such governors-general as Lord Ripon, backed by a reformed Parliament here, in which it is to hoped natives of India, as well as of the British Colonies, will sit.

This pseudo *esprit de corps* has unfortunately been fostered in the Cooper's Hill College, as engineering in India during the past few years shows, and as one who believes that the British Empire is for *all* its subjects, I rejoice that the excessive cost, and small utility to India of this educational mistake, has appeared in ENGINEERING, and hope that the Secretary of State for India will not ignore the matter, for at present that great dependency is weighed down by an officialdom, which looks on that great national trust as created solely for itself and its family.

I am, Sir, yours truly,
H. SOMERSET MACKENZIE.

London, November 27, 1884.

RAILWAY BRAKES.

To the Editor of Engineering.

SIR,—I am very much surprised that the letter on "Pressure or Vacuum Brakes," published in your issue of November 28, has been allowed to go, so far, unanswered, but I shall feel obliged if you can spare me a few lines to call attention to one or two points, which if not contradicted, might be calculated to mislead.

The writer takes for granted that compulsory legislation must necessarily stereotype a certain form of brake. Now this is not the case at all. The great object of compulsory legislation would be to insure the safety of the public, by preventing the use of dangerous brakes and the compulsory adoption of brakes which should fulfil certain conditions *at least*. But the choice of the brake fulfilling these conditions *at least*, and as many more as the company might think fit, could be left for the railway company to decide upon. Then there would be every "reasonable chance of brake patents being tried, adopted, and paid for," which would by no means put a stop to competition, but the contrary.

The writer above referred to also states that "scientifically and theoretically it will be admitted that pressure and a vacuum are susceptible of the same degree and efficiency of control;" but this point has already been most ably answered and disproved in your columns.

I am, Sir, yours faithfully,
H. W. T.

December 8, 1884.

THE IRON AND METAL TRADES IN ITALY.

To the Editor of Engineering.

SIR,—Some information on the present state of the iron, metal, and allied trades with Italy may interest your readers.

From a comparatively early period in modern history, Italian thinkers held very sound views on political economy, and many of the principles subsequently developed by Adam Smith and his school, had been foreshadowed by Italian writers. These traditions were handed down through the times when even theoretical studies were barely tolerated. Later, when the moment of emancipation arrived, there is no doubt that the leaders of the people—the men who made Italy—such as Cavour, Sella and Minghetti, were staunch freetraders. Still, their good intentions were overridden by financial necessities, and it could be remarked of Italy, that whereas free trade found there most enthusiastic advocates, somehow or other their practice always tended to the opposite direction.

The Conservatives were driven from power in 1876, but the advanced Liberals who succeeded them, have proved still more decided protectionists. It is fair to say that political and social considerations, besides merely commercial views, have combined towards this result. The abolition of religious orders, the reduced state of the Church, the impoverishment of the propertied classes, made it imperative to find new openings for labour. As neither party in the State consider it advisable that any portion of the community should suffer in homage to the principles of free trade, all are agreed that every effort shall be made to promote the employment of native labour, rather than the importation of foreign commodities. The Milan Exhibition of 1881 much favoured these views, it being shown that home industry was, in many articles, nearly able to compete with foreign wares. The Exhibition at Turin last summer further confirmed these ideas, and it is now a recognised maxim that the development of national industry and the fostering of native labour, shall be a leading object of the national policy.

Much is being done in that direction. I visited a short time ago iron works at Piombino, where the labour is to a great extent supplied from a neighbouring convict prison. The Government farm out the prisoners for one franc, say 10d. a day, to cover food and clothing, and as each man receives for himself an additional 5d. per day of ten hours' work, all are anxious to be selected for employment, and better behaved gangs of workers could not be found. It is needless to add that in spite of general depression, these iron works are giving handsome dividends to their shareholders, while supplying home consumption at lower prices than English or Belgian iron.

Another company possessing large works in central Italy, had such confidence in the prospects of their home trade that they did not hesitate at working up a stock of 12,000 tons of bars. This boldness may answer or not, but meanwhile Italian dealers will not be tempted to place orders abroad.

Excepting the making of rails, which Italian capitalists have been too wary to undertake, almost everything wanted for railways or tramways is now made in the country. The rule with the Government departments is, that when an article can be had of native manufacture, it shall be preferred, if not more than 5 per cent. dearer than the foreign importation duty paid.

And any foreign contractor who in spite of this secures a contract, will meet with small mercy should any fault be found in his goods.

The trials of armour plates recently made at Spezia were primarily intended to determine the relative merits of the Sheffield compound plate as compared with the Creusôt solid steel. But ultimately they have served to settle which system shall be adopted in the new steel works to be established at Terni. These have obtained a contract for the supply of 12,000 tons at the price of 80*l.* per ton, a considerable portion of the cost being advanced by Government in order to facilitate the purchase of plant and material.

Another running contract has been granted to an establishment near Genoa for 15,000 tons of Siemens steel plates and angles for shipbuilding. Prices to be regulated on foreign markets, plus cost of carriage and import duties. This clearly secures a handsome margin to the Italian manufacturer. Further facts could be quoted, but these are sufficient to account for the increasing difficulty of trade with Italy.

Yours faithfully,
C. C.

December 8, 1884.

TRAIN LIGHTING BY ELECTRICITY.

To the Editor of Engineering.

SIR,—I am glad to see, in a current number of your journal, a notice of the experiments which are being carried out by the Great Eastern Railway, and I trust, Sir, that you, who have done so much to keep the great "brake" question before the public, will take every opportunity of reminding us that railway carriages can be much better and more cheaply lighted than they now are either by oil or by gas.

As you have thought well to refer to the trials which took place about a year ago on the District Railway, perhaps I may be permitted to state once again that the plan of putting machinery of any kind into a van was not recommended by me, and that I have always advocated the use of a separate engine placed on the locomotive, an arrangement which Mr. Woodley was not inclined to adopt when he first went into the matter. This is the only practicable scheme for lighting trains *on a large scale*, and the sentimental objections at present raised to the lights being extinguished, whenever it may be necessary to disconnect the locomotive engine, ought not to weigh with those who know from experience that it makes little or no difference in well-lighted stations whether the carriage lamps are lighted or not; at any rate, secondary batteries are not yet perfect enough, nor cheap enough, to allow of their being placed under the seats of every carriage, and, until they are, there is no probability of their being employed to any great extent, except by inventors of systems which, as I have shown elsewhere, are of no earthly use without them.

I have no pecuniary interest in any of the methods hitherto proposed, so there can be no harm in my calling attention to the fact that the cost of fitting up a long train and its locomotive with electric light machinery is but half that of putting in gas apparatus, and also that, by the evaporation of about 200 lb. of water, fifty incandescent lamps, of 20 candle-power each, may be kept lighted for one hour; but when I tell you, Sir, that I *have* come across railway people who did not even know that "the weight of water had anything to do with the question," you will understand why I am so anxious to secure your help.

Faithfully yours,
W. H. MASSEY.

Twyford, Berks, December 6, 1884.

SECONDARY BATTERIES.

To the Editor of Engineering.

SIR,—Mr. Sellon's letter, of the 24th ult., escaped our notice until it was too late for a reply to reach you in time for last week's issue. However, we are pleased to see that an unknown friend has taken our part.

Mr. Sellon appears to have quite forgotten our letter to the *Electrician* of the 26th of January last, in reply to one from the Electric Power Storage Company, to which we beg to refer him, and we hardly need add any more than is there stated.

The effect of nitric acid in hastening the formation of

Planté batteries was not known until the year 1882, although Mr. Planté himself had devoted a great part of his life to the subject, and had at various times tried several *chemical processes* long before the date of Mr. Sellon's patent.

The effect of nitric acid is, perhaps, best described in Planté's specification of his patent of 1882. It runs as follows: "The chemical action is not limited to the mere surfaces of the sheets, *but penetrates into the interior of the metal*, creating new interstices, enlarging the already existing natural pores, and consequently facilitating the ulterior electro-chemical action produced by the primary current."

We quite agree with Mr. Sellon that an accurate knowledge of the early history of secondary batteries is desirable, but we fail to see in what way he advanced the science by the matter contained in his specification, as published in his letter to you of the 24th ult.; and, although it was at one time thought that Faure had improved upon the Planté battery, the results obtained do not confirm that opinion, Planté's own discoveries being, as yet, unsurpassed.

Yours faithfully,
ELWELL-PARKER, Limited.
Per P. BEDFOR.) ELWELL.

Commercial-road, Wolverhampton,
December 10, 1884.

THE STATE OF THE NAVY—SHIPBUILDING CONTRACTS.

TO THE EDITOR OF ENGINEERING.

SIR,—In the opinion of the writer much of the delay and expense attending work for the English Admiralty, is due to the ripening of a system which was some years ago put in force when the higher culture of marine engineers and shipbuilders was taken in hand; prominent Admiralty officers acting as sponsors on the occasion that the School of Naval Architecture and Marine Engineering was started.

It is not the wish of the writer to say anything against that excellent institution or its successor at Greenwich, where, no doubt, the course of study is all that can be desired, but there does seem a tendency to introduce an amount of paper theory which is quite opposed to that practical spirit which has made English shipwork famous.

No doubt many practical men are somewhat behind in matters requiring abstract treatment, but whether their places are better supplied by men fresh from college is open to question.

No amount of book learning will inspire that grasp of useful detail that is to be acquired by a few years' drill in a shipyard, and it is rather annoying to find large portions of work condemned by men who have never had an adze or hammer and chisel in their hands, except to the disadvantage of these tools.

The key to advancement in the Government service would seem to be success at college and attendance at public meetings. Most busy men seem able hardly to spare the time for this sort of thing, but Admiralty officials seem able to do their own work and also to direct that of others, both in private and public.

Much has been said about specifications. Could you obtain one relating to some recent ship and publish the important paragraphs? Yours truly,

DUPLEX.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

The Hull Coal Trade.—The coal brought to Hull during the month of November was 108,896 tons, against 115,816 tons in the same month last year, the decrease being 6920 tons. There arrived by river 51,144 tons, and by rail 57,752 tons. The total entries of coal to the end of November, for the current year, were 1,210,728 tons, against 1,247,728 tons last year, the decrease being 37,000 tons. Messrs. Thomas Wilson and Co. have represented that, as the coal inspectorship is now vacant, they consider the present a favourable opportunity of terminating the tax on the coal trade. It is, they say, a tax from which they get no return or benefit. The matter is under the consideration of the Hull Chamber of Commerce and Shipping. They have resolved to recommend for the consideration of the Coal Committee of the Corporation that all firms purchasing coal direct from the collieries for their own use and consumption on board of steamers, should be exempt from the coal inspection tax.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the market was again flat and prices were tending lower. The unfavourable Board of Trade returns and the approach of the holidays together with the falling off in shipments from the Tees have had a depressing influence, and as the requirements of most buyers have been supplied during the past few weeks, there is a strong disposition to wait for lower terms before purchasing again. No. 3 g.m.b., f.o.b. Tees for prompt shipment is offering at 36s. per ton, but only small lots are changing hands even at this concession in price. The exports of pig iron from Middlesbrough to date this month, are 19,800 tons, and they have chiefly been to Scotland. Last month to corresponding date the total was 18,000 tons. Hematite pig iron is a trifle easier at 44s. 6d. for Nos. 1, 2, and 3 f.o.b. west coast ports. In the manufactured iron trade dulness still prevails and the mills continue to work short time. Ship plates are quoted 4*l.* 17s. 6d. to 5*l.* per ton and angles 4*l.* 12s. 6d. less 2½ per cent. at works.

The Steel Trade.—The steel trade is much more active now than it was a few months ago, but it is far from being anything like fully employed. The steel rail mills are very short of work, but it is reported that prospects are better.

Shipbuilding and Engineering.—Towards the close of the month the shipbuilders' returns, showing the number of vessels built in the North of England, will be published. It is known that they will show a great falling off in this important industry during the year. That is a fact that has been too severely realised to be easily forgotten. The great point of interest is the prospect in the early future. As far as can be ascertained, at present, the builders are very badly off for work, and find it most difficult to secure orders. It is, however, believed that there will not be a more favourable time to negotiate contracts than that of the close and the beginning of the year, and that before the spring many of the shipyards will be better employed than was expected. There is nothing new in engineering

Wages in the Shipbuilding Trade.—The employers at the Hartlepools, Stockton, and Middlesbrough, with the exception of the firm of Messrs. R. Dixon and Co., of Middlesbrough, one of the largest in the trade, have given notice of a 7½ per cent. reduction in wages, to take effect after the New Year holidays. The men are opposed to a further reduction, and contend that they have had 17½ per cent. taken off their wages this year.

A Big Gasholder.—It is stated that Messrs. Ashmore and While, of Stockton, have entered into a contract to supply one of the metropolitan gas companies with the largest gasholder in the world. The holder is to be 180 ft. high, and is to have a capacity of 8,000,000 cubic feet.

The Coal and Coke Trades.—There is a steady demand for all kinds of fuel, and prices are unaltered.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The pig-iron warrant market was flat on Thursday, and prices fell 2½d. per ton. Transactions took place during the forenoon at 42s. 11½d. down to 42s. 10d. cash, also at 43s. 1d. and 43s. one month; and at the close of the market there were sellers at 42s. 10d. cash and 43s. one month, with buyers at ½d. lower per ton. In the afternoon business was transacted at 42s. 10s. down to 42s. 8d. cash, the market closing with buyers at 42s. 8d. cash and 42s. 9½d. one month, and sellers asking ½d. more per ton. Friday's market was likewise flat, and iron further receded in price 1d. per ton, the decline over the week being being 3½d. per ton. During the forenoon there were transactions at 42s. 9d. and 42s. 9½d. cash, and the closing quotations were sellers at 42s. 9d. cash and 42s. 10½d. one month, with buyers at ½d. per ton lower. In the afternoon the closing rates were sellers at 42s. 7½d. cash, and buyers offering ½d. per ton under. Flatness was also the rule in Monday's market. Business was reported in the forenoon at 42s. 6d. down to 42s. 4½d. cash, also at 42s. 6d., 42s. 7d. and 42s. 6d. one month, with sellers at the close at 42s. 4½d. cash and 42s. 6d. one month, and buyers ½d. lower per ton. Down to 42s. 4d. cash was accepted in the afternoon, and at the close buyers were offering 42s. 4½d. cash, with sellers asking ½d. per ton higher. Yesterday's market was firmer, and there was a recovery of the 2½d. lost on the previous day. In the morning business was done at 42s. 5d. up to 42s. 6½d. cash, also at 42s. 7d. up to 42s. 8d. one month, and buyers at the close were offering 42s. 6d. cash and 42s. 7½d. one month, with sellers near. The quotations in the afternoon ranged from 42s. 6d. to 42s. 7½d. cash, and from 42s. 8d. to 42s. 9d. one month, the close being sellers at the top quotations, with buyers at 42s. 7d. cash. There were transactions this forenoon at 42s. 7d. down to 42s. 2½d. cash, and at 42s. 8½d. down to 42s. 5d. one month, the close being sellers at 42s. 3d. cash and 42s. 5d. one month, with buyers offering ½d. per ton under. In the afternoon transactions were reported at 42s. 2d. to 42s. 3d. cash, and at 42s. 4½d. one month, and subsequently sellers were asking the top quotations, with buyers at ½d. per ton lower. The market remains in the same unsettled position that has formerly been reported, owing to the suspicious feelings which still hold possession of the minds of so many operators. In consequence of the extreme depression that exists people will not buy, and they are afraid to sell, at least until warrants circulate more freely. Some dealers, however, still show a disposition to oversell, but the stock of warrants is so firmly held that this is done with the utmost caution. General trade continues to be extremely dull; indeed it appears to be rather worse than it has been at any former stage of the present crisis, and at the moment there is no immediate prospect of any improvement. Shipping iron is very flat. Some decided reductions have been made in prices, which it is hoped will encourage buyers. The number of blast furnaces in actual operation remains at 93, as last week. A year ago there were 103 blowing. Last week's shipments of pig iron were abnormally low, amounting only to 4722 tons, as compared with 6540 tons in the preceding week, and 8274 tons in the corresponding week of last year. The largest amounts were 800 tons to the United States, 1085 tons to Italy, and 530 tons to Holland. None was despatched to Russia, Canada, India, China, or Japan. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood yesterday afternoon at 579,493 tons, as compared with 579,669 tons yesterday week, showing a decrease of 176 tons over the week.

Great Drop in the Price of Special Brands of Pig Iron.—Some anxiety was occasioned in Glasgow iron circles last Thursday afternoon, by an announcement that a reduction of 2s. 6d. per ton was to be made by Messrs Baird and Co., of Gartsherrie, on the price of their No. 1 and No. 3 brands of pig iron—viz., to 52s. 6d. and 47s. 6d. respectively per ton. Such a serious reduction, and at a time when the price of pig iron is said to be below paying point, indicates something more than rivalry for orders. For some time past the complaint has been that there is an over production of iron, considering the heavy stocks—something like nine months' consumption. Attempts have been made to get a general reduction in the number of furnaces in blast, but these have failed, and although most of the ironmasters have an understood arrangement as to their production, others have been acting independently, and stocks have had a comparatively trifling reduction. What the result of this step on the part of the Gartsherrie firm may be it is difficult to say. It has been announced that one of the smaller iron works will be stopped, and it is feared that others will be forced either to stop altogether, or to blow out some of their furnaces. The Coltness Iron Company have followed the example set by Messrs. Baird and Co., by lowering their prices 2s. per ton.

Trade on the Clyde.—No further progress has been made towards a satisfactory solution of the wages difficulty between Mr. Pearce and the ironworkers in Fairfield Shipbuilding Yard, partly on account of the fact, it is said, of Mr. Pearce never having returned from London, where he is understood to be looking after Admiralty orders. Large bodies of workmen have been paid off lately from that and some other yards, but at Messrs. Caird and Co.'s yard, Greenock, a number of workmen have been put on full time laying the keel and setting the frames of a new 5000-ton steel steamer for the Peninsular and Oriental Steam Navigation Company. Messrs. Russell and Co., Port-Glasgow and Greenock, are about to make a reduction of 6d. per 100 rivets on the hull of a new vessel which is to be laid down. It is yet to be seen how the proposed reduction will be taken by the workmen. Messrs. D. and W. Henderson and Co., Meadowside Shipyard, Partick, have just concluded an order to build a splendid steam yacht for Mr. N. B. Stewart, of Wemyss Bay. She is to be a vessel of 800 tons, 215 ft. long by 28 ft. broad and 19 ft. deep.

Institution of Engineers and Shipbuilders in Scotland.—A meeting of the graduates' section of this Institution was held last night, when Mr. Ebenezer Hall Brown, of Fairfield Engine Works, read a paper on "Radial Valve Gear," in the course of which he vigorously criticised Joy's and Morton's gears, and made a number of valuable suggestions as to the mode of setting valve gear in marine engines. An interesting discussion was excited by the paper, one of the speakers, Mr. Hugh Reed, of Hyde Park Locomotive Works, giving a number of statistics as to the use of Joy's gear in locomotive engines made at those works for South Africa, and for a well known English line of railway.

Glasgow Engineers' Association.—The fifth meeting of this association was held in their rooms, Bothwell-street, on the 27th ult. The President occupied the chair. Mr. William MacGlashan, Edinburgh, read a paper upon "The Principles of Measurement and the Theory of Errors." Considering first the nature of measurement he proceeded to discuss the various units in common use together with the application of these to scientific research; he then touched upon the theory of errors, showing its use in finding a close approximation to a true result from a number of differing observations. Incidentally he referred to the metric system, commenting on its advantages as compared with the system in common use. A short discussion followed, in the course of which attention was drawn to the fact that while the English law permitted the use of the metric system no standards were provided by the authorities.

THE UNITED STATES NAVY.—We learn from Washington that the United States Navy Department is pushing on the construction of steel guns for new cruisers. The material of which these guns is made is furnished by the Midvale Steel Works, of Philadelphia, for 5 in. and 6 in. calibres, while that for larger calibres is imported from England, there being no hammers of sufficient power in the United States to forge ingots of steel of sufficient size for such heavy guns.

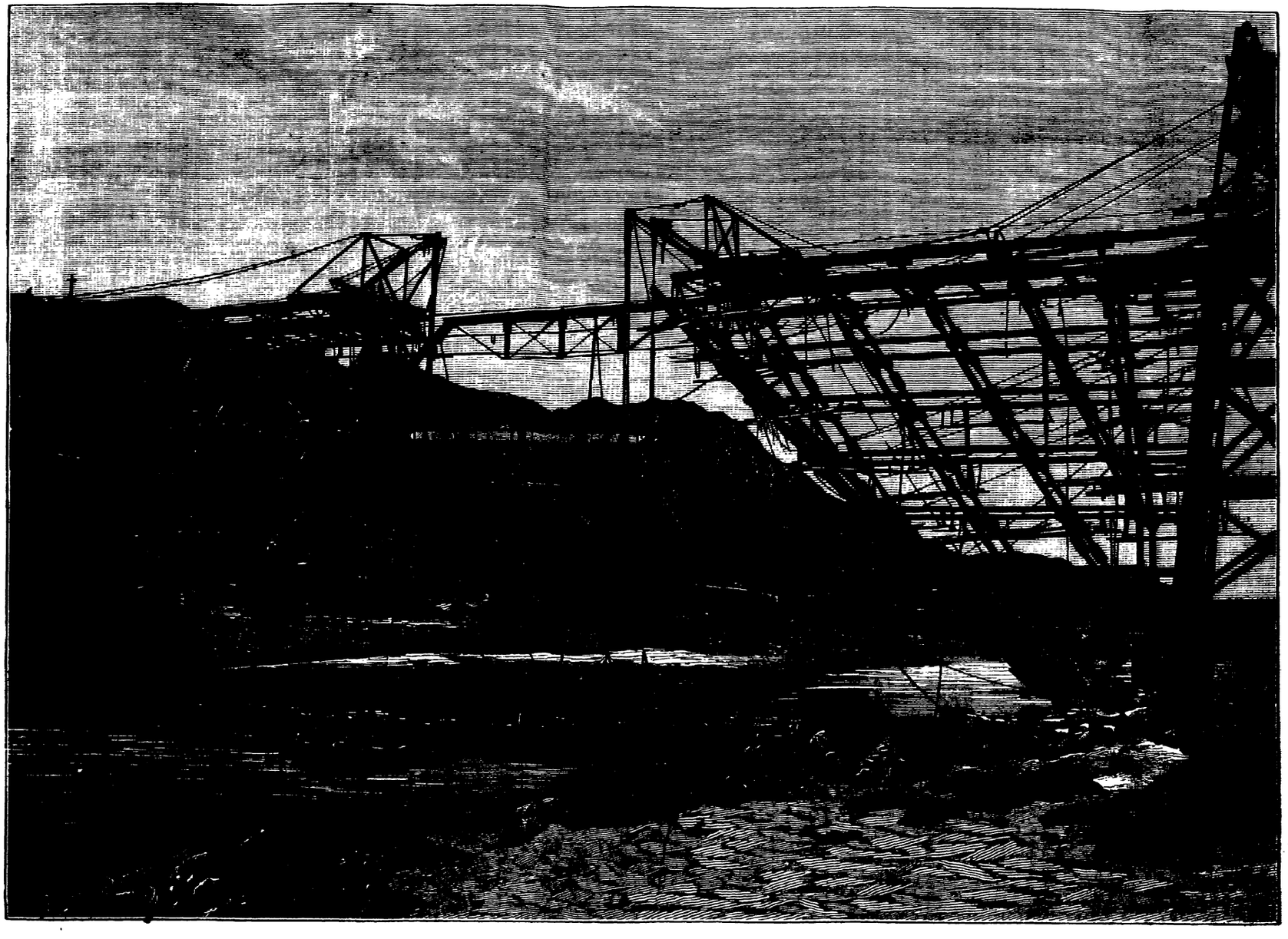
CANADIAN PACIFIC RAILWAY.—The Canadian Pacific Railway Company has undertaken another great enterprise. Mr. G. Stephen, the president, has left for London, to establish a steamship line between the terminus on the mainland of British Columbia and Yokohama, Japan, and Hong Kong, China. From calculations made by experts the directors will guarantee to lay down goods shipped in Hong Kong and Yokohama at Liverpool, ten days in advance of the Suez route. A short railway line to the Atlantic coast, now in progress, is part of the scheme. Mr. Stephen, while in London, will endeavour also to raise capital to build branch lines in Montana and the North-West Territory, to connect with the Canadian Pacific.

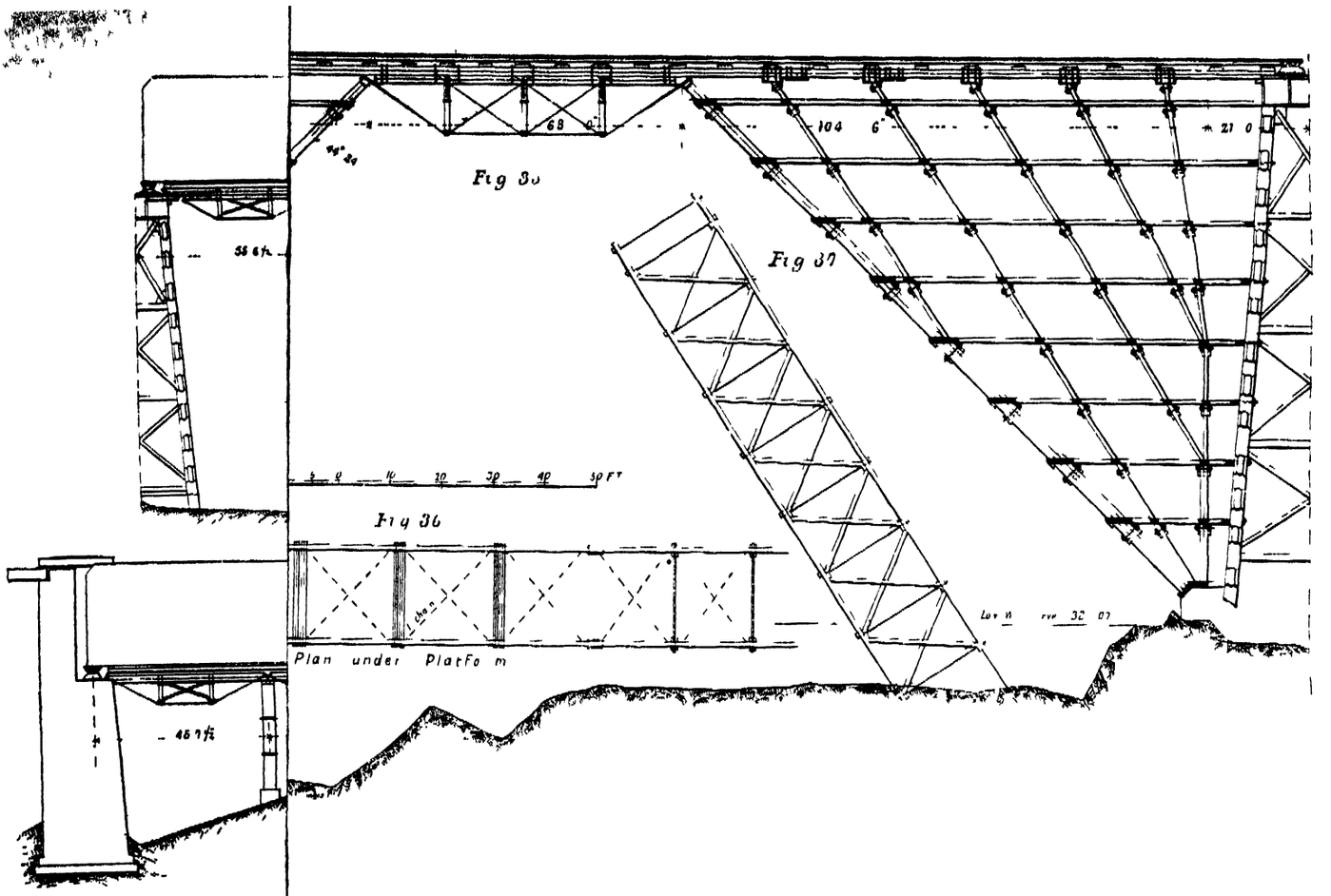
SILVERTON.—The silver mines in the district o Silverton, New South Wales, have now attracted a population of upwards of 3000 persons. Mr. C. S. Wilkinson, a geological surveyor attached to the New South Wales Department of Mines, reported to the Colonial Government on July 15th in the following terms: "I have examined forty distinct silver-bearing veins, varying in thickness up to 6 ft., but seldom more than 1 ft., and ranging in length from a few feet to 60 yards, taken collectively. A considerable quantity of rich ore will be raised from these veins, but some will probably not pay when the easily worked portions near the surface have been taken out. I have also seen the lodes at the Pinnacles and Broken Hill. They are argentiferous lead lodes of large extent and permanent."

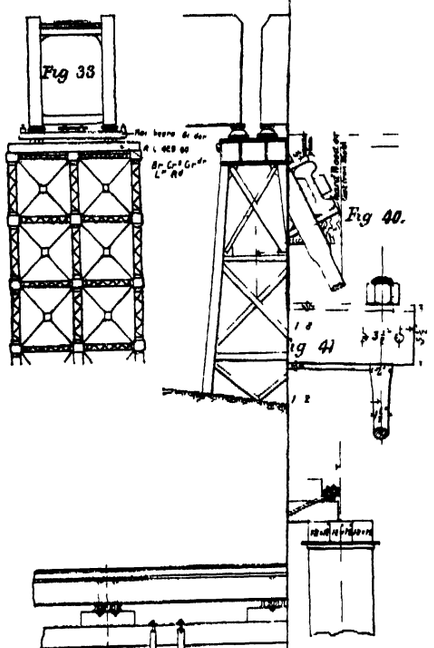
BRIDGE OVER THE RIVER INDUS, AT ATTOCK; PUNJAUB NORTHERN STATE RAILWAY.

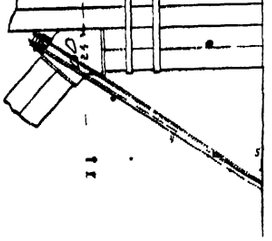
MR. F. L. O'CALLAGHAN, ENGINEER-IN-CHIEF.

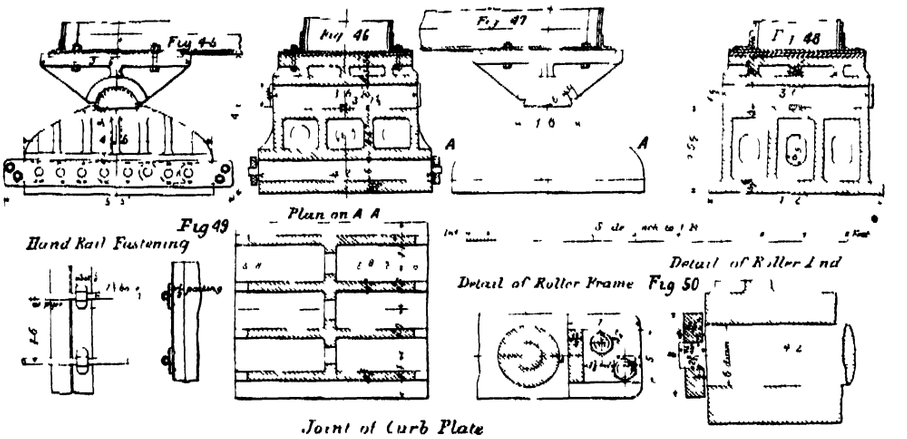
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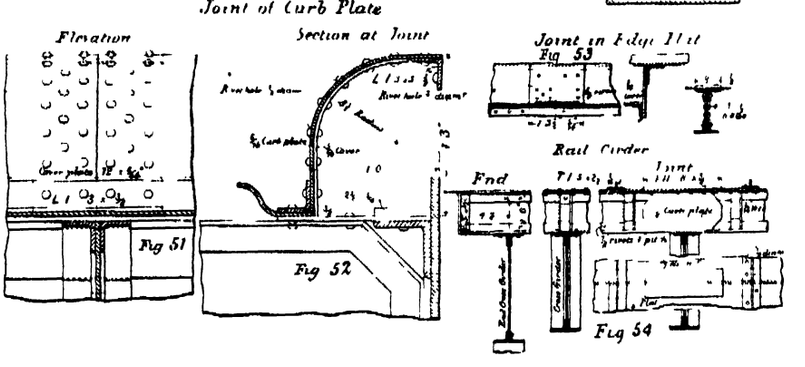



Fig 35
Fig 37
Fig 36
Plan under Platform


Fig 38
Fig 40.
Fig 41




Fig 45
Fig 46
Fig 47
Fig 48
Fig 49
Plan on A A
Hand Rail Fastening
Detail of Roller End
Detail of Roller Frame
Fig 50


Joint of Curb Plate
Elevation
Section at Joint
Joint in Edge Plate
Fig 53
Rail Girder
End
Joint
Fig 51
Fig 52
Fig 54

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The Publisher begs to state that he is able to supply one or two sets of ENGINEERING complete from the commencement.

The Publisher desires to draw the attention of Manufacturers and Purchasers to the advantages offered by the INFORMATION AND INQUIRY ROOM *established at the offices of this Journal. In this room are kept for the benefit of visitors, files of the principal English and foreign technical journals, and the circulars and catalogues of the leading manufacturers in the Engineering Trades, either for reference or distribution. A classified arrangement of the various advertisements which appear either continuously or from time to time in* ENGINEERING *will also be available for reference. Manufacturers are invited to contribute their catalogues and circulars, which will be indexed and placed under the care of an attendant.*

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Ordinary meeting, Tuesday, December 16th, at 8 p.m. Papers to be further discussed: "The Working of Tramways by Steam," by the Hon. R. C. Parsons, B.A., B.C.E., M. Inst. C.E. "The Sydney Steam Tramways," by W. Shellshear, Assoc. M. Inst. C.E.—Students' meeting, Friday, December 19th, at 7.30 p.m. Paper to be read and discussed: "The Difference in Design of British and Foreign Locomotive Engines," by F. H. Hobblethwaite, Stud. Inst. C.E. Mr. Woods, Member of Council, in the chair.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, the 17th inst., at 7 p.m., at 25, Great George-street, Westminster, the following papers will be read: "On the Reduction of Temperature Means from Short Series of Observations to the Equivalents of Longer Periods," by Dr. R. Julius Hann, Hon. Mem. R. Met. Soc. "The Diversity of Scales for Registering the Force of Wind," by Charles Harding, F.R. Met. Soc. "Report on the Phenological Observations for 1884," by the Rev. T. A. Preston, M.A., F.R. Met. Soc.

ENGINEERING.

FRIDAY, DECEMBER 12, 1884.

THE ADMIRALTY PROPOSALS.

SUFFICIENT time has now elapsed since the announcement of the Government proposals for increasing the strength of the Navy, to enable a calm judgment to be arrived at respecting their nature. The early impressions formed upon hearing them, which are reflected in our article of last week, are confirmed by more mature consideration. The programme laid down is quite insufficient for the purposes of the country; while the manner in which it is proposed to be carried out is inexcusably dilatory and inefficient. Five years is the most sanguine estimate that can be formed by the Government of the time that will be occupied in carrying out their present proposals. But judging from the slowness with which they are to be carried into effect, even this unnecessary length of time will probably be exceeded. The chief aim of the Government seems to be to proceed slowly in the matter.

Lord Northbrook and Sir Thomas Brassey stated in Parliament that, besides proceeding with the ordinary work of the Navy at the current rate of progress, the following additional vessels will be put in hand. Four armoured battle-ships, five armoured cruisers, two torpedo rams of the Polyphemus class, ten unarmoured auxiliary cruisers of the second-class, and thirty seagoing torpedo boats. Three of the unarmoured battle-ships, the vessels which are most urgently required, are, however, still *in nubibus*, as far as design is concerned. Lord Northbrook says, in describing one of the armoured ships which is to be laid down, "With regard to the particular design of the other three armour-clad ships it is proposed to construct, I cannot now give any further information. The Board of Admiralty have had several designs before them, and it is a matter of considerable difficulty to decide upon them, and there is no reason, at the present time, to come to any conclusion as to the particular class of ship."

We thus see that the Admiralty are not only unprepared to go forward rapidly with the construction of the most powerful of the ships which are included in their programme, but the First Lord does not even consider that there is any reason, at the present time, to come to any conclusion about them. The whole of the policy of the Admiralty appears to be conceived in this spirit, for none of the vessels are to be commenced till the next financial year; and the smaller and simpler ones, which might be rapidly completed, are to be built at the rate of only a few per annum.

One of the most striking features in the speeches delivered by Lord Northbrook and Sir Thomas Brassey in Parliament, is the complacency which is exhibited by the Admiralty respecting the delays which have taken place in the past construction of warships, and the present slow and unsatisfactory rate of progress. Lord Northbrook is "prepared to maintain that, during the last four years, the construction of armour-plated ships has progressed at a rate as rapid as possible, consistently with the economical construction of such ships. . . . We have supplied money enough to build these ships as economically and rapidly as possible." Sir Thomas Brassey goes farther, and tries to prove, with the aid of carefully arranged figures, that the Admiralty have performed marvellous feats in rapidity of production. He thinks that the Admiralty have achieved "largely advantageous results in rapidity of construction, and in the number of ships which can be built for a given sum of money." Sir Thomas Brassey and the Admiralty officials are welcome to all the satisfaction they may derive out of such stereotyped and meaningless utterances as these. The public care only for results, and, whatever may be said, they will look beyond mere words, and form their judgment upon what is practically done to increase the effective strength of the Navy. No one can take exception to Sir Thomas Brassey's language; but, unfortunately, it has never been translated into tangible practical results.

It was at first supposed that the whole of the ships intended to be built by the Government, including the four armourclads, were to cost 3,100,000*l.*, exclusive of armament. This sum, however, is found upon examination to provide for one ironclad only; and it is not too much to say that the return to be obtained as the result of all this expenditure will be inadequate and unsatisfactory. We have frequently called attention to the fact that it is not additional expenditure only that is required for the purposes of the Navy, but a more economical and businesslike expenditure than now prevails. If the Admiralty constructors do not see their way to reduce the cost of construction of the new vessels, we recommend them to apply to private shipbuilders for advice in the matter. This is a question that urgently requires dealing with, and that sheer necessity will force the Admiralty to deal with before very long. A further sum of 1,600,000*l.* is allowed for in the estimates for the armaments for these ships.

We do not see any allowance made for the cost of the three remaining ironclads, the designs of which are not yet decided upon; but we suppose that, at the present extravagant rate of expenditure, they cannot be put down at less than 750,000*l.* each. This will add 2,250,000*l.* to the above figures, making the total cost of the vessels described by Lord Northbrook and Sir Thomas Brassey, including the four armourclads, 5,350,000*l.*, without armament.

Lord Northbrook does not promise that the four ironclads will be laid down before the beginning, or even before the end, of next financial year. The one which is decided upon, is apparently to be similar to the Benbow. She is to have 18 in. armour, with a battery protected by 3 in. steel. Her speed is to be 15½ knots; and the armament will consist of two 110-ton guns in a turret, one 18-ton rear-firing gun, and twelve 6 in. guns in a battery. The turret will have the same armour upon it as the belt; but there will only be one turret, as in the Conqueror. Sir Thomas Brassey says that the whole thirteen guns outside the turret will be protected "with armour, proof not only against all machine guns, but also against the new six-pounder shell guns." This vessel is to be laid down at Chatham early next year; which, we presume, means in about six months' time. Of the other three, it is not clearly stated whether one or two are to be built by contract, but it appears that at least one will be. This, however, judging by Lord Northbrook's reference to the incompleteness of the design, is a question for the distant future.

The next item of importance in the Government programme is the construction of five belted cruisers, of an improved Mersey class. The Mersey class consists of four ships, fitted with protected decks of 3 in. steel, which are inclined at the sides, and also with water-line belts of 6 in. steel. The new cruisers are not to have inclined decks, but are to be fitted with armour belts of 10 in. steel for the protection of their vital parts. Lord Northbrook states that the water-lines of these ships will be protected by steel armour from end to end. They are each to be of about 5000 tons displacement, and are to carry about 1000 tons weight of armour. They will be armed with torpedoes, and also be fitted for ramming. Some of the guns will be fired from a protected house. The [illegible] twelve 4-ton guns, with numerous machine guns. The speed will be 17 knots, and the coal supply sufficient for 2000 knots steaming at full speed, and for 8000 knots steaming at a reduced cruising speed of 10 knots. Lord Northbrook thinks that these vessels will be able to contend with the inferior ironclads of other nations. Sir Thomas Brassey says, in describing one of them, "She is, therefore, in one sense an ironclad, her water-line being protected by side armour or a belt deck from end to end. She is also an ironclad in the sense that her directing house for the shelter of the steering-wheel and directing instruments is strongly armoured. From this house the under-water broadside torpedoes and the guns can be fired, and she can be directed as a ram. In another sense she is not armoured, because her guns' crews will have no armour protection. They will be protected only by shields against the fire of the lighter machine guns." Three of these vessels are to be built by contract, and two in the dockyards.

The next item is two torpedo rams of the Polyphemus class. These vessels will be of about 3000 tons displacement, and rather longer and wider than, but otherwise identical with, the Polyphemus in under-water arrangements, except that there will be no torpedo discharge through the ram itself. They will also be made more habitable than that vessel, by being continued up above the convex armoured deck in the same form as ordinary ships. The deck will be protected with 3 in. armour. These vessels are to have but small gun armament. Their estimated speed is 17½ knots; and the coal supply is to be equal to 1600 knots at full speed, and 6400 knots at a speed of 10 knots. The two vessels of the Polyphemus class are to be built by contract.

The Admiralty also intend to lay down ten torpedo cruisers of the Scout type. These will be almost identical with two vessels which are now building, but will differ from them in having the

gun armament more fully developed and the torpedo armament reduced. They will be armed with six 4-ton guns, and are intended to act as cruisers in time of peace, and as fast torpedo auxiliaries in time of war. They will be jury-rigged, and their estimated speed is 16 knots; the coal supply being sufficient for 1650 knots steaming at full speed, and 7000 knots at a speed of 10 knots. Nine of these vessels are to be built by contract, and one in the dockyards.

The last item in the programme relates to thirty first-class torpedo boats. But the progress contemplated with these is very slow, as only ten are intended to be commenced during the next financial year. The whole programme, therefore, includes four ironclads of the first-class, five belted cruisers, two armoured torpedo rams, ten small torpedo cruisers, and thirty first-class torpedo boats. Those which are to be built by contract are two ironclads, three belted cruisers, two torpedo rams, nine vessels of the Scout class, and thirty first-class torpedo boats. The remaining vessels will be laid down in the dockyards. The cost of three of the ironclads does not appear to be included, however, in the sum of 3,100,000*l.* which has been laid before Parliament.

There are several statements contained in the ministerial proposals which are difficult to understand. For instance, Sir Thomas Brassey states that, if the present proposals are carried out, the annual production of armourclads will be increased by 2000 tons, or, a total of 14,000 tons of displacement will be produced each year instead of 12,000. This is difficult to reconcile with the statement that four ironclads of at least 10,000 tons each are to be built within five years, because this would constitute an increase of 8000 tons per annum. It surely cannot be intended after what has been said about four ironclads to build only one. If so, Sir Thomas Brassey's estimate of the increase of tonnage per annum, would be correct; and it is somewhat ominous to note that only one ironclad is provided for in the amount named of 3,100,000*l.* Both Lord Northbrook and Sir Thomas Brassey, however, state most emphatically that four additional ironclads are intended to be laid down, and although these are not provided for in the present estimate of cost, and are also not included in Sir Thomas Brassey's estimate of the increase of tonnage per annum, it surely cannot be possible that four additional ironclads are not intended to be built.

Lord Northbrook stated in his speech that no one at the Admiralty has ever expressed any dislike of discussion of subjects connected with the Navy; and that no member of the Board of Admiralty has yet been able to enter into the present discussion. It is difficult to see what object would be served by the Admiralty expressing dislike of public discussion; while Lord Northbrook's statement that no member of the Board of Admiralty has entered into the present discussion is not in accordance with the facts. Sir Thomas Brassey has, upon more than one occasion, discussed at considerable length questions which have been raised by Lord Henry Lennox, and other Admiralty critics. Lord Northbrook states that the principles which have guided the policy of the present Government, have been four in number, viz., first, to decline to lay down ships of gigantic size, merely because other nations have done it; second, to take money enough "to press forward as quickly as possible the ships we have begun to construct." With regard to this second principle of policy we do not now question Lord Northbrook's statement that money enough may have been taken for the purpose; but it has been proved over and over again that, however this may be, the ships have not been pressed forward, but have lingered on for many years in the dockyard hands without being completed. The present backward state of the Navy is largely due to the circumstance that construction has not progressed at a rate as rapid as possible consistently with economical production, as Lord Northbrook says it has; and that, whatever objects may have been aimed at, economical and rapid construction has certainly not even been approached to, much less accomplished. We are at one with Lord Carnarvon in not being able to see the advantage, either as regards efficiency or as regards economy, in keeping a ship nine years in building and then, when she is completed, finding out by some means or other that she would not work as was expected.

The third principle of policy put forward by Lord Northbrook is that the Admiralty have not multiplied types of ships, but have built all their ships of as nearly the same type as possible. Fourthly, especial attention has been paid to speed—that is to say, the speed of the ships laid down has been, on an average, 16 knots. Whether it be true or not that the Admiralty have not multiplied types of ships, there is certainly grave doubt as to the efficiency of the type which has been selected. The type which has been followed by the Admiralty is one which Mr. Barnaby has made peculiarly his own, and which there has always been much discussion about. During the year 1877 we published many articles respecting the qualities of H.M.S. Inflexible, which was the first ship of this class; and attention has again been called to the matter by Sir Edward Reed in his recent paper at the United Service Institution. We have also read with considerable interest a letter in the *Times* of the 2nd inst., signed by a "Captain, R.N.," again raising the question which was so warmly discussed seven years ago. He says that captains of Her Majesty's ships are told that the armoured citadels of these ships contain a sufficient amount of floating power and stability to keep them afloat after the ends above the armoured deck have been riddled with shot. He adds, "Now this is exactly what a great many of us do not believe, and what we should like to see actually tried before we are asked to take these ships into action."

We have never been able to understand the apathy of naval officers, and of others interested in the efficiency of Her Majesty's ships in this matter. It is a fact well known to many of the captains of these ships—that is, it is one they ought to be aware of—that many of the so-called armoured ships may have their sea-going qualities seriously compromised, or even destroyed, without the armour-plating being pierced. The penetration of the unarmoured ends of citadel ships, would first cause the speed and manœuvring qualities to become reduced; and, as the thinly plated ends become more and more injured, the sea-going qualities of the vessels would gradually disappear, and some of them might even be sunk, without any penetration of the armour-plating. This fact was directly admitted by the Admiralty Committee upon H.M.S. Inflexible; and that Committee recommended that no more ships of the class should be built. Ships of the same class have, however, since been built, notwithstanding the recommendation of this Committee; and some of these ships are even said to be worse off than the Inflexible, as far as armoured stability is concerned. If the captains of these ships have any doubt upon the point, or entertain a false sense of security respecting them, they should insist upon the facts being clearly laid before them. Armour-plating may, or may not, be invulnerable. But common sense teaches that such protection as it affords should be fully utilised where it is applied; and that it is folly to go to the expense of building a large armour-plated ship, and, after all, to leave her open to the risk of being destroyed without the armour being even penetrated.

The Admiralty programme falls considerably short of that laid before the United Service Institution by Sir Edward Reed, although the latter was considered, by nearly all naval authorities, to be itself too moderate and inadequate for the requirements of the service. Sir Edward Reed's programme included "five additional armoured ships of the first class, five extremely fast armoured cruisers, eight extremely fast unarmoured cruisers, fifteen extremely fast auxiliaries to armoured ships, and fifty torpedo boats of the first class." This programme was to be carried out in three years, at a total expenditure of 6,355,000*l.* One striking difference between this and the Admiralty programme is that Sir Edward Reed recommends immediate and rapid progress, whereas the Admiralty adhere to their old policy of procrastination and delay. Sir Edward Reed pointed out that it is erroneous to compare partially armoured ships, such as those which are building for our own Navy, with the completely armoured ships of other navies; and that the unarmoured parts of our ships, whatever their value may be, cannot be regarded as armoured tonnage. This appears to be quite a sound argument, although it may be pushed too far, because these thinly plated ends, which may be pierced by light guns, and when thus penetrated may prevent a vessel from being driven at high speed, certainly cannot rank in value with armoured ends, which would remain uninjured, except against attacks from the very heaviest artillery.

Sir Edward Reed took objection to Sir Thomas Brassey's comparisons between the armoured navies of England and France, on the ground that Sir Thomas Brassey included in it, all ships possessing armour of 9 in. thickness and upwards. The comparison which Sir Edward Reed puts forward against this, is one between ships built and building in this country and in France, with 15 in. armour and upwards. He showed that England has only eleven ships of this class against fourteen possessed by France. The total displacement of these eleven English ships, including the part of their tonnage without the protection of side armour, is 105,030 tons, against 126,288 tons of the French. If the unarmoured ends be deducted, the total armoured displacement of the eleven English ships only amounts to 51,570 tons. Sir Edward Reed says that, "If any one should be so infatuated as to reckon the total tonnage of our ships (although the half of it is wholly without side armour), the excess in favour of the French would be still 21,000 tons, or more than two first-class armoured ships."

Sir Edward Reed called attention to two points which have been discussed over and over again. One is that protected decks must be covered with plates of at least 2½ in. to 3 in. in thickness, in order to resist artillery fire; and the other is that it is a delusion to regard the supposed protection which the coal supply gives as a valuable component element of an unarmoured vessel's defence. He says it is "a cruel farce to tell the sailor to look for a part of his permanent defence to that which was put on board expressly to be consumed." Sir William Armstrong, in writing to the *Times* of the 4th inst., refers to the proper thickness for the protective under-deck as being a "very minor question." He only observes that "different thicknesses of protective deck will suit different classes of unarmoured vessels." We cannot attach any precise meaning to this statement, particularly in view of the fact that the Esmeralda, which Sir William Armstrong recently described as an "incomparably superior vessel," and one which "would be very difficult to sink or disable, even if opposed to an ironclad," has her deck covered with plates of only 1 in. thick. Mr. White, one of Sir W. Armstrong's officials, stated at the United Service Institution, that the builders of the Esmeralda did not look upon her as a perfect fighting ship, and that she was only perfect up to a certain point. He said that they are now building more efficient ships with 3 in. steel decks. This statement compares strangely with Sir W. Armstrong's own eulogium, pronounced only a few weeks ago, upon the incomparably superior fighting qualities of the Esmeralda.

There was a remarkable unanimity of opinion expressed at the United Service Institution, upon the necessity of largely increasing the strength of the Navy, and of even exceeding the programme which Sir Edward Reed laid down. Naval officers and politicians vied with each other in expressing approval of the recommendations, so far as they went. Mr. C. Norwood, M.P., who was one of the members of Lord Ravensworth's Committee, acknowledged the great dissatisfaction which has arisen on all sides, owing to delay in the completion of vessels in the royal dockyards. He says that the Committee came to the conclusion that the large mercantile ship constructors were able to construct war vessels, and that the royal dockyards should especially maintain within them the means for repairs. Everything points to the advantage of enlarging the area of war-ship production by employing as many private shipbuilders as possible in it. It is admitted upon all sides that the quality of the ships built by private contract is as good, and cheaper, than those built in the royal dockyards; while it is possible to still farther diminish their cost by means of simpler and improved methods of construction. Ships built by contract are far more costly than they need be, and builders are frequently put to losses which ought not to occur, merely because of the defects in the present system of constructing war-ships. Our correspondent "Navis" called attention last week to Mr. Barnaby's evidence upon this point, before Lord Ravensworth's Committee. He points out that Mr. Barnaby playfully said that a Government contract for building ships of war, almost always, he believes, results in loss; and that "we get the ships, and the builder has to accept the loss," which he often has to do. The chief persons to blame for this are the constructors themselves, and the principal cause of it may perhaps be found in the evidence of Mr. Barnes, the surveyor of dockyards. Mr. Barnes said, in reply to question

503, "Our specifications are not meagre, to say the least of it; and I think if you were to put in them all the minute details which the overseer only has power over—he has no power over anything but mere details—you would not look at the specification, for contractors would be frightened." This appears to imply that details are purposely omitted from the Admiralty specifications in order that contractors may not be frightened into putting on a price that will pay for the cost of the work. Hence the natural result, which was playfully hinted at by Mr. Barnaby, often follows, viz., that contracts result in loss to the builder. It appears to be one of the chief duties of an overseer, to exercise his official arts, so as to circumvent the builder, and secure the introduction of all those details into a ship, which the constructors refrain from putting in a specification for fear of frightening the contractor.

RECENT RAILWAY ACCIDENTS.

Another batch of inspectors' reports to the Board of Trade has recently been issued, and as they are of a character which is becoming more common, it will not be out of place to draw attention to a few points in connection with them. Taking the four accidents reported on, the first thing which strikes us is the sudden, unlooked-for emergency to be met in each case, and next, in three out of four cases the inadequate means provided for coping with this emergency, while at the same time, in one case, the advantages of having the best safeguard are clearly shown. On the 11th October, a Metropolitan Inner Circle train, while standing at Queen's-road, Bayswater Station, was run into by another train which had been improperly allowed to leave Notting-hill Gate Station, and eighteen persons in the standing train were injured, as well as all the vehicles being damaged. In the first instance this collision was certainly due to the signalman at Notting-hill Gate, who owns to forgetting himself and to having taken off his signals, and sent on the second train before receiving permission from the section in advance. The Board of Trade Inspector also finds, however, that the driver and fireman of this train probably missed seeing the distant signal from Queen's-road, which he believes was at danger, and further, that as there were 108 yards in which to stop, after emerging from the tunnel, "it would appear that the application of the vacuum brake was not so prompt as it might have been, or the collision would have been altogether avoided, or its force at any rate reduced considerably below what it actually appears to have been, since the 7.35 train was driven forward about two carriage-lengths." We have here an emergency of a very unexpected character, due primarily to the fault of a signalman, and resulting in an accident either from the failure of a driver to apply the vacuum brake promptly or from that brake not acting so efficiently as it should have done. The case was, in fact, one of many in which the degree of efficiency of the brake was of great importance.

On the 1st of November a train entering Central Station, Sunderland, came into collision with another train which was being shunted. Twenty-eight passengers were injured. The inspector finds that this emergency, like that in the previous case, was caused by an act of momentary forgetfulness on the part of a signalman who had served in that capacity for 11½ years, five of which had been passed in his present post. General Hutchinson says, "The brake power made use of on each train was no doubt of great value in mitigating the force of the collision, and had the engine and tender, as well as the carriages of the empty market train, been fitted with the Westinghouse brake, it is possible that the collision might have been altogether avoided."

On the 30th of October there occurred a more remarkable case of a run off and subsequent collision, near the North Pole Junction of the West London Railway, nearly a mile south of Willesden Station. The 6.30 P.M. up passenger train from Willesden to Addison-road, immediately after it quitted the platform at Willesden passed on to the down line, or wrong road, owing to pair of points of a crossover road not having been properly set for the up line, and the train continued to run on the wrong line to North Pole Junction until it reached a pair of catch points at the foot of a steep incline of 1 in 60; these points being contrived to intercept any vehicles which might break away from a down train and run back. The train entered the catch siding and ran forward until it came to the further end, when after carrying away the stop-blocks the engine ran down the embankment, and the carriages turning over fouled the down line which they had just left, as a down passenger train for Willesden was approaching from the opposite direction, thus causing a collision and injury to sixteen people. As in the cases already mentioned, this accident and collision were caused in the first instance by the signalman, and also by neglect on the part of the driver and fireman in not finding out that they were running on the wrong line. As Colonel Yolland says, "The catch siding had been put in for a very different purpose, but it fortunately was there on this occasion, or the results might have been most serious." The meeting of two trains running in opposite directions on the same line of rails is indeed sufficient to cause fearful disaster. Great as the emergency was, however, had both trains been equipped with a quick-acting brake in the hands of the driver, and which he was in the habit of using on all occasions, instead of the Clarke-Webb chain brake only to be used on emergency, the results would have been much less serious. We learn that so soon as the engine took the catch points the driver called out to the fireman "put the brake on," whereupon "the fireman turned the hand brake a few times, and then flew to the patent brake cord," while the driver did all that remained in his power by opening the whistle; but, he adds, "it was all over then." As regards the down train, very much the same occurred. On getting a signal from a hand lamp, and hearing a shout, the driver applied his hand brake while the fireman "flew across for the patent brake cord on the driver's side, and was still pulling at the cord at the time they ran into the coach," the speed having meanwhile been reduced from 20 to 10 miles per hour. It must be allowed that the circumstances were hardly such as to warrant the wasting of valuable seconds in running about after a brake cord, though nothing else was to be done, it appears.

The next case occurred on the 10th of November at Herne Hill South Junction, on the Chatham and Dover Railway. A light engine in running round its train, overran the intended stopping point by sixty yards, and fouled the up main line as the passenger train from Bickley was approaching. A collision with injuries to twelve persons resulted. The driver of the light engine attributes his mishap to the fact the rails were rendered greasy by the crushed dead leaves which covered them; still no harm would have resulted from the emergency thus created, had there been, as the inspector remarks, "a good continuous brake on the Bickley train, and had it been promptly applied, it is quite possible the collision might have been altogether avoided."

It is to be noted that the whole of these accidents were caused in the first instance not by fog or snowstorm, broken axles or rails, &c., but by apparently otherwise excellent servants making mistakes in dealing with the usual daily traffic under ordinary conditions; and no doubt this element of human fallibility must always form a fruitful source of accident on railways.

The moral to be drawn from these four accidents is pretty plain. As we have frequently pointed out, most of our railway accidents are now characterised by a dreadful suddenness, and the greater the emergency the more imperative it is that the only means of safety should be as quick and responsive as the circumstances are sudden. In other words, when signalmen and drivers have blundered, as in each of the cases we have mentioned, nothing but an appliance at once certain and instantaneous in action can be expected to be of any use, and abundant experience has repeatedly demonstrated the fact that the Westinghouse brake of all those in use is not to be excelled in these essentials of a really competent life-saving appliance. The vacuum brake, on the other hand, so long as physical laws remain as they are, must of necessity be slower in action than a pressure brake, and consequently even were it as much to be depended upon as the latter, it can never give the same amount of security. That this brake is not to be trusted, however, we have had numerous illustrations, and only last week our columns contained a notice of a failure at Nottingham, which resulted in the train running a quarter of a mile past the station, which was fortunately clear at the time. It is said that this failure resulted from the main pipe on the tender being choked with either ice or water, and there is no doubt that all vacuum brakes are liable to be affected by these causes, particularly at this season of the year. The immense volumes of moist air which enter the pipes and cylinders each time the brake is applied, quickly condenses on the surfaces already cooled by the rarefaction which has been in progress, and both ice and water must result, and considerable risks be run in consequence. Should a hard winter occur, some valuable experience as to the action of the different brakes now in use will no doubt be gained; but let us hope at not too great a cost.

IRON AND STEEL PLATES.

The change in the production of plates in the North of England is now rapidly progressing, so rapidly that the extent of iron plates made by the associated makers will be in the next year materially reduced. As the extent of that production and its variation is not generally known, it may be well before referring to the present change, to note the gradual and large growth in the plate manufacture in the North. The records of the Board of Arbitration enable us to do this; and from these records we draw up the following table, which shows the quantity of iron plates sold by the associated makers in the north-east in the years referred to:

Plate Production, 1873—78.

Years.	Tons.
1873	165,593
1874	178,272
1875	175,417
1876	172,374
1877	214,723
1878	233,964

It will be seen that whilst there was in the six years embraced in the above table a growth in the extent of the production it was one that was very small in comparison with that we shall find in the later years; and it will be also noticed that in the next year the output had fallen back almost to that of four years previous. The following Table shows the extent of the production of plates in the later years:

Plate Production, 1879—83.

Years.	Tons.
1879	173,700
1880	316,722
1881	391,468
1882	433,216
1883	440,157

It is noticeable that in the year 1880 the production almost doubled that of the previous year, and the advance has been steadily continuous since that time there has been a change. The figures for the whole of the present year cannot, of course, be procurable for some months, but it is certain from those which have already been gathered that there has been already a falling off, and that it will in the future be greater. In the last two months reported on, the deliveries of iron plates have been in round numbers about 38,000 tons. That rate of production would give about 288,000 tons, a startling declension when the figures are compared with those for the past year. In a year the extent of the production of iron plates in the North, has fallen off from the maximum attained—that of the past year—to less than that of the production of four years ago; and it is still further declining. At the same time it ought to be added that its proportion to the total production of manufactured iron is greater than it was ten years ago. Still the production of iron plates has declined so rapidly that it is now rather less than half of what it was in the last two months of last year.

There has been a partial recompense by the upgrowth of the steel-plate trade. A year ago steel plates were not produced in any large quantity in the county of Durham, or in what is misnamed the "Cleveland district." Now, the Consett Iron Company is producing them from two Siemens furnaces, and is rapidly carrying on works for quadrupling of its plant. At Spennymoor also a new steel plant is at work. At Eston, the large firm of Bolckow, Vaughan, and Co. have entered into the production, and others are producing steel ingots which may be rolled into plates. On the Tyne, too, the two largest of the manufacturing companies are either laying down steel-making plant or have it in contemplation; and it is said that in one of these cases—that of the Palmer Shipbuilding Company—it is possible that the basic process may be the adopted method, though we believe an exact decision is not come to.

THE THOMSON-HOUSTON SYSTEM OF ELECTRIC LIGHTING.

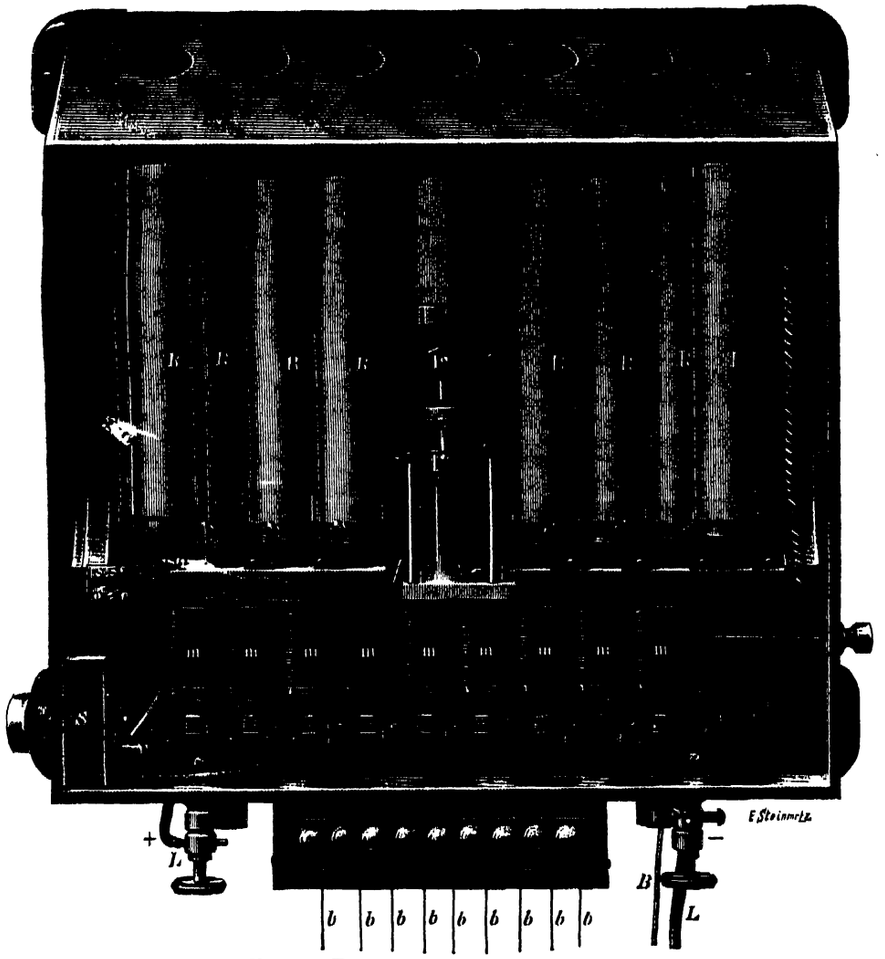


FIG. 4. THE THOMSON-RICE DISTRIBUTOR.

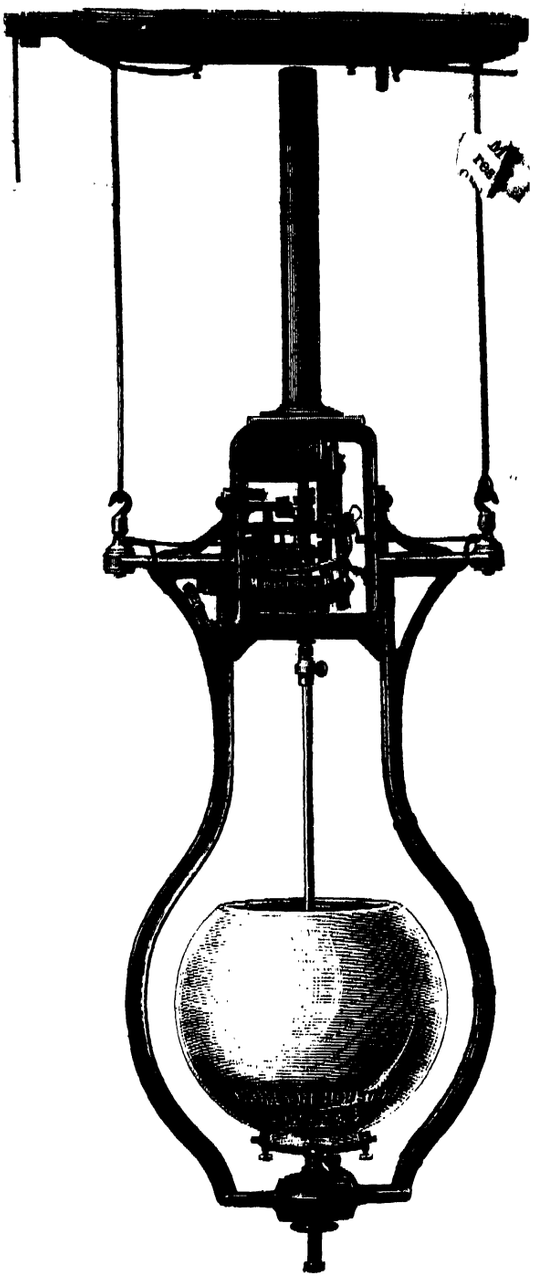


FIG. 3. THE THOMSON-HOUSTON STANDARD ARC LAMP.

There are no reliable statistics as to the extent of the production of steel plates as yet. The steel works are not, we believe, recognised by the Board of Arbitration, though the rules of the latter might readily embrace the workers both at the steel rail and the steel-plate mills. Thus the figures we have are only those that show how much the work is falling away in the iron-plate trade; and we only know that in some degree the steel-plate trade is growing, but to what extent it counterbalances the loss we do not know.

It would be very desirable in the interests of the trade of the North, that the same reliable statistics as to extent of production and of price that we have had for more than a decade as to manufactured iron should be extended now to that which seems to be taking its place—manufactured steel. Ten years comprised the growth and the beginning of the decay of the iron rail trade; and a decade now seems to be witnessing the growth and the commencement of the fall of the iron-plate trade. The Board of Arbitration has done well in that period in the interests of the manufactured iron trade; and not the least of its services that it has rendered, are the volumes of statistics that it has from time to time given out—reliable figures as to the price and production of the chief classes of iron made in the bounds of its rule. It is clear now that the iron trade in two of the chief of its branches is sinking rapidly; and it would be well if the same organisation could be extended now to the industry that is replacing them; some carefully compiled and reliable figures given us for tabulation, comparison, and instruction would have possessed great interest and value.

THE PHILADELPHIA ELECTRICAL EXHIBITION.—No. X.

By C. J. H. WOODBURY, Boston.

THE THOMSON-HOUSTON SYSTEM.

THE arc lamp of the Thomson-Houston system contains several novelties, among which is the regulation of the arc without the use of hydraulic regulators or dash-pots.

On the opposite page are shown a perspective view of the mechanism of this lamp (Fig. 1) and a diagram (Fig. 2). In the latter the lower magnet D, adjusted by the variable resistance r, is in the main circuit, and exerts a constant pull, like a long spring; the upper magnet S is in a shunt circuit wound to a standard resistance. The carbon rod is held by a cam clutch at g, which is connected by a series of levers to the swinging yoke C, which is an armature for both magnets. The connections of the main circuit are clearly shown. If the arc becomes too long, the magnet S receives an excess of current, and attracting its armature C, swings the yoke, and through the levers releases the cam; the spring E is introduced into the series of levers to prevent abrupt action of the magnets from being rigidly transmitted to the carbon rod, and thereby serves to insure slow feeding of the carbon. At N the carbon rod is scored, so that when the upper carbon is nearly consumed, the clutch is prevented from holding the rod, and the current is switched from the lamp. The general proportions of the standard lamp are shown by Fig. 3, which represents an arc lamp with the sides removed from the case containing the feeding mechanism. For positions where the space is limited, lamps are made in which the upper carbon is clutched by the feeding mechanism; this arrangement saving the length of a carbon, or 14 in. in the total height of a lamp.

The Thomson-Houston system has an arrangement for using a few incandescence lamps on arc circuits. In the method of simply connecting incandescence lamps in a multiple series on an arc circuit, if there is no method of compensating for the changes in resistance whenever a branch circuit is opened by any lamp in a series being switched out or from breaking a carbon, the excess of current diverted through the remaining series, injures the life of the lamps, or rapidly destroys them; in some instances so rapidly as to destroy at least one lamp in each series and produce an open circuit.

There are several methods of using compensating resistances, so that whenever one lamp is switched out an equivalent section of a resistance box is added to the circuit. The first regulating device of this nature was operated by a pair of clock movements, one of which was thrown into operation by a solenoid whenever the current varied from a certain range. It was inevitable that the clocks should be neglected, and the fires which ensued from several causes obliged the underwriters to forbid its use until safety devices were arranged.

Professor Thomson and his assistant, Mr. Rice, have made a distributor which accomplishes its object, without clockwork or apparatus requiring personal attention, all such operations being produced automatically by the electric current.

Fig. 4 shows the distributor, which consists of an iron case containing a number of resistance coils of German silver R, wound upon copper tubes, which prevent sparking by inductively taking up the extra current formed when lamp switches are moved. Below these resistance coils are electromagnets m, whose coils form a portion of the branch wire leading to the incandescence lamps. Under the case are the knobs which switch the current into the

THE THOMSON-HOUSTON SYSTEM OF ELECTRIC LIGHTING.

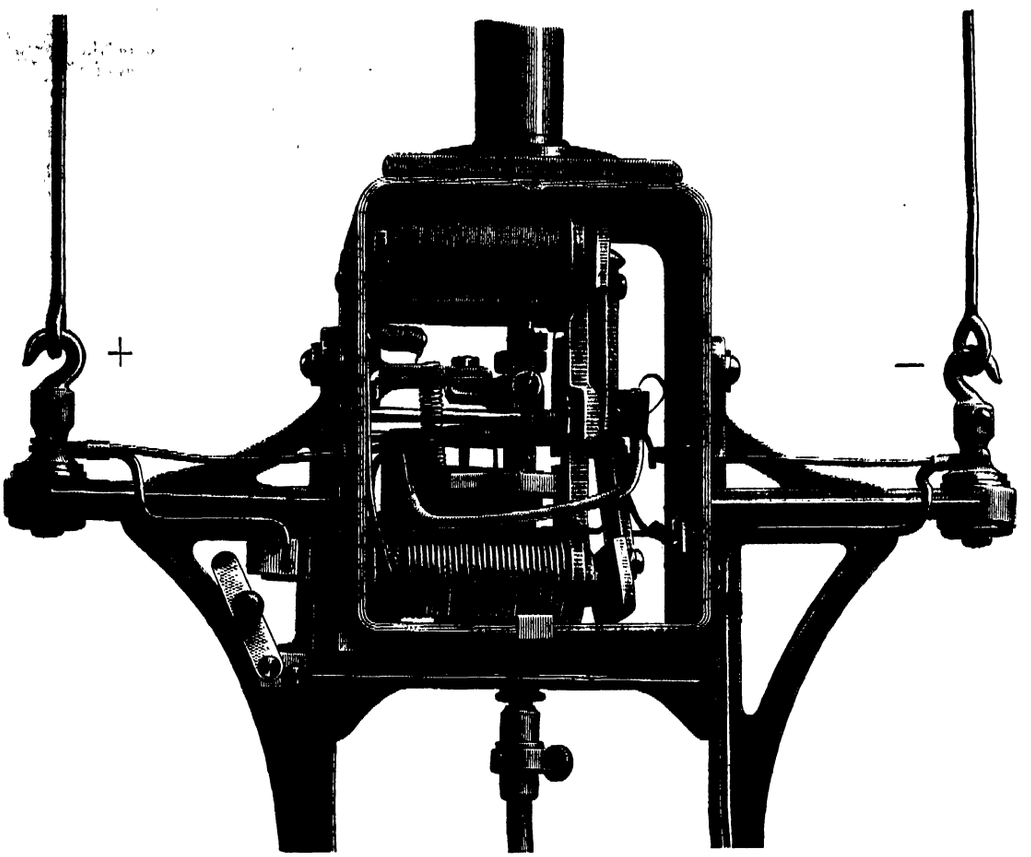


FIG. 1. MECHANISM OF THE THOMSON-HOUSTON LAMP.

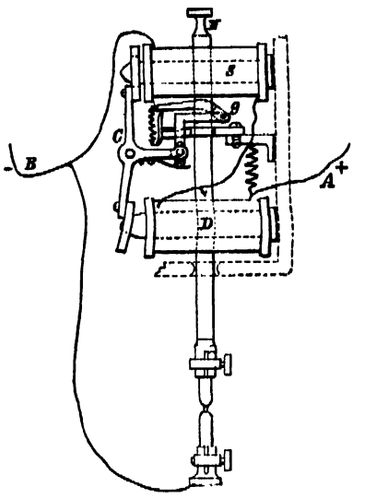


FIG. 2.

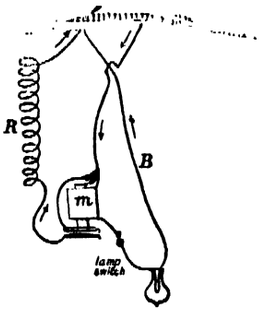


FIG. 5.

branch wires *b*, leading to the incandescent lamps. One return wire B suffices for the group of lamps.

The operation of the distributor is as follows: The wires of the high tension current for arc lamps are attached to the binding posts L L, and are allowed to enter by the switch S at the left of the case. The safety switch, in the middle of the coils, closes the circuit which charges the distributor. The electro-magnets in series with such lamps as are switched in the circuit become charged, and raise their armatures. If a lamp breaks or is turned out, the corresponding magnet *m* drops its armature, and the current for that lamp is shunted through a resistance coil.

The arrangement of one parallel of the series is shown in Fig. 5. It will be observed that the frame and armature of the electro-magnet *m* also serve as a conductor when required to turn the current through the resistance R.

At the right of Fig. 4 may be seen a dimmer D, which also turns the resistance coils in multiple arc with the lamps, thereby diminishing the amount of current supplied to the lamps, in proportion to the number of resistance coils thrown in circuit. The dimmer is operated by turning the handle protruding through the right-hand side of the case, and with the push buttons at the lower side, used to switch the lamps in or out, is the only feature of the distributor requiring personal attention, while the apparatus is in the circuit. Touch a button, and the corresponding incandescence lamp glows or is extinguished. Turn the dimmer, and its luminosity can be varied to suit requirements. No pretence is made that such an apparatus can lay claim to an electrical economy, but there are many places where a few incandescence lights are needed in the range of arc-lighting systems, and this fills the demand with commercial economy and convenience.

The incandescence lamps used in this system have carbons made of thread, and differ from the Swan lamp in the omission of the parchmentising process. It is stated that this company will introduce a new incandescence lamp in the immediate future.

The small arc lamps at this exhibit were connected in parallel series, the 10-ampère current being divided and kept uniform in each branch by the steadying effect of a large coil at the beginning of each series.

The exhibit of this company was a fine illustration of the latest applications of electrical science to illumination, particularly in the skill used in the control of electric currents of high potential

PRIVATE BILL LEGISLATION.

THE railway schemes affecting the suburbs of the metropolis this year are not so numerous as those introduced last session, and out of their number three are but the revivals of applications then unsuccessful. The improvement of the railway communication with the Crystal Palace from the east is the object of two schemes, and the one which will be first described, called the Crystal Palace, South-Eastern, and Metropolitan Railway, connects that place of entertainment with New Cross. It is jointly promoted by the South-Eastern and Metropolitan Railway Companies and the Crystal Palace Company, and consists of two lines of an aggregate length of about four miles. No. 1 commences by a junction with the South-Eastern branch of the East London Railway at the point near where that branch is carried over Trundley's-lane, thence passes under New Cross and Lewisham High-road on the west side of the South-Eastern Railway; turning to the west, it crosses over the main line of the Brighton Railway Company about half a mile south of New Cross-road; it now climbs the Brockley Hill on a southerly course situate about midway between the last-mentioned line and the High Level line to the Crystal Palace, passing about 250 yards west of the Forest Hill Station, from near which last point the course of last session's project is followed to its termination, situate 60 yards south-east of the north tower of the Crystal Palace. The gradients necessary to overcome the great difference in level, about 330 ft., are of course steep, the maximum being 1 in 55. There are tunnels of an aggregate length of about a quarter of a mile, and viaducts of nearly the same length are introduced.

No. 2 is a short junction commencing at a point on the North Kent line of the South Eastern Railway 355 yards north of the north face of the bridge carrying the New Cross-road over that line, and terminating at a point on the proposed Railway No. 1 near where the latter crosses the same road.

For several sessions past, lines to accomplish the objects of the present scheme have been projected; some of these failed on Standing Orders, [illegible] and Crystal Palace Railway, though supported by the South-Eastern Railway Company, failed last year to pass Committee. During that contest, evidence was given in opposition by Mr. J. P. Knight, on behalf of the Brighton Company, to the effect that in 1881 a through service of trains from Liverpool-street was worked by his company over the East London Railway to New Cross, thence over his company's line to the Crystal Palace, but it had turned out a complete failure, not being sufficiently patronised by the public. He also gave it as his opinion that an independent scheme of the nature proposed could not be a financial success. As in the present case, this last and perhaps most important objection will not obtain; it is possible that a means of communication which will enable Metropolitan and District trains to continue their present course beyond New Cross to the Palace may be proved to possess such advantages to the public that Parliament will no longer withhold its sanction.

In order to render the influence of the scheme as widespread as possible, it is proposed in addition to the three companies already named, to admit the East London, Great Eastern, Metropolitan, District, London Chatham and Dover, and London and Brighton Railway Companies to share in its benefits, and the whole number called the contracting companies are to be authorised, either one or more of them, to subscribe funds towards the construction, maintenance, and working of the proposed railways.

Of the schemes which contemplate improvements in the access to the Palace from the East, the first on the list is the Beckenham, South Norwood Park, and Crystal Palace Railway, and it is proposed to be constructed by an independent company. It consists of three lines of an aggregate length of three miles. Nos. 1 and 2 form a continuous line, which commences by a junction with the Beckenham and Crystal Palace low-level line of the London, Chatham, and Dover Railway, at a

point 600 yards south of the bridge, carrying Clay-lane over that line, and thence passing through South Norwood, takes a course nearly parallel to Pawson's-place, South Norwood Hill, and Church-road, to its termination near the south-west end of the Crystal Palace High Level Station, where it forms a junction with the London, Chatham, and Dover Railway. No. 3 forms a junction between No. 1 and No. 2 at South Norwood and the Croydon and London Branch of the South-Eastern Railway, at the southern end of Elmer's End Station.

As in the preceding instance, there is great difference in the levels of the ground at the extremities of the line, steep gradients are the rule, 1 in 46 being the maximum; there is a tunnel about a quarter of a mile long, and some rather heavy earthworks. Running powers are to be asked for over so much of the London, Chatham, and Dover Railway as lies between the intended junctions of Railway No. 1 and Victoria and Holborn Viaduct Stations, together with the use of those stations, also over so much of the same company's line as lies between the High Level Crystal Palace Station and the before-mentioned terminal stations, as well as over so much of the lines of the South-Eastern Railway Company as lies between the Junction at Elmer's End and Cannon-street and Charing Cross Stations, including these stations. These companies, or either of them, are to be empowered to enter into agreements for the construction, use, and working of the proposed railways.

The Crystal Palace High Level, Beulah, and Beckenham Railway is projected between almost exactly the same points as that last described, but its intermediate course is somewhat different. It is independently promoted and consists of two lines having an aggregate length of about 3¼ miles. No. 1 commences by a junction with the above-mentioned Beckenham and Crystal Palace line of the London, Chatham, and Dover Railway at a point about 200 yards south of the Clay-lane Bridge already described. Thence it passes north of Grange Wood, through Beulah Hill, across Vermont-road and Westow-street, to the Crystal Palace High Level Station, at the south end of which it forms two junctions with the lines of the London, Chatham, and Dover Railway Company. On account of its course being more circuitous than that of the rival scheme, its gradients are not quite so steep, 1 in 66 being the maximum; but the works [illegible] there being half a mile of tunnelling and about 700 yards of viaduct. Running powers are to be asked for over the Crystal Palace and South London junction line of the London, Chatham, and Dover Railway Company, and over the same company's lines between the point of commencement near Clay-lane and Beckenham Station. Powers are also to be taken to enable that company to enter into agreements for the construction and working of the proposed lines.

The Croydon Direct Railway is another attempt by an independent company to improve the railway communication between Croydon and the London, Chatham, and Dover Railway system. In 1883, the Oxted and Groombridge Company, despairing of being able to carry out their undertaking unless they were able to obtain access to metropolitan termini, proposed a line between Sanderstead, south of Croydon, and Dulwich, with running powers from the first-named place to Oxted, over the Croydon and Oxted line of the South-Eastern and London and Brighton Railway Companies. The London, Chatham, and Dover Railway Company gave the scheme hearty support, as by reciprocal arrangements it would have enabled them to push their influence well into Sussex. After having passed the Commons it was rejected by the Lords, the opposing companies undertaking to make the line from Oxted to Groombridge. In the following session, two schemes, adopting for almost their entire length the course of the rejected line referred to, were introduced into Parliament; one of these did not reach Committee, but the other, also called the Croydon Direct Railway, was the cause of a long contest in the Commons, by whom it was eventually rejected, principally, it is believed, on account of the hopeless financial prospects of such an expensive line in independent hands, and without substantial support from any existing company or adequate connection with metropolitan centres.

The present scheme, so far as its engineering features are concerned, is an exact reproduction of that of last year. It is six miles one furlong in length and commences by a junction with the main line of the London, Chatham, and Dover Railway, near the south-eastern end of the platform at Dulwich Station; thence taking a southerly course it crosses under the Crystal Palace line of the Brighton Railway about a quarter of a mile east of Lower Norwood Station; it is then carried under Beulah Hill by a tunnel a quarter of a mile in length. The Balham and Croydon line is crossed about half a mile west of Thornton Heath Station, and the Epsom and Croydon, and Croydon and Wimbledon, lines close to their junction near Waddon Station. From this last crossing the line is carried between Duppas Hill and Haling Park, and terminates about a quarter of a mile south of the south-west corner of that estate.

The chief objects of the line are to develop building sites and to afford the localities traversed additional railway facilities, and above all to give Croydon a direct access to Ludgate Hill Station and to those northern railway systems whose trains now run through that station. To enable this to be done running powers are to be asked for over the London, Chatham, and Dover Railway between the proposed junction at Dulwich and Victoria, Holborn Viaduct, and Ludgate-hill Stations, and powers are to be taken to enable that company to enter into agreements for the construction, use, and working of the proposed railway.

The London and Brighton and South-Eastern Railway Companies will, of course, oppose the former, especially as it will be seen from the above description that the line will cut right through their metropolitan district in close proximity to many of their stations.

Under the title of Various Powers, the London, Chatham, and Dover Railway Company redeposit plans relating to a scheme which they unsuccessfully promoted last session. It was then called "Shortlands to Nunhead." The scheme comprises four railways, one and two of which—about four miles in aggregate length—consist of a communication between the company's main line at a point about 340 yards north-westward of Shortlands Station and their Nunhead and Blackheath line at its junction with the Crystal Palace High Level line about half a mile west of Brockley Station. In its course the line passes to the east of Beckenham-place, near to and to the east of Southend, and crosses the Mid-Kent line of the South-Eastern Railway about a quarter of a mile north of Catford Bridge Station.

Railways 3 and 4, each about thirty chains in length, form up-and-down junctions between the South London line of the Brighton Company at Queen's-road Station and the Crystal Palace High Level line at a point about a quarter of a mile west of the termination of Railway No. 1 above described. These would permit direct access from the main line of the London, Chatham, and Dover Company to the London Bridge Station of the Brighton Company.

This project would, as in the case of that last described, afford to many places direct access to Ludgate Hill and that part of London, which they do not at present possess, and would at the same time give some relief to the company's traffic, which occasionally suffers from the congestion caused by there being but two lines of rails through the tunnel under Sydenham Hill, but on the other hand it will be vigorously opposed by the South-Eastern Company, whose lines at present pretty well cover the ground proposed to be occupied.

As was the case last year, owing to the aggressive nature of many of the schemes described above, a keen struggle is imminent should the difficulty attached to the deposit be successfully got over by the independent promoters. The nature of the questions involved is too important to admit of compromise, and neither of the gentlemen holding sway over the companies interested, are likely to give way until completely deserted by fortune.

During the session of 1883, a short line, independently promoted, called the Bexley Heath Railway, was sanctioned, by which the important residential districts of Eltham and Bexley Heath were assured much improved railway communication with the metropolis. The line commenced near Lee on the Dartford loop and terminated by a junction with the North Kent line about midway between Erith and Dartford Stations. This session the South-Eastern Railway Company propose to take power to contribute funds to this undertaking, and the Bexley Heath Railway Company have deposited plans of a short line, about two miles in length, which commences by a junction with the authorised line of 1883. Starting from a point on that line, about half a mile to the north of the centre of the village of Eltham, near Well Hall, it takes a westerly course through Kidbrooke and terminates by a junction with the North Kent line of the South-Eastern Railway, near the eastern end of the platform at Blackheath Station. This piece of line may be made in substitution of the authorised line between the point of junction and the Dartford loop line.

A new street and sewer diversion near Eltham, also form part of the scheme. Running powers will be asked for over the North Kent line into Blackheath Station, and powers to enable the South-Eastern Railway to subscribe to the funds of the undertaking.

The Metropolitan Railway Company do not deposit any plans relating to new works in the metropolis, but do so with regard to some proposed works affecting their Aylesbury line, which consist of a branch about three miles long from their authorised line near Amersham, to the town of Chesham; a deviation of their authorised line is also proposed which extends into the parishes of Great and Little Missenden and Amersham. Lands are also to be purchased on the north side of King's Cross-road, near Baker-street, in order to erect a station for the accommodation of Clerkenwell, which is very much required. The proposed site is about 50 chains from Farringdon-street Station, and about 30 chains from King's Cross, and would be convenient were it not for the fact that from the level of the ground to rails is nearly 40 ft. on the original line, and about 45 ft. on the widened line.

The Ealing, Harrow, and Edgeware Railway is the most extensive project proposed this session in the neighbourhood of the metropolis. It is independently promoted, and consists of six railways of an aggregate length of nearly twelve miles; it commences by junctions with the Great Western and District Railways, near the Ealing Station on both lines; it then takes a north-westerly direction near Perivale and Greenford, thence turning north it passes on the west side of Harrow, being at its nearest point a little less than half a mile from the church; here two branches leave the main line to form junctions with the Metropolitan Railway Company's line at points 300 yards and 400 yards respectively west of the west end of that company's station at this town. The main line is continued in a north-easterly direction, passing near Stanmore to the Edgeware line of the Great Northern Railway Company, near its termination at Edgeware.

Running powers are asked for over the Great Western Railway between the junction of the proposed line near Spring Road, and the junction of that railway with the North and South-Western Junction Railway near Acton Wells; also into the Ealing Station of the Metropolitan District Railway, also over so much of the Metropolitan Railway as lies boween the Western Junction of the proposed line and Harrow Station, and over so much of the Great Northern Railway as lies between the intended junction therewith and the junction of that railway with the Metropolitan Railway, near Farringdon-street. Powers are to be taken to enable the Great Western, Midland, North-Western, Metropolitan, and District Railway Companies to enter into agreements for the construction, use, and working of the proposed lines.

The London and Blackwall Railway Company propose to widen their line between Little Prescott-street, a point about 500 yards from the termination of the line, and the western end of the platform at Stepney Station, being a distance of nearly a mile and a half; the widening will be on the north side, west of Bower-street, and on the south side for the remainder of the work.

NOTES.

A Silurian Scorpion.

Herr Lindström, a Stockholm geologist, has found a very perfect fossil scorpion in the Upper Silurian rocks of the island of Gotland, in Sweden. The cuticle can be distinguished, also the dorsal plates of the abdomen and the cephalothorax. The surface is quite similar in appearance to the scorpions of to-day, and its organisation proves it to have lived on land and breathed air. It has been called *Palæophonous Nuncius*, and is evidently one of the most ancient of terrestrial animals, the libellules found in the Devonian formation of Canada having hitherto been esteemed the

oldest known. It is remarkable that the four pairs of thoracic claws are thick and pointed like those of the embryons of several other tracheates and campodea, a form of claw which does not exist in the known fossil scorpions of the carboniferous era, which in their appendages resemble those of to-day.

Hudson's Bay Route to Europe.

The prospects of a proposed route from the Canadian North-West to Europe *vid* Hudson's Bay are not considered encouraging. A diary for August shows that ice prevailed in the straits for nineteen days out of the thirty-one, and that snowstorms prevailed on five other days. As the straits ought to be open during August, the outlook for the other months cannot be bright. Mr. J. W. Klatze, a Dominion Government, official who was sent to inquire into the feasibility of constructing a railway from Winnepeg to Hudson's Bay, has returned to Ottawa. He does not speak favourably of the ultimate success of the undertaking, and thinks, if it is ever accomplished, it will be at a price which few capitalists would care to pay. Putting the difficulties of the navigation of the straits, and the almost insurmountable barriers in the way of constructing a railway to the bay together, the outlook for north-west settlers having direct communication by this route with Europe is not at all hopeful.

Mönch's Fire Extinguisher.

A new method of utilising carbonic acid gas for extinguishing fire is now being introduced by Mr. Mönch, of Berlin, several establishments in Berlin having been fitted with the apparatus. The system depends upon filling the room where a conflagration has commenced with a sufficient quantity of carbonic acid gas to suppress the flame. The apparatus consists of a wrought-iron receiver of sufficient strength to resist a pressure of 250 lb. to the square inch, and which is filled with highly compressed carbonic acid. This receiver can at any time be charged by means of a battery of wrought-iron flasks connected to it. Such flasks filled with highly compressed carbonic acid are a regular article of commerce in Germany, and when attached to Mr. Mönch's receiver, the latter can be filled with the gas as desired at any convenient pressure. From the receiver branch pipes fitted with valves are laid to the different apartments it is desired to protect, and which can at any time be filled with the gas discharged from suitable nozzles fitted to the pipes. Smaller and independent reservoirs are also made which can be carried easily from place to place, and the contents liberated at any desired spot. In Germany, where fluid carbonic acid forms a large and increasing industry, Mr. Mönch's system would naturally find favour, and at one of the places where it has been adopted—the varnish works of Mr. Krauthammer, of Berlin—its efficiency has been proved by the prompt suppression of an incipient fire, which is the special *rôle* of this class of apparatus.

A Phenomenon of the Edison Lamp.

In Mr. Edison's exhibit at the Philadelphia Exhibition a curious phenomenon was shown. Midway between the legs of the filament in an Edison incandescent lamp an insulated electrode of platinum strip was inserted, the tip of the electrode ending about ½ in. below the arch of the loop. When the lamp was in action, if a galvanometer was connected between the electrode and one terminal of the filament, a current was observed, which changed in direction according as the + or − terminal of the carbon was connected to the instrument. This shows that there is a discharge or current through the vacuum of the lamp. The current was many times stronger when the + pole of the carbon was that connected. The current was also increased by increasing the current in the lamp. After the lamp has been in use some time the positive-platinum or stronger current becomes weaker, possibly through some effect of polarisation such as that noticed by Edlund in his experiments on the discharge through vacuo. On letting the lamp rest the current recovers itself again. A current was also obtained through the glass of the lamp by laying the platinum electrode on it outside. It would appear that in these lamps the air (or carbon) particles are dissipated in a charged state from the filament in right lines.

The North-East Coast Institute of Engineers and Shipbuilders.

A new scientific and technical society, under the title of the North-East Coast Institution of Engineers and Shipbuilders, has been launched at Newcastle, for the purpose of advancing the science and practice of engineering and shipbuilding, and of affording means for the interchange of ideas and information among its members. The new organisation embraces the district of the Tyne, the Wear, and the Tees, an area within which there is abundant material for the formation of a most successful association, both as regards numbers, or the quality of the papers and discussions. Many of those forming the new Society are members of the more important societies which meet in London, but still few can spare the time to regularly attend distant meetings, and even if they could, the peculiar wants of their own locality would seldom come under discussion. The inaugural meeting of the new Institute took place on November 28, when the President, Mr. W. Boyd, gave an address. The vice-presidents are Messrs. F. C. Marshall, Newcastle, W. H. White, Elswick, Wigham Richardson, Newcastle, C. W. Hutchinson, Elswick, W. Clark, Sunderland, and Robert Thompson, Sunderland. The Institution consists of members, associates, graduates, and honorary members, the subscription being two guineas for members who are principals and half a guinea for those in subordinate positions, and thus every facility, in a pecuniary sense, is offered to those who are the less affluent. We wish the new association every success. It contains within it all the requisite elements of knowledge and experience, and it only remains for the members to exert themselves for the common good to raise the Institution to a high position among the scientific societies of the country.

The Hammond Electrical Engineering College.

On Wednesday last a well-attended conversazione was held at the Hammond Electrical Engineering College in Red Lion-square, Holborn. There was a large display of electrical and scientific apparatus, including dynamo machines of various kinds, lamps and fittings, measuring instruments, audiphones and phonographs, besides the regular appliances of a chemical and an electrical laboratory. The latest novelty in electric lighting, Trouvé's portable lamp, was exhibited. This consists of a six-cell bichromate battery working with a very strong solution of bichromate of potash and sulphuric acid, and a four or five candle-power incandescent lamp. The battery is contained in a case of very moderate dimensions, weighing about 5 lb., and is so arranged that the zincs are only immersed in the liquid under certain conditions. In one form of apparatus the act of lifting the battery from the table allows the plates to descend into the solution and lights the lamp, while in another the same effect is produced by placing the battery upon the ground or the table. The former variety is designed for use in magazines, the holds of ships, and the like, where the lamp is carried by the watchman or patrol, while the latter can be employed for mining, for domestic purposes, and by railway travellers. The idea may, of course, be worked out in many different ways, the principle being that when the battery is placed in a position convenient for its use the plates shall be free to descend into the liquid. The supply of bichromate solution is stated to last for four hours, when it needs to be renewed, at a cost of about a penny. There are forty pupils in connection with the college, part attending the classes and part engaged either on the indoor or outdoor work of the Hammond Company, the scheme of education embracing one year's course of theoretical study followed by a year of practical training. The building includes class room, laboratories, and workshops, and is fitted with all the requirements for the demonstration of electrical science.

NOTES FROM PARIS.

By H. Vivarez.

Some Proposed Industrial Developments.

It very rarely happens that the governing body of any country addresses itself to the consideration—apart from any political motive—of a remedy against misery, and a means for the extinction of pauperism. Such an event is worth putting on record, and we note with satisfaction that a French deputy, M. Denayrouze, has appealed to the Chamber of Deputies to support by its vote a measure he had prepared, one of purely scientific interest, but the social consequences of which might be of considerable importance. Just at the moment when the requirements of public expenditure involves the amassing of millions upon millions of francs, M. Denayrouze submits his proposal, one of very modest proportions, under the form of a credit of 20,000 francs, to be devoted in sums of 5000 francs as Prizes for the best essays, submitted to the French Institute (the Academie des Sciences), and on the following subjects: 1. What are the best practical means for effecting, under easily maintained and economical conditions for agriculturists, a combination of the nitrogen of the air with the other elements of the atmosphere, water, and soil, in such a way as to produce quickly and in large quantities, nitrogenised compounds, which contain the essential principles of manures — principles which nature creates only slowly and sparingly. 2. What will be the best means to effect under economical conditions, easily attainable by artisans in towns, the production for home use of a small motive power, equivalent for example to that of an apprentice, a woman, or a labourer. The method should involve the utilisation of any form of energy, heat, electricity, mechanical work, chemical force, &c. The means adopted are of no importance, provided that the desired end be obtained, this end being to permit any artisan engaged on small industries, to work at home, without being obliged to remain under the necessity of foregoing the assistance of mechanical power. This is practically, in the actual state of applied science, to some extent monopolised by a small number of capitalists, owners of water or steam power, and the manual labour of the artisan working at home, cannot enter into competition. 3. What will be the best practical method under conditions favourable for agriculturists, of producing small machines or sources of power capable of developing in the field, energies equal to that of a man, of a horse, and of a pair of oxen. 4. What will be the best practical means of producing at a moderate price, a form of aluminium possessing the qualities of iron, the ore of which is met with all over the world. This metal, discovered by Sainte-Claire Deville, only about half a century ago, and adapted to various decorative purposes during the last twenty-five years would find a universal field for application so soon as its production, under the conditions named, became practical. It is certain that the initiative taken by the Government will not suffice to encourage able inventors in bringing these four problems to a successful issue. Two of them, the first and the last, present indefinite difficulties, whilst the other two have already been partially solved. But M. Denayrouze can justly urge that official assistance has already proved of great service in industry, especially in the manufacture of sulphate of soda and of beet-root sugar, and which were created out of the necessities of the French Government. Of the four subjects which we have mentioned, the last referring to the manufacture of aluminium is certainly the one presenting the least apparent interest. The ore of this metal is found in far greater abundance than that of iron, but it is certain that any mode of treatment by which it may be produced at a reasonable price, must be [illegible] and the time must be far distant when the two metals will represent any comparable market value. Moreover, the physical properties of aluminium do not at all compare with those of iron. If it is lighter, and less oxidisable than iron, it cannot be welded, and its powers of resistance are quite insignificant, so that although, did price permit, a vast number of uses would be found for it, it could never enter largely into those industries where iron is now employed. The actual process followed in the production of aluminium is well known. The treatment, due to Sainte-Claire Deville, and worked industrially at the present time, is based on the employment of sodium. The price of the aluminium is therefore a direct function of the cost of sodium, which has latterly been sensibly reduced, the present market value being about 5s. a pound. In the preparation of this metal the abundance of its base —sea salt—is compensated by the difficulty of separation. But the gradual reduction in cost arising from various causes, and especially from the application of new processes, renders it probable that a corresponding diminution in the price of aluminium will take place, and at least one important works in Germany is devoted to the manufacture of this metal, and of magnesium. This latter would find a valuable application for illuminating purposes, if its price could be sufficiently reduced. Especially for the open air, where the magnesia produced by the combustion of magnesium can be easily removed, or deposited without inconvenience, magnesium furnishes light of an intensity comparable to that of electricity, and with infinitely greater simplicity, since none of the complicated and costly apparatus of dynamo machines, lamps, conductors, &c., are needed.

THE LATE MR. JAMES NAPIER, F.R.S.E.

Many of our readers will share in our regret at the death, about ten days since, of Mr. James Napier, F.R.S.E., F.C.S., of Glasgow, who was long prominently identified with industrial chemistry, and with various other manufacturing arts, more especially that of electro-metallurgy.

Mr. Napier, who was born in 1810, was a native of

the village of Partick, which forms one of the western suburbs of Glasgow, and was the son of a hand-loom weaver in very humble circumstances. His first occupation at eight years of age was that of a "teaser" in a calico-printing works; then he became a "draw-boy" to a weaver, at a wage of 1s. 6d. per week. By-and-by he became a weaver himself, and subsequently he found permanent employment as a dyer, and by the time he was eighteen years of age he was a piece-dyer, with full charge of his employer's works at Meadowside, close by the site now occupied as Meadowside Shipyard. He remained in that position for about seven years. While still a youth he imbibed a great taste for reading, and attended a night school for two winters. Some notion may be formed of Napier's very humble station in early life if we mention that when he got married at twenty-one years of age he had a wage of only 13s. per week.

Falling into a weakly state of health, Napier was strongly enjoined by his medical adviser to leave the dyeing trade. He did so, and for about a year he was employed as a clerk, &c., by his former master; and owing, in some measure, to the high excellence of an essay on dyeing which he wrote for a mutual improvement society, he was brought under the favourable notice of the late Mr. John Joseph Griffin, who then had a publishing business in Glasgow, combined with that of a dealer in chemicals and chemical philosophical apparatus—a business which subsequently grew to large proportions in London. Mr. Napier became zealously attached to the latter portion of Messrs. Griffin and Co.'s business in their well-known Buchanan-street establishment. He had a great desire to become a chemist, and here he was afforded an excellent opportunity of carrying out his wishes. In Griffin's warehouse he became acquainted with the late Dr. James Young, F.R.S., the "father of the paraffin industry," and who was at that time laboratory assistant to the late Professor Graham, who eventually became the Master of the Mint. That early acquaintance led to a life-long and most friendly intimacy.

In the year 1842 there was commenced the *Glasgow Practical Mechanic and Engineer's Magazine*, the editor of which resolved to publish a series of papers on different trades written by practical men, and from a workman's standpoint. The deceased Mr. Napier was asked to furnish a few papers on dyeing, which appeared in the years 1843 and 1844. Two years afterwards an American publisher printed the entire series, with a little addition on calico-printing, the whole forming a goodly sized volume, entitled "A Practical Treatise on Dyeing and Calico-Printing," but neither the name of the author nor the source from which the papers on dyeing were taken was mentioned. Mr. Napier nevertheless felt proud that his efforts had been appreciated. In 1852 he revised and extended his magazine papers, and they were issued by Messrs. Griffin and Co. as "A Manual of the Art of Dyeing." A third edition of it was published in 1875, in which there was embodied a treatise on dyeing receipts, the first edition of which was published in the year 1855. The "Manual" named above is certainly one of the most authoritative works on dyeing in the English language, no mean portion of its value being due to the accuracy and fulness with which the author has stated and illustrated the scientific principles on which the dyer's art is based.

In the year 1839 a great amount of interest was excited in regard to certain discoveries that had just been made in connection with the new art of electro-typing, or electro-metallurgy. Mr. Griffin became quite full of the subject, and Mr. Napier, who had already devoted much attention to it, was affected in a similar way; indeed, such an adept had he become in electro-plating that he was engaged to take a leading position under Mr. Pellatt in the London works of Messrs. Elkington and Mason, after he had been about four years in Messrs. Griffin and Co.'s employment. Under his guidance innumerable electro-type processes were repeated as soon as particulars regarding them were published, and original experiments were made in a variety of forms, and frequently on an extensive scale, with the view to the removal of particular difficulties, or to find the means of accomplishing desirable ends; in short, Mr. Napier eventually became one of the most experienced manipulators in the new art. Considering these facts, Messrs. Griffin and Co. requested Mr. Napier to write a volume for their series of "Scientific Manuals," entitled "A Manual of Electro-Metallurgy; including the Applications of the Art to Manufacturing Processes." It first appeared in 1851, and it soon became such a standard authority on the subject that a fourth edition was called for in the year 1860.

While engaged with Messrs. Elkington and Mason, Mr. Napier became much interested in a new process of copper-smelting, for which he took out a patent in the year 1846. It was for some time carried on at the Spitty Works, Swansea. Owing to various difficulties with the workmen, and pecuniary or other difficulties amongst the capitalists who undertook to provide the means to work the process upon an extensive scale, it could not bear up against, and compete with, the process then [illegible]

By-and-by Mr. Napier returned to [illegible] again settled down in his native village of Partick, where he established a laboratory and carried on a variety of useful work. Subsequently he spent about a year in the service of the late Marquis of Breadalbane at Killin, where a deposit of copper ore had been discovered, and where vitriol chambers were erected under Mr. Napier's superintendence, to manufacture acid for dealing with the ore chemically. The metalliferous deposit, however, proved to be much more limited in extent than had been anticipated. Mr. Napier again returned to Glasgow, and partly at the instigation of Mr. James Young he started a large sulphuric acid manufactory in the east end of the city, much of the produce in the early years of the business being taken by Mr. Young's new oil works at Addiwell, and by the dynamite works of Mr. Nobel's company. He retired from the active management of that business in the year 1875, and left it to his two sons.

Mr. Napier was long connected with the Philosophical Society of Glasgow, to whose proceedings he contributed a variety of valuable papers. He was also a zealous worker in the management of Anderson's College, and when Mr. Young instituted the Chair of Technical Chemistry in Glasgow, Mr. Napier was made one of the trustees. Amongst the other works which he wrote, we may specially mention his "Ancient Workers in Metal" (now out of print), his "Manufacturing Arts in Ancient Times," his "Notes and Reminiscences of Partick," and his "Old Ballad Folk-Lore," for he was a keen and enthusiastic antiquarian as well as a man of science, and an active and useful worker in helping forward important manufacturing works.

NOTES FROM THE UNITED STATES.

PHILADELPHIA, November 28, 1884.

THE industrial depression is becoming more marked each day. Reductions of wages are being made in all industries, and ranging from 5 to 20 per cent. A great deal of capacity has shut down since last writing in iron, steel, textiles, hardware, shipbuilding and engine building. This depression is usual in every presidential year, but is more serious this time than heretofore. On the other hand, there is a noticeable improvement in the volume of exchange, but prices are weaker than a month ago, and it is not likely that the volume of business, even with the restrictions in progress, will be sufficient to strengthen these prices. Large enterprises are talked of, but orders for material will not be placed, probably until January, when a better knowledge of the general condition of the country can be had, when the annual statements and settlements are made by the various manufacturing and railroad interests as to their con[illegible] In the iron trade very little business has been done, and that only for current wants. Large steel rail transactions are likely to take place in a few weeks. Inside prices to-day are 27 dols. A further decline is regarded as probable by buyers. Bessemer pig, foreign, is held at 19 dols.; 10 per cent. spiegeleisen at 22.75 dols. tide; 20 per cent., 26 dols.; steel slabs, 37 dols.; old rails, 17.50 dols. to 18 dols.; Scotch pig iron is arriving in small lots and going mostly into consumption, but at a very narrow margin to the importers. The use of southern and western iron in the Middle States is increasing, and foundry men and mill men are finding it necessary to increase their purchases. The supply of American Scotch is also increasing. Southern irons are delivered here at from 16 dols. to 16.50 dols. Pennsylvania forge ranges from 16 dols. to 17 dols.; Pennsylvania foundry, 17.50 dols. to 20 dols., according to quality and number. The bulk of No. 1, selling at 19 dols. closed down, about eight in all. Structural iron is under fair inquiry, and 5000 tons are under negotiation Iron combinations have been broken, and it is probable that the combination on structural iron will also go. Manufacturers are avoiding over-production as much as possible. The position is unfavourable to any early improvement, but there is confidence expressed that January will bring a large amount of business, which, but for political interferences, would have been placed before this time. Steel nails are crowding out iron nails little by little. The Hocking Valley coal strike is about over, the miners being defeated. Comparatively little opposition is being made to the sweeping reductions everywhere, the workmen feeling that it is useless to oppose the decline.

TRIAL TRIPS AND LAUNCHES.

MESSRS. BARCLAY, CURLE, AND CO., Whiteinch, Glasgow, on Wednesday, 3rd December, launched the Madeira, a steel screw steamer, of 1830 tons gross register, and measuring 300 ft. by 36 ft. by 20 ft. She was built to the order of the British and African Steam Navigation Company, of Glasgow and Liverpool; her general design and equipments are very similar to those of the Opobo and Roquelle, which were recently constructed for the com[illegible] Port-Glasgow, [illegible] the Ravenscraig, a vessel of [illegible] by 38 ft. by 23 ft., and classed [illegible] years in red in the Liverpool Register. The vessel has been built to the order of Messrs. Thom and Connochie, Glasgow, and is the third vessel built for that firm by Messrs. Duncan and Co., within the past two years.

Messrs. James and George Thomson, Clydebank, launched, on the 4th inst., an iron screw steamer of about 4500 tons gross register, which has been built for the Canada Shipping Company (Beaver Line). She was named the Lake Superior and measures 410 ft. by 44 ft. by 33 ft; she has a large double-bottom space under the machinery and boilers sufficient to bring up her deadweight carrying capacity to 5000 tons. The engines have cylinders of 48 in. and 91 in. in diameter, respectively, with piston stroke of 60 in., and steam will be supplied by two double-ended boilers, each 18 ft. in diameter, and each having four furnaces.

On Friday, the 5th December, Messrs. William Hamilton and Co., Port-Glasgow, launched a handsomely modelled steel sailing barque, named the Glen Afton, a vessel of 1100 tons net register, to carry 1900 tons deadweight, and measuring 224 ft. by 35 ft. 6 in. by 20 ft. 1 in. She has been built to the orders of the Dundee Shipowners' Company (Messrs. W. O. Taylor and Co., managers).

The Falklandhill, an iron sailing vessel of 1700 tons, net register, and measuring 245 ft. by 37 ft. 6 in. by 21 ft. 6 in., was launched by Messrs. Russell and Co., Port-Glasgow, on Saturday the 6th inst. She has been built to the order of Messrs. J. R. Dickson and Co., Glasgow, and is to be engaged in the East Indian trade.

THE MIDLAND RAILWAY CARRIAGE AND WAGON COMPANY.—We are informed that Mr. D. N. Arnold has ceased to be the general manager of the Midland Railway Carriage and Wagon Company Limited, and that he is no longer connected with the management of the company.

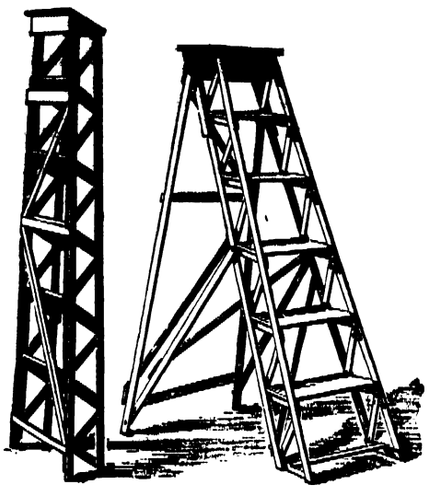
CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—The opening meeting of this Society was held at the Society's rooms, No. 7, Westminster Chambers, on the 3rd instant, when the newly elected President, Mr. Thomas Cole, A.M.I.C.E., delivered his inaugural address, taking for his subject the progress of sanitation and of sanitary legislation during the last fifty years, a period including the rise and growth of what may almost be termed a revolution in the matter of things sanitary, and culminating in the Public Health Act, in which is incorporated the 15 main Acts and 10 subsidiary Acts which form our sanitary legislation. Mr. Cole then pointed to several of the permissive clauses of the Public Health Act which should be compulsory, and alluded to the necessity of town surveyors being placed in the position of independence enjoyed by medical officers of health; and in conclusion pointed out the duties of private individuals and of public authorities to further diminish the decreased death rate that has followed from the sanitation of fifty years.

NEW ZEALAND MECHANICAL INDUSTRY.—Messrs. Sparrow and Co., of Dunedin, have just executed an order for ten columns of cast-iron cylinders to support the superstructure of the Cobden bridge, at Gregmouth, the total weight of the columns required and the malleable ironwork for the superstructure being about 320 tons. The New Zealand Government has always hitherto been in the habit of sending home for this class of work, and the present experiment therefore marks a new departure. Only recently cylinders have been obtained from England for the Taieri bridge and the Clarence bridge, Marlborough, and no opportunity has ever been given to colonial firms to tender. On this occasion, however, Mr. J. Watson, who had the contract, arranged with Messrs. Sparrow and Co. that they should set up plant specially for the work and supply the whole of the columns. Seven months was the contract time, and the manufacturers have been able to prepare their plant and turn the work out to the satisfaction of the district engineer two clear months within the limit.

THE INTERNATIONAL INVENTIONS EXHIBITION.—The applications for space have now all been examined by sub-committees of the Council, and a selection has been made of the most promising. The number of applications has been so great that it has been decided to limit very strictly the admissions in those classes which may be considered to have been fully represented in the exhibitions of the present and of the past year. The Council will, therefore, be obliged to refuse many valuable exhibits in such classes as those relating to food, clothing, and building construction. It will even be a difficult matter to accommodate those which have been selected, and it is feared that the list will have to be still further reduced. As soon as possible, information will be sent to those who have applied for space; but the enormous number of applications, far in excess of what was expected, have made it impossible to do this up to the present. The guarantee fund now amounts to 48,280*l.*, a sum considerably in excess of that subscribed for the Health Exhibition, or for the Fisheries, the amount for the former being 26,518*l.*, and that for the latter 26,656*l.*—*Journal of the Society of Arts.*

[illegible]

The [illegible] shows a very neat arrangement [illegible] invented by Mr. Charles Allan Jones, of Gloucester, and manufactured by Messrs. Matthews and Co., of the same place. It will be seen that by skilful disposition of the material the weight has been reduced to an exceedingly small amount, with the result that the steps can be carried about with the greatest ease. In libraries where the ladders are in constant requisition, this is a most important feature, while in ordinary dwellings it is no less deserving of



consideration, as the movement of heavy, clumsy steps, often in the hands of female servants, is the cause of numerous accidents to mirrors, chandeliers, wall papers, and other fittings. It is scarcely necessary to add a detailed description. In the open position the steps are exceedingly firm, and are quite free from the usual "walking action" on an uneven floor. When closed they will stand upright without any support. In spite of their apparent lightness they will bear a man standing on every tread from the top to the bottom.

THE RIVER HUMBER.*

By A. C. Hurtzig.

The estuary of the Humber extends from the Trent Falls, at the confluence of the Trent and the Ouse, to Spurn Point, a distance of thirty-eight miles. Receiving the drainage from an area equal to one-fifth of the whole of England, and with tidal conditions probably unsurpassed in any other large river or estuary, it is pre-eminently adapted to carry a great commerce. Unlike the Mersey, with its 8 ft. or 9 ft. over the bar at low water, it has a deep low-water entrance channel of 60 ft. to 70 ft. available at all states of the tide. This needs no dredging to keep it open, and so powerful is the scouring action that in spite of a million tons of mud being thrown into the river every year, no ill effects have been observed. Hull is the third port of the kingdom, the annual value of its imports and exports being 40 millions, while those of Liverpool and London are, respectively, 200 and 200 millions. Grimsby's trade is 12 millions, and that of Goole 9 millions.

At Trent Falls the Humber is about one mile wide; at Hull it is about two miles, and at Spurn, some four miles at high water, but there are places of greater width than this. In its lower portions the Humber forms a favourable harbour of refuge for coasting vessels, and it said that as many as 700 to 800 sail have been anchored in the roadsteads at one time. From Spurn Point up to Hull there is a deep low-water channel, such that the largest slip in the British Navy may navigate it, and anchor opposite the town at any state of the tide. Of course any hostile ship could do the same, and the Stallingboro' fort and Paull battery would prove but a poor defence in the absence of naval reinforcements. But although vessels can reach Hull at all times, they can only enter the docks when the tide serves. The tide at Hull depends upon many causes besides the attractions of the sun and moon, indeed in this river the direct action of these bodies is scarcely felt. In the open ocean the crest of the tidal wave travels approximately at the same rate as the earth rolls. But as soon as the narrow seas of the British Isles are entered, the wave loses its distinctive character and travels in the different channels at very reduced and varying rates, and with many peculiarities. This tidal *wave* is essentially different from the tidal *current*. The speed of the wave is that at which the crest or high-water mark travels, but the speed of the tidal current is the actual velocity of the water. The average speed of the tidal wave between Spurn and Hull is twenty-two miles an hour, that is, high water at Hull occurs about an hour after high water at Spurn, and the distance between them is twenty-two miles; but the actual motion of the water never exceeds five miles an hour. The great tidal wave arriving from the Atlantic is broken up on reaching the British Isles, and divides north and south, the velocity being reduced from many hundred miles per hour to thirty, forty, or fifty miles. The part which passes round Scotland helps to form the tidal wave in the North Sea, passing the mouth of the Humber in a S.S.E. direction. There is thus no direct impulse into the estuary as there is into the Severn, and consequently the range of tide is not excessive. At the same time the Humber meets the sea at a point where the tidal wave has its maximum oscillation, and consequently tides of 20 ft. to 22 ft. are of usual occurrence at Hull. Assuming the rate of flow in the river to be four miles an hour, it is evident that the tidal current cannot travel more than twenty-four miles, and yet the river is tidal up to Naburn Lock in the Ouse, a distance of eighty miles, where high water occurs four hours later than at Spurn, by which time nearly all the water which entered the estuary from the sea has gone out. This is due to the impulse caused by the ingress of the tidal water in the first twenty-four miles, and this impulse is transmitted forward in the same way that an undulation may be sent along a rope by shaking one end of it.

The Humber is an exceedingly turbid river, and it is a debated point whether this silt comes down with the land water, or is carried in by the sea. The advocates of the latter theory point to the fact that thirty miles of clay cliffs between Bridlington and Spurn are wasting at the rate of 2½ yards per year, and that the material is borne southward by the tide to the mouth of the river ready to be carried into it, and they strengthen their cause by showing that during a freshet, when the land water is abundant, the river is clearer. Those who favour the opinion that the mud comes from the up-country, show that the cliffs are carried away on the ebb tide, when the detritus goes out to sea, and not to the mouth of the river. The clearness during a freshet they ascribe to the fact that some of the affluents of the Ouse come from a part of the country that does not provide mud, and consequently the increase of total water in the stream may be greater than the increase of suspended alluvial matter. The author is one of those who recognise the turbidity of the Ouse as being due to material carried down by the stream. On account of the continual to-and-fro flow of the tidal water, an object moving with the current only makes five miles net progress towards the sea in a fortnight. It therefore follows that in each five miles length of the river there is concentrated fourteen days' detritus from a water-shed of 10,500 square miles, and this should amply account for its muddiness. Analyses also show that at the turn of high tide the amount of suspended matter is least, and at low tide it is greatest.

The levels of high and low water, as well as tidal ranges, vary from Spurn upwards. The typical spring tide in the Humber, *i.e.*, the eight o'clock tide at Hull, ranges 20 ft. 3 in. at Hull. The same tide at Spurn has only a range of 18 ft. 2 in. Spring tides of much greater range occur nearly every fortnight; during the last ten years the greatest range was 27 ft., on March 9, 1875. The other extreme was reached on November 10, 1877, when there was but 5 ft. 7 in. between the levels of high and low water. These poor neap tides seal the outfall sewers for a long time, and give rise to unsanitary conditions in Hull, which are being removed by the erection of sewage pumping stations. The tide always reaches a mark 16 ft. above the dock sill at Hull, exactly three hours before high water, independently of any condition of the wind or weather, and during the next hour it always rises [illegible] much as during the two succeeding hours. Thus the height and the moment of high water can be foretold with absolute accuracy for two hours before it occurs.

The Humber is exceedingly well lighted. At Spurn Point stands a lighthouse erected by Smeaton. It was commenced in 1772, and the fires were kindled on September 5, 1776, illumination by coal fires being continued for about forty years, when lamps and reflectors were introduced. About thirty-seven years later the reflectors were replaced by lenticular or dioptric apparatus, as at present in use. The encroachments of the sea upon Spurn Point, amounting at one time to three yards per annum, were a great source of anxiety, but since 1863 there has been a gradual improvement due to the erection of groynes. In 1880 there were on the Humber three light vessels, and twelve substantial lighthouses, and all the way the channel is amply buoyed, so that both by day and night the mariner finds his course perfectly plain.

The most noticeable object on the banks of the river is Grimsby hydraulic tower, 310 ft. in. height, which was built in 1849 by Mr. Rendle and Sir William (then Mr.) Armstrong. Soon after it was completed the hydraulic accumulator was invented, and the necessity for such high erections for storing water under pressure was done away with.

The Humber in the neighbourhood of Hull has during recent years been the subject of some severe Parliamentary contests. Excellent as is the geographical position of Hull as a port, yet it suffers increasingly from its comparative isolation on the north bank of the river. The crossing of the Humber involves many difficulties. The Hull and Lincoln Railway scheme in 1883 included a high-level bridge across the river, with wide spans for the passage of shipping, but the opposition of persons interested in the trade of Goole proved fatal to it. In 1873 a tunnel was proposed, but the Lord's Committee pronounced the plan of building it by caissons to be infeasible. The Manchester, Sheffield, and Lincolnshire Railway propose to carry a driftway under the river to determine the possibility of making a tunnel, and at present they are boring on the banks. A depth of 150 ft. has been reached at each side, and for over 100 ft. there is a bed of solid clay, which is believed to extend all the way across the river. The centre point of the tunnel invert will be 120 ft. between H. W. O. S. T., so that there would be at least 30 ft. to 40 ft. of the clay above the crown of the arch to protect it from percolation through the permeable strata. From the centre the driftway would fall 5 ft. each way in 90 chains, and then rise with a gradient of 1 in 100 to the Yorkshire and Lincolnshire sides.

It is intended to carry out some improvement works in the Ouse by training the channel, but these, the author believes, would have no effect upon the amount of tidal water in the river, and would not lessen the scour below Hull. The proposed works in the Humber he fears would not be so harmless. The present deep channels in front of Hull are dependent, he holds, for their very existence upon the maintenance of the existing natural conditions in the Upper Humber, and particularly of the south channel past Chalders Ness. Now the conservancy lines would shut up the present channels and substitute a new one through the sand banks, to serve both for ebb and flood. This trained channel would terminate a good way above Hull, and below it the water would follow its own course, probably with the result of altering the existing conditions of affairs opposite Hull. Fortunately there is no immediate prospect of the works being commenced.

Goole and Grimsby are both increasing their trade, while Hull remains nearly stationary. But there is hope that better times will come soon. There are great works in progress by which the tidal facilities of the Humber will be fully utilised. Ships drawing under 18 ft. of water will be able to enter the new Alexandra Dock at low water, so that a majority of the vessels frequenting the port will be able to pass in without any delay.

* Abstract of a paper read before the Hull Literary and Philosophical Society.

MODERN AGRICULTURAL IMPLEMENTS.*

By D. Pidgeon.

(*Concluded from page* 488).

Class VI. *Food Preparing Machines.*—There is little to be said of this class of agricultural implements, the chaff-cutter, grist mill, oil-cake crusher, and turnip cutter, being all respectable old-fashioned machines, long settled down upon their lees. Some half-dozen patents, however, are annually taken out for safety appliances in chaff-cutters, and one of these, introduced by Crowley and Co., of Sheffield, in 1878, has merit. The machine is provided with a lever, which throws the feed rolls in and out of gear, and controls the speed gear for determining the length of chaff cut. In case of a man having both hands caught in the feed, his body would be drawn against the lever in question, whose movement instantly stops the rolls. A further push against the same lever reverses the feed and frees the man, who in ordinary cases would be quite helpless until assistance arrived.

Grist mills and oil-cake breakers present absolutely no new features to remark upon, while, with regard to root-slicers, it is now nearly fifty years since Gardner, of Banbury, patented the well-known turnip cutter which still bears his name, and remains the best machine of its class among a thousand rivals. This is the only agricultural implement which seems incapable of improvement. Unlike the thrashing machine, it is no "survival of the fittest," but sprang from the head of the Oxfordshire ironmonger, like Minerva from the head of Jove, complete and invincible.

In consequence of its bulk, the transport of forage is very costly, and hay pressers, although used by shippers, have never come into vogue on the farm, because they give opportunities for putting inferior stuff into the bale.

In the Pilter press, shown for the first time at the Paris Exhibition of 1878, the hay is forced into a cylindrical chamber by the action of two conical rollers, which divide the stuff into bands, and wind these around each other, without injury to the fibre, until the cylinder is filled with a compact mass of hay. This issues like a sausage from a sausage machine, and presses against a plate, whose resistance is adjusted according to the density required in the bale. When about 3 ft. of compressed hay protrudes, the machine is stopped, and the bale tied up with wires. Each bale weighs about 2 cwt., and its density varies from 12 lb. to 25 lb. per cubic foot, 18 lb. being recommended for conveyance by rail, and 25 lb. for shipment.

The Dederick press, an American invention, consists of three parts:

1. A vibrating beam with packer for doubling and forcing the hay into the mouth of the compressing chamber.

2. A reciprocating traverser, or hay piston, for forcing the doubled mouthful of hay into the compressing chamber, and

3. The compressing chamber itself, in which self-acting springs allow the ingress of hay, but prevent its expansion backwards.

The bales are rectangular in shape, are bound with wire, and can be made of any length.

This machine will compress 45 lb. of hay into one cubic foot, or a ton of hay into a ton of measurement. It has yet to be seen whether such a press can not be applied to the saving of green hay in the field. The compression would prevent fermentation, even if hay were packed in a much greener state than it is generally stacked, and hay might thus be secured in more valuable condition than when stacked and sweated in the usual way. One machine, capable of pressing 2½ tons per hour, could deal with the crop as rapidly as by ordinary stacking. The hands employed would be less numerous, and when the market is the destination of the hay, such a scheme seems very practicable.

Class VII. *Milling Machinery.*—Milling, although one of the most ancient mechanical processes, is just now undergoing changes of a radical character, extremely interesting in themselves, and even, possibly, involving the abandonment of the millstone itself in favour of a system

* Paper read before Section G of the British Association at Montreal.

of grinding by rollers. It would be impossible, with the time at disposal, to introduce even the merest outline of modern milling, and those, therefore, who are interested in the subject are referred to the paper already quoted, as read before the Society of Arts by the author in 1883.

Class VIII. *Dairy Appliances.*—Twenty years ago, scarcely any foreign butter was imported into England, but now, not a hundredth part of the butter eaten in London is of English origin. Great Britain, indeed, buys 12,000,000*l.* worth of butter every year from the foreigner, although the climate, the soil, the price of cows, wages, and the cost of transport, are all in favour of the native dairyman.

The English farmer makes up his butter once or twice a week, and sends it, say, to the London market, where the retail butterman must go, very early every morning, to make a selection from many hundreds of "tubs," each differing in quality from the other, and not very temptingly display in wrappings of cloth, or even old newspaper. Butter from Normandy or Denmark, on the other hand, comes forward in a very different condition. Agents attend the local markets, and buy all their produce from the farmers, whom they keep advised of the qualities in vogue. This butter goes to a factory, where it is first mixed by machinery, and then put up, nattily papered, in boxes holding a dozen 2 lb. rolls. The contents of every box distinguished by a given brand, are exactly alike, so that the retailer can order from day to day, with the certainty of getting just what he wants, without any expenditure of time or trouble.

The enterprising dairyman has now at command a great variety of machinery. The separation of milk from cream, hitherto effected slowly by gravitation, is brought about instantaneously by means of centrifugal separators, of whose many forms the Laval machine, exhibited for the first time in England at Kilburn, in 1879, is the best known type. Milk runs through a tap into a spheroidal vessel, about a foot in its larger diameter, which rotates at a speed of 6000 or 7000 revolutions per minute. The heavier milk is at once thrown outwards towards the circumference, while the lighter cream remains near the centre, and each is drawn off from its respective zone by suitable outlet pipes. Cream is thus separated at the rate of 60 gallons an hour, the action being continuous so long as milk is flowing into the separator.

Where the centrifuge has not yet been adopted, either Cooley's American or Swartz's Swedish setting vessels are rapidly replacing the old shallow pans, the theory that shallow setting promotes quick rising being now exploded. The Cooley cans are cylindrical in form, and closed with covers, containing air, the whole being submerged in water of 45 deg. to 55 deg. temperature. The Swartz cans are narrow and deep ovals immersed in, but not covered by, cold water and having no lids. By the American plan sweet cream can be obtained, whether in a clean dairy or in a dirty scullery, and both systems protect the milk from taking up either germs or flavours from the atmosphere.

It has long been known that, if milk is artificially cooled immediately after leaving the cow, it will keep sweet much longer than if allowed to cool naturally, especially in hot weather. This is obvious, because the floating germs [illegible] in the warm milk just the soil [illegible] for rapid development, while they do not flourish in a cold, even if suitable, soil. Tubular refrigerators are consequently much used in the best dairies, and where a constant supply of cold water is at hand, are most useful adjuncts either to the mechanical cream separator or to the immersed setting cans.

Of recent improvements in churns there is little to be said, but the case is different with regard to the "butter-worker," a device to which the French and Dutch owe much of their trade, because it enables them to amalgamate the butters of many farms and supply a constant quality to the factor. There are several excellent forms of butter workers, in the best of which there is no need for the attendant to touch the butter from first to last of the process of amalgamation.

Many appliances for scientific dairying are now within reach of British farmers, but before they will win back the trade which the foreigner has taken away, dairymen must either associate or establish their own butter factories, or middlemen must do so as they have done on the Continent. A trade of 12,000,000*l.* sterling per annum is not to be permanently lost without an effort, and it remains for dairy farmers, having realised what a mine of wealth they are abandoning to their foreign competitors, to take a hint from the old saw, *fas est et ab hoste doceri.*

Class IX. *Poultry Farm Appliances.*—The link between poultry farming and machinery is very slight, and it is, besides, unnecessary to describe such well-known devices as the incubator, the artificial mother, and the feeding machine, which, indeed, are only introduced here in order that a subject, interesting in itself, and of great agricultural importance, should not be dismissed without remark.

It appears, from trustworthy statistics, that there are 40,000,000 of fowls kept in France, and that country produces poultry for the table whose annual valve is 6,000,000*l.* sterling, and 4,000,000,000 of eggs, worth 10,000,000*l.* sterling at the lowest computation. One-fifth of all the eggs laid in France are sent to this country, which pays to foreigners for eggs and poultry the astounding sum of 8,000,000*l.* annually.

Here, then, are three imports, viz., butter, eggs, and fowls, whose combined value is not less than 20,000,000*l.* That sum equals the whole export trade of England in wool or iron, which, next to the cotton manufactures, are its chief branches of foreign trade. It is one-third of its largest import, corn; one-half its next largest, cotton; nearly equal to the whole import of sugar, and nearly double the whole import of tea—and the British farmer has thrown it away!

France owes her supremacy in poultry farming partly to the fact that she is a country of small proprietors, but chiefly to the more economical and minutely industrial character of her farmers. They understand that successful poultry farming is an art requiring care and skill, and they treat it accordingly. Fowls, on the other hand, are only an ornamental feature of an English farm, where they pick up a living at the barn-door in the best way they can. If stock were now bred, fed, and tended as it was in the days of the flail, we should hear that stock farming, like poultry farming, "does not pay." But in regard to the production of meat and wool, old plans having given way to new, and it is [illegible] these are vastly superior to the practice of a past generation that stock farming is now like every [illegible] of a farmer's business, [illegible] and [illegible] France can teach us about poultry, it will become [illegible] the British farmer's while to seek for a share in that business of 6,000,000*l.* which he now quietly abandons to the foreigner.

In the case of the poultry-yard and dairy, as in every other matter connected with his calling, the English farmer has the great advantage of access through the R.A.S.E. to the best and latest intelligence upon every subject, whether closely or remotely connected with agriculture. The motto of the Society, adopted at a time when there was much more practice than science both on the farm and in the workshop, has already become that of the agricultural engineer, and a new prosperity awaits British agriculture whenever it can be fully characterised as "Practice with Science."

NOTES FROM THE SOUTH-WEST.

Portishead District Water Company.—At the half-yearly meeting of the Portishead District Water Company on Saturday it was reported that with only a moderate increase in the present rental the income account of the company would be placed upon a satisfactory basis.

Newport.—There is not much to add with respect to the steam coal; a quiet tone continues to prevail, and there is little pressure in any quarter. The arrivals of iron ore have been numerous during the week, and in consequence discharging has been going on with activity. This trade does not show any signs of improvement. In the manufactured and kindred trades, although great depression continues, a more cheerful feeling seems also to prevail. The clearances of iron last week comprised 800 tons to Paysandu. Last week's coal clearances were 36,801 tons. From Bilbao there arrived 16,031 tons of iron ore, and 5555 tons came to hand from other sources.

Coal at Pontypridd.—The discovery of the 3 ft. 6 in. seam at the Marine Rhondda Colliery by boring has been followed up by the removal of the rock above it, and the first truck load of coal was on Thursday sent by railway to the Cyfarthfa works. Specimen lumps were also sent to some local men, and all declare the coal to be of excellent quality.

Maesteg.—The Great Western Railway Company has just completed a contract with Mr. Lorton for constructing a double line of railway from Maesteg to Tywith, which is to be completed by the end of June. Three or four sidings have also to be constructed near the Maesteg Railway Station. It is stated that a handsome new [illegible] will be built at once, and a new platform erected on the eastern side of the station, where passengers for the down trains will have to wait. These improvements are carried out because of the great increase in the traffic from Glyncorrwg, Cymmer, and Blaengwynfi; and probably to make it unnecessary to divert any of the traffic to the Swansea and Rhondda Railway when the latter is opened.

Cardiff.—An easy tone continues to prevail in the steam coal market, and most shippers are keeping their collieries going upon old contracts. The patent fuel market maintains a satisfactory aspect. Prices continue to be quoted at about their previous level. Iron ore continues dull. Last week's coal clearances comprised 113,668 tons of coal, 1685 tons of iron, 2330 tons of patent fuel, and 1258 tons of coke. From Bilbao there arrived 1876 tons of iron ore, and 1590 tons came to hand from other sources.

Water Supply of Cardiff.—Mr. T. A. Walker, the contractor for the new reservoir at Llanishen, has a considerable body of workmen upon the ground. A siding is being constructed to connect the works with the Rhymney Railway in order to facilitate the conveyance of the requisite *matériel*. The contractor's engine, in all probability, will convey the whole of the traffic from the Rhymney line to the works.

Caerphilly.—During the past few weeks the collieries in this district have been worked with more regularity than for some time past, the tonnage of house and gas coal despatched to Newport and Cardiff being large. The Cwmglo Colliery Company is pushing operations forward in a successful manner. The Cwmglo, Everglyn, and Rhos Lantwitt Collieries are raising a large tonnage of coal daily. The Lantwitt and Black Vein Colliery, which is the largest undertaking in the district, is also employing a large number of hands.

Swansea.—The steam coal trade has maintained a fairly healthy tone. Collieries are not working to the full extent of their productive powers; still shippers are fairly well off for orders, and are able to maintain prices. There are considerable stocks of patent fuel on hand. The proposed increase of the Navy has imparted a little more strength to the iron trade.

FOREIGN AND COLONIAL NOTES.

Newport News.—Newport News, situated about equidistant from Fortress Munroe and Norfolk, is coming into notice as a shipping port, particularly for grain. A steam elevator of a capacity equal to 1,600,000 bushels, and shipping 20,000 bushels per hour, has been recently completed. By means of the Chesapeake and Ohio Railroad Newport News is directly connected with large iron furnaces in Virginia and the coal mines of West Virginia.

Breaking up a Monitor.—The once famous monitor Roanoke, built at a heavy expense by the United States Government, is being demolished at Marens Hook, on the Delaware, below Philadelphia. The vessel was sold in November, 1883, at a sale of abandoned war vessels, and was purchased by Mr. E. Bernard, of Westbrook, Connecticut, for [illegible].

American Telegraphy.—A long-termed agreement has been signed between the Western Union Telegraph Company, [illegible] and [illegible], and the Anglo-American Company, whereby the Western Union will have the exclusive control of the wires on the Chicago, Burlington, and Quincy line.

Russian Railways.—It is stated that the Russian Government has determined upon constructing the remaining 137 miles of the Transcaspian Railway, and that the rails have been ordered to be shipped at once from a southern manufactory down the Volga and across the Caspian.

Cuban Iron Minerals.—Two of the largest Pennsylvanian iron companies are now importing iron ore from Cuba. A railway has been constructed from Santiago for a distance of about 17½ miles into the province of Jaragua for the purpose of facilitating shipments.

Hergott Springs.—A trial has been made of the fitness of the water obtained from an artesian bore at Hergott Springs, South Australia, for locomotive purposes. The test was carried out with a train consisting of eleven goods trucks, three road vans, one water tank, two carriages, and a truck van. The journey from Hergott to Farina, a distance of about 30 miles, was made in good time with the gauge-glass full of water, and a pressure of 115 lb. to 120 lb., without any signs of priming. The train was then taken on to Beltana, the weight being increased at Farina. On going up a steep incline a short distance from Beltana, priming occurred, and the water in the boiler was mixed with a little fresh, with the result that no further priming was noticed.

The Murray.—Works at Hart's Island for deepening the channel of the Murray appear to have been successful. Captains report that they have already made a difference of 2 ft. in what used to be one of the worst places in the river.

Norfolk and Western Railroad.—The Norfolk and Western Railroad Company owns about 1000 acres of land at Lambert's Point, just four miles below Norfolk, Virginia, and it is now building there one of the finest coal-shipping piers in the United States, sufficiently long for seven or eight vessels to load at once. The coal comes from the Pocahontas mines.

Carrara Marble.—The total production of the marble quarries of Carrara last year was 173,593 tons, of which 115,644 tons were rough blocks, and 57,949 tons sawn or worked. The exportation in 1883 amounted to 147,188 tons, showing a decrease on that of the previous year of 10,782 tons, and an increase of 24,383 tons on the quantity exported in 1881.

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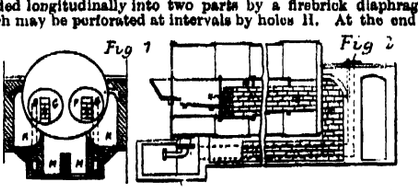
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STEAM BOILERS.

930. D. H. Lowry, Widnes, Lanc. Steam Boilers. [6*d.* 6 *Figs.*] January 8, 1884.—A gas producer is employed in lieu of the ordinary furnace, and between the gas producer and the flues is placed a bridge D, and from the bridge the flue is divided longitudinally into two parts by a firebrick diaphragm, which may be perforated at intervals by holes H. At the end of



the flue is a perforated slide I for admitting air in regulated quantities to the flue. The gases from the flues F return by the flues M, from which they pass to the flues K and to the chimney. The boilers are first fired with complete combustion of fuel in the furnace, and when the flues are well heated the supply of air to the fuel is lessened, the gas produced being burnt at the end of the flues F, at which point air is then admitted. (*Accepted October* 17, 1884).

1429. E. H. Lake, London. (*E. F. Gordon and H. Hobbs, Concord, N.H., U.S.A.*) **Steam Generators.** [6*d.* 4 *Figs.*] January 14, 1884.—Two circular series of upright water tubes connect an annular water space with a steam and water drum, and surround a central fireplace. The inner tubes are arranged closely

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Daglish R. & Co .. .. .. St. Helen's, Lancashire
Grange Iron Co., Limited .. Durham
Piggott, Thos., & Co. .. .. Birmingham

Clutches (Friction).
Bagshaw J., & Sons .. .. Batley
Mather & Platt .. .. .. Salford Ironworks, Manchester

Coal Cutting Machines.
Grange Iron Co., Limited .. Durham

Coal Merchants.
Clay Cross Co .. .. .. Clay Cross, near Chesterfield

Coke Ovens.
Simon, H .. .. 20, Mount Street, Manchester

Colliery Plant.
Clay Cross Co. .. .. .. Clay Cross, near Chesterfield
Daglish, R., & Co. .. .. St. Helen's, Lancashire
Davy Brothers, Limited .. Sheffield
Goodwin, James, & Co .. .. Motherwell, N.B.
Grange Iron Co., Limited .. Durham
Hathorn, Davey & Co. .. .. Leeds
Lowca Engineering Co., Ltd., The Whitehaven
McCulloch, T., & Sons .. .. Kilmarnock
Walker Brothers .. .. .. Pagefield Ironworks, Wigan
Woods, Hamilton & Co. .. .. Salford, Manchester

Compasses.

Negretti & Zambra .. .. Holborn Viaduct, E.C.

Condensers (Fresh Water).

Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Normandy, A. .. .. .. Custom House Station, Victoria Docks, E.
Suffield & Brown .. .. .. James St. and Devonport St., E.

Condensers (for Steam Engines).

McCulloch, T., & Sons .. .. Kilmarnock
Morton, Alexr., & Thomson .. 96, Buchanan Street, Glasgow
Suffield & Brown .. .. .. James St. and Devonport St., E.
Worthington Pumping Engine Co 114, Queen Victoria Street, E.C.

Coppersmiths.

Birmingham Battery & Metal Co Birmingham
Storey, I., & Sons .. .. .. Knott Mill, Manchester

Cotton Presses.

Piggott, Thos., & Co. .. .. Birmingham
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Couplings (Railway).

Roger, Robert, & Co. .. .. Stockton-on-Tees
Turton, Geo. .. .. .. 4, Westminster Chambers, S.W.

Cranes, Travellers, Winches, &c.

Anderson & Gallwey .. .. Cremorne Works, Lot's Road, Chelsea, S.W.
Appleby Brothers .. .. .. East Greenwich, S.E.
Ashbury Railway Carriage & Iron Co., Limited .. .. .. Openshaw, Manchester
Balmforth, Wm., Executors of (Late), Steam) .. .. .. Rodley, near Leeds
Butters Brothers .. .. .. 63, Hope Street, Glasgow
Carrick & Ritchie .. .. .. Edinburgh
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Cochrane, Jno. .. .. .. Berthead
Coles, H. J. .. .. .. 89, Summer Street, S.E.
Cowans, Sheldon & Co., Limited St. Nicholas Works, Carlisle
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
East Ferry Road Engineering Works Co., Limited .. .. Millwall, E.
Fielding & Platt .. .. .. Gloucester
Gibbins, R. C., & Co. .. .. Berkley Street, Birmingham
Grange Iron Co., Limited .. Durham
Hanna, Donald & Wilson .. Paisley, N.B.
Hepworth, Wm. .. .. .. Quebec Works, Bradford
Jansen, C., Son & Co. .. .. Darlington
Ince Foundry & Engineering Co. Newport, Monmouthshire
Jessop, J., & Son .. .. .. Leicester
Melville, W. M. .. .. .. Kirkcaldy
Ormerod, Grierson & Co. .. Hulme, Manchester
Paul, M., & Co. .. .. .. Levenford Works, Dumbarton
Pickering, John, ... Stockton-on-Tees
Priestman Brothers .. .. Hull
Ransomes & Rapier .. .. 5, Westminster Chambers, S.W.
Roger, R., & Co. .. .. Iron Foundry, Stockton-on-Tees
Rose, Downs & Thompson .. Hull
Russell, Geo., & Co. .. .. Motherwell, near Glasgow
Savile Street Foundry and Engineering Co., Limited. .. Sheffield
Selig, Sonnenthal & Co. .. 85, Queen Victoria Street, E.C.
Shanks, Alexander, & Son .. Dens Ironworks, Arbroath
Shipiaw, A., & Co. .. .. Berkley Street, Birmingham
Smith, Thos. .. .. .. Rodley, near Leeds
Stothert & Pitt, Limited .. Bath
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Tweddell, R. H. .. .. .. 74, Delahay Street, S.W.
Walker, T., & Co. .. .. .. Leeds
Wilson, John H., & Co. .. .. Sandhills, Liverpool

Crankshafts.

Beardmore, I. & W. .. .. Glasgow
Bessemer, Henry, & Co., Limited Sheffield
Clarke's Crank Co., Limited .. Lincoln
Mersey Forge, Limited, The .. Liverpool

Crucibles.

[illegible] & Co. .. .. .. Lambeth, S.E.

Cupolas.

Thwaites Brothers .. .. Vulcan Ironworks, Bradford

Disinerustants.

Bell, J. .. .. Asbestos Works, Southwark, S.E.
Patent Steam Boiler Company .. 28, Heneage St., Birmingham
The Disincrustant Marseillais Co. Cheetham, Manchester

Disinfectors.

Manlove, Alliott, Fryer & Co. .. Nottingham

Disintegrators.

Askham Bros. & Wilson, Ltd. .. Sheffield
Evans, J., & Co. .. .. .. Trumpet St., Gathorne, Manchester
Farmer, Jas., & Sons .. .. Salford, Manchester
Hartley & Arnoux Brothers .. Stoke-on-Trent
Jordan, T. B., Son & Commans. 52, Gracechurch Street, E.C.
Marsden, Francis .. .. .. Sheffield
Triggs, P. (Carr's) .. .. .. 39, Broad Street, Bristol

Distillery Plant.—*(See Brewery and Distillery Plant).*

Distilling (Water) Apparatus.

Chaplin, Alex., & Co. .. .. Glasgow
Normandy, A. .. .. .. Custom House Station, Victoria Docks, E.
Ross & Duncan .. .. .. Glasgow

Diving Apparatus.

Barnett & Foster .. .. .. 252, Eagle Wharf Road, N.

Drawings, Tracings, &c.

Kell, J., & Son .. .. .. 40, King Street, Covent Garden
Masser & Thorpe .. .. .. 8, Quality Court, E.C.
Thorp, John H. .. .. .. Copthall House, Telegraph St., Moorgate Street, E.C.

Dredging Machines.

Bruce & Bathe .. .. .. 9, Victoria Chambers, S.W.
Coles, H. J. .. .. .. 89, Summer Street, S.E.
Edwards & Symes .. .. .. Wharf Road, Cubitt Town, E.
Fleming & Ferguson .. .. Paisley, N.B.
Hanna, Donald & Wilson .. Paisley, N.B.
Hunter & English .. .. .. Bow, London, E.
McIntyre, H., & Co. .. .. Paisley, near Glasgow
Priestman Brothers .. .. Hull
Rose, Downs & Thompson .. Old Foundry, Hull
Stothert & Pitt, Limited .. .. Bath

Ebonite.

Winter, F. .. .. 138, London Wall, E.C.

Economisers (Fuel).

Gosling, Robert, & Co. .. .. Hatton Court, Ipswich
Green, E., & Son .. .. .. St. Ann's Square, Manchester
Lowcock, A. .. .. Coleham Foundry, Shrewsbury
Pollock, Macnab, & Highgate .. Shettleston, Glasgow

Electric Lighting Plant.

Crompton, R. E., & Co. .. .. Arc Works, Chelmsford
Glover, W. T., & Co. .. .. 25, Booth Street, Manchester
Lane, Howard, & Co. .. .. 115 & 116, Palmerston Buildings, London, E.C.
Woodhouse & Rawson .. .. 11, Queen Victoria Street, E.C.

Electrical Engineers.

Crompton, R. E., & Co. .. .. Mansion House Buildings, E.C.
Edmunds & Goolden .. .. 2, Victoria Mansions, S.W.
Johnson & Phillips .. .. 14, Union Ct., Old Broad St., E.C.
Woodhouse & Rawson .. .. 11, Queen Victoria Street, E.C.

Elevators, Grain, Coal, &c.

Priestman Brothers .. .. Hull
Rose, Downs & Thompson .. Old Foundry, Hull

Emery and Emery Cloth.

Acton & Borman .. .. .. 72, Shoe Lane, E.C.
Goldsworthy, T., & Sons .. .. Hulme, Manchester
Oakey, John, & Sons .. .. Wellington Mills, London, S.E.

Emery Wheels.

Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Slack's Emery Wheel & Machine Co., Limited .. .. .. Ardwick, Manchester
Sterne, L., & Co., Limited .. Glasgow & London

Engine and Boiler Fittings.

Cran, Jno. & Co. .. .. .. Albert Engine Works, Leith
Dewrance, John, & Co. .. .. 136, Great Dover Street, S.E.
Foster, Edward, & Son .. .. Halifax
Galloway, W. & J., & Sons .. Manchester
McCulloch, T., & Sons .. .. Kilmarnock
M'Neil, G., Jr. .. .. .. Kinning Park Ironworks, Glasgow
Picking, Hopkins & Co. .. .. Bow, London, E.
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Weir, G. & J. .. .. .. 49, Jamaica Street, Glasgow
Winn, Charles, & Co. .. .. Granville Street, Birmingham

Engines (Air).

Tyler, H., & Co. .. .. .. 84, Whitecross Street, E.C.

Engines (Blowing).

Adamson, D., & Co. .. .. Dukinfield, Manchester
Carrick & Wardale .. .. Gateshead
Daglish, R., & Co. .. .. St. Helen's, Lancashire
Davy Brothers, Limited .. .. Sheffield
Galloway, W. & J., & Sons .. Manchester
Goodfellow & Matthews .. .. Hyde, near Manchester
McCulloch, T., & Sons .. .. Kilmarnock
Nail, W., & Son .. .. .. St. Helen's Junction, Lancashire
Ormerod, Grierson & Co. .. .. Hulme, Manchester
Savile Street Foundry and Engineering Co., Limited .. Sheffield
Tylwalker Brothers .. .. Vulcan Ironworks, Bradford
Walker Brothers .. .. .. Wigan

Engines (Gas).

Andrew, J. K. H., & Co. .. .. Stockport
Barker, T. B., & Co. .. .. Schofield St., Birmingham
British Gas Engine & Engineering Co. .. .. .. 11, Queen Victoria Street, E.C.
Crossley Bros., Limited .. .. Manchester
Muller, H. L. .. .. .. Birmingham
Okes, J. C. R. .. .. .. 55, Queen Victoria Street, E.C.
Sterne, L., & Co., Limited .. Crown Ironworks, Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Engines (Locomotive).

Appleby Brothers .. .. .. East Greenwich, S.E.
Bagnall, W. G. .. .. .. Stafford
Baldwin Locomotive Works .. Philadelphia, U.S.A.
Balmforth, Wm. (Executors of) Rodley, near Leeds
Black, Hawthorn & Co. .. .. Gateshead-on-Tyne
Chaplin, A., & Co. .. .. Glasgow
Dübs, Kerr & Co. .. .. .. 101, Leadenhall Street, E.C.
Falcon Engine & Car Works, Ltd. Loughborough
Fowler, J., & Co. .. .. .. Leeds
Grange Iron Co., Limited .. Durham
Hawthorn, R. W. .. .. .. Newcastle-on-Tyne
Hudswell, Clarke & Co. .. .. Leeds
Hunslet Engine Co. .. .. .. Leeds
Jessop, J., & Son .. .. .. Leicester
Kerr, Stuart & Co. .. .. .. 20, Buckleraury, E.C.
Lewen Engineering Co., Ltd., The Whitehaven
Manning, Wardle & Co. .. .. Boyne Engine Works, Leeds
McCulloch, T., & Sons .. .. Kilmarnock
Peckett, Thomas .. .. .. Atlas Engine Works, Bristol
Rogers Loco. & Machine Works .. Paterson, N.J., U.S.A.
Walker Brothers .. .. .. Pagefield Ironworks, Wigan

Engines (Marine).

Appleby Brothers .. .. .. East Greenwich, S.E.
Burrell, C., & Sons, Limited .. Thetford
Cochran & Co. .. .. .. Birkenhead
Cran, John, & Co. .. .. .. Albert Engine Works, Leith
Hanna, Donald & Wilson .. Paisley, N.B.
Hawthorn, R. & W. .. .. Newcastle-on-Tyne
Hayes, Ed. .. .. Stony Stratford
Hunter & English .. .. .. Bow, L.
Paul, M., & Co. .. .. .. Lavenford Works, Dumbarton
Plenty & Son .. .. Kagle Ironworks, Newbury, [illegible]
Rankin & Blackmore .. .. Greenock
Roger, R., & Co. .. .. .. Stockton-on-Tees
Rose, Downs & Thompson .. Hull
Rose & Duncan .. .. .. Whitefield Works, Glasgow
Thornycroft, J. I., & Co. .. Chiswick, W.
Vosper & Co. .. .. .. Broad Street, Portsmouth
Wilson, Alex. & Co. .. .. Vauxhall Ironworks, Wandsworth Road, S.W.
Wilson, H. M. .. .. .. Blyth, Northumberland
Yarrow & Co. .. .. .. Isle of Dogs, London, E.

Engines (Portable).

Appleby Brothers .. .. .. East Greenwich, S.E.
Barrows & Stewart .. .. Banbury
Belleville, J. & Co .. .. & St. Denis, Seine
Clayton & Shuttleworth .. Lincoln
Davey, Paxman & Co. .. .. Colchester
Farmer, Robey, Brown & Co. Gainsborough
Foster, W., & Co., Limited .. Lincoln
Garrett, R., & Sons .. .. Leiston Works, Suffolk
Hindley, E. S. .. .. .. Bourton, Dorset
Hornsby, R., & Sons, Limited .. Grantham
Marshall, Sons & Co., Limited .. Gainsborough
Mather, G. R. .. .. .. Wellingborough
Ransomes, Sims & Jefferies, Ltd Ipswich
Reading Ironworks Co., Ltd. .. Reading
Robey & Co. .. .. Lincoln
Ruston, Proctor & Co. .. .. Sheaf Ironworks, Lincoln
Smedley Brothers .. .. .. Belper
Turner, E. R. & F. .. .. .. Ipswich

Engines (Rotary).

Heenan & Froude .. .. .. Manchester

Engines (Stationary).

Adamson, D., & Co. .. .. Dukinfield, Manchester
Appleby Brothers .. .. .. East Greenwich, S.E.
Arlot, McNeil & Co. .. .. Helen Street, Govan, Glasgow
Allen & Macfellan .. .. .. Sentinel Works, Glasgow
Barr, James .. .. Kilmarnock
Barrows & Stewart .. .. Banbury
Beckwith, E., & Co. .. .. Sunderland
Brotherhood, P. .. .. .. Belvedere Road, Westminster Bridge, S.E.
Buckley and Taylor .. .. Castle Ironworks, Oldham
Bumsted, F. D. .. .. .. Hednesford, Staffs.
Carrick & Wardale .. .. Gateshead
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Clayton & Shuttleworth .. .. Lincoln
Coalbrookdale Co., Limited .. Coalbrookdale, Shropshire
Cochrane, J. .. .. Barrhead
Coles, H. J. .. .. Summer Street, S.E.
Coley, Henry .. .. Mansion House Chambers, 11, Queen Victoria Street, E.C.
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Craig, A. F., & Co. .. .. Paisley, N.B.
Daglish, R., & Co. .. .. St. Helen's, Lancashire
Davey, Paxman & Co. .. .. Colchester
Davy Brothers, Limited .. Sheffield
Donkin, B., & Co. .. .. .. Bermondsey, S.E.
Douglas & Grant .. .. .. Dunmiller Foundry, Kirkcaldy, N.B.
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Farmer, Jas., & Sons .. .. Salford, Manchester
Farmer, Robey, Brown & Co. .. Trent Foundry, Gainsborough
Foster, W., & Co., Limited .. Lincoln
Fowler, J., & Co. .. .. .. Leeds
Galloway, W. & J., & Sons .. Manchester
Garrett, R., & Sons .. .. Leiston Works, Suffolk
Goodfellow & Matthews .. .. Hyde, near Manchester
Grange Iron Co., Limited .. Durham

Engines (Stationary).—*Continued.*

Manson, Wm. .. .. .. Quebec Works, Bradford
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Hathorn, Davey & Co. .. .. Leeds
Heenan & Froude .. .. .. Manchester
Herbert & Law .. .. .. Edinburgh
Hick, Hargreaves & Co. .. .. Soho Ironworks, Bolton
Hindley, E. S. .. .. .. Bourton, Dorset
Holborow & Co. .. .. .. Dudbridge Ironworks, Stroud
Hornsby, R., & Sons, Limited .. Grantham
Hunter & English .. .. .. Bow, E.
Ince Foundry & Engineering Co. Newport, Monmouthshire
Jessop, J., & Son .. .. .. Leicester
Lowen Engineering Co., Ltd., The Whitehaven
Machinery & Hardware Co., Ltd. 147, Queen Victoria Street, E.C.
Manlove, Alliott, Fryer & Co. .. Nottingham
Marshall, Sons & Co., Limited .. Gainsborough
McCulloch, T., & Sons .. .. Kilmarnock
Moreland, Richard, & Son .. 3, Old Street, E.C.
Musgrave, J., & Sons .. .. Bolton
Nail, Wm., & Son .. .. .. St. Helen's Junction, Lancashire
New, D., & Co. .. .. .. 15, Devonshire Chambers, E.C.
Norman, J. & Co. .. .. .. Kopposhill Engine Works, Glasgow
Ormerod, Grierson & Co. .. .. Hulme, Manchester
Paul, M., & Co. .. .. .. Dumbarton
Peskett, Thomas .. .. .. Atlas Engine Works, Bristol
Piggott, T., & Co. .. .. .. Springhill, Birmingham
Ransomes, Sims & Jefferies, Ltd. Ipswich
Robey & Co. .. .. Lincoln
Roger, R., & Co. .. .. .. Stockton-on-Tees
Rose, Downs & Thompson .. Hull
Russell, Geo., & Co. .. .. Motherwell, near Glasgow
Ruston, Proctor & Co. .. .. Sheaf Ironworks, Lincoln
Savile Street Foundry and Engineering Co., Limited .. Sheffield
Shanks, Alexander, & Son .. Dens Ironworks, Arbroath
Smedley Brothers .. .. .. Belper
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Taylor & Challen .. .. .. Birmingham
Turner, E. R. & F. .. .. .. Ipswich
Tyler, H., & Co. .. .. .. 84 & 85, Upper Whitecross Street, E.C.
Walker Brothers .. .. .. Pagefield Ironworks, Wigan
Walker, T., & Co. .. .. .. Leeds
Whitmore & Binyon .. .. .. 28, Mark Lane, E.C.
Wilkes & Robinson .. .. .. Thames Ditton, Surrey
Wilson, Alex., & Co. .. .. Vauxhall Ironworks, Wandsworth Road, S.W.
Woods, Hamilton & Co. .. .. Salford, Manchester

Engines (Traction).

Aveling & Porter .. .. .. Rochester
Burrell, C., & Sons, Limited .. Thetford
Clayton & Shuttleworth .. .. Lincoln
Foster, Wm., & Co., Limited .. Lincoln
Fowler, John, & Co. .. .. Leeds
Marshall, Sons & Co. .. .. Gainsborough
Reading Ironworks Co., Ltd. .. Reading

Engravers, Mechanical, &c.

Hare & Co. .. .. 31, Essex Street, Strand
Rimbault, J. H. .. .. .. 30, Malden Lane, W.C.

Excavators.

Bruce & Bathe .. .. .. 9, Victoria Chambers, Westminster, S.W.
Chaplin, Alex., & Co. .. Glasgow
Fleming & Ferguson .. .. Paisley, N.B.
Priestman Brothers .. .. 51, Queen Victoria Street, E.C.
Rose, Downs & Thompson .. Hull
Ruston, Proctor & Co. .. .. Sheaf Ironworks, Lincoln
Schram, Richard, & Co. .. .. 9, Northumberland Street, W.C.

Fans and Blowers.

Allday, Wm., Sons, & Co. .. Birmingham
Cajell, R. A. .. ..
Donald, J., & Sons .. .. .. 42, Cadogan Street, Glasgow
Donkin, B., & Co. .. .. .. Bermondsey, S.E.
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Grange Iron Co., Limited .. Durham
McCulloch, T., & Sons .. .. Kilmarnock
Savile Street Foundry and Engineering Co., Limited .. .. Sheffield
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Schiele, C., & Co. .. .. .. 2, Clarence Buildings, Manchester
Thwaites Brothers .. .. .. Vulcan Ironworks, Bradford
Union Engineering Co. .. .. Booth Street, Manchester
Walker Brothers .. .. .. Wigan

Feed-Water Heaters.

British Gas Engine & Engineering Co. .. .. 11, Queen Victoria Street, E.C.
Savile Street Foundry and Engineering Co., Limited .. .. Sheffield
Sterne, L., & Co., Limited .. Crown Ironworks, Glasgow
Tangye Limited .. .. .. Cornwall Works, Birmingham
Taylor & Challen .. .. .. Derwent Foundry, Birmingham
Wright, Jos., & Co. .. .. Tipton, Staffordshire
Woods, Hamilton & Co. .. .. Salford, Manchester

Fencing.

Dennis, W. F., & Co. .. .. 101, Leadenhall Street, E.C.

Files and File Sharpening Apparatus.

Bedford, J., & Sons .. .. Lion Works, Sheffield
Jowitt, T., & Sons .. .. .. Sheffield
Tilghman Patent Sand Blast Co., Sheffield

Filtering Apparatus.

Halliday, J., & Co. .. .. Water Street, Newtown, Manchester
Pulsometer Engineering Co. .. Nine Elms, S.W.

Fire Clay Goods.

Farnley Iron Co. .. .. .. Farnley, near Leeds
Glenboig Union Fire Clay Co., The Glasgow
Kershaw & Pole .. .. .. 2, Fan Court, Fenchurch St., E.C.
Lowood, J. Grayson, & Co. .. 80, Attercliffe Road, Sheffield

Fire Engines.

Morris, John .. .. .. Salford, Manchester
Rose, W., & Co. .. .. .. Deansgate, Manchester
Worthington Pumping Engine Co. 114, Queen Victoria Street, E.C.

Floor Cloth Machinery.

Farmer, Jas., & Sons .. .. Salford, Manchester
Landale, James .. .. .. Kirkcaldy, N.B.
Summers, T. & W. .. .. .. Gloucester

Forges (Portable).

Thwaites Brothers .. .. Vulcan Ironworks, Bradford

Forgings (Iron and Steel).

Askham Bros. & Wilson, Ltd. .. Sheffield
Beardmore, I. & W. .. .. Glasgow
Bessemer, Henry, & Co., Limited Sheffield
Brown, Bailey, Dixon & Co. .. Sheffield
Clarke's Crank Co. .. .. .. Lincoln
Glasgow Hydraulic Forge Co. .. Sentinel Works, Polmadie, Glasgow
Goodfellow & Matthews .. .. Hyde, near Manchester
Hill & Smith .. .. Brierley Hill Ironworks, near Dudley
Ibbotson Brothers & Co., Ltd. .. Sheffield
Jackson, F. R., & Co. .. .. Salford Rolling Mills, Manchester
Jessop, Wm., & Sons .. .. Sheffield [ter
Kirkstall Forge Co. .. .. .. Near Leeds
Landore Siemens Steel Co. .. Landore, South Wales
Leeds Forge Co., Limited .. Leeds
Mersey Forge, Limited, The .. Liverpool
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury
Osborne, S., & Co. .. .. .. Sheffield
Savile Street Foundry and Engineering Co., Limited .. .. Sheffield
Spencer, J., & Son .. .. .. Newcastle-on-Tyne
Staffordshire Wheel & Axle Co., Limited .. .. Springhill, Birmingham
Stanners Close's Steel Co. .. Wolsingham, via Darlington
Steel Co. of Scotland, The .. Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Furnace Fittings.

Galloway, W. & J., & Sons .. Manchester
Martin, W. A. & Co. .. .. Pomeik Street, S.E.

Galvanised Iron.

Hill & Smith .. .. .. Tipton, Staffordshire
Lysaght, John, Limited .. .. Bristol
Morewood & Co. .. .. .. Soho, Birmingham

Gas Exhausters.

Donkin, B., & Co. .. .. .. Bermondsey, S.E.
Klerting Brothers .. .. .. 17, Lancaster Avenue, Manchester
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Savile Street Foundry and Engineering Co., Limited .. Sheffield

Gas Works (Plant for).

Dowson Economic Gas Co., Ltd., 3, Great Queen Street, Westminster, S.W.
Grange Iron Co., Limited .. Durham
Hanna, Donald & Wilson .. Paisley, N.B.
Morton, J. & W. .. .. .. Stna Works, Smethwick, Birmingham
Jansen, C., Son, & Co. .. .. Darlington
Miller, M. L. .. .. Birmingham
Piggott, Thos., & Co. .. .. Springhill, Birmingham

Gauge Glasses.

Martin, Guilbert .. .. .. 1 & 2, Falcon Street, E.C.
Moncrieff, John .. .. .. Nth. Brit. Glass Works, Perth
Tomey & Sons .. .. Tay Glass Works, Perth, N.B.
Tomey, Jos., & Sons .. .. Manor Glass Works, Aston, Birmingham

Gauges (Pressure).

Dewrance & Co. .. .. .. 136, Great Dover Street, S.E.
Negretti & Zambra .. .. .. Holborn Viaduct, E.C.
Salter, Geo., & Co. .. .. West Bromwich
Schaffer & Budenberg .. .. 1, Southgate, Manchester

Gearing.—*(See Wheels, Geared.)*

Girders.

Ashbury Railway Carriage & Iron Co., Limited .. .. .. Openshaw, Manchester
Davies Bros. & Co. .. .. .. Crown Ironworks, Wolverhampton
De Bergue & Co., Limited .. Manchester
Goodwin, James, & Co. .. .. Motherwell, N.B.
Jansen, C., Son & Co. .. .. Darlington
Ince Foundry & Engineering Co. Newport, Monmouthshire
Lowen Engineering Co., Ltd., The Whitehaven
Lysaght, John, Limited .. .. Bristol
McCulloch, T., & Sons .. .. Kilmarnock
Measures, Bros. & Co. .. .. Southwark St., S.E.
Moreland, Richard, & Son .. 3, Old Street, E.C.

Glass Machinery (Plate)

Daglish, R., & Co. .. .. .. St. Helen's, Lancashire
Musgrave, J., & Sons .. .. Bolton

Glazing.

Braby & Son .. .. 356, Euston Road, London
Grover & Co., Limited .. .. Britannia Works, Wharf Rd., N.

Governors (Engine).

Blair, George .. .. 32, Queen Street, Glasgow
Dunean Bros. (Taite's Electric) .. 32, Queen Victoria Street, E.C.
McCulloch, T., & Sons .. .. Kilmarnock
Murdoch, Wm., & Co. .. .. 30, Hope Street, Glasgow
Schaffer & Budenberg .. .. Manchester
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Whitley Partners .. .. .. Hunslet Road, Leeds

Grindstones.

Akeroyd, James, & Sons .. .. Harehills, near Leeds
Robson, Robert .. .. .. 21, Grainger Street, West, Newcastle-on-Tyne

Gunpowder Machinery.

Hall, J. & E. .. .. .. Dartford, Kent
Hastie, J., & Co. .. .. .. Kilbiain Engine Works, Greenock.
Savile Street Foundry and Engineering Co., Limited .. .. Sheffield
Taylor & Challen .. .. .. Birmingham

Hammers (Hydraulic).

Anderson & Gallwey .. .. Cremorne Works, Lot's Road, Chelsea, S.W.
Fielding & Platt .. .. .. Gloucester
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W.

Hammers (Power).

Player, W. & J. .. .. .. Lionel Street, Birmingham
Thwaites Brothers .. .. .. Vulcan Ironworks, Bradford

Hammers (Steam).—*(See Steam Hammers.)*

Heating Apparatus.

Körting Brothers .. .. .. 17, Lancaster Avenue, Manchester
Thames Bank Iron Co., The .. Upper Ground Street, S.E.

Hematite Pig Iron.

West Cumberland Iron & Steel Co. .. .. Workington, Cumberland

Hoisting Machinery.

Appleby Brothers .. .. .. East Greenwich, S.E.
Balmforth Wm. (Executors of) .. Rodley, near Leeds
Carrick & Ritchie .. .. .. Edinburgh
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Coles, H. J. .. .. Summer Street, S.E.
Cowans, Sheldon & Co., Limited St. Nicholas Works, Carlisle
Craig, A. F., & Co. .. .. .. Paisley, N.B.
Crowley, John, & Co. .. .. Sheffield
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Gibbins, R. C., & Co. .. .. Berkley Street, Birmingham
Glover, Walter T., & Co. .. 25, Booth Street, Manchester
Hunter & English .. .. .. Bow, E.
Lesage, J., & Son .. .. .. Leicester
Melville, W. M. .. .. .. Kirkcaldy
Pickering, John. .. .. .. Stockton-on-Tees
Priest, Rowland .. .. .. Cradley Heath, Staffs.
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Shanks, Alexander, & Son .. Dens Ironworks, Arbroath
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Waygood, S., & Co. .. .. .. Newington Works, Falmouth Street, S.E.

Hoops for Boiler Flues.

Bolton Iron & Steel Co. .. .. Bolton
Bowling Iron Co., Limited .. Bradford

Hose Pipes.

Morris, John .. .. Salford, Manchester
Richards & Co. .. .. Aberdeen
Rose, W., & Co. .. .. Deansgate, Manchester
Worthington Pumping Engine Co. 114, Queen Victoria Street, E.C

Hydraulic Machinery.

Adamson, D., & Co. .. .. Dukinfield, Manchester
Anderson & Gallwey .. .. Cremorne Works, Lot's Road, Chelsea, S.W.
Berry, Henry .. .. Croydon Works, Hunslet, Leeds
Coles, H. J. .. .. 89, Summer Street, S.E.
Cowans, Sheldon & Co., Limited St. Nicholas Works, Carlisle
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Dudgeon, Richard .. .. .. 114, Fanshawe Street, N.C.
Fielding & Platt .. .. .. Gloucester
Hathorn, Davey & Co. .. .. Leeds
Middleton, Robert .. .. .. Sheepscar Foundry, Leeds
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Ramsbottom, J. .. .. .. Hunslet, Leeds
Rose, Downs & Thompson .. Old Foundry, Hull
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W.
Williams, W. L. .. .. .. 2, Westminster Chambers, S.W.

Hydraulic Presses.

Anderson & Gallway .. .. Cremorne Works, Lot's Road, Chelsea, S.W.
Bourne, Fenny, & Co., Limited Sheffield [Chelsea, S.W.
Carrick & Wardale .. .. Gateshead-on-Tyne
Coles, H. J. .. .. .. 89, Sumner St., Southwark, S.E.
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Fife, Wm. & Platt .. .. Gloucester
Middleton, Robert .. .. Sheepscar Foundry, Leeds.
Neilson, John, & Co. .. .. Keppochill Engine Works, Glasgow
Rose, Downs & Thompson .. Old Foundry, Hull
Stothert & Pitt, Limited.. .. Bath
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W.
Tyler, H., & Co. .. .. .. 84, Upper Whitecross St., E.C.
Woods, Hamilton & Co. .. .. Salford, Manchester

Hydraulic Rams.

Blake, John.. .. .. .. Accrington, Lancashire

Hydrokineter.

Weir, G. & J. .. .. .. 49, Jamaica Street, Glasgow

Ice Making Machines.

Piggott, T., & Co. .. .. .. Springhill, Birmingham

Incandescent Electric Lamps.

Woodhouse & Rawson .. .. 11, Queen Victoria Street, E.C.

India Rubber Goods.

Angus, Geo., & Co. .. .. Newcastle-on-Tyne
Harburg India Rubber Comb Co. 138, London Wall, E.C.
India Rubber, Gutta Percha & Telegraph Works Co., Limited Silvertown, Essex
MacLellan, George, & Co. .. Glasgow Rubber Works, Glasgow
North British Rubber Co., Ltd. Edinburgh
Star Rubber Co., The .. .. 131, West Regent St., Glasgow

Indicators (Steam Engine).

Hannan & Buchanan .. .. 75, Robertson Street, Glasgow
Taite & Carlton (Stroudley's Speed) 63, Queen Victoria Street, E.C.

Injectors.

Donald, J., & Son .. .. .. 42, Cadogan Street, Glasgow
Fairburn & Hall .. .. .. 63, Royal Exchange, Manchester
Gresham & Craven .. .. .. Manchester
Hancock Inspirator Co. .. .. 108, Upper Thames St., E.C.
Holden & Brooke .. .. .. St. Simon Works, Salford
Körting Brothers .. .. .. 17, Lancaster Avenue, Manchester
Madan, C. S. .. .. 21, Mansfield Chambers, St. Anne's Square, Manchester
Manlove, Alliott, Fryer & Co. .. Nottingham
Patent Exhaust Steam Injector Co., Limited .. .. 4, St. Ann's Square, Manchester
Schaffer & Budenburg .. .. St. Mary Street, Manchester

Insurance Companies.

Employers' Liability Assurance Corporation, Limited .. .. 84 & 85, King William Street, E.C.
London Mutual Boiler Insurance Co., Limited .. .. .. 17, Queen Victoria Street, E.C.

Iron and Steel Works (Plant for).

Adamson, D., & Co. .. .. Dukinfield, Manchester
Davey, Bros., Limited .. .. Sheffield
Galloway, W. & J., & Sons .. Manchester
Goodwin, James, & Co. .. .. Ardrossan, N.B.
McCulloch, T., & Sons .. .. Kilmarnock
Thwaites Bros. .. .. .. Bradford
Walker Bros. .. .. .. Wigan
Walker, T., & Co. .. .. .. Leeds
Whitwell, W. (Stoves) .. .. Stockton-on-Tees
Woods, Hamilton & Co. .. .. Salford, Manchester

Iron Buildings.

Davies Brothers & Co. .. .. Crown Iron Works, Wolverhampton
Davies, M. H. .. .. .. Grange Rd., Bermondsey, S.E.
Dixon, I. .. .. Windsor Ironworks, Liverpool
Lysaght, John, Limited .. .. Bristol
Macfarlane, Walter, & Co. .. Possil Park, Glasgow
Morewood & Co. .. .. .. Soho, Birmingham
Morton, F., & Co., Limited .. Naylor St. Ironworks, Liverpool

Iron Joists (Rolled).

Measures Bros. & Co. .. .. Southwark Street, S.E.
Shelton Bar Iron Co. .. .. Stoke-on-Trent, and Cannon Street, London, E.C.

Iron Merchants.

Beatson, John, & Son .. .. 40c, St. Mary's Gate, Derby
Henderson & Glass .. .. Liverpool

Jacks (Lifting).

Dudgeon, Richard .. .. .. 114, Fenchurch Street, E.C.
Gibbins, R. C., & Co. .. .. Berkley St., Birmingham
Pickering, John. .. .. .. Stockton-on-Tees
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Shirlaw, A., & Co.. .. .. Berkley Street, Birmingham
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Keys and Pins.

Smith, H. Ford .. .. .. Seddon St., Salford, Manchester

Lamps.

Barnett & Foster .. .. .. 25a, Eagle Wharf Road, N.
Wells, A. C., & Co. .. .. Withy Grove, Manchester

Launches and Yachts.

Burnet, L., & Co. .. .. .. Govan, Glasgow
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Cochran & Co. .. .. .. Birkenhead [Glasgow
Copland, J., & Co. .. .. .. Albert Engine Works, Leith
Dan Wynne, G. F. G .. .. .. Chertsey
Edwards & Symes .. .. .. Wharf Rd., Cubitt Town, E.
Forrestt & Son .. .. .. Limehouse, E.
Hanna, Donald & Wilson .. .. Paisley, N.B.
Hayes, Ed. .. .. Stony Stratford
Kerr, Stuart & Co. .. .. .. 20, Bucklersbury, E.C.
Miller, Tapp & Rouse .. .. Middle Mall, Hammersmith
Paul, M., & Co. .. .. .. Levenford Works, Dumbarton
Rose & Duncan .. .. .. Whitefield Works, Glasgow
Thornycroft, J. I., & Co. .. Chiswick, W.
Vosper & Co. .. .. .. Broad Street, Portsmouth
Yarrow & Co. .. .. .. Poplar, E.

Laundry Machines.

Manlove, Alliott, Fryer & Co. .. Nottingham

Lead Refiners and Merchants.

Holman, Rogers, Michell & Co. St. Helen's, Lancashire

Leather Machinery.

Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Stothert & Pitt, Limited .. Bath

Lifts.

Coles, H. J. .. .. .. 89, Sumner Street, S.E.
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Gibbins, R. C., & Co. .. .. Berkley St., Birmingham
Hanson, W. .. .. Bradford
Hunter & English .. .. .. Bow, E.
Pickering, John. .. .. .. Stockton-on-Tees
Waygood, R., & Co. .. .. Falmouth Road, S.E.

Linoleum Machinery.—*(See Floor Cloth Machinery.)*

Lithographers.

Kell, Thos., & Son.. .. .. 40, King Street, Covent Garden, W.C.

Locomotive Details.

Storey, I., & Sons .. .. .. Knott Mill, Manchester

Locomotive Engines.—*(See Engines, Locomotive.)*

Lubricants and Oils.

Bell, J. .. .. Asbestos Works, Southwark, S.E.
Bilton's American Lubricating Cream .. .. .. 23, Brunswick St., Liverpool
Bradford, J., & Sons .. .. Liverpool
Crane, P. Moir, & Co., ... Bank Street, Manchester
Engelbert & Co. .. .. .. 70 & 71, Bishopsgate St., E.C.
Fleming, A. B., & Co., Limited 16, Whitefriars Street, E.C.
Price's Patent Candle Co., Ltd. Battersea, S.W.
Ragosine & Co. .. .. .. 7, Idol Lane, E.C.
Wilson, J. Veitch, & Co. .. .. Glasgow

Lubricators.

Blake, J. .. .. Accrington, Lancashire
Dawrance & Co. .. .. .. 198, Great Dover Street, S.E.
Foster, Edward, & Son .. .. Halifax
Körting Brothers .. .. .. 17, Lancaster Avenue, Manchester
Nettlefolds, Limited .. .. Birmingham [chester
Tribe Brothers .. .. .. 19, St. George St., Westminster
Whitehouse & Co. .. .. .. Tipton Hall Chain Works, Staffordshire

Machine Tools.

Anderson & Gallway .. .. Cremorne Works, Lot's Road, Chelsea, S.W.
Archdale, Jas., & Co. .. .. Leicam Street, Birmingham
Askham Bros. & Wilson, Ltd. .. Sheffield
Asquith, W. .. .. Highmead Well Works, Halifax
Barlow, H. B., & Co. .. .. Carrbrook Works, Manchester
Beckwith, E., & Co. .. .. Sunderland
Berry, F., & Sons .. .. .. Calderdale Ironworks, Sowerby Bridge
Berry, H. .. .. Croydon Works, Hunslet, Leeds
Booth, Geo., & Co. .. .. .. Halifax
Butterfield, F. & J., & Co. .. Keighley, Yorkshire
Cameron, John .. .. .. Oldfield Road Ironworks, Salford
Churchill, C., & Co. .. .. Cross Street, Finsbury, E.C.
Cowley, John, & Son .. .. Hyde, near Manchester
Craig & Donald .. .. .. Johnstone, near Glasgow
Davis & Primrose .. .. .. Etna Ironworks, Bangor Road, Leith, N.B.
De Bergue & Co., Limited .. Manchester
Dron & Lawson .. .. .. Cranston Hill Tool Works, Glasgow
Earnshaw, A., & Co. .. .. Crown Works, Booth Town, Halifax
Fielding & Platt .. .. .. Gloucester
Galloway, W. & J., & Sons .. Manchester
Harpers Limited .. .. .. Albion Ironworks, Aberdeen
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Heap, Joshua, & Co., Limited .. Ashton-under-Lyne
Kendall & Gent .. .. .. Victoria Works, Manchester
Lang, J., & Sons .. .. .. Johnstone, N.B.
Lee & Hunt .. .. Arkwright Works, Manchester
Loudon Bros. .. .. Bothwell Street, Glasgow
Machinery & Hardware Co., Ltd. 147, Queen Victoria Street, E.C.
McArthur, A., & Son .. .. Johnston, N.B.
Muir, Wm., & Co.... .. .. Shrubourne Street, Manchester
New, D., & Co. .. .. .. 13, Devonshire Chambers, E.C.
Pitt Bros. .. .. Yorkshire Machine Tool Works, Liversedge
Pollock, Macnab, & Highgate .. Shettlestone, Glasgow
Rushworth & Co. .. .. .. Sowerby Bridge, Yorkshire
Scott, James, & Co. .. .. .. West Mount Ironworks, Halifax
Scrivan & Co. .. .. .. Leeds Old Foundry, Marsh Lane, Leeds
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Shepherd, Hill & Co. .. .. Leeds
Shirlaw, A., & Co.... .. .. Suffolk Works, Birmingham
Smith & Coventry .. .. .. Ordsall Lane, Salford, Manchester
Smith & Willshaw.. .. .. Halifax
Tangyes Machine Tool Co., Ltd. Soho, Birmingham
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W.
Widdowson, J. H. .. .. .. Ordsall Lane, Salford
Winn, Charles, & Co. .. .. Granville Street, Birmingham

Maize Dressing Machinery.

Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow

Mathematical Instruments, Makers.

Archbutt, J. & W. E. .. .. Westminster Bridge Road, Lambeth, S.W.
Negretti & Zambra .. .. Holborn Viaduct, E.C.
Stanley, W. F. .. .. .. Great Turnstile, Holborn, W.C.

Mattresses (Spring).

Morris, John .. .. .. Salford, Manchester

Metals (Phosphor, Alloys, &c.).

Billington & Newton .. .. Longport, Staffordshire
Cookshutt & Jowett .. .. 145, Thornton Road, Bradford
Dick, Alex. .. .. 110, Cannon Street, E.C.
Evans, James, & Co. .. .. Gaythorn, Manchester
Hughes, J. & J. .. .. .. Woodcock Street, Birmingham
Phosphor Bronze Co., Limited.. Sumner Street, S.E.

Meters.

Manchester Water Meter Co., Limited .. .. Ardwick, Manchester
Worthington Pumping Engine Co. 144, Queen Victoria Street, E.C.

Mill Gearing, Shafting, &c.

Askham Bros. & Wilson, Ltd. .. Sheffield
Besseme, Henry, & Co., Limited Sheffield
Bodley, Bros., & Co. .. .. Exeter
Brown, Bayley, Dixon & Co. .. Sheffield
Buckley & Taylor .. .. .. Castle Ironworks, Oldham
Forsyth, Miller & Co. .. .. Mile End, Glasgow
Goodfellow & Matthews .. .. Hyde, near Manchester
Hawthorn, R. & W. .. .. .. Newcastle-on-Tyne
Hick, Hargreaves & Co. .. .. Soho Ironworks, Bolton
Hind, H., & Co. .. .. .. Nottingham
Jackson, P. R., & Co. .. .. Salford Rolling Mills, Salford
Kirkstall Forge Co. .. .. .. Leeds
McCulloch, T., & Sons .. .. Kilmarnock
Musgrave, John, & Sons .. .. Bolton
Savile Street Foundry and Engineering Co., Limited.. .. Sheffield
Smith, Parfrey & Hitchings .. Buckingham Palace Rd., S.W.
Staffordshire Wheel & Axle Co. Spring Hill, Birmingham
Taylor & Challen .. .. .. Derwent Foundry, Birmingham
Whitmore & Binyon .. .. .. 28, Mark Lane, E.C.
Yates & Co. .. .. Sheaf Works, Hunslet Road, Leeds

Mill Machinery (Flour, Corn, and Rice).

Clayton & Shuttleworth .. .. Lincoln
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Herbert, A. & Co. .. .. .. Edinburgh
Hunter & English .. .. .. Bow, E.
Landale, James .. .. .. Kirkcaldy, N.B.
Marshall, Sons & Co., Limited .. Gainsborough
McCulloch, T., & Son .. .. Kilmarnock
Norman, J., & Co. .. .. .. Keppochill Engine Works, Glasgow
Ransomes, Head, & Jefferies .. Ipswich
Ruston, Proctor, & Co. .. .. Lincoln
Turner, E. R. & F.... .. .. Ipswich
Whitmore & Binyon .. .. .. 28, Mark Lane, E.C.

Mills (Paint, Oil, Mortar, &c.).

Butters Brothers .. .. .. Lambhill Street, Glasgow
Follows & Bate, Limited (Paint) Manchester
Rose, Downs, & Thompson .. Hull
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Spencer & Co. .. .. .. Melksham, Wilts
Wilson, John H., & Co. .. .. Sandhills, Liverpool

Mining Machinery.

Askham Bros. & Wilson, Ltd. .. Sheffield
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Clay Cross Co. .. .. .. Clay Cross, near Chesterfield
Daglish, R. & Co. .. .. .. St. Helens, Lanc.
Hathorn, Davey & Co. .. .. Leeds
Jordan, T. B., Son & Commans.. 52, Gracechurch Street, E.C.
McCulloch, T., & Sons .. .. Kilmarnock
Robey & Co.... .. .. .. Lincoln
Ruston, Proctor & Co. .. .. Lincoln
Schiran, Richard, & Co. .. .. 9, Northumberland St., W.C.
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Walker, Bros. .. .. .. Wigan

Moulding Machines.

Whittaker, Wm., & Co.... .. Oldham

Non-Conducting Compositions.

Anderson, D., & Son, Limited .. Lagan Felt Works, Belfast
Bell, J. .. .. Asbestos Works, Southwark, S.E.
Blacks, A., & Co. .. .. .. 21, Lime Street, E.C.
Keenan, M. .. .. Armagh Works, Tredegar Wks., N. Bow, E.
Leroy, F., & Co. .. .. .. Gray Street, Commercial Rd., E.

Nuts (Finished).

Mercer, Ed. .. .. Hollinwood, Manchester

Oils.—*(See Lubricants.)*

Oil Cans.

Kaye, Jos., & Co. .. .. .. Bank Works, Kirkstall, Leeds.

Oil Distilling Plant.

Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow

Oil Mill Machinery.

Pigrott, Thos., & Co. .. .. Birmingham
Rose, Downs & Thompson .. Old Foundry, Hull
Rowlandson, W. .. .. .. 132, Boundary St., Liverpool
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Packing (Engine).

Beldam Packing & Rubber Co... 77, Gracechurch Street, E.C.
Bell, John .. .. Asbestos Works, Southwark
Blamey & Son .. .. .. Catherine St., City Road, E.C.
Briggs Bros. .. .. Malthy Place, Hunslet, Leeds
Lindsay, R. B., & Co. .. .. Plantation Quay (West) Glasgow
Mead, F. M., & Co. .. .. 32BD, Kennington Road, S.E.
Peck & Co., Limited .. .. 116, Cannon Street, E.C.
United Asbestos Co., Ltd., The.. 161, Queen Victoria Street, E.C.

Paints.

Ragosine & Co. .. .. .. 7, Idol Lane, Great Tower St.
United Asbestos Co., Limited .. 161, Queen Victoria Street, E.C.

Paper.

Hodgkinson & Co... .. ..

Paper Making Machinery.

Donkin, B., & Co.... .. .. Bermondsey, S.E.
Dowdes & Grant .. .. .. Kirkcaldy, N.B.

Patent Agents.

Alexander, E. P. .. .. .. 86, Southampton Buildings, W.C.
Allison, Brothers .. .. .. 52, Chancery Lane, W.C.
Brewer & Jensen .. .. .. 23, Chancery Lane, W.C.
Brookes, Wm. .. .. .. 55 & 56, Chancery Lane, W.C
Craven, T. E., & Son .. .. 24, Victoria Chambers, South Parade, Leeds
Harris & Mills .. .. .. 23, Southampton Buildings, W.C.
Horn & Son .. .. 172, Strand, W.C.
Inventors' Patent Right Association, Limited .. .. .. 21, Cockspur Street, S.W.
Phillips & Leigh .. .. .. 22, Southampton Buildings, Chancery Lane, W.C.
Redfern, G. F. .. .. .. 4, South Street, Finsbury, E.C.
Thompson & Boult .. .. .. 6, Lord Street, Liverpool
Thompson, W. R. M., & Co. .. 95, Buchanan Street, Glasgow
Vaughan & Son .. .. .. 57, Chancery Lane, W.C.
Wise, W. Lloyd .. .. .. 40, Lincoln's Inn Fields, W.C.

Patterns.

Ormerod, Grierson & Co.... .. Manchester

Permanent Way.

Askham Bros. & Wilson, Ltd. .. Sheffield
Dick, Kerr & Co. .. .. .. 101, Leadenhall Street, E.C.
Hartley & Arnoux Brothers .. Stoke-on-Trent
Ince Foundry & Engineering Co. Newport, Monmouthshire
Kerr, Stuart & Co.... .. .. 20, Bucklersbury, E.C.
Thomson & Browning .. .. 5, Victoria Street, S.C.

Pig Iron Breakers.

Evans, J., & Co. .. .. .. Trumpet Street, Manchester

Pile Drivers.

Gibbins, R. C., & Co. .. .. Berkley Street, Birmingham

Piles.

Goodwin, James, & Co. .. .. 4a, Great Tower Street, E.C.

Pipe Founders.

Clay Cross Co. .. .. .. Clay Cross, near Chesterfield
Ince Foundry & Engineering Co. Newport, Monmouthshire

Pipe (Drain) Making Machinery.

Clayton, Howlett & Venables .. Harrow Road, W.

Pipes (Sanitary).

Doulton & Co. .. .. .. Lambeth, S.E.
Farnley Iron Co., Limited .. Farnley, near Leeds
Glenboig Union Fire Clay Co., The Glasgow

Pistons and Piston Rings.

Atkins & Co. .. .. .. Special Tool Works, Stanley Street, Sheffield
Bates, Timothy, & Co. .. .. Sowerby Bridge
Jackson, P. R., & Co. .. .. Salford Rolling Mills, Manchester
Lockwood & Carlisle .. .. Eagle Foundry, Park, Sheffield

Plates (Iron and Steel).

Beardmore, I. & W. .. .. Glasgow
Brown, Bayley, Dixon & Co. .. Sheffield
Jessop, Wm., & Sons, Limited Sheffield
Landore Siemens Steel Co., The.. Landore, South Wales
Leeds Forge Co., Limited .. Leeds
Shelton Bar Iron Co. .. .. Stoke-on-Trent, and Cannon Street, London, E.C.
Steel Co of Scotland, Limited.. Glasgow
West Cumberland Iron & Steel Co., Limited .. .. .. Workington

Portable Engines.—*(See Engines, Portable.)*

Portable Railways.—*(See Railways, Portable.)*

Pottery and Encaustic Tile Machinery.

Bodley Brothers & Co. .. .. Exeter
Boulton, W. .. .. Burslem, Staffordshire

Presses (Hydraulic).—*(See Hydraulic Presses.)*

Printing Machinery for Textile Fabrics.

Farmer, Jas., & Sons .. .. Salford

Propellers.

Jackson, P. R., & Co. .. .. Salford Rolling Mills, Manchester
Rose & Duncan .. .. .. Glasgow [tei
Savile Street Foundry and Engineering Co., Limited.. .. Sheffield

Pulley Blocks.

Crowley, John, & Co. .. .. Sheffield
Pickering, John. .. .. .. Stockton-on-Tees
Priest, Rowland .. .. .. Cradley Heath, Staffs.
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Tangyes Limited .. .. .. Birmingham
Thomson, Wm. .. .. .. Kinning Park, Glasgow

Pulleys (Cast Iron).

Bagshaw, J. & Sons .. .. Batley, Yorkshire
Bodley Brothers & Co. .. .. Exeter
Buckley & Taylor .. .. .. Castle Iron Works, Oldham
Crossley, Geo. .. .. .. Cleckheaton, Yorkshire
Goodfellow & Matthews .. .. Hyde, near Manchester
Harper & Co. .. .. Albion Ironworks, Aberdeen
Jackson, P. R., & Co. .. .. Salford Rolling Mill, Manchester
Ormerod, Grierson & Co.... .. Hulme, Manchester
Reading Ironworks Co. .. .. Reading
Rowlandson, W. .. .. .. 132, Boundary St., Liverpool
Taylor & Challen .. .. .. Derwent Foundry, Birmingham
Yates, J. & Co. .. .. .. Hunslet, near Leeds

Pulleys (Wrought Iron).

Bagshaw, J., & Sons .. .. Batley
Crossley, G. .. .. Albion Machine Works, Cleckheaton
Hall, J. & E. .. .. .. Dartford Ironworks, Kent
Rudswell, Clark & Co. .. .. Railway Foundry, Leeds
Mackie, J. & J. & Co .. .. Reading
Okes, J. C. R. .. .. .. 39, Queen Victoria Street, E.C.
Pickering, John. .. .. .. Stockton-on-Tees
Reading Ironworks Co., Ltd. .. Reading

Pumps and Pumping Machinery.

Allen, W. H. & Co. .. .. York Street, Lambeth, S.E.
Anderson & Gallway .. .. Cremorne Works, Lot's Road, Chelsea, S.W.
Blundell, G. T., & Co. .. .. Limehouse, London
Cameron, John .. .. .. Old Field Rd. Ironworks, Salford
Carrick & Wardle .. .. .. Gateshead
Chaplin, A., & Co.... .. .. Glasgow
Clay Cross Co. .. .. .. Clay Cross, near Chesterfield
Coalbrookdale Co., Limited .. Coalbrookdale, Shropshire
Cochrane, Jno. .. .. .. Barrhead
Coles, H. J. .. .. Sumner Street, S.E.
Craig, A. F., & Co. .. .. Paisley, N.B.
Daglish, R., & Co.... .. .. St. Helen's, Lancashire
Drysdale & Co. .. .. .. Bon Accord Engine Works Glasgow
Evans, Jos., & Sons .. .. Wolverhampton
Fairburn & Hall .. .. .. 63, Royal Exchange, Manchester
Fielding & Platt .. .. .. Gloucester
Grange Iron Co., Limited .. Durham
Hanna, Donald & Wilson .. Paisley
Hanson, Wm. .. .. Bradford
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Hathorn, Davey & Co. .. .. Leeds
Hatton, J. .. .. Coventry
Hett, C. L. .. .. Auchenlee Foundry, Brigg
Hunter & English .. .. .. Bow, E.
Isler, C., & Co. .. .. .. 88, Southwark Street, S.E.
Le Grand & Sutcliff .. .. 100, Bunhill Row, E.C.
Loudon, Bros. .. .. Bothwell Street, Glasgow
Lowca Engineering Co., Ltd., The Whitehaven
Mather & Platt .. .. .. Manchester
McCulloch, T., & Sons .. .. Kilmarnock
Moreland, Richard, & Son .. 3, Old Street, E.C.
Neill, W., & Son .. .. .. 81, Helen's Junction, Lancashire
New, D., & Co. .. .. .. 15, Devonshire Chambers, E.C.
Okes, J. C. R. .. .. .. 39, Queen Victoria Street, E.C.
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Pearn, Frank, & Co. .. .. Manchester
Piggott, Thos., & Co. .. .. Birmingham
Pulsometer Engineering Co., Ltd. Nine Elms, S.W.
Ramsbottom, Jno. .. .. .. Saynor Road, Leeds
Ruston, Proctor, & Co.— .. .. Street Works, Lincoln
Savile Street Foundry and Engineering Co., Limited.. .. Sheffield
Selig, Sonnenthal & Co. .. .. 85, Queen Victoria Street, E.C.
Shanks, Alexander, & Son .. Dens Ironworks, Arbroath
Silvester, F. & Co. .. .. .. Castle Hill Works, Newcastle, Staff
Simpson & Co. .. .. Pimlico, London
Stannah, J. .. .. 235, Southwark Bridge Rd., S.E
Stothert & Pitt, Limited .. .. Bath
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Taylor & Challen .. .. .. Birmingham
Thwaites Brothers .. .. .. Vulcan Ironworks, Bradford
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W
Tyler, H., & Co. .. .. .. 84, Upper Whitecross St., E.C
Westinghouse Brake Co., Ltd., .. York Road, King's Cross, N.
Wilson, Alex., & Co. .. .. Vauxhall Ironworks, Wandsworth Road, S.W.
Wilson, John H., & Co.... .. Sandhills, Liverpool
Worthington Pumping Engine Co. 114, Queen Victoria Street, E.C
Woods, Hamilton & Co. .. .. Salford, Manchester

Pumps (Centrifugal).

Allen, W. H., & Co. .. .. York St. Works, Lambeth, S.E.
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Evans, J., & Sons .. .. .. Wolverhampton
Hathorn, Davey & Co. .. .. Leeds
Hett, C. L. .. .. Brigg
Lowca Engineering Co., Ltd., The Whitehaven
New, D., & Co. .. .. .. 15, Devonshire Chambers,
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Ruston, Proctor & Co. .. .. Lincoln
Simpson & Co. .. .. Pimlico, London
Tangyes Limited .. .. .. Cornwall Works, Birmingham

Pumps (Bucket).

[illegible] .. .. .. Oldfield Rd. Ironworks, Salford
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works, Glasgow
Coalbrookdale Co., Limited .. Coalbrookdale, Staffordshire
Cochrane, John .. .. .. Barrhead, N.B.
Coles, H. J. .. .. 89, Sumner St., Southwark, S.E.
Hanson, W. .. .. Quebec Works, Bradford
Hathorn, Davey & Co. .. .. Leeds
Hatton, J. .. .. Coventry
London Brothers .. .. .. Bothwell Street, Glasgow
Lowca Engineering Co., Ltd., The Whitehaven
McCulloch, T., & Sons .. .. Kilmarnock
New, D., & Co. .. .. .. 15, Devonshire Chambers, E.C.
Okes, J. C. R. .. .. .. 39, Queen Victoria Street, E.C.
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Roger, R., & Co. .. .. .. Stockton-on-Tees
Stannah, J. .. .. 235, Southwark Bridge Rd., S.E.
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Wilson, Alex., & Co. .. .. Vauxhall Ironworks, Wandsworth Road, S.W.
Wilson, John H., & Co.... .. Sandhills, Liverpool

Punching and Shearing Machines.

Anderson & Gallway .. .. Cremorne Works, Lot's Road, Chelsea, S.W.
Beckwith, E., & Co. .. .. Sunderland
Berry, F., & Sons .. .. .. Calderdale Ironworks, Sowerby
Fielding & Platt .. .. .. Gloucester [Bridge
Tweddell, R. H. .. .. .. 14, Delahay Street, S.W.

Railway Agents.

Oldham Brothers .. .. .. 110, Cannon Street, E.C.

Railway and Contractors' Plant.

Askham Bros. & Wilson, Ltd. .. Sheffield
Beatson, John, & Son .. .. 40c, St. Mary's Gate, Derby
Brown, Bayley, Dixon & Co. .. Sheffield
Chaplin, Alex., & Co. .. .. Cranston Hill Engine Works Glasgow
Darlington Steel & Iron Co., Ltd. 3, Victoria St., Westminster, S.W.
Dick, Kerr & Co. .. .. .. 101, Leadenhall Street, E.C.
Goodwin, Jas., & Co. .. .. Ardrossan, N.B
Hadfield's Steel Foundry Co. .. Attercliffe, Sheffield
Hartley & Arnoux Brothers .. Stoke-on-Trent
Lisson, J., & Son & Co. .. .. Darlington
Ince Foundry & Engineering Co. Newport, Monmouthshire
Ransomes & Rapier .. .. .. 5, Westminster Chambers, S.W
Thomson & Browning .. .. 5, Victoria St., Westminster
Wood, C. .. .. Tees Ironworks, Middlesbro'-on-Tees

Railways (Portable).

Bagnall, W. G. .. .. .. Stafford
Dick, Kerr & Co. .. .. .. 101, Leadenhall Street, E.C.
Fowler, J., & Co. .. .. .. Leeds
Hartley & Arnoux Brothers .. Stoke-on-Trent
Kerr, Stuart & Co.... .. .. 20, Bucklersbury, E.C.
Wood, C. .. .. Tees Ironworks, Middlesbro'-on-Tees

Rail Benders.

Rollmer & Jones .. .. .. Dashwood House, London, E.C.

Rail Lifters.

De Bergue & Co., Limited .. Manchester

Rails (Steel or Iron).

Askham Bros. & Wilson, Ltd. .. Sheffield
Beatson, J., & Son.. .. .. 40c, St. Mary's Gate, Derby
Brown, Bayley, Dixon, & Co., Ltd. Sheffield
Darlington Steel & Iron Co., Ltd. 3, Victoria St., Westminster, S.W.
Hartley & Arnoux Brothers .. Stoke-on-Trent
Shelton Bar Iron Co. .. .. Stoke-on-Trent, and Cannon Street, London, E.C.
Steel Co of Scotland, Limited.. Glasgow
West Cumberland Iron & Steel Co. Workington, Cumberland

Reducing Valves.
Hanson, Wm. .. .. .. Quebec Works, Bradford

Refrigerating Machinery.
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Douglas & Grant .. .. .. Dunnikier Foundry, Kirkcaldy, N.B.
Hall, J. & E. .. .. . Dartford Ironworks, Kent

Rice Dressing Machinery.
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Douglas & Grant .. .. .. Kirkcaldy, N.B.
Hunter & English .. .. .. Bow, E.
Landale, James .. .. .. Kirkcaldy, N.B.
McCulloch, T., & Sons .. .. Kilmarnock
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow
Sands, Harold . .. .. Popham Street, Nottingham

Rivets.—*(See Bolts, Rivets, &c.)*

Rivetting Machines.
Anderson & Gallway .. .. Cremorne Works, Lot's Road, Chelsea, S.W.
Berry, Henry .. .. .. Croydon Works, Hunslet, Leeds
De Bergue & Co., Limited .. Manchester
Drysdale & Co. .. .. .. Bon Accord Engine Works, Glasgow
Fielding & Platt .. .. .. Gloucester
Gilmer, W. F., & Co. .. .. Quayside, Newcastle-on-Tyne
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Higginson & Co. .. .. .. Massey Street, Liverpool
New, D., & Co. .. .. .. 15, Devonshire Chambers, E.C.
Tweddell, B. H. .. .. .. 14, Delahay Street, S.W.

Rock Drills.
Glover & Hulson .. .. .. St. James's Road, S.E.
Hartley & Arnoux Brothers .. Stoke-on-Trent
Jordan, T. H., Son, & Commons 52, Gracechurch St., E.C.
Schram, Richard, & Co. .. .. 9, Northumberland Street, W.C.

Rolling Mills.—*(See Iron & Steel Works, Plant for.)*

Rolls (Chilled and Grain).
Perry, Thomas, & Son .. .. Highfield Works, Bilston

Roofs (Iron, Steel and Zinc).
Ashbury Railway Carriage & Iron Co., Limited .. .. .. Openshaw, Manchester
Davies, Bros., & Co. .. .. . Crown Ironworks, Wolverhampton
Davies, M. H. .. .. .. Grange Road, Bermondsey, S.E.
De Bergue & Co., Limited .. Manchester
Dixon, Isaac .. .. .. Windsor Ironworks, Liverpool
Goodwin, Jas., & Co. .. .. Motherwell, N.B.
Hanna, Donald & Wilson .. .. Paisley, N.B.
Hill & Smith .. .. .. Tipton, Staffordshire
Janson, C., Son & Co. .. .. Darlington
Iron Foundry & Engineering Co. Newport, Monmouthshire
Lewes Engineering Co., Ltd., The Whitehaven
Lysaght, J., Limited .. .. St. Vincent Works, Bristol
McCulloch, T., & Sons .. .. Kilmarnock
Murewood & Co. .. .. .. Woodford Ironworks, Soho, Birmingham
Morton, Francis & Co. .. .. Naylor St. Ironworks, Liverpool
Walker Brothers .. .. .. Wigan

Rope Driving Gear.
Goodfellow & Matthews .. .. Hyde, near Manchester
McCulloch, T., & Sons .. .. Kilmarnock

Ropes (Driving).
Hanson, Scott & Co. .. .. Stockport

Ropes (Wire).—*(See Wire Ropes.)*

Rustless Iron.
The Bower-Barff Rustless Iron Co., Limited .. .. .. 23, Queen Victoria Street, E.C.

Sanitary Appliances.
Doulton & Co. .. .. . Lambeth, S.E.
Winn, Charles, & Co. .. . Granville Street, Birmingham

Shafting.
Bagshaw, J., & Sons .. .. Batley, near Leeds
Bessemer, Henry, & Co., Limited Sheffield
Brown, Bayley, Dixon & Co. .. Sheffield
Goodfellow & Matthews .. .. Hyde, near Manchester
Harper & Co. .. .. .. Albion Ironworks, Aberdeen
Hick, Hargreaves & Co. .. .. Soho Ironworks, Bolton
Hind, H., & Son .. .. .. Nottingham
Jackson, F. R., & Co. .. .. Salford Rolling Mills, Manchester
Kirkstall Forge Co. .. .. Leeds
McCulloch, T., & Sons .. .. Kilmarnock
New, D., & Co. .. .. .. 15, Devonshire Chambers, E.C.
Taylor & Challen .. .. .. Derwent Foundry, Birmingham
Yates, J., & Co. .. .. .. Sheaf Works, Hunslet Rd., Leeds

Ship Builders.
Abercorn Shipbuilding Co. .. Abbey Works, Paisley, N.B.
Alley & Maclellan .. .. .. Glasgow
Ross & Duncan .. .. .. Glasgow
Simons, W., & Cy .. .. .. Renfrew
Yarrow & Co. .. .. .. Isle of Dogs, E.

Slide Valves.
Thom, J. .. .. 8, Storey Sq., Barrow-in-Furness

Smiths' Fires.
Thwaites Brothers .. .. Vulcan Ironworks, Bradford

Soda Water Machinery.
Barnett & Foster .. .. .. 25a, Eagle Wharf Road, N.

Speed Indicators.
Selig, Sonnenthal & Co. .. .. 83, Queen Victoria Street, E.C.
Tatte & Carlton .. .. .. 63, Queen Victoria Street, E.C.

Springs.
Ibbotson Brothers & Co., Limited Sheffield
Osborn, Samuel, & Co. .. .. Sheffield
Salter, George, & Co. .. .. West Bromwich
Spencer, J., & Sons .. .. Newburn Steel Works, Newcastle-on-Tyne
Sterne, L., & Co., Limited .. Crown Ironworks, Glasgow
Turton, Thos. & Sons .. .. Sheaf Works, Sheffield

Steam Hammers.
Booth, Geo., & Co... .. .. Halifax
Cochrane, John .. .. Merrhead
Davis & Primrose .. .. .. Etna Ironworks, Bangor Road, Leith, N.B.
Davy Brothers, Limited.. .. Sheffield
Dudgeon, Richard, ... 114, Fenchurch Street, E.C.
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Massey, B. & S. .. .. .. Manchester
Musgrave, J., & Sons .. .. Bolton
Pollock, Macnab, & Highgate .. Shettlestone, Glasgow
Rushworth & Co. .. .. .. Bowerby Bridge, Yorkshire
Saville Street Foundry and Engineering Co., Limited.. .. Sheffield
Thwaites Brothers.. .. .. Vulcan Ironworks, Bradford
Walker Brothers .. .. .. Pagefield Ironworks, Wigan
Walker, T., & Co .. .. .. Leeds

Steam Traps.
Blake, J. .. .. Accrington, Lancashire
Hanson, W. .. .. Quebec Works, Bradford
Lancaster & Tonge.. .. .. Pendleton, Manchester
Vaughan & Son .. .. .. West Gorton, Manchester

Steel Makers.
Askham Bros. & Wilson, Ltd. .. Sheffield
Beardmore, I. & W. .. .. Parkhead Ironworks, Glasgow
Bessemer, H. & Co., Limited .. Sheffield
Bolton Iron & Steel Co. .. .. Bolton
Brown, Bayley, Dixon & Co. .. Sheffield
Hadfield's Steel Foundry Co. .. Attercliffe, Sheffield
Howell & Co. .. .. .. Sheffield
Ibbotson Bros. & Co., Limited.. Sheffield
Jackson, F. R., & Co. .. .. Salford Rolling Mills, Manchester
Jessop, W., & Sons, Limited .. Sheffield
Landore Siemens-Steel Co., Ltd. Landore, South Wales
Leeds Forge Co., Limited .. Leeds
Marsden, Francis .. .. .. Slavonia Works, Sheffield
Osborn, S., & Co. .. .. .. Sheffield
Stanniars Close's Steel Co. .. Wolsingham, near Darlington
Steel Co. of Scotland, The .. 150, Hope Street, Glasgow
Tangyes Limited .. .. .. Cornwall Works, Birmingham
Turton, T., & Sons .. .. Sheaf Works, Sheffield
West Cumberland Iron and Steel Co. .. .. Workington, Cumberland

Steel and Iron Works (Plant for).—*(See Iron and Steel Works.)*

Steering Gear.
Donkin & Nichol .. .. .. Newcastle-on-Tyne
Grange Iron Co., Limited .. Durham
Lynn, John, & Co. .. .. Sunderland
Paul, M., & Co. .. .. .. Leventorf Works, Dumbarton
Pigrott, T., & Co. .. .. .. Springhill, Birmingham
Wilson, J. H., & Co. .. .. Sandhills, Liverpool

Stokers (Mechanical).
Hodgkinson & Co., Limited .. Manchester
Procter, J. .. .. Burnley, Lancashire

Stone Breakers.
Baxter, W. H., & Co. .. .. Albion Street, Leeds
Brinjes & Goodwin .. .. Whitechapel, E.
Goodwin, Jas., & Co. .. .. Motherwell, near Glasgow
Saville Street Foundry & Engineering Co., Limited .. Sheffield

Stone Dressing Machinery.
Harper & Co. .. .. .. Albion Ironworks, Aberdeen
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow

Stone Merchants.
Akroyd, James, & Sons.. .. Harehills, near Leeds
Kudolfhite Co., The .. .. 114a, Queen Victoria St., E.C.

Sugar Machinery.
Aitken, McNeil & Co. .. .. Helen Street, Govan, Glasgow
Clayton, Howlett & Venables .. Harrow Road, W.
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Davis & Primrose .. .. .. Etna Ironworks, Bangor Road, Leith
Harvey, Robert, & Co. .. .. Park Grove Ironworks, Glasgow
Landale, James .. .. .. Kirkcaldy, N.B
Manlove, Alliott, Fryer & Co. .. Nottingham
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow
Pigrott, T., & Co. .. .. .. Springhill, Birmingham
Sands, Harold .. .. .. Popham Street, Nottingham

Surface Plates.
Okes, J. C. R. .. .. .. 39, Queen Victoria Street, E.C.
Richards, G., & Co. .. .. Atlantic Works, Broadheath, near Manchester

Tanks.
Bellamy, John .. .. .. Byng Street, Millwall, E.
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Davies Bros. & Co. .. .. Crown Ironworks, Wolverhampton
Hanna, Donald & Wilson .. Paisley, N.B.
McCulloch, T., & Sons .. .. Kilmarnock
Murewood & Co. .. .. .. Soho, Birmingham
Norman, John, & Co. .. .. Keppochill Engine Works, Glasgow

Tanners and Curriers.
Hepburn & Gale, Limited .. Long Lane, Southwark, S.E.
McIntosh, Peter, & Sons .. 129a, Stockwell St., Glasgow
Norris, S. E., & Co. .. .. High Street, Shadwell, E.
Webb & Son... .. .. .. Stowmarket
White, John, & Sons .. .. Bingley, Yorkshire
Wilcock, Mark .. .. .. Bowerby Bridge

Tea Dressing Machinery.
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Marshall, Sons & Co., Limited.. Gainsborough

Telegraphs (Engine and Steering).
Chadburn & Son .. .. .. Lord Street, Liverpool

Telegraph Wire and Cables.
Glover, W. T., & Co. .. .. 25, Booth Street, Manchester

Timber Merchants.
Keen, J. .. .. 264, Waterloo Bridge Road, S.E.

Time Checking Machinery.
Llewellin's Patent Machine Co. Bristol

Tools (Hand and Small).
Chatwin, Thos. .. .. .. Gt. Tindal St., Birmingham
Churchill, C., & Co. .. .. 21, Cross Street, Finsbury, E.C.
Cowley, John, & Son .. .. Hyde, near Manchester
Gibb, James, & Co. .. .. 22, St. Mary Axe, E.C.
Hemp, Joshua, & Co., Limited .. Ashton-under-Lyne
Ibbotson Brothers & Co., Limited Sheffield
Jowitt, Thos., & Sons .. .. Sheffield
Nettlefolds, Limited .. .. Birmingham
Richards, George, & Co. .. .. 13, City Road, Manchester
Selig, Sonnenthal & Co. .. .. 83, Queen Victoria Street, E.C.
Shirley, A., & Co.... .. .. Suffolk Works, Birmingham
Smith & Coventry.. .. .. Ordsall Lane, Salford, Manchester
Widdowson, J. H... .. .. Ordsall Lane, Manchester

Torpedo Boats.
Hanna, Donald & Wilson .. Paisley
Thornycroft, J. I., & Co. .. Chiswick, W.
Yarrow & Co. .. .. .. Isle of Dogs, E.

Tramways and Tramway Plant.
Askham Bros. & Wilson, Ltd. . Sheffield
Carrington, W. T. H. (Wire) .. 9 & 11, Fenchurch Street, E.C.
Dick, Kerr & Co. .. .. .. 101, Leadenhall Street, E.C.
Hadfield's Steel Foundry Co. .. Attercliffe, Sheffield
Hartley & Arnoux Brothers .. Stoke-on-Trent
Kerr, Stuart & Co. .. .. 20, Buckleraburry, E.C.
Saville Street Foundry and Engineering Co., Limited.. .. Sheffield

Tube Cleaners.
Boaz, W. .. .. 29, West India Dock Road

Tube Expanders.
Dron & Lawson .. .. .. Cranstonhill Tool Works, Glasgow
Dudgeon, Richd. .. .. .. 114, Fenchurch Street, E.C.
Gibb, James, & Co. .. .. 22, St. Mary Axe, E.C.
Selig, Sonnenthal & Co. .. .. 83, Queen Victoria Street, E.C.
Thomson, Wm. .. .. .. Kinning Park, Glasgow

Tube Making Machinery.
Farmer, Jas., & Sons .. .. Salford, Manchester

Tube Wells.
Isler, C., & Co. .. .. .. 86, Southwark Street, S.E.
Le Grand & Sutcliff .. .. 100, Bunhill Row, E.C.

Tubes (Brass).
Birmingham Battery & Metal Co. Birmingham
Munts's Metal Co., Limited .. Trench Walls, nr. Birmingham

Tubes (Iron and Steel).
Aird, Jos. .. .. Tipton, Staffordshire
Birmingham Battery & Metal Co. Birmingham
Caledonian Tube Co. .. .. Coatbridge, near Glasgow
Cradesda Cold-Drawn Seamless Steel Tube Co., The .. Ladasm Street, Birmingham
Donald, J., & Son .. .. .. 42, Cadogan Street, Glasgow
Eadie, J., & Sons .. .. .. Clydesdale Tube Works, Ruthergien, near Glasgow
Farmar, Jas., & Sons .. .. Salford
Galloway, W. & J., & Sons .. Manchester
Hilditch & Hilditch .. .. Tube Works, Walsall
Howell & Co. .. .. .. Brook Steel Works, Sheffield
Lane, Howard, & Co. .. .. 115 & 116, Palmerston Buildings, London, E.C.
Lewis, E., & Sons .. .. .. Wolverhampton
Lloyd & Lloyd .. .. .. Birmingham
Marshall, J., & Sons .. .. Glasgow
McOhee, Jas., & Co. .. .. Coatbridge, N.B.
Russell, Jas., & Sons .. .. Crown Tube Works, Wednesbury
Skidmore, H. P. .. .. .. Netherton, near Dudley
Spencer, John .. .. .. Wednesbury
Spencer, J. E. & S. .. .. 3, Queen Street Place, Cannon Street, E.C.
Stewart, A. & J .. .. .. Clyde Tube Works, Coatbridge
Weldless Steel Tube Co. .. Ickniold Port Rd., Birmingham

Turbines.
Donkin, B., & Co.... .. .. Bermondsey, S.E.
Hanna, Donald & Wilson .. Paisley, N.B.
Hett, C. L. .. .. Ancholme Foundry, Brigg
King, H. J. H. .. .. .. Stroud, Gloucestershire
McKenzie, Thos., & Sons, Ltd.. 16, Holborn Viaduct, E.C.
Schram, Richard, & Co. .. .. 8, Northumberland Street, W.C.
Stothert & Pitt, Limited.. .. Bath

Turnstiles.
Isler, C., & Co. .. .. .. 86, Southwark Street, S.E.
Le Grand & Sutcliff .. .. 100, Bunhill Row, E.C.

Tuyeres.
Newlove, R. B., & Co. (Water).. Nottingham

Tyres (Railway).
Bessemer, H., & Co., Limited .. Sheffield
Brown, Bailey, Dixon, & Co. .. Sheffield
Landore Siemens-Steel Co., Ltd. Landore, South Wales
Leeds Forge Co., Limited .. Leeds

Valuers, Engineering.
Kirk, W., Price & Goulty .. 52, Queen Victoria Street, E.C.

Valves (Gas, Water, &c.).
Alley & Macleilen .. .. .. Glasgow
Bewrance, J., & Co, ... 158, Great Dover Street, S.E.
Donkin, B., & Co.... .. .. Bermondsey, S.E.
Foster, Edward, & Son .. .. Halifax
Glenfield Co., Limited .. .. Kilmarnock, N.B.
Hanna, Donald & Wilson .. .. Paisley, N.B.
Hanson, Wm. .. .. .. Quebec Works, Bradford
Hartley & Sugden, Limited .. Halifax
Hunter & English.. .. .. Bow, London, E.
Owens, S., & Co. .. .. .. Whitefriars Street, E.C.
Rhodes, B. .. .. 240, Bow Road, E.
Walker, Bros. .. .. .. Pagefield Ironworks, Wigan
Woods, Hamilton & Co. .. .. Salford, Manchester

Valves, Safety.
Adams, Thos. (Executors of) .. West Gorton, Manchester
Blake, J. .. .. Accrington, Lancashire

Ventilators.
Boyle, R., & Son .. .. .. 64, Holborn Viaduct, E.C.

Vices.
Crampton Brothers .. .. 29, West Bar Green, Sheffield
Mawbray, W. M. .. .. .. Sheaf Island Works, Sheffield

Vulcanite.
Winter, F. .. .. 186, London Wall, E.C.

Wagon (Railway) Builders.
Ashbury Railway Carriage & Iron Co., Limited .. .. .. Openshaw, Manchester
Bagnall, W. C. .. .. .. Stafford
Falcon Engine & Car Works, Ltd. Loughborough
Metropolitan Railway Carriage & Wagon Co., Limited .. Saltley Works, Birmingham
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury

Wagons (Tip).
Dick, Kerr & Co. .. .. .. 101, Leadenhall Street, E.C.
Hartley & Arnoux Brothers .. Stoke-on-Trent

Water Closets.
Winn, Charles, & Co. .. .. Granville Street, Birmingham

Water Meters.
Glenfield Co., Limited .. .. Kilmarnock, N.B.
Manchester Water Meter Co., Ltd. Tipping Street, Ardwick, Manchester
Worthington Pumping Engine Co. 114, Queen Victoria Street, E.C

Water Purifying Apparatus.
Porter, John Henderson.. .. 1 & 2, Tudor Street, E.C.

Water Wheels.
Aitken, McNeil & Co. .. .. Helen Street, Govan, Glasgow
Bodley Brothers & Co. .. .. Exeter
Copeland, J., & Co. .. .. Dobbie's Loan, Glasgow
Hett, C. L. .. .. Brigg
King, H. J. H. .. .. .. Stroud, Gloucestershire
Norman, John, & Co. .. .. Keppochill Engine Work Glasgow
Stothert & Pitt, Limited.. .. Bath

Weighing Machines.
East Ferry Road Engineering Works Co., Limited .. .. Millwall, E.
Hodgson & Steel .. .. .. Regent Road, Manchester
Janson, Chas., Son & Co.... .. Darlington
Pooley, Henry, & Son .. .. Albion Foundry, Liverpool
Salter, G., & Co. .. .. .. West Bromwich
Scott, Jas., & Son .. .. .. 10, Tibb Lane, Cross Stre Manchester

Well Engineers.
Isler, C., & Co. .. .. .. 86, Southwark St., London, S
Le Grand & Sutcliff .. .. 100, Bunhill Row, E.C.

Wheels (Geared).
Bodley Brothers & Co. .. .. Exeter
Buckley & Taylor .. .. .. Castle Ironworks, Oldham
Forsyth, Miller & Co. .. .. Mile End, Glasgow
Goodfellow & Matthews .. .. Hyde, near Manchester
Hadfield's Steel Foundry Co. .. Attercliffe, Sheffield
Harper & Co. .. .. .. Albion Ironworks, Aberdeen
Hawthorn, R. & W. .. .. Newcastle-on-Tyne
Hind, H., & Son .. .. .. Nottingham
Jackson, F. R., & Co. .. .. Salford Rolling Mills, Manchester
Manlove, Alliott, Fryer, & Co... Nottingham
McCulloch, T., & Sons .. .. Kilmarnock
Musgrave, J., & Sons, Limited.. Bolton
Ormerod, Grierson & Co... .. Hulme, Manchester
Perry, Thomas, & Son .. .. Highfields Works, Bilston
Rowlandson, W. .. .. .. 132, Boundary St., Liverpool
Smith, Parfrey & Hitchings .. Buckingham Palace Rd., S.
Staffordshire Wheel & Axle Co. Springhill, Birmingham

Wheels (Railway).
Ashbury Railway Carriage and Iron Co., Limited .. .. Openshaw, Manchester
Metropolitan Railway Carriage and Wagon Co. .. .. .. Saltley, Birmingham
Midland Railway Carriage and Wagon Co., Limited .. .. Abbey Works, Shrewsbury
Staffordshire Wheel & Axle Co., Limited .. .. Springhill, Birmingham

Wheels (Road) and Axles.
Smith, Parfrey & Hitchings .. Buckingham Palace Rd.,

Whistles (Signal).
Cran, J., & Co. .. .. .. Leith

Winches, Steam.—*(See Cranes).*

Wire and Wire Rope Makers.
Birmingham Battery & Metal Co. Birmingham
Bullivant & Co. .. .. .. 72, Mark Lane, London,
Cradock, Geo., & Co. .. .. Wakefield
Dennis, W. F., & Co. .. .. 101, Leadenhall Street, E
Glover, W. T., & Co. .. .. 25, Booth Street, Manche
Lane, Howard, & Co. .. .. 115 & 116, Palmerston ings, London, E.C.
Warrington Wire Rope Co. .. 13, Horse Plasma, Liver

Wire Making Machinery.
Crossley, Geo. .. .. .. Cleckheaton, Yorkshire
Farmer, Jas., & Sons .. .. Salford, Manchester

Wire Working Machinery.
Farmer, Jas., & Sons .. .. Salford, Manchester

Wire Tramways.
Carrington, W. T. H. .. .. 9 & 11, Fenchurch Avenu

Wood Working Machine Makers.
Barr, James.. .. .. .. Kilmarnock
Blake, J. .. .. Accrington, Lancashire
Carrick & Ritchie .. .. .. Waverley Engineering Edinburgh
Hindley, E. S. .. .. .. Bourton, Dorset
Marshall, Sons, & Co., Limited.. Gainsborough
M'Howall, John, & Sons .. .. Johnstone, near Glasgo
Mansome, A., & Co. .. .. Sterley Works, Chelsea
Richards, G., & Co. .. .. Atlantic Works, Bro near Manchester
Sands, Harold .. .. .. Popham Street, Nottin
Worsam, Samuel, & Co.... .. King's Road, Chelsea,

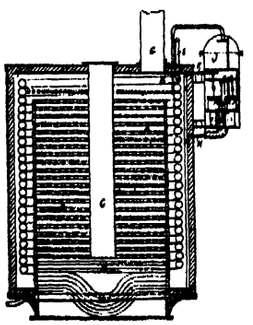
round a firebrick lining to the furnace, and distance pieces are inserted between the tubes to form a closed wall, except at one point where a tube is omitted to provide an opening for the passage of the gas between the two series of tubes, a deflector causing them to pass completely around the annular flue between the tubes. The outer circle is surrounded by a casing in removable sections. (*Accepted November* 14, 1884).

1270. J. Stark, Glasgow. Preventing Corrosion of Boilers. [2d.]—January 23, 1884.—The inner surfaces of the boiler are partially or entirely coated with a thin layer of zinc or other suitable material not of sufficient thickness to interfere with the proper transmission of heat to its contents. The coating is effected by electro-deposition or by dipping or washing with molten metal, conveniently effected before construction. (*Accepted November* 7, 1884).

2164. F. D. Rees, Manchester. Construction of Steam Boilers. [4d.] January 30, 1884.—Sectional steam or hot water boilers are composed of tubes arranged in one or more rings attached to water chambers at each end, and arranged so as to be capable of internal firing. (*Accepted November* 14, 1884).

2185. [6d. 3 *Figs.*]—Internal tubes connected with combustion chambers at the ends of the boiler may be passed through the outer water tubes. (*Accepted November* 14, 1884).

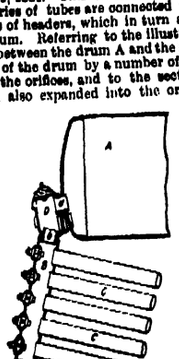
2181. T. Craddock, London. Steam Boiler. [6d. 7 *Figs.*] January 1, 1884.—The generative portion of the boiler consists of a single tube A which forms the firebox B by passing round it as clearly shown, and on arriving at the top of the firebox is wound inward to a central pipe C, and then backwards to the circumference, and so on, forming a cylinder serving as the outer walls of the generative part of the boiler, the interior of which is partially filled with a tube as far as the central pipe C. The tube A passes from the top to a separator J from which the steam passes by a pipe F to a superheating tube K, and by a steam pipe S to the engine. The products of combustion pass up from B between the generative coils A, down the annular space between the outer portion of the generative tubes and the inner surfaces of the super-



heating coils, and up between the outer surfaces of these latter coils and the casing to the chimney G. The fuel is supplied to the grate B through the central pipe C. The generative tube may be made in separate parts, joined together at the circumference, so that one division can be removed without interfering with the other. The separator J consists of a small vessel containing two steam cylinders and two pump cylinders of the simplest descriptions. The steam and water enter the first or upper division of the vessel, the steam rising to the top and the water passing to the bottom and by a water pipe to the well from which the pumps draw. The steam passes to the cylinder valves, the cylinders exhausting into the pipes K, and the pumps forcing the water down the pipes H, so as to cause an efficient circulation. The difference of pressure in the upper chamber and in the tubes K is just sufficient to drive the pumps. (*Accepted October* 31, 1884).

11,979. H. H. Lake, London. (*C. Guth, ... Rhine*). **Purifying Feed-Water in Steam Boilers.** [6d. 12 *Figs.*] August 8, 1884.—The feed-water is caused to enter a depositing chamber having perforated plates, it being forced through the plates by means of a steam inlet pipe. The chamber is arranged within the boiler, and is in open communication with the steam and water space. (*Sealed November* 14, 1884).

12,189. C. A. Knight, Glasgow. Steam Boiler. [8d. 18 *Figs.* September 9, 1884.—This relates to that class of steam boilers in which a series of tubes are connected with each other at the ends by means of headers, which in turn are connected to an upper vessel or drum. Referring to the illustration, a water-box D is interposed between the drum A and the headers B, and is connected to the end of the drum by a number of short horizontal tubes expanded into the orifices, and to the sections or headers by separate tubes *b*, also expanded into the orifices. Openings



are provided in the box D for expanding the tubes *b* and *d*. The headers B are formed of square wrought-iron tubes having their ends closed, a separate header being fixed at each end of each section of tubes. Each header may, however, embrace two or more sections, being strengthened by stays or stay tubes. In small boilers the tubes C may be connected to a single broad header, the front end of which is connected by short tubes directly to the front dished end of the water drum. This header it made of cast steel or malleable cast iron. (*Accepted October* 10, 1884).

12,519. W. Hayes, Lincoln. Steam Boilers. [4d. 3 *Figs.*] October 13, 1884.—The shell of the boiler containing the furnace tubes is of a cylindrical shape as far as the furnace end of the tubes, at which end the outer cylindrical shell is formed so that the upper part of the shell extends beyond the furnace tubes to a part in line with the front of the furnace, whilst the lower side of the shell does not quite extend to the furnace end of the tubes. A similarly formed end of a vertical cylinder covering the furnace space is joined to the cylindrical shell. The boiler thus consists essentially of a horizontal and a vertical cylinder, the plane of junction of the two being inclined at 45 deg. to each. (*Accepted November* 14, 1884).

1773. W. Wilkinson, Wigan, Lanc. Condensing Steam and Heating the Furnace Supply Draught. [4d. 1 *Fig.*] January 19, 1884.—A condensing chamber is traversed by numerous tubes, and is placed in front of the closed ash-pan of the furnace. The tubes communicate with the ash-pan by a suitable connection, and all the air drawn into the furnace is forced to pass through these tubes. (*Accepted November* 14, 1884).

STEAM BOILER FURNACES.

245. W. Morris, Doncaster, and J. Wood, West Stockwerth. Furnaces. [6d. 6 *Figs.*] January 1, 1884.—The firebars are made of a taper form in cross-section, and have transverse air spaces in the upper part shaped so as to allow of the ashes falling freely away. The bridge above the firebars is formed by a partition having openings, the side and upper parts of which form a superheating surface for the products of combustion. Air passages are made in the lower part of the bridge below the firebars, and are provided with pipes opening behind the bridge. The

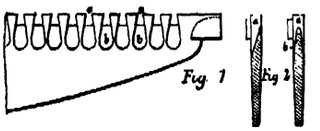
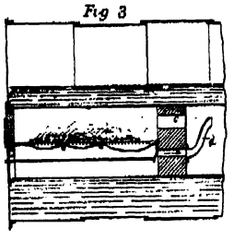


Fig. 1 Fig. 2

Fig 3



air passages are provided with dampers. Referring to the illustrations, Figs. 1 and 2 show the firebars, which are made narrower at the bottom than at the top, and are provided at the top with transverse taper passages, wider at the bottom *b* than at the top, and with an inclined lower portion as shown. The transverse passages of the different bars may be arranged in line, but are preferably out of line. Fig. 3 is a section of the furnace. Openings *c* are provided at each side through the bridge. Tubes *d* convey air behind the bridge for the combustion of the gases. (*Accepted October* 24, 1884).

312. J. Stephenson and W. Topham, Bradford. Grate Bars for Steam Boilers and other Furnaces. [4d. 3 *Figs.*] January 3, 1884.—Three, four, or more longitudinal bars are joined together by crossbars alternating in position between the different bars, the whole being cast together to form a broad grate bar with a series of openings therein. The middle, side, and crossbars of the grate bars are made of equal thickness of metal at the top or fire side, and the middle and side bars are thickened at the bottom. This construction, it is stated, prevents unequal expansion and contraction, and secures a larger area of air space on the top of the grate surface, and reduces the liability of the bars burning away. (*Accepted October* 28, 1884).

2290. J. C. Brentnall, Heaton Norris, Lanc. Travelling Grates or Furnaces. [6d. 4 *Figs.*] January 25, 1884.—The bars are linked together at their ends, so as to form an endless surface, and are driven by revolving screws mounted at [illegible] and the bars may be operated by screws of varying pitch so that the spaces between them may be narrow at the front, wider at the centre, and contracted towards the back. The ends of the bars enter between the helical fins on the screws and rest on the screws. (*Accepted November* 7, 1884).

7169. J. Cornforth, Birmingham. Consuming Smoke and Saving Fuel. [6d. 6 *Figs.*] May 3, 1884.—The bridge is hollow and is provided with a movable flap or valve at the end of and beneath the firebars. It is also provided with a series of movable perforated baffle plates connected to the flap by a link and fixed perforated baffle plates, the air entering under the flap, passing in a zig-zag course to the top of the hollow bridge, and thence through a series of holes in the top plate. Two tubes, one on each side of the firebars, may also be employed to heat air passing to the hollow bridge. The flap or valve is connected by a rod to a handle at the front of the furnace, by means of which it can be operated. (*Accepted October* 3, 1884).

12,711. A. C. Henderson, London. (*M. Krudewig, Frankfort-on-Main, and W. Kloh and T. Hymes, New York, U.S.A.*) **Smoke and Gas Consuming Furnaces.** [6d. 4 *Figs.*] September 23, 1884.—A coal bin placed within the furnace is arranged to deliver fuel upon an inclined grate, the constant progression of the fuel over the grate bars being assisted by means of plungers arranged to slide at the upper end of the bars and actuated by a crankshaft and lever. An ash door at the bottom of the furnace is opened from without by means of a lever, the height at which the slide is set determining the depth of fuel. Air passages formed in the side walls of the furnace lead from the front to the rear, and then back again and deliver heated air in front of the fuel. (*Accepted October* 31, 1884).

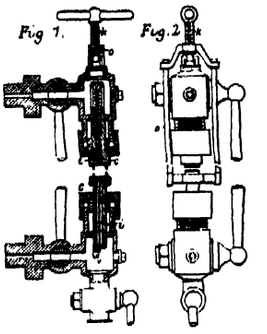
STEAM BOILER FITTINGS.

1522. A. Schmid, Zurich, Switz. Safety Valves [4d. 2 *Figs.*] January 16, 1884.—A disc-shaped valve rests on the edge of a cylindrical valve seat and has a pointed top fitting into a socket in a short horizontal lever pivotted at its other end to the frame of the apparatus. The lever has also a conical socket at the top vertically over the valve centre into which fits the downwardly projecting point in the centre of a disc adapted to receive the pressure of a helical spring. The top of the spring bears against a similar disc having in its upper surface a socket to receive the point of a regulating screw. (*Sealed November* 28, 1884).

1939. H. Wilkinson, London. Indicating Low Water and High Pressure in Steam Boilers. [6d. 2 *Figs.*] January 23, 1884.—An outer tube is open at the bottom to the water in the boiler, and at or near the top to the steam, and at the upper end terminates in an inclosed chamber. This tube surrounds an inner tube having a different rate of expansion when heated, and firmly secured to the bottom of the outer tube. The water in the tube, there being practically no circulation, is comparatively cold, and consequently, as the water lowers, the rods expand, and the difference between their expansion is caused to complete an electric circuit and operate an electric bell and indicator. A flexible diaphragm is attached to the chamber, and also completes a circuit to the bell and indicator should the pressure rise too high. (*Accepted November* 14, 1884).

1566. H. H. Lake, London. (*E. Schneider, Gaarden, Germany*). **Water Gauges.** [6d. 2 *Figs.*] January 16, 1884.—The gauge glass is secured between two stems C C provided with annular grooves containing each a ring of gutta-percha, the lower frame being raised to secure the glass by means of the screw

Fig 1. Fig. 2.



k and frame *o* as shown in Fig. 2. A spherical valve *v* is supported at the upper end of the upper stem C by a spiral spring, and is retained in position by a wire. A valve *v* is pivotted to the lower stem. Two rods *i* project out beyond the jaws of the stems C. When a glass breaks the valves are forced upon their seats. (*Accepted October* 10, 1884).

2517. Automatic Water Gauges for Steam Boilers. T. Crook, Preston. [4d. 6 *Figs.*] February 1, 1884.—A metal valve is fitted in each inlet port to the gauge fittings, and has two inclined slots cut in its guide. Lugs on a spindle passing to the front of the fitting where it is fitted with a handle, take into the slots, and on turning the spindle from the normal position to the right or left, the valve is opened or shut, it being held open in the one position by means of a cam surface in the inlet port. On turning the spindle from the open position to its normal position the cam surface retains the valve in the open position, there being sufficient play in the inclined slots, until escape of steam takes place from the front when it is automatically closed. The valve, as will clearly be seen, may thus also be employed in lieu of the ordinary cocks. (*Accepted November* 7, 1884).

STEAM TRAPS.

2432. H. Hyde and W. Eastwood, Ashton-under-Lyne. Steam Traps. [6d. 1 *Fig.*] January 31, 1884.—In the top of a receiver is a valve seating of a much larger diameter than the expansion pipe. On the end of the expansion pipe is screwed a tube passing through the centre of the seating and carrying the valve. The valve and seating are made of such diameters that the opening shall correspond, when the valve is slightly raised, with the area of the expansion pipe. Any dirt passing through the pipe falls to the bottom of the vessel, only clear water passing off through the valve. (*Accepted November* 14, 1884).

STEAM ENGINES.

497. W. Wilkinson, Kempston, Bedford. Steam Engines and Boilers. [6d. 5 *Figs.*] January 3, 1884.—To connect the main brackets for carrying the crankshaft of the engines at the top of boilers of the locomotive type, two or more vertical angle pieces are rivetted to the outer shell or cover plate at the firebox on each side of the [illegible] and also be rivetted, bolted to them. In order to assist in governing the engine, steam from the boiler acts against the resistance of a spring on a piston in a cylinder forming the standard arms or to the governor weight, that as the pressure falls the throttle valve is more or less opened. (*Accepted October* 31, 1884).

ROTARY ENGINES.

2552. B. Todd, London. Rotary Fluid Pressure Meter, Applicable also as a Liquid Meter. [6d. 3 *Figs.*] June 3, 1884.—Three cylinders are fixed on a boss on a shaft, and with their axes coinciding respectively with the sides of an equilateral triangle circumscribing the shaft. Each cylinder is fitted with a packed plunger projecting beyond the mouth of its cylinder, the projecting end being forked and carrying a roller bearing against the internal periphery of a ring fixed in the casing eccentric to the shaft. The end also carries a segment of a roller bearing against the surface of a guide bracket projecting from the boss in a plane parallel to the axis of the cylinder and of the shaft. The ports lead from the bottoms of the three cylinders and open through a facing on the boss, on which bears a circular centrally-hollowed slide held in a position eccentric to the shaft by a crank-pin on which it is free to rotate, the exhaust passing by the hollow of the slide through a central passage in the boss. The steam enters by a central tubular spindle, passing through packing in a casing covering the slide and bolted to the boss and serving as a journal. The resultant of the pressure communicated through the roller and the segment of the roller causes the boss to revolve. (*Accepted November* 7, 1884).

GAS ENGINES.

295. J. Hargreaves, Widnes, Lanc. Increasing the Efficiency of Thermo-Dynamic Engines. [4d. 1 *Fig.*] January 2, 1884.—This relates to hot air or gas engines. In compressing the air, water in the form of spray is injected along with the air into the air compressor, which water serves to keep the compressor cool and diffuses a quantity of water vapour amongst the air. The air, vapour, and any unevaporated water is then made to traverse a vessel heated by the exhaust gases from the engine, through which they pass in a reverse direction to the exhaust gases. (*Accepted October* 24, 1884).

454. E. Skene, London. Gas Engines. [6d. 8 *Figs.*] January 2, 1884.—The pistons of the two cylinders A A^1 are connected to a single crank, the cylinder A being utilised for the explosion and exhaust and A^1 effecting the suction of the explosive charge and aiding in the exhaust. The gas is drawn in through a valve D, consisting of a plunger sliding in a cylinder and operated by the rod *e* from the eccentric E against the resistance of a spring, which returns the valve when the rod *e* is withdrawn. The cut-off is regulated by a governor F, which on an increase of speed lifts the rod *e*. The inlet to the cylinder A^1 is controlled by a plug valve G, the air being drawn in through the valve G is closed and When the suction stroke is completed the valve G^1 (Fig. 2). the charge delivered into the cylinder C, both pistons aiding, in forcing the products of combustion of the last working stroke

through the valve K, operating by a cam L in a similar manner to the valve D. The surface of the cam L is provided with steps of different length and can be slid along a key on the shaft by the governor F, so as to regulate the time during which the exhaust is open. When the exhaust is closed the two cylinders compress the charge. When the gas is cut off the heat of the combustion chamber serves to expand the air and give out power for one or more strokes. The ignition is effected by the plug valve G. Referring to *Fig. 3*, at the outlet M to the combustion chamber is a small passage or hole in the valve seat which allows a small portion of the mixture to pass into a tube R, the inner end of which may be filled with wire gauze. The area of the supply passage is

Fig. 1.

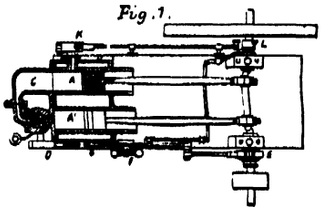


Fig. 2.

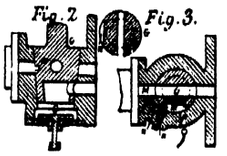


Fig. 3.

regulated by a set screw N. The gases pass in from the tube R into a pocket m^1 and through an opening P to an outside burner, where the mixture in the pocket m^1 is ignited. As the plug rotates the pocket m^1 comes opposite the port M and ignites the charge in the explosion chamber C. The pocket m^1 may be partially filled with asbestos to prevent heating, and a piece of spongy platinum be embedded in it, so as to insure ignition. In a modification the pocket m^1 makes communication with a passage leading to a chamber placed in an external chimney, and maintained at such a temperature as will ignite the explosive charge. The engine may be made double-acting by connecting the pistons to opposite cranks and using the forward ends for drawing in the charge. (*Accepted October* 31, 1884).

9662. S. L. Wiegand, Philadelphia, U.S.A. Gas Engines. [6*d.* 11 *Figs.*] April 22, 1884.—The vertical working cylinder A is provided with a non-conducting jacket on its upper part, and has attached to its lower part a large cylinder B. A long trunk piston C working through a packing between the cylinders has attached to its lower portion a piston E working in the cylinder B. Air is admitted through valves in the piston into the annular space of the cylinder B, and is discharged through the valve J into the cylinder A. The valve chamber containing the exhaust valve M operated by a cam or eccentric on the shaft O, is placed on the top of the cylinder A, the exhaust being opened during the first part only of the upward stroke. The cam operating the valves of the engine consists of two parts, one keyed to the shaft, and the other capable of turning upon the shaft, and having its position controlled by a speed regulator. The exhaust valve M is closed, and the igniting valve open during the whole of the downstroke, the two valves are open during the first part of each upstroke, and are both closed during the latter part of

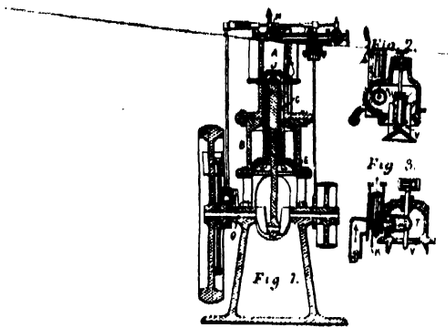


Fig. 1.

the upstroke for a proportion depending on the adjustment of the cam. The gas is introduced by a pump W, the piston of which moves with the main plunger, and the inlet valve of which opens and closes with the exhaust valve. When the inlet valve closes, the gas is forced into the cylinder A, and is compressed by the plunger, the proportions of gas and air being always the same. The igniting device consists of a small chamber T (Fig. 2), connected to or shut off from the cylinder A by a valve V. In the chamber T is a tube S heated by a jet of burning gas forced in by a jet of air previously heated by passing through a pipe k located in the chimney through which the products of the ignited flame are discharged. The air for the igniting jet passes from the pump B through the igniting chamber T. The valve V is made hollow through its stem with a series of openings made in both the lower and upper parts of its stem, a current of air being induced in a downward direction through the centre of the valve, when the valve is open, and air is forcing out through the valve M. (*Accepted October* 14, 1884).

12,815. J. Dougill, Manchester. Gas Motor Engines. [4*d.* 6 *Figs.*] September 1½, 1884.—Referring to Fig. 1, which represents an arrangement of governor for a gas engine, the sliding sleeve *d* carries a rod *e*, which is capable of being moved backwards and forwards across the ends of the sleeve. The rod *e* is arranged to be moved across the end of the sleeve by a projection on a rod operated by an eccentric, and which comes in contact with one end of *e*. When the speed of the engine is too great the sleeve *d* is moved along a stud in opposition to a spring in the ordinary manner, and causes the rod *e* to be moved out of the path of the projections. The other end of *e* operates the ordinary spring gas supply valve. The slide valve is shown in Fig. 2. The seat is formed with four passages, the first having two or more ports C C. The flat slide E has its centre part cut away for the reception of the smaller slide A. Assuming the piston of the engine to be just commencing its outer stroke, the slide A is moved to the right, uncovering the ports D D H, air and gas flowing through the ports, along the body of the slide A, and by the port C C to the cylinder. The movement of the slide E then cuts off the supply of gas and air at the ports C bringing the igniter flame F opposite the first port C, as shown, when the mixture is ex-

Fig. 1.

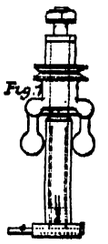
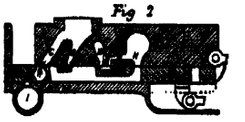


Fig. 2.



ploded. I is the stationary burner. Gas alone enters by the ports D, and mixes with the air at H. (*Accepted October* 28, 1884).

12,716. A. W. L. Reddie, London. (*P. Murray, Newark, N.J., U.S.A.*) **Gas Engines.** [1*s.* 4*d.* 20 *Figs.*] September 23, 1884.—The air and gas are admitted in suitable proportions into a chamber containing a mixing apparatus, through which they are drawn by a pump and forced into a reservoir through a valve controlled by a governor operated by the engine, which regulates the pressure in the tank and the amount delivered to the engine. The gas passes from the reservoir through a single valve controlling ports leading to opposite ends of the cylinder. The injecting valves are located at opposite ends of the cylinder, and make communication between the cylinder and burners carried by the valves. The exhaust outlet is at the middle of the length of the cylinder, and communicates with a coil situated in the reservoir, the exhaust thus heating, and raising the pressure of, the combustible gas. The piston is of such length with relation to the length of its stroke, that the exhaust outlet will be fully opened just as the piston completes its stroke in each direction, at which time the inlet valves are opened to admit the charge which is compressed during the back stroke. The details of the engine are fully illustrated and described. (*Accepted October* 24, 1884).

ENGINE FITTINGS.

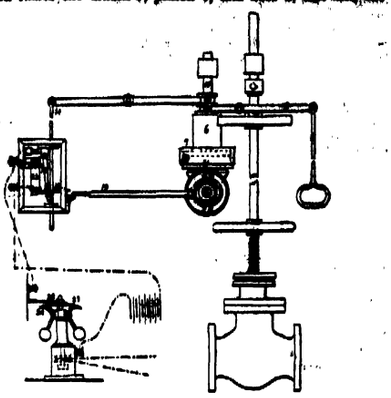
695. A. E. and H. M. Butler, Leeds. Manufacture of Cranked Axles. [6*d.* 8 *Figs.*] January 4, 1884.—The "crank mould" is formed with recesses and corresponding projections at the points where the corners or angles of the crank are required, by which means the fibre of the metal is made to run in the same line as the crank. The crank mould is then formed at one operation by pressure into a complete crank. (*Accepted October* 24, 1884).

690. R. Rhodes, London. Metallic Packings for Piston Rod and other Glands. [4*d.* 1 *Fig.*] January 4, 1884.—A strip of soft metal is wound round the spindle to be packed so as to form a coil which is pushed down into the gland box. A core of resilient packing (consisting preferably of the asbestos compound packing described in Specification 1884 of 1879 covered with asbestos yarn), or other elastic packing is forced between the metallic coil and the surface of the gland box which is fitted with the usual cover. Loose metallic wedge-shaped pieces may be fitted in the bottom of the gland box and of the cover. (*Accepted October* 21, 1884).

1[illegible]. [illegible], Manchester. Stuffing-Boxes of Piston Rods, &c. [6*d.* 5 *Figs.*] January 14, 1884.—The rod passes through rings or coils of metallic or other packing encircled by helical or other springs which tend to press the packing upon the rod. The space between the walls of the stuffing-box and the springs is filled with lubricating material. When metallic packing rings are employed they are grooved on their outer surfaces to receive a circular helical spring. The meeting ends of two separate packing rings may be made with inclined surfaces which are pressed upon by the springs either directly or through a wedged-shaped ring to force the packing rings apart. Wedge-shaped tongue pieces are inserted between the inclined end surfaces of the parts of the ring, so that when pressed inwards they also tend to force these pieces inwards. The packing may be inclosed in a casing constructed in halves and arranged to fit the interior of the stuffing-box. (*Accepted November* 7, 1884).

1615. J. M. Hall, Manchester. Governing Steam, &c., Engines. [6*d.* 5 *Figs.*] January 8, 1884.—The driving pulley of the engine is free to revolve in each direction, and is restrained from endwise movement by a fixed collar on one side and a sliding collar on the other. The sliding collar has suitably-shaped projections taking into recesses in the boss, and is forced against the boss by a spiral spring surrounding the shaft. As the resistance of the pulley to turning is increased, it is rotated, against the resistance of the spring bearing against a second fixed collar and by means of the projections on the shaft, in the opposite direction to its rotation, and the sliding collar is driven backwards, its movement being communicated to the throttle valve or expansion link. In order to compensate for variation of steam pressure, an annular weight consisting of four or more segments pivotted at their ends to an annular casing surrounding the spiral spring, is attached to the sliding collar. The weights by the centrifugal force tend to fly outwards, but are prevented from so doing by a sliding tubular piece surrounding the tapered ends of the segments, and forced over them by a second spiral spring. This tubular piece is connected to the throttle valve. (*Accepted November* 4, 1884).

2332. M. B. Copland, Preston, Lanc. Automatically Stopping Stationary Engines when the Required Maximum of Speed is Exceeded. [6*d.* 8 *Figs.*] January 20, 1884.—Referring to the illustration, on the required increase of speed a revolving plate 27 on the governor is caused by the upward pressure of the curved arms 34 to make contact with a spring terminal 26 and so close the circuit of an electro-magnet 25, which attracts the end of a cross lever 18 and brings its opposite end opposite a rod 19 operated by an eccentric; or the cross lever may be operated directly by the governor. The vibrating rod 19 then pushes back the lever 18, and with it a counterweighted stop or detent 16 to which the lever 18 is pivotted. The stop or detent releases the pendent rod 14 and allows a sliding clutch 7, pinion 6, and boss 8 to descend on the rod 10, the sliding clutch engaging with another clutch 11 driven by the engine. The pinion 6 is thus rotated, causing the valve to be closed by the gearing shown in the illustration. The parts are restored to the positions shown in the drawing by depressing the end of the lever 9, which raises the clutch 7, pinion 6, and boss 8, and also the



pendent rod 14, the detent 16 being forced to return to its position by the counterweight. (*Accepted October* 7, 1884).

12,969. J. L. Heald, Crockett, Cal., U.S.A. Engine Governors. [6*d.* 12 *Figs.*] September 30, 1884.—A pair of weighted arms cross each other diagonally to a central vertical line, and have their lower ends hinged to a horizontally rotating disc to the sides of which are secured steel springs, behind each arm, so as to curve above them. The upper ends of the springs are connected by links with the upper weighted ends of the arms and tend to counteract the centrifugal force. The arms act upon a vertically adjustable central stem connected to a double balanced valve. (*Accepted October* 31, 1884).

CONDENSERS.

2236. H. H. Lake, London. (*A. Vivien, St. Quentin, and A. D. R. Dujardin, Lille, France.*) **Evaporating Apparatus.** [10*d.* 10 *Figs.*] January 28, 1884.—The steam admission pipe is arranged at the centre of the tubular portion of the apparatus and passes through a stuffing-box, which allows it to expand or contract. The steam passes from the centre to the circumference in contact with a number of vertical tubes, it being forced to follow a spiral course by means of a spiral vertical partition. The inert vapours are removed from the bottom to the top of the apparatus by means of a perforated pipe. The water of condensation passes off at the end of the steam circuit. A safety vessel formed of two concentric annular pieces is provided at the top of the apparatus. Circular dripping pieces prevent the projection of liquid along the walls of the casing or of the central tube into the safety vessel. In a modification the water falls upon stepped trays in the form of a cascade. (*Accepted October* 10, 1884).

1148. A. Budenberg, Manchester. (*Schaffer and Budenberg, Buckau, Germany*). **Tachometers or Continuous Speed Indicators.** [6*d.* 3 *Figs.*] January 10, 1884.—The driving spindle passes through the centre of the casing parallel to the dial, and carries within the casing a balanced ring forced by springs to occupy such a position, that its plane cuts the axis of the spindle at about right angles. When the spindle is rotated, the ring tends to revolve at right angles to the spindle and its exact angle will be determined by the speed of rotation, the mass of the ring and the strength of the springs, and will thus occupy a different position for every different velocity. The position of the ring is indicated by the index on a dial by any ordinary method, such, for example, as that employed in the pressure gauge. (*Accepted November* 4, 1884).

1049. W. Ashton, Manchester. Power Meters for Ascertaining the Duty of Steam Engines. [6*d.* 3 *Figs.*] January 9, 1884.—A cone, preferably a hyperbolic conoid, and a roller are mounted in frames, so that their axes are at right angles. The cone frame is connected to a reciprocating part of the engine so as to move in the direction of the length of the roller and in so doing to rotate. On the cone spindle is a wheel gearing with a long faced wheel connected with the registering mechanism. The roller is mounted in a frame jointed to a vibrating standard hinged at its lower end and acted upon by a spring, which tends to keep the roller in contact with the cone. The piston of a small cylinder, whose ends are connected with the ends of the working cylinder, is connected by links to the roller frame, and, as it moves backwards and forwards against the resistance of springs and in proportion to the steam pressure acting on it, it causes the roller to be moved along the cone and thus adjust its speed according to the pressure. The roller may be fluted circumferentially and the cone longitudinally, so as to prevent the cone slipping on the roller. (*Accepted November* 4, 1884).

LUBRICATORS.

13,073. D. Sugden, Denholme, Yorks. Lubricators. [4*d.* 4 *Figs.*] October 2, 1884.—A plunger fitting in a cylinder is made to descend upon the oil in the cylinder by means of a ratchet wheel operating a worm gearing with a wormwheel on a rod screwed into the plunger. The wormwheel is prepared with claws fitting into corresponding claws on the boss of the handle secured to the top of the plunger screw, the claws being kept in contact by means of springs. The claws on the boss are lowered from the claws on the wheel by a rod descending with the plunger rod when the plunger is near the bottom of its stroke. (*Accepted November* 4, 1884).

UNITED STATES PATENTS AND PATENT PRACTICE.

Descriptions with illustrations of inventions patented in the United States of America from 1847 to the present time, and reports of trials of patent law cases in the United States, may be consulted, gratis, at the offices of ENGINEERING, 35 and 36, Bedford-street, Strand.

BOSTON DOCK.—This undertaking is now so far completed as to be ready for the commencement of business. There is 26 ft. of water in the basin of the dock, while in the new cut through the clays to deep water there is 30 ft. Owing to the extreme dryness of the past summer, a large amount of sand has accumulated in the bed of the Witham, but freshets are now scouring out the channel, and it is hoped that this difficulty will soon be obviated. Two vessels entered the dock on Tuesday to take in coal, and it is expected that there will be a large trade in that commodity. A number of colliery owners from Nottingham have visited the dock, and have expressed their satisfaction with the dock works.

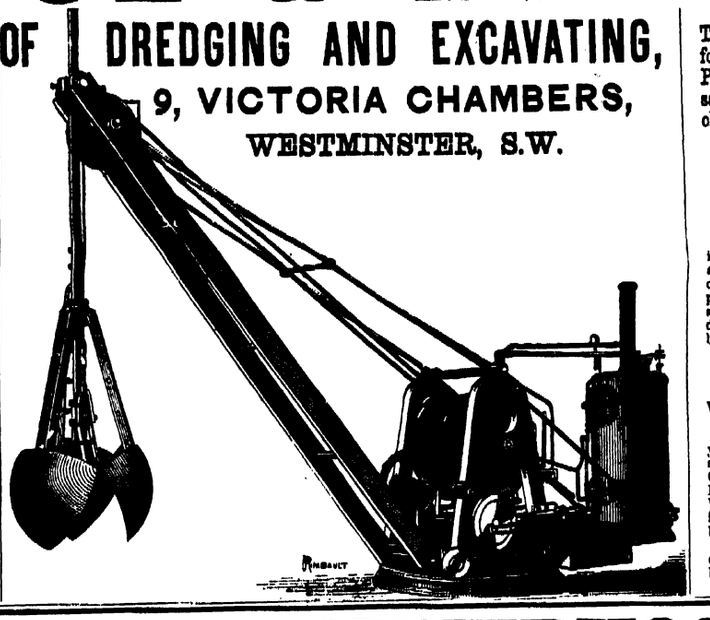


BRUCE & BATHO'S

SYSTEM OF DREDGING AND EXCAVATING,

9, VICTORIA CHAMBERS,
WESTMINSTER, S.W.

Excavators used at
LONDON DOCKS,
WEXFORD,
CARDIFF,
HARWICH
CORK,
FRANCE,
ST. PETERSBURG,
BENARES
PARA,
MADAGASCAR,
POTI,
CALCUTTA,
SINGAPORE.



These Excavators have been largely used for sinking Wells or Cylinders for Bridge Piers, Quay Walls, &c., having worked satisfactorily in mud, sand, gravel, shingle, clay, &c. Cost of excavating by this system is cheaper than any other at present in use.

TESTIMONIALS.

WESTMINSTER, 8th April, 1880.

DEAR SIR,—I have used your Excavators for sinking over 200 cylinders, through the gravel, in the bed and at the edge of the Thames, down to the London clay, and found them very well adapted to the purpose, being able to sink cylinders 7 ft. 6 in. in diameter at the rate of 2 ft. per hour, with great ease. In dredging, excavating, or unloading barges, they would be of the greatest service.—Yours truly,

(Signed) C. R. WALKER,
Contractors' Engineer.

PARKESTON, HARWICH, 28th Jan., 1882.

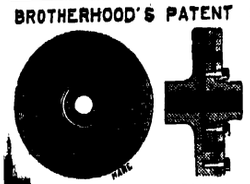
W. DUFF BRUCE, Esq., 9, Victoria Chambers, Westminster, S.W.

DEAR SIR,—We have much pleasure in informing you that the Excavators supplied to us by you for sinking the concrete cylinders required for the New Quay we are constructing here for the Great Eastern Railway Company, are giving us every satisfaction. With them we are able to sink the cylinders NINE FEET in diameter through the stiff silty clay forming the bed of the river, a depth of about 30 ft., in two days.

We can confidently recommend them for this class of work, or for dredging purposes, or for discharging barges.—Yours faithfully,

(Signed) J. COCHRANE & SON. 5548

BROTHERHOOD'S PATENT



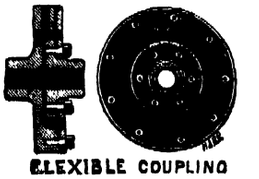
FLEXIBLE COUPLING

PETER BROTHERHOOD,

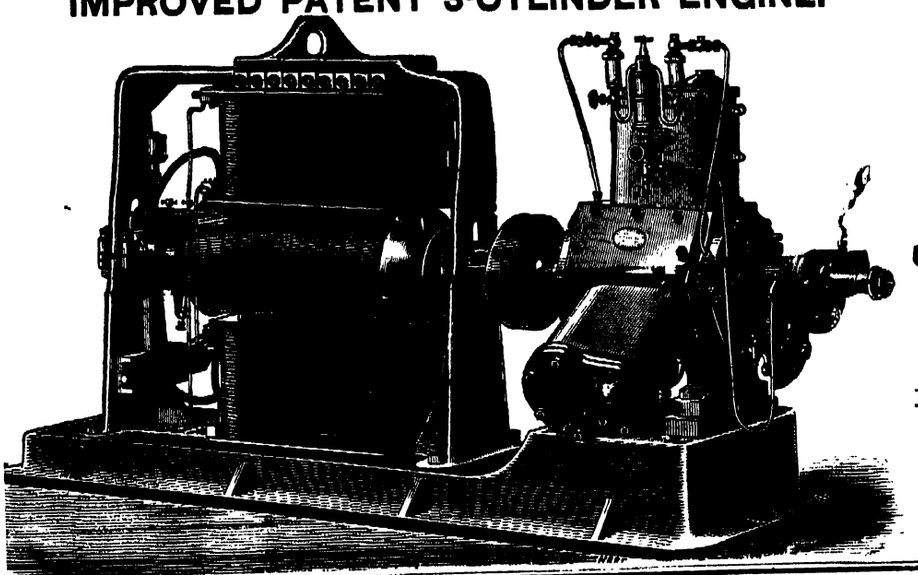
MECHANICAL ENGINEER,
BELVEDERE ROAD, WESTMINSTER BRIDGE, LONDON, S.E.

IMPROVED PATENT 3-CYLINDER ENGINE.

BROTHERHOOD'S PATENT



FLEXIBLE COUPLING



THE MOST
ECONOMICAL
AND
EFFECTIVE
FOR
SHIP LIGHTING
As in General Use in the British, French, Italian, Danish, &c., &c., Navies.

FOR DRIVING
FANS,
CENTRIFUGAL
PUMPS,
AND OTHER
HIGH-SPEED
MACHINERY.

5204



Non-Compression Engine.

GAS ENGINES

FROM 1 MAN TO 100 HP.



Compression Engine.

ALL SIZES ABOVE 2 HP. SELF STARTING. 5136

ATKINSON'S PATENTS.



Feed-Water Heater.

FEED-WATER HEATERS.

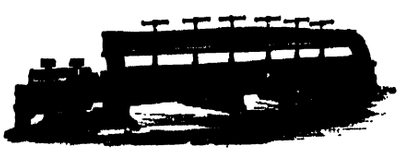
(JOHN HASTIE & CO., GREENOCK, SOLE MAKERS OF THESE HEATERS FOR SCOTLAND.)

Sole Makers: BRITISH GAS ENGINE & ENGINEERING COMPANY, Limited, 11, Queen Victoria St., London, E.C.

SHIPBUILDERS' & BOILERMAKERS' TOOLS

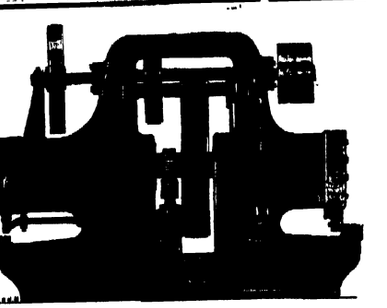
SMITH BROTHERS & CO.,

Kingston Engine Works, Kinning Park, GLASGOW.



MAKERS OF ALL KINDS OF

Punching and Shearing Machines, Plate Bending Rollers, Plate Edge Planing Machines, Beam Bending and Horizontal Punching Machines (with either Single, Double, or without Angle Iron Cutter combined), Keel Plate or Garboard Strake Bending Machines, Plate-Straightening Machines, Countersink Drills, and Single-Drill Verticals, &c., &c. 5321

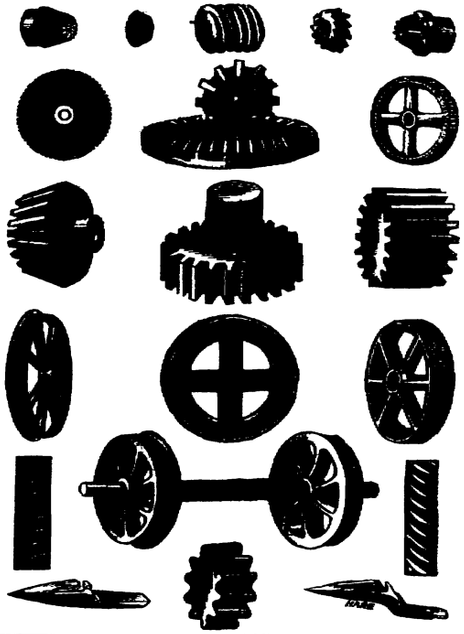


Punching and Shearing Machine, with Angle Iron Cutter.

TANGYES LIMITED CORNWALL WORKS, BIRMINGHAM

LONDON: 35, Queen Victoria Street. NEWCASTLE: St. Nicholas Buings. MANCHESTER: Deansgate. GLASGOW: Argyle and Hope Streets. (H.)

TANGYES' MALLEABLE CASTINGS

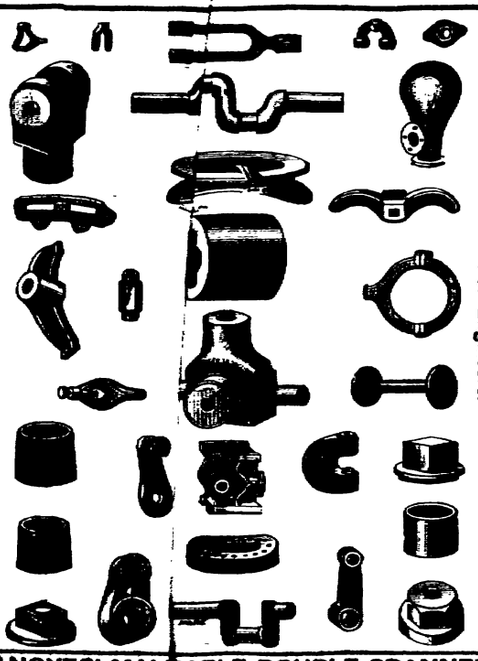


Quotations for these and other Malleable Castings on Application.

261

TANGYES' MALLEABLE CASTINGS

For Engineers.



Quotations for these and other Malleable Castings on Application.

262

TANGYES' MALLEABLE CASTINGS

Railway Carriage, Wagon and Telegraph Fittings.

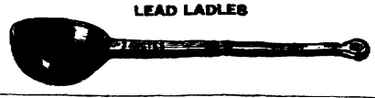


Quotations for these and other Malleable Castings on Application.

263

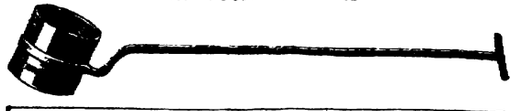
TANGYES' MALLEABLE LADLES

LEAD LADLES



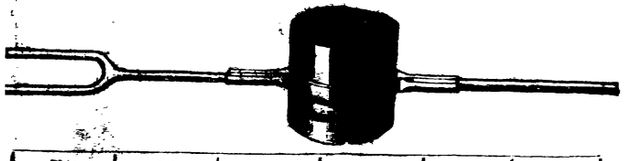
Size	No. 25	No. 26	No. 27	No. 28
To hold	4 lbs.	7 lbs.	14 lbs.	28 lbs.

HAND FOUNDRY LADLES



Size	1	2	3	4
To carry.....	28 lbs.	40 lbs.	50 lbs.	60 lbs.

FOUNDRY LADLES

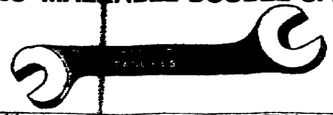


Size	10	11	12	13	14
To carry	1 cwt.	1½ cwt.	2 cwt.	2½ cwt.	3½ cwt.

The Lead Ladles are entirely of Malleable Iron.

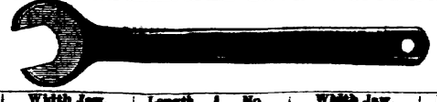
The Hand and Foundry Ladles have Wrought Iron Handles

TANGYES' MALLEABLE DOUBLE SPANNERS



No.	Width Jaw.	Length.	No.	Width Jaw.	Length.
75	⅜ ins. and ⅜ ins.	5 ins.	89	1¼ ins. and 1¼ ins.	13 ins.
76	" "	5½ "	90	1¼ " 1¼ "	14 "
77	" "	6 "	91	1¼ " 1¼ "	15 "
78	" "	6½ "	92	1¼ " 1¼ "	15½ "
79	" "	7 "	93	1¼ " 1¼ "	16 "
80	" "	7½ "	94	1¼ " 1¼ "	16½ "
81	" "	8 "	95	1¼ " 1¼ "	17 "
82	" "	8½ "	96	1¼ " 1¼ "	17½ "
83	" "	9 "	97	1¼ " 1¼ "	18 "
84	" 1	9½ "	98	1¼ " 1¼ "	18½ "
85	" 1	10 "	99	1¼ " 1¼ "	19 "
86	" 1¼	10½ "	100	1¼ " 2 "	19 "
87	1 " 1¼ "	11 "	101	1¼ " 2 "	19½ "
88	1 " 1½ "	12½ "			

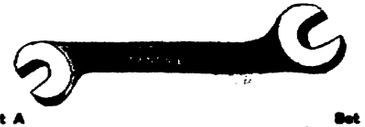
TANGYES' MALLEABLE SINGLE SPANNERS



No.	Width Jaw.	Length.	No.	Width Jaw.	Length.
102	⅜ ins.	5½ ins.	115	1¾ ins.	17½ ins.
103	"	5¾ "	116	2 "	18 "
104	"	7 "	117	2¼ "	19 "
105	"	8¼ "	118	2½ "	20 "
106	"	9 "	119	2¾ "	21 "
107	"	9½ "	120	3 "	22 "
108	1	11 "	121	3¼ "	23 "
109	1¼	11½ "	122	3½ "	24 "
110	1¼	14 "	123	3¾ "	25 "
111	1¼	15 "	124	4 "	26 "
112	1¼	15½ "	125	4¼ "	27 "
113	1¼	16 "	126	4½ "	28 "
114	1½ "	17 "			

TANGYES' MALLEABLE DOUBLE SPANNERS

TO FIT WHITWORTH NUTS.



Set A

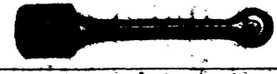
No.	To fit Hexagon Headed Bolts, diam.	Length
29	⅜ ins. and ⅜ ins.	8 ins.
30	" "	10½ "
31	" "	15 "
32	1 " 1 "	17 "
33	1¼ " 1¼ "	21 "
34	1¼ " 1¼ "	24 "
35	1¼ " 1¼ "	25 "
36	1½ " 1½ "	29 "

Set B

No.	To fit Hexagon Headed Bolts, diam.	Length
38	⅜ ins. and ⅜ ins.	10 ins.
39	" "	12 "
40	" 1 "	17 "
41	1 " 1 "	21 "
42	1 " 1¼ "	24 "
43	1 " 1¼ "	25 "
44	1¼ " 1¼ "	29 "

In ordering complete sets, a reference to A or B will be sufficient.

TANGYES' MALLEABLE BOX SPANNERS OR SCREW KEYS



No.	Size	Length	No.	Size	Length
1	⅜ ins.	6 ins.	9	1¼ ins.	19 ins.
2	"	7 "	10	1¼ "	20 "
3	"	8 "	11	1¼ "	21 "
4	"	9 "	12	1¼ "	22 "
5	"	10 "	13	1¼ "	23 "
6	"	11 "	14	1¼ "	24 "
7	1 "	12 "	15	1¼ "	25 "
8	1¼ "	13 "	16	1¼ "	26 "

Quotations on Application.

DICK, KERR & CO., Engineers and Contractors, (Five Medals awarded, Calcutta International Exhibition, 1883-4.)



SOLE MANUFACTURERS OF

KERR'S PATENT

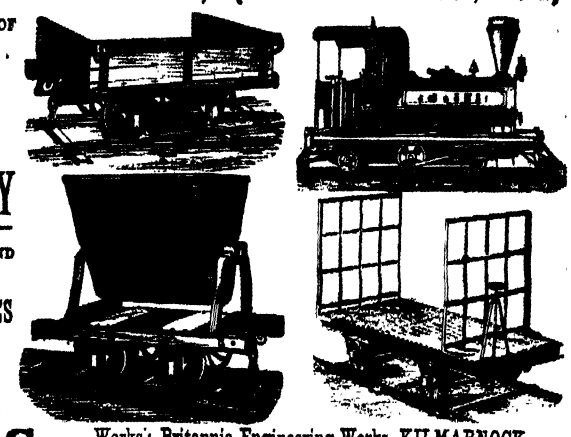
PORTABLE RAILWAY

SUITABLE FOR MINES AND PLANTATIONS

WAGONS & LOCOMOTIVES

FOR ALL CLASSES OF WORK.

Catalogues and Prices on application. 5024



101, LEADENHALL ST., LONDON, E.C. Works: Britannia Engineering Works, KILMARNOCK.

JAMES ARCHDALE & CO.,



MANCHESTER WORKS, LEDSAM STREET, BIRMINGHAM.

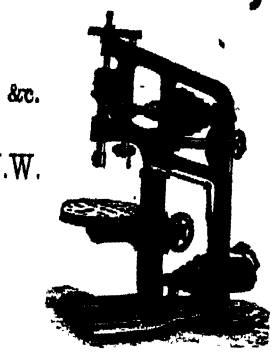
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CONTRACTORS TO THE BRITISH & FOREIGN GOVERNMENTS.

London Agent: ALLEN LEE, Electrician, 3, Camden Cottages, Camden Rd., N.W.

WHERE A STOCK OF OUR TOOLS MAY ALWAYS BE SEEN. 5351





New Patent Barring Engine.

AUTOMATIC MOTION FOR MOVING INTO GEAR, AND FALLS OUT OF GEAR AUTOMATICALLY WHEN MAIN ENGINE STARTS.

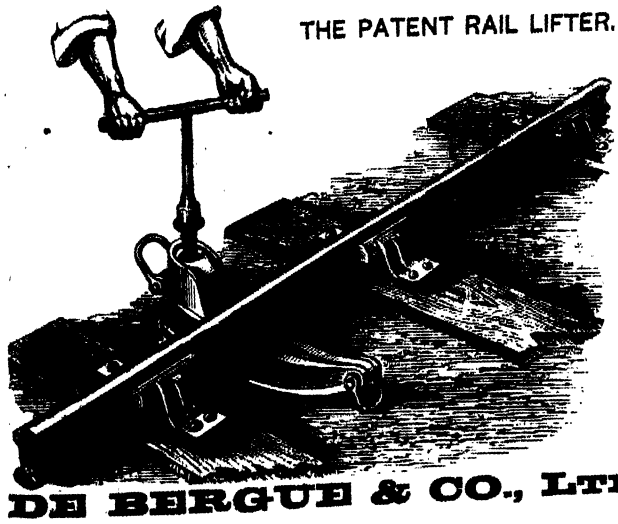
The SIMPLEST, SAFEST and BEST, and also the CHEAPEST Automatic Safety Apparatus for Turning Main Engines.

Sole Makers: HICK, HARGREAVES & CO., ENGINEERS, MILLWRIGHTS, AND BOILER MAKERS.

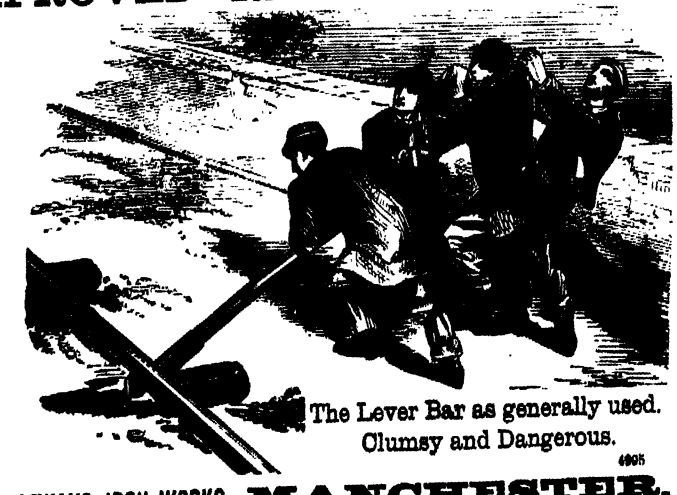
SOHO IRONWORKS, BOLTON. 5199

DE BERGUE'S PATENT IMPROVED RAIL LIFTERS.

THE PATENT RAIL LIFTER.



Entirely supersede the old inconvenient Lever Bars, and effect a great saving in Labour.



The Lever Bar as generally used. Clumsy and Dangerous. 4905

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TRADE MARK.

JOHN LYSAGHT, Limited,

TRADE MARK.

IRON ROOFS & BUILDINGS,

DESIGNS AND ESTIMATES UPON APPLICATION.

GALVANIZED CORRUGATED AND PLAIN SHEETS.
GALVANIZED STEEL SHEETS FOR WORKING UP.
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BRISTOL: ST. VINCENT'S GALVANIZED IRON WORKS.
WOLVERHAMPTON: SWAN GARDEN MILLS.
LONDON: 28, GRACECHURCH STREET, E. C. 4083

THE MERSEY FORGE, LIMITED



CRANK SHAFT FOR No. 206.
Forged Weight, 24 tons 11 cwt.; Finished Weight, 15 tons 8 cwt. 2 lbs.

LIVERPOOL,

MANUFACTURERS OF

Marine and other Crank Shafts,

STERN AND RUDDER FRAMES,

FORGINGS OF ALL KINDS

IN IRON AND STEEL.

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Town Office: 5, Harrington Street. 4082

ROOT'S PATENT STEAM BOILER.

NEW MODEL

WITH

STULLWELDED PATENT FEED WATER PURIFIER

High Pressure and Large Power with Safety Capacious Water and Steam Space.

—PERFECT CIRCULATION.—

GREAT EFFICIENCY AND ECONOMY.

Sulphates, Carbonates, and other Impurities Intercepted and Readily Removed from Purifier. Generative part of Boiler Continuing Free from Scale.

FOR PRICES AND PARTICULARS APPLY TO

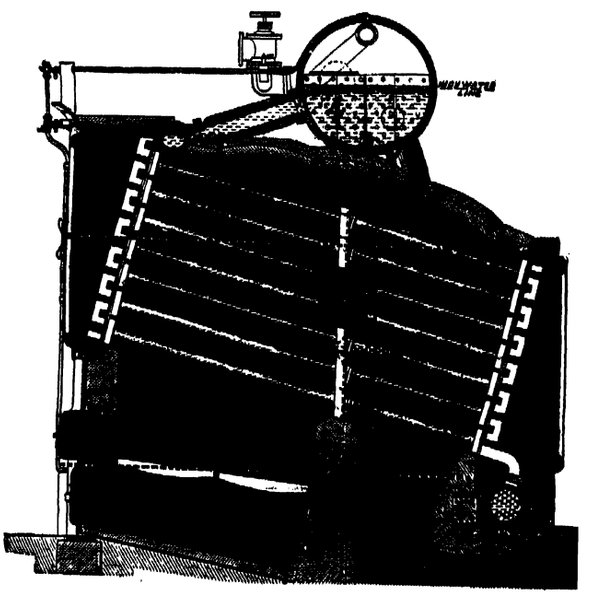
THE PATENT STEAM BOILER CO.

—(ESTABLISHED 1869.)—

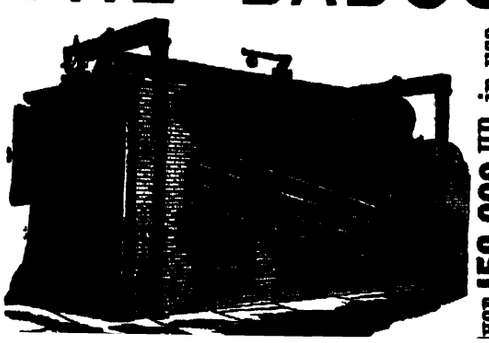
HEAD OFFICE AND WORKS: 28, HENEAGE STREET, BIRMINGHAM.

LONDON OFFICE: 11, QUEEN VICTORIA STREET, E.C.

CONRAD KNAP, REPRESENTATIVE. 5418



THE BABCOCK AND WILCOX CO



over 150,000 HP. in use.

(NEW YORK & GLASGOW)

PATENT

WATER-TUBE STEAM BOILER

Safe, Economical (as to space and fuel), and Durable; Having Perfect Water Circulation, and Spacio Steam-room; Easy of Transportation, and perfectly Accessible for Cleaning external and internal

For Illustrated Circular and full particulars apply to our European Offices,

107, HOPE STREET, GLASGOW, SCOTLAND

40, CANNON STREET, LONDON, E.C.; and

3, VICTORIA BUILDINGS, DEANSGATE, MANCHESTER.

For the Colonies and New Zealand, apply at No. 9 Spring Street, Sydney, N.S.W.

TANNETT WALKER & Co.,

ENGINEERS, LEEDS,

Makers of the heaviest class of Machinery used in the manufacture of **IRON** and of **STEEL** by the Bessemer and Siemens processes.

COGGING, RAIL & PLATE MILL ENGINES.

Armour Plate and Forging Presses.

STEAM HAMMERS.

Hydraulic Cranes and Capstans.

5263

WORKS:
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LONDON, S.E.

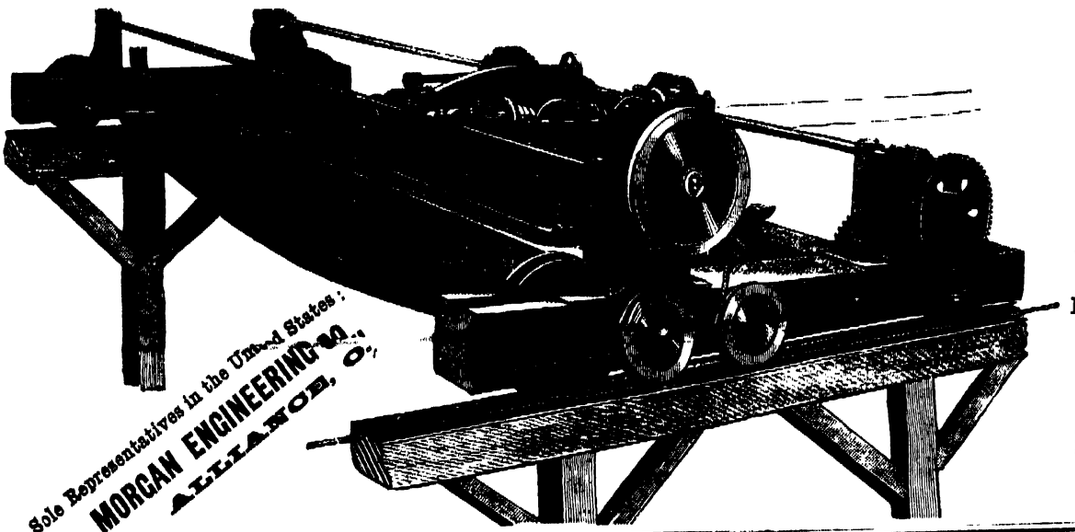
APPLEBY BROTHERS.

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STEAM, HAND, AND HYDRAULIC, FIXED, PORTABLE OR LOCO.

OVERHEAD TRAVELLERS
And Lifting Machinery of all descriptions.

Boilers.
All types of Land and Marine, and in all sizes.



STEAM ENGINES
Of all types and powers for Mills, Mines, Water Works, &c.

Winding Gear MACHINERY,
Combined or separate.

IRON BRIDGES,
Iron Roofs and Girder Work of all kinds.

4040

HARDINGHAM's Patent Sectional STEAM BOILER

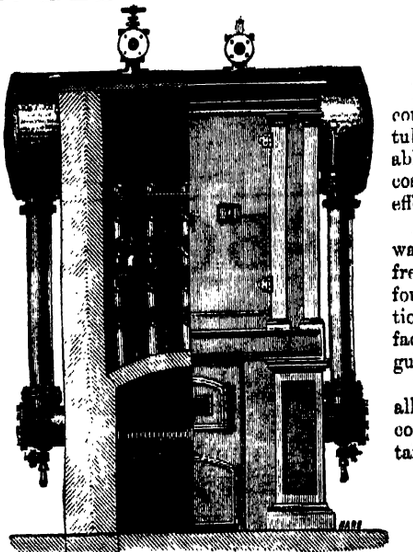
ANNULAR WATER-TUBE SYSTEM.

—:—

FOR
FULL PARTICULARS,
Apply to
F.G.M. Hardingham
Engineer,
91, Fleet Street,
LONDON, E.C.

—:—





—:—

By this improved construction of Water-tube Boiler, considerable economy in first cost and in working is effected.

Although the waterways are exceptionally free from liability to fouling, the construction affords peculiar facilities for their regular inspection.

The system further allows of extreme compactness being attained.

—:—

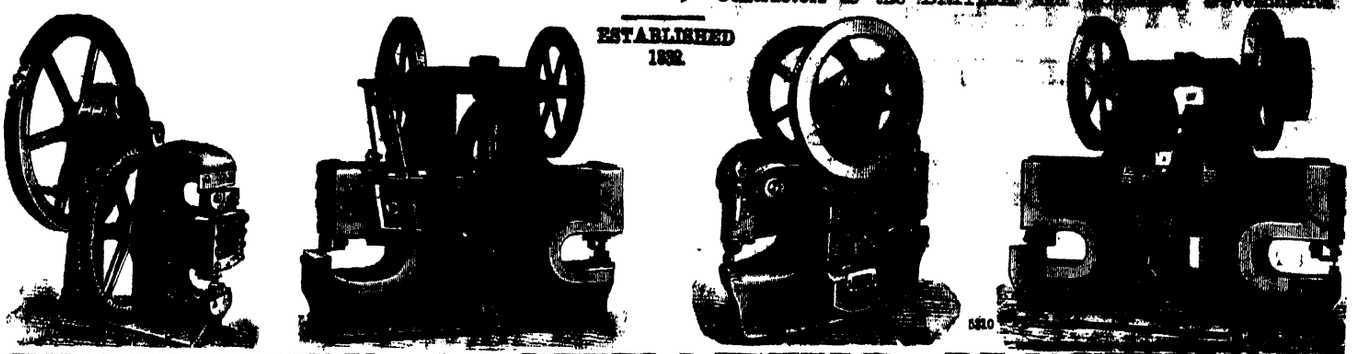
4967

The Boiler represented in the above sketch indicates 110 *HP., and occupies a space* 11 *ft. by* 9 *ft.*

FRANCIS BERRY & SONS,

Ironfounders, Engineers, and Tool Makers,
SOWERBY BRIDGE, NEAR HALIFAX.
Contractors to the BRITISH and FOREIGN Governments.

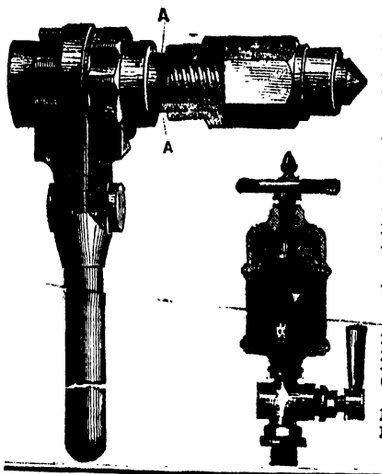
ESTABLISHED 1832.



PUNCHING & SHEARING MACHINES.

NETTLEFOLDS LIMITED, BIRMINGHAM,

SOLE MANUFACTURERS OF
WESTON'S STORER'S
PATENT DIFFERENTIAL RATCHET BRACE.—PATENT OPEN TOP SUET LUBRICATOR.



These BRACES, which have been several years before the public, and are MUCH APPRECIATED by their NETTLEFOLDS have lately CONSIDERABLY IMPROVED by enclosing the SCREW in a SLEEVE (A) which always PROTECTS it from INJURY either from DIRT or BLOWS. This SLEEVE also acts as a GUIDE for the NUT thus keeping it steady throughout the whole of its traverse, and consequently enabling the drilling to be effected with PERFECT ACCURACY.

The SUET LUBRICATOR has effected a saving of 70 per cent. in the cost of lubricating material used for Nettlefolds' Engines, and has now been fully tested in their works on 15 Cylinders working to 7[illegible] horse-power.

Messrs. HICKS, HARGREAVES & Co. write:—"We find the saving in *excess* of that stated in Messrs. Nettlefold & Chamberlain's Report—viz., 70 per cent., and the cylinders to which these Lubricators have been applied are in beautiful condition. We shall adopt them for all our engines."

By this Invention the steam is lubricated before passing to the valves, while the supply of grease is uniform and constant.

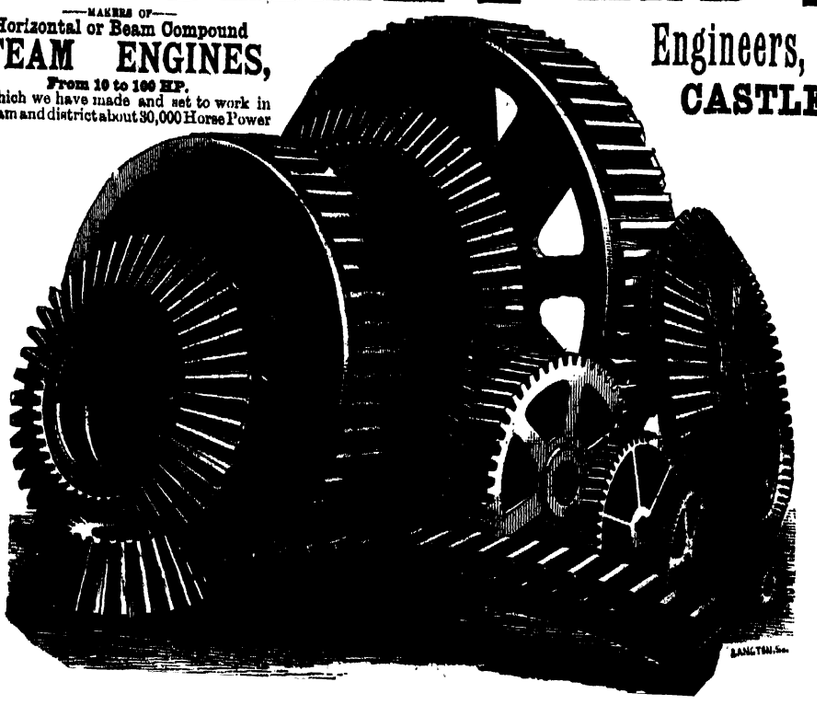
SOLD BY THE UNDERMENTIONED AGENTS:—

LONDON	Wakeman, C. H., Gt. Charles St.	SHEFFIELD	Wilkes Brothers & Co., Tasker Sons &
LIVERPOOL	Sharp & Carline, 54, James Street.	NEWCASTLE-ON-TYNE	Galloway & Co.
MANCHESTER	Edmondsons & Co.	NOTTINGHAM	Manlove, Alliott, Fryer & Co.
GLASGOW	W. McGeoch & Co., Schaffer & Budenberg.	BELFAST	Patterson, R., & Sons.
EDINBURGH	Redpath, Brown & Co., Thos. Scott.	DERBY	Handyside & Co.
BRISTOL	Weston, J. D., & Son.	RUSSIA	Sumner, John M. & Co., Manchester
		AUSTRIA	Simon, Henry, Manchester.
		GERMANY	Schaffer & Budenberg, Manchester

OF WHOM PRICED LISTS AND FULL PARTICULARS MAY BE OBTAINED.

BUCKLEY AND TAYLOR,

—MAKERS OF—
Horizontal or Beam Compound
STEAM ENGINES,
From 10 to 100 HP.
Of which we have made and set to work in Oldham and district about 30,000 Horse Power



Engineers, Millwrights, and Ironfounders
CASTLE IRONWORKS, OLDHAM.

—MAKERS OF THE—
COMPOUND ENGINE
Driving the Textile Machinery at the Oldham Exhibition.

LANCASHIRE STEAM BOILER
Made with the best Machinery, with Holes Drilled or Punched, and Plates Planed.

PATENT ELASTIC SPRING
PINION AND BEVEL WHEEL
Specially designed, and adapted for heavy work, varying loads, and sudden shocks.

PATENT BEVEL WHEELS
WITH SEPARATE STEEL RIMS,
APPLIED IN CASES WHERE GREAT STRENGTH IS REQUIRED.

MAIN DRIVING DRUM
For Ropes or Belts up to 30 feet diameter.

All other classes of Wheels moulded by our Patent Machines.

Agent for BUCKLEY & CO.'S (Sheffield)
PATENT COMPENSATING PISTON

RANSOMES AND RAPIER,

5, WESTMINSTER CHAMBERS,

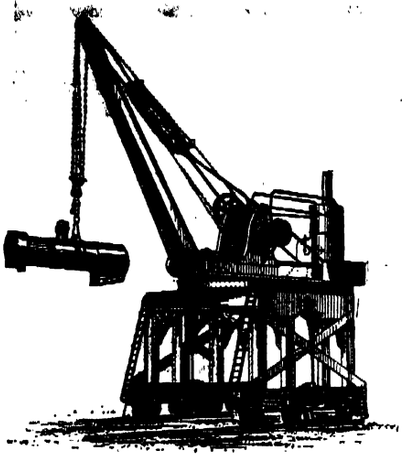
LONDON,

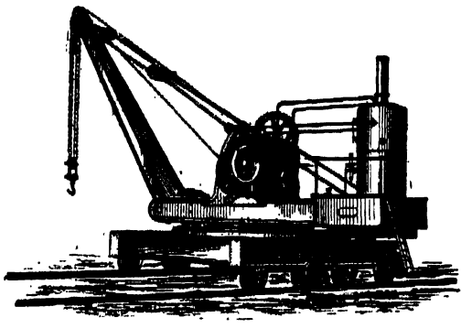
And WATERSIDE IRONWORKS, IPSWICH,

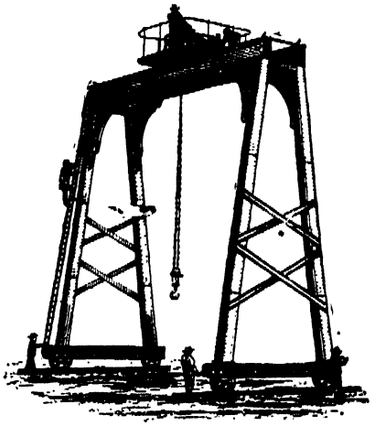
— MAKERS OF ALL KINDS OF —

STEAM & HAND CRANES

From 5 Cwt. to 50 Tons Load.



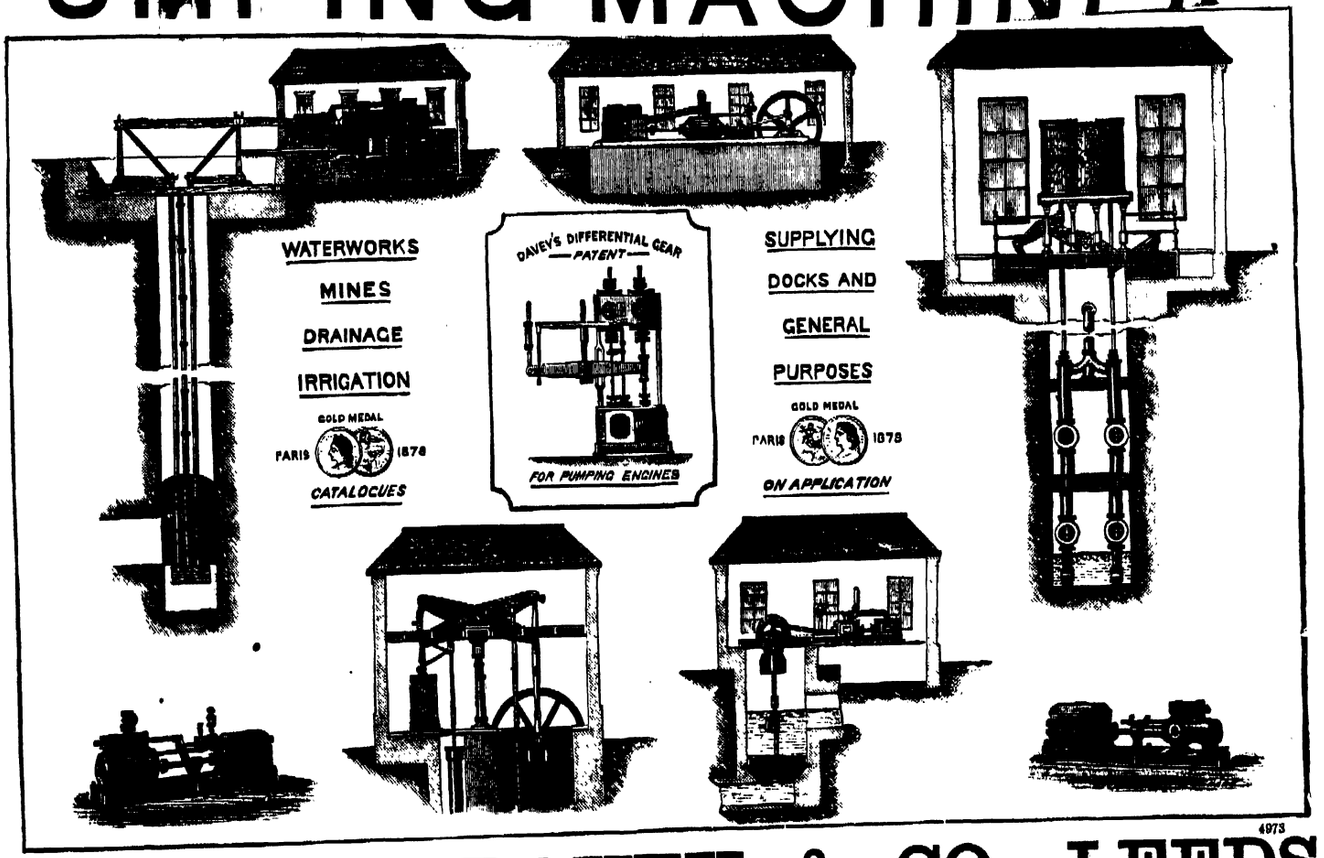




FOR PRICES AND ILLUSTRATIONS APPLY TO 5068

RANSOMES & RAPIER, 5, Westminster Chambers, LONDON, S.W.

PUMPING MACHINERY.



4973

HATHORN, DAVEY & CO., LEEDS.

F. G. BONE'S Patent COMPOUND TUBULAR CORNISH BOILERS

Ten most important features connected with these Boilers are—

1. Simplicity of Construction. 2. Saving of Fuel.
3. Greater Heating Surface. 4. Decidedly cheaper.
5. Can be Easily Cleaned. 6. Most Durable.
7. Accessible for Repairs without Disturbing the other Parts.
8. Great Economy in Boiler Space.
9. Will Burn either Tan, Breeze, Small Coal, or Sawdust.
10. Is Superseding all Others.

Testimonials and Prices on Application.



We beg to call attention to the small amount of space these Boilers occupy—

9ft.	long,	5ft. 6in.	diameter,	20-horse power.
10ft.	,,	5ft. 6in.	,,	30 ,,
12ft.	,,	6ft. 0in.	,,	40 ,,
13ft.	,,	6ft. 6in.	,,	50 ,,
14ft.	,,	7ft. 0in.	,,	60 ,,
15ft.	,,	7ft. 6in.	,,	70 ,,
16ft.	,,	8ft. 0in.	,,	80 ,,
17ft.	,,	8ft. 0in.	,,	90 ,,
18ft.	,,	8ft. 0in.	,,	100 ,,

SOUTH LONDON BOILER WORKS, LONG LANE, BERMONDSEY, LONDON.

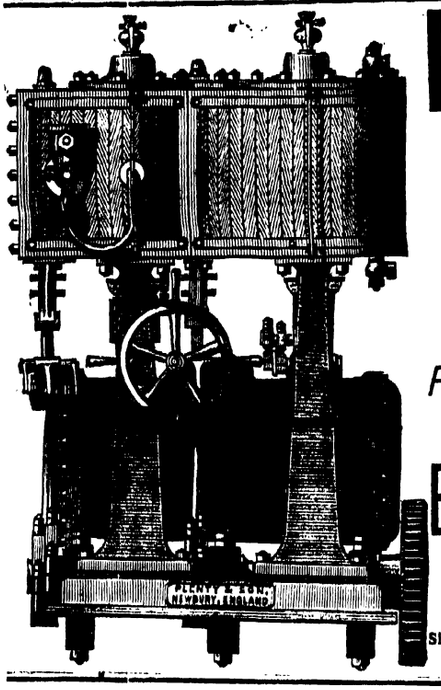
A LARGE NUMBER OF PRACTICAL MEN KEPT ON HAND SPECIALLY FOR BOILER REPAIRS. 4180

BRASS & COPPER TUBES

SEAMLESS & BRAZED, FOR BOILERS, SURFACE CONDENSERS &c 4867

BRASS & COPPER WIRE, SHEETS &c.

BIRMINGHAM BATTERY & METAL CO. BIRMINGHAM.



PLENTY & SON,

EAGLE IRONWORKS,

NEWBURY, BERKS.

MANUFACTURERS TO THE ADMIRALTY.

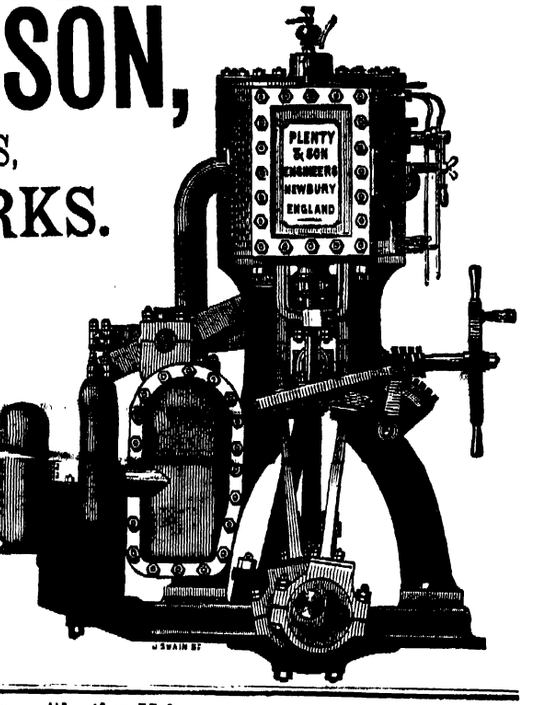
First Prize, Royal Yacht Club, Cowes.

ENGINES & BOILERS

FOR

SMALL STEAMERS, YACHTS, TUGS, LAUNCHES, &c.

Simple, High-Pressure, Compound, and Surface Condensing Engines always to be seen in progress at Works. 4227

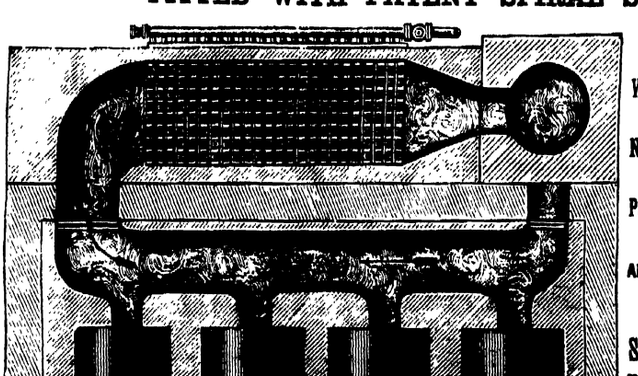


Gained the HIGHEST AWARD wherever exhibited in Competition with other Makers.

LOWCOCK'S IMPROVED FUEL ECONOMISER

(FOR UTILISING THE WASTE HEAT FROM STEAM BOILERS),

FITTED WITH PATENT SPIRAL SCRAPER AND POSITIVE REVERSING MOTION



PLAN.

SPECIAL ADVANTAGES.

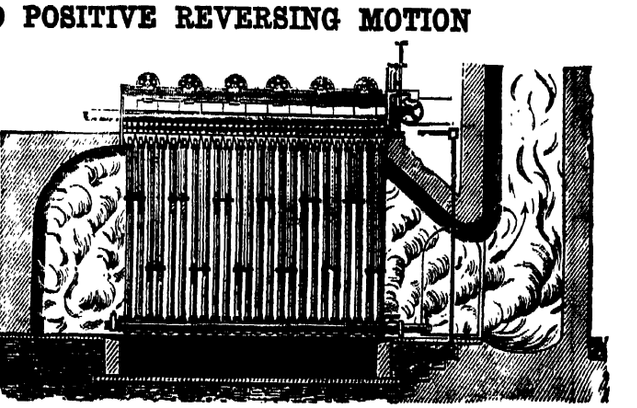
Vertical Pipe Castings. Guaranteed sound and perfectly true.

New Patent Spiral Scrapers The most effectual removers of *soot*.

Patent Reversing Gear. Never sticks or gets out of order.

ALREADY IN OPERATION TO HUNDREDS OF STEAM BOILERS.

Saves from 20 to 25 per cent. of the fuel.



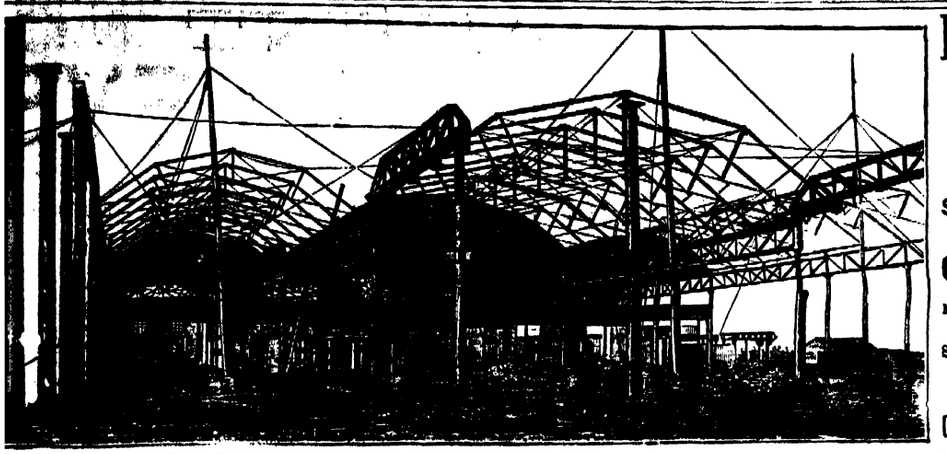
ELEVATION.

N.B.—CAN BE APPLIED TO ALL SORTS OF BOILERS AND THE FIXING DOES NOT INVOLVE ANY STOPPAGE OF WORKS.

The ECONOMISER has for many years been recognised as indispensable to all large users of Steam Power, and has been most extensively adopted throughout the United Kingdom and abroad.

PRICES, TESTIMONIALS, AND FURTHER PARTICULARS ON APPLICATION TO 4430

ARTHUR LOWCOCK, (PATENTEE & SOLE MAKER) Coleham Foundry, Shrewsbury, England.



From Photo. of STEEL ROLLING MILLS, covering many acres, showing ROOFS in IRON and STEEL, in course of erection by MOREWOOD & CO.

Roofs and Buildings
IN IRON AND STEEL.

MOREWOOD & CO.
WOODFORD IRONWORKS,
SOHO, BIRMINGHAM.
LONDON OFFICES—158, LEADENHALL STREET, E.C.

CORRUGATED AND GALVANISED SHEETS,
LION WORKS, BIRMINGHAM

Manufacturers of every description of *Roofs* and *Buildings* in Iron and **STEEL** for Forges, Rolling Mills, Railway Stations, Goods Sheds, Yards, Docks, Stores, and General Purposes.
Special Curved Corrugated Iron Roofs without Framing for moderate Spans.
WROUGHT IRON WATER TANKS, any size.
ANNEALING AND GALVANIZING POTS.
Corrugated Iron & **STEEL** Sheets & Fastenings, &c.
Ridges, Gutters, and Tanks, Galvanized or Painted.
Wrought-Iron Lattice and Plate Girders. Railway, Road and Foot Bridges.
DESIGNS AND ESTIMATES ON APPLICATION. 4909

Paris, 1878.—GOLD MEDALS AWARDED.—Melbourne, 1881.

WM. JESSOP & SONS, LIMITED,

BRIGHTSIDE WORKS, SHEFFIELD,

MANUFACTURERS OF

EVERY DESCRIPTION OF TOOL STEEL & STEEL CASTINGS,

Cast, Shear, German, Spring, Blister & Sheet Steel for all purposes.

Files of First Quality.—Steel Lagging Plates for Cylinders.—Steel Boiler & Ship Plates & Forgings of all kinds.

DEPOTS:—Manchester, Paris, Dusseldorf, St. Petersburg, New York, Boston, Philadelphia, Cincinnati, St. Louis, Chicago, San Francisco, Baltimore, Providence, Montreal.

LONDON OFFICE: MESSRS. CORNES, CALVERT & CO., 30, WALBROOK, E.C. 5137

DAVY BROTHERS, LIMITED,

SHEFFIELD,

MANUFACTURERS OF

STEAM HAMMERS

From 1 Cwt. to 50 Tons, for every kind of work,

Fitted with DAVY'S PATENT VALVES, which save from 25 to 50 per cent. of Steam.

BESSEMER STEEL WORKS PLANT,

FORGE AND ROLLING MILL MACHINERY,

Steam Engines for Mills, Ironworks, Collieries, &c.

SINGLE AND DOUBLE FLUED BOILERS. 5178

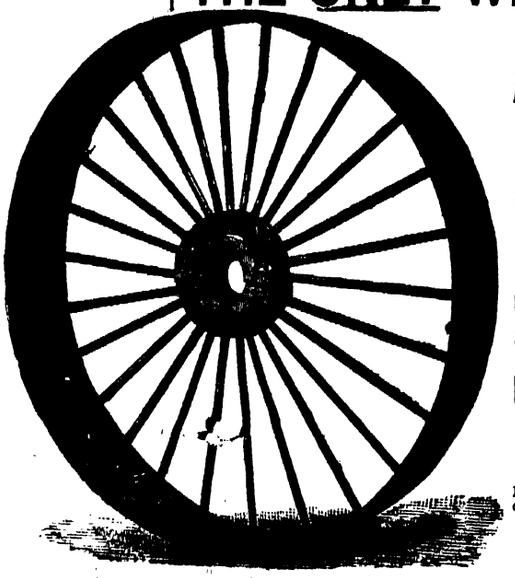
RODGERS' PATENT
WROUGHT IRON PULLEYS

Telegraphic Address, "LOOO," LEEDS.

WROUGHT IRON THROUGHOUT, RIM, ARMS, AND BOSS.

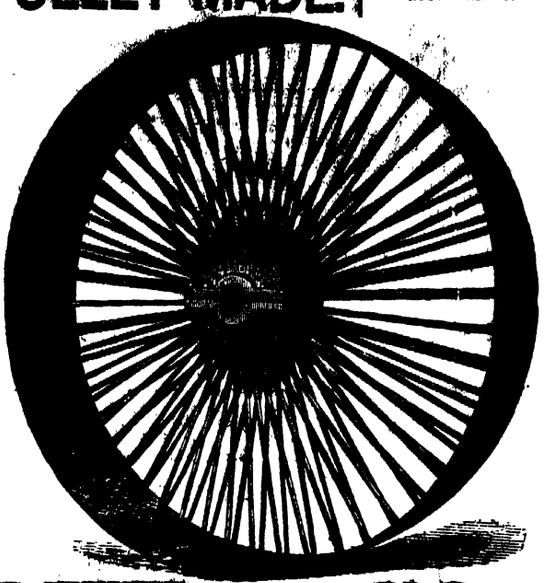
THE ONLY WROUGHT IRON PULLEY MADE.

Telegraphic Address, "LOOO" LEEDS.



SPLIT OR SOLID.

All Sizes up to 24 feet Diameter.



40,000

IN USE.

The Best Pulley in the World

USED SOLELY FOR

DRIVING THE ELECTRIC LIGHT

AT THE

HEALTH EXHIBITION,

SOUTH KENSINGTON.

Messrs. Marshall, Sons and Co., Limited, keep a Stock of our Pulleys at their Depôt, Marshalls' Buildings, 79, Farringdon Road, London, E.C.

SOLE MAKERS:

HUDSWELL, CLARKE & CO.,

RAILWAY FOUNDRY, LEEDS.

— SOLE AGENTS —

France—O. BORISSOW, Rue a Fiens, 3ter, Lille,
Russia—S. G. MARTIN, Galerny No. 12, Quartier 8, St. Petersburg.
Austria—J. EGLI, I, Berz Freiung 7, Vienna.
Saxony—W. W. DERHAM, Leipzig.
Belgium—D. GRANDY, Rue de l'Abattoir 30, Gand.
Italy—A. SINGTON & CO., Manchester and Milan.

Holland—VAN RIETSCHOTEN EN HOUWENS, Rotterdam.
Portugal—ALFD. HARRISON, Rua Nova St. Domingos 95, Oporto.
Dominion of Canada—T. J. CHURCH, 672, Craig St. Montreal.
Lancashire & District—F. B. WELCH & CO., Market St., Manchester.
North of England—Snowball & Co., Side, Newcastle-on-Tyne.
W. of England—Townsend & Young, Arch House, John St., Bristol.

Glasgow & District—Robertson & Co., 9, Old Sneddon St., Paisley.
South of Ireland—Jas. F. Roberts, 72, Francis Street, Dublin
New Zealand—Walter Brown, 1, College Green, Wellington.
Australia and Tasmania—John J. Horrocks & Co., Adelaide and Sydney.
Scandinavia—Messrs. Oberle & Thomas, Manchester & Mulhouse

MATTHEW PAUL & CO.,

MAKERS OF

Steam and Hand Windlasses,

STEAM STEERING GEAR, ALSO SCREW STEERING GEAR,

AND EVERY DESCRIPTION OF SHIP FITTINGS.

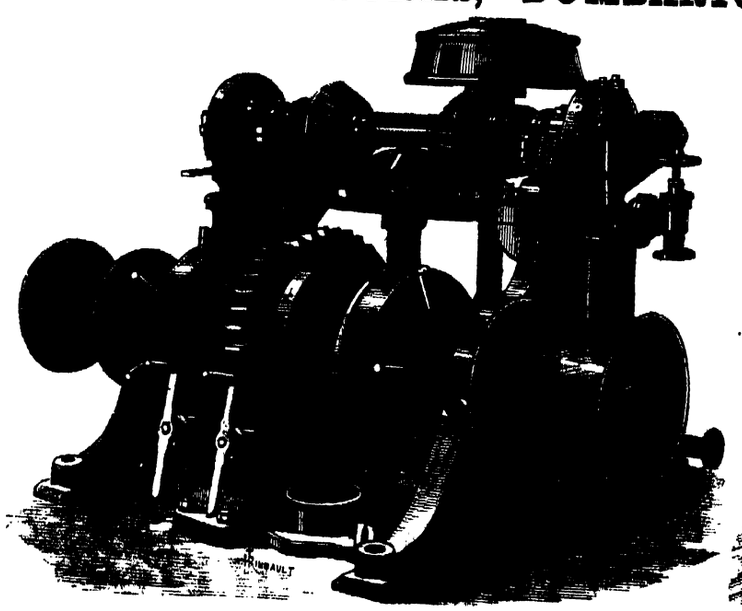
LAND & MARINE ENGINES,

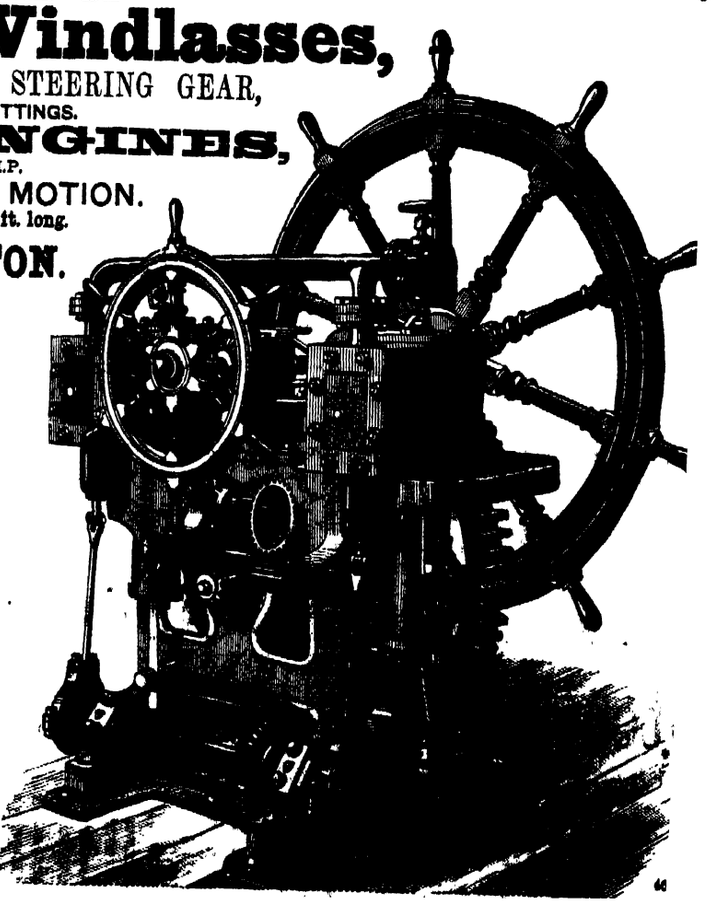
OF ALL SORTS AND SIZES UP TO 1,000 I.H.P.

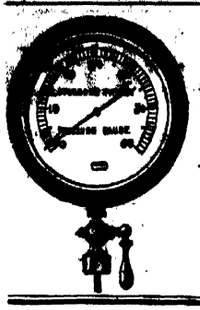
LAUNCH ENGINES, WITH PATENT VALVE MOTION.

BUILDERS of LAUNCHES, BARGES, and YACHTS, up to 100 ft. long.

LEVENFORD WORKS, DUMBARTON.







Only Gold Medal for Gauges at the Paris Exhibition, 1878.

BOURDON'S TRADE E. BOURDON LATE Inventor & Manufacturer GAUGES (OWN MAKE)

NEGRETTI & ZAMBRA, OPTICIANS, HOLBORN VIADUCT,

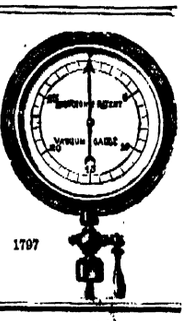
Telephone No. 6583.] SOLE AGENTS IN LONDON. [Telephone No. 6583.

M. BOURDON cautions Persons using Steam Gauges that a large number of very inferior instruments are sold, bearing his name, which are not of his manufacture, a great proportion of them also having a forged Trade Mark.

AGENTS :—J. CASARTELLI, 43, Market St., Manchester; CHADBURN & SONS, 71 & 73, Lord St., Liverpool. 1797

NEGRETTI & ZAMBRA'S NEW CATALOGUE of Scientific Instruments, 500 pages, 1,000 Engravings, is now published, price 5s. 6d.

N. & Z. are Sole Agents for Ritchie & Sons' Patent Liquid Compasses, and for Steinheil's Patent Photographic Lenses and Prisms.



CRANES. TURNTABLES. TRAVERSERS

COWANS, SHELDON & CO., LTD., ST. NICHOLAS WORKS, CARLISLE. 5008

DANIEL ADAMSON & CO.,

[Established 1851.] ENGINEERS AND BOILER MAKERS, [Established 1851.]

DUKINFIELD, NEAR MANCHESTER.

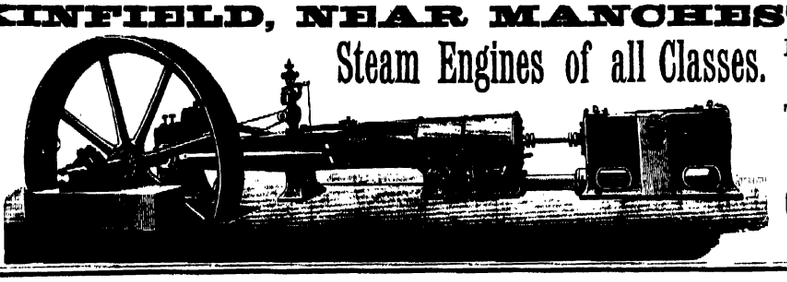
SOLE MAKERS OF

THE WHEELOCK PATENT

Automatic Expansion Engine

Which has gained highest awards in competition with Corliss and other Automatic Expansion Engines.

BULKLEY PATENT INJECTOR CONDENSER.



Steam Engines of all Classes.

BLOWING ENGINES, AIR COMPRESSORS, BESSEMER PLANT, TESTING MACHINES, PATENT HYDRAULIC JACKS.

GENERAL HYDRAULIC ENGINEERS. 5401

BELL'S ASBESTOS

BELL'S PATENT ASBESTOS BLOCK PACKING, for High-pressure Engines.

The following Testimonials refer to this Packing :—

New Zealand Shipping Co., Limited.

BELL'S Asbestos Works, Southwark. S.S. "Ruapehu." Royal Albert Dock, 19th May, 1884.

Gentlemen,—I beg to state that your Patent Asbestos Block Packing was used in the high-pressure pistons of this ship with the following remarkable results :—

14,000 miles continuous steaming without renewal.

Steam Pressure.....110 lbs. Vacuum.....29 inches.

My experience does not show an equal result from any other packing.

The voyage from [illegible] test run from New Zealand on record.

Yours obediently,

D. HENDERSON, Chief Engineer, S.S. "Ruapehu."

Manchester, Sheffield, and Lincolnshire Railway—Steamship Department, Grimsby, April 10th, 1884.

Dear Sir,—I have much pleasure in stating that after a trial of over nine months, and comparing with other packings, I can confidently recommend your Asbestos Packing. It is especially valuable when high pressures are employed, as in cases where other packings have perished, owing to high temperatures, your packing has invariably stood well. I have also used it with complete success in a gland has heated with other packings, and also in cases of badly scored piston rods. I consider the results I have obtained by its use for our marine engines to have been in every way highly satisfactory.

Yours truly,

G. H. CLARKE, Sup. Engineer.

Mr. J. BELL.

Department of the Director of Navy Contracts.

Admiralty, Whitehall, 20th June, 1884.

Sir,—I have to inform you that your tender has been accepted for Bell's Rolled Cloth Asbestos packing to sample submitted.

Elastic core.....square. Elastic core.....round.

JOHN COLLETT, Director of Navy Contracts.

To Mr. JOHN BELL.

The Patent Block Packing is square, as Fig. 1, and Figs. 2 and 4 represent the Bound Cock Packing with solid and hollow rubber core, and Fig. 3 without core, but with rubber laid.

As these packings are extensively imitated, and as it is a common practice among sales and agents to supply the cheaper manufactures at my list prices, users are requested see that the packing supplied to them bears the trade mark.

BELL'S ASBESTOS BOILER PRESERVATIVE.

This useful mixture by absorbing the free oxygen that is in the water entirely checks pitting and corrosion. It also disintegrates incrustation so immediately as to prevent its adhering to the plates.

Not only is a great economy of fuel effected by keeping boilers clean, but the risk of having the plates burned is thereby obviated.

It has been computed that 1-16 in. thick of incrustation causes a waste of 15 per cent. of coal ; ¼ in., 60 per cent. ; ½ in., 120 per cent.

Thus the Preservative avoids the great risks which are inseparable from scaled plates lengthens the life of a boiler, and covers its own cost a hundred-fold by economy of fuel.

It is entirely harmless, and has no injurious action on metals.

It can be put into the feed tank or boiler, as may be most convenient.

Sold in drums and casks bearing the trade mark, without which none is genuine.

BELL'S ASBESTOS YARN & SOAPSTONE PACKING, for Locomotives, and all Stationary Engines running at very high speed with intense friction.

Sandwell Park Colliery, Smethwick, 1st February, 1884.

To BELL'S Asbestos Works.—Dear Sirs,—I have much pleasure in stating that I have used your Asbestos Packing for the last thirteen months for our large winding engines which are running night and day, and also for the fan, pumping and hauling Engines at the above Colliery, and during that period we have not used more than one third the packing we had formerly ; and this I attribute to your Packing, on account of its great durability and general excellence of quality.

I am, dear Sirs, yours faithfully,

THOMAS WENTEN, Colliery Engineer.



TRADE MARK

— BELL'S ASBESTOS. —

The goods of this house are of the highest quality only, and no attempt is made to compete with other manufacturers by the supply of inferior materials at low prices. All "home" orders should be sent direct to the undermentioned depôts and not through agents or factors.



FIG. 1.



FIG. 2



FIG. 4.



FIG. 3.

BELL'S ASBESTOS BOILER AND PIPE COVERING COMPOSITION, for coating every class of steam pipes and boilers, non-combustible and easily applied when steam is up; adheres to metals and preserves them from rust; prevents the unequal expansion and contraction of boilers exposed to weather; saves 80 per cent. more surface than any other coating, and is absolutely indestructible. It can be stirred [illegible] years' use, mixed up with 30 per cent. of fresh, and applied again. The composition [illegible] mixed with water to the consistency required for use. [illegible] 24 dcs.

A Boy can [illegible] one ton of coal was saved per week, and although the fire was raked out every evening, 20 lb. of steam were found in the boiler next morning.

The following Testimonial refers to this Covering :—

Offices of the Wimbledon Local Board, Wimbledon, Nov. 26th, 1883.

"Dear Sir,—It may interest you to know that we save exactly 40 per cent. in fuel through using your covering.—Yours truly,

"W. SANTO CRIMP, C.E., F.G.S."

The Tamar and Kit Hill Granite Company, Limited,

Gunnislake, Tavistock, 8th April, 1884.

MR. JOHN BELL, Southwark, S.E.

Sir,—I have much pleasure in stating that the Asbestos Covering applied by you to the boiler of our travelling crane at Kit Hill, has yielded most remarkable results. Since it has been in use we have saved fully half our coals, and have effected a great saving in the time it takes to get up steam, which is often a matter of great importance to us. I should add that the crane runs on high gantries, and is fully exposed to all weather. I have formed the highest opinion of your Asbestos as used for this purpose, and as you are aware, have had another boiler similarly covered, though it has not since been used. I can most strongly recommend the material.—I am, Sir, yours faithfully,

W. J. CHALK, Assoc. M. Inst. C.E., Engineer and Manager.

BELL'S ASBESTOS & INDIA-RUBBER WOVEN TAPE AND SHEETING,

for making every class of Steam and Water Joints. It can be bent by hand to the form required without puckering, and is especially useful in making joints of manhole and mudhole doors. It is kept in stock in rolls of 100 ft., from ¼ in. to 8 in. wide, and any thickness from 1-16th in. upwards. Manhole covers can be lifted many times before the renewal of the jointing material is necessary.

The same material is made up into sheets about 40 in. square, and each sheet bears the Trade Mark, without which none is genuine.

It is very necessary to guard against imitations of this useful material, and to secure themselves against being supplied with these inferior articles at my price, users are recommended to see that every 10 ft. length of the Asbestos Tape purchased by them bears the Trade Mark.

BELL'S SPECIAL LONDON-MADE ASBESTOS MILLBOARD,

for Dry Steam Joints, made of the best Asbestos fibre, is well known for its toughness and purity, and is absolutely free from the injurious ingredients frequently used to attain an appearance of finish, regardless of the real utility of the material. Made in sheets measuring about 40 in. square, from 1-64th in. to 1 in., and ¼ millimetre to 25 millimetres thick. Each sheet bears the Trade Mark.

The following copy of acceptance of tender refers to above :—

Department of the Director of Navy Contracts.

Admiralty, Whitehall, S.W., 17th May, 1884.

Sir,—I have to inform you that your tender for Asbestos Millboard has been accepted.

JOHN COLLETT, Director of Navy Contracts.

Mr. JOHN BELL.

BELL'S ASBESTOS EXPANSION SHEETING, Patent.

This Sheeting is another combination of Asbestos with India-rubber, giving to the steam user the special advantages of both materials.

The India-rubber Washer is protected from the action of heat and grease by an outer coating of vulcanised Asbestos Cloth, thus producing an excellent joint where expansion and contraction render other materials unserviceable.

This material is admirably suited to steam pipe joints and every class of valve.

Valves made of this material are very durable, as they are not subject to injury by oil

BELL'S "ASBESTOS LUBRICANT" REGD.

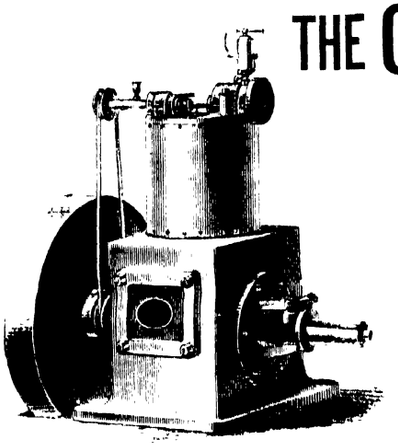
ILLUSTRATED PRICED CATALOGUE FREE ON APPLICATION TO

BELL'S ASBESTOS WORKS, SOUTHWARK, LONDON, S.E. 4942

—OR THE DEPOTS—

11 & 13, St. Vincent Place, GLASGOW. 39, Mount Stuart Sq., CARDIFF. 21, Ritter Strasse, BERLIN.

118a, SOUTHWARK ST., S.E. Victoria Buildings, Deansgate, MANCHESTER.



THE COALBROOKDALE COMPANY, LIMITED

SOLE MAKERS OF

ELWELL & PARKER'S PATENT

HIGH SPEED ENGINES,

THE MOST EFFICIENT AND RELIABLE MADE.

Also LIGHT BALANCED PULLEYS, SHAFTING, &c.

Electric Lighting and Plating Installations, complete. 5137

COALBROOKDALE, R.S.O., SHROPSHIRE.

THE SAVILE STREET FOUNDRY AND ENGINEERING CO.,

(LIMITED), SHEFFIELD, SOLE MANUFACTURERS OF

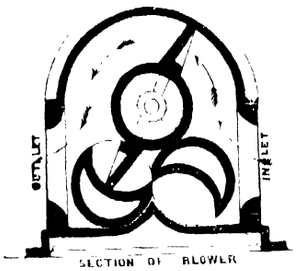
Baker's Patent Rotary Pressure

—:o:—

BAKER'S PATENT ROTARY PUMP.

—:o:—

CRUCIBLE STEEL CASTINGS.



SECTION OF BLOWER

Blower and Gas Exhauster.

—:o:—

HALL'S PATENT STONE BREAKER.

—:o:—

General Machinery of Every Description.

London Offices and Exhibition Rooms, 53, Queen Victoria Street, E.C. (Opposite Mansion House Station.) Messrs. BECK & CO., Limited, Agents. 4655

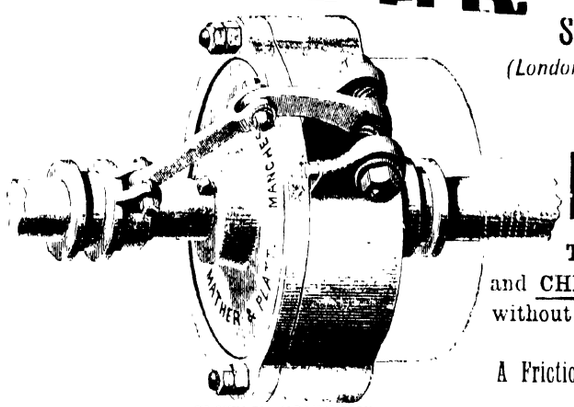
MATHER & PLATT,

SALFORD IRON WORKS, MANCHESTER,

(London Representatives, Messrs. LEWIS OLRICK & CO., 27, Leadenhall Street, E.C.)

PATENT

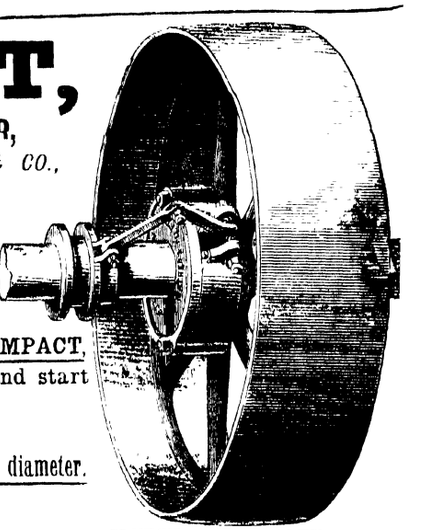
FRICTION CLUTCH.



CLUTCH COUPLING.

These Clutches are SIMPLE, DURABLE, COMPACT, and CHEAP, are easily thrown in and out of gear, and start without shock when running full speed.

A Friction Clutch 3 ft. diameter equals a Cone Clutch 6 ft. diameter.



CLUTCH AND PULLEY

LIBERAL TERMS TO THE TRADE.

PRICES ON APPLICATION.

GOODFELLOW & MATTHEWS,

(LATE B. GOODFELLOW. ESTABLISHED 1838.)

HYDE, NEAR MANCHESTER,

MAKERS OF

ROPE & WHEEL GEARING

All Descriptions of Millwright Work.

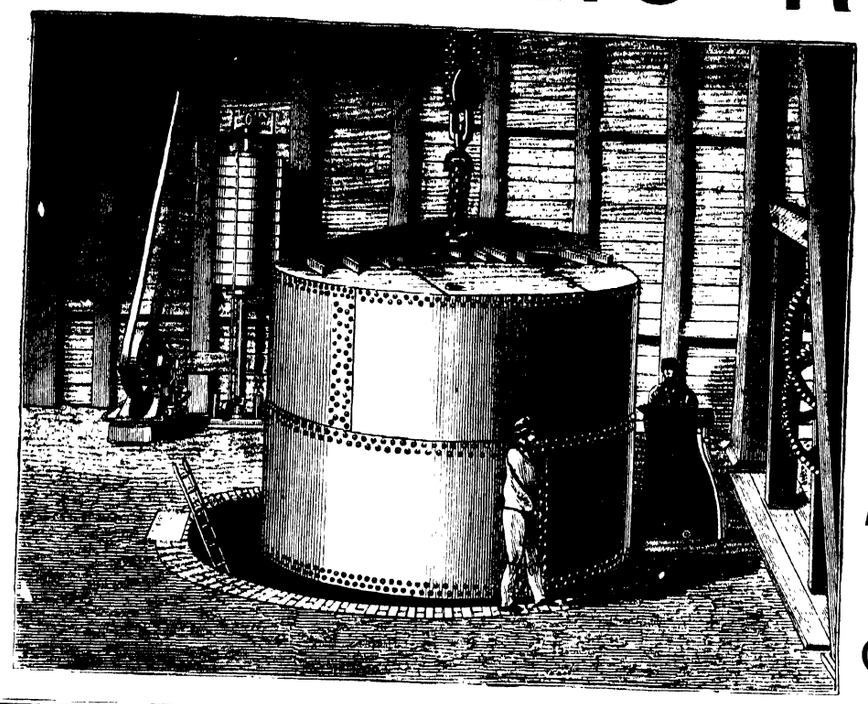
HIGH CLASS STATIONARY, PUMPING, and BLOWING ENGINES, with CORLISS OR OTHER VALVE GEARS

IMPROVED METALLIC PISTONS AND AIR PUMP BUCKETS.

CYLINDERS, &c., BORED AND VALVE FACINGS PLANED IN THEIR PLACES. WHEELS, &c., MOULDED BY PATENT MACHINER

FLY-WHEELS, ROPE AND BELT PULLEYS &c., TURNED TO ANY SIZE. FORGINGS OF EVERY DESCRIPTION. 5000

HYDRAULIC RIVETTERS



OF THE MOST RECENT TYPES.

Punching, Shearing, Bending, Forging, Hoisting,

AND OTHER HIGH-PRESSURE

HYDRAULIC MACHINERY

Please Note Change of Address:

ANDERSON & CALLWEY

Hydraulic Labour-Saving Machine Makers,

CREMORNE WORKS, 4085

CHELSEA, LONDON, S.W.

Contractors to the British and Foreign Governments.

BRIDGE FOUNDATION CYLINDERS.

THE STOCKTON FORGE CO.

Make a Speciality of this work, turning out over 100 tons per week; also large quantities of Railway Chairs. STOCKTON-ON-TEES. 4086

WALKER BROTHERS,

ENGINEERS AND BOILER MAKERS,

PAGEFIELD IRON WORKS, WIGAN.

WALKERS' PATENT

AIR-COMPRESSING ENGINES

For COLLIERIES STEEL WORKS, &c., and as supplied to HER MAJESTY'S GOVERNMENT for INDIA

WALKERS' PATENT GUIBAL VENTILATING FANS,

For Mines, Collieries, Tunnels, Sewers, &c. Diameters from the smallest size up to 50ft. With Simple or Compound Condensing Engines

MAKERS OF THE GUIBAL, SCHIELE (his latest Patent), AND WADDLE FANS.

LOCOMOTIVES. STEAM HAMMERS, Patterns up to 20 tons. FORGE and ROLLING MILL PLANT. WINDING, HAULING, and PUMPING ENGINES. IMPROVED FEED PUMPS for BOILERS.

STEAM CAPSTANS, Patterns for lifting up to 60 tons. OVERHEAD TRAVELLERS AND OTHER CRANES.

HORIZONTAL AND VERTICAL, STATIONARY, AND LOCOMOTIVE BOILERS.

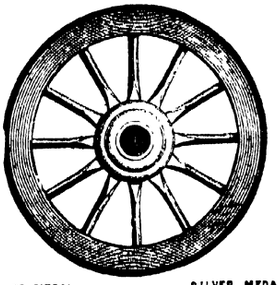
Iron and Steel Forgings. Horizontal and Vertical Engines, Condensing and Non-Condensing. Roofs, Girders, Bridges, Pit Cages, &c., and all kinds of Iron and Steel Work.

WALKERS' Patent, as adapted to Bessemer Blowing Engines, is now in successful operation at the following Steel Works, and is about to be applied to other Engines for similar purposes:—

Messrs. BOLCKOW, VAUGHAN and CO., Eston, Middlesbro'.
" The DOWLAIS IRON CO., Dowlais.
" CHARLES CAMMELL and CO., Cyclops Works, Sheffield.
" The DARLINGTON IRON and STEEL CO., Darlington.
" The WEARDALE IRON and STEEL CO., near Durham.
" The NORTH-EASTERN STEEL CO., Middlesbro'.

And to nearly 200 other Engines for a variety of purposes throughout the country.

The advantages afforded by the application of the Patented Valves to Bessemer Engines, are a greater endurance than has yet been attained by valves worked automatically (eccentrics, &c., for the valves not being required), and an almost perfect expulsion of the whole of the compressed air from the cylinders. 4102



SILVER MEDAL



SILVER MEDAL



WHEELS.

Made by Machinery, all sizes, for Carriages, Carts, Vans, Wagons, Cabs, Omnibuses, &c.

WHEELS.

Large Stock always on hand. Tyreing Repairs and Special Orders executed at the shortest notice.

AXLES AND SPRINGS SUPPLIED.

—:o:—

PRICES ON APPLICATION.

—:o:—

SMITH, PARFREY & HITCHINGS

PIMLICO WHEEL WORKS, 3113

BUCKINGHAM PALACE ROAD, LONDON.

W. ROWLANDSON,

132, Boundary St.,

LIVERPOOL,

—MAKER OF—

OIL MILL MACHINERY

On the Old ANGLO-AMERICAN.

OIL BOILING PLANT,

Machine Moulded Wheels,

PULLEYS, SHAFTING,

ELEVATORS,

ENDLESS BAND CONVEYERS,

AND ALL KINDS OF MILLWRIGHT AND ENGINEERS' WORK. 5278

GOLD MEDAL, PARIS, 1878.

GAUGE GLASSES

AND

ENAMELS

For Iron, Cast-iron, Copper, &c.



PATENT **GUILBERT-MARTIN**

Patentee and Manufacturer of the

PATENT

RED REFLECTING GAUGE GLASS,

Showing through the water a Broad Red Line.

N.B.—All Glasses are of the finest quality, and manufactured expressly to resist extreme pressure.

DEPÔT:

1 & 2, FALCON STREET,

Aldersgate Street,

LONDON, E.C.

The above line shown in black is of a rich Red. 5002

REPRESENTED BY

E. M. HAMBURGER.

JESSOP'S CRANES

—:o:=:o:—

SPECIALITIES:

CRANES,

TRAVELLERS,

WINDING ENGINES,

HOISTS,

WINCHES,

—PUMPS,—

MILL ENGINES

FITTED WITH

COLLMANN'S PATENT VALVE GEAR.

Cheapest and Most Efficient Crane in the Market.

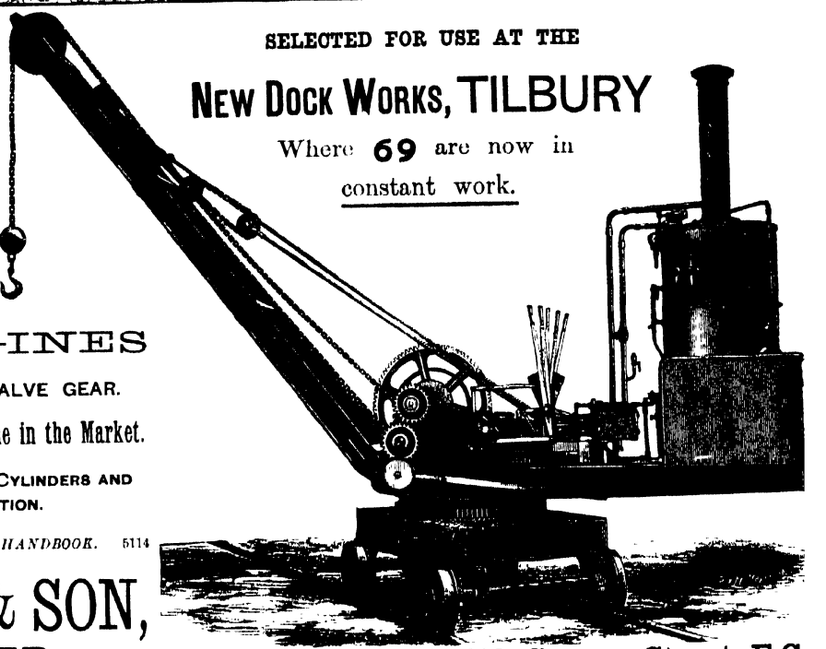
ALL OUR CRANES HAVE TWO CYLINDERS AND LINK REVERSING MOTION.

SEND FOR ILLUSTRATED HANDBOOK. 5114

SELECTED FOR USE AT THE

NEW DOCK WORKS, TILBURY

Where **69** are now in constant work.



J. JESSOP & SON,

LEICESTER.

LONDON OFFICE: 113, Cannon Street, E.C.

AWARDED

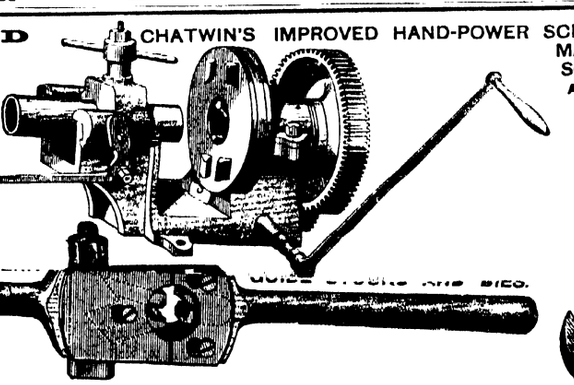
A

Gold & Silver Medal

AND

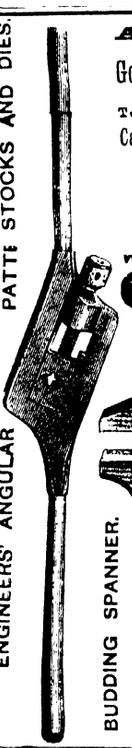
Two 1st Class Certificates at Calcutta Exhibition, 1884.

CHATWIN'S IMPROVED HAND-POWER SCREWING MACHINE, SCREWING AT ONCE OVER.

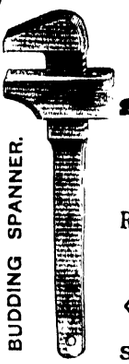


PATENT STOCKS AND DIES.

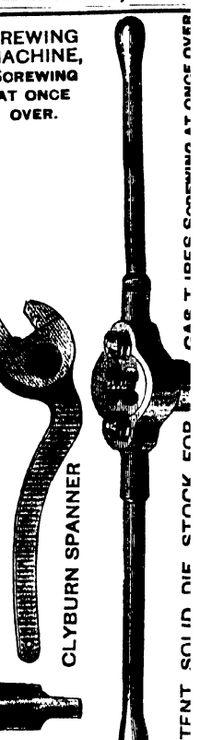
ENGINEERS' ANGULAR



BUDDING SPANNER.



CLYBURN SPANNER



PATENT SOLID DIE STOCK FOR GAS TUBES SCREWING AT ONCE OVER

THOMAS CHATWIN,

GT. TINDAL STREET, BIRMINGHAM,

MANUFACTURER OF

STOCKS, DIES, AND TAPS,

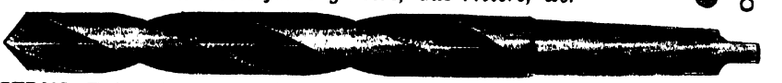
PATENT HAND-POWER SCREWING MACHINES. TWIST DRILLS,

STANDARD CYLINDRICAL GAUGES, RIMERS,

CLYBURN, BUDDING, AND OTHER SPANNERS,

RATCHET BRACES, TUBE CUTTERS, TUBE WRENCHES, TUBE VICES,

And General Tools for Engineers, Gas Fitters, &c. 4324



STRAIGHT LIP TWIST DRILL, WITH INCREASE TWIST AND GRINDING LINE.

FUEL ECONOMISER

GREEN'S PATENT

Has been awarded the GOLD MEDAL at the CALCUTTA EXHIBITION, in addition to TWELVE MEDALS previously given at other Exhibitions. 5091

ST. ANN'S SQUARE, MANCHESTER. **WORKS: WAKEFIELD**

BUTTERS BROS., Contractors' Engineers,

PERCY CRANE AND ENGINE WORKS, LAMBHILL STREET, PAISLEY ROAD,

MAKERS OF HENDERSON'S PATENT DERRICK CRANES, FROM 15 CWT. TO 30 TONS.

OFFICES:
93, HOPE STREET,
GLASGOW.

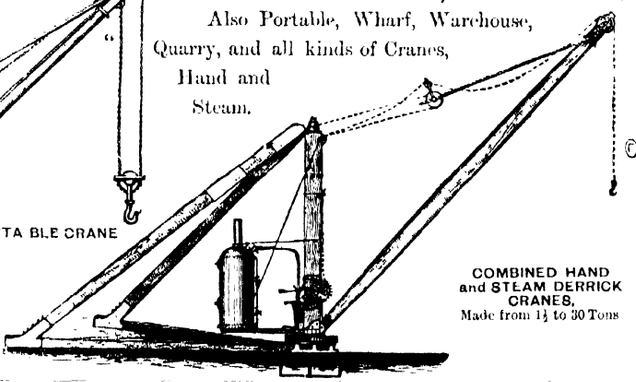
Also Portable, Wharf, Warehouse, Quarry, and all kinds of Cranes, Hand and Steam.

5005

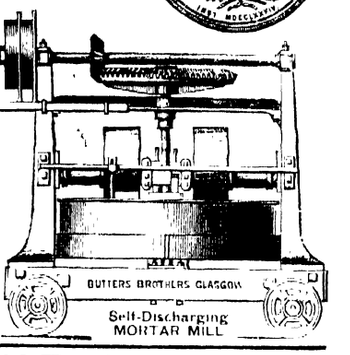
TESTIMONIALS ON APPLICATION.



Hand PORTA BLE CRANE



COMBINED HAND and STEAM DERRICK CRANES, Made from 1½ to 30 Tons



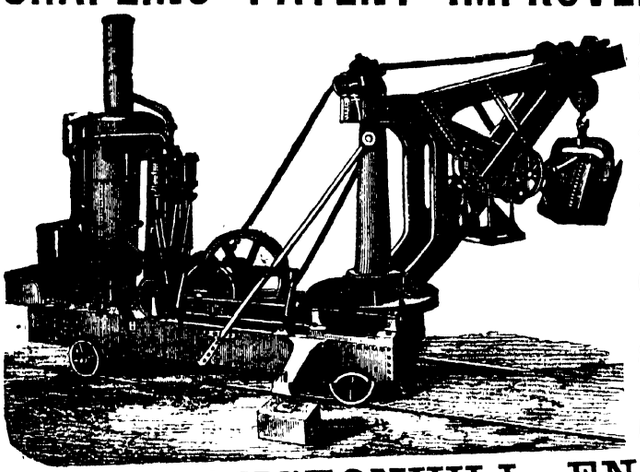
Self-Discharging MORTAR MILL

LIGHT FORGINGS.

BRAKE WORK.
WAGON IRONWORK.

GLASGOW HYDRAULIC FORGE CO., LIMITED, Sentinel Works, Polmadie, Glasgow, and Canal Road, King's Cross, London. 5403

CHAPLINS' PATENT IMPROVED STEAM EXCAVATOR OR "NAVVY."



The illustration shows our general arrangement, and the ordinary mode of working, of this valuable labour-saving Machine. Its improved construction and the adjustment of motive mechanism and gearing are similar to those of our well-known STEAM CRANES, and have been specially designed to render it much stronger and more durable, as well as more simple, easily managed, and efficient in its action, than those hitherto in use. Two men are sufficient to work it.

It is made exceptionally strong in all its parts, wrought-iron and steel being principally used in its construction; and we can confidently refer to a number we have made, now working in various parts of the country, Dock-making, Railway-making, and Excavating generally, with the greatest success.

Our usual size of Excavator, as here described and illustrated, is calculated to PERFORM THE WHOLE OPERATION OF DIGGING, SLEWING, AND EMPTYING INTO WAGONS IN ONE MINUTE, DOING THE WORK OF FROM 40 TO 60 MEN. The bucket can be of greater or lesser capacity, according to the nature of the material to be excavated; the usual size holding about one cubic yard.

ALWAYS IN STOCK OR IN PROGRESS A VARIETY OF OUR

Chaplins' Patent Steam Cranes, Hoists, Locomotives
PUMPING & WINDING ENGINES; and High-Pressure
Steam Yacht and Compound Marine Engines of all Classes.

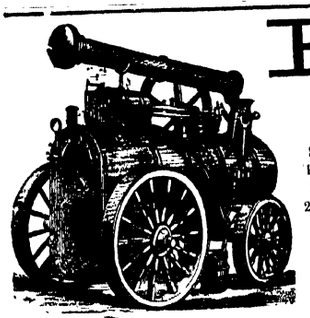
ALEXANDER CHAPLIN & CO., Patentees and Sole Manufacturers,

CRANSTONHILL ENGINE WORKS, GLASGOW,

AND

(SOLE LONDON HOUSE) 63, QUEEN VICTORIA STREET, LONDON, E.C. 2364

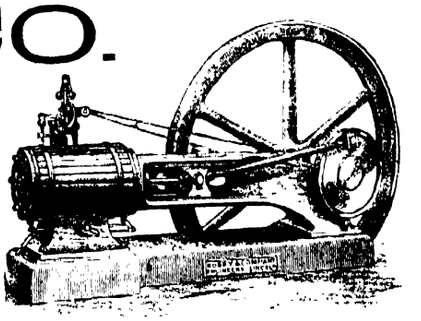
ROBEY & CO.



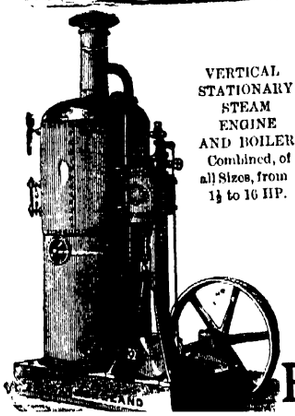
SUPERIOR PORTABLE ENGINES 2½ to 50 HP.

First PRIZE for PORTABLE ENGINES, Melbourne Exhibition, 1881.

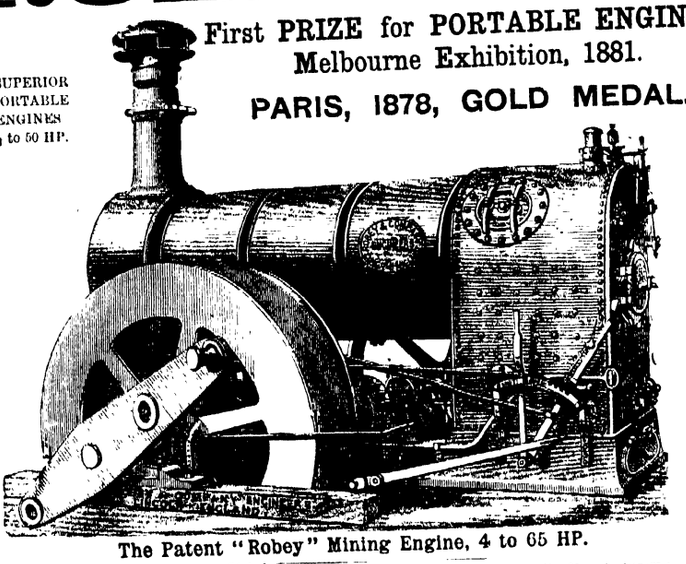
PARIS, 1878, GOLD MEDAL.



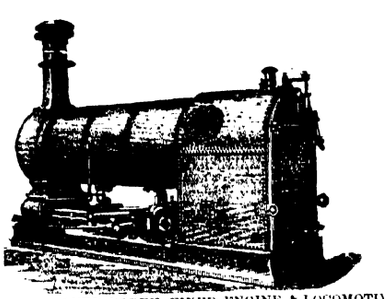
HORIZONTAL FIXED ENGINE, 4 to 60 HP.
☞ References can be given to upwards of 9,000 Engines now at work.



VERTICAL STATIONARY STEAM ENGINE AND BOILER Combined, of all Sizes, from 1½ to 16 HP.



The Patent "Robey" Mining Engine, 4 to 65 HP.



Prices and full Particulars of the Machinery here illustrated on application to the Manufacturers:

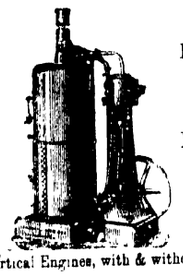
ROBEY & CO., Globe Works, LINCOLN, ENGLAND.

THE IMPROVED ROBEY FIXED ENGINE & LOCOMOTIVE BOILER Combined, 4 to 65 HP., and COMPOUND ROBEY SEMI-FIXED ENGINE. 4561

MARSHALL, SONS, & CO., LIMITED,

[TELEPHONE No. 664

BRITANNIA IRONWORKS, GAINSBOROUGH, AND MARSHALLS' BUILDINGS, 79, FARRINGDON ROAD, LONDON, E.



Vertical Engines, with & without Boilers

—:o:—

MORE THAN 12,350 ENGINES MADE AND SUPPLIED.

—:o:—

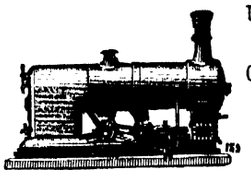


Portable and Semi-Portable Engines for all kinds of Fuel.

—:o:—

Calcutta Exhibition, 1884, AWARDED THE **GOLD MEDAL** FOR **SEMI-PORTABLE AND COMPOUND ENGINES.**

—:o:—

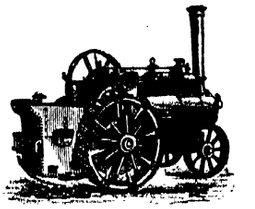


High-Pressure and Compound Engines, with and without Boilers.

—:o:—

UPWARDS OF 220 GOLD & SILVER MEDALS AWARDED.

—:o:—



Improved Traction Engines.

ENGINES SPECIALLY EQUIPPED FOR DRIVING ELECTRIC LIGHT MACHINERY.

CALCUTTA EXHIBITION, 1884.—Five Gold and Three Silver Medals.
AMSTERDAM EXHIBITION, 1883.—The Diploma of Honour.
ELECTRICAL EXHIBITION, Crystal Palace, 1882.—Gold Medal.
MELBOURNE EXHIBITION, 1881.—Highest Award for all Exhibits. Five Gol
SYDNEY EXHIBITION, 1880.—Two Special and Four First Prizes. [Medi
PARIS EXHIBITION, 1878.—Two Gold Medals and other Prizes.

CATALOGUES IN ENGLISH, FRENCH, GERMAN, SPANISH, POLISH, OR RUSSIAN, FREE ON APPLICATION.

"ENGELBERT'S

FOR CYLINDERS, VALVES, HEAVY BEARINGS, and SHAFTING.

Saves 40 per cent. over Tallow. Lasts twice as long as Olive Oil.

ENGELBERT & Co.,

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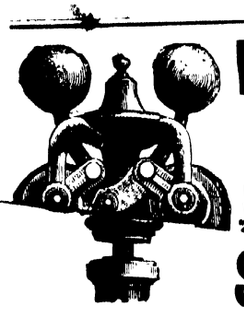
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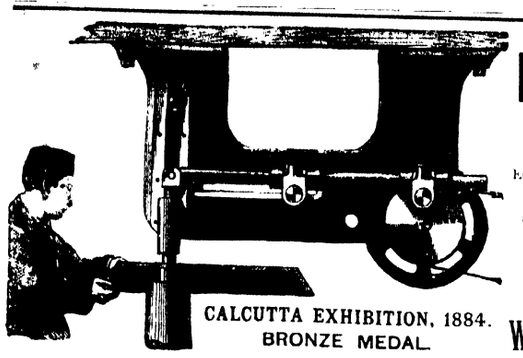
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